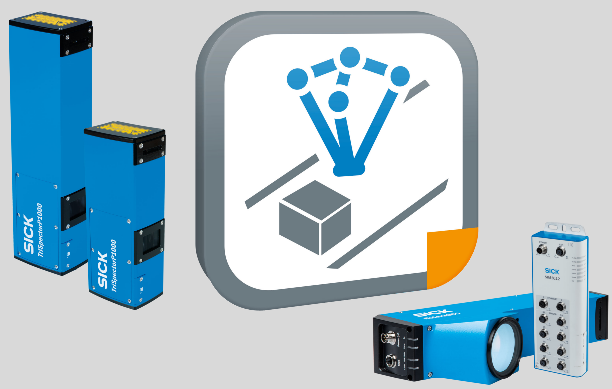
OPERATING INSTRUCTIONS

3D Belt Pick

SensorApps

SICK
Sensor Intelligence.



Described product

3D Belt Pick SensorApp (version 5.0)

Manufacturer

SICK AG
Erwin-Sick-Str. 1
79183 Waldkirch
Germany

Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Information on the operating instructions

These operating instructions provide important information on how to use devices 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 device applications

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

NOTE
Read these operating instructions carefully to familiarize yourself with the device and its functions before commencing any work.

The operating instructions are an integral part of the product. Store the instructions in the immediate vicinity of the device so they remain accessible to staff at all times. Should the device be passed on to a third party, these operating instructions should be handed over with it.

These operating instructions do not provide information on the handling and safe operation of the machine or system in which the device is integrated. Information on this can be found in the operating instructions for the machine or system.

1.2 Explanation of symbols

Warnings and important information in this document are labeled with symbols. Signal words introduce the instructions and indicate the extent of the hazard. To avoid accidents, damage, and personal injury, always comply with the instructions and act carefully.

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.

2 Safety information

2.1 Intended use

The 3D Belt Pick SensorApp is a software application specialized for locating products on a conveyor belt. The 3D Belt Pick SensorApp can be used on:

- TriSpectorP1030 programmable 3D camera
- TriSpectorP1060 programmable 3D camera
- Ruler3120 programmable 3D camera, together with SIM1012 or SIM2500

The camera uses laser triangulation to detect objects on the conveyor belt. The 3D Belt Pick SensorApp reports the location, height, and orientation of each detected object to a connected picking system.

SICK AG assumes no liability for losses or damage arising from the use of the product, either directly or indirectly. This applies in particular to use of the product that does not conform to its intended purpose and is not described in this documentation.

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.
- 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 the documentation must be strictly observed.
- Shut down the product immediately in case of damage.

2.3 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

2.3.1 Programmable product

For programmable products, the respective programmer is responsible for his/her programming performance and the resulting working principle of the product.

The liability and warranty of SICK AG is limited to the product specification (functionality and any programming interfaces) according to the agreed conditions.

Therefore, SICK AG is not liable, among other things, for damages that are caused by programming of the customer or third parties.

2.4 Modifications and conversions

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

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.

2.5 Cybersecurity

Overview

To protect against cybersecurity threats, it is necessary to continuously monitor and maintain a comprehensive cybersecurity concept. A suitable concept consists of organizational, technical, procedural, electronic, and physical levels of defense and considers suitable measures for different types of risks. The measures implemented in this product can only support protection against cybersecurity threats if the product is used as part of such a concept.

You will find further information at www.sick.com/psirt, e.g.:
- General information on cybersecurity
- Contact option for reporting vulnerabilities
- Information on known vulnerabilities (security advisories)

2.6 Requirements for skilled persons and operating personnel

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.

The following qualifications are required for various activities:

Table 1: Activities and technical requirements

Activities	Qualification
Mounting, maintenance	■ Basic practical technical training ■ Knowledge of the current safety regulations in the workplace
Electrical installation, device replacement	■ Practical electrical training ■ Knowledge of current electrical safety regulations ■ Knowledge of the operation and control of the devices in their particular application
Commissioning, configuration	■ Basic knowledge of the computer operating system used ■ Basic knowledge of the design and setup of the described connections and interfaces ■ Basic knowledge of data transmission

Activities	Qualification
Operation of the device for the particular application	▪ Knowledge of the operation and control of the devices in their particular application ▪ Knowledge of the software and hardware environment for the particular application

2.7 Operational safety and specific hazards

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

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.

CAUTION
Optical radiation: Class 2 Laser Product

The human eye is not at risk when briefly exposed to the radiation for up to 0.25 seconds. Exposure to the laser beam for longer periods of time may cause damage to the retina. The laser radiation is harmless to human skin.

- Do not look into the laser beam intentionally.
- Never point the laser beam at people's eyes.
- If it is not possible to avoid looking directly into the laser beam, e.g., during commissioning and maintenance work, suitable eye protection must be worn.
- Avoid laser beam reflections caused by reflective surfaces. Be particularly careful during mounting and alignment work.
- Do not open the housing. Opening the housing may increase the level of risk.
- Current national regulations regarding laser protection must be observed.

NOTICE

If the device itself is installed in a way that obscures the attached warning labels, additional, clearly visible labels must be attached. Additional signs are not included in the delivery.

3 Getting started

The purpose of this chapter is to quickly and easily connect the camera and capture initial 2D and 3D images.

NOTE
Before using the product in a production environment, the complete operating instructions must have been read and understood.

3.1 Mounting the device

The camera and the laser are fitted so that the laser illuminates the object from one direction and the camera views the object from another direction.

- Mount the device with respect to the defined field of view.
- The laser line must be vertical and perpendicular to the movement direction of the object.
- Make sure that the camera is properly cooled.

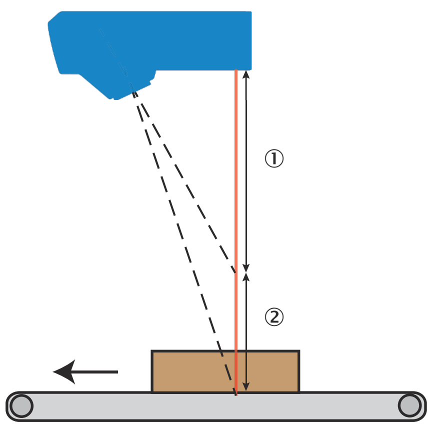


Figure 1: Mounting position

① Stand-off from device bottom (laser side)

② Measuring range

For detailed information about how to mount the camera, see "Mechanical installation", page 17.

NOTICE

- Never connect any signals while the camera is powered.
- Never connect a powered Power-I/O terminal or powered I/O signals to a camera.
- Never connect a powered encoder interface unit to a camera.
- Never connect signal levels that exceed the input specification to the encoder inputs.

3.2 Connecting the camera

Connect the camera according to the instructions in the camera's Operating Instructions, see "Further information", page 14.

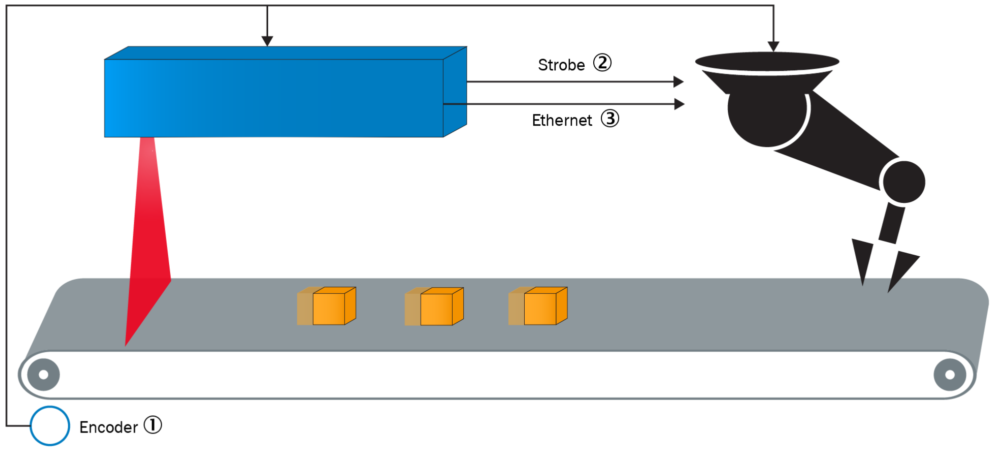


Figure 2: Standard electical installation, TriSpectorP1000

① Encoder
② Strobe
③ Ethernet

For further information about the electrical installation, see "Standard electrical installation", page 20.

3.3 Installing PC software

3D Belt Pick

The SICK AppManager software is required to install or upgrade the 3D Belt Pick SensorApp on the camera.
Download the latest version of SICK AppManager from www.sick.com/SICK_AppManager. To install SICK AppManager on the PC, open the installation (.exe) file and follow the instructions on the screen.

Stream Setup software

The **Steam Setup** software is used together with Ruler3000.

Download and install the latest version of the **3D Stream SDK** and the **Stream Setup Installer** from the SICK Support Portal, supportportal.sick.com/products/vision/3d-vision/ruler-series/ruler3000/.
For further information about the Stream Setup software and installation see the Ruler3000 operating instruction, see "Further information", page 14.

For further information about software installation, see "Software installation and upgrade", page 22.

3.4 Starting up the system

Detailed information about how to get started with the camera can be found in the camera's operating instruction, see "Further information", page 14.

3.4.1 Connecting the TriSpectorP1000

NOTE
Before starting SICK AppManager, make sure that the network communication settings are correctly set up:

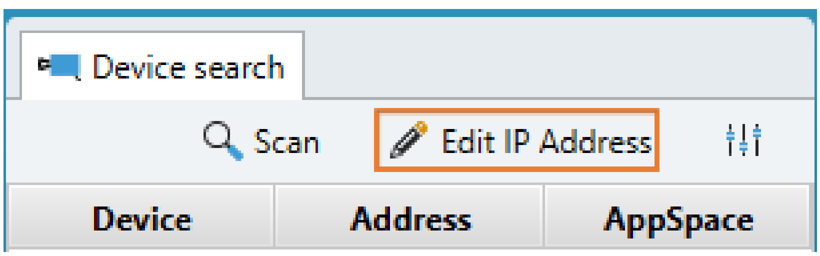
- The device must be connected to the PC via Ethernet.
- The PC must be on the same network as the device.
- The PC must not use the same IP address as the device. The device's default IP address is 192.168.0.1.

To access the device from SICK AppManager:
1. Open SICK AppManager.
2. On the **Device Search** tab, click **Scan** to search for and display all available devices on the network.
3. Click the device with port 2122.

Device information as well as active applications are now displayed on the **Device** tab (the lower left pane).

Setting the camera IP address

To change the camera's IP address in SICK AppManager, click **Edit IP Address** on the **Device search** tab. Enter the new IP address and netmask for the camera.

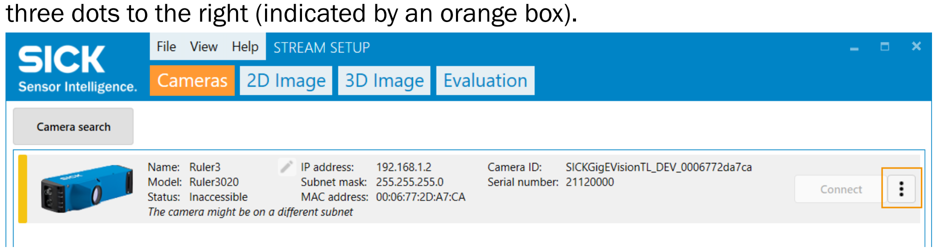


More information about the TriSpectorP1000 is available in the camera's operating instructions, see "Further information", page 14.

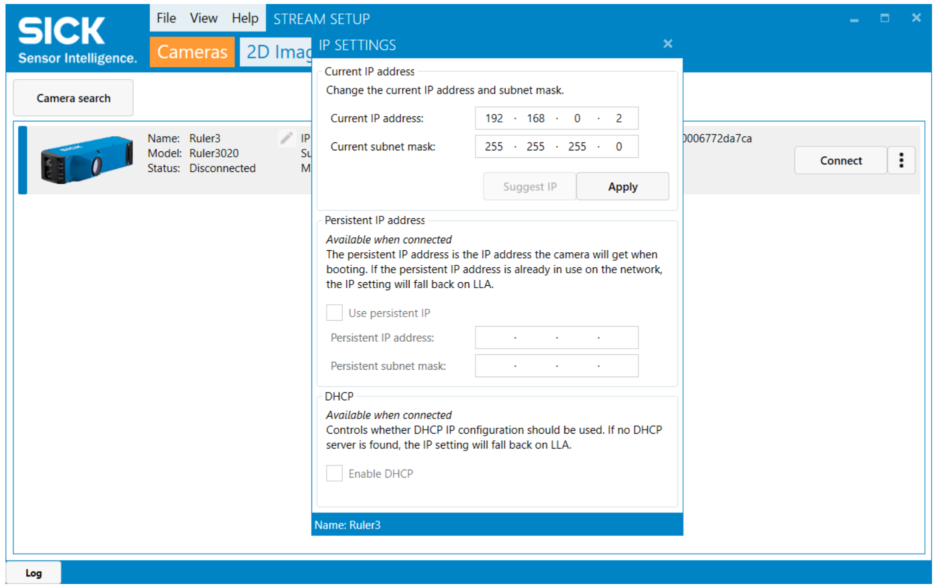
3.4.2 Connecting the Ruler3000

If the camera you want to connect to is not on the same subnet as port 2 on the SIM, you have to reconfigure the camera before you can connect to it.

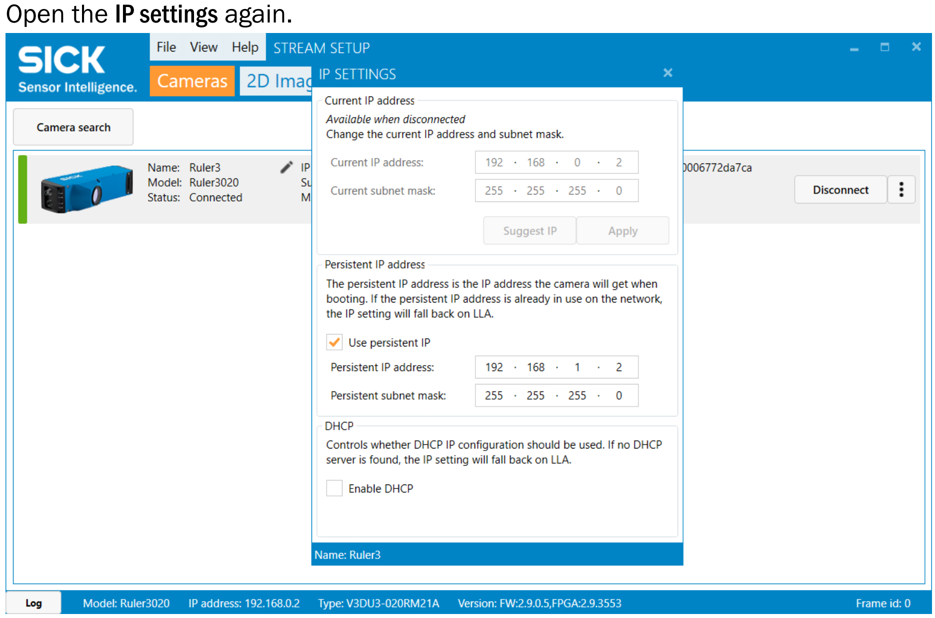
1. Connect to Ruler3000 using **Stream Setup** and change IP address by clicking the three dots to the right (indicated by an orange box).



2. Select **IP settings.**
3. Change the **Current IP address** to match the subnet of your PC and click **Apply.**



4. Click **Connect**.
5. Open the **IP settings** again.



6. Select the **Use persistent IP** checkbox and set the **Persistent IP address** to 192.168.1.2 and the **Persistent subnet mask** to 255.255.255.0.
7. Make sure the **Enable DHCP** is not selected.
8. Close the **IP settings** dialog.

More information about connecting the Ruler3000 using **Stream Setup** is available in the camera's operating instructions, see "Further information", page 14.

Changing the SIM IP address

The SIM IP address can be changed through SICK AppManager.

4 Product description

4.1 Overview

The 3D Belt Pick SensorApp is a stand-alone application ready for installation on the device with SICK AppManager. The web-based graphical user interface guides the user during the conveyor belt setup, alignment and configuration, and provides an operator interface during run-time.

The TriSpectorP1000 and the Ruler3000, in combination with the SIM, are programmable devices. The devices send picking positions to a picking system, when configured with the SICK 3D Belt Pick SensorApp.

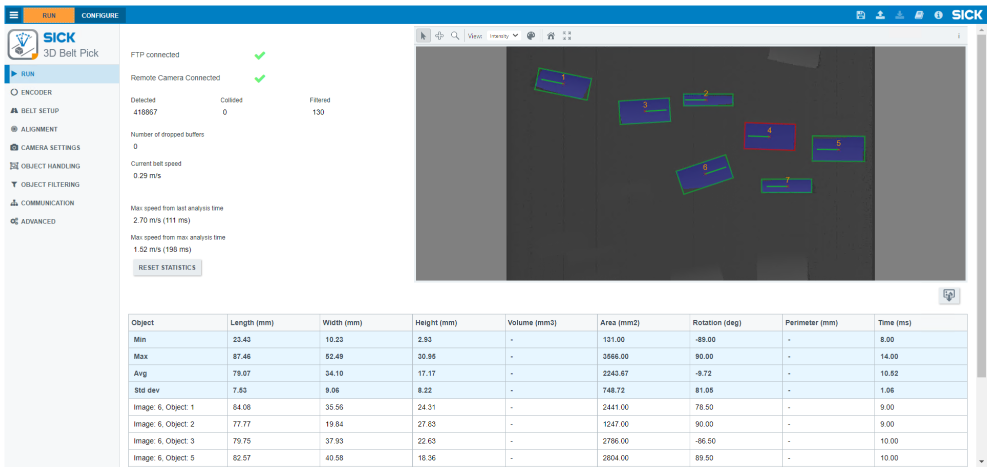


Figure 3: 3D Belt Pick overview

4.2 System requirements

- PC screen resolution: Monitor with a minimum width of 1280 pixels (1600 pixels or higher is recommended for best user experience).
- Web browser: Google Chrome, latest version. Browser support for WebGL and WebSockets is required.
- SICK AppManager, latest version see "Software installation and upgrade", page 22.

