

Ruler3000

3D vision

SICK
Sensor Intelligence.



Described product

Ruler3000

Manufacturer

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Original document

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Contents

1	About this document.....	7
1.1	Information on the operating instructions.....	7
1.2	Explanation of symbols.....	7
2	Safety information.....	8
2.1	Intended use.....	8
2.2	Improper use.....	8
2.3	Limitation of liability.....	8
2.4	Modifications and conversions.....	8
2.5	Cybersecurity.....	9
2.6	Requirements for skilled persons and operating personnel.....	9
2.7	Operational safety and particular hazards.....	10
2.8	Warning signs on the device.....	11
2.9	Note on laser radiation.....	11
3	Getting started.....	12
3.1	Mounting the device.....	12
3.2	Connecting the camera.....	12
3.3	Installing PC software.....	13
3.4	Capturing the first images.....	13
3.4.1	Finding and connecting the camera.....	14
3.4.2	Getting a 2D image.....	14
3.4.3	Getting a 3D image.....	14
4	Product description.....	16
4.1	Introduction.....	16
4.2	Measuring with a 3D camera.....	16
4.3	Hardware description.....	19
4.3.1	Sensor.....	19
4.3.2	LED indicators.....	20
4.4	Interface and communication standards.....	20
4.4.1	GigE Vision®.....	21
4.4.2	GenICam™.....	21
4.4.3	GenIStream API.....	21
4.4.4	SICK AppSpace.....	22
5	Transport and storage.....	24
5.1	Transport.....	24
5.2	Unpacking.....	24
5.3	Transport inspection.....	24
5.4	Storage.....	24
6	Mounting.....	26
6.1	Mounting instructions.....	26
6.2	Required parts.....	26

6.3	Mounting the device.....	26
6.4	Field of view diagram.....	28
7	Electrical installation.....	30
7.1	Conditions for specified enclosure rating.....	30
7.2	Wiring instructions.....	30
7.3	Prerequisites for safe operation of the device.....	31
7.4	Connecting the camera.....	33
7.5	Electrical connections.....	34
7.5.1	Power I/O connector.....	35
7.5.2	GigE connector.....	36
7.6	Connecting a CDB650-204.....	36
8	Configuration.....	39
8.1	Software installation.....	39
8.1.1	System recommendations.....	39
8.1.2	Network preparations.....	39
8.1.3	Installing PC software.....	39
8.2	Connecting the camera.....	40
8.3	Configuring Ruler3000.....	40
8.3.1	Editing parameters.....	41
8.4	Extraction region.....	42
8.4.1	Setting extraction region.....	45
8.4.2	Measurement mode.....	46
8.4.3	Maximum buffer size.....	46
8.5	Laser profile extraction.....	46
8.5.1	Exposure time.....	47
8.5.2	Detection threshold.....	48
8.5.3	Advanced.....	48
8.6	3D image format.....	52
8.6.1	Additional components.....	52
8.6.2	Range (3D) measurements.....	54
8.7	Triggering.....	55
8.7.1	3D triggering concepts.....	55
8.7.2	Profile triggering.....	56
8.7.3	Image triggering.....	59
8.8	Calibration.....	61
8.8.1	Rectification.....	61
9	Operation.....	63
9.1	Stream Setup graphical user interface.....	63
9.1.1	Menu bar.....	64
9.1.2	Tabs.....	64
9.1.3	Control bar.....	68
9.1.4	Parameter settings pane.....	70
9.1.5	Log section.....	70

9.1.6	Status bar.....	71
9.2	Using the interface.....	71
9.2.1	Importing and exporting configuration files.....	71
9.2.2	Booting the device using a camera configuration.....	72
9.2.3	Visualizing 2D data.....	73
9.2.4	Collecting 3D data.....	74
9.2.5	Image components and visualization.....	74
9.2.6	Loading and saving image buffers.....	78
9.2.7	Handling log messages.....	79
9.2.8	Camera files.....	80
9.2.9	Updating firmware.....	80
10	Maintenance.....	82
10.1	Maintenance plan.....	82
10.2	Cleaning.....	82
10.3	Laser lifetime.....	83
10.3.1	About laser lifetime.....	83
11	Troubleshooting.....	85
11.1	Over triggering.....	85
11.2	Encoder line trigger setup tips.....	85
11.3	Network card settings.....	85
11.4	Rescue mode.....	85
11.5	Repairs.....	85
11.6	Returns.....	86
12	Decommissioning.....	87
12.1	Disposal.....	87
13	Technical data.....	88
13.1	Product data.....	88
13.2	Features.....	88
13.3	Performance.....	89
13.3.1	Signal dynamic range.....	89
13.3.2	Light sensitivity.....	89
13.3.3	Maximum line rate.....	89
13.4	Interfaces.....	90
13.5	Ambient data.....	90
13.6	Mechanics and electronics.....	91
13.7	Dimensional drawings.....	92
14	Accessories.....	93
15	Glossary.....	94
15.1	Terms and abbreviations.....	94
16	Annex.....	95

- 16.1 Range (3D) measurement..... 95
 - 16.1.1 Occlusion..... 95
 - 16.1.2 Width resolution and resolution in the motion direction..... 96
 - 16.1.3 Sensor coordinate system..... 96
- 16.2 Features..... 97
 - 16.2.1 Setting parameters in GenICam..... 97
 - 16.2.2 Device control..... 98
 - 16.2.3 Image format control..... 100
 - 16.2.4 Scan 3D control..... 101
 - 16.2.5 Acquisition control..... 104
 - 16.2.6 Digital I/O control..... 105
 - 16.2.7 Counter and timer control..... 106
 - 16.2.8 Encoder control..... 107
 - 16.2.9 Event control..... 108
 - 16.2.10 User Set control..... 108
 - 16.2.11 File access control..... 109
 - 16.2.12 Chunk data control..... 110
 - 16.2.13 Test control..... 111
 - 16.2.14 Transport layer control..... 112
- 16.3 Recommended network card settings..... 113
 - 16.3.1 Connecting multiple cameras..... 114
- 16.4 Connecting encoders..... 115
- 16.5 EU declaration of conformity/Certificates..... 117

1 About this document

1.1 Information on the operating instructions

These operating instructions provide important information on how to use devices from SICK AG.

Prerequisites for safe work are:

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

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



NOTE

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

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

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

1.2 Explanation of symbols

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



DANGER

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



WARNING

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



CAUTION

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



NOTICE

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



NOTE

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

2 Safety information

2.1 Intended use

Streaming cameras are the vision image acquisition component in a machine vision system. They make measurements on the objects that pass in front of the camera, and send the measurement results to an external processing unit for further processing. Comply with the data on the type label.

Misuse

Different or additional use is considered to be improper use. SICK AG shall not be held liable for personal injury and damage to property resulting from this.

2.2 Improper use

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

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



WARNING

Danger due to improper use!

Any improper use can result in dangerous situations.

Therefore, observe the following information:

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

2.3 Limitation of liability

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

- Non-adherence to the product documentation (e.g., operating instructions)
- Incorrect use
- Use of untrained staff
- Unauthorized conversions or repair
- Technical modifications
- Use of unauthorized spare parts, consumables, and accessories

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

2.4 Modifications and conversions



NOTICE

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

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

2.5 Cybersecurity

Protection against cybersecurity threats requires a comprehensive and holistic cybersecurity concept that must be continuously monitored and maintained. Such a concept consists of organizational, technical, process-related, electronic and physical defense levels and sets up appropriate measures for the different types of risk. SICK's products and solutions must be regarded as an integral part of this concept.

Information on Cybersecurity can be found at: www.sick.com/psirt.

2.6 Requirements for skilled persons and operating personnel



WARNING

Risk of injury due to insufficient training.

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

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

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

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

The following qualifications are required for various activities:

Table 1: Activities and technical requirements

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

2.7 Operational safety and particular hazards

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

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

Operating the product in conjunction with external illumination systems may result in hazardous radiation exposure. Please note the accompanying production documentation.



CAUTION

Optical radiation: 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.

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

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



WARNING

Electrical voltage!

Electrical voltage can cause severe injury or death.

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



WARNING

Risk of injury and damage caused by potential equalization currents!

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

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

2.8 Warning signs on the device

A class 2 laser is installed in the device. The housing is labeled with a warning sign.



EN/IEC 60825-1:2014 Complies with FDA performance standards for laser products except for conformance with IEC 60825-1 Ed.3., as described in Laser Notice No.56, dated May 8, 2019.

