FOS-HVS

Quality control system

Version 3.x

SICK
Sensor Intelligence.

Described product

FOS-HVS

Foreign Object Detection System

Version 3.x

Manufacturer

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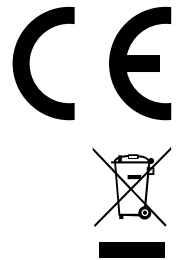79183 Waldkirch
Germany

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

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

The operating instructions are an integral part of the product and should remain accessible to the personnel at all times. When handing this product over to a third party, include these operating instructions.

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

1.2 Target group

This document is intended for persons who commission, install, operate and maintain the product.

1.3 Further information

The product page with further information can be found at: www.sick.com/[PART NUMBER].

The following information is available depending on the product:
- Data sheets
- This document in all available language versions
- CAD files and dimensional drawings
- Certificates (e.g., declaration of conformity)
- Other publications
- Software
- Accessories

1.4 Related applicable documents

Related applicable documents from SICK

Document	Title	Part number	Source
Operating instructions	Ranger3 3D Vision	8020774	www.sick.com/8020774
Operating instructions	SIM2500 - Sensor Integration Machine	8023295	www.sick.com/8023295
Operating instructions	SIM2000ST-E - Sensor Integration Machine	8028476	www.sick.com/8028476

1.5 Symbols and document conventions

Warnings and other notes

⚠ **DANGER**
Indicates a situation presenting imminent danger, which will lead to death or serious injuries if not prevented.

WARNING
Indicates a situation presenting possible danger, which may lead to death or serious injuries if not prevented.

CAUTION
Indicates a situation presenting possible danger, which may lead to moderate or minor injuries if not prevented.

NOTICE
Indicates a situation presenting possible danger, which may lead to property damage if not prevented.

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

Instructions to action

► The arrow denotes instructions to action.

1. The sequence of instructions is numbered.
2. Follow the order in which the numbered instructions are given.
✓ The tick denotes the results of an action.

2 Safety information

2.1 Basic safety instructions

> ⚠️ **DANGER**
> **Mechanically moving system components in the inspection cell**
>
> ► Before setting up and configuring the system, switch off the inspection cell

> ⚠️ **DANGER**
> **Danger from electrical voltage**
>
> Risk of electrical shock. Contact will result in death, burns or shock.
>
> ► Electrical work may only be performed on the system by qualified specialist personnel.
> ► Before working on electrical components, observe the five safety rules:
>   ○ Disconnect
>   ○ Secure against being switched back on.
>   ○ Ensure that there is no voltage.
>   ○ Ground and short-circuit.
>   ○ Cover or enclose live parts in the vicinity

> ⚠️ **WARNING**
> **Risk of injury and damage caused by electrical current**
>
> Due to equipotential bonding currents, incorrect earthing can lead to the following dangers and faults: Voltage is applied to the metal housing, cable fires due to cable shields heating up, the product and other devices become damaged.
>
> ► Generate the same ground potential at all grounding points.
> ► Ground the equipotential bonding via the functional ground connection with a low impedance.

> ⚠️ **WARNING**
> The product uses one or more line lasers of laser class 2.
>
> 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.
>
> ► Never look directly into the laser beam.
> ► Never point the laser beam at people's eyes.
> ► During commissioning or maintenance work, suitable eye protection must be worn.
> ► Avoid laser beam reflection caused by reflective surfaces, especially during assembly and alignment work.
> ► Do not use optical instruments.
> ► Do not open the housing.
> ► Current national regulations regarding laser protection must be observed.

Special local conditions

► The local laws, regulations, technical rules and internal company operating instructions at the usage site must be observed.

Storage of documents

▶ This document and further technical documentation/information
  ○ Must be kept available for reference.
  ○ Must be handed on to new operating entities/new specialist personnel.

2.2 Warnings on the device

> **!** **NOTICE**
> There are warnings on the device.
>
> ▶ Read and observe the notes in these operating instructions concerning the relevant warning.
> ▶ Do not remove or cover warning labels.
> ▶ Replace damaged or missing labels.

The rules for affixing laser warning labels of laser class 2 apply.

The following warning signs are included in the scope of delivery of the system:

26 mm x 52 mm   25 mm x 70 mm

$$P_0 = \underline{\qquad} W$$
$$\lambda = \underline{\qquad} nm$$

LASER 2

Klassifiziert nach DIN EN 60825-1:2015-07
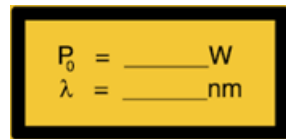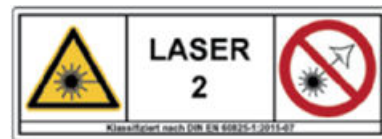
▶ Permanently affix the warning signs in the area of the system or near the laser unit in accordance with their purpose and ensure that they are clearly visible and legible during normal operation, maintenance and service work.
▶ Affix the label in such a way that it is legible without exposure to dangerous laser radiation.

2.3 Notes on the laser

Important information

> ⚠ **WARNING**
> If any operating or adjusting devices other than those specified here are used or other methods are employed, this can lead to dangerous exposure to radiation.

Overview

The product is equipped with one or more Class 2 lasers according to EN/IEC 60825-1:2014 (DIN EN 60825-1:2015) and complies with 21 CFR1040.10 with the exception of the deviations listed in the Laser Notice No. 50, dated June 24, 2007.

Class 2 laser products emit a visible beam in the wavelength range between 400 nm … 700 nm in which eye protection is normally provided by averting reactions such as natural eyelid closure.

Class 2 laser products normally do not cause eye injury, but they may pose a hazard due to glare and temporary loss of vision caused by the laser pulse.

The eyelid closure reflex of the human eye occurs within 0.25 seconds after the impact of the Class 2 laser beam and provides adequate protection. It is possible, however, to suppress the eyelid closure reflex and to look into the laser long enough to cause harm to the eye.

When working with a Class 2 laser, the generally applicable regulations and notes on operational safety regarding laser protection apply.

▶ Perform installation in accordance with laser safety regulations.
▶ Avoid glare in the work area in all life cycles.
▶ Suitably shield or cover the affected areas. The area may need to be cordoned off, if necessary. In this way, possible secondary hazards due to reflection from machine parts, for example, can be reduced or eliminated.

Laser specifications

	Red laser	Green laser	Blue laser
Wavelength (nm)	660	520	405
Power (mW)	80	70	75

Switching off the laser

The laser is switched on and off by the evaluation unit via the modulation pin and is only switched on when it is needed for a scan during an inspection. Switching off the laser unit in phases in which it is not required serves to optimize the laser service life.

NOTE
Switching off the laser via the modulation pin is only a functionality to extend the laser service life, but is not a safety-related function according to the Machinery Directive.

▶ To switch off the laser, disconnect the power supply of the overall system.

2.4 Intended use

The FOS-HVS (**F**oreign **O**bject Detection **S**ystem) for foreign body detection consists of a number of different hardware and software components for product and process optimization in the manufacturing industry. Foreign objects are reliably detected on a variety of surfaces. The product is only suitable for use in industrial environments.

The product must only be used within the limits of the prescribed and specified technical specifications and operating conditions at all times.

Incorrect use, improper modification or manipulation of the product will invalidate any warranty from SICK; in addition, any responsibility and liability of SICK for damage and secondary damage caused by this is excluded.

2.5 Improper use

Impermissible use

• As a safety component as defined in the relevant applicable safety standards for machines, e.g. Machinery Directive.
• Detection of persons and animals
• Detection of transparent items

Impermissible ambient conditions

• Outdoor areas
• Direct UV radiation (sunlight)
• Precipitation
• Inadequate protection against moisture and contamination
• Publicly accessible areas
• Explosion-hazardous area
• Corrosive environment

2.6 Qualification of personnel

Any work on the product may only be carried out by personnel qualified and authorized to do so.

Qualified personnel are able to perform tasks assigned to them and can independently recognize and avoid any potential hazards. This requires, for example:

- technical training
- experience
- knowledge of the applicable regulations and standards

2.7 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)

3 Product description

3.1 Scope of delivery

> **!** **NOTICE**
> ► After delivery, inspect the product for transport damage and report any such damage immediately.
> ► Check that the delivery includes all components listed on the delivery note.

3.2 Product characteristics

Overview

The FOS-HVS Foreign Object Detection System is used to detect foreign objects on the surface of high-voltage storages, which can lead to damage in the further course.

The system consists of one or more system heads, each with a controller, one or two Ranger3 cameras, and a line laser as well as another higher-level controller for the system.

The use of multiple parallel system heads enables objects of different dimensions to be inspected, and inspection tasks with varying requirements with regard to resolution and detection quality to be achieved.

System components
- System head
  - Ranger3
  - Line laser
  - SIM2500 control system
- SIM2000ST-E control system
- Encoder
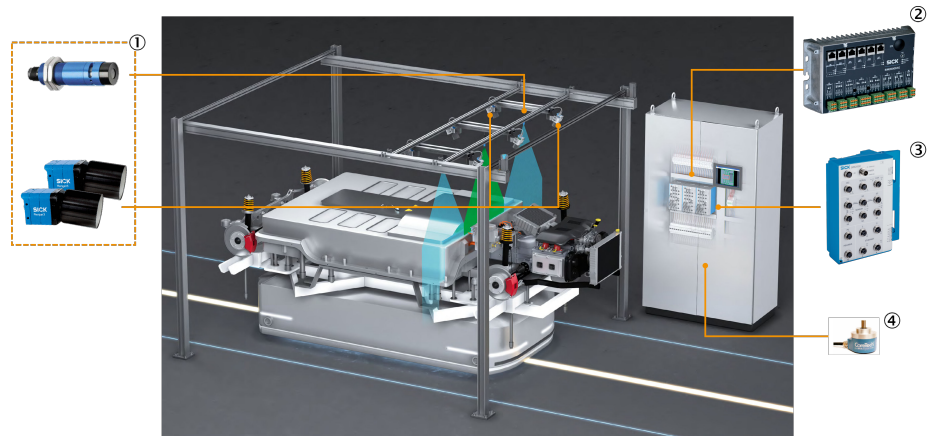
Figure 1: System setup

① System head
② SIM2000ST-E control system
③ SIM2500 control system
④ Encoder

Variants

Variant	Number of system heads
Mono 1600	2 single heads (2 Ranger3)

Variant	Number of system heads
Duo 1600	2 double heads (4 Ranger3)
Duo 2400	3 double heads (6 Ranger3)

3.3 Typical system structure

Mono variant
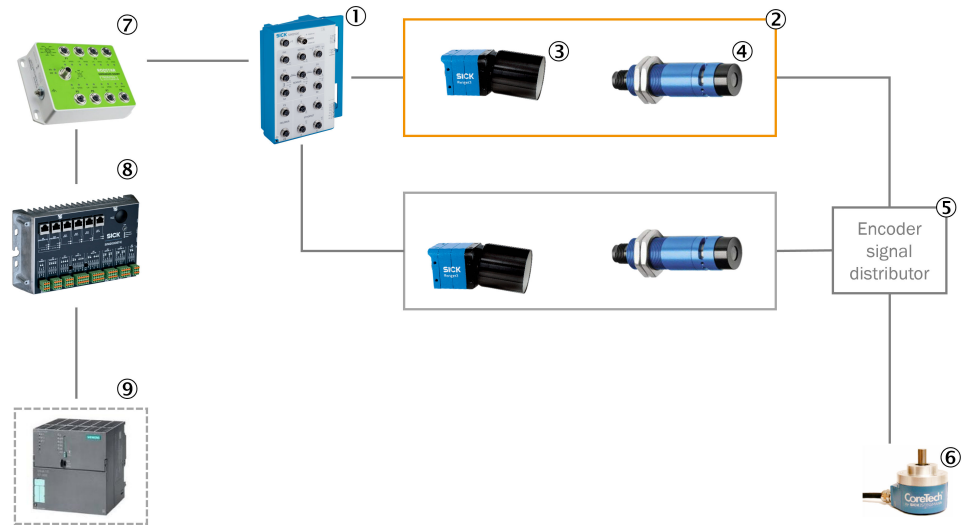
Figure 2: Typical system structure for Mono variant

① SIM2500 Sensor Integration Machine

② System head, comprising Ranger3 camera(s) and line laser

③ Ranger3 3D Machine Vision

④ Line laser

⑤ Encoder signal distributor

⑥ Encoder

⑦ Network switch

⑧ SIM2000ST-E Sensor Integration Machine

⑨ Signal transmission with higher-level PLC

Duo variant

The SIM system head combination at the bottom of the picture is optional and only available in a system with 3 heads.
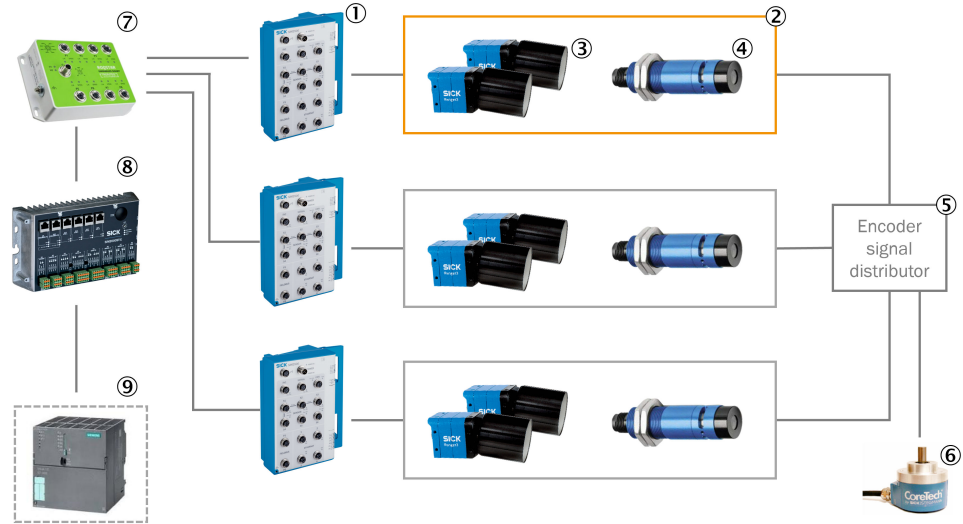
Figure 3: Typical system structure for Duo variant

①   SIM2500 Sensor Integration Machine
②   System head, comprising Ranger3 camera(s) and line laser
③   Ranger3 3D Machine Vision
④   Line laser
⑤   Encoder signal distributor
⑥   Encoder
⑦   Network switch
⑧   SIM2000ST-E Sensor Integration Machine
⑨   Signal transmission with higher-level PLC

3.4 System components

3.4.1 System head

Overview

Each system head consists of one or two Ranger3 cameras (①) and one line laser (②).
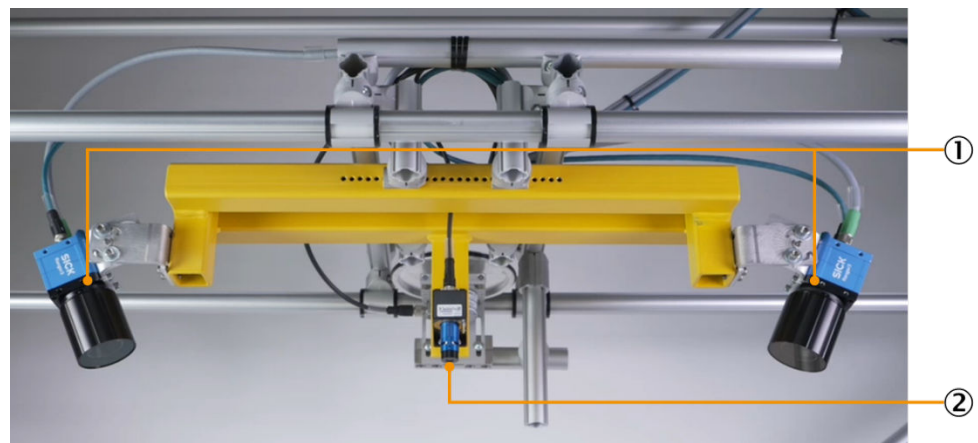
Figure 4: FOS-HVS system head

①   Ranger3
②   Line laser

The system head consists of the Ranger3 cameras, the laser unit including mounting brackets, and a stable carrier unit. The alignment of the components of the system head to each other is performed and calibrated at the factory.

The pre-calibrated system head simplifies the commissioning process, as no further calibration is required. Likewise, in the event of an error, the entire system head can be replaced without the need for recalibration.

Line laser
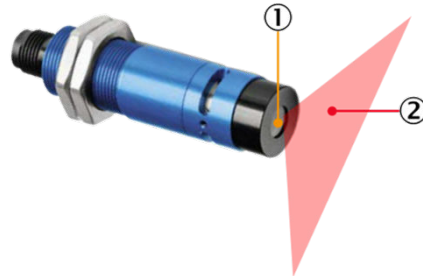
Figure 5: Laser exit

①   Laser output aperture

②   Fanning of the laser beam

3.4.2 SIM2500 controller (secondary)

Figure 6: SIM2500 controller (secondary)

The SIM2500 controller is used as a secondary SIM for each system head. The images are processed and evaluated on the respective SIM.

The secondary SIMs of the system heads communicate with the primary SIM.

3.4.3 SIM2000ST-E controller (primary)

Figure 7: SIM2000ST-E controller (primary)

The primary SIM has a number of special functions. This includes communication with the PLC to receive an inspection start signal and a result transmission.