4.3 Further information

This operating instruction and software support the following models:

- TriSpectorP1030
- TriSpectorP1060
- Ruler3120 together with SIM1012 or SIM2500

TrispectorP1000

- Online product page: www.sick.com/TriSpectorP1000
- Operating instructions (part no 8022395): www.sick.com/8022395

Ruler3000

- Online product page: www.sick.com/Ruler3000
- Operating instructions (part no 8026049): www.sick.com/8026049

SIM (Sensor Integration Machine)

- Online product page: www.sick.com/SIM10xx
- Online product page: www.sick.com/SIM2x00

3D Belt Pick

Release notes:
- Included in 3D Belt Pick SensorApp, available via SICK AppManager.
- Available via supportportal.sick.com.

Video tutorial:
- Tutorial SICK 3D Belt Pick SensorApp (based on 3D Belt Pick version 3.0)

SICK Support Portal

All manufacturer-specific documents, containing information about interfaces, communication protocols and plug-ins, are available from the 3D Belt Pick page via SICK Support Portal.

- supportportal.sick.com/downloads/3d-belt-pick/

5 System installation

The belt picking system requires proper mechanical, electrical and software installation, which is described in this section.

5.1 Required items

All items listed are required to set up a working system. Some items are available at SICK, and some are picking system dependent and thereby available at the robot manufacturer. Some items are to be provided by the user.

5.1.1 SICK deliverables

The following devices support the use of the 3D Belt Pick SensorApp:

Camera	Product ID (Glass)	Product ID (PMMA)
TriSpectorP1030 S50 (Medium FoV)	1106177	1106180
TriSpectorP1060 S50 (Large FoV)	1106181	1106182
Ruler3120	1122973	Not available

Device	Product ID
SIM1012	1128736

NOTE
For the TriSpectorP1000 models listed above, the 3D Belt Pick SensorApp is pre-installed on the device. For other TriSpectorP1030 and TriSpectorP1060 models, it is possible to download and run the 3D Belt Pick SensorApp in Trial mode. For further information, see "Software installation and upgrade", page 22.

- SICK 3D Belt Pick SensorApp.
- Encoder. Ideally, use the same encoder for the picking system and the camera. The recommended minimum resolution is 5 to 10 pulses per mm, depending on the required profile distance resolution. Observe that the encoder input of the picking system may be limited in terms of max frequency. Refer to the picking system documentation for details.
- Encoder splitter. An incremental encoder splitter is required to split the encoder signal into different voltages and destinations in case the picking system uses a different encoder signal voltage.
- Printable alignment target, see "Printable alignment target", page 57.
- 3D Belt Pick accessory set. A hardware set including cables, an encoder terminal and a mounting bracket kit. For further details, see "Accessories", page 59.
- Other items delivered by SICK, such as mechanical mounting parts, encoders, and cables. For further information, see the respective product pages at www.sick.com.

Functional expandability

It is possible to add customized software features as plug-ins to the main SensorApp. For further information, contact SICK technical support.

5.1.2 Robot manufacturer deliverables

The picking system requires hardware and software to communicate over Ethernet TCP/IP or UDP and to process the received Ethernet packets. The exact configuration of the picking system depends on the model or brand, and is not covered in this manual. For manufacturer-specific references, see "Further information", page 14.

Generally, the following items are required:

- Encoder interface.
- Functions for conveyor tracking.
- Functions for object queue management.
- Support for an incoming digital 24V strobe signal.

5.2 Mechanical installation

Mount the camera according to the instructions in the Operating Instructions, see "Further information", page 14.

The distance between the camera and the picking zone is estimated based on the object properties and the belt speed, see "Positioning and orienting the camera", page 18. It is recommended to mount the camera in an adjustable fashion, to make it possible to do a test run before the permanent camera position is determined.

5.2.1 Determining the camera mounting height

The minimum and maximum distance at which the device can detect moving objects vary between the models. The figures show the maximum guaranteed field of view (FOV) for each model.

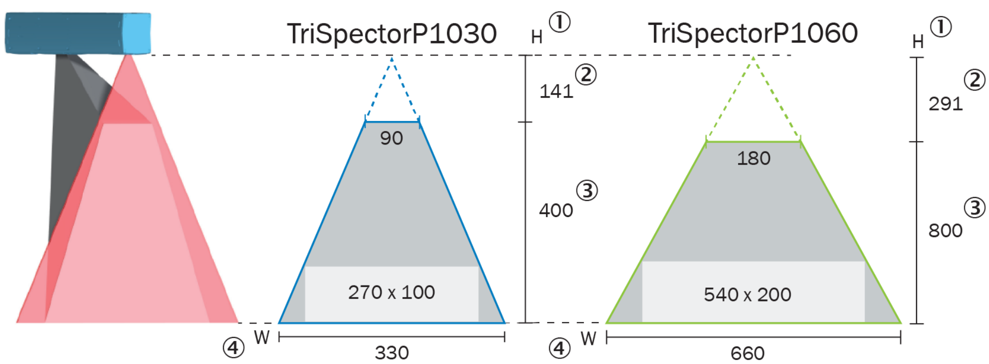


Figure 4: Guaranteed field of view for the TriSpectorP1000 models

① Maximum height range
② Stand-off
③ Measuring range
④ Width at maximum working distance

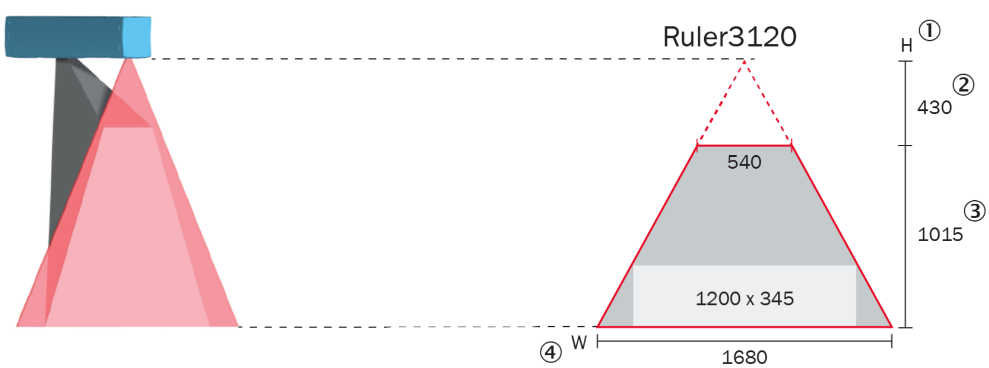


Figure 5: Guaranteed field of view for the Ruler3000 model

① Maximum height range
② Stand-off
③ Measuring range
④ Width at maximum working distance

NOTE
The FOV is shaped as a trapezoid. The width closest to the camera determines the usable FOV width.

Consider the following factors when mounting the camera:

- **Camera height**: The shortest distance from the camera to the conveyor belt.
- **Object height**: The maximum height of the objects to be picked.
- **FOV width**: The maximum width at which the camera can capture data. The FOV width increases with the distance to the camera.

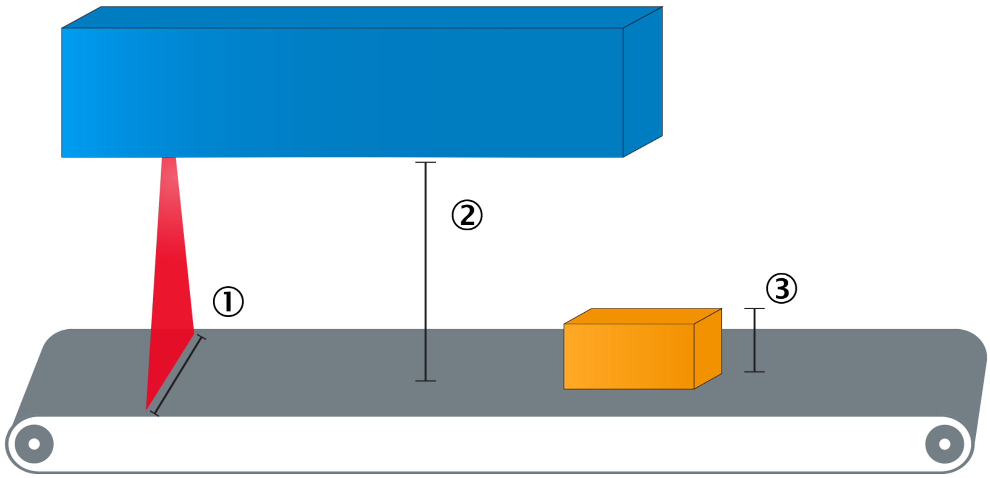


Figure 6: Estimating camera mounting height

① Field of view (FOV) width
② Camera height
③ Object height

Mount the camera so that the object height fits in the camera's FOV. Otherwise, objects will not be detected on the conveyor belt.

If running a TriSpectorP1000, use the formula to estimate the recommended camera height:

$$\text{Recommended camera height} = \text{Object height} + 1.6 \bullet \text{FOV width}$$

NOTE
The formula is an estimation. Due to manufacturing tolerances, the actual mounting height may differ. Always ensure room for adjustment in case this formula is used as input for designing the in-machine mounting system.

If running a Ruler3000, verify the recommended mounting height with the Operating instructions, see "Further information", page 14.

5.2.2 Positioning and orienting the camera

Mount the camera with a good angular alignment to the conveyor belt. Minimize the angular alignment parameters, see figure 7. For optimal performance: Roll and pitch should be less than ±1° and yaw should be less than ±1° relative to the movement direction of the conveyor belt.

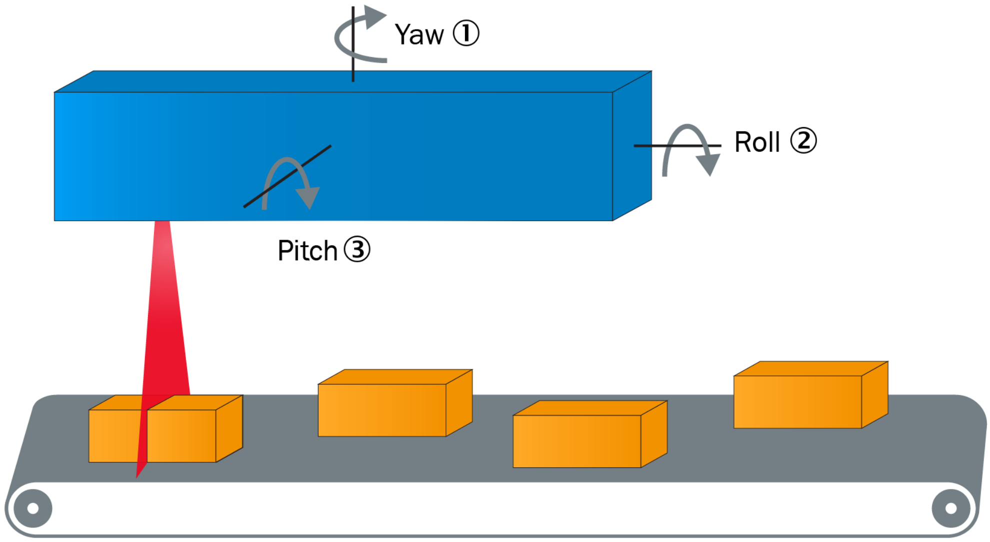


Figure 7: Angular alignment parameters

① Yaw

② Roll

③ Pitch

While the conveyor belt with the objects is moving, the camera continuously records images and processes them. The distance from the laser to the start of the robot's picking zone is called the Camera Lead Distance, CLD. The CLD must be equal to or longer than the total distance an object moves during the image acquisition and the processing of the recorded buffer.

The CLD is related to the **Buffer length** which, in turn, depends on the object size. The **Buffer length** is entered as a setting in the GUI, see "Buffer settings", page 34. As a first estimate of the **Buffer length**, use the formula:

Buffer length (mm) = 2 • Max projected object size (mm)

The Max projected object size is the longest projection of the largest object in the direction of motion.

The CLD is then estimated using the formula:

CLD (mm) = Buffer length (mm) + Conveyor belt speed (mm/s) • Image analysis time (s)

Use 200 ms as a first estimate of the image analysis time. The actual image analysis time varies depending on the object frequency, resolution, and additional processing settings, e.g. singulation, and must be determined by testing.

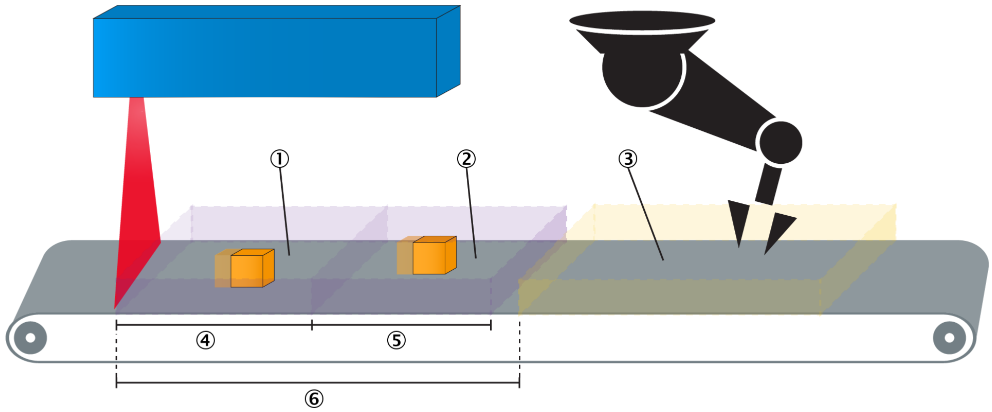


Figure 8: Calculating camera lead distance

① 3D profile buffer
② Processing
③ Robot work area
④ Buffer length
⑤ Processing time • Conveyor belt speed
⑥ Camera lead distance (CLD)

5.2.3 Ambient light shielding and reflex management

It is recommended to shield the camera installation with a tunnel-like structure to block unwanted stray light. The shielding and all structures that are hit by the laser light, such as the conveyor belt and the supporting structures next to the conveyor belt, should be designed so that disturbing reflexes are avoided:

- Select surface finishes that do not give reflexes.
- Adapt the geometries of these surfaces so that any possible reflexes are cast in a direction where they do not risk disturbing the measurements.

5.3 Standard electrical installation

Depending on the robot manufacturer, additional installation steps may be required. See the camera's Operating Instructions for signal levels, pin assignment and electrical details.

For additional installation information covering the Ruler3000 and SIM combination, supportportal.sick.com.

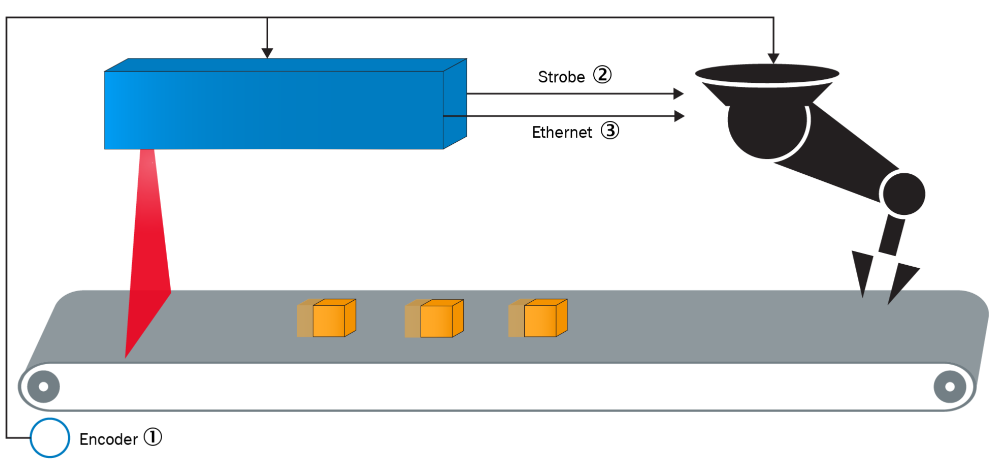


Figure 9: Standard electrical installation, TriSpectorP1000

① Encoder

② Strobe
③ Ethernet

The following connections are required:

1. Connect I/O_4 from the camera to Digital Input on the picking system. This signal is a 24 V digital signal referred to as a strobe signal.
2. Connect the encoder to the camera. Preferably, use the same encoder as used for belt tracking to reduce the points of failure. The encoder signal levels for the camera are TTL.

NOTE
If the picking system uses a different encoder signal voltage than the camera (TTL), use an encoder splitter to split the encoder signal to different voltages and destinations. For more information, see "SICK deliverables", page 16.

NOTE
If the Ruler3000 + SIM is not connected to the encoder correctly, the perceived direction of the conveyor belt can be compromised. Make sure the Ruler3000 and SIM both interpret the movement of the conveyor belt in the same direction.