Ptotal < 22mW, DC or pulsed; $\lambda = 660 \pm 15 \text{nm}$; $P < C6 * 1 \text{mW}$ within 7mm aperture

Figure 1: Warning sign on the device: Laser class 2 (EN/IEC 60825-1:2014)

- ① Laser radiation – Never look into the light beam – Laser class 2 (EN/IEC 60825-1:2014)
- ② EN/IEC 60825-1:2014

Complies with the FDA performance requirements for laser products except for conformance with IEC 60825-1 Ed.3., as described in Laser Notice 56 dated May 8, 2019.

$P_{\text{total}} < 22 \text{mW}$, DC or pulsed; $\lambda = 660 \pm 15 \text{nm}$; $P < C6 * 1 \text{mW}$ within 7mm aperture

If the device itself is installed in a way that obscures the attached warning labels, additional, clearly visible labels must be attached.

2.9 Note on laser radiation

This laser product corresponds to laser class 2 after having been assessed on the basis of the Low Voltage Directive 2014/35/EU, which applies to all manufacturers placing products on the market, in conjunction with EN 60825-1:2014 in the currently applicable version. Due to the differing statutory requirements on occupational safety according to guideline 2006/25/EC, this product has to be assessed based on the older standard EN 60825-1:2007. Employers therefore need to instead base their occupational safety measures on laser class 2M. Please observe the national regulations in relation to this.

3 Getting started

The purpose of this chapter is to quickly and easily connect the camera and capture initial 2D and 3D images. A connection module, e.g. CDB650-204, can be used to simplify the connection procedure.



NOTE

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

3.1 Mounting the device

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

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

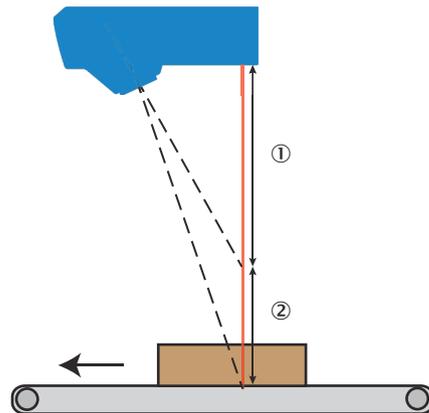


Figure 2: Mounting position, stand-off from device bottom (laser side) is 245.5 mm.

- ① Stand-off from device bottom, 245.5 mm
- ② Measuring range, 125 mm

For detailed information about how to mount the camera, see "[Mounting](#)", page 26.



NOTICE

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

3.2 Connecting the camera

See [figure 3](#) for an overview of the electrical connections for the installation. The encoder, photoelectric switch and connection module are optional accessories.

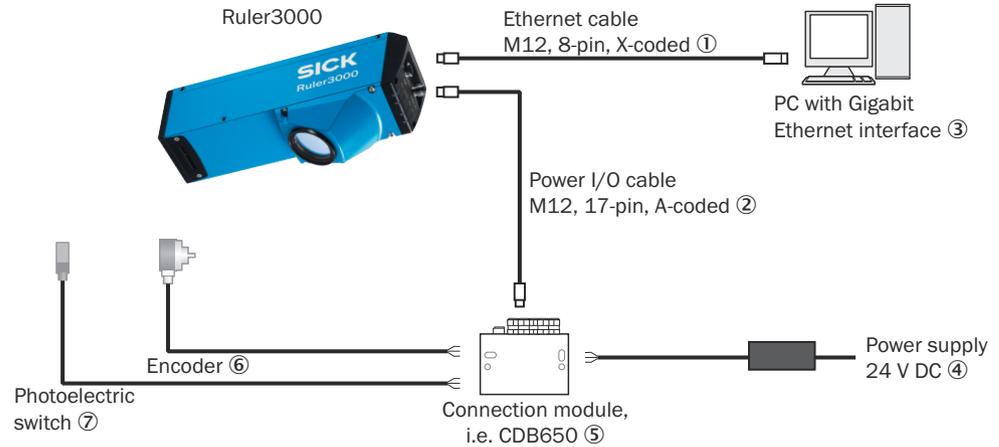


Figure 3: Electrical connections for Ruler3000.

- ① Ethernet cable, M12, 8-pin, X-coded
- ② Power I/O cable M12, 17-pin, A-coded
- ③ PC with Gigabit Ethernet interface
- ④ Power supply 24 V DC
- ⑤ Connection module, i.e. CDB650
- ⑥ Encoder
- ⑦ Photoelectric switch

To prepare the camera for operation, do as follows:

1. Remove the protection caps that cover the connections for Gigabit Ethernet (GigE) and Power I/O on the back of the camera.
2. Connect the Ethernet cable to the GigE connector on the camera. Connect the other end of the Ethernet cable to the Network Interface Card (NIC) in the PC.
3. Connect the connection module to the Power I/O connector on the camera using the power I/O cable.
4. Connect a 24V DC power supply to the connection module. 24V on terminal 1 and GND on terminal 2.
5. Switch on the power to the system.

For further information about the electrical installation, see "[Electrical installation](#)", page 30. The pin assignment is described in "[Electrical connections](#)", page 34. For further information about the connection module, see "[Connecting a CDB650-204](#)", page 36.

3.3 Installing PC software



Download and install the latest version of the **3D Stream SDK** and the **Stream Setup Installer** from the SICK Support Portal, support-portal.sick.com.

For further information about the PC software and installation, see "[Software installation](#)", page 39.

3.4 Capturing the first images

Before the device can be used in a machine vision system, it must be configured. This is done by adjusting parameters in the **Stream Setup** software until the image result is satisfactory.

See "[Features](#)", [page 97](#) for a list of available parameters. For detailed information about how to edit the parameters in the user interface, see "[Configuration](#)", [page 39](#).

3.4.1 Finding and connecting the camera

In the **Cameras** tab, you see the last connected device and can reconnect to it. Use the **Camera search** button to search the network and see a list of all available devices. If the camera you want to connect to is not on the same subnet as the NIC you have to reconfigure the camera to the same subnet before you can connect to it. For information about editing the IP settings, see "[Editing IP settings](#)", [page 65](#).

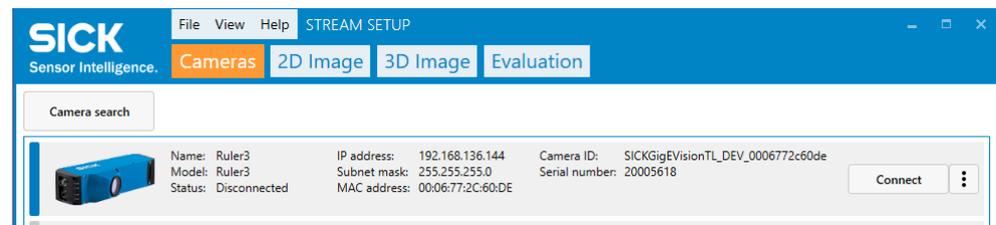


Figure 4: Connecting the camera.

3.4.2 Getting a 2D image

Next, you capture and view the 2D image data in the **2D Image** tab. Click the play button to view the 2D image and the laser line. A 2D image is what the camera sees when it is used as an ordinary camera. You can edit parameter values related to the image acquisition and evaluate the result directly in the image viewer until the result is satisfactory.

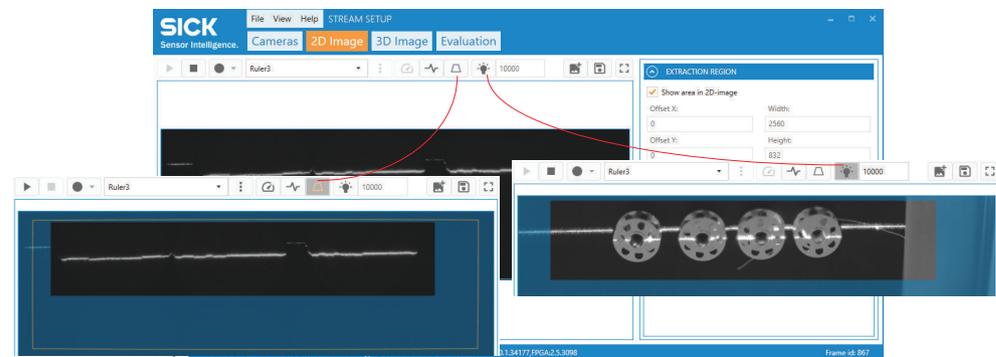


Figure 5: Getting the 2D image. The guaranteed FOV and boost exposure features are illustrated.

To see exactly where on the object the laser line goes, use the **Boost exposure** button to temporarily brighten the area. You also have the possibility to verify that the region you are viewing falls within the guaranteed field of view, by clicking **Guaranteed FOV**.

3.4.3 Getting a 3D image

In the **3D Image** tab, you view the 3D image that is the result of using laser triangulation. Click the play button to start acquiring profiles. A 3D image is generated from acquired profiles. You can edit parameter values and evaluate the result directly in the image viewer until the result is satisfactory. You also have several options to visualize the 3D image.