4   Mounting

System requirements

Connection to the voltage supply and network
- Supply voltage according to the technical data
- PROFINET for communicating with the higher-level system

Operation site
- Closed room
- Flat and firm surface
- Low-vibration environment
- Protected from wind and free of drafts
- Clean and dry
- Ambient temperature according to the technical data

> **NOTE**
> Avoid strong temperature fluctuations.

> **NOTE**
> The cooling fins and fans of the SIMs must not be covered or restricted in their functionality.

> **NOTE**
> **Ambient light shielding**
>
> To achieve consistently reliable inspection results, even at different times, the complete inspection cell must, if necessary, be protected against ambient light.

Access and space requirements
- The measuring point must be accessible for installation, alignment, and maintenance work.
- Regardless of the space required for the devices, there must be enough space at the operation site for the following activities:
  - Mounting and alignment
  - Operation
  - Cleaning, maintenance, and service

Further topics

- Data sheet

5 Electrical installation

Important information

⚠️ **DANGER FROM ELECTRICAL VOLTAGE**
Touching live devices, which may still be energized, can lead to death, burns or electrical shock.

- ► Electrical work may only be performed on the system by qualified specialist personnel.
- ► Always connect equipotential bonding (earthing).
- ► Do not disconnect or remove the protective conductor.
- ► The voltage supply must be disconnected when attaching or detaching electrical connections.
- ► Before working on electrical components, observe the five safety rules:
    - o Disconnect.
    - o Secure against being switched back on.
    - o Ensure that there is no voltage.
    - o Ground and short-circuit.
    - o Cover or enclose live parts in the vicinity.

ⓘ **NOTE**
Observe the circuit diagram provided during commissioning.

6   Commissioning

Configuring the system

The initial commissioning is described in a separate document. The essential steps are:

- Installing and connecting the components
- System configurations:
    - IP addresses
    - Internal I/O ports
    - Controllers (SIMs)
    - Ranger3
    - PLC communication
    - Calibration data
    - Encoder
    - FTP
- Setting up the inspection objects and criteria
- Full backup
- Acceptance test

The necessary settings and parameters in the menus to configure the system are described in section Configuration of the secondary SIMs.

7 Operation

7.1 Structure of the user interfaces

Overview

The system has user interfaces with different functions:
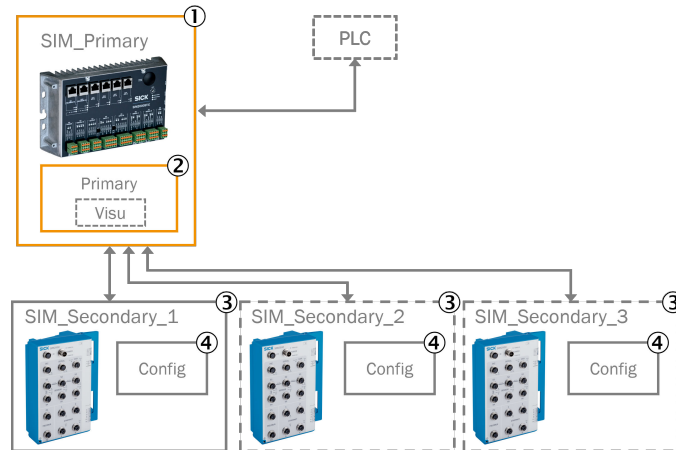
Figure 8: Structure of the user interfaces

① Controller

SIM2000ST-E (primary)

② Configuration of the primary SIM

- Access via browser

③ Controllers for the system heads

SIM2500 (secondary)

Optional: **SIM_Secondary_2** and **SIM_Secondary_3**

④ Configuration of the individual SIMs

- Access via browser

Main Page of the primary SIM

The Main Page of the primary SIM displays information on the system status or the status of the controller. The user **Run** can view the status of the overall system via the status messages. The display also shows the status of the system.

For activities such as configuration or adjustments, the **Authorized Client** user can log on directly to the respective controller (SIM).

IP address
- **SIM_Primary:** `http://192.168.0.10`

Visualization

The interface for **visualizing** the overall system is displayed for the operator on the primary SIM (connection via web browser).

Configuration

The inspections are **configured** via the respective web page of each individual secondary SIM. This is used to configure the Ranger3 cameras and articles, and to set up the inspections for each secondary SIM individually.

A computer must be connected to display the web pages. The IP address of the relevant page is opened via the computer using the browser.

Typical IP addresses of the SIMs (these may differ depending on the configuration):

IP addresses
- **SIM_Secondary_1**: `http://192.168.0.1`
- **SIM_Secondary_2**: `http://192.168.0.2`

7.2   System start

7.2.1   Switching on the system

As soon as the voltage is switched on, the devices are started. Both the startup of the cameras and the startup of the SIMs takes some time.

- ► To start up all components automatically, set Power to **On**.
- ✓ The message **Starting up** is displayed in the status bar. The system starts. The green LED symbol in the status line on the right indicates that the startup process is currently running without errors.

Status	Description
🟢	The system has started correctly and is now ready for performing inspections.
🔴	The system could not be started successfully. Diagnosis: • Test Article: Check whether the article was able to be loaded correctly. • App Status: The storage space on the device can be checked here. It also displays the status of all apps on the device. • Logger: Information about the system status can also be output in the logger.

7.2.2   Logging on to the system

Overview

The user logs on to the system on the SIMs.

The currently logged in user is displayed in the status bar at the bottom left. Depending on the current user level, there is a different role name to the right of the user icon.

Important information

ⓘ **NOTE**
If the **Stay logged in** option is not enabled in the login window, the default user **Run** is set at system startup.

User names and passwords

User level	Password
Maintenance	`main`
Run	

Procedure

- ► To initiate a user change, click on the user icon at the bottom left.
- ✓ The login window opens. The login window is shown with the drop-down menu open. The drop-down menu shows the names of the users configured in the sys-

tem. Depending on the application, this list may differ from the entries displayed here.
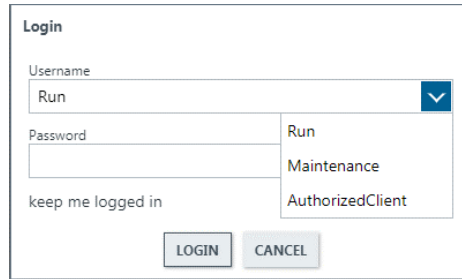
Figure 9: Login window and list of available users

► To select the desired name, click on the entry in the drop-down menu or enter the name directly.

Incorrect credentials

If an incorrect username or password is selected, or if the username or password is entered with a typo, the following message appears.
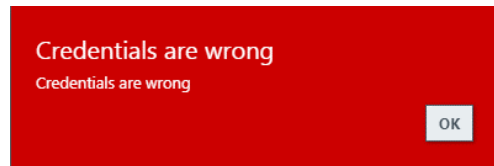
► Click OK to confirm the message and repeat the entries for logging in.

Automatic login

If the selected user should be logged in automatically at the next restart, the **Keep me logged in** option can be set.

> **!** **NOTICE**
> Make sure the selection is truly intentional. Especially when a user with higher rights is logged in, it may be necessary to reset this setting (deselect the checkbox) before exiting the system. Otherwise, when the system is restarted by the automatic login, configuration options may be available to other users that are not intended for them.

7.3 Common functions

The functions described below apply to all user interfaces.

7.3.1 Structure of the configuration interface

> **ⓘ** **NOTE**
> Depending on the status of the application, not all of the areas shown here may be present in the active window at all times.
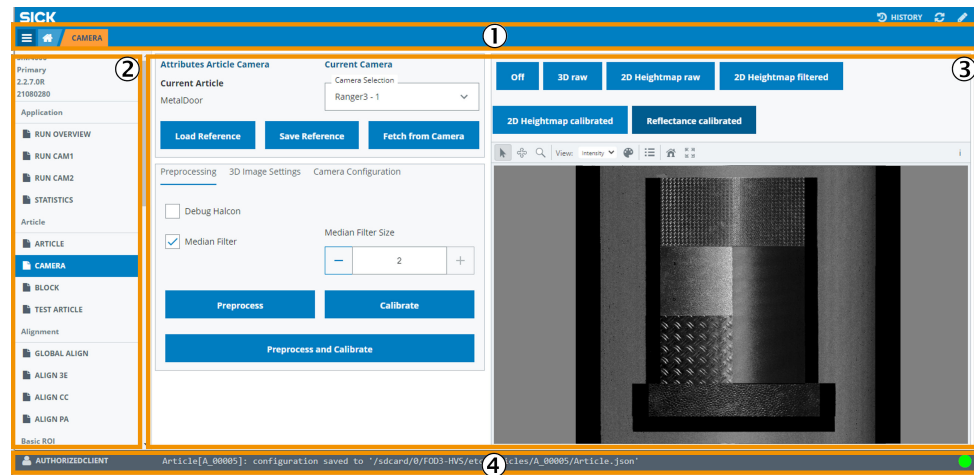
Figure 10: Structure of the user interface

①   Title bar

②   Menu area

③   Main window

④   Status bar

7.3.1.1   Title bar
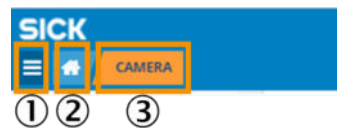
Figure 11: Title bar

Function	Description
①	Show and hide the operating menu.
②	Home button.
③	Displays the currently activated menu.

7.3.1.2   Menu area

The menu area contains the individual selection options for the functions of the system.

The entries displayed here may vary depending on the logged-in user. Only those menu items are displayed for which the user has the appropriate rights. Headings (menu groups) above a group of menu items are displayed even if the logged-in user has no rights for any of the submenus.

7.3.1.3   Main window

Application-specific information is displayed in the main window of the application. General information is displayed in the title of the main window.

Depending on the displayed area, the main window may appear divided into two parts.

- Left area: block for the actions for the selected menu item. This is where settings for the cameras, for articles, for image storage and transmission, etc. are configured.
- Right area: Image display.

7.3.1.4 Status bar

The status bar is present in all interfaces.

For the SIMs, the status refers to the respective component.

Figure 12: Status bar

Range	Description
①	The currently logged in user is displayed in the status bar at the bottom left. Clicking on the user name opens the login dialog, which can be used to log in as another user.
②	To the right of the displayed user is the status bar. The system displays messages to the user here (e.g., if a camera is not available). Each message in the status line is overwritten by the subsequent message. The messages are displayed here on one line. The last status entry always remains visible until a more current message is displayed. Example: The message "**Primary App: Ready to inspect article 01 with serial number 12345678**" is displayed on the status line. Once the article ID has been received by the FOS system, the FOS system confirms this to the PLC. The scan run is then started.
③	The LED symbol indicates the status of the respective SIM. The status of the overall system is displayed at the top next to the inspection results.

7.3.2 Application menu group

7.3.2.1 Settings page

The settings can be used to select the language, units, and display mode.

To change the settings, first click on the pencil symbol.
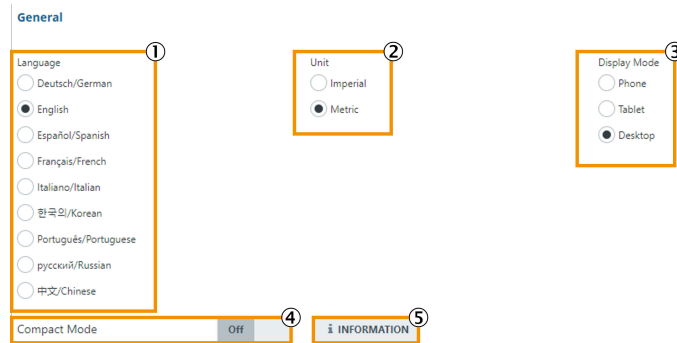
Figure 13: Menu/Settings

Function	Description
①	Select language
②	Select unit (Imperial/Metric)
③	Select display mode (Phone/Tablet/Desktop)
④	Select compact mode (On/Off) ⓘ **NOTE** | Compact mode is not available for this application.
⑤	Open an overview with information about the current application.

7.4 Operating the primary SIM (Main Page)

Overview

The Main Page of the primary SIM provides an overview of the system status and can be used to configure general system parameters.

The structure and layout of the menu area changes depending on the logged-in user.

▶ To open the Main Page of the inspection configuration, call up the following IP address via a computer connected over Ethernet:

`192.168.0.10`

7.4.1 Application menu group

7.4.1.1 Inspection page: sample application windows

No article selected

The following figure shows the display of the primary SIM if no article has been selected yet.

Before each inspection, a valid article must be selected by the PLC, i.e., an ID must be transferred. As long as the article selection has not been made, the message **No Article** appears.

Figure 14: Application window (no article selected)

Inspection OK

The following figure shows the display after a successful inspection.
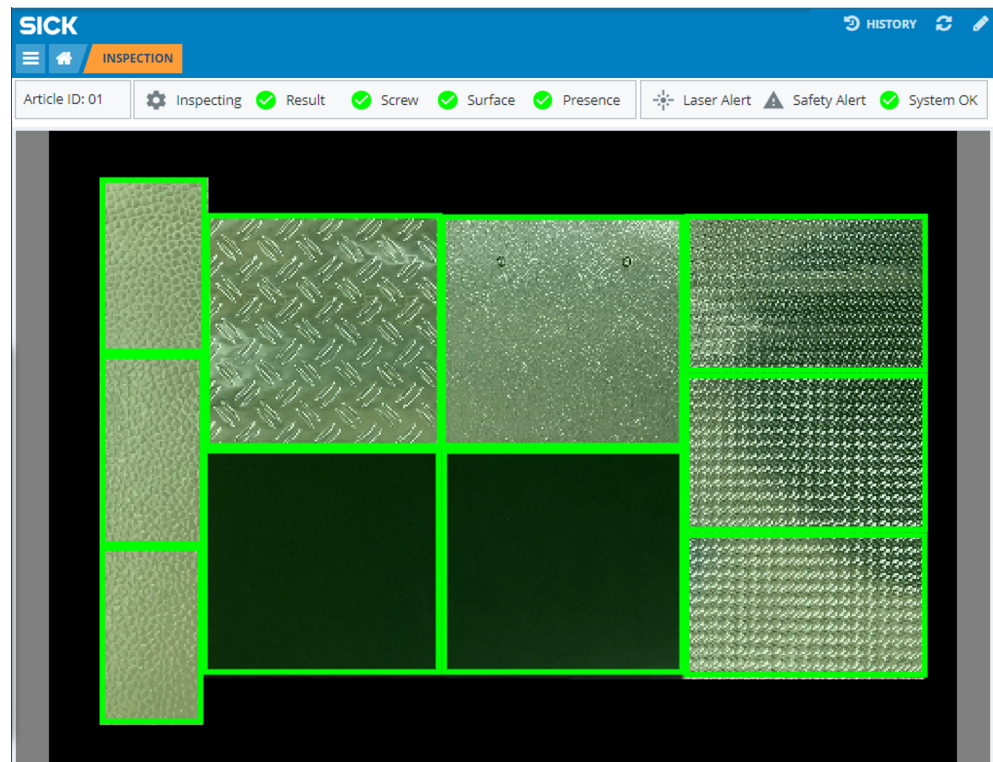
Figure 15: Inspection OK application window

Inspection NOK

The following figure shows the display if an error was detected in a block. In this case, an error has occurred during the screw inspection. This may be due, for example, to one or both screws not being present or being too short or too long. The region where an error occurred is shown here in red.
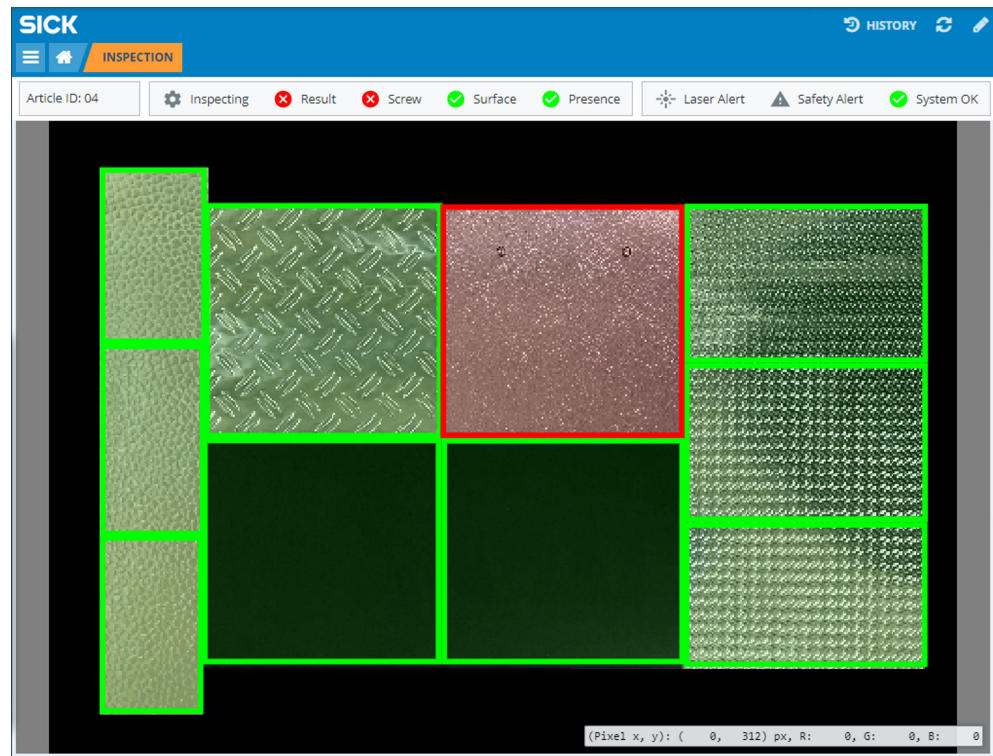
Figure 16: Inspection NOK application window