3. Connect an Ethernet cable from the camera to a common dedicated network.

In addition to the above-mentioned signals, the following optional signals and indicators are available:

- **Run mode output. I/O_5** is a 24V output signal that is active (set high) when the camera is in **Run** mode and ready to detect objects. This signal can be used as an extra condition to run the conveyor belt or as an extra logic control signal in the picking system. The signal is deactivated when the system is in **Edit** mode or when there is an ongoing alignment.
- The **Remote LED** (on SIM), indicates if a remote camera is connected or not.
- The **State LED** (on TriSpectorP1000), **System ready LED** (on SIM), indicates if the sensor app is running:
  a) **Off**: The sensor app is not running.
  b) **On**: The sensor app is running.
- The **Result LED** indicates the operating mode:
  a) **Green, steady**: The device is in run mode.
  b) **Blue, steady**: The device is in configuration mode. Interaction with the device is needed.
  c) **Red, steady**. No valid configuration exits. Invalid setup, or other applications are active on the device. Interaction with the device is needed.
  d) **Off**: Playback mode.
- **Laser off input. I/O_1** can be used for temporarily switching off the laser, for example during maintenance

NOTE
For further information about manufacturer-specific electrical installation, see the 3D Belt Pick page via the SICK Support Portal: supportportal.sick.com/downloads/3d-belt-pick/.

5.4 Software installation and upgrade

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

- Installing or upgrading the 3D Belt Pick SensorApp on the camera.
- Reading and changing the TriSpectorP1000 or SIM IP address.
- Installing firmware updates.

NOTE
For the TriSpectorP1000 models listed in "SICK deliverables", page 16, the 3D Belt Pick SensorApp is factory installed on the camera.

Download the latest version of SICK AppManager from www.sick.com/SICK_AppManager. To install SICK AppManager on the PC, open the installation (.exe) file and follow the instructions on the screen.

5.4.1 Accessing the device from SICK AppManager

NOTE
Before starting SICK AppManager, make sure that the network communication settings are correctly set up:

- The device must be connected to the PC via Ethernet.
- The PC must be on the same network as the device.
- The PC must not use the same IP address as the device. The device's default IP address is 192.168.0.1.

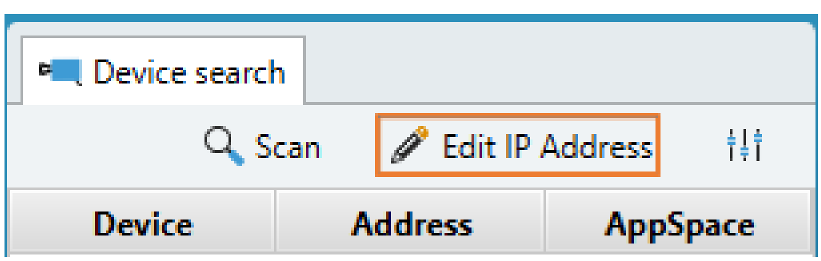
To access the device from SICK AppManager:

1. Open SICK AppManager.
2. On the **Device Search** tab, click **Scan** to search for and display all available devices on the network.
3. Click the device with port 2122.

Device information as well as active applications are now displayed on the **Device** tab (the lower left pane).

5.4.2 Setting the camera IP address

To change the camera's IP address in SICK AppManager, click **Edit IP Address** on the **Device search** tab. Enter the new IP address and netmask for the camera.



5.4.3 Installing or upgrading the 3D Belt Pick SensorApp

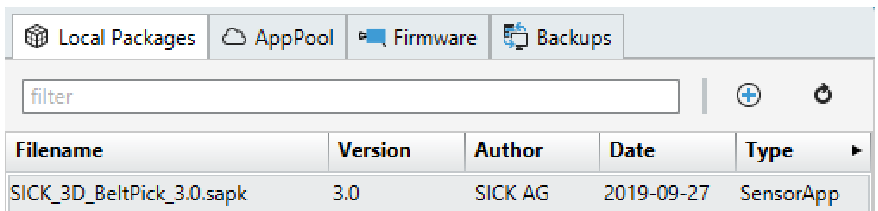
For installation or upgrade of the 3D Belt Pick SensorApp via SICK AppManager, follow the steps below.

NOTE
For TriSpectorP1030 and TriSpectorP1060 models which are not listed in "SICK deliverables", page 16, the 3D Belt Pick SensorApp can be installed and run in Trial mode, where a maximum of 2000 objects are reported.

1. Open SICK AppManager and connect to the camera, see "Accessing the device from SICK AppManager ", page 22.
2. If the **Device** tab (lower left pane) contains any pre-installed applications, including old versions of 3D Belt Pick, right-click the applications and delete them.
3. To download and install 3D Belt Pick directly from the 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 3D Belt Pick in the list of available SensorApps.
   d) Click **Download and install** to download 3D Belt Pick to the PC and install it on the camera

   Or:

   a) Click the **Local Packages** tab in SICK AppManager.
   b) Drag and drop the 3D Belt Pick .sapk file into the file list.

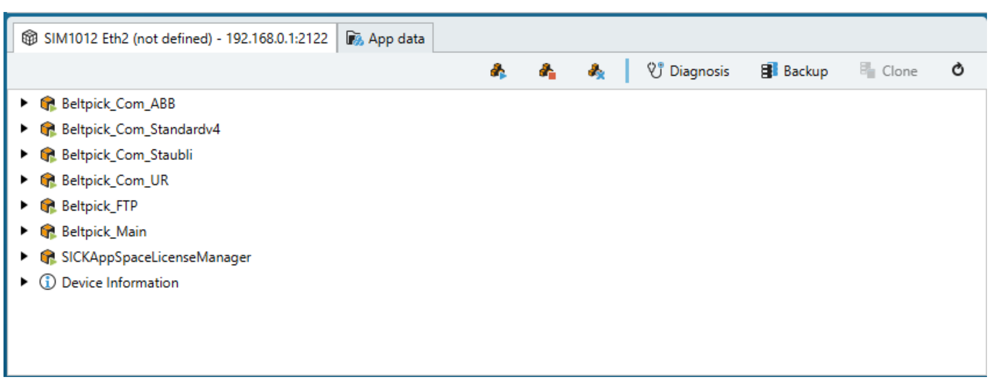


   c) Click **Install** to install 3D Belt Pick on the camera.

The 3D Belt Pick SensorApp is now installed and running on the camera. The 3D Belt Pick .sapk file contains the following apps:

- The **Beltpick_Main** app.
- Communication apps (denoted by "Com"), each representing a communication protocol.

All installed apps appear on the **Device** tab. A red lock indicates that the app is locked for editing.



5.4.4 Upgrading the device firmware

Check the device firmware version:

1. Double-click the **Device Information** icon in SICK AppManager.
2. Check that the firmware version installed on the device matches the firmware version required by the SICK 3D Belt Pick SensorApp. For details, see the 3D Belt Pick Release Notes (supportportal.sick.com/downloads/3d-belt-pick/).

If the firmware versions do not match, the recommended firmware version for the device can be downloaded from supportportal.sick.com.

Install the firmware on the device:

1. Drag and drop the downloaded file to the **Firmware** tab in SICK AppManager.
2. Click **Install**.

NOTE
After upgrading the SensorApp or the device firmware, reload the GUI in the web browser.

6 Configuration and operation

Configuring the 3D Belt Pick SensorApp:

1. Open the 3D Belt Pick GUI by entering the device’s IP address in a Google Chrome web browser. Make sure that the network communication settings are correctly set up, see "Software installation and upgrade", page 22.
2. Configure the encoder, see "Encoder", page 27.
3. Perform the belt setup configuration, see "Belt setup", page 29.
4. Perform an alignment to relate the camera’s internal coordinate system to the picking system’s coordinate system, see "Alignment", page 30.
5. Edit the image acquisition settings for the camera, see "Camera settings", page 32.
6. Edit the settings for how to define and handle objects on the belt, see "Object handling", page 35
7. If applicable, set further inspection criteria for the objects on the belt, see "Object filtering", page 39
8. The application is now ready to run!

The GUI contains tabs corresponding to the configuration steps listed above. The content of each tab is described below. If you are already familiar with the configuration and above-mentioned subpages, see "Laser configuration (TriSpectorP1000)", page 44, for a feasibility evaluation workflow description.

Edit mode and Run mode

For most tabs, there is an **Edit/Run** toggle at the top of the page. **Run** means that the system is running, and no parameter values can be edited. Set the toggle to **Edit** to stop **Run** mode and edit the parameter values. To save the edited parameter values to the camera’s flash memory, click **Save to Flash**.

6.1 Graphical User Interface (GUI)

6.1.1 Overview of the user interface

The graphical user interface is divided into different parts, with a navigation menu to the left, a toolbar at the top and the image viewer covering most of the interface.

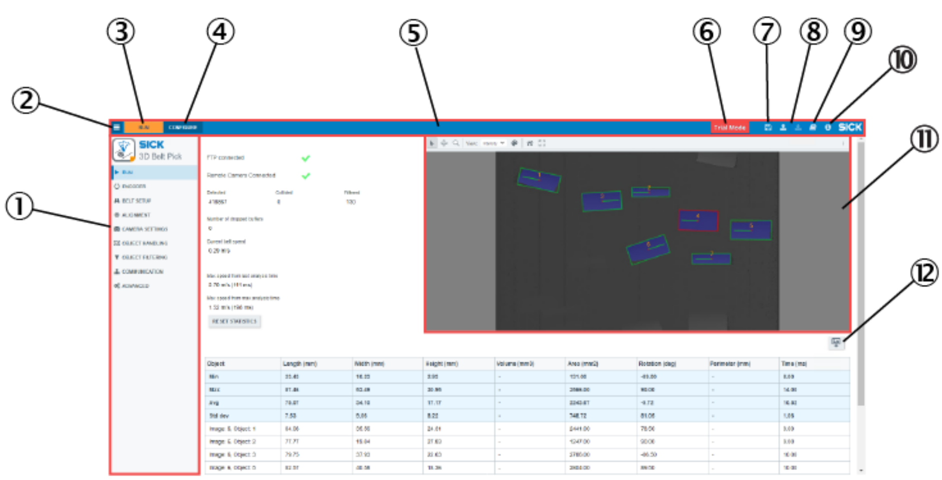


Figure 10: Graphical user interface overview

① Navigation pane

② Show/Hide navigation pane

③ Go to Run mode

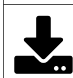
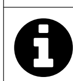
④ Go to Configure mode

⑤ Toolbar

⑥ Trial mode active. Indicates that the licensing terms are not met.
⑦ Save to flash
⑧ Export/Import configuration
⑨ Download Operating Instruction
⑩ Show About dialog
⑪ Image viewer
⑫ Save current image

6.1.2 Toolbar buttons

The toolbar buttons can be used throughout the software.

Button	Name	Function
	**Save to flash**	Saves the current settings and configuration on the device.
	**Export**	Exports the current configuration as a .json file to the configuration PC. A configuration file includes settings for the belt setup, alignment, object handling, object filtering and communication. To change a configuration, it is possible to edit the saved configuration file and then re-import it by using the **Import** button.
	**Import**	Imports a configuration from a previously saved configuration file. Select which settings to import: • **Import encoder, belt and alignment** – Import settings for encoder configuration, belt setup and alignment. • **Import camera and object** – Import camera settings, object handling settings and object filtering settings. • **Import communication** – Import settings for communication protocols.
	**Operating instruction**	Opens the operating instructions for 3D Belt Pick.
	**Information**	Opens the **About** dialog.

NOTE
If importing a configuration file saved in a version prior to version 5.0, the default configuration is used instead. A copy of the old configuration is saved to the `/public` folder as `Configuration_backup_vX.json`. X denotes the Belt Pick version used in the old configuration. The old configuration can be accessed in the public folder through **AppManager**. A warning is logged.

NOTE
A saved configuration is only valid for the major 3D Belt Pick version that was used for creating the configuration file.

For example: A configuration file that was created in 3D Belt Pick version 4.0 is valid for version 4.1, but not for version 3.0.

6.1.3 About dialog

The **About** dialog shows information about the current installation.

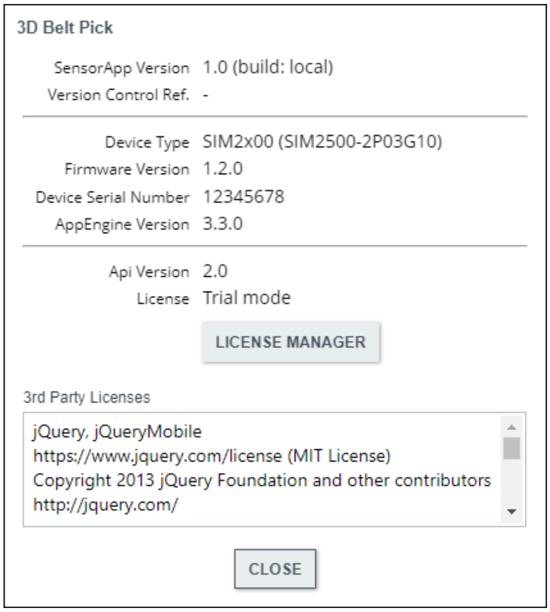


Figure 11: About dialog

6.2 Encoder

6.2.1 Encoder settings

Encoder direction

Three factors affect the encoder direction:

- The phase of the encoder.
- How the encoder is physically turned.
- How the camera is oriented relative to the conveyor belt.

To check that the encoder direction relative to the conveyor belt direction is correct, run the conveyor belt and note the value on the **Current encoder value (pulses)** counter. If the value does not increase when running the conveyor belt, change the **Encoder direction**.

NOTE
If the Ruler3000 + SIM is not connected to the encoder correctly, the perceived direction of the conveyor belt can be compromised. Make sure the Ruler3000 and SIM both interpret the movement of the conveyor belt in the same direction.

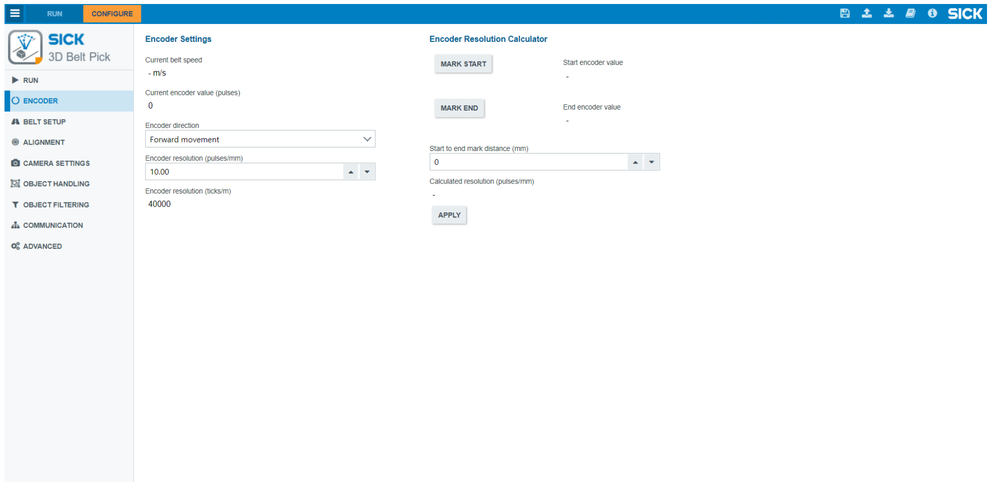


Figure 12: 3D Belt Pick encoder settings

Encoder resolution

The encoder resolution (pulses/mm) can be set directly, calculated manually, or calculated using the **Encoder Resolution Calculator**, see "Encoder resolution calculator", page 28.

Use the following formula to calculate the encoder resolution manually:

Encoder resolution (pulses/mm) = (End encoder value - Start encoder value) / Distance (mm)

A pulse is defined as the entire time cycle from the positive edge on the A channel to the next positive edge on the A channel.

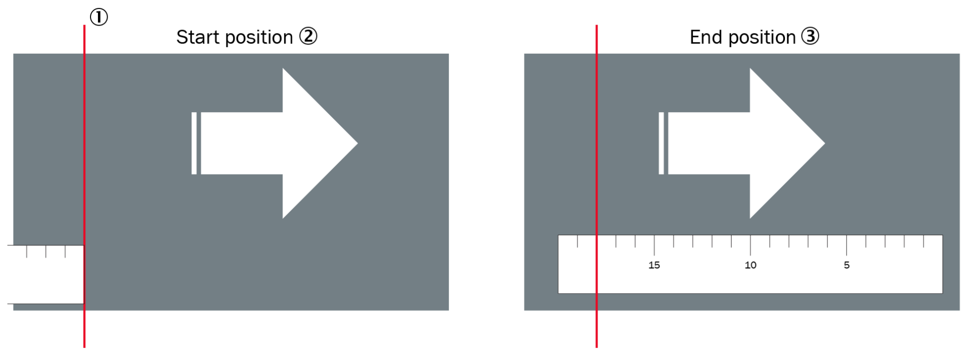
NOTE
Some picking systems define the encoder scale in ticks. One pulse equals four encoder ticks.

6.2.2 Encoder resolution calculator

Use the **Encoder Resolution Calculator** to calculate the encoder resolution for the current setup. The calculated resolution can be applied directly to the Encoder settings section.