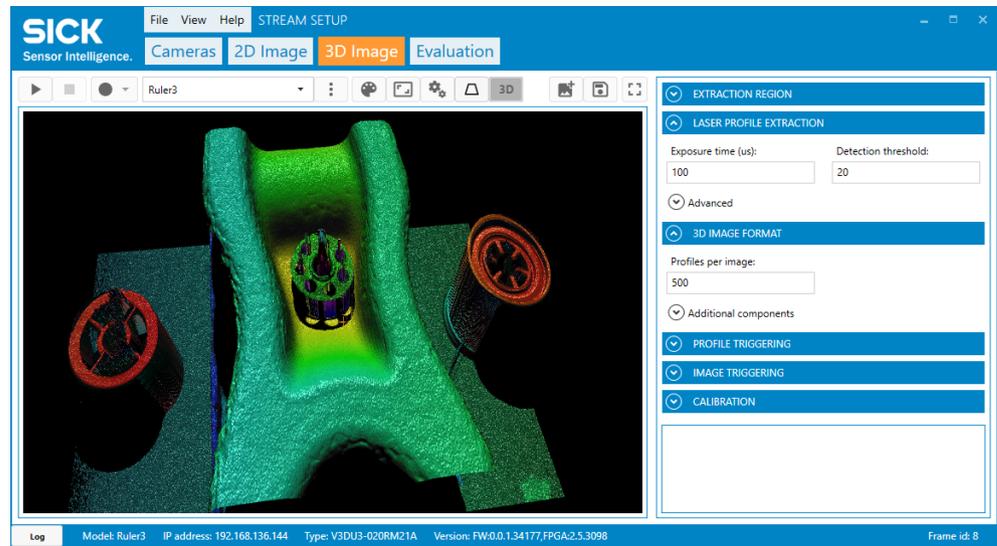


Figure 6: Getting the 3D image.

4 Product description

4.1 Introduction

Ruler3000 is a high-speed 3D camera with integrated laser, intended to be the vision component in a machine vision system. Ruler3000 makes measurements on the objects that pass in front of the camera and sends the measurement results to a PC for further processing. The measurements can be started and stopped from the PC, and triggered by encoders and photoelectric switches in the system.

The main function of Ruler3000 is to measure the 3D shape of objects by the use of laser line triangulation. This can be used for example for generating 3D images of the object, for size rejection or volume measurement, or for finding shape defects. Since the optics in the camera is mounted at a fixed distance and angle from the laser, the position of each point of the cross-section can be calculated by detecting the laser line in the image. In the image below, the colors represent height.

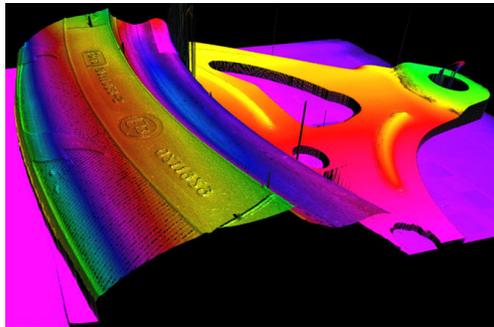


Figure 7: Example of 3D image

The 3D image which is the result of a measurement is a calibrated 3D point cloud, representing the visible surface of the object. For each point in the point cloud, you can retrieve its position (x, y, z) in millimeters, in a coordinate system relative to the Ruler3000, and the reflectance, i.e. the amount of light that is reflected by the object.

3D image data can also be retrieved as rectified maps with z values with a fixed x and y sample distance. Rectified height maps reduce the bandwidth and make image processing easier, but they might contain fewer details than the corresponding point clouds.

4.2 Measuring with a 3D camera

The Ruler3000 measures the shape of objects using laser triangulation. It analyzes images of the object as it passes under a laser line. Each image shows the laser line as a cross-section of the object viewed from an angle. The result of a measurement is a profile. The profile contains one value for each measured point along the cross-section, for example the height of the object along its width.

For the camera to measure an entire object, the object (or the camera) must move so that the camera can make a series of measurements along the object. The result of such a measurement is a collection of profiles, where each profile contains the measurement of a cross-section at a certain location along the transportation direction.

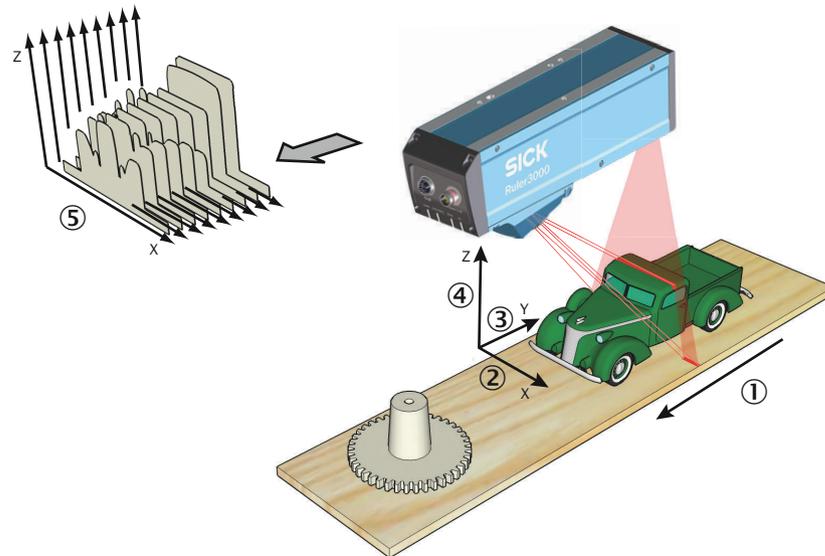


Figure 8: Measuring the range of a cross-section of an object.

- ① Transportation direction
- ② X (width)
- ③ Y (negative transport direction)
- ④ Z (range)
- ⑤ Profiles

The Ruler3000 makes three different types of measurements:

Range	Measures the position of the object along the laser line.
Reflectance	Measures the amount of light that is reflected by the object along the laser line.
Scatter	Measures how the incoming laser light is distributed beneath the surface of the object. This is useful for example for finding the orientation of fibers in wood.

Note that the output from the camera is not images of the object, but a set of range and/or reflectance and/or scatter values. One value for each point along the cross-section of the object. The measurements can be visualized as a profile plot showing the shape of the cross-section, or by combining several profiles, as a complete 3D image of the object.

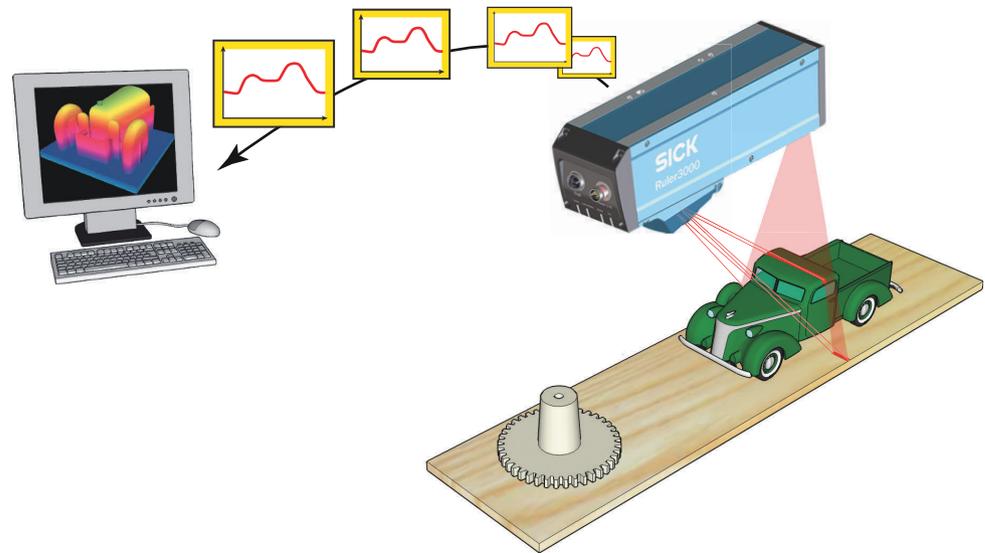


Figure 9: Profiles are sent from the Ruler3000 to a PC, where they are analyzed.

In the system, the Ruler3000 camera acts as a data streamer. It is connected to a PC through a Gigabit Ethernet network. The camera sends the profiles to the computer, and the computer runs a custom application that retrieves the profiles and processes the measurement data in them. The data is delivered from the camera using integers and the API and GUI aids in scaling this to floating-point mm values.

Before the camera can be used in the system, the following needs to be done:

- Find the right way to mount the camera.
- Configure the camera to take the proper measurements.
- Write the application that retrieves and processes the profiles sent from the camera.