New inspection

The inspection details (depending on the inspection result) remain on the display until a new inspection is started. As soon as a new inspection is started, the blocks and their colorings are reset.
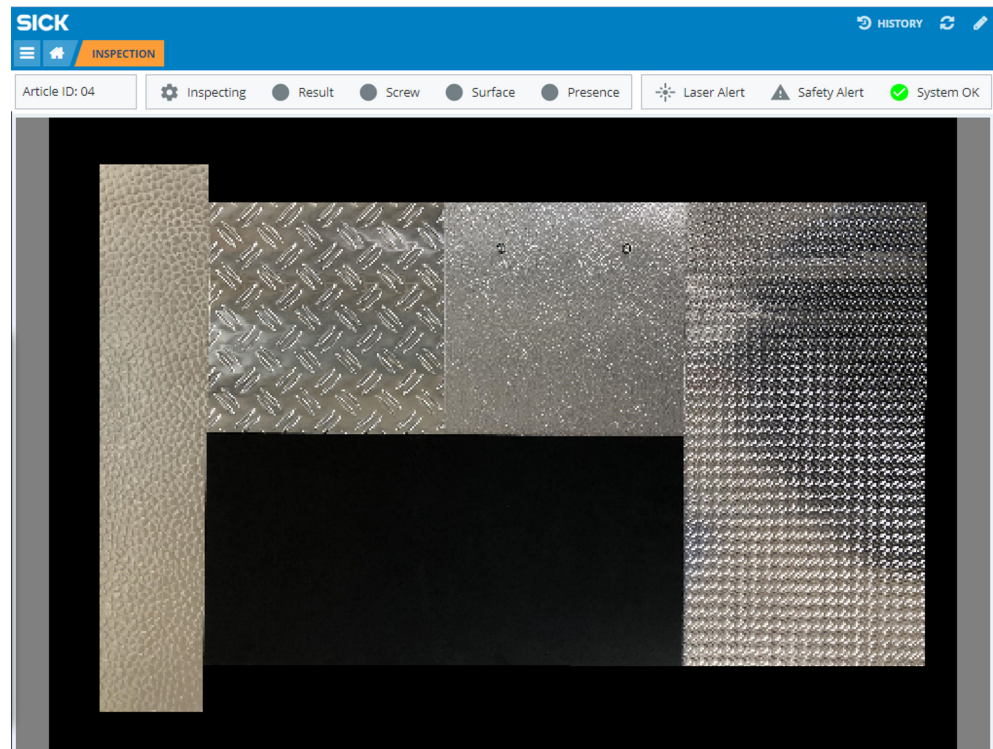
Figure 17: Application window when restarting an inspection

7.4.1.2 Status page

Status of the overall system

The Status page can be used to view the status of the overall system. The top line displays the article ID during operation. Next to it are the flags for displaying the system status.

The **Details** area displays detailed information about the last inspection.

Further topics

- System messages

7.4.1.3 Statistics page

The **Statistics** page displays the total statistics for the inspection results of the system as well as the statistics for the individual cameras per station.

The statistics are global, i.e. there is no differentiation by **Article ID**. The statistics are not saved and are only incremented if an inspection has been completed without a safety alert and a result is available.

The statistics are automatically set to 0 after clicking the **Reset** button and after switching the system off and on again.

7.4.1.4 PLC-Status page

The **PLC-Status** page displays information about the communication with the PLC. The page indicates whether there is a valid article present, and whether the inspection can be started or if there is a protection fault.

The **Status - Input (ControlBitsOut & DataOut)** and **Status - Output (ControlBitsIn & DataIn)** blocks show the states of the control bits and the data fields. The control bits are set to report the status of the system and the result of the last inspection to the PLC.

The **Status - Fieldbus** block shows information on the status of the fieldbus. If the fieldbus is connected, this is indicated by a green LED symbol.

7.4.1.5 PLC-Simulation page

The left part of the window under the **PLC-Simulation** menu item corresponds to the window in the **PLC-Status** menu.

The **Test** block contains settings for testing the system (for example, running tests without a PLC connected).

7.4.2 General menu group

The **General** menu group (App-State page, Logger page, System page and Info page) is described in the secondary SIM area (see "General menu group", page 65).

7.4.3 System messages

Status bar at top

Report/Display	Color	Description
Inspecting	Green	Inspection in progress.
	Gray	No inspection.
Result	Green	Inspection result pending and reports **OK**.
	Gray	No inspection result available.
	Red	Inspection result pending and reports **NOK**.

Report/Display	Color	Description
Screw	(In connection with the **Result** flag)	
(green check icon)	Green	The screw check reports **OK**.
	Red	The screw check reports **NOK**.
Surface	(In connection with the **Result** flag)	
(green check icon)	Green	The surface check reports **OK**.
	Red	The surface check reports **NOK**.
Presence	(In connection with the **Result** flag)	
(green check icon)	Green	The presence check reports **OK**.
	Red	The presence check reports **NOK**.

Report/Display	Description
System OK (green check icon)	• System functional • Connection between the devices is established
System OK (red alert icon)	• System not functional • Connection between the devices is not established
Safety Alert (red warning triangle)	Safety warning • Display of the text in the main window: **Safety Alert** • Icon on the icon bar is active (red) A safety warning means that a safety door is open or a safety light-beam sensor has been interrupted so any inspection that was started had to be aborted.
Laser Alert (yellow sun icon)	Laser warning • Display of the text in the main window: **Laser degrading! Exchange system head at <affected SIM> soon!** • Icon on the icon bar is active (yellow) This message is displayed when the **Check Laser** function has been set up for diagnostic purposes, and the expected minimum brightness value has not been reached several times in a row during operation. The laser warning does not have a direct effect on the inspection result. As soon as the laser brightness is sufficient, the system continues to run the inspections.

Center of image

Report/Display	Description
No Article	• No article selected yet • Sending of the article ID by the PLC is still pending • Article to be inspected has not yet been transmitted • The article is automatically transmitted to the application by the PLC when a high-voltage storage enters the final inspection
Not Ready	• System not ready for inspection
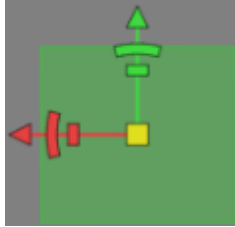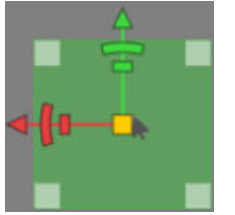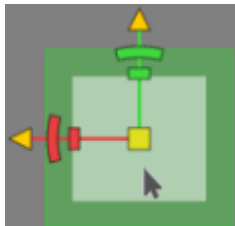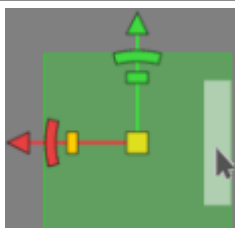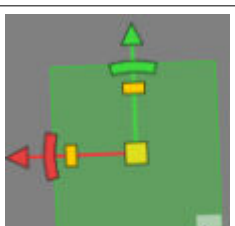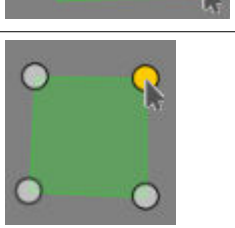
7.5 Inspection process and result display
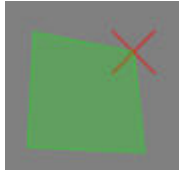
Report/Display	Description
(green gear icon)	The **Inspecting** status indicates that an inspection is in progress. When the inspection is started, a unique identifier is assigned to this inspection. This number consists of a time stamp from the date and time in the format YYYYMMDD_HHMMSS (year, month, day, hour from 00-23, minute, second).

7.6 Configuration of the secondary SIMs

7.6.1 Graphic operation

The following describes the graphic operations needed to set edges and regions.

Function	Description
	Click on an active region. A coordinate system is displayed with a green arrow and a red arrow. If this region is used to search for an edge, the search direction is in the direction of the red arrow.
	Move the mouse to the yellow square in the center while holding down the left mouse button. Move the mouse downwards. The region is reduced symmetrically about the midpoint of the region Move the mouse upwards. The region is enlarged symmetrically about the midpoint of the region.
	Clicking on the arc section while holding down the left mouse button opens the option to rotate the region. Moving the mouse to the right rotates the region clockwise. Moving the mouse to the left rotates the region counterclockwise.
	Move the mouse to the inner area of the region while holding down the left mouse button. The region can now be moved.
	Move the mouse to the border area. A gray rectangle appears. By clicking on the gray area. While holding down the left mouse button, this side can be moved to widen or narrow the region at the selected side.
	Move the mouse to a corner of the region. By clicking on the corner while holding down the left mouse button, the region can be zoomed in or out from the selected corner. The change is made on an imaginary straight line between the selected corner and the midpoint of the region. This option does not exist for the Ellipse region type.
	The circles mark the support points of this freeform region. When the mouse is moved over a circle, the circle is colored yellow. By clicking on the circle with the left mouse button and holding down the mouse button, this support point can be moved. Only for the Polygon region type.

Function	Description
	The cross marks the last point edited. This support point is the active support point. This is important for operations like Delete, Insert Before or Insert After (for the Polygon region type only).

7.6.2 Image display functions
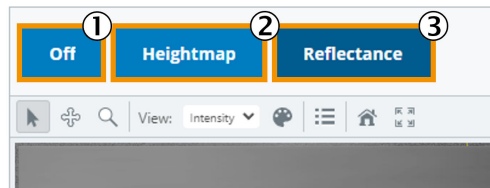
Figure 18: Configuration of the image displays

Button	Description
① Off	Turn off the image display.
② Heightmap	Displays the heightmap of the inspection object. In the high-resolution heightmap, equal heights are displayed in the same gray value. Areas of the inspection object that are closer to the camera (i.e., higher on the inspection object) appear lighter. Deeper areas appear correspondingly darker.
③ Reflectance	Displays a light/dark image (based on the reflection of the laser beam into the camera).

The operation using the functions described below in the icon bar above the image applies to the right-hand display window.

Button	Description
	Navigate in the image. Additional information is displayed at the bottom right of the screen.
	Reposition the displayed image or section in the display window. For positioning, it is sufficient to click in the image area (it is not necessary to click on the camera image). The mouse wheel can be used to enlarge/reduce the image section.
	Zoom: If the connected mouse does not have a rotary wheel, this function can be used to enlarge/reduce the image section. To zoom in, position the mouse pointer (magnifying glass icon) in the center of the image. Hold down the left mouse button and move the mouse pointer outward. To zoom out, position the mouse pointer (magnifying glass icon) at the edge of the image. Hold down the left mouse button and move the mouse pointer to the center of the image.
View	Only the **Intensity** setting is available.
	Color settings are not supported in the current version.
	Only the **Color range** setting is available.

Button	Description
🏠	Restore the default display settings.
⛶	Enlarge the image display to full screen mode. Press Esc to exit full screen mode.

7.6.2.1 Additional information about the image

```
(Pixel x, y): ( 1552,  1113) px, (World x, y, z): (  627.09,   488.33,   109.60) mm, Intensity:  4543.00
```

Figure 19: Additional information (Heightmap)

```
(Pixel x, y): ( 1567,  1116) px, (World x, y): (  633.67,   489.64) mm, Intensity:   146.00
```

Figure 20: Additional information (Reflectance)

Pixel x,y	Specifies the position of the mouse pointer. This corresponds to one pixel value. The origin of the coordinate system is in the upper left corner of the image. The x-values increase from left to right in the image according to the x-axis of a left-handed Cartesian coordinate system (x-values ≙ column values). The y-values increase from top to bottom (y-values ≙ row values).
World (x, y, z)	The two or three following values specify the distances from the current mouse pointer position (of the pixel currently selected by the mouse pointer) to the image origin in world coordinates. • The x-value represents the distance from the mouse pointer in the image to the origin (top left) in the horizontal direction (to the right). The unit of measurement is [mm] and specifies the actual distance of this point on the inspection object in the horizontal direction. • The y-value specifies the distance to the origin in the scan direction. The unit here is also [mm]. This applies to camera 1 of a system head as well as to camera 2. Although camera 1 captures its image looking backwards on its run, and camera 2 captures its image looking forwards on its run, the images are coordinated so that the operator always sees the same image and thus the same navigation in the image. • For the **Heightmap** image type: The z-value in this triple is the height value. This value is also given in the unit [mm] and thus in world coordinates. This height value outputs the actual value above the zero line of the camera. This zero line is set at the factory during calibration.
Intensity	For the **Reflectance** image type, the **Intensity** value represents a brightness value, i.e. how strongly the laser line was reflected. The value range is 0-255. For the **Heightmap** image type, the **Intensity** value is the uncalibrated z-value (height). The value has no relevance here, however, for operating and setting up the system.

A calibration of the system head with its two cameras ensures the output of values specified in world coordinates. The conversion factor from pixels into world coordinates is based on this calibration.

ⓘ **NOTE**
The calibration is valid for the conditions existing at the time of calibration. This includes the height of the system head above a reference on the inspection object as well as the X and Y alignment of the system head, and the alignment of the two cameras and the laser in a system head to each other. If one of these variables is changed by improper operation or by external influence, the evaluation may be impaired.

Since the system documented here is intended to detect small defects and thus small deviations from the normal state of an inspection object, even small changes in positioning can lead to deviations in the inspection.

7.6.3 Application menu group

7.6.3.1 Run Overview page

The **Run Overview** page shows the camera images for **CAM1** and **CAM2** side by side with the relevant color markings (see "Run Cam1 / Run Cam2 page", page 33).

7.6.3.2 Run Cam1 / Run Cam2 page

The **Run Cam1** and **Run Cam2** pages display the actual camera image together with the inspection regions if the **Display Used ROI** option is enabled. In this view, any errors found are highlighted in color (red). If no errors are found, the region is highlighted in green.

If a region in the schematic diagram is highlighted in color during an inspection, the reason for this result can be viewed on this page.

7.6.3.2.1 Test result display OK

If there are no deviations during an inspection and the inspection object is therefore evaluated as OK, the Result indicator appears green. The following figure shows the display during an inspection run in which no foreign objects were found in the displayed camera and the screw inspection was also successful.

Indication in the Result column
- **OK**: Region found/processing step successful
- **OK**: For OK test
- **ck OK**: Additional inspection for special regions OK
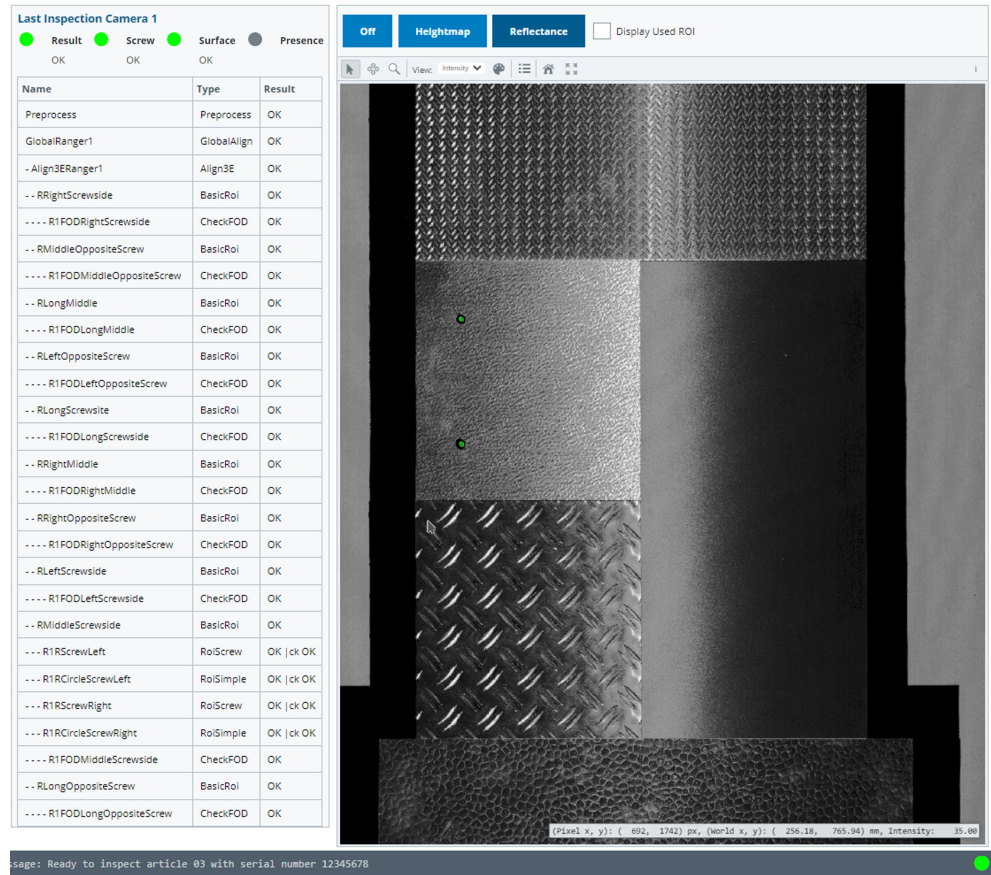
Figure 21: Inspection run: Inspection object OK - no foreign bodies present

7.6.3.2.2 **Test result display NOK**

The following figure shows an inspection where test foreign bodies have been applied and consequently many regions are highlighted in red. Several small cubes and a missing screw can be seen as foreign bodies in the image. The foreign body itself is highlighted in a darker red. If the Result indicator is red, deviations were detected during the inspection or foreign objects were found in the area.