Calculating the encoder resolution:

1. Stop the conveyor belt.
2. Place a ruler or other measuring equipment on the conveyor belt, see figure 13, page 29.
3. Note the ruler value under the laser line.
4. Click **Mark start**.
5. Run the conveyor belt for as long as possible but still practical for measurement.
6. Stop the conveyor belt.
7. Note the ruler value under the laser line.
8. Click **Mark end**. The start and end encoder values are displayed in the GUI.
9. Calculate the distance between the start and end positions based on the ruler values. Enter the value in the **Start to end mark distance (mm)** textbox.
10. The calculated encoder resolution is displayed as the **Calculated resolution (pulses/mm)** in the GUI. Click **Apply** to apply the calculated encoder resolution to the **Encoder settings** section in the GUI
11. Click **Save to flash**, located in the toolbar.



$$\begin{array}{r} \textit{Encoder start} = 40002 \\ \textit{Encoder end} = 41082 \\ \textit{End distance} = 180\ mm \end{array} = \frac{41082 - 40002}{180} = 6\ \textit{pulses/mm}$$

Figure 13: Calculating encoder resolution

① Laser line

② Start position

③ End position

6.3 Belt setup

A **Belt setup** is required before the first use or when the camera or conveyor belt position has changed. The **Belt setup** includes making the camera aware of the conveyor belt width, standoff and the orientation of the camera.

6.3.1 Field of view setup

When the **Belt setup** page is in **Configure** mode, an image is displayed in the image viewer. This image consists of continuous height profiles, each showing the conveyor belt under the laser line. For information about height profiles, see the operating instructions for the device.

NOTE

Put objects with contrasting colors to clearly distinguish the conveyor belt edges from the background during the FOV setup. Use bright objects on a dark conveyor belt, close to the conveyor belt edges under the laser line. Use flat objects, to ensure that the camera height measurement is not affected.

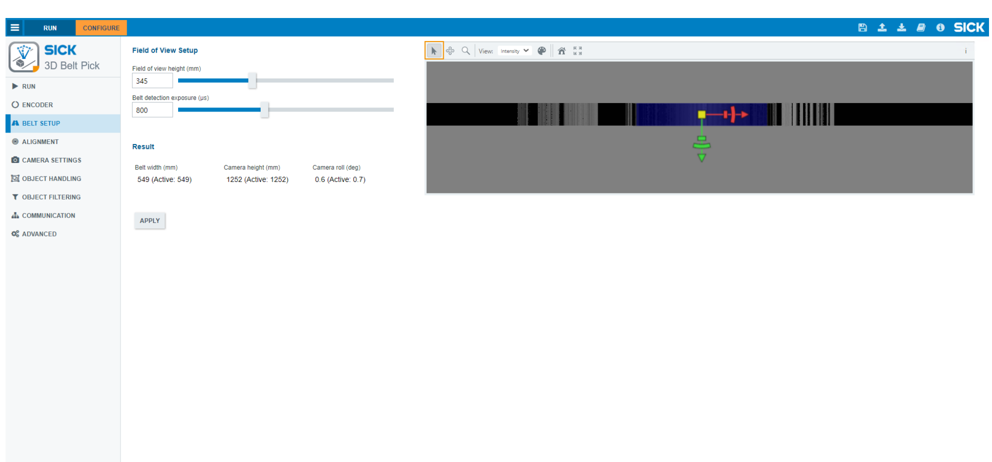


Figure 14: Setting up field of view

Setting up the field of view:

- Use the **Field of view height** slider to set the height of the FOV for the image acquisition. Objects that are taller than the set FOV height will not appear in the image.
- Use the **Belt detection exposure** slider to set the exposure time to get a better view of the conveyor belt edges. The **Belt detection exposure** is only used during the conveyor belt setup and is separate from the Exposure setting under the Camera Settings tab.
- Use the **Select** tool (indicated by an orange box in figure 14) to adjust the blue region so that it displays the region where the conveyor belt is. The camera will automatically measure the camera height within this region.

The measured and the applied values for conveyor belt width, camera height, and camera roll are displayed below the image.

- To use the measured values for the conveyor belt setup, click **Apply**.
- To save the measured values permanently, click **Save to flash**.

CAUTION
Before saving the result, check the camera setup to confirm that the estimated result values are reasonable. Otherwise, the picking system may damage itself and the conveyor belt.

NOTE
The warning message "**Field of View is outside Guaranteed Field of View! Consider adjusting belt region, camera distance or item height.**" may appear when setting the conveyor belt width or the FOV height.

When this message appears, the camera has detected that the current conveyor belt width and FOV height settings are outside the guaranteed FOV for the current mounting height. There are two possible consequences:

- The guaranteed field of view denotes the boundaries for the settings that can be ported between different cameras, taking manufacturing tolerances into account. The application may run with these settings, but if the camera is replaced by another of the same type, the settings may not be possible to reproduce.
- The processing time may increase.

6.4 Alignment

The purpose of the alignment is to align the camera's internal coordinate system with the work frame of the picking system. After the alignment, the camera is able to output data in a coordinate system that is known to the picking system. The alignment target is a printable target, see "Printable alignment target", page 57.

The alignment procedure is done from the **Alignment** tab. The **Alignment target exposure** setting is only used during alignment and is separate from the **Exposure** setting under the **Camera settings** tab.

The alignment procedure is a combination of two steps:

- Scanning the alignment target with the camera.
- Alignment of the picking system, sometimes called base-frame calibration.

6.4.1 Alignment procedure

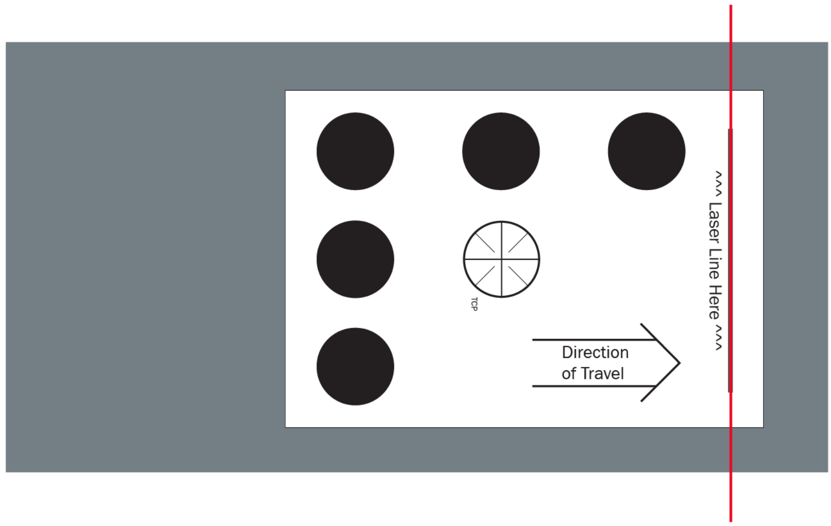
NOTE
No data or trigger signal is sent to the picking system during the alignment. Activation of the picking system's alignment function must be done manually before starting the alignment procedure.

Make sure that all electrical connections are set up and that all settings on the **Belt setup** tab are correct before starting the alignment.

Follow the steps to do the alignment. For the alignment of the picking system (step 6), refer to the procedure specified by the robot manufacturer.

Aligning the system:

1. Place the alignment target on the conveyor belt. Make sure that the laser line is between the two lines on the paper. Make sure that the paper is fixed to the conveyor belt.



2. Measure the diameter of the black circles and enter it in the GUI. (See the orange rectangle in figure 15.)
3. Click **Start alignment** to start the alignment procedure.
4. Run the conveyor belt to capture the image of the target. The entire alignment target has to pass the laser line before the image is fully acquired.
5. Check that all the black circles on the alignment target are detected in the acquired image. If not, adjust the **Alignment target exposure** setting and start over from step 3.
6. To align the camera with the picking system, continue to run the conveyor belt until the alignment target is in the picking zone. Continue the alignment in accordance with the procedure specified by the robot manufacturer.
7. Click **Save to flash** to save the configuration permanently to the camera's flash memory. When the alignment is saved, the system automatically returns to **Run** mode.

NOTE
The alignment target must not be moved by any other means than the running conveyor belt during the alignment procedure.

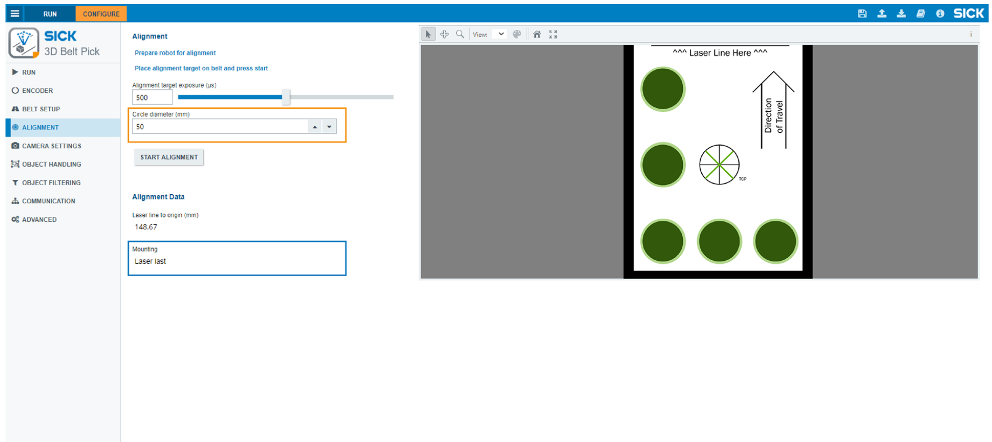


Figure 15: Alignment tab

NOTE

The camera can be mounted in two different ways: **Laser last** (see the blue box in figure 15) or **Laser first**. Depending on the choice, the view may be mirrored, but it will not affect any data or coordinates.

Troubleshooting

If the alignment does not succeed, make sure that:

- The acquired image containing the alignment target has a good contrast to be able to detect all the black circles. If not, adjust the **Alignment target exposure** on the **Alignment** tab. Start with a low value and increase it until all circles are visible and can be detected.
- The placement of the paper is according to the specification.
- The paper has not been folded.
- The circle diameter is entered correctly.
- The full width of the paper is within the edges of the conveyor belt.

If the image is black when using a Ruler3000, make sure to use a correct calibration file.

- Import a custom calibration file, see "Custom camera calibration (Ruler3000)", page 45.

6.5 Camera settings

6.5.1 Image settings

The **Exposure**, **Laser threshold**, and **Peak selection mode** are related and must all be tuned to acquire good height profiles.

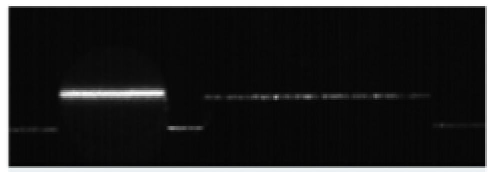
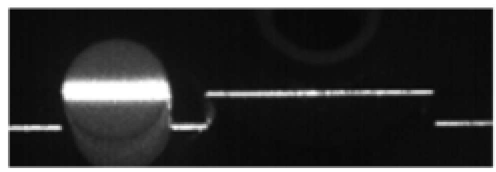
6.5.1.1 Setting exposure time

To tune the **Exposure** time, select the darkest, brightest, and shiniest objects from the available range of objects and place them under the laser line. Look at the sensor image that is displayed, and adjust the **Exposure** setting so that each object's profile is visible in the laser line. Setting the exposure too high can cause reflections that disturbs the object detection.

Finding the ideal exposure is a matter of finding the best compromise:

- If the laser line appears wide, the image is likely overexposed. Try to reduce the **Exposure** time.
- If the laser line is partly invisible, the image is likely underexposed. Try to increase the **Exposure** time.

Table 2: Examples of exposure

Underexposed sensor image	
Correctly exposed sensor image	
Overexposed sensor image	

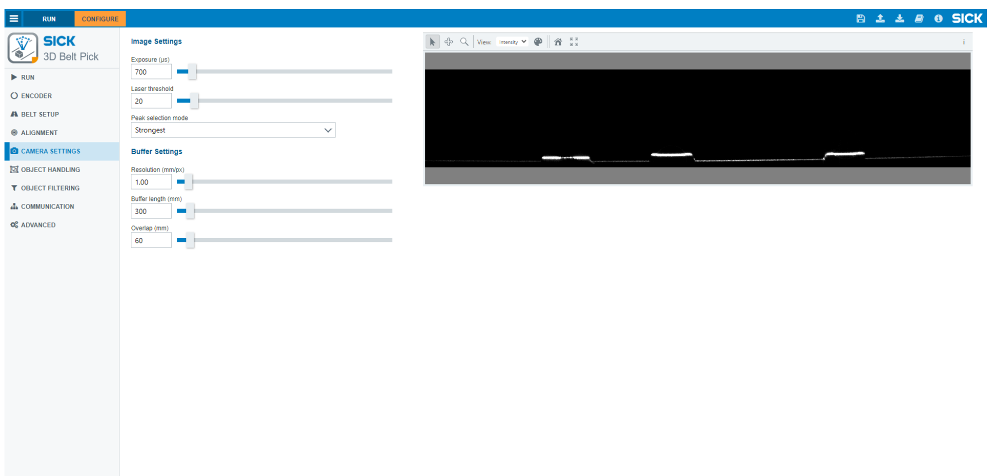


Figure 16: Camera settings tab

NOTE
If it is not possible to find an exposure level that fits all objects, try to find the best compromise.

6.5.1.2 Adjusting laser threshold and peak selection

The **Laser threshold** is the minimum intensity value a pixel must have to be interpreted as the laser line. Set the **Laser threshold** high enough to reliably detect height profiles, but low enough to neglect stray light and reflections.

The laser **Peak selection mode** allows better handling of reflexes. It is also very useful when working with objects with transparent surfaces, see figure 17, page 34 for details.

- **Strongest** locates the point with the highest intensity.
- **Top most** and **Bottom most** locate the highest or lowest point where the intensity is higher than the value set by the **Laser threshold**.

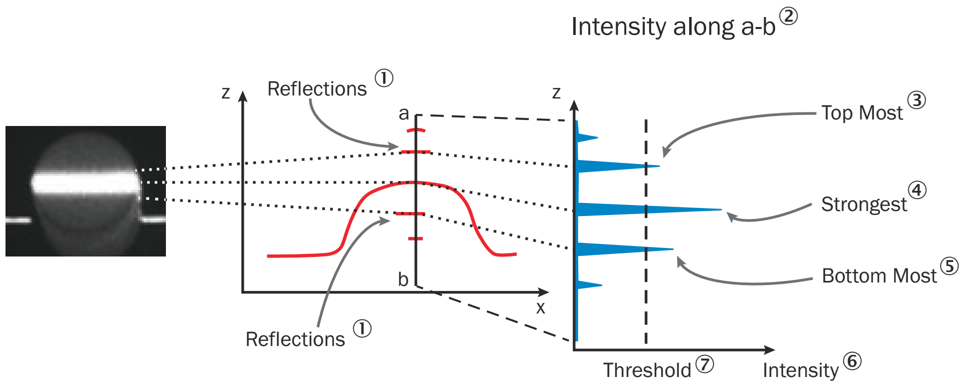


Figure 17: Finding the peaks

①	Reflections
②	Intensity along a-b
③	Top Most
④	Strongest
⑤	Bottom Most
⑥	Intensity
⑦	Threshold

6.5.2 Buffer settings

While the conveyor belt is moving, the device continuously acquires height profiles. To process the data stream, the device divides the data stream into image buffers. Each buffer consisting of a number of profiles. The end of the current buffer is saved and copied into the next buffer, to guarantee that no objects near the end of a buffer are split into different images and missed. This part is referred to as an overlap. Due to the overlap, the processed image is longer than the acquired image:

Processed image = acquired image + overlap

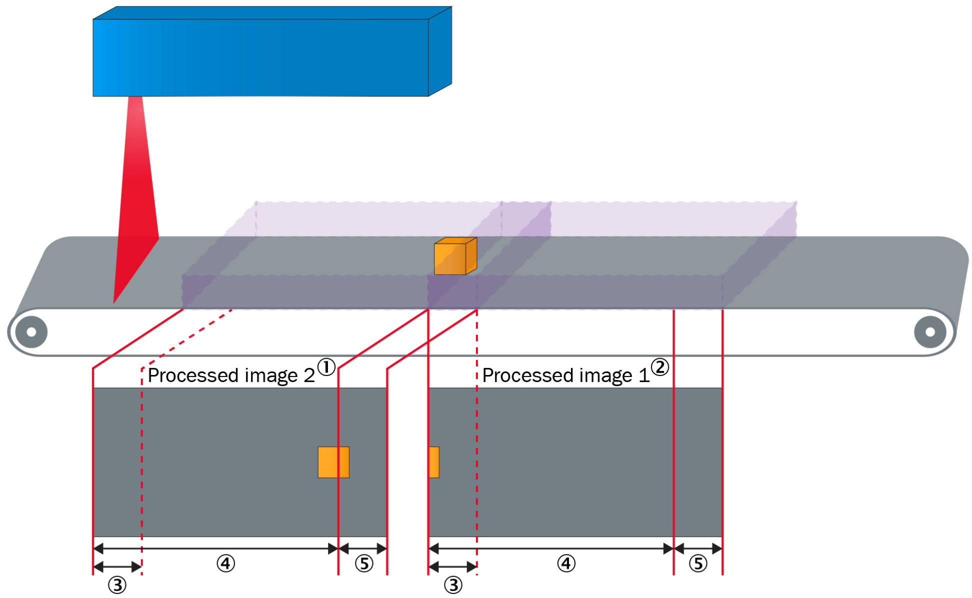


Figure 18: Image buffers and overlaps

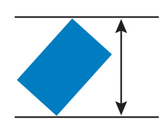
① Second processed image
② First processed image
③ Saved for next buffer
④ Buffer length
⑤ Overlap

To adapt the buffer acquisition to the object of interest, tune the following parameters:

Resolution The **Resolution** sets the resolution for the obtained 3D images, in mm/px. The resolution across the belt is equal to the resolution along the belt. A fine resolution increases the positioning accuracy while a coarse resolution decreases the processing time.