More information about 3D measurements, see "[Range \(3D\) measurement](#)", page 95.

Range

By default, the range measurement values from the camera are calibrated and rectified – that is:

- Z (range) coordinates are represented by real-world positions and distances, delivered in a depth-map with a fixed sample distance.
- X coordinates are given by the column position of the data.
- Y coordinates are represented for example by the sequence number of the measurement, or by the encoder value for when the profile was captured.

Reflectance

The reflectance values along the laser line can be collected in parallel to the 3D data. The reflectance values are saved as a grayscale image, with 8-bit resolution corresponding to each point in the range dataset

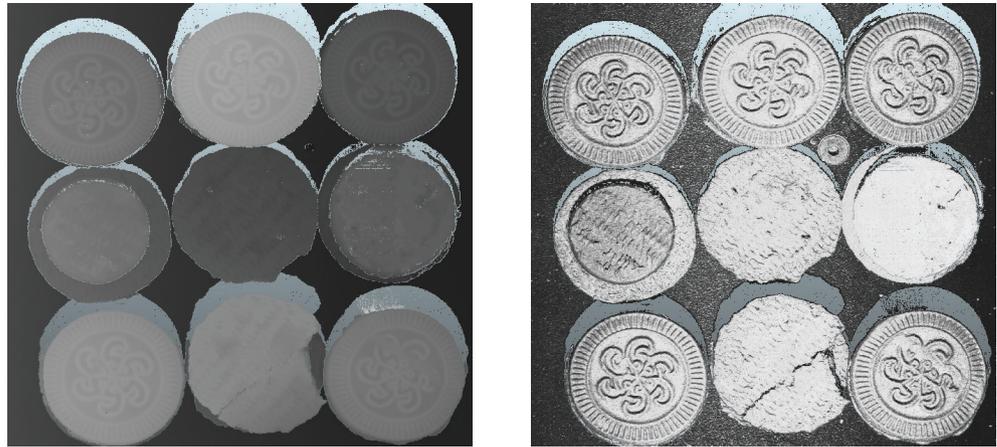


Figure 10: Cookies depth map, higher value is brighter (left). Reflectance data for the same set of cookies (right).

Scatter

The scatter component measures the intensity of the light seen beside the laser signal. The scatter signal can be explained as the amount of scattered light received in a sampling window at a distance from the peak laser position.

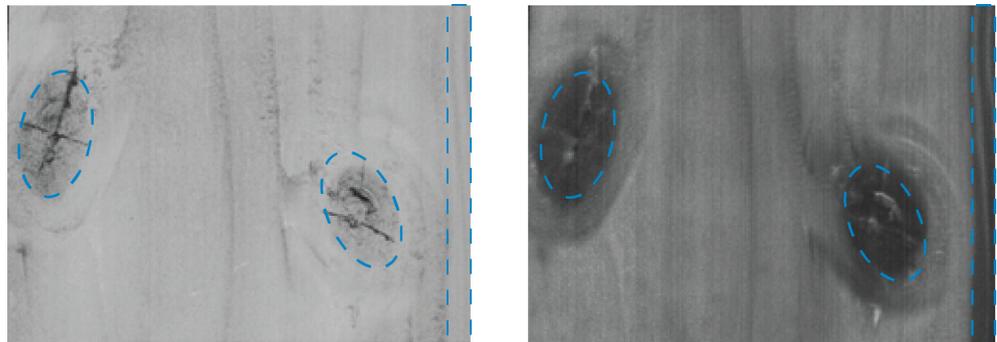


Figure 11: Wooden board displayed with reflectance (left) and scatter (right). The knots and the blue-stained right edge of the board (outlined in blue) appear dark in the scatter image.

4.3 Hardware description

4.3.1 Sensor

The Ruler3000 camera is based on a unique SICK CMOS sensor which has a 2D pixel matrix, row-parallel AD-converters, and a processor architecture that enables image processing directly on the sensor. The technology is called ROCC, which means Rapid On-Chip Calculation. For technical details, see ["Technical data"](#), page 88.

4.3.2 LED indicators

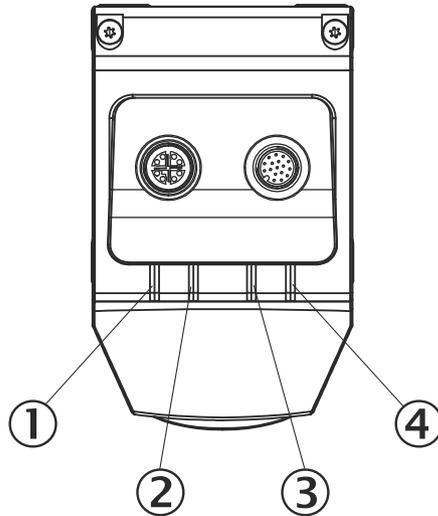


Figure 12: LED indicators, Ruler3000

- ① LED: Laser
- ② LED: Link/Data
- ③ LED: State
- ④ LED: On

Indicator	LED	Color	Function
Laser	●	Yellow	Internal or external laser is on or strobing
Link/Data		Off	No Ethernet connection
	●	Green	Connection established, 1 gigabit/s
	●	Green (flashing)	Ethernet frames are being transmitted or received
State	●	Yellow (flashing)	Booting (slow flashing) or firmware upgrade (fast flashing)
	●	Yellow	Idle
	●	Green	Continuous or single frame acquisition
	●	Red (flashing)	Thermal warning (risk of overheating)
	●	Red	The device is in rescue mode, due to software problems or overheating For more information, see "Rescue mode", page 85
On	●	Green	Power ON

● = illuminated, ● = flashing

4.4 Interface and communication standards

Ruler3000 complies with the GenICam™ and the GigE Vision® standards. For detail on supported versions see the Device Control feature.

4.4.1 GigE Vision®

GigE Vision® is a camera interface standard that is based on the Gigabit Ethernet communication protocol. The GigE Vision® standard is owned by AIA (Automated Imaging Association). GigE Vision cameras must support GenICam.

For further information, see <https://www.visiononline.org/vision-standards.cfm>.

4.4.2 GenICam™

GenICam™ is a standard that provides a generic programming interface for different kinds of cameras and devices. The standard is owned by EMVA (European Machine Vision Association) and consists of multiple modules. Ruler3000 complies with the following modules:

GenAPI	Application programming interface (API) for configuring the camera.
Standard Feature Naming Convention (SFNC)	Standardized names and types for common device features.
GenTL	Transport layer interface for grabbing images.
GenTL SFNC	Standardized names and types for features.

The **Stream Setup** GUI has, for simplicity, more descriptive names. For the same reason, there are only a few parameters available in the GUI. It is still possible to reach all of the available GenICam™ parameters via the API, see "Features", page 97. For information about how to set parameters, see "Setting parameters in GenICam", page 97.

For further information, see www.emva.org/standards-technology/genicam/.

4.4.3 GenIStream API

The **GenIStream API** is SICKs camera control and frame grabbing API. It is tailor-made for the Ranger3 and Ruler3000 camera families.

It includes functions for camera discovery and connection, parameter handling, grabbing/loading/saving images, etc., and is provided for C++ and C#.

GenIStream is included in the **3D Stream SDK**, which also contains example programs written with **GenIStream**, documentation of **GenIStream**, parameter configuration files, and camera firmware. For information about installation, see "Software installation", page 39.

4.4.3.1 GenIStream API Examples

Grabbing an image

The most basic C++ code to grab an image:

```
std::shared_ptr<genistream::CameraDiscovery> discovery =
    genistream::CameraDiscovery::createFromProducerFile("SICKGigEVisionTL.cti");

std::shared_ptr<genistream::ICamera> camera =
    discovery->connectTo(genistream::Ip4Address("192.168.1.17"));

std::shared_ptr<genistream::FrameGrabber> grabber =
    camera->createFrameGrabber(1);

grabber->start();
genistream::FrameGrabber::IFrameWaitResult result = grabber->grab();
std::shared_ptr<genistream::frame::IFrame> frame = result.getOrThrow();
grabber->stop();

frame->save("my_image_file");
```

4.4.4 SICK AppSpace

The Ruler3000 product family is part of the SICK AppSpace ecosystem, which consists of software tools and programmable sensors or devices. See [figure 13](#) for an overview of SICK AppSpace.