Indication in the Result column
- **NOK**: Region not found/processing step not successful
- **NOK**: For NOK test
- **ck NOK**: Additional inspection for special regions NOK
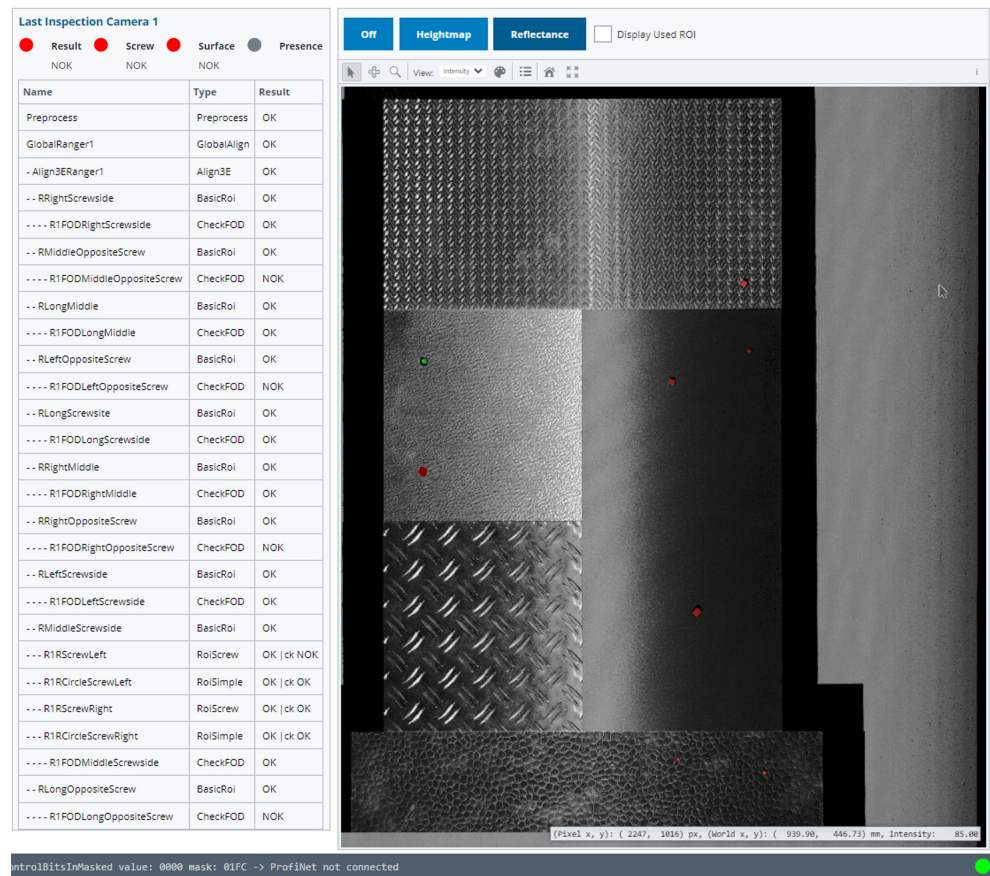
Figure 22: Inspection run: Inspection object NOK - foreign bodies present

> **NOTE**
> If many regions are displayed in red and no corresponding number of foreign bodies can be seen on the surface, it must be checked whether the determination of the coordinate system to which these regions are bound (alignment) may have been unsuccessful. The determination of a coordinate system is necessary to compensate for deviations of the position of inspection objects from the ideal position.

7.6.4 Statistics page

The **Statistics** page displays the statistics for the inspection results of the individual cameras at the respective station.

The statistics are global, i.e. there is no differentiation by **Article ID**. The statistics are not saved and are only incremented if an inspection has been completed without a safety alert and a result is available.

7.6.5 Article menu group

7.6.5.1 Article page

The **Article** page is used to manage articles (maintain and article, create or delete an article). The article to be edited (for which the alignment, ROIs, etc. are to be created or modified) can be selected on this page.

7.6.5.1.1 Articles

Function	Description
Add	Prepare new article. A working name is assigned to the article for this purpose. This name has the form New Article with a digit. Further editing of this article is done in the **Attributes Current Article** block.
Delete	Delete the article displayed in the drop-down menu. Before the article is deleted, a confirmation prompt is displayed.
Save all Articles	Save all changes made since the last save for all existing articles.
Clear Memory	Clean up memory on the device. This deletes from memory the configurations loaded for unused articles. The deletion does not, however, affect the information stored in the configuration.

7.6.5.1.2 Attributes Current Article

Function	Description
Article Name	Article description (freely selectable)
Article Extern ID (PLC Identification)	Identifier for communication with an external system (PLC). The PLC can use this ID to control the selection of an article. The ID is alphanumeric and comprises 1-4 characters (depending on the configuration) (e.g., A123).
Article IntKey	System-internal identification number, is generated automatically.
Upload Schema Image	This option can be used to load a schematic diagram into the system.

7.6.5.1.3 Backup/Restore Current Article

The settings of an article can be saved to an external location or loaded from an external location using this function.

The article backup is a zipped file and contains:

- the files describing the article (`Article.json`)
- a schema of the article (`ArticleSchema.png`)
- depending on the configuration of the system head, one or more reference images for the camera(s) (`Cam1_Reference_r3.json`, `Cam2_Reference_r3.json`)

Function	Description
Create	Create a backup file of the current article in the buffer memory of the SIM.
Download	Download the backup file from the buffer memory of the SIM to the computer.
Upload	Load the backup file into the buffer memory of the SIM using the file browser.
Restore	Replace the current article with the backup file.

7.6.5.1.4 Save current article

▶ To save the current article from the device to the buffer memory, click **Create**.
✓ A status message is displayed during editing. When the backup file has been created, the indicator changes to a green tick:

> **i** **NOTE**
> To save memory space, the backup file is now available for downloading for 60 seconds. After the 60 seconds have elapsed, the backup file is deleted.

▶ To save the backup file, click **Download**.

✓ A file browser window opens.
The suggested file name contains:
  o the content of the file (ArticleBackup)
  o the application name
  o the name of the device from which the backup originates
  o the article name
  o a time stamp (four-digit year, two-digit month, two-digit day, the milliseconds elapsed since the date change)
If the suggested file name for the backup is not customized, the file will be saved with the default name, e.g., `ArticleBackup-FOD3-HVS-SIM_Primary-ArticleSurfaceStruct-<YYYYMMDD>_<ms since 0:00>.zip`
The file names are therefore always unique, since a simultaneous backup (at the same millisecond) is not possible.

7.6.5.1.5 Load saved article

▶ To load the settings of an article from an external location, click **Upload.**
If a valid ZIP file is selected, processing is indicated by a progress bar. At the end of processing, a message appears informing you that the transfer of the newly loaded article will not be completed until you click the **Restore** button.

> ⓘ **NOTE**
> Before confirming, check the article name and article ID to make sure that the article you actually want is overwritten.

▶ To replace the existing article with the loaded one, click **Restore** and click **OK** to confirm.
Loading of the article is completed.
Clicking **Cancel** cancels the loading and does not overwrite the current article.

7.6.5.1.6 System parameters

Parameter	Description
Memory Usage (0..100%)	Current memory usage in % and remaining free memory in MB
Disk /sdcard usage (0..100%)	Current memory usage in % and remaining free memory in MB (SD card)
Disk /ram usage (0..100%)	Current memory usage in % and remaining free memory in MB (internal cache)

7.6.5.2 Camera page

Overview

The **Camera** page is used to select the desired camera for the relevant system head. A reference image can be saved and loaded here for the configured camera, or an image can be loaded from the camera.

Function	Description
Current Camera	Selection of the desired camera. ⓘ NOTE | Regardless of the system head, the two cameras of a system head are always designated Ranger3-1 and Ranger3-2. The camera mounted at the front of the system head during the scan and looking backwards at the high-voltage storage is the Ranger3-1 camera. The other camera is Ranger3-2.
Load Reference	Load the saved reference image of this camera.
Save Reference	Save the camera image as a reference image after the scan run is complete. The image is then available even after a system restart and can be reloaded using **Load Reference**.

Function	Description
Fetch from Camera	Capture an image directly from the camera. This function provides assistance during setup or maintenance mode.

Reference images

The reference image is required for setting up the inspections. It is recommended to take an image of an OK part as a reference image. This makes it easier to set the target values and the tolerances (e.g., for screw inspection).

7.6.5.2.1 Preprocessing tab

The **Preprocessing** tab is used to configure the settings for image preprocessing.

Function	Description
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE |** This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.
Median Filter	The Median filter is used for image preprocessing. This parameter must not be changed.
Median Filter Size	The filter size can be changed using the – and + buttons. The default setting is filter size 2.
Preprocess	Image preprocessing is used to improve the evaluability of the camera image.
Calibrate	Calibrate camera image.
Preprocess and Calibrate	Perform image preprocessing and calibration in one sequence.

7.6.5.2.2 3D Image Settings tab

The **3D Image Settings** tab is used to configure the 3D settings for the heightmap and height range.

Function	Description
Show 3D Heightmap	Show or hide 3D heightmap.
Decoration Mode	**User:** Apply the min/max values under **Decoration Mode User** for the height range in the captured image. **Auto Min/Max:** The system automatically determines the min/max values for the height range in the captured image.
Height Min Height Max	Set the height range in the captured image.
Decoration Mode Auto Min/Max	Display the values automatically determined by the system. This allows the min/max values to be determined by the system and the desired parameters based on these values to be subsequently set using the values in **Decoration Mode User** itself.

7.6.5.2.3 Camera Configuration tab

Camera configuration can be used to configure specific camera settings for each article.

ⓘ **NOTE**

Correct configuration of the article-specific camera parameters is crucial for a successful inspection. The buttons in the following table are therefore only available to operators with a permission level of **Authorized Client** or higher.

After the parameters have been appropriately configured for the article, the parameters must be read from the camera and saved in the article.

During each inspection and also when the execution plan is loaded, these parameters are read from the article configuration and loaded into the camera. This overwrites the current parameters on the camera.

Function	Description
Have Camera Configuration	Status indicator: Green when the article-specific parameters are loaded into the camera at the start of the inspection. ⓘ **NOTE │** If the status indicator is red or the display is missing, the parameters that are currently on the camera are used when starting the inspection. This configuration may be unsuitable for inspecting the current article.
Exposure Time (µs)	Display of parameter values
Multi Slope Mode	
Grab Timeout (s)	
Detection Threshold	
Number Profiles per Frame	
Fetch Camera Configuration	Load the current settings on the camera that work for the inspection of the current article from the currently selected camera into the article configuration. The previous settings in the article will be overwritten. ⓘ **NOTE │** When setting up a new article or making adjustments to an existing article, the **Fetch Camera Configuration** action must be performed for each camera. The article must then be saved. If multiple cameras are involved in the inspection of the article, the settings of all cameras must be loaded into the article configuration via this path once the article setup is complete. After that, the status indicator for the article-camera combination must be green.
Clear Camera Configuration	Delete the current parameters on the active camera.

7.6.5.2.4 Adjust configuration

The following procedure is recommended for adjusting the configuration:

► Select the desired article and camera.
► Transfer the configuration to the camera. This is done automatically at the start of an inspection run. This can also be done without an inspection by opening **Set Plan to Camera**. The button can be found on the page in the **Test Article** menu.
► Clear the existing camera configuration on the camera using the **Camera** page, **Clear Camera Configuration** action.
► Adjust the article-specific camera settings and verify the settings by means of test runs.
► Transfer the current parameters from the camera to the article configuration using the **Fetch Camera Configuration** action.
► Save the article.

7.6.5.3 Block page

The purpose of the blocks in the schematic diagram is to indicate in which area of the inspection object defects were found.

Blocks can be created and configured using the parameters described below.

Function	Description
Block	Currently selected block.

Function	Description
Add	Add new block.
Delete	Delete block.
Block Name	Input field for name assignment.
Display in Setup	Show block in schematic diagram (enabled by default).

Rectangle selection

The following configuration options are available for the **Rectangle** selection. The settings can also be adjusted directly in the image using the mouse.

Function	Description
Center X	X-value/column value of the midpoint of the rectangle. Larger values shift the midpoint to the right, smaller values to the left.
Center Y	Y-value/line value of the midpoint of the rectangle. Larger values shift the midpoint downward, smaller values shift it upward.
Height	Width of the rectangle. If this value is changed, the width is aligned symmetrically about the midpoint.
Width	Height of the rectangle. If this value is changed, the height is aligned symmetrically about the midpoint.
Angle	The angle determines the orientation of the rectangle. If the angle = 0°, the height is vertical and the width is horizontal. If the angle = 90°, the height is horizontal and the width is vertical.

Circle selection

The following configuration options are available for the **Circle** selection. The settings can also be adjusted directly in the image using the mouse.

Function	Description
Center X	X-value/column value of the midpoint of the circle. Larger values shift the midpoint to the right, smaller values to the left.
Center Y	Y-value/line value of the midpoint of the circle. Larger values shift the midpoint downward, smaller values shift it upward.
Radius	Radius of the circular block.

7.6.5.4 Test Article page

The **Test Article** page provides the ability to check the condition of the article. When an article is loaded, it can be inspected.

Function	Description
Test Article	Article is tested. The result is displayed in the status bar below the buttons. **No error, article is fine.:** Article loaded completely and correctly. **Article has errors. See error text for details.:** Article cannot be loaded. Article with this ID does not exist. In addition, a log of the article with detailed information is output in the display window on the right hand side.
Set Plan to Camera	Transfer the configuration data of the current article to the camera.

Function	Description
Article Extern ID	Enter the external identification number. This is used in the communication with the PLC.
From Current Article	Read the external article ID of the article currently active in the system so an inspection can be performed by clicking **Test Article**. The external article ID changes if the last inspected article is not the currently selected article.

7.6.6   Alignment menu group

To compensate for positioning deviations (i.e. a change in the positioning of the inspection object under the camera) and to compensate for manufacturing tolerances on the inspection object, the position and orientation of the entire inspection object or of special regions on the inspection object are determined and corrected in the camera image. This step is referred to below as **Alignment** or **Align**.

A coordinate system for the entire inspection object, or multiple coordinate systems for special regions on the inspection object are taught in based on the reference image. The coordinate systems serve as the basis for the position and orientation of all other regions and inspections on the camera image.

During the inspection, these coordinate systems are localized on the current camera image and the position and orientation of the inspection object are thereby corrected for the other regions and inspections.

The following procedures are available:

- Global Align
- Align 3E
- Align CC
- Align PA

7.6.6.1   Higher-level functions

The following general functions are identical for the different alignment types:

Function	Description
Create	Create a new object of type Alignment (depending on the current menu item **Global Align**, **Align 3E**, **Align CC** or **Align PA**).
Delete	Delete the active alignment. ⓘ **NOTE** | No additional confirmation prompt appears.
Duplicate	Duplicate the active alignment. This can be used, for example, to transfer an alignment to another camera. The teach-in status is also applied.
Teach	Apply current settings. ⓘ **NOTE** | Changes to the **3E**, **CC** and **PA** alignment that were performed in areas below must first be applied by clicking **Select** (**Common** tab). Otherwise, the previously valid state is applied.
Teach State	The teach-in status changes from red ❌ to green ✅ once the settings have been applied.
Global Align State	Display for the alignments **3E**, **CC** and **PA** whether global alignment is set up and working.

7.6.6.2   Global Align page

The global alignment returns the origin of the coordinate system in the upper area of the camera image. A separate global alignment can be used for each article.

The global alignment must be followed by one of the three alignments (**3E, CC, PA**). Each region to be checked expects an alignment as an input parameter.

7.6.6.2.1 Common tab

Function	Description
Name Global Alignment	Input field for name assignment.
Camera Selection	Selection of the desired camera.
Identity	If the **Identity** option is enabled, the transformation matrix of the identical 2D image is used. In this case it is not necessary to apply the settings (the **Teach** button is inactive).

7.6.6.2.2 Options tab

Function	Description
Display Alignment Anchor	Show the coordinate system icon at the origin of the global alignment.
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE |** This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.6.3 Align 3E page

Overview

The abbreviation **3E** stands for an alignment over the 3 search edges (3 edges) that are used to scan the inspection object.

First, a straight line is placed through the midpoints of edges 1 and 2. Then, starting from the midpoint of edge 3, a straight line orthogonal to the first straight line is determined.

In the following figure, the edges of the first straight line are located on the bar that is perpendicular in the image (marked ① in the image). The edge of the orthogonal straight line (marked ② in the picture) is located at the bottom edge of the inspection object.

The midpoints of the edges are represented in the image by a red cross. The determined straight lines by orange lines.