Buffer length The **Buffer length** sets the length of the scanned buffers. The camera reports all objects in one buffer to the picking system and the strobe signal provides a time reference to the picking system. The **Buffer length** should be set as long as possible but with respect to the limitations given by the **CLD** (Camera Lead Distance).

Overlap The **Overlap** must be long enough to cover the longest projection of the largest object to be handled plus a margin of 10-20%. This will ensure that e.g. a rectangular object fits into one processed buffer even if it is oriented along the diagonal. Setting it larger than needed will waste processing time since data will be processed twice.



6.6 Object handling

The **Object handling** tab contains settings for how to define and handle objects on the conveyor belt.

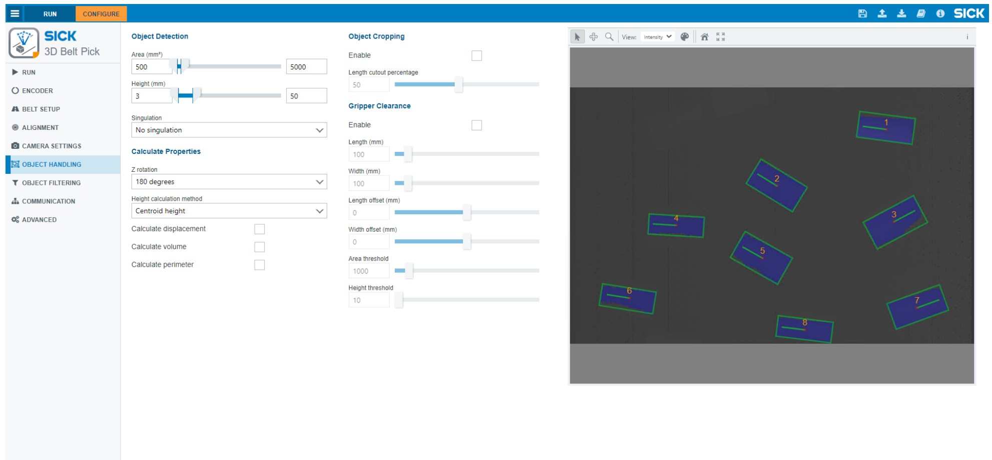


Figure 19: Object handling tab

6.6.1 Object detection

The **Object Detection** parameters define the size for a valid object. Only objects within the specified area range and height range are reported.

- The **Area** slider limits the minimum and maximum area for objects to be reported.
- The **Height** slider limits the minimum and maximum height for objects to be reported. Set a narrow height range to improve the performance and filter out unwanted noise.

The **Area** and **Height** settings define the size of a valid object. Objects outside the set area and height range appear in the image but are not processed or reported as valid objects.

Singulation

If nearby objects on the conveyor belt are densely clustered and in contact with each other, the cluster is normally detected as one large object. If the combined area or height is larger than the set **Area** or **Height** limit, the cluster is ignored. If both the area and the height are within the set limits, the position coordinates for the combined cluster are reported, likely resulting in a mis-pick.

Singulation is an optional image-processing step, which intends to separate such clustered objects into single objects. Note that there is no absolute guarantee that the singulation is successful. The success probability depends on the size and nature of the areas in which the objects are in contact with each other. The smaller the contact area, the higher the probability for success.

The singulation function works better if the specified **Area** range is as narrow as possible.

Setting a suitable Area range:

1. Select a **Singulation** method.
2. Position a few objects on the conveyor belt. The objects must not touch each other.
3. Do a test run, see "Object filtering", page 39. The estimated area for each object appears in the image viewer.
4. Set the minimum and maximum **Area** as close to the actual sizes of the objects as possible.

Select **Singulation** method depending on the object type:

- **Erosion based:** The singulation process is based on a binary operation called erosion. This mode works best for box-, pouch-, or pillow-shaped objects with small overlaps.
- **Edge detection based:** The singulation process is based on edge filtering. This mode works best for objects with rounded upper surface, such as (semi-) spherical or cylindrically shaped objects.

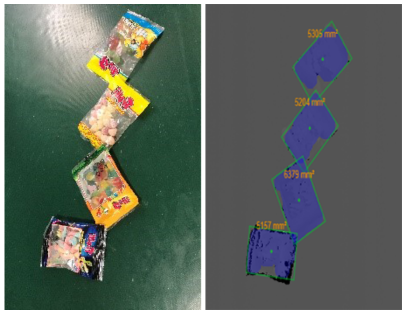


Figure 20: Erosion based singulation

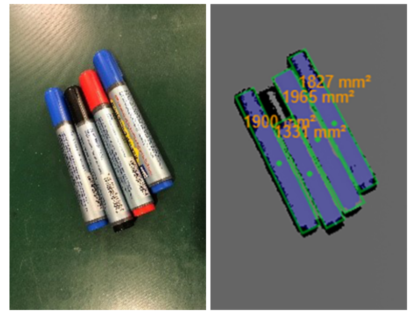


Figure 21: Edge detection based singulation

For **Edge detection based** singulation, adjust the **Edge based singulation threshold** by experimenting until the singulation works well. A low threshold makes the edge detection sensitive, which means that small edges are more likely found. A low threshold also increases the risk of detecting false objects, due to, e.g., reflexes or small height variations on the conveyor belt. A high threshold setting is less sensitive to noise but may not be able to detect all objects.

6.6.2 Calculate properties

The **Calculate Properties** parameters are related to the rotation, shape, and symmetry of the objects on the conveyor belt.

- The **Z rotation** defines if the rotation-angle should be measured from -90° to +90° (180° range) or from -180° to +180° (360° range). A 360° range requires that the object have a shape that allows the system to detect such orientation, see "Z rotation", page 50. It is also possible to set **No Z rotation**, where the reported angle is always set to 0°. In **No Z rotation** mode, the speed of the image processing is increased, which is useful for applications with tight timing margins.
- The **Height calculation method** selects which algorithm to use for calculating the object height. The selection depends on the gripper design and objects shape. For available options and exceptions, see table 3, page 37. By default, the X and Y values are reported as the center of gravity, see "Pick point", page 49.
- Select the **Calculate displacement** checkbox to calculate the displacement for asymmetric objects and send it to the picking system, see "Displacement", page 51. This option is only relevant when **Z rotation** is set to 180°or 360°.
- Select the **Calculate volume** checkbox to calculate the object volume. When the checkbox is selected, the calculated volume is sent to the picking system and included in the **Run** statistics, see "Run statistics", page 43.
- Select the **Calculate perimeter** checkbox to calculate the object perimeter. When the checkbox is selected, the calculated perimeter is sent to the picking system and included in the **Run** statistics, see "Run statistics", page 43.

Table 3: Height calculation methods

Method	Reported height value	Use case
No height	Not measured. Reported as 0.	For reducing image-processing time when height is not relevant to the application.

Method	Reported height value	Use case
Centroid height	Measures the object height above the conveyor belt at the object centroid[1].	For picking tasks where the pick point has to be in the center of mass, to reduce risk of dropping because of forces on the vacuum gripper.
Bounding box center	Measures the object height above the conveyor belt at the bounding box center[1].	For picking tasks where the pick point needs to be defined based on the bounding box center, length, and width.
Robust max	Measures all height values, removes false peaks, and reports the highest value.	For optically challenging objects with highly varying color and rough upper surfaces. The reported height is not related to the centroid or the bounding box center position, meaning that it is not recommended with a vacuum gripper.
Fit plane	Fits a plane to the object and measures the height in the centroids position.	For flat top objects where the data is very noisy.
Soft object	Calculates the mean value of the object's average height and the max height derived using **Robust max**.	For soft objects, such as inflated plastic bags, where the picking height is preferred a bit lower than the top of the bag.
Highest point	Measures the object height at the object's highest point. The X and Y locations are reported in this point.	For objects with large height variations.

1 The height in the bounding box center or centroid point is calculated based on height values from a small region, to reduce noise sensitivity.

6.6.3 Object cropping

The **Object Cropping** section contains settings for handling objects with irregular, longitudinal shapes. For such objects, it is possible to use only the center part of the object as basis for the pick point and orientation calculations.

- Select the **Enable** checkbox to enable object cropping.
- The object is cropped along the longest side of the surrounding bounding box. The **Length cutout percentage** slider sets the length of the cutout region.

The image viewer displays the most recently acquired image. When **Object Cropping** is enabled, the currently set cutout region is displayed for each found object in the image.

6.6.4 Gripper clearance

The **Gripper Clearance** section allows the user to set a rectangular clearance zone around each object. The object is only picked if there are no neighboring objects in the clearance zone. The aim is to ensure that the gripper does not collide with other objects during the picking.

Select the **Enable** checkbox to create a clearance zone around each object. The following parameters define each clearance zone:

- The **Length** and **Width** parameters set the size of the clearance zone.
- The **Length offset** and **Width offset** parameters move the clearance zone's center point. If the offset is zero in both directions, the center of the clearance zone is in the object's pick point, see "Pick point", page 49.
- The **Area threshold** and **Height threshold** parameters set the area and height limits for neighboring objects that are in the clearance zone but not likely to cause a collision. Neighboring objects that are below the set limits are ignored.

The image viewer displays the most recently acquired image. When **Gripper Clearance** is enabled, the currently set clearance zone is displayed around each found object.

6.7 Object filtering

The **Object filtering** tab lets the user set a minimum and maximum value for each measured object parameter and use these parameter values as criteria for which objects to report.

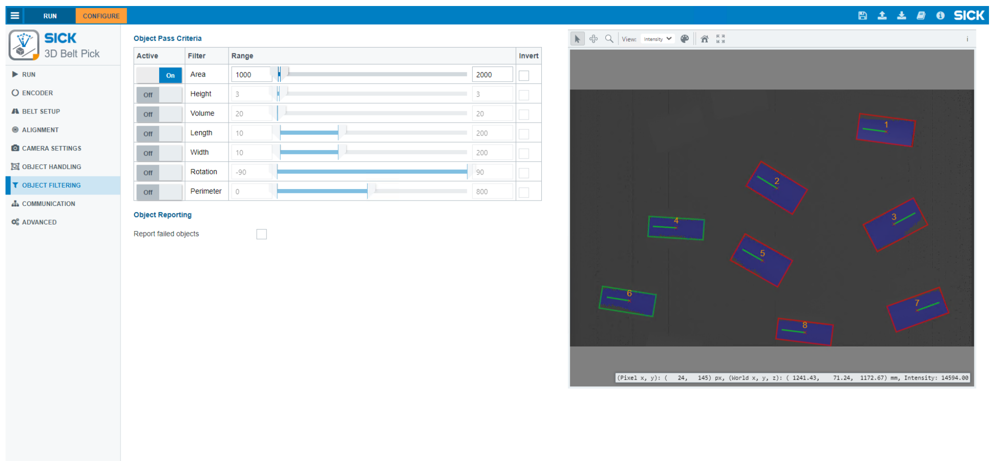


Figure 22: Object filtering tab

6.7.1 Object pass criteria

The **Filter** column contains all the selectable parameters for object filtering. All filters are deactivated by default.

- Set the **Active** toggle to **On** to activate a filter for a parameter.
- Edit the sliders in the **Range** column to set the minimum and maximum value for each activated filter. Only objects within the set range are reported to the picking system.
- Select the **Invert** checkbox to invert the range, which means that only objects outside the set range are reported to the picking system.

NOTE
When activating the filters for the **Volume** and **Perimeter** parameters, the **Calculate volume** and **Calculate perimeter** checkboxes on the **Object handling** tab are automatically selected.

NOTE
The parameter values (in particular the **Length**, **Width**, and **Perimeter** parameters) may be slightly overestimated. Noise around the object edges causes overestimation, and is especially common for images with missing data. To ensure that the filter range covers the objects of interest, it is recommended to scan a few objects and note the parameter values in the run statistics. For further information, see "Run statistics", page 43. Use the statistics as basis when setting the filter range.

6.7.2 Object reporting

By default, objects outside the set filter limits are not reported to the picking system. To report all found objects, select the **Report failed objects** checkbox. Objects outside the set limits are then reported to the picking system as failed objects.

6.8 Communication

The **Communication** tab lets the user define different communication methods.

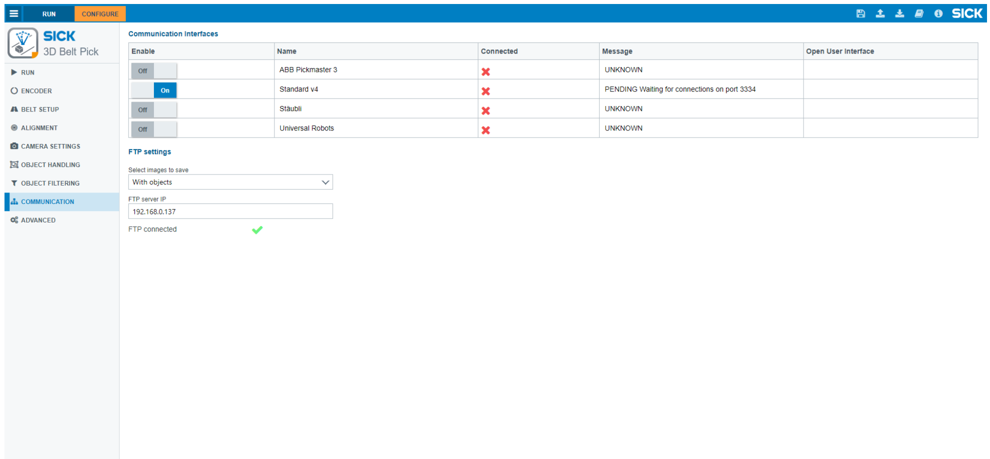


Figure 23: Communication tab

> **NOTE**
> The ABB communication setting is always shown as disconnected, since it is UDP-based.

6.8.1 Communication interfaces

The communication plug-in list contains the available communication protocol options. Select the communication plug-in which corresponds to the destination picking system. The port setting and Ethernet settings for the camera are automatically updated accordingly.

Use the list to enable or disable the communication plug-ins. Access the communication plug-in user interface by clicking the **Open user interface** button. This button is only visible if there is an available user interface for the plug-in.

For other robot and controller brands, a standard CSV protocol is available. For further information regarding the standard protocol, see "Standard CSV communication protocol (version 4)", page 52.

It is possible to create additional, customized communication protocols. New communication protocols are created as plug-ins to the main 3D Belt Pick SensorApp. Once a new protocol plug-in is installed, it appears automatically in the protocol list in the GUI.

For further information about customized protocols, contact SICK technical support.

> **NOTE**
> The developer of the communication plug-in is responsible for the specific functionality of the plug-in.

> **NOTE**
> For ABB, Standard v4, Stäubli, and Universal Robots plug-ins, disabling the plug-in means that the server is closed. This means the server cannot be reached and the port can be used for other purposes.

6.8.2 FTP settings

The **FTP settings** section contains settings for logging images to an FTP server. Select which images to log from the **Select images to save** list box:

Option	Description
None	No images saved. The FTP image logging is turned off.
With objects	Only log images that contain objects.
With failed objects	Only log images that contain failed objects.
With collided objects	Only log images that contain collided objects.
With failed or collided objects	Log images that contain either failed and/or collided objects.
All	Log all images.

To log images to an FTP server, the following criteria must be met:

- The FTP server must be connected to the same network as the camera.
- The FTP Server must have a user account with User ID: "SICK" and password: "SICK". The FTP Client of the camera can then use the user ID and password to log onto the server.
- The FTP server and the user must have the credentials to create files and folders.
- The FTP server firewall must allow FTP traffic using port 21.

NOTE
When enabled, the FTP file transfer will reduce the performance of the camera. Pay attention to possible warning messages in the GUI.

Click **Save to flash** in the toolbar, to save the FTP settings permanently.

6.9 Run

The **Run** tab displays live images and performance information. Information about the software version currently running can be found in the **About** dialog.

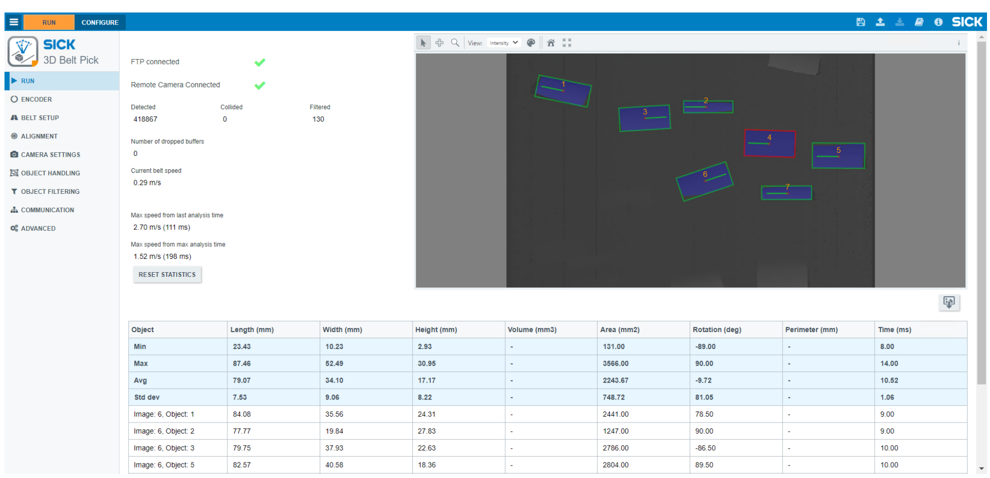


Figure 24: Run tab

NOTE
If the TriSpectorP1000 is mounted as **Laser first**, the **Run** view will be mirrored. If the Ruler3000 is mounted as **Laser last**, the **Run** view will be mirrored. The mounting position will not affect the received data.