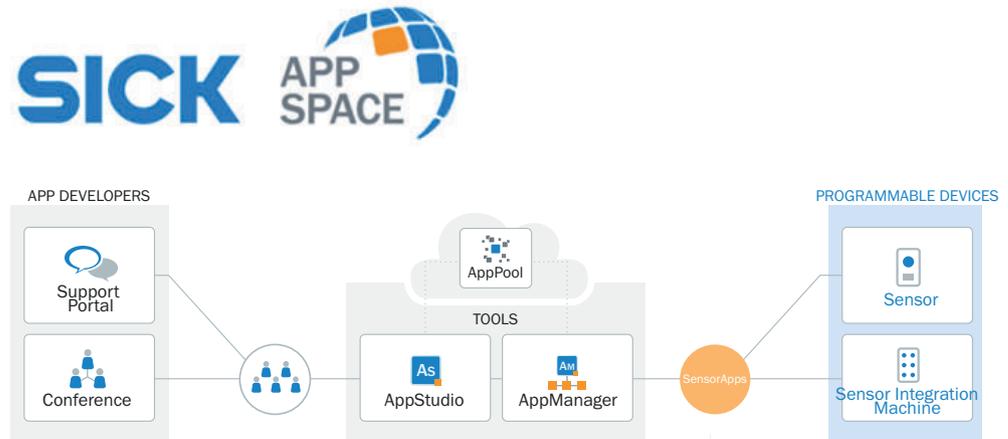


Figure 13: SICK AppSpace

SICK AppSpace includes the following components and resources:

- SICK AppManager: A software tool used for the installation and management of SensorApps and device firmware updates.
- SICK AppPool: A cloud-based repository for storing and sharing SensorApps. SICK AppPool can be accessed directly from SICK AppManager, SICK AppStudio and from the web.
- SICK AppStudio: A Software Development Kit (SDK) for developing SensorApps on programmable SICK devices. Its user interface for machine operators can be created individually as a web GUI.
- The SICK Support Portal (supportportal.sick.com) contains tutorials and instructions for programming the device in SICK AppStudio.

The only way to run AppSpace with a Ruler3000 is to connect the device to either a SIM or an IPC running SICK AppEngine. This extra hardware in turn runs an AppSpace app. This is due to that Ruler3000 is a streaming device and not a processing unit.

For more information about SICK AppSpace, see www.sick.com/SICK_AppSpace.

4.4.4.1 Integration

You can find the Ruler3000 AppSpace getting started app via the SICK Support portal: supportportal.sick.com. Select **Vision/3D vision** and **Ruler3000**.

The AppSpace API for interacting with the Ruler3000 is basic. AppSpace is using a GigEVision driver that is generic for connecting any GigEVision camera in AppSpace. Thus it is not made specifically for Ruler3000. There are no camera-specific crowns for loading configuration files or loading .dat files, it is all generic.

The API consist of two crowns, `Image.Provider.RemoteCamera` and `Image.Provider.RemoteCamera.GigEVisionConfig`. For more information about how to use these crowns from LUA to get the most out of a Ruler3000 integration, see the API documentation belonging to the AppEngine firmware you will run. This information is found on supportportal.sick.com.

4.4.4.2 Hardware setup

When developing an AppSpace app using the Ruler3000 we recommend using the SIM4000. It is, however, a bit lacking in power. If the Ruler3000 will be used under heavy load, using the SIM4000 might be an issue. However, new varieties are on the horizon which will make it possible to use AppSpace for more demanding applications.

It is recommended to use a switch between the SIM and the Ruler3000. This will allow you to configure the camera from **Stream Setup** and easily switching over to your AppSpace app.

4.4.4.3 Comparison AppSpace vs. GenIStream

SICK AppSpace	GenIStream
Callback is the only option to get images.	Choose to use callback or polling to retrieve images.
Parameter setting must be done by defining names with strings, you need to know the exact name.	Parameter setting is static, i.e. strings are not needed.
No details about the images are coming with the callback. You need to find out if it is range, reflectance, scatter, etc. Rectified image needs to be scaled and "offsetted" to get wanted mm values.	Details about the buffer content available. You know exactly what components you get (range, reflectance, scatter, etc.). It is possible to directly access floating-point mm values.
Cannot load parameter files or buffers saved in Stream Setup , .dat files.	Possible to save/load parameter files and handle camera configurations. FrameGrabber functionality, buffers can be saved if there is not enough time to analyze them.
Large image processing library included.	No image processing library included.
Chunkdata is not possible to use (encoder values, I/O values, etc.).	
	Possibility to search for cameras on the network.
	Possible to do a firmware update, IP configuration, file transfer, etc.
	Event available when camera disconnects.

5 Transport and storage

5.1 Transport

For your own safety, please read and observe the following notes:



NOTICE

Damage to the product due to improper transport.

- The device must be packaged for transport with protection against shock and damp.
 - Recommendation: Use the original packaging as it provides the best protection.
 - Transport should be performed by trained specialist staff only.
 - The utmost care and attention is required at all times during unloading and transportation on company premises.
 - Note the symbols on the packaging.
 - Do not remove packaging until immediately before you start mounting.
-

5.2 Unpacking

- To protect the device against condensation, allow it to equilibrate with the ambient temperature before unpacking if necessary.
- Handle the device with care and protect it from mechanical damage.
- To avoid ingress of dust and water, only remove the protective caps of the electrical connections just before attaching the connecting cable.

5.3 Transport inspection

Immediately upon receipt in Goods-in, check the delivery for completeness and for any damage that may have occurred in transit. In the case of transit damage that is visible externally, proceed as follows:

- Do not accept the delivery or only do so conditionally.
 - Note the scope of damage on the transport documents or on the transport company's delivery note.
 - File a complaint.
-



NOTE

Complaints regarding defects should be filed as soon as these are detected. Damage claims are only valid before the applicable complaint deadlines.

5.4 Storage

Store the device under the following conditions:

- Recommendation: Use the original packaging.
- Electrical connections are provided with a protective cap (as in the delivery condition).
- Do not store outdoors.
- Store in a dry area that is protected from dust.
- To allow any residual dampness to evaporate, do not package in airtight containers.
- Do not expose to any aggressive substances.
- Protect from sunlight.
- Avoid mechanical shocks.
- Storage temperature: see "Technical data", page 88.

- Relative humidity: [see "Technical data", page 88.](#)
- For storage periods of longer than 3 months, check the general condition of all components and packaging on a regular basis.

6 Mounting

6.1 Mounting instructions

- Observe the technical data.
- To prevent condensation, avoid exposing the device to rapid changes in temperature.
- The mounting site has to be designed for the weight of the device.
- It should be mounted so that it is exposed to as little shock and vibration as possible. Optional mounting accessories are available, [see "Accessories", page 93](#).
- Protect the device from moisture, contamination, and damage.
- Ensure a sufficient level of cooling using ambient air/convection and/or heat dissipation through mechanical mounting. Observe the permitted operating temperature, [see "Technical data", page 88](#).

6.2 Required parts

You need the following parts to get started with Ruler3000:

- Ruler3000 camera.
- PC with a network interface card (NIC) that supports Gigabit Ethernet. For information about requirements, ["Recommended network card settings", page 113](#).
- Power I/O cable.
- Ethernet cable for Gigabit Ethernet, with M12 connector for the camera.
- 24 Voltage supply.
- Connection module, i.e. CDB650 or similar (optional).

6.3 Mounting the device

The camera and laser are mounted inside the device so that the laser illuminates the object from one direction, and the camera views the object from another direction. The height positioning of the Ruler depends on the maximum width and height of the objects to be inspected. The wider the objects are, the higher the unit must be positioned. When the Ruler3000 is turned on, the emitted laser line must always cover the entire object width and should also extend a little on each side.

Ruler3020

Camera coordinate system in mm (inch) ①

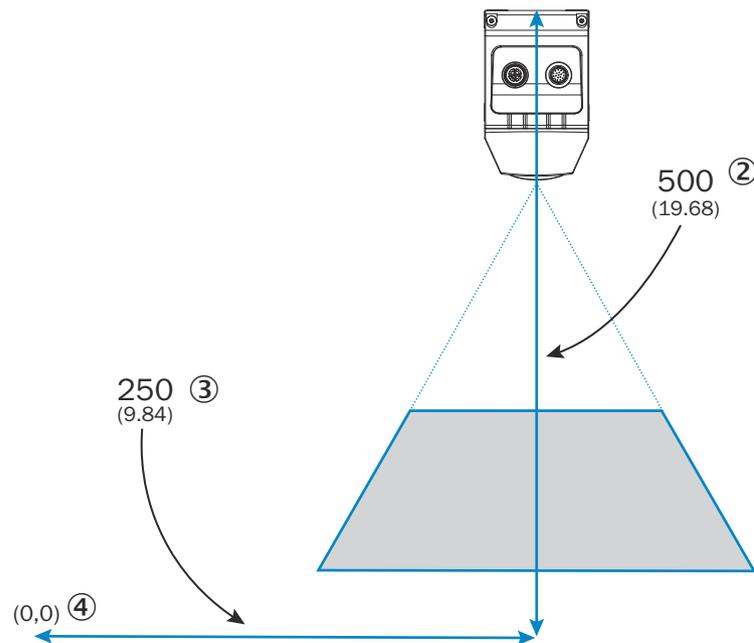


Figure 14: Ruler3000 coordinate system.