Using this combination, it is possible to determine an origin and an angle for a coordinate system that describes the position and orientation of the inspection object in the camera image. This coordinate system is shown in turquoise in the image. The origin and the angle of the axes to the image edges give the position and orientation of the inspection object.
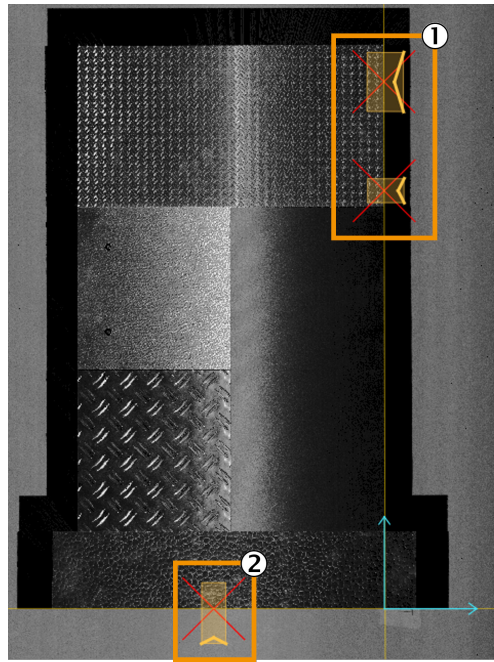
Figure 23: Align 3E

Procedure

If one or more alignments of type **Align 3E** have already been created, then this/the first one from the drop-down menu is displayed under **Current Align 3E**.

▶ Click the **Create** button.
▶ The input field for assigning a name to the **Align 3E** in the **Common** tab becomes active.
▶ Enter a unique name in the **Name Align 3E** field.
▶ Assign a global alignment via the drop-down menu.
▶ Click **Select** to confirm.
▶ To apply the settings, click **Teach**.

7.6.6.3.1 Common tab

Function	Description
Name Align 3E	Input field for name assignment. The entered name is preceded by an abbreviation to indicate the camera ([**C1**],[**C2**]). In addition, an abbreviation indicating the alignment type ([**3E**], [**CC**], [**PA**]) is prefixed.
Global Align Selection	Assign the global alignment.
Select	Apply the changes.

7.6.6.3.2 Options tab

The **Options** tab is used to set the display or maintenance parameters.

Function	Description
Display found Edge Points	Show the found scanning point of the edge using a red cross.
Display Alignment Anchor	Show the alignment coordinate system.
Display Perpendicular Line	Show the straight line through the edge points 1 and 2 (horizontal straight line in this example).

Function	Description
Display Straight Line	Show the straight line through edge point 3 (a perpendicular line in this example).
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE**	This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

While the edges have not yet been correctly positioned and taught in, the teach-in result

for the edges **Edge 1** to **Edge 3** is shown with the symbol ❌ . The edges are positioned on the tabs **Edge 1** to **Edge 3**.

7.6.6.3.3 Edge 1, Edge 2 and Edge 3 tabs

Overview

The **Edge 1**, **Edge 2** and **Edge 3** tabs are used to set the edges for alignment.

To activate the search rectangle for the edge layout of the first edge, click the **Edge 1** tab.

The search rectangle is displayed as a filled green rectangle:
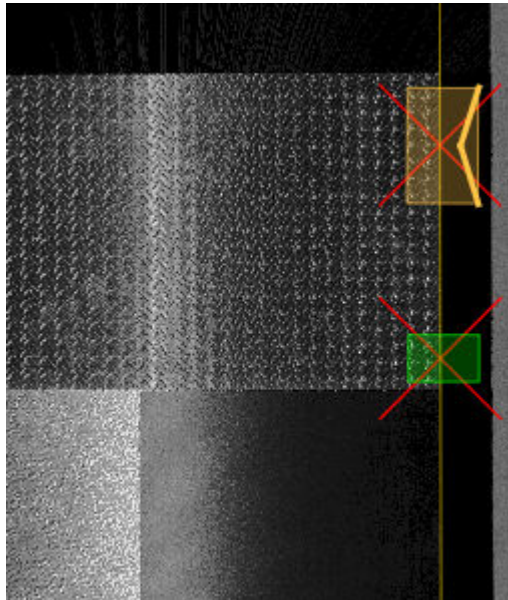
ⓘ **NOTE** | If the search region is not displayed in the image, the zoom factor may be too large and the region is outside the display area. Decrease the zoom factor to view and move the region.

Now resize, position, and orient the rectangle manually or use the numeric input fields on the tab.

Additional input parameters

Table 1: Transition

Function	Description
All	All height differences (contrast differences) are searched for. • Dark areas ≙ deeper • Bright areas ≙ higher
Negative	Contrast transitions from light to dark are searched for.
Positive	Contrast transitions from dark to light are searched for.

Table 2: Selection

Function	Description
All	All edges found will be used. ⓘ **NOTE ❘** If multiple edge points are found, the system will no longer work. It is therefore recommended not to use this option.
First	The first edge found in the search direction is used.
Last	The last edge found in the search direction is used.

7.6.6.4 Align CC page

Align CC stands for an alignment determined by searching two circular structures (e.g. holes) on the inspection object. The midpoint of each of these circles is determined.

The first midpoint of the circle is used as coordinate origin. A straight line is then drawn from this point through the midpoint of the second circle. This connecting straight line through the midpoint of the circles determines the orientation of the coordinate system.

7.6.6.4.1 Common tab

The configuration options in the **Common** tab are the same for the alignment types **3E**, **CC** and **PA** (see "Common tab", page 43).

7.6.6.4.2 Options tab

The **Options** tab is used to set the display or maintenance parameters.

Function	Description
Display found Circle Points	Show the found midpoints of the circles in the image.
Display Alignment Anchor	Show alignment anchor.
Display Line between Circle Points	Show the straight line between the midpoint of the circles.
Display Circle Region	Show the circle region.
Display Intermediate Region	Show the intermediate region.
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE ❘** This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.6.4.3 Center Circle tab

The **Center Circle** tab is used to specify the parameters of a search rectangle for determining the midpoint of the first circle.

Function	Description
Center X	X-value/column value of the midpoint of the rectangle. Larger values shift the midpoint to the right, smaller values to the left.
Center Y	Y-value/line value of the midpoint of the rectangle. Larger values shift the midpoint downward, smaller values shift it upward.
Width	Width of the rectangle. If this value is changed, the width is aligned symmetrically about the midpoint.
Height	Height of the rectangle. If this value is changed, the height is aligned symmetrically about the midpoint.
Angle	The angle determines the orientation of the rectangle. If the angle = 0°, the height is vertical and the width is horizontal. If the angle = 90°, the height is horizontal and the width is vertical.
Height Min	Minimum height value of the HVS surface within the search rectangle.
Height Max	Maximum height value of the HVS surface within the search rectangle.
Smallest Outer Diameter	Minimum outer diameter of the circle.

7.6.6.4.4 Angle Circle tab

The **Angle Circle** tab is used to specify the parameters of a search rectangle for determining the midpoint of the second circle.

Function	Description
Center X	X-value/column value of the midpoint of the rectangle. Larger values shift the midpoint to the right, smaller values to the left.
Center Y	Y-value/line value of the midpoint of the rectangle. Larger values shift the midpoint downward, smaller values shift it upward.
Width	Width of the rectangle. If this value is changed, the width is aligned symmetrically about the midpoint.
Height	Height of the rectangle. If this value is changed, the height is aligned symmetrically about the midpoint.
Angle	The angle determines the orientation of the rectangle. If the angle = 0°, the height is vertical and the width is horizontal. If the angle = 90°, the height is horizontal and the width is vertical.
Height Min	Minimum height value of the surface of the inspection object within the search rectangle.
Height Max	Maximum height value of the surface of the inspection object within the search rectangle.
Smallest Outer Diameter	Minimum outer diameter of the circle.

7.6.6.5 Align PA page

Align PA is an alignment for determining the position and orientation of objects on the surface (pads, etc.). This can then be used, for example, to align areas that are not to be checked.

First, an object is searched for that corresponds to the settings (minimum and maximum area, minimum and maximum height above the base height applicable in the search region). The (geometric) center of gravity and the orientation of the major axis of the found object then give the origin and the orientation of the coordinate system.

7.6.6.5.1   Common tab

The configuration options in the **Common** tab are the same for the alignment types **3E**, **CC** and **PA** .

7.6.6.5.2   Options tab

The **Options** tab is used to set the display or maintenance parameters.

Function	Description
Display found Region	Display the surface used to determine the origin and orientation of the coordinate system in the image.
Display rejected Region	Show the region that is not in use.
Display Alignment Anchor	Show the alignment coordinate system.
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Debug Halcon	This option supports system maintenance and further development. ⓘ NOTE	This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.6.5.3   Parameters tab

Function	Description
Offset Ground Min	Minimum height of objects above the base height of the search region used for the search.
Offset Ground Max	Maximum height of objects above the base height of the search region used for the search.
Area Min	Minimum area that must be fulfilled by the object to be found.
Area Max	Maximum area that must be fulfilled by the object to be found.
X-Length Min	Minimum extension in the X dimension.
X-Length Max	Maximum extension in the X dimension.
Y-Length Min	Minimum extension in the Y dimension.
Y-Length Max	Maximum extension in the Y dimension.
Opening Rect Length X Opening Rect Length Y	The parameters are used to eliminate small defects near the objects found. This makes the position and orientation of the coordinate system more stable.

7.6.6.5.4   ROI tab

The search region can be created as a rectangle or an ellipse. The detailed descriptions for a rectangular search region or for an elliptical region can be found in the section **Basic ROI** .

7.6.6.5.5   Symmetric Blob tab

In the case of symmetrical objects, the angle determined for the reference object and the inspection object may differ by +-180°. All regions linked to this alignment are then also rotated by +-180°. This can be prevented using the settings on the **Symmetric Blob** tab.

Function	Description
Adjust Angle to Half Circle	Activates the limitation of the angle to a semicircle (e.g. 180°). This angle can be entered manually or determined automatically.

Function	Description
Set from Current Teach Angle	Apply the automatically determined angle.

7.6.7 Basic ROI menu group

The check for foreign bodies is always carried out in base regions. Base regions can optionally also contain special regions of type **ROI Simple**, **ROI Circle**, **ROI Screw** or **ROI Seal** (see "Special Feature menu group", page 51). No check for foreign objects is generally performed in these regions, but instead special inspections.

7.6.7.1 Basic ROI page

Overview

The **Basic ROI** page is used to create a region as a basis for checking for foreign objects. The surface of an inspection object is typically divided into different regions. The system supports three different types of regions:

- **Rectangle**: rectangular region
- **Ellipse**: circular region
- **Polygon**/freeform region: arbitrary number of points to describe irregular regions

General functions

Function	Description
Create	Create a new object of type Region (type Rectangle, Ellipse or Polygon).
Delete	Delete the active region.
Duplicate	Duplicate the active region. This allows the copy of this region to be used by moving it to another location or transferring it to another camera.
Teach	Apply current settings. The teach-in status changes from ❌ to ✅ once the settings have been applied. ⓘ **NOTE** | For all changes in the **Common** and **ROI** tabs, the **Teach** button must be pressed to apply the changes.

7.6.7.1.1 Common tab

Function	Description
Name Basic ROI	Input field for name assignment. The entered name is preceded by an abbreviation to indicate the camera ([**C1**],[**C2**]).
Alignment Selection	Select the alignment to which this region will be attached. Apply the selection by clicking the **Select** button. Once the region has been assigned to an alignment, the graphical layout can occur. By default, a region of type Rectangle is shown (in this case a square with a 300 mm edge length). The upper left point is 100 mm away from the upper left edge of the image in both dimensions (x and y).

Function	Description
Block Selection	Select a block in the schematic diagram. Apply the selection by clicking the **Select** button. As soon as an inspection in a region in this block leads to an NOK result, the selected block is shown in red on the display. Several inspections can be assigned to the same block in the schematic diagram (both inspections use the same block for display). This is the case if, for example, a check for foreign bodies is to be performed in one region and a check for screws is to be performed in a neighboring region or a region within the region. The display changes from ❌ to ✅ once the settings have been applied.
Name Block	Display the currently valid selection.

After clicking the **Teach** button, the ROI is displayed.

ⓘ **NOTE** | If the search region is not displayed in the image, the zoom factor may be too large and the region is outside the display area. Decrease the zoom factor to view and move the region.

7.6.7.1.2 Options tab

The **Options** tab is used to set the display or maintenance parameters.

Changes on this page do not affect the status of the taught-in parameters. The status of the system (indicated by the teach-in status) remains unchanged when changes are made here.

Function	Description
Display ROI	Show region (enabled by default).
Display Result Region	Show result region.
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE**	This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.7.1.3 ROI tab

The radio button can be used to choose between rectangle, ellipse, and polygon.

Rectangle selection

The following configuration options are available for the **Rectangle** selection. The settings can also be adjusted directly in the image using the mouse.

Function	Description
Center X	X-value/column value of the midpoint of the rectangle. Larger values shift the midpoint to the right, smaller values to the left.
Center Y	Y-value/line value of the midpoint of the rectangle. Larger values shift the midpoint downward, smaller values shift it upward.
Width	Width of the rectangle. If this value is changed, the width is aligned symmetrically about the midpoint.

Function	Description
Height	Height of the rectangle. If this value is changed, the height is aligned symmetrically about the midpoint.
Angle	The angle determines the orientation of the rectangle. If the angle = 0°, the height is vertical and the width is horizontal. If the angle = 90°, the height is horizontal and the width is vertical.

Ellipse selection

The following configuration options are available for the **Ellipse** selection. The settings can also be adjusted directly in the image using the mouse.

Function	Description
Center X	X value/column value of the midpoint of the ellipse. Larger values shift the midpoint to the right, smaller values to the left.
Center Y	Y-value/line value of the midpoint of the ellipse. Larger values shift the midpoint downward, smaller values shift it upward.
Angle	The angle determines the orientation of the ellipse. For an angle = 0°, radius 1 changes the width of the ellipse and radius 2 changes the height. For an angle = 90°, radius 1 changes the height of the ellipse and radius 2 changes the width.
Radius 1	Radius along the major semi-axis of the ellipse.
Radius 2	Radius along the minor semi-axis of the ellipse. ⓘ **NOTE** If the same value is selected for radius 1 and radius 2, a circle is created.

Polygon selection

The points of a polygon are numbered in ascending order from the starting point (point 1). When inserting or deleting points, a renumbering occurs.

The points can be positioned graphically or using the adjustments described below.

Function	Description
Points Current Point Index	Select the next point to be edited from the drop-down menu.
Current Point X	X-coordinate of the active point. Larger values move the point to the right, smaller values to the left.
Current Point Y	Y-coordinate of the active point. Larger values move the point down, smaller values move it up.
Insert Before	Insert a point before the current point in the sequence (midway between the two previously adjacent points). If the current point has the number 1, the new point will have the number 1. ⓘ **NOTE** In the default rectangle when creating a new freeform region, the points are numbered clockwise (point 1 = upper left point). By moving the individual points, however, it is possible to have the points numbered in counterclockwise ascending order. This must be taken into account when inserting.
Insert After	Insert a point after the current point in the sequence (midway between the two previously adjacent points). The new point is given an index that is 1 higher than the current point. The subsequent list of points is renumbered in ascending order.

Function	Description
Append At End	Regardless of the current point, insert a point at the end of the sequence (midway between the last point and point 1).
Delete Point	Delete current point. The subsequent point then becomes the active point and receives the number of the deleted point. If the current point is the last point of the sequence, the second to last point becomes the new active point. When only four points remain, the button becomes inactive.
Delete Last Point	Delete last point in the sequence. If the current point is the last point of the sequence, the second to last point becomes the new active point. When only four points remain, the button becomes inactive.
Turn Ratio in Degrees	Rotation of the entire polygon. The **Turn Ratio in Degrees** value defines the angle of rotation.
Turn +	Rotate the polygon clockwise by the rotation angle.
Turn -	Rotate the polygon counterclockwise by the rotation angle.
Turn +90°	Rotate the polygon clockwise by 90°.
Turn -90°	Rotate the polygon counterclockwise by 90°.
Mirror Vertical	Vertical mirroring of the entire polygon
Mirror Horizontal	Horizontal mirroring of the entire polygon

7.6.7.2 Selector page

The **Selector** page provides assistance during setup operation. The aim of the selector is to be able to quickly change regions. This can also be done for other cameras using the **Camera Selection** drop-down menu.

The image in the right-hand column is mouse sensitive. By clicking on a region in the image, that region is selected and its parameters are displayed on the left-hand side.

Function	Description
Camera Selection	Select camera.
Reload	Reload article. All unsaved changes are lost.
Basic ROI Selection	Display or selection of the base ROI.
Special Feature Selection	Display or selection of the special region.
Check Selection	Display or selection of the inspection.
Set to Current	Apply changes to the respective area. By applying, the corresponding settings are loaded in the system. Switching to other menu pages updates the settings of the pages to the defaults set here.
Go to Page	Switch to the respective editing page.

7.6.8 Special Feature menu group

The **Special Feature** menu group brings together different types of special regions. These are used to exclude from a region areas where inspection is not performed or is performed with different settings. This allows specific objects in a region (such as screws or rivets) to be omitted and then treated separately as required.