If a valid configuration exists, the camera will automatically go into **Run** mode when the **Run** tab is active. Meaning that if the camera is connected to the picking system, it automatically outputs the valid data to it.

The **Run** view continuously monitors and displays parameters related to the current run, see "Run parameters", page 42. It also displays the maximum possible conveyor belt speed based on the current acquisition settings. All statistics are reset when the camera restarts or when the user clicks **Reset statistics**.

The image viewer on the **Run** tab displays and classifies the objects in the acquired 3D images:

- Objects with blue overlays are the valid objects found in the image. A bounding box and the orientation are displayed for each object, see figure 24, page 41.
- An object is only considered valid if it is fully inside the image. Objects touching the border are not considered valid. If this issue causes problems, consider increasing the conveyor belt width set in the camera.
- Objects with a red overlay are either outside the set filter limits (detected by the system but not reported) or duplicates. The reason for duplicates is that objects which are fully inside the overlap region are found twice, see "Buffer settings", page 34. The second time, the object is considered a duplicate and is not reported to the picking system.

If no valid configuration exists, the system does not enter **Run** mode. Instead, the **Run** view displays an error message with information about the type of error. Possible error types are: invalid setup, wrong device type or that other applications are active on the device).

6.9.1 Run parameters

Parameter	Description
Remote Camera Connected	Indicates whether the camera is connected to the picking system. The indicator is not available for the ABB protocol.
FTP Connected	Indicates whether the camera is connected to an FTP server.
Detected	Shows the total number of detected objects since the last reset. This counts all objects detected within the limits set by the **Object Detection** parameters **Area** and **Height** in the **Object handling** tab.
Collided	Counts the number of objects being closer to each other than what is set by the **Gripper Clearance** parameters in the **Object handling** tab. • The counter **Collided** only increments if the **Gripper Clearance** feature is enabled.
Filtered	Counts the number of objects detected outside the set limits of the **Filter** GUI view. • The counter **Filtered** is only active if the **Filter** feature is enabled. Every filter reject is counted regardless how the checkbox **Report failed objects** is set.

NOTE
If an object is detected as both **Collided** and **Filtered**, it will be counted by both these counters.

Number of dropped buffers	The total number of buffers for which no data is reported. For a dropped buffer, the image processing is too slow, and no result can be delivered on time. If dropped buffers appear frequently during a run, see "Laser configuration (TriSpectorP1000)", page 44 for suggestions on how to increase the image-processing speed.
Current belt speed	The measured conveyor belt speed, based on encoder information.

Parameter	Description
Max speed from last analysis time	The maximum conveyor belt speed that can be set, based on the time it took to analyze the last image. The analysis time is displayed within parentheses.
Max speed from max analysis time	The maximum conveyor belt speed that can be set based on the worst-case image analysis time since the last reset of statistics. The value indicates if there are any potential problems with the current conveyor belt speed or object rate. The image analysis time varies based on: • The **Buffer Length** and the resolution. • The number of objects per buffer. • The size of the objects.
Reset statistics	Resets current information about detected objects and max analysis time. These variables are also reset at camera reset or reboot.
Save image	Saves the current image to file.

6.9.2 Run statistics

The table below the image viewer lists measured parameter values and statistics for recently reported objects, see figure 24, page 41.

- The **Length**, **Width**, **Height**, **Area**, and **Rotation** values are calculated and displayed for all objects.
- To calculate and display the **Volume** and **Perimeter** values, select the **Calculate volume** and **Calculate perimeter** checkboxes on the **Object handling** tab. De-select a checkbox to reset the statistics for the corresponding parameter.
- The **Time (ms)** value shows the processing time for the objects. The processing time includes the time for measuring the characteristics of the object; such as length, width, volume, area, rotation, pick point, and gripper collision.
- The standard deviation, mean, maximum and minimum values for the 100 most recently reported objects are listed at the top of the table.
- Measurements for the ten most recently reported objects are listed on single table rows below the statistics. New objects are added to the top of the list. Objects that are outside the set filter limits are not added to the table.
- Each reported object is displayed in the image viewer with an assigned object ID. The image number and the object ID for each reported object are included in the table.
- Click **Reset statistics** to clear all single object measurements and all statistics.

6.9.3 Operator view

Use the following link to open the **Run** view as a separate, non-editable operator interface:

localhost:8080/#!page=Run&fullscreen=true

The operator view displays all the content from the **Run** view, but all menus are invisible, and it is not possible to edit any parameters or settings.

6.10 Advanced

The **Advanced** tab contains functions for playback, reset, and logging.

NOTE
If the **Factory reset** function is used multiple times during a short time period, the device may stop responding. To solve this, open SICK AppManager and restart all apps on the device.

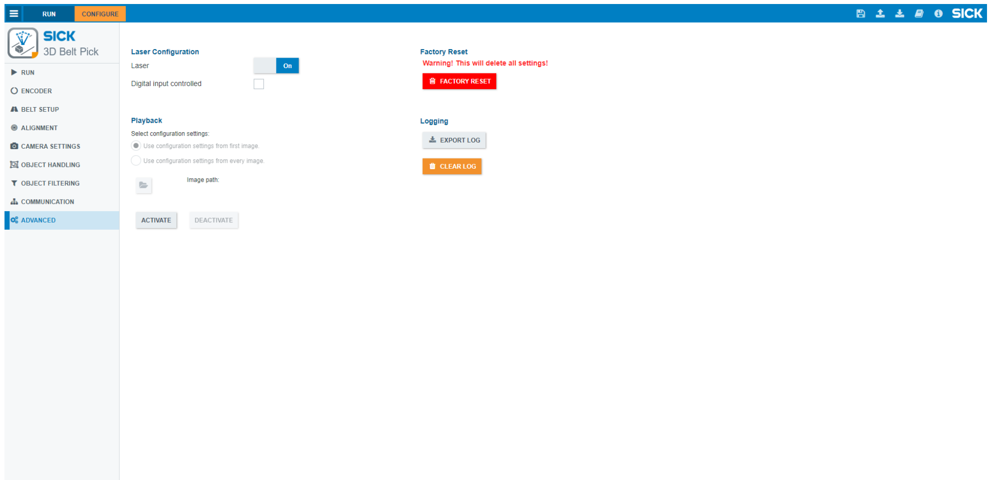


Figure 25: Advanced tab, TriSpectorP1000

NOTE
Features for laser configuration is only available for TriSpectorP1000.

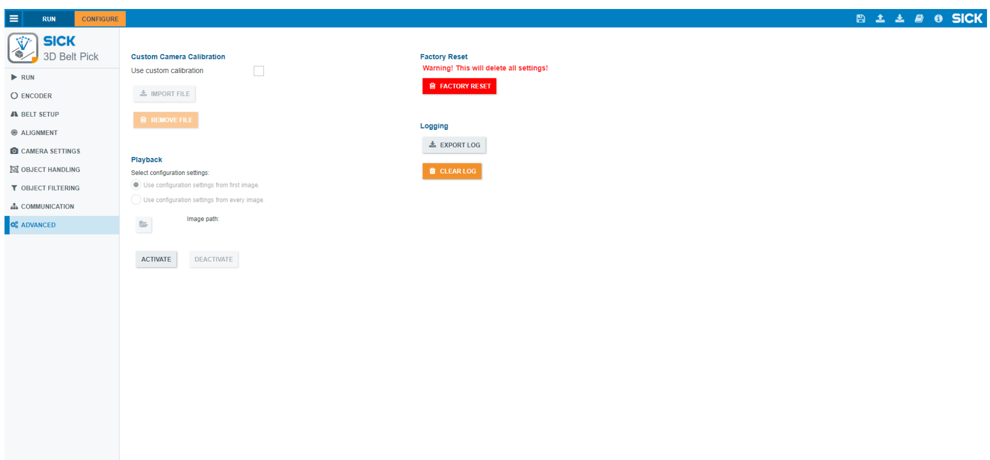


Figure 26: Advanced tab, Ruler3000

NOTE
Features for custom camera calibration is only available for Ruler3000.

6.10.1 Laser configuration (TriSpectorP1000)

The laser can be turned on or off from GUI, Digital Input and Command channel. When the laser is off the image will become dark and no objects can be detected. It is recommended to turn the laser off during maintenance.

- Select the **Digital Input Controlled** checkbox to control the laser from the digital input. Input 1 is used, and the laser is active when the input is high.

NOTE
When the laser is controlled through the digital input it is not possible to control the laser in another way, i.e. GUI or command channel.

6.10.2 Custom camera calibration (Ruler3000)

If the image is black when using a Ruler3000, make sure to use a correct calibration file. By default, a generic calibration file is used to calculate the sensor ROI by default.

The sensor ROI might not be calculated correctly if the current device's calibration is significantly different than the generic. Therefore, the image will be black. To solve this issue, the individual calibration for the specific camera individual can be downloaded using **Stream Setup** and then uploaded to **3D Belt Pick**.

Select the **Use custom calibration** checkbox to enable custom camera calibration. The custom calibration is downloaded from the camera using **Stream Setup**. Connect the Ruler3000 to **Stream Setup** and download the calibration file, see "Camera files", page 45.

Click the **Import file** button to select the json file to be uploaded to 3D Belt Pick.

Click the **Remove file** button to remove the calibration file from 3D Belt Pick.

6.10.2.1 Camera files

Follow the steps below to access files that are stored on the camera:

1. In the **Cameras** tab, select **Camera files** by clicking the **Camera action menu** button, i.e the three dots to the right. You can also access the **Camera action menu** from the **2D Image** and **3D Image** tabs.

✓ The **Camera files** window opens and different files and actions are displayed in a list.

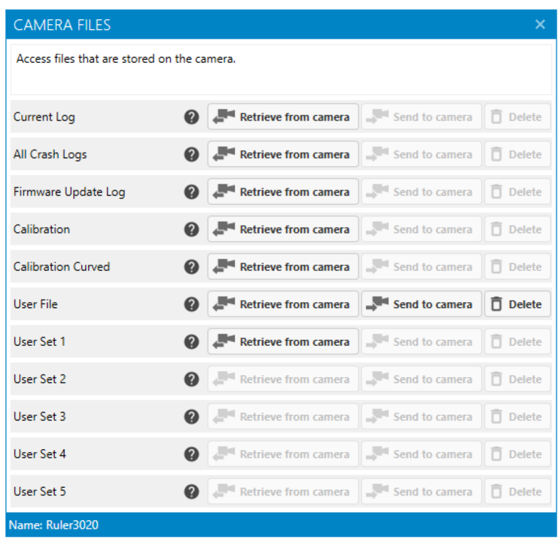


*Figure 27: **Camera files** GUI reference.*

2. Click the **Retrieve from camera** button corresponding to the **Calibration** line.

6.10.3 Playback

The **Playback** mode allows to play and view images already captured by the camera. Possible images to view:

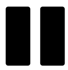
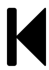
- .3dbp images (3D Belt Pick images aquired with TriSpectorP1000 or SIM + Ruler3000)
- .png images (aquired with TriSpectorC)

Activate Playback mode

1. Open the **Advanced** tab and select **Activate**.
2. Select which configuration setting to use.

3. Click the **File folder** button and specify the path to the images.
4. Use the arrows in the toolbar to control the image flow.

Table 4: Controls available for Playback images

Button	Name	Function
	**Play**	Plays the available images in a continuous flow.
	**Pause**	Pauses the image flow.
	**First image**	Go back to the first image in the folder.
	**Step backward**	Steps backward one image.
	**Step forward**	Steps forward one image.

6.10.4 Factory reset

The **Factory reset** deletes all configuration and alignment settings that have been made and resets the camera to its default state.

6.10.5 Logging

The **Export log** button saves the log details to the PC as a text file called `beltpick.log`.

The **Clear log** button deletes all log information from the device.

6.11 Feasibility evaluation workflow

When considering a new, previously untested application, the following workflow is recommended to evaluate the camera performance offline before integrating.

NOTE
For feasibility studies, no communication settings are needed.

1. Mount the camera and connect it to a PC. Do not connect it to the picking system.
2. Do the **Belt setup** (see "Belt setup", page 29) procedure to make the camera aware of the conveyor belt width and height, as well as the orientation of the camera. These steps are necessary even though the destination system is not connected.
3. Adjust the **Camera settings** (see "Camera settings", page 32), the **Object handling** settings (see "Object handling", page 35), and the camera position so that the objects are clearly visible in the image and reflections are correctly handled.
4. Position object samples, representing the full range of possible products to be picked, under the laser line. Use the extreme ends of variation such as the darkest versus the brightest object, the most shiny versus the most matte object and the smallest versus the largest object.
5. Tune the **Exposure** (see "Setting exposure time", page 32) to find a value that works for all samples. If dark samples are underexposed, lower the **Laser Threshold** (see "Adjusting laser threshold and peak selection ", page 33), but be aware of any disturbing reflexes, see "Ambient light shielding and reflex management", page 20.

6. Arrange the objects in a realistic fashion on the conveyor belt, with respect to the number of objects and spacing between them. Observe how the images of the samples appear directly in the live view, or activate a connection to an FTP server to record the images and study them in detail, see "Communication", page 40. Specifically look out for missing data, problems with reflexes, too many objects per image and signs of misdetections due to objects being too close to each other.
7. Evaluate the camera position for mechanical fit. Verify the camera height and the CLD, see "Mechanical installation", page 17.

To further refine the CLD estimation, read out the conveyor belt speed and image analysis time parameters from the **Max speed from max analysis time** on the **Run** tab, see "Run parameters", page 42. Adjust the parameters to maintain performance at a workable CLD. For detailed parameter descriptions, see "Buffer settings", page 34.

- Reduce the conveyor belt speed to allow more time for the image processing to complete.
- Reduce the number of objects on the conveyor belt to increase the image-processing speed.
- Disable the **Volume** and **Perimeter** measurements on the **Object filtering** tab to increase the image-processing speed.
- Make the **Resolution** coarser to make the image-processing run faster.
- Decrease the **Buffer Length** to automatically reduce the CLD. Make sure that the **Buffer Length** remains longer than the **Overlap**.
- Make sure the **Overlap** is no longer than the longest projection of the largest object plus 10 to 20%. A longer overlap results in unnecessary double processing of the image data.
- The **Time (ms)** can be used to verify if some objects are more time consuming than others when it comes to processing.

7 Interaction with the picking system

Data between the device and the picking system is communicated over Ethernet UDP or TCP/IP with text strings. The positive edge of the strobe signal is used for time synchronization. For an overview of the communication steps for each image acquisition, see "Signaling and communication", page 48.

There are several communication protocols available, but all convey roughly the same data. For a detailed description of the data and the standard CSV protocol, see "Standard CSV communication protocol (version 4)", page 52. For information about the other available protocols, see the 3D Belt Pick page on SICK Support Portal, **support-portal.sick.com/downloads/3d-belt-pick/**.

7.1 Common coordinate system

In the common coordinate system, the X-axis is along the direction of travel with lower values close to the camera. The Y-axis is cross-belt with its zero somewhere on the conveyor belt. The Z-axis points straight up from the conveyor belt toward the camera with its zero on the conveyor belt surface. The camera can be mounted in two different ways: **Laser first** or **Laser last**.

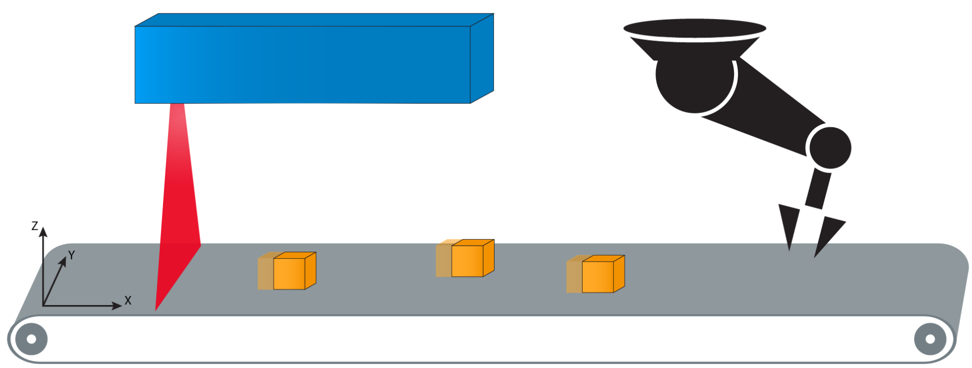


Figure 28: Coordinate system, here illustating laser first mounting

NOTE
Selecting **Laser first** will not affect the axes of the common coordinate system, but it will mirror the image in the **Run** view.

7.1.1 Alignment procedure

The alignment procedure creates a common coordinate system for the camera and the picking system, see "Alignment", page 30. When the alignment procedure is completed, the common origin for the combined system (the camera and the picking system) is located at the alignment target's TCP-marker where the alignment target was originally placed before scanning it.

7.1.2 Signaling and communication

An overview of the communication steps for each image acquisition is illustrated in the figure below. The communication steps are described in detail below the figure.