- ① Camera coordinate system in mm (inch)
- ② y axis, from device top
- ③ x axis, from device center
- ④ Origo

Mount the Ruler3000 with respect to the defined field of view (FOV), see [see "Field of view diagram", page 28](#), and other equipment to be used by the vision system, such as encoder and photoelectric switch. The field of view is located at a certain distance from the device, the stand-off, and is a trapezoid-shaped area in the laser plane. The maximum height and the maximum width of the object to be inspected define a rectangle that must be entirely inside the trapezoid total FOV. For correct measurement results, the laser line must be vertical and perpendicular to the movement direction of the object.

Mount the Ruler3000 in a position above the surface to be scanned. The default scan direction is shown in [figure 15](#). If a scan is performed in the opposite direction, the acquired image will be mirrored in the Y direction, see [table 6](#) where different triggering modes are described.

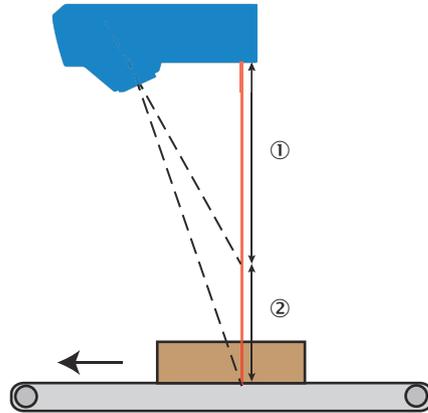


Figure 15: Mounting position

- ① Stand-off from device bottom, 245.5 mm
- ② Measuring range, 125 mm



NOTE

The recommended mounting position is laser first, which will give a faster result. However, the image will be mirrored in Y direction when viewed in **Stream Setup**. If you need to be able to for example read text on the scanned items, choose mounting position laser last.

For best result, it is important to shield out direct sunlight and other disturbing light from the field of view. The camera is fitted with an optical red band pass filter to reduce ambient light but some shielding might still be needed.

6.4 Field of view diagram

Each device is uniquely calibrated, which means different devices can have slightly different fields of view. The maximum guaranteed field of view represents a value guaranteed for any Ruler3000. The brighter area represents an example of a field of view.



NOTE

To ensure the application can be used by several Ruler3000 of the same type, make sure all data of interest is within the guaranteed field of view, see "[Visualizing 2D data](#)", [page 73](#).

Ruler3020

Guaranteed field of view in mm (inch) ①

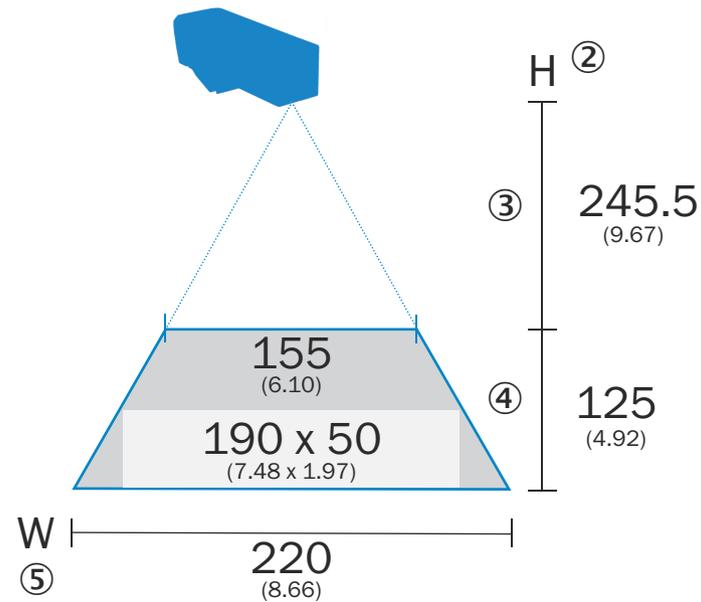


Figure 16: Field of view diagram

- ① Guaranteed field of view
- ② Maximum height range
- ③ Stand-off
- ④ Measuring range
- ⑤ Width at maximum working distance

Table 2: Preliminary measurement details

	Ruler3020
Field of view (height)	125 mm
Field of view (width)	155 / 220 mm
Stand-off from device bottom (laser side)	245.5 mm
Stand-off from device top	315.5 mm
X resolution (min/max)	63 μm / 88 μm
Z resolution (min/max)	8 μm / 15 μm
Laser wavelength	660 nm

7 Electrical installation

7.1 Conditions for specified enclosure rating

To ensure compliance with the IP65 and IP67 enclosure rating of the device during operation, the following requirements must be met:

- The cables plugged into the electrical M12 connections must be screwed tight.
- Any electrical M12 connections that are not being used must be sealed with protective plugs that are screwed tight (as in the delivery condition).

7.2 Wiring instructions



NOTE

Pre-assembled cables can be found online at:

- www.sick.com/Ruler3000
-



NOTICE

Faults during operation and device or system defects!

Incorrect wiring may result in operational faults and defects.

- Follow the wiring notes precisely.
-

Observe the following safety measures:

- Standard safety requirements must be met when working in electrical systems.
- Only connect and disconnect electrical connections when there is no power to the system. Otherwise, the devices may be damaged.
- Use only shielded cables. The shield has to be connected at both ends of the cable.
- Ensure that loose cable ends are isolated.
- Connect unused pins to GND and leave unused output pins floating.
- Wire cross-sections of the supply cable from the customer's power system should be designed and protected in accordance with the applicable standards.
- Make sure that the Power-I/O cable is protected by a separate slow-blow fuse with a maximum rating of 2.0 A. This fuse must be located at the start of the supply circuit. If using CDB650-204, see [see "Connecting a CDB650-204", page 36](#), connection module a 2A fuse is already present. If another connection method is used, a 2A fuse needs to be added to the installation.
- The voltage supply must meet the requirements of ES1 and PS2 (EN 62368-1) or SELV/PELV and LPS.
- Configure the circuits connected to the device as ES1 circuits or as SELV circuits.
- Connect the connecting cables in a de-energized state. Switch on the supply voltage only after complete installation/connection of all connecting cables to the device and control system.

7.3 Prerequisites for safe operation of the device



WARNING

Risk of injury and damage caused by electrical current!

As a result of equipotential bonding currents between the device and other grounded devices in the system, faulty grounding of the device can give rise to the following dangers and faults:

- Dangerous voltages are applied to the metal housings.
- Devices will behave incorrectly or be destroyed.
- Cable shielding will be damaged by overheating and cause cable fires.

Remedial measures

- Only skilled electricians should be permitted to carry out work on the electrical system.
- If the cable insulation is damaged, disconnect the voltage supply immediately and have the damage repaired.
- Ensure that the ground potential is the same at all grounding points.
- Where local conditions do not meet the requirements for a safe earthing method, take appropriate measures. For example, ensure low-impedance and current-carrying equipotential bonding.

The device is connected to the peripheral devices (voltage supply, any local trigger sensor(s), system controller) via shielded cables. The cable shield – for the data cable, for example – rests against the metal housing of the device. The device can be grounded through the cable shield or through a blind tapped hole in the housing, for example.

If the peripheral devices have metal housings and the cable shields are also in contact with their housings, it is assumed that all devices involved in the installation have the **same ground potential**.

This is achieved by complying with the following conditions:

- Mounting the devices on conductive metal surfaces
- Correctly grounding the devices and metal surfaces in the system
- If necessary: low-impedance and current-carrying equipotential bonding between areas with different ground potentials

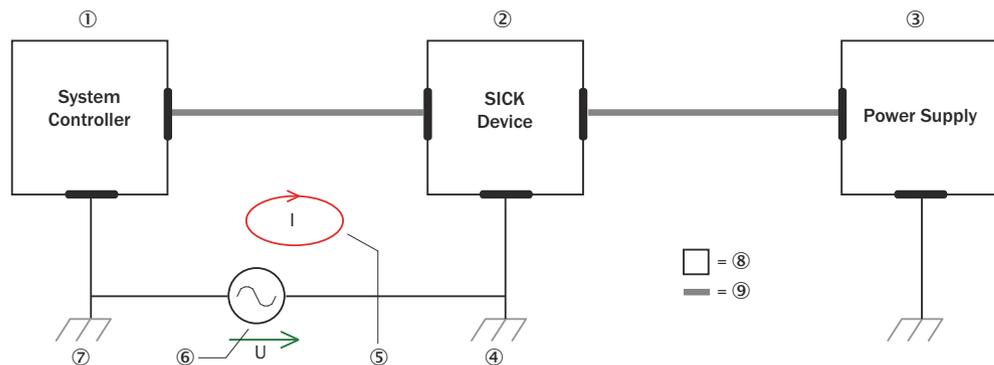


Figure 17: Example: Occurrence of equipotential bonding currents in the system configuration

- ① System controller
- ② Device
- ③ Voltage supply
- ④ Grounding point 2
- ⑤ Closed current loop with equalizing currents via cable shield
- ⑥ Ground potential difference

- ⑦ Grounding point 1
- ⑧ Metal housing
- ⑨ Shielded electrical cable

If these conditions are not fulfilled, equipotential bonding currents can flow along the cable shielding between the devices due to differing ground potentials and cause the hazards specified. This is, for example, possible in cases where there are devices within a widely distributed system covering several buildings.