These special functions are:

- ROI Simple
- ROI Circle

- ROI Screw
- ROI Seal

7.6.8.1   Higher-level functions

Function	Description
Align State	The status indicates whether the alignments associated with the special feature have been successfully applied.
Teach State	The teach-in status changes from red ❌ to green ✅ once the settings have been applied.

7.6.8.2   ROI Simple page

Overview

The **ROI Simple** function can be used to exclude self-created regions in an evaluation region.

Example

In one region there is a hole for a screw. This hole and the screw inside it should not be detected as a foreign object when searching for foreign objects. This region is therefore excluded from the check.

To do so, a special **ROI Simple** region is created and placed on the screw. It is the operator's responsibility to ensure that this region is placed on the correct base ROI! Verification by the system is not possible.

7.6.8.2.1   Common tab

Function	Description
Name ROI Simple	Input field for name assignment.
Basic ROI Selection	Select the basic ROI from which the respective region is to be subtracted. In the drop-down menu, you can select from the regions already available. Apply the selection by clicking the **Select** button.
Select	Apply the selection.
Activated	Enable/disable the region that has been set up (enabled by default).

After clicking the **Teach** button, the ROI is displayed.

ⓘ **NOTE** | If the search region is not displayed in the image, the zoom factor may be too large and the region is outside the display area. Decrease the zoom factor to view and move the region.

7.6.8.2.2   Options tab

The **Options** tab is used to set the display or maintenance parameters.

Function	Description
Display ROI	Show region (enabled by default).
Display Result Region	Show result region.
Display Difference Region	Show difference region.
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.

Function	Description
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE** ❘ This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.8.2.3 ROI tab

The radio button can be used to choose between **Rectangle**, **Ellipse** or **Polygon**.

When the recess (in this example **Ellipse**, circular) has been created and placed over the screw hole, this region can be applied by clicking the Teach button (analogous to a base ROI, see "Basic ROI page", page 48).

The evaluation region is displayed transparently filled with yellow to indicate that an area is omitted in this region. The recessed area is displayed with a green outer contour. The area of the recessed region is displayed in transparent blue.
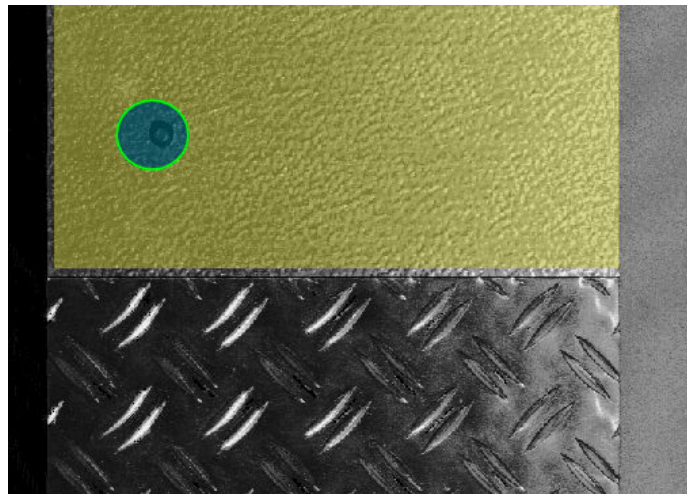
Figure 24: Base ROI display with recess

7.6.8.3 ROI Circle page

The **ROI Circle** function can be used to automatically exclude circular areas (e.g. cable grommets, rivets, flanges or holes for screws or centering pins) in a specified evaluation region. Typically, these objects are characterized by being raised above the HVB surface. This could cause them to be mistakenly identified as foreign bodies. **ROI Circle** offers the possibility to teach-in several similar objects (e.g. sills with several identical flanges) in one step. In addition, a check for foreign objects can be activated for the flanges that have been found.

7.6.8.3.1 Common tab

Function	Description
Name ROI Circle	Input field for name assignment.
Basic ROI Selection	Select the base ROI from which the respective region is to be subtracted. In the drop-down menu, you can select from the regions already available. Apply the selection by clicking the **Select** button.
Block Selection	Select block. Recommendation: Select the same block as for the base ROI.
Activated	Enable/disable the region that has been set up (enabled by default).

After clicking the **Teach** button, the ROI is displayed.

ⓘ **NOTE** | If the search region is not displayed in the image, the zoom factor may be too large and the region is outside the display area. Decrease the zoom factor to view and move the region.

7.6.8.3.2 Options tab

The **Options** tab is used to set the display or maintenance parameters.

Function	Description
Display ROI	Show region (enabled by default).
Display Result Region	Show result region.
Display Difference Region	Show difference region.
Display Flange Region	Show flange region.
Display Foreign Bodies	Display foreign objects found.
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE**	This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.8.3.3 Parameters tab

The parameters in this tab control the automatic finding of circles.

Function	Description
Search Objects	Parameters for object search **Light:** Circles to be found automatically are brighter and thus higher than the surroundings in the region. **Dark:** Circles to be found automatically are darker and thus deeper than the surrounding area in the region. ⓘ **NOTE**	Image processing refers to height differences, which are displayed as brightness differences in the heightmap.
Check Mode	Check mode **Dynamic:** Check mode for inhomogeneous surfaces with varying height. **Absolute:** Check mode for planar surfaces with a uniform height. The search mode setting affects the tabs **Param. Dynamic** and **Param. Absolute**. Only the available parameters of the selected search mode are activated.
Height Min	Minimum height at which the circles for the recesses must be located. This value indicates how far (in mm) the circle region must be above the surrounding surface.

Function	Description
Diameter Min	Minimum diameter (in real measure [mm]) of the circles to be searched. Smallest possible value: 1.0. Only those circles that meet the previous conditions and have the minimum diameter specified here are searched for. ⓘ **NOTE** | The diameter must not be chosen too small, as this can cause circles to be placed in structures that do not correspond to the desired circles. These circles result from the selected parameters and the inhomogeneous surface of the inspection object. The number of circles found and the number of circles expected therefore do not match.
Diameter Max	Maximum diameter (in real measure [mm]) of the circles to be searched. Only those circles that meet the previous conditions and have the minimum diameter specified here are searched for. ⓘ **NOTE** | The diameter must not be chosen too large, as this can also cause circles to be placed between contours in regions that do not correspond to the desired recess regions.
Number Expected Circles	Number of expected circles.

7.6.8.3.4 Param. Dynamic tab

In dynamic check mode, the flanges are found by blob extraction. The following parameters can be set for the dynamic check mode.

Function	Description
Mask Width	Width of the circle search mask.
Mask Height	Height of the circle search mask.
Median Filter	For the median filter, the size in the **Median Filter Size** field is used. The filter is applied to the region. Parameter cannot be edited.
Median Filter Size	Size of the median filter. Parameter cannot be edited.
Fill-Up NoData	**NoData** pixels are padded with the height value from the surrounding pixels. Parameter cannot be edited.
Fill-Up Lowest Height	Threshold value above which fill-in takes place. Values that are smaller are set to a new (larger) height. This new height corresponds to the most common grayscale value (height value) in the region. Parameter cannot be edited.

7.6.8.3.5 Param. Absolute tab

In absolute check mode, the flanges are found by a plane fit. The following parameters can be set for the absolute check mode.

Function	Description
Planefit Most Gray	Enable/disable pre-processing by inserting a calculated planar level into the search area. This option restricts the values for the plane fit. By default, all pixels within the ROI are used for this purpose. This option creates a histogram (the height/gray value). Only those points are used whose height is within the range around the most frequent value.

Function	Description
Most Gray Offset Min	Lower limit for plane fit processing.
Most Gray Offset Max	Upper limit for plane fit processing.

7.6.8.3.6 Flange tab

The **Flange** tab is used to perform a foreign object check on the flange. Since a flange is higher than the surrounding area, it must be defined so that it is not itself recognized as a foreign object.

Function	Description
Activated	Activate/deactivate foreign object detection on the flanges.
Elongation Min	Minimum extension of foreign bodies on the flanges.
Height Min	Minimum height (in mm) of foreign bodies on the flanges.
Erosion Size	This reduces the outer and inner contour of the flanges to avoid incorrect measurements.

7.6.8.3.7 ROI tab

The detailed descriptions for a rectangular, elliptical or polygon region can be found in the **Basic ROI** .

7.6.8.4 ROI Screw page

The **ROI Screw** function is used to set up a screw check. The screw check can be used to check whether a screw is present at the relevant position and has been inserted correctly.

7.6.8.4.1 Common tab

The configuration options in the **Common** tab are the same as those described in the **ROI Circle** menu .

7.6.8.4.2 Options tab

The configuration options in the **Options** tab are the same as those described in the **ROI Simple** menu .

7.6.8.4.3 Parameters tab

The **Parameters** tab is used to enter the set values for the screw check.

Function	Description
Screw Diameter	Screw diameter. Everything larger than the set diameter is segmented within the ROI.
Hole Diameter	Hole diameter. A circle with the hole diameter is subtracted from the ROI. The reference height is determined in the remaining circular ring.
Screw Height Nominal	Nominal height that the screw protrudes above the surrounding region.
Screw Height Lower Tolerance	Height tolerance (in mm), which specifies how far down (screw protrudes less) the area can be before the test is output as NOK.
Screw Height Upper Tolerance	Height tolerance (in mm), which specifies how far up (screw protrudes further) the area can be before the test is output as NOK.
Screw Height (calculated)	Calculated value (in mm) of the screw height.

> **NOTE**
> Screws must protrude at least 4 mm so that they can be segmented reliably and the protrusion height can be measured.

Example

A nominal height of 6 mm is required to have a tolerance of 1 mm at the bottom and 3 mm at the top. The **Screw Height Lower Tolerance** value should then be set to **1** mm and the **Screw Height Upper Tolerance** value to **3** mm.

7.6.8.4.4 ROI tab

The ROI for the screws must be positioned centrally above the through hole. The ROI should only cover the flange around the through hole (if present).

The region can be positioned graphically or using the following adjustments.

Function	Description
Center X	X value/column value of the midpoint of the ellipse. Larger values shift the midpoint to the right, smaller values to the left.
Center Y	Y-value/line value of the midpoint of the ellipse. Larger values shift the midpoint downward, smaller values shift it upward.
Angle	The angle determines the orientation of the ellipse. For an angle = 0°, radius 1 changes the width of the ellipse and radius 2 changes the height. For an angle = 90°, radius 1 changes the height of the ellipse and radius 2 changes the width.
Radius 1	Radius along the major semi-axis of the ellipse.
Radius 2	Radius along the minor semi-axis of the ellipse.

7.6.8.5 ROI Seal page

The **ROI Seal** function is used to search for foreign bodies in the area of rubber seals, sealing beads or other structures that may have slight tolerances when positioned on the inspection object. The position tolerances are included in the inspections.

7.6.8.5.1 Common tab

The configuration options in the **Common** tab are the same as those described in the **ROI Circle** menu ().

7.6.8.5.2 Options tab

The **Options** tab is used to set the display or maintenance parameters.

Function	Description
Display ROI	Show region (enabled by default).
Display Result Region	Show result region.
Display Difference Region	Show difference region.
Display Junctions	Show contour deviations along the course of the rubber seal. These "branches" occur when a foreign object is directly against the rubber seal.
Display Inner Circle	Show inner circle. To distinguish the rubber seal from possible foreign objects, a smallest inner circle on the rubber seal is used to look for outliers.

Function	Description
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE |** This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.8.5.3 Segmentation tab

The following configuration options are available in the **Segmentation** tab.

Function	Description
Offset Ground Min	Minimum height difference (in mm) between the rubber seal and the surface of the inspection object.
Offset Ground Max	Maximum height value (in mm) for the surfaces on the inspection object on which a rubber seal is installed.
Seal Length X Min	Extension of the rubber seal in the X direction, minimum value (in mm).
Seal Length X Max	Extension of the rubber seal in the X direction, maximum value (in mm).
Seal Length Y Min	Extension of the rubber seal in the Y direction, minimum value (in mm).
Seal Length Y Max	Extension of the rubber seal in the Y direction, maximum value (in mm).
Threshold Shadow Reflectance	Threshold value for shadowing (from laser or camera view or due to adjacent foreign objects). This value is needed to handle artifacts at the transitions from the rubber seal to the surface (**NoData** regions).

7.6.8.5.4 Mask tab

The **Mask** tab is used to adjust the inspection region for surface checks to avoid false detections.

Function	Description
Dilation Shadow X	Widening (enlargement) in the X direction of the region where the shadow is located.
Dilation Shadow Y	Widening (enlargement) in the Y direction of the region where the shadow is located.
Dilation Rubber X	Widening (enlargement) in the X direction of the region where the rubber seal is located.
Dilation Rubber Y	Widening (enlargement) in the Y direction of the region where the rubber seal is located.

7.6.8.5.5 Check tab

The **Check** tab is used to check the rubber seal.

Function	Description
Rubber Inner Circle Max	Maximum value (in mm) for the inner circle on the rubber seal in the current region on the inspection object.
Rubber Inner Circle (calculated)	Calculated value (in mm) for the inner circle on the rubber seal.
Rubber Height Max	Maximum value (in mm) for the height of the rubber seal.
Foreign Bodies Elongation Min	Minimum size (in mm) of the extent of foreign bodies during this inspection.

7.6.8.5.6   Steadiness tab

The **Steadiness** tab is used to check the uniformity (continuity) of the rubber seal. Inspecting for uniformity involves detecting foreign objects resting against the rubber seal.

Function	Description
Check Steadiness	Enable/disable steadiness check.
Smooth Rubber Border	Parameter for smoothing out image capture-related "frayed" edges (shadows, noise, etc.) of the rubber seal. In the case of the rubber seal, "branches" are detected if an object lies against the rubber seal.
Junction Length Min	Minimum length of contour deviations (in mm) that are considered to be deviations from steadiness.
Junction Length Max	Maximum length of contour deviations (in mm) that are considered to be deviations from steadiness. The maximum value is used so that interruptions in the rubber seal are not identified as a fault and part of the rubber seal then being evaluated as a foreign body when interruptions are present.
Junction Length (calculated)	The value of the length of the contour deviation (in mm) actually determined during setup on the reference image.

7.6.8.5.7   ROI tab

Rectangle selection

The following configuration options are available for the **Rectangle** selection. The settings can also be adjusted directly in the image using the mouse.

Function	Description
Use Basic ROI	Activate/deactivate the use of base ROI. If this option is deactivated, **ROI Seal** is used; only then are the following options active.
Center X	X-value/column value of the midpoint of the region.
Center Y	Y-value/line value of the midpoint of the region.
Width	Width of the region.
Height	Height of the region.
Angle	Angle of the main axis of gravity of the region.

Polygon selection

The configuration options for the Polygon selection are described in the **Basic ROI** menu ()

7.6.9   Checks menu group

7.6.9.1   Check FOD page

Higher-level functions

Function	Description
Create	Create a new surface inspection (FOD).
Delete	Delete the active surface inspection.
Duplicate	Duplicate the active surface inspection. This allows the copy to be used for another region with minor adjustments if necessary.

Function	Description
Get ROI	Generate the ROI to be used based on the selected base ROI with any special features it contains. The status changes from ❌ to ✅ if the settings are valid. ⓘ **NOTE** │ To apply the changes from the areas below, click the **Get ROI** button.
Test	Apply surface inspection settings. The status displays the inspection result. If no foreign objects are found, the status changes to green.

7.6.9.1.1 Common tab

Function	Description
Name Check FOD	Input field for name assignment.
Basic ROI Selection	Select the base ROI to be used for the check. In the drop-down menu, you can select from the regions already available. Apply the selection by clicking the **Select** button. After clicking the **Get ROI** button, the ROI is displayed.
Activated	Enable/disable the setup inspection (enabled by default).

ⓘ **NOTE** │ If the search region is not displayed in the image, the zoom factor may be too large and the region is outside the display area. Decrease the zoom factor to view and move the region.

7.6.9.1.2 Options tab

The **Options** tab is used to set the display or maintenance parameters.

Function	Description
Display ROI	Show region (enabled by default).
Display Found Objects	Display foreign objects found.
Display Used ROI	Display the region where foreign objects are searched for.
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Display Debug Region	This option supports system maintenance and further development. ⓘ **NOTE** │ This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.9.1.3 Parameters tab

Function	Description
Search Objects	Parameters for object search **Light**: Regions to be found automatically are brighter and thus higher than the surroundings in the region. **Dark**: Regions to be found automatically are darker and thus deeper than the surrounding area in the region. ⓘ **NOTE** │ Image processing refers to height differences, which are displayed as brightness differences in the heightmap.

Function	Description
Check Mode	Check mode **Dynamic:** Check mode for inhomogeneous surfaces with varying height. **Absolute:** Check mode for planar surfaces with a uniform height. The search mode setting affects the tabs **Param. Dynamic** and **Param. Absolute**. Only the available parameters of the selected search mode are activated.
Height Min	Minimum height (in mm) for the foreign bodies to be detected in the inspection region. This value indicates how far the region is above the base ROI.
Elongation Min	Threshold value for the minimum extension of the foreign body to be detected.
No Data Elongation Min	Threshold value for the minimum extension of the areas with **NoData**.
Use Basic ROI	Activate/deactivate the use of base ROI. The entire area of the corresponding base ROI is used for the inspection. Areas that have been excluded, for example using **ROI Simple**, will still be taken into account.