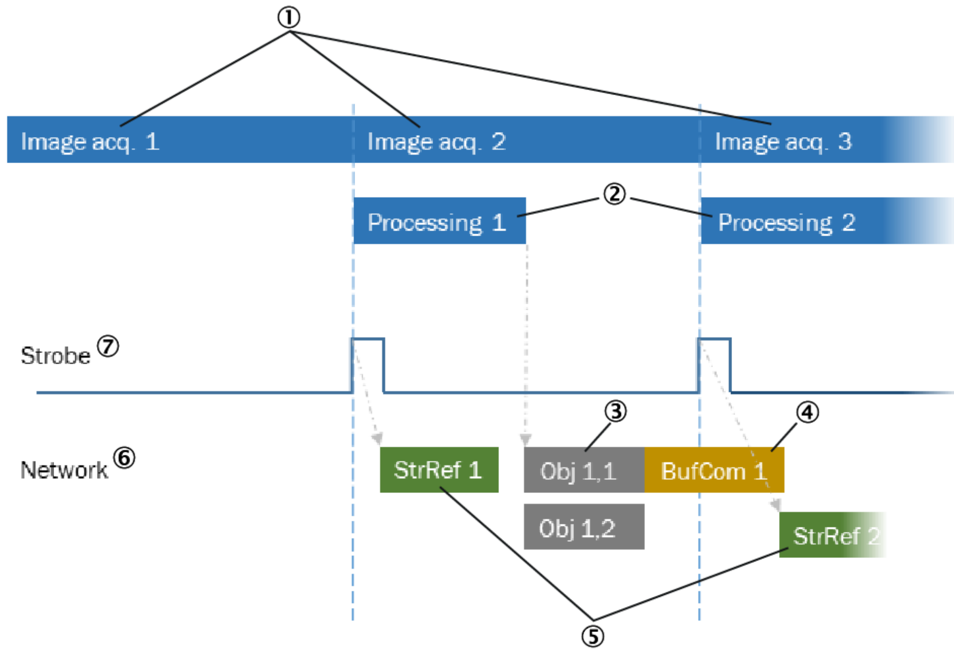


Figure 29: Communication steps for image aquisition

①	Image aquisition, image X
②	Image processing, image X
③	Object message, image X, index Y
④	Buffer complete message, image X
⑤	Strobe reference message, image X
⑥	Network
⑦	Strobe

When the camera has acquired a new image buffer, the camera activates the strobe signal. The strobe defines the time for which the object position coordinates are valid. Paired with the strobe, the **Strobe reference message** is sent over Ethernet directly after the strobe signal. The **Strobe ID**, paired with the timestamp of the strobe, is used in subsequent messaging to resolve the motion-tracking task.

The camera continues with the processing of the acquired image. When the image processing has finished, one **Object message** per found object is sent over Ethernet. Each **Object message** contains the object data and the associated **Strobe ID** linking back to the corresponding strobe signal, through the **Strobe reference message**. The object data is given in the coordinate system defined at alignment and at the point in time (position of the belt) when the strobe signal was sent.

When there are no more objects to report in one image buffer, the **Buffer complete message** is sent to signal that there is no more data for the specified **Strobe ID**.

7.1.3 Pick point

The position of the object can be reported in different ways. The most favorable option depends on the picking method and the object shape.

- **Centroid** is the mean x, y position of all pixels of the object.
- **Highest Point** is the x, y, z position of the object's highest point.
- **Bounding Box** is the smallest rectangle that contains all the pixels of the object. The center of the bounding box is called Bounding Box center and is used for calculating the z coordinate of an object with the **Bounding Box Center** height calculation method.

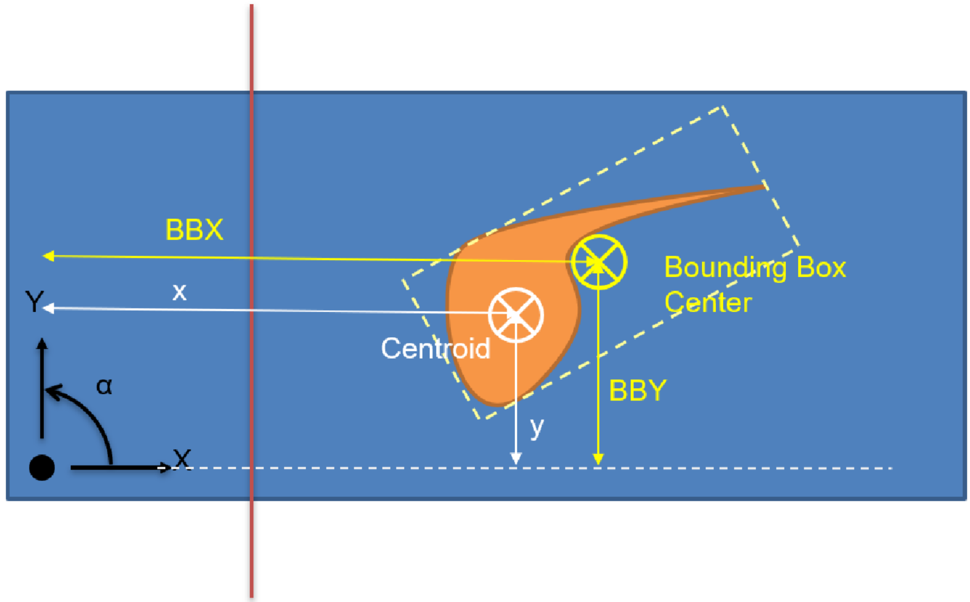


Figure 30: Position of an object

7.1.4 Z rotation

The Z rotation can be reported in three different modes: **180°**, **360°**, and **No Z rotation**. Symmetric objects will look the same when flipped along one axis, for example, a rectangular box. Consequently, it is impossible to differentiate more than 180° rotation. So, for symmetric objects, **180°**-mode should be used, and it will report a ±90° rotation counter-clockwise from the direction of travel. The red line in figure X denotes the projected laser line.

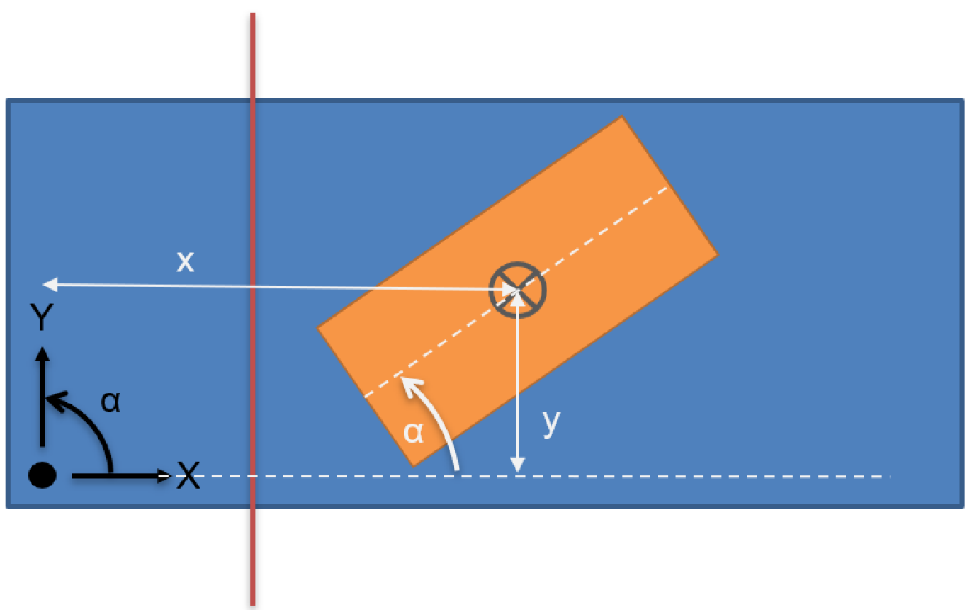


Figure 31: Z rotation mode, symmetrical object

Objects that are assymetric along the longest side of the bounding box can be reported in **360°**-mode where coordinates are output with ±180° rotation. The reported angle is the angle of the line between the centroid (grey) and the center of the bounding box (yellow) versus the direction of travel. In **No Z rotation** mode, the angle measurement is switched off, and the reported angular value is set to 0°.

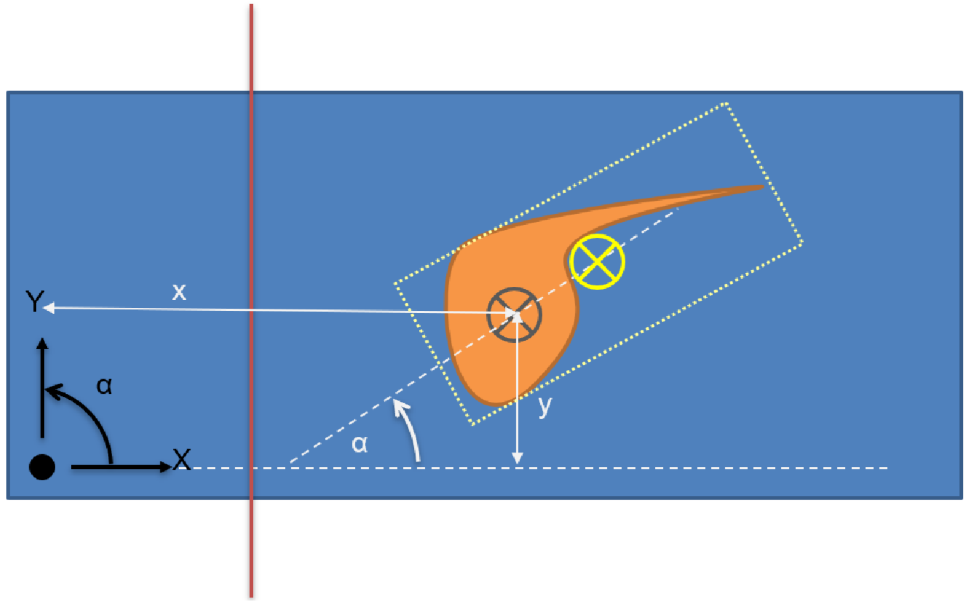


Figure 32: Z rotation mode, assymetrical object

7.1.5 Displacement

The displacement (Left side or Right side) is relevant for objects that are asymmetric along the shortest side of the bounding box. The displacement is defined as the position of the centroid (grey) in relation to the center line along the bounding box (white). If the centroid is on the right side of the line, the displacement is defined as Right side, see figure 33, page 51.

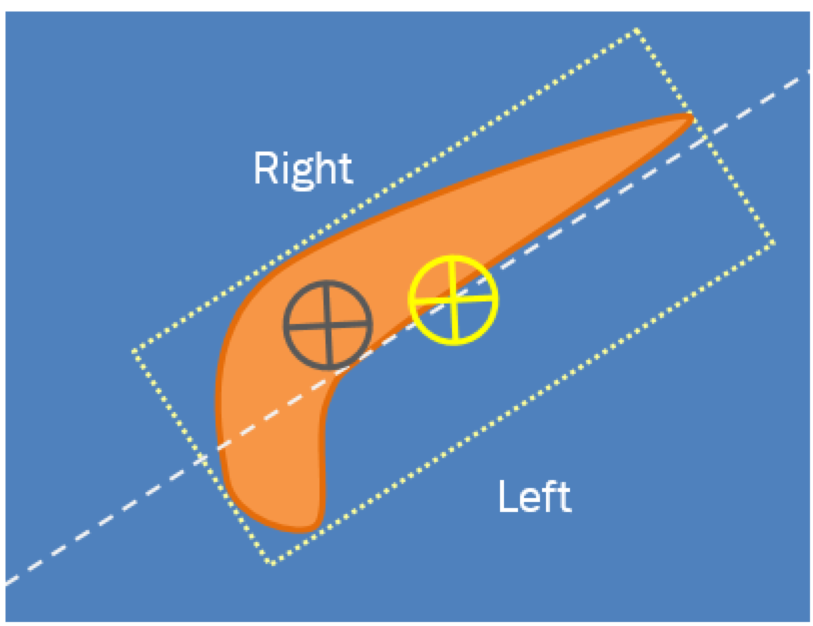


Figure 33: Displacement, right side

In the GUI, the displacement is displayed with a thick line.

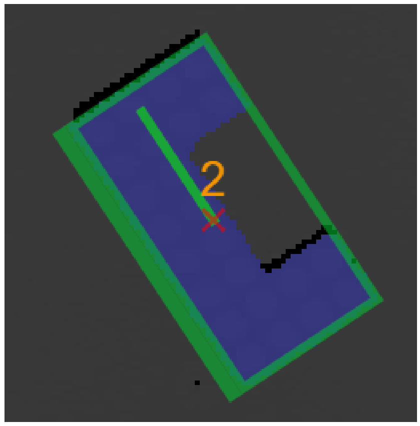


Figure 34: Left displacement

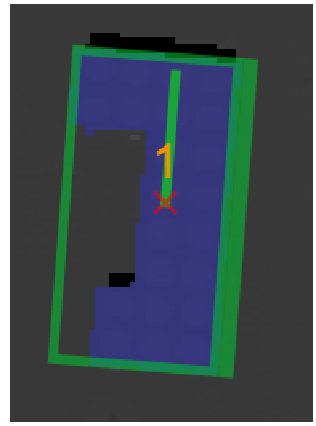


Figure 35: Right displacement

7.2 Standard CSV communication protocol (version 4)

This section describes the standard CSV protocol recommended for robot and controller brands that are not yet listed on the **Communications** tab.

Communication is provided via a TCP server on port 3334. The data format is string decimal (numbers are given with 2 decimals). The decimal sign is a dot (.). Negative values are prepended with a minus sign (-).

The message format consists of the following fields:

- The **Start Mark** field, denoted by `S4>`, which marks the start of a message.
- The **Message Type** field, containing the message ID (0 – 255) .
- The **Data** field, which contains the message content. Use commas to separate the variables included in the **Data** field.
- The **Stop Mark** field, denoted by `\n`.

Example:

```
S4>ID,variable_1,variable_2\n
```

7.2.1 Output message types

The message content and variables for each output message type are listed below. For a summary of the communication steps during an image acquisition, see "Signaling and communication", page 48.

7.2.1.1 Strobe reference message (Message type: 10)

The **Strobe reference message** is sent just after the strobe digital output signal to provide an ID to use in later messaging. The **Strobe reference message** links a strobe pulse to an **Object message**.

If the processing of an image buffer is finished before the next image buffer acquisition is completed, no **Strobe reference message** is needed.

Field	Type	Unit	Description
Message Type	16-bit unsigned integer		Always 10 for this message type.
Strobe ID	16-bit unsigned integer		Strobe ID of the last digital output strobe . **Note**: The Strobe ID has a wrap-around at 65536. This must be handled by the picking system.
Status	error code		Reserved for future use.

Example:

```
S4>10,3453,0\n
```

7.2.1.2 Object message (Message type: 30)

An **Object message** is sent for each object detected in the image. It contains the position and rotation (pose) of the object as well as some metadata.

Field	Type	Unit	Description
Message Type	16-bit unsigned integer		Always 30 for this message type.
Strobe ID	16-bit unsigned integer		Strobe ID that the object positions relate to. **Note**: The Strobe ID has a wrap-around at 65536. This must be handled by the picking system.
Index	integer		Object index in image.
Accept	enum		The result from **Object Filtering** if the check-box **Report Failed Objects** is selected. If not selected, the value will always be 1.
Label	integer		Label to differentiate between object types depending on classification in image analysis. (Currently not in use, reserved for future use.)
Pickpoint X	decimal	mm	Pick point X (along belt).
Pickpoint Y	decimal	mm	Pick point Y (across belt).
Pickpoint Z	decimal	mm	Pick point Z (above belt).
Length	decimal	mm	Object length (longest side).
Width	decimal	mm	Object width (shortest side).
Height	decimal	mm	Object height above belt according to selected Height Calculation Method.
Bounding Box X	decimal	mm	Bounding Box center position X (along belt).
Bounding Box Y	decimal	mm	Bounding Box center position Y (across belt).
Rotation	decimal	degrees	Rotation angle around the Z-axis (positive counter clockwise). For details, see "Z rotation", page 50. 180°-mode: [-90°, 90°] 360°-mode: [-180°, 180°] No Z rotation mode: 0°
Area	decimal	mm^2	Object area.
Volume	decimal	mm^3	Calculated object volume. Volume measurements are inactivated by default and the default volume is set to 0. To enable volume measurement, see "Calculate properties", page 37.
Displacement	enum		Object center of gravity displacement. For details, see "Displacement", page 51. 0 = Not defined 1 = Right side heavy 2 = Left side heavy

Field	Type	Unit	Description
Perimeter	decimal	mm	Calculated object perimeter in mm. Perimeter measurements are inactivated by default and the default perimeter is set to 0. To enable perimeter measurements, see "Calculate properties", page 37.
Custom1			Reserved for future use.
Custom2			Reserved for future use.
Custom3			Reserved for future use.
Custom4			Reserved for future use.

Example:

```
S4>30,3453,5,1,2,1.00,2.00,3.00,10.00,20.00,30.00,1.00,2.00,45.00,12
3.00,1234.00,0,12.34,0,0,0,0\n
```

7.2.1.3 Buffer complete message (Message type: 40)

When there are no more objects to report in an image buffer, the **Buffer complete** message is sent to signal that there are no more data for the specified **Strobe ID**.

Field	Type	Unit	Description
Message Type	16-bit unsigned integer		Always 40 for this message type.
Strobe ID	16-bit unsigned integer		Strobe ID of the buffer. **Note**: The Strobe ID has a wrap-around at 65536. This must be handled by the picking system.
NbItems	integer		The total number of objects found in the buffer related to the Strobe ID.

Example:

```
S4>40,3453,5\n
```

7.3 Command channel

A command channel interface is available for external configuration of the camera settings, without using the built-in web GUI. The command channel allows an external controller, such as a PLC, to read and write settings from and to the camera. The command channel can be used to facilitate back-up, to switch jobs and to adjust individual job settings.

For information about the command channel protocol, see "Command channel protocol", page 61.

8 Accessories

Accessories can be found online at:

- www.sick.com/TriSpectorP1000
- www.sick.com/Ruler3000

Accessory set

The SICK 3D Belt Pick Accessory set contains a set of accessories for the camera hardware setup:

- Cables
- Encoder splitter
- Mounting bracket kit

There is one set for the TriSpectorp1000 and one set for the Ruler3000 in combination with a SIM. For details, see www.sick.com.