Remedial measures

The most common solution to prevent equipotential bonding currents on cable shields is to ensure low-impedance and current-carrying equipotential bonding. If this equipotential bonding is not possible, the following solution approaches serve as a suggestion.



NOTICE

We expressly advise against opening up the cable shields. This would mean that the EMC limit values can no longer be complied with and that the safe operation of the device data interfaces can no longer be guaranteed.

Measures for widely distributed system installations

On widely distributed system installations with correspondingly large potential differences, the setting up of local islands and connecting them using commercially available **electro-optical signal isolators** is recommended. This measure achieves a high degree of resistance to electromagnetic interference.

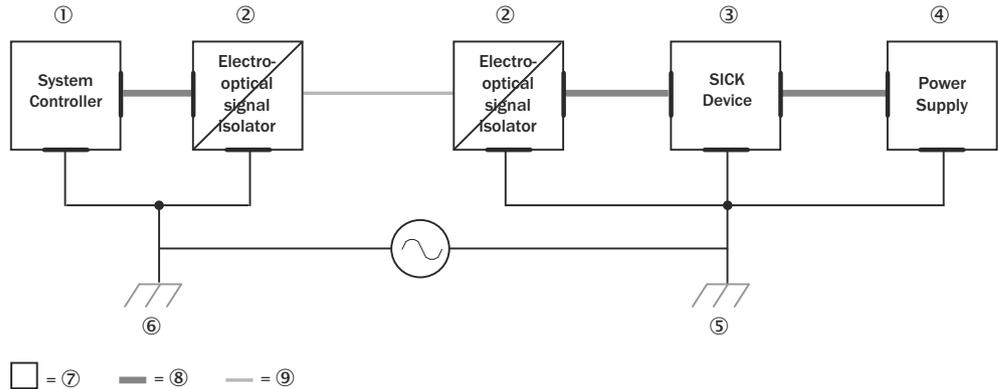


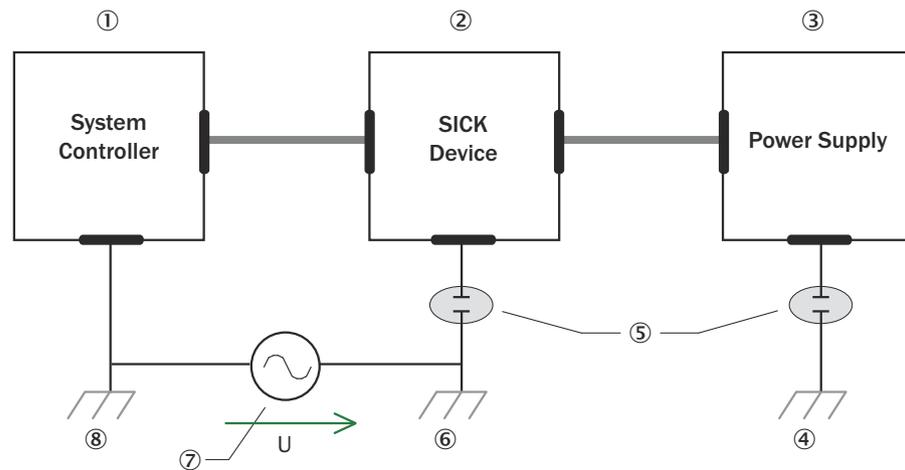
Figure 18: Example: Prevention of equipotential bonding currents in the system configuration by the use of electro-optical signal isolators

- ① System controller
- ② Electro-optical signal isolator
- ③ Device
- ④ Voltage supply
- ⑤ Grounding point 2
- ⑥ Grounding point 1
- ⑦ Metal housing
- ⑧ Shielded electrical cable
- ⑨ Optical fiber

The use of electro-optical signal isolators between the islands isolates the ground loop. Within the islands, a stable equipotential bonding prevents equalizing currents on the cable shields.

Measures for small system installations

For smaller installations with only slight potential differences, insulated mounting of the device and peripheral devices may be an adequate solution.



□ = ⑨ — = ⑩

Figure 19: Example: Prevention of equipotential bonding currents in the system configuration by the insulated mounting of the device

- ① System controller
- ② Device
- ③ Voltage supply
- ④ Grounding point 3
- ⑤ Insulated mounting
- ⑥ Grounding point 2
- ⑦ Ground potential difference
- ⑧ Grounding point 1
- ⑨ Metal housing
- ⑩ Shielded electrical cable

Even in the event of large differences in the ground potential, ground loops are effectively prevented. As a result, equalizing currents can no longer flow via the cable shields and metal housing.



NOTICE

The voltage supply for the device and the connected peripheral devices must also guarantee the required level of insulation.

Under certain circumstances, a tangible potential can develop between the insulated metal housings and the local ground potential.

7.4 Connecting the camera



NOTICE

- Never connect any signals while the camera is powered.
- Never connect a powered Power-I/O terminal or powered I/O signals to a camera.



NOTICE

- Never connect a powered encoder interface unit to a camera.
- Never connect signal levels that exceed the input specification to the encoder inputs.

Failure to follow these rules can damage the camera.



NOTE

The function of the camera is not tested and guaranteed for Power I/O cables longer than 10 meters.



NOTE

Use only shielded cables. The shield has to be connected at both ends of the cable.

There are two connectors on the back of the camera: Gigabit Ethernet (GigE) and Power I/O (see figure 20, page 34).

To prepare the camera for operation, do as follows:

1. Remove the protection caps that cover the connections for Gigabit Ethernet (GigE) and Power I/O.
2. Connect the Ethernet cable to the GigE connector on the camera. Connect the other end of the Ethernet cable to the Network Interface Card (NIC) in the PC.
3. Connect the connecting module to the Power I/O connector on the camera.
4. Connect the unpowered voltage supply to the connecting module.
5. Switch on the power to the system.

For more information on how to connect I/O signals to the camera, see "[Electrical connections](#)", page 34.

7.5 Electrical connections

There are two connectors and four LEDs on the backplate of Ruler3000.

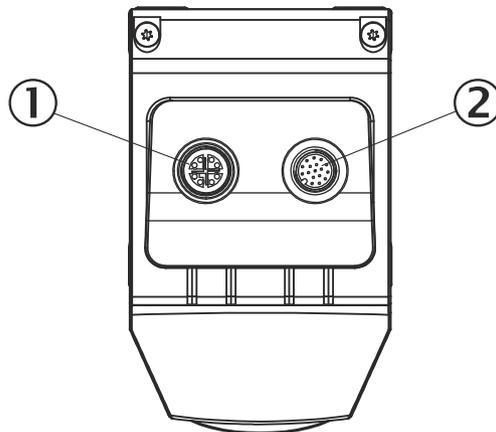
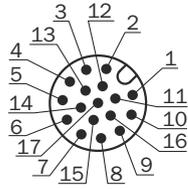


Figure 20: Backplate of the Ruler3000 device

- ① Connector Gigabit Ethernet (GigE): M12, 8-pin female, X-coded
- ② Connector Power I/O: M12, 17-pin male

7.5.1 Power I/O connector



Pin assignment

Table 3: Power I/O connector, 17-pin

Pin	Signal	Description
1	GND	Power/signal ground
2	POWER SUPPLY	Voltage supply DC 24 V +/-10%
3	-	Not connected
4	-	Not connected
5	ENC IN A+ ¹	Depending on used encoder type: Encoder Input A+ (5 V) or Encoder Input A (24 V) Configurable: RS-422 TTL or HTL Default: RS-422 TTL
6	ENC IN A- ¹	Depending on used encoder type: Encoder Input A- or Do not connect Configurable: RS-422 TTL or HTL Default: RS-422 TTL
7	-	Reserved
8	-	Reserved
9	-	Not connected
10	I/O 1	24 V Frame trigger input ³
11	ENC IN B+ ¹	Depending on used encoder type: Encoder Input B+ (5 V) or Encoder Input B (24 V) Configurable: RS-422 TTL or HTL Default: RS-422 TTL
12	ENC IN B- ¹	Depending on used encoder type: Encoder Input B- or Do not connect Configurable: RS-422 TTL or HTL Default: RS-422 TTL
13	-	Reserved
14	LASER STROBE OUT2 ²	5 V trigger output for Laser or Strobe
15	I/O 2	24 V Line trigger input ³
16	I/O 3	Encoder reset input ³
17	I/O 4	Frame synchronization output ³

¹ Depends on the encoder type, see descriptions below

² Note that Laser strobe out1 is internally connected to the laser and only Laser strobe out2 is externally available

³ Later firmware releases can give configurable 24V I/O options.