7.6.9.1.4 Param. Dynamic tab

Function	Description
Mask Width	Width of the mask for searching for foreign bodies.
Mask Height	Height of the mask for searching for foreign bodies.
Median Filter	Enable/disable pre-processing median filter. For the median filter, the size in the **Median Filter Size** field is used. The filter is applied to the region.
Median Filter Size	Size of the median filter.
Fill-Up NoData	Enable/disable padding of NoData pixels. **NoData** pixels are padded with the height value from the surrounding pixels.
Fill-Up Lowest Height	Threshold value above which fill-in takes place. Values that are smaller are set to a new (larger) height. This new height corresponds to the most common grayscale value (height value) in the region.

7.6.9.1.5 Param. Absolute tab

The configuration options in the **Param. Absolute** tab are the same as those described in the **ROI Circle** menu ().

7.6.9.2 Check Presence page

Overview

The **Check Presence** function is used to check the presence of objects on the high-voltage storage. The results are displayed in the **Presence** status bar.

Higher-level functions

Function	Description
Create	Create a new presence inspection.
Delete	Delete the active presence inspection.
Duplicate	Duplicate the active presence inspection. This allows the copy to be used for another region with minor adjustments if necessary.

Function	Description
Get ROI	Generate the ROI to be used based on the selected base ROI with any special features it contains. The status changes from ❌ to ✅ if the settings are valid. ⓘ **NOTE** | To apply the changes from the areas below, click the **Get ROI** button.
Teach	Run presence check with the current settings on the reference image. The status changes to green if the presence check is successful.

7.6.9.2.1 Common tab

The configuration options in the **Common** tab are the same as those described in the **Check FOD** menu ().

7.6.9.2.2 Options tab

Function	Description
Display ROI	Show region (enabled by default).
Display Found Objects	Display found objects.
Display Rejected Objects	Display discarded objects.
Display Used ROI	Display the region where objects are searched for.
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE** | This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.9.2.3 Parameters tab

Function	Description
CheckMode	Check mode **Relative:** For an object with reference to a reference plane. **Absolute:** For an object without reference to a reference plane. Reference plane: Surface area of the high-voltage storage within the ROI. The check mode setting affects the parameters **Relative Height Min** and **Relative Height Max** or **Absolute Height Min** and **Absolute Height Max**.
Relative Height Min Relative Height Max	Minimum and maximum height deviation relative to the average height of the reference plane that the object must have in order to be found.
Absolute Height Min Absolute Height Max	Minimum and maximum absolute height that the object must have to be found.
X-Length Min X-Length Max	Minimum and maximum elongation in X-direction that the object must have to be found.
Y-Length Min Y-Length Max	Minimum and maximum elongation in Y-direction that the object must have to be found.
Area Min Area Max	Minimum and maximum area that the object must be have to be found.
Opening Filter X-Length Opening Filter Y-Length	Eliminate small malfunctions near the found objects using these values for the opening filter.

Function	Description
Use Basic ROI	Activate/deactivate the use of base ROI. The entire area of the corresponding base ROI is used for the inspection. Areas that have been excluded, for example using **ROI Simple**, will still be taken into account.

7.6.9.3 Check Laser page

Overview

The **Check Laser** function is used to monitor the brightness of the laser using the intensity image.

Recommendation: If there are several lasers in the system, configure at least one **Check Laser** function per laser for one of the associated cameras.

The function does not affect the overall result of the test.

Higher-level functions

Function	Description
Create	Create a new laser test.
Delete	Delete the active laser test.
Duplicate	Duplicate the active laser test. This allows the copy to be used for another region with minor adjustments if necessary.
Get ROI	Generate the ROI to be used based on the selected base ROI with any special features it contains. The status changes from ❌ to ✅ if the settings are valid. ⓘ **NOTE** | To apply the changes from the areas below, click the **Get ROI** button.
Teach	Perform laser test. The average intensity value in the region used is calculated. The status changes to green once the average intensity value has been calculated.

7.6.9.3.1 Common tab

The configuration options in the **Common** tab are the same as those described in the **Check FOD** menu ().

7.6.9.3.2 Options tab

Function	Description
Display ROI	Show region (enabled by default).
Display Used ROI	Display the region in which the laser brightness is inspected.
Display Debug Region	Parameters for development. This can be used to display the debug region used for system maintenance.
Debug Halcon	This option supports system maintenance and further development. ⓘ **NOTE** | This option is not required in inspection mode. Since this option uses up additional time, it should always be deactivated in inspection mode.

7.6.9.3.3 Parameters tab

Function	Description
Reflectance Threshold	The laser warning is triggered if this threshold value is not reached several times in a row during operation.

Function	Description
Reflectance Mean	Calculated average intensity value in the region used. The value is displayed after clicking on the **Teach** button.
Use Basic ROI	Activate/deactivate the use of base ROI. The entire area of the corresponding base ROI is used for the inspection. Areas that have been excluded, for example using **ROI Simple**, will still be taken into account.

7.6.10 Device menu group

7.6.10.1 Ranger3-1 - Calibration / Ranger3-2 - Calibration page

The **Calibration** menu is used to install a camera calibration on the SIM or to back it up from the SIM to a computer. For a system with multiple probes, always ensure that the connection to the desired controller (SIM) exists before performing the backup.

The upper part of the window displays the status of the system and the connection.

Function	Description
Setup OK	Camera settings: 🟢 Settings are valid. 🔴 Settings are not invalid.
Connected	Connection status: 🟢 Camera is connected to the associated SIM. 🔴 No connection between the camera and SIM.
Running	Camera status: 🟢 Camera is working correctly and is ready to take images. 🔴 Camera is not ready.
Status	Status of the calibration: 🟢 Status of the calibration is valid. 🔴 Status of the calibration is invalid.
Download	Start downloading the calibration file for the active camera. If the download is successful, a corresponding message appears in the status bar.
Upload	Upload a calibration file. Clicking **Upload** opens the default directory in Explorer (navigate to the appropriate directory if necessary). Clicking **Open** in Explorer starts the upload directly. The new calibration file will then be available immediately. If the upload is successful, a corresponding message appears in the status bar. The file must be of type *.**json** and contain the correct sequence number 1 or 2 in the name based on the device. Accordingly, the appropriate **Ranger3-1 - Calibration** or **Ranger3-2 - Calibration** page must be open. Factory-supplied files for the respective system head are: • `xxxxxxx_yyyyyyyy_zzzzzzzz_R3-1_CalibrationResult.json` • `xxxxxxx_yyyyyyyy_zzzzzzzz_R3-2_CalibrationResult.json` `xxxxxxx` = P/N of the system head `yyyyyyyy` = S/N of the system head `zzzzzzzz` = S/N of the Ranger3 Example: `2123164_24010001_2349005_R3-1_CalibrationResult.json`

Function	Description
Calibration Status Message	Status message of the last action.

> **NOTE**
>
> The calibration is valid for the conditions existing at the time of calibration. This includes the height of the system head above a reference on the inspection object as well as the X and Y alignment of the system head, and the alignment of the two cameras and the laser in a system head to each other.
>
> If one of these variables is changed by improper operation or by external influence, the evaluation may be impaired.
>
> Since the Foreign Object Detection System is intended to detect small defects and thus small deviations from the normal state of an inspection object, even small changes in positioning can lead to deviations in the inspection.

7.6.11 General menu group

The **General** menu contains functions that perform cross-application tasks and are required for using the application or that provide settings that can be used for further information.

7.6.11.1 App-State page

Overview

The **App-State** page shows the CPU load and the memory usage in the upper area.

The list of individual apps is displayed in tabular form in the lower area. This list is used for detailed troubleshooting.

Table columns

The **Status** page shows **OK** to indicate error-free functioning.

The entries in the columns **AE-State** and **Memory (kB)** can be used for initial diagnostics purposes. This information is especially important if the status does not indicate **OK**.

7.6.11.2 Logger page

System messages are output on the **Logger** page. The operating menu for the log output provides the following functions.

Function	Description
⬇	Save log output to the connected device where the browser is open (opens **Save As** dialog).
💾	Save current log output to the SIM. For this operation, a message appears in the log output <**Logs copied to …**> from which the location of the log output can be read.
🗑	Delete all entries from the log output.

Function	Description
Log Level	Set the level for which log outputs are to be made. Hierarchy of configurable levels: • Warning • Info • Fine • Finer • Finest ⓘ **NOTE** | Entries in the **Severe** level are always displayed. This level cannot be turned off. All log outputs up to the currently set level are always displayed.

7.6.11.3 Image Storage page

Function	Description
Process-/Raw-Images	Used to configure which images for inspections runs are to be transferred for storage. • **OK** • **Not OK** • **Error**
Dump-Images (jpg)	Transfer dump images for saving (images of the result of an inspection with the selected areas as they appear in the interface).
Save Configuration	Save settings from this window. The settings are valid from the moment of saving.

ⓘ **NOTE**
To ensure that the images are actually saved, an established and also active FTP connection to an FTP server is required.

7.6.11.4 FTP-Client page

FTP is used to transfer the large image files to an FTP server. The settings for the data transfer to the FTP server can be configured for the **Maintenance** user level and above.

Function	Description
Save Configuration	Save parameters persistently after the connection is successfully established.
Check Configuration	Test the configuration that has been set. The inspection result is displayed in the **FTP-Client Status** window. In the event of an error, the status is displayed in red in the right-hand window.
Enabled	To enable the FTP client, the switch must be set to active. To change connection parameters, the switch must be deactivated.
Mandatory	If the switch is enabled, image saving is mandatory. If an image cannot be saved, the inspection system is no longer ready for inspection and signals **BV Ready = False** to the PLC.
FTP-Transmission Error	Enable monitoring of the FTP connection. If the FTP connection is interrupted and the data cannot be transferred, the connection error is signaled by activating control bit 16. The control bit remains active until the FTP connection is restored and an image has been able to be transferred without errors. As soon as the connection is re-established, the control bit is automatically deactivated.
Host (IP Address)	IP address to the FTP server with a valid port number.

Function	Description
Login Name Password	Login name and password valid on the FTP server.
Passive Mode	Option set. Connection is established by the client.
Stay Connected	Option set. Keep connection to FTP server permanently. This ensures no new connection setup is necessary during operation.
Verbose Logs	This option should only be set when setting up the connection. The detailed logs are not required in inspection mode.
Keep Alive Interval	Time interval during which an attempt is made to maintain the FTP connection (setting 30 s).
Check Connection Interval	Time interval after which it is checked whether the connection still exists (setting 60 s).
Connect Timeout	When establishing the connection for the first time: Time interval within which the connection must be established (setting 5,000 ms).
Transmit Timeout	Time interval within which a sent image must be received (setting 5,000 ms).

7.6.11.5   System page

7.6.11.5.1   System Functions

The system functions can be used in the event of an error or for recovery purposes.

Function	Description
Restart Apps	Restart all apps on the device (equivalent to restarting the application).
Reboot Device	Restart device (SIM).

7.6.11.5.2   Backup/Restore

This block can be used to store the system settings in an external location or to load them from an external location.

Recommendation: After restoring the system, also reset the statistics (page **Statistics**,).

Function	Description
Create	Create a backup file of the current system settings in the buffer memory of the SIM.
Download	Download the backup file from the buffer memory of the SIM to the computer.
Upload	Load the backup file into the buffer memory of the SIM using the file browser.
Restore	Replace the current system settings with the backup file.

7.6.11.5.3   Free Memory Monitoring

If the memory usage exceeds a certain value, there is a risk that the SIM2500 controller will no longer work reliably. The **Free Memory Monitoring** function is used to monitor the memory usage. If the warning level is exceeded, a warning is issued.

Function	Description
Enable Memory Monitoring	Activate/deactivate memory monitoring.
Clear Warning State Below	As soon as the memory usage falls below this value, the warning is deleted.

Function	Description
Set Warning State Above	As soon as this value is exceeded, a warning is issued.
Clear Critical State Below	As soon as the memory usage falls below this value, the critical status is deleted.
Set Critical State Above	As soon as this value is exceeded, the critical status is set.
Save Configuration	Save settings from this window.

7.6.11.5.4 System resources

Function	Description
CPU Load (0..100%)	Processor load
Memory Usage (0..100%)	Memory usage in percent
Mem Used (MB)	Used working memory
Mem Free (MB)	Free working memory
Mem Capacity (MB)	Total memory space
Disk /ram usage (0..100%)	Used temporary storage in the RAM (working memory) of the SIM
Disk /public usage (0..100%)	Used persistent storage on the flash memory of the SIM
Disk /sdcard usage (0..100%)	Used storage on the SD card

7.6.11.6 Info page

The **Info** page displays a range of information, for example:

Range	Description
Configuration	Information about the configuration of this application
Device	Information about the device
Statistics	Statistical information

8 Maintenance

8.1 Important information

> ⚠ **NOTICE**
> **Decalibration as a result of cleaning**
>
> During cleaning processes for the laser unit as well as for the cameras, there is always a risk of decalibration due to a physical change in the position or focus adjustment of the cameras or lasers.

8.2 Backing up the SIMs

Procedure for performing a full backup after setting up each SIM:

► Run **Backup/Restore Current Article** for each article (see "Backup/Restore Current Article", page 36)
► **Backup/Restore** for the system settings (see "Backup/Restore", page 67)
► Backup of the **SOPAS parametrization file** in the SICK **AppManager (SOPAS-Vars)**

8.3 Visual inspection of the cables

► Check the electrical installation regularly.
► Make sure that all cable connections are secure.

> ⚠ **WARNING**
> **Loose connections or scorched cables**
>
> ► Rectify defects such as loose connections or scorched cables immediately.

> ⚠ **WARNING**
> **Damaged cable insulation**
>
> If the insulation on the connecting cables is damaged, there is a risk of fatal electrocution.

8.4 Cleaning

Contamination of the sensor can impair the measurement behavior. Sensors must be cleaned regularly.

> ⓘ **NOTE**
> Information is included in the operating instructions for the components.

8.4.1 Laser unit maintenance

Contamination on the laser unit can impair or even completely prevent recording.

Important information

⚠️ **WARNING**

The product uses one or more line lasers of laser class 2.

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.

▶ Never look directly into the laser beam.
▶ Never point the laser beam at people's eyes.
▶ During commissioning or maintenance work, suitable eye protection must be worn.
▶ Avoid laser beam reflection caused by reflective surfaces, especially during assembly and alignment work.
▶ Do not use optical instruments.
▶ Do not open the housing.
▶ Current national regulations regarding laser protection must be observed.

❗ **NOTICE**

Possible impairment of the laser quality

Dust and fingerprints on optical interfaces can reduce the beam quality.

▶ Do not touch the glass lenses with your fingers.

❗ **NOTICE**

Reduced recording performance due to scratches or streaks

Optical performance is degraded by scratches and streaks on the lens or acrylic glass.

▶ Do not use aggressive cleaning agents.
▶ Do not use abrasive cleaning agents.
▶ Avoid scratching and abrasive movements.

ℹ️ **NOTE**

No maintenance is required to maintain laser class 2.

Procedure

▶ Disconnect the laser from voltage before performing maintenance work on the laser unit.
▶ To do this, disconnect the power supply to the entire system.
✓ This disconnects the controllers and thus also the laser unit from the power supply.
▶ Clean the optical surfaces regularly using a clean, damp, lint-free cloth.

Further topics

• Notes on the laser

9   Troubleshooting

9.1   Important information

⚠ **WARNING**
Danger in the event of malfunction
Cease operation if the cause of the malfunction has not been clearly identified!

▶   If errors cannot be clearly identified and not safely eliminated, shut down the system.

ℹ **NOTE**
If an error cannot be resolved with the help of the information provided in this section, contact your local SICK subsidiary.

For a quick response to your inquiry you will need the following information:

- Exact name of the system component
- Firmware version
- Log files
- Configuration file(s)

9.2   Troubleshooting the Ranger3 camera

There are four LEDs on the back of the Ranger3 camera that indicate status and faults.

ℹ **NOTE**
Detailed information can be found in the operating instructions for the component.

9.3   Troubleshooting on the controller

ℹ **NOTE**
Detailed information can be found in the operating instructions for the component.

System-specific displays

Table 3: Primary SIM

LED			Assignment of FOS-HVS status	Description
DEVICE READY	🔆	Green Flashing		Device booting
	🟢	Green		Runlevel **READY**, no errors detected
	🔴	Red		Error during boot process
SYSTEM READY	🟢	Green	**BVReady** (complete system)	**SYSTEM READY** displays PLC status bit **BVReady** . This corresponds to the overall system status.
	🔴	Red		
RESULT	🟢	Green	**Station State Primary**	**RESULT** shows the local status of the primary SIM. The status turns red as soon as there is a local problem.
	🔴	Red		
	🔆	Green Flashing		The application boots.

Table 4: Secondary SIM

LED			Assignment of FOS-HVS status	Description
Dev RDY	🟠	Orange		Device booting
	🟢	Green		Runlevel **READY**, no errors detected
	🔴	Red		Error during boot process
Sys RDY	🟢	Green	**Station State Secondary**	**Sys RDY** displays the local status of the secondary SIM. The status turns red as soon as there is a local problem.
	🔴	Red		
	🟢	Green Flashing		The application boots.
Result	not used			

10 Decommissioning

!	**NOTICE**

Disposal of batteries, electrical and electronic devices

►　In accordance with international directives and regulations, batteries, accumulators, and electrical or electronic devices must not be disposed of with household waste.