9 Glossary

9.1 Terms and abbreviations

CLD	Camera Lead Distance. The distance between the laser line and the start of the work area of the picking system.
Encoder pulse	An encoder pulse is defined as the entire time cycle from the positive edge on the A channel to the next positive edge on the A channel.
Encoder tick	One encoder pulse equals four encoder ticks.
FTP	File Transfer Protocol. Standard network protocol used for transfer of computer files between a client and a server.
FOV	Field of view. The maximum guaranteed image acquisition area is called Field of view.
GUI	Graphical User Interface.
Laser First	A way of mounting the device. This way the laser will come first in the moving conveyor belt's direction and the camera will come last.
Laser Last	A way of mounting the device. This way the camera will come first in the moving conveyor belt's direction and the laser will come last.
Laser triangulation	A technology that uses a laser line and a camera to create height profiles. A complete 3D image is acquired by collecting height profiles across the object while it moves under the laser line.
Object	Refers to the item/part/product on the conveyor belt.
Picking system	A picking system could also be known as a robot, robot controller or PLC in any combination used to pick objects on a moving belt.
Picking zone	The area in which it is possible for the picking system to pick objects. Also called Robot work area.
PLC	
Strobe signal	A strobe signal is a synchronization signal, also known as a latch/trig signal. The strobe signal provides a time reference to the picking system and is sent for every image that the camera acquires.
TCP/IP	TCP is an abbreviation for Transmission Control Protocol and IP is an abbreviation for Internet Protocol. TCP/IP provides a communication service between two parties.
TTL	Signal standard for digital I/O signals, with a signal voltage range of 0 to 5V DC.
UDP	User Datagram Protocol. With UDP, applications can send messages to other hosts on an IP network.

10 Annex

10.1 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/licensetexts.

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

10.1.1 License handling

To run the 3D Belt Pick sensor app on SIM and SICK AppEngine, you need to activate a license. Use the SICK License Manager sensor app to activate a license. The SICK License Manager is reached from the About dialog, see "About dialog", page 26.

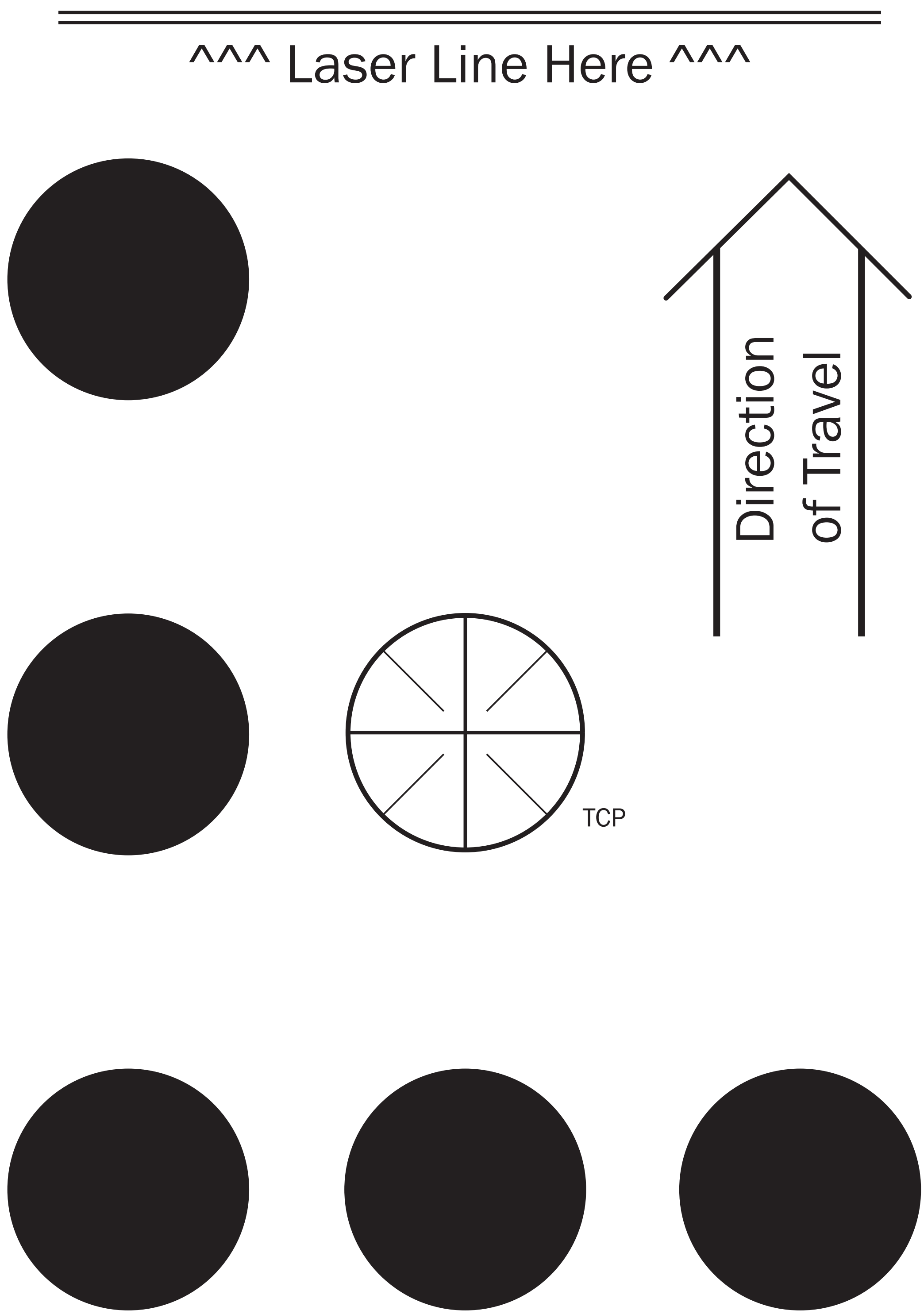
To install the 3D Belt Pick SensorApp on a device, the SICK AppManager software must be installed on the PC, see "Software installation and upgrade", page 22.

10.2 Printable alignment target

The printable alignment target is found on the next page, see figure 0, page 58. It is possible to print the target in any size, as long as the black circles have a diameter of minimum 10 mm. For the camera to detect the alignment target properly, the circle diameter on the printed target must be accurately entered as a parameter in the GUI.

NOTE
Make sure that the alignment target is visible in the field of view. The distance from the edge of any of the black circles to the end of the field of view must be 10 mm or more.

NOTE
Be thorough and accurate when positioning the target on the belt prior to the alignment. The software does not check how well the laser line is fitted between the pair of lines be on the target. This means that alignment using a misplaced target may appear as successful though the result is the opposite.


^^^ Laser Line Here ^^^
Direction
of Travel
TCP

10.3 Accessories

Accessories can be found online at:

- www.sick.com/TriSpectorP1000
- www.sick.com/Ruler3000

Accessory set

The SICK 3D Belt Pick Accessory set contains a set of accessories for the camera hardware setup:

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10.4 Connecting multiple cameras

For applications where the conveyor belt is wider than the maximal filed of view width for the camera, it is possible to connect multiple cameras to the same picking system. A multi-camera setup is suitable for applications where each object is smaller than about one-third of the maximal FoV width for the camera.

When using multiple cameras, each camera is connected and defined as a separate position source in the robot controller. The required logic for handling objects in the overlap zones, possibly detected by two cameras, must be added in the robot controller by the user.

10.4.1 Introduction

To set up the belt picking system with multiple cameras, add the following steps to the installation procedure:

- Connect each camera[1)] separately to the robot controller:
  - Wire each strobe signal to a unique input on the robot controller.
  - Connect all the cameras and the robot controller to the same Ethernet network.
- Connect the same encoder signal to all the cameras and to the robot controller. It is recommended to use an encoder splitter to ensure signal drive capability.
- Define each camera as a unique and parallel position source in the robot controller.
- Align each camera with the robot separately.
- Optional: Use the command channel for global storage and deployment of the camera settings from the robot controller.

10.4.2 Use cases

Case 1: Randomly positioned objects on a wide belt

Arrange the cameras so that their FoVs are overlapping, see the figure below. Make the overlap large enough to fit the largest projection of the largest object to be handled, see the outlined box in figure 36. Set the **Height** range as narrow as possible, with regard to the objects to be picked.

1) For Ruler3000: one camera and one SIM

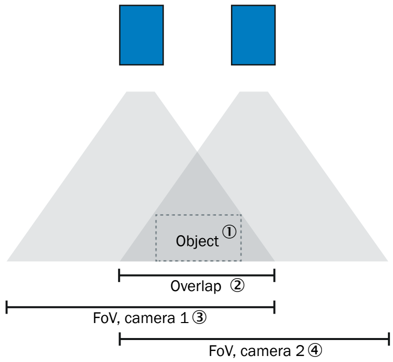

Figure 36: Overlapping cameras

① Object
② Overlap
③ Field of view, camera 1
④ Field of view, camera 2

Separate the cameras' laser planes in the conveyor belt's direction of motion to avoid interference of the laser planes, see figure 37, page 60.

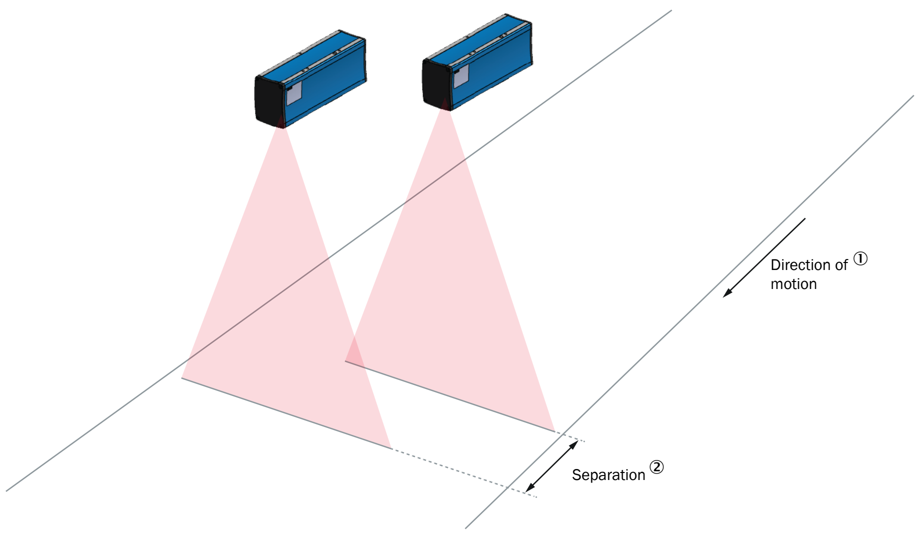

Figure 37: Separated laser planes

① Direction of motion
② Separation

The required separation between the laser planes depends on the maximum object height. When the separation between the laser planes is long enough, no laser line from neighboring cameras should be seen in the sensor image on the **Job** tab.

Case 2: Objects organized in lanes on the belt

If there are defined empty zones on the belt, the cameras can be mounted without overlapping FoVs. Align the cameras so that the gap coincides with the empty zones on the belt, see figure 38, page 61.

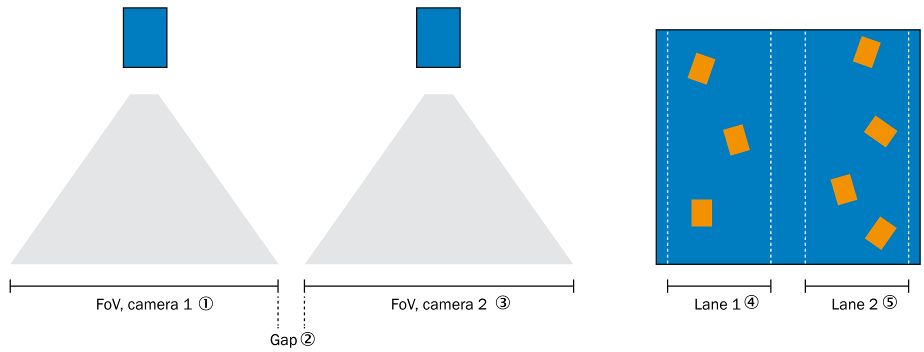

Figure 38: No overlapping cameras

① Field of view, camera 1
② Gap
③ Field of view, camera 2
④ Lane 1
⑤ Lane 2

If the empty zones are narrow, it is recommended to separate the laser planes in the direction of motion according to the description for overlapping cameras, see figure 37, page 60.

NOTE
Mechanical guides can be used for creating empty zones, by directing the moving objects into lanes.

10.5 Command channel protocol

10.5.1 Introduction

The command channel interface is used for external configuration of the camera settings, without using the built-in web GUI. The command channel allows an external controller, such as a PLC, to read and write settings from and to the camera.

NOTE
It is not recommended to use the web GUI and command channel at the same time, since changes from the command channel are not reflected in the web GUI.

For complete documentation, see the separate Command Channel Reference package (supportportal.sick.com/downloads/3d-belt-pick/).

10.5.2 Communication interface

The physical layer for the command channel is raw Ethernet TCP socket communication, with the camera acting as server on port 3300. Connect the robot controller or PLC to the camera’s IP address as a TCP client to send and receive the data as raw ASCII text in JSON format.

10.5.3 JSON schema

Get the complete schema by sending an empty JSON object {}. This can be used to list and validate all commands and settings. It also contains full documentation of all available parameters. The same schema is used for request and response messages.

> **NOTE**
> If settings under **Encoder**, **Alignment**, or **Camera settings** are written to the camera in **Run** mode, the `RESET_RUN` command must be sent to apply these settings.

Name	Description
Version	**Required.** Defines the protocol version. Must be 4 in this version.
Result	The result of the last request. Only applicable to response message. Returns "Valid" if OK, otherwise an error message.
Status	The status of the camera. Only applicable to response message. INVALID = Invalid Configuration RUN = Run mode EDIT = Edit mode
Settings	The settings used by the camera. This is included in the response if the Settings object is included in the request.
Statistics	The statistics from the **Run** view, see "Run", page 41. This is included in the response if an empty statistics object is present in the request.
Counters	The counters from the **Run** view, see "Run", page 41. This is included in the response if an empty counters object is present in the request.
Command	`RESET_STATISTICS` = Clear all statistics `RESET_RUN` = Restart **Run** mode to apply settings under **Encoder**, **Alignment** or **Camera** categories. This will resynchronize the communication with the picker system and objects on the conveyor might not be reported.

10.5.4 Examples

For complete documentation, see the separate Command Channel Reference package (supportportal.sick.com/downloads/3d-belt-pick/).

Writing settings to the camera

To change one or more settings, send a JSON object with all parameters and values for the settings to be updated. The camera returns the complete settings object after changes are applied.

> **NOTE**
> The version equals the version of the installed 3D Belt Pick application.

Example:

- Set the **Exposure** setting to 100:
  `{"Version":5,"Settings":{"Camera":{"Exposure":100}}}`
- Returns:

```
{
    "Version": 5,
    "Result": "Valid",
    "Status": "RUN"
    "Settings": {
        "Camera": {
            "Exposure": 100
        ...
        }
        ...
    }
}
```

Writing filter settings to the camera

The filter settings are nested below the job settings. The camera returns the complete set of currently used settings.

Example:

- Set the maximum value for the **Length** filter to 100:

```
{
    ...
    "Settings": {
        "Job": {
            "Filtering": {
                "Filters": {
                    "Length": {
                        "RangeMaxValue": 100
                    }
                }
            }
        }
    }
}
```

Back-up and restore

Sending an empty settings object, returns the complete set of currently used settings. For back-up and restore purposes, the response can be saved and later sent back to the camera (denoted by three dots in the example).

Example:

```
{"Version":5, "Settings": {}}
```

- Returns:

```
{
    ...
    "Settings": {
        ...
        }
    }
}
```

Switching jobs

To switch jobs, send a command which includes a complete set of settings (denoted by three dots in the example).

Example:

```
{
    ...
    "Settings": {
        ...
        }
    }
}
```

Checking the device status

The device status is returned with every response. Status `RUN` means that the device is in **Run** mode with no errors.

Example:

```
{ "Version":5 }
```

- Returns:

```
{
   "Version": 5,
   "Result": "Valid",
   "Status": "RUN",
}
```

Getting statistics

The request example below returns the run statistics. For details, see "Run statistics", page 43. Statistics are only returned for parameters for which filtering is active. If no objects have been detected, no values are returned.

Example:

```
{ "Version":5,"Statistics": {} }
```

- Returns:

```
{
   ...
   "Statistics": {
      "Height": {
      "Average": 10.053333108624,
      "Deviation": 0.080829035879878,
      "Maximum": 10.099999774247,
      "Minimum": 9.9599997773767
   },
   "Length": {
      "Average": 53.133910912247,
      "Deviation": 0.92723096036059,
      "Maximum": 54.175178187715,
      "Minimum": 52.397455358037,
   }
}
```

Getting counters

The request example below returns the run counters. For more information, see "Run parameters", page 42.

Example:

```
{ "Version":5,"Counters": {} }
```

- Returns:

```
{
   ...
   "Counters": {
      "Detected": 5,
      "Collided": 1,
      "Filtered": 0,
      "Passed": 4,
      "DroppedBuffers": 0
   }
}
```

Executing commands

The command example below executes the `RESET_STATISTICS` command. The `RESET_RUN` command can be sent at the same time as settings to change and apply required settings instantly.

Example:

```
{ "Version":5,"Command": "RESET_ STATISTICS" }
```

- Returns:

```
{
   "Version": 5,
   "Result": "Valid",
   "Status": "RUN"
}
```

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