Notes

- Make sure, that at all times, the voltage at the I/O pins is lower or equal to the voltage at the supply pins. If not, you risk power on the camera through the I/O pins although it is turned off (V supply = 0 V), which is strictly forbidden.
- When using a single-channel encoder, connect it to Encoder Input A+/A- (pin 5 and 6)

Encoder types

Ruler3000 supports the following encoder types:

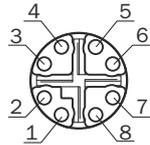
- RS-422 (5V): Two differential channels (A+/A- and B+/B-) are used as input from the encoder to the camera. The signal swing is 5 V. The maximum encoder frequency is 2 MHz.
- HTL (24 V): Two single-ended channels (A and B) are used. The signal swing is 24 V. The maximum encoder frequency is 400 kHz.

Signal levels

Table 4: Signal levels for Power I/O connector

Signal	Pins	Low	High	Remark
24 V inputs	10, 15, 16, 17	0... 9 V	12.5... V_Supply	Pulldown: 22.5 kΩ
TTL	5, 6, 11, 12	0... +0.8 V	+2 V... V_Supply	RC-termination, 112 Ω / 340 pF
24 V outputs	16, 17			Output type: Push-pull. Max output current: 100 mA
5 V outputs	14			Output type: Push-pull.

7.5.2 GigE connector



Pin assignment

Table 5: GigE connector, 8-pin

Pin	Signal
1	GETH L1+
2	GETH L1-
3	GETH L2+
4	GETH L2-
5	GETH L4+
6	GETH L4-
7	GETH L3-
8	GETH L3+

7.6 Connecting a CDB650-204

The **Connection Device Basic** (CDB) offers options for quickly connecting one sensor, via host PCs or PLCs, in accordance with industrial standards. Both the sensor and the connection module meet all IP 65 enclosure rating requirements for dust and water spray protection.

A 2A fuse is included in the CDB. If another connection method is used, a 2A fuse needs to be added to the installation.

Please refer to the CDB650 Operating Instruction before connecting the Ruler3000 to the CDB.



Figure 21: Electrical connections for CDB650-204

- ① Cable gland, 5 x
- ② 17-pin M12 female connector, A-coded

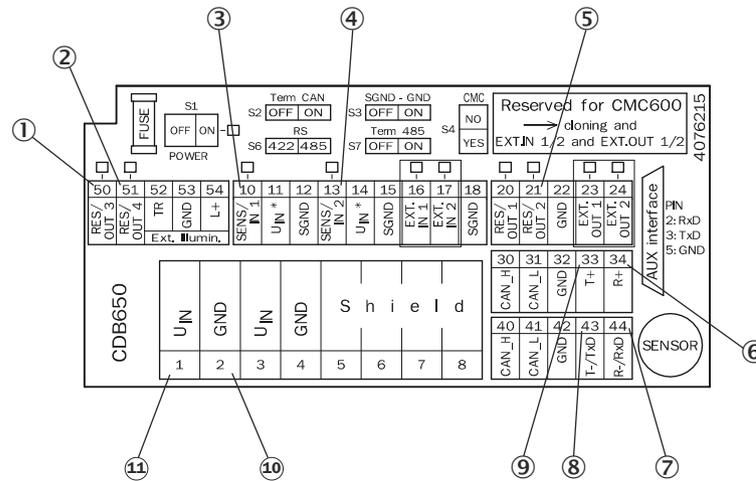


Figure 22: Connection ports for CDB650-204

	Terminal in CDB650	Signal in Ruler3000	Voltage
①	50	I/O 3	24 V input
②	51	I/O 4	24 V output
③	10	I/O 1	24 V input
④	13	I/O 2	24 V input
⑤	21	Laser trigger 2	5 V output
⑥	34	Encoder B+	5/24 V input
⑦	44	Encoder B-	5/24 V input
⑧	43	Encoder A-	5/24 V input
⑨	33	Encoder A+	5/24 V input
⑩	2	GND	-

7 ELECTRICAL INSTALLATION

	Terminal in CDB650	Signal in Ruler3000	Voltage
①	1	Power supply	24 V input

8 Configuration

8.1 Software installation

8.1.1 System recommendations

The PC requirements for the system will depend on your application, but as a general guideline the following is recommended for minimal operation:

- Windows 10, 64 bit.
- Gigabit Ethernet adapter that supports Jumbo Frames and is dedicated for camera communication, see "[Recommended network card settings](#)", page 113.



NOTE

Please read the release notes in the **3D Stream SDK** for detailed information.

8.1.2 Network preparations

Due to the amount of data that the camera delivers per second, it is required to connect it to the PC using a dedicated Gigabit Ethernet network, without other interfering traffic. If the PC must be connected to other equipment, for example network printers, the PC should be equipped with (at least) two network interface cards (NIC).

Multiple cameras can be connected using a NIC with multiple ports, or multiple NICs. To connect multiple cameras to a single NIC limits the maximum speed of the cameras. For best performance, connect each camera to a separate NIC.

For recommended network settings, see "[Recommended network card settings](#)", page 113.

8.1.3 Installing PC software

The latest version of the Stream Setup can be downloaded from the SICK Support Portal, supportportal.sick.com.



1. Log in to the SICK Support Portal.
2. Navigate to the **Ruler3000** product page (Vision/3D vision/Ruler3000).
3. Under **Releases**, click the link corresponding to the latest version of the **3D Stream SDK**. This includes the API and some code examples.
4. Download the **3D Stream SDK**.
5. Unzip the file and follow the instructions in the `README.txt` file.
6. Under **Downloads**, click the link corresponding to the latest version of the **Stream Setup**.
7. Download the **Stream Setup Installer** and unzip the file.

The zip file contains the **Stream Setup** application, which is used for the configuration and operation procedures described in this manual. To start the installation, click the **StreamSetupInstaller.exe** file.

Follow the instructions in the setup wizard to install **Stream Setup**.

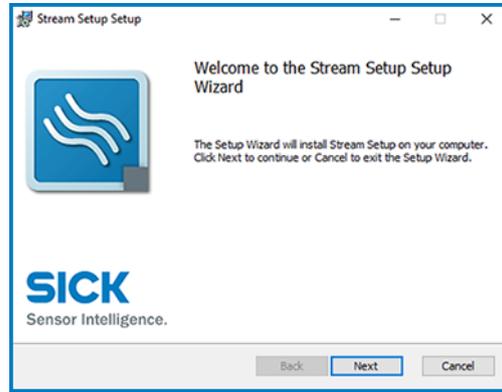


Figure 23: Setup wizard, Stream Setup.

8.2 Connecting the camera

The last connected device is displayed at start-up together with a color bar indicating the device status:



Device is available, but not connected.



Device is available and already connected.



Device is available, but cannot be connected unless the IP settings on the device or the local NIC are modified.



Device is already in use.

1. If the suggested device is correct and available, click **Connect**.
2. If the suggested device is not correct or if the IP settings need to be modified,
 - a) Click **Camera search** to see all devices that are available on the network.
 - b) Select the correct device.
 - c) If needed, click the three dots to the right and select **IP settings** to edit the IP settings of the device, see ["Editing IP settings", page 65](#).
 - d) Click **Connect**.
- ✓ When the device is connected, select **2D Image** to continue the workflow.
3. In the **2D Image** tab, click the play button to view the 2D image and the laser line.

8.3 Configuring Ruler3000

The Ruler3000 is designed to deliver good measurement data for both dark and bright objects by default.

Before the camera can be used in the system, it has to be configured. This is usually done by setting up the camera in a production-like environment and evaluate different parameter settings until the result is satisfactory. The Ruler3000 can be configured to fit many different applications.

The following sections describe what can be specified when configuring the Ruler3000 using **Stream Setup**. The Ruler3000 also has a large number of parameters that are not exposed in Stream Setup but can be configured using GenICam or GenIStream, see "[GenIStream API](#)", page 21.

Extraction region	Where on the sensor to measure and dimensions of the 3D output image.
Laser profile extraction	For how long to expose the sensor, using HDR, etc.
3D image format	How many profiles to include for each 3D image. How to handle reflectance and