►　The owner is obligated to dispose of the devices at the end of their service life via the appropriate public disposal points.

►　This icon on the product, packaging, or in this document indicates that a product is covered by these provisions:

!	**NOTICE**

The applicable local and statutory environmental regulations and guidelines for the disposal of industrial and electrical waste must be observed.

The following assemblies may contain substances that need to be disposed of separately:

• **Electronics**: Capacitors, accumulators, batteries
• **Displays**: Liquid in the LC displays

11 Technical data

11.1 Data sheet

11.1.1 System/system heads

	Mono 1600	Duo 1600	Duo 2400
Number of Ranger3 cameras	2	4	6
Supply voltage	24 V DC ± 10%		
Ambient data			
Ambient temperature, operation	0 °C … +45 °C		
Ambient temperature, storage	-20 °C … +60 °C		
Permissible relative humidity	20% … 80% Non-condensing		

11.1.2 Application

	Mono 1600	Duo 1600	Duo 2400
Small superstructure	✓	✓	✓
Cushion superstructure	-	✓	✓
Central tunnel	-	-	✓
Calotted surface	✓	✓	✓
Occlusion compensation (in scan direction)	-	✓	✓

11.1.3 Optical properties

	Mono 1600	Duo 1600	Duo 2400
Laser colors	Single or multicolored: red, green, blue	Single or multicolored: red, green, blue	Multicolor: green-red-green or blue-green-blue
Laser class	2		
Typical camera distance	750 mm		
Typical field of view width	1,600 mm	1,600 mm	2,400 mm

11.1.4 Detection size

	Mono 1600	Duo 1600	Duo 2400
Minimum object size (L x W x H)	4 mm x 4 mm x 2 mm		

11.1.5 Evaluation time

	Mono 1600	Duo 1600	Duo 2400
Typical scan speed	350 mm/s		
Typical evaluation time including scan time (HVS length: 2,200 mm x width 1,700 mm)	25 s		

11.1.6 Transport tolerances (max.)

	Mono 1600	Duo 1600	Duo 2400
In transport direction		± 10 mm	
Lateral tolerance		± 10 mm	
Height tolerance		± 2.5 mm	
Angle roll		± 0.5°	

11.1.7 Interfaces

	Mono 1600	Duo 1600	Duo 2400
Communication with higher-level PLC		PROFINET	
Data export		FTP client	
Fastest cycle time for fieldbus / PROFINET		8 ms	

11.2 Dimensional drawings

> **NOTE**
> Information is included in the operating instructions for the components.

11.2.1 FOS-HVS system head

11.2.1.1 FOS-HVS Mono
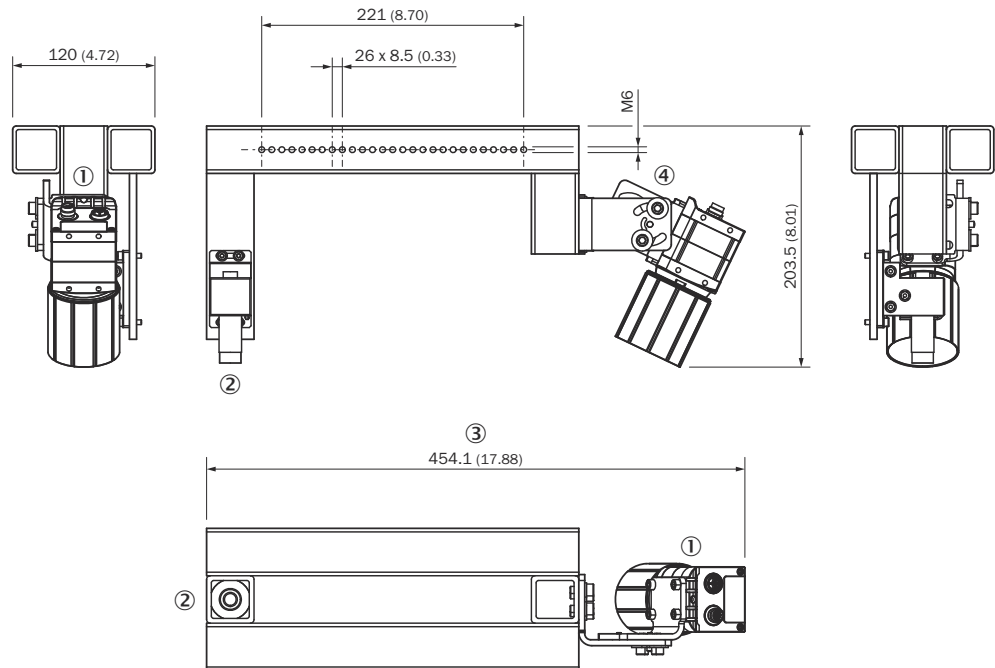
Figure 25: Dimensional drawings of FOS-HVS system head Mono

11.2.1.2 FOS-HVS Duo
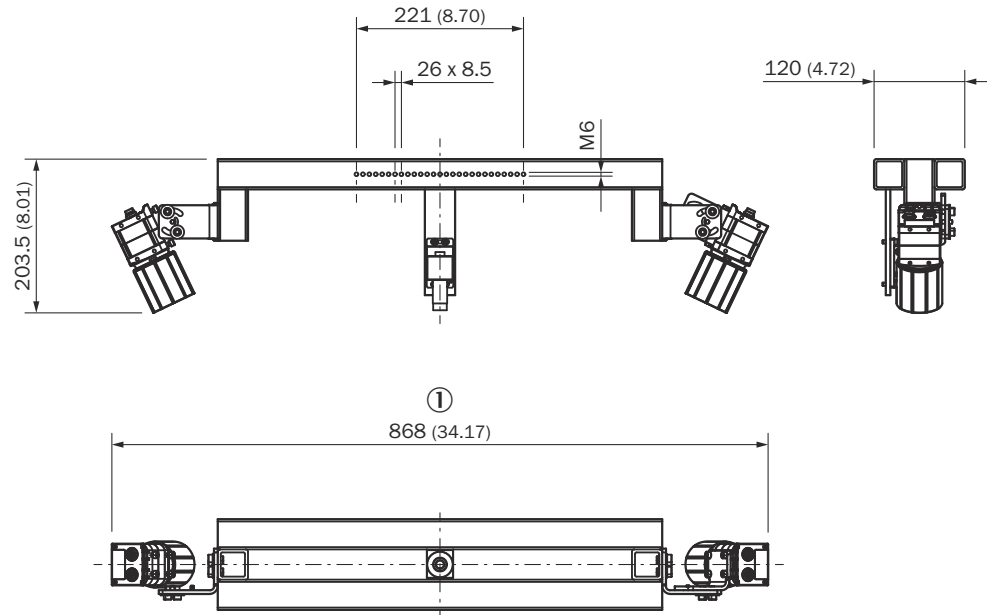
Figure 26: Dimensional drawings of FOS-HVS system head Duo

12 Spare parts

Part number	Description
2123164	System head, red, 16 mm lens
2124274	System head, red, 16 mm lens, single camera
2123165	System head, green, 16 mm lens
2130485	System head, green, 16 mm lens, single camera
2124126	System head, blue, 16 mm lens
2130484	System head, blue, 16 mm lens, single camera
2138195	Primary SIM2000ST-E
2138187	Secondary SIM2500 for system head
2125739	Encoder distributor

13 Annex

13.1 User levels and permissions

Access permissions on the primary SIM

	User level	
Menu	**Run**	**Maintenance**
Application menu group		
Inspection	x	x
Status	x	x
Statistics	x	x
PLC-Status	x	x
PLC-Simulation		x
General menu group		
App-State	x	x
Logger	x	x
System		x
Info	x	x
Application menu group		
Settings	x	x

Access permission on the secondary SIM

	User level	
Menu	**Run**	**Maintenance**
Application menu group		
Run Overview	x	x
Run Cam1	x	x
Run Cam2	x	x
Statistics	x	x
Article menu group		
Article		x
Camera		x
Block		x
Test Article		x
Alignment menu group		
Global Align		x
Align 3E		x
Align CC		x
Align PA		x
Basic ROI menu group		
Basic ROI		x
Selector		x
Special Feature menu group		
ROI Simple		x
ROI Circle		x

	User level	
Menu	**Run**	**Maintenance**
ROI Screw		x
ROI Seal		x
Checks		
Check FOD		x
Check Presence		x
Check Laser		x
Device menu group		
Ranger3-1 - Calibration		x
Ranger3-2 - Calibration		x
General menu group		
App-State	x	x
Logger	x	x
Image Storage		x
FTP-Client		x
System		x
Info	x	x
Application menu group		
Settings	x	x

13.2 Test sequence
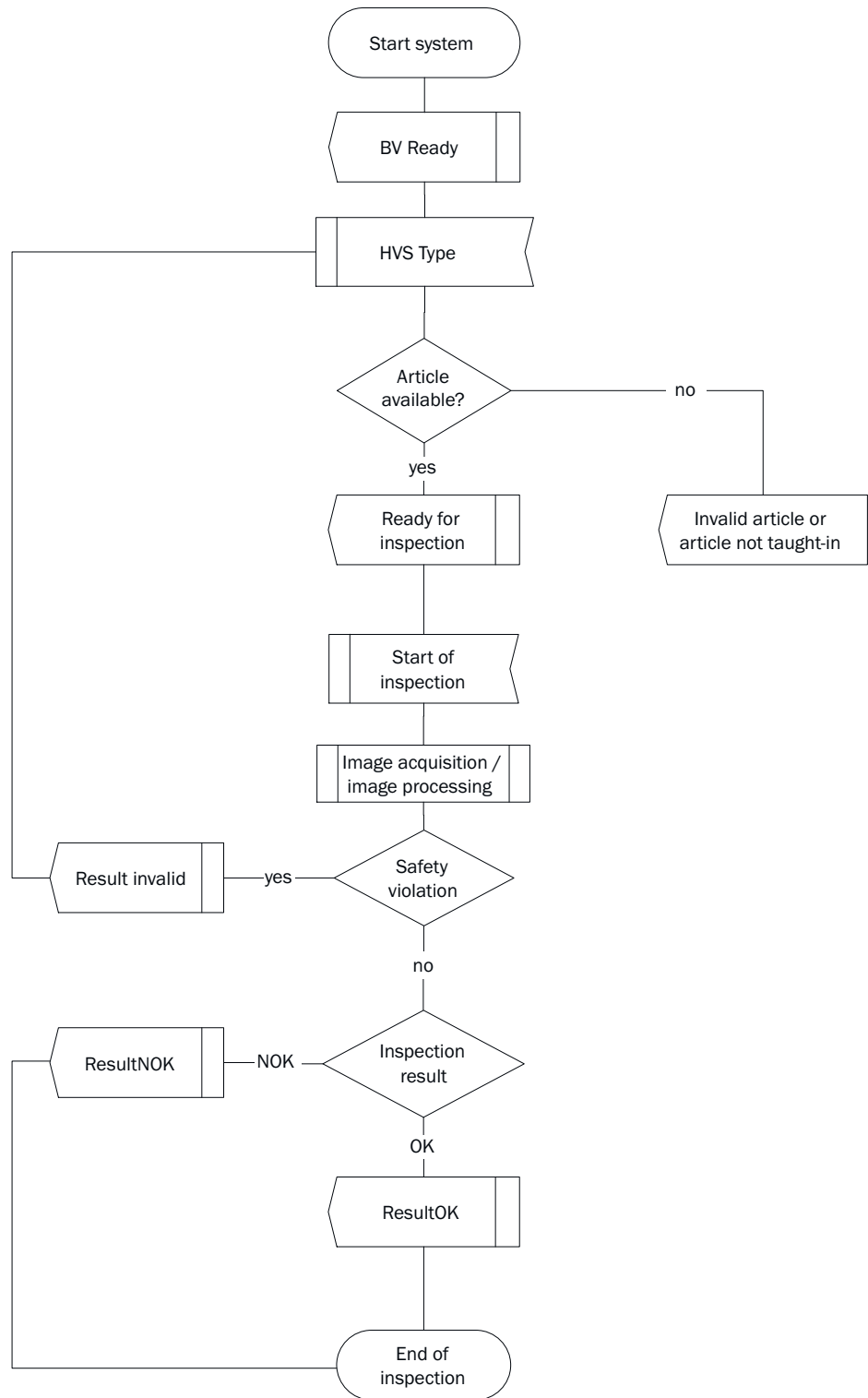
13.3   ControlBits process diagram
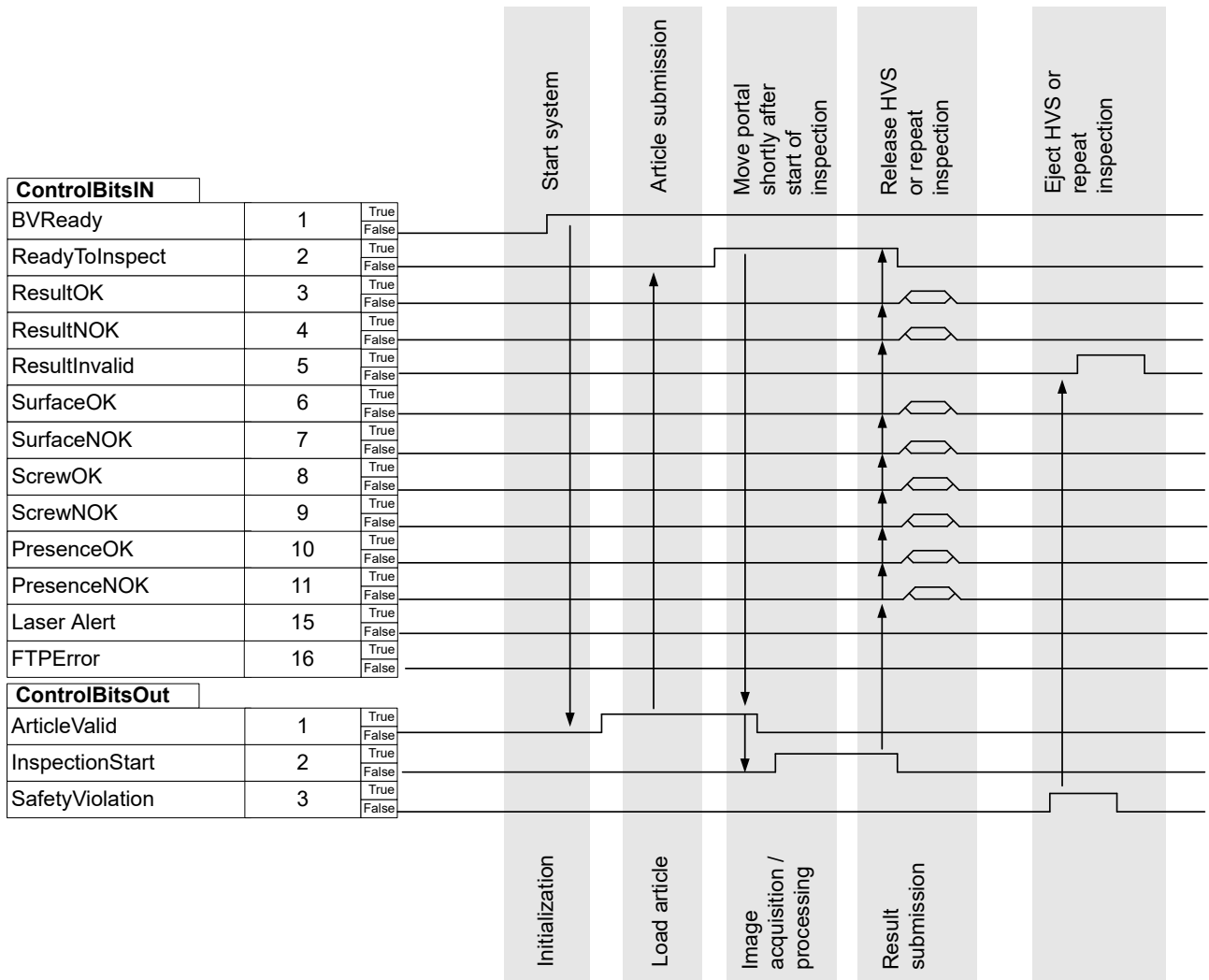
13.4 ControlBitsIn

Name	ControlBit
1: BV ready	1
2: Ready to inspect	2
3: Result OK	3
4: Result NOK	4
5: Result invalid	5
6: Surface OK	6
7: Surface NOK	7
8: Screw OK	8
9: Screw NOK	9
10: Presence OK	10
11: Presence NOK	11
- free -	12
- free -	13
- free -	14
15: Laser alert	15
16: FTP error	16

13.5 ControlBitsOut

Name	ControlBit
1: Article valid	1
2: Inspection start	2
3: Safety Alert	3

13.6 Data IN

Possible values per byte in byte array

ASCII char	Status	Description
0	NONE	• Initialization
1	OK	• Image successfully analyzed • "OK" result
2	WARN	• Image successfully analyzed • "Warning" result
3	NOK	• Image successfully analyzed • "NOK" result
4	ERROR	• Image not successfully analyzed • Error during data recording or processing

Assignment of results for position in byte array

Position in byte array	Name
1	ResultCode
2	ResultCodeSurface
3	ResultCodeScrew
4	ResultCodePresence
5	LaserAlert
6	FTPError

13.7   Data OUT

Name	Length in bytes
Article ID	1 … 4
Serial ID	1 … 64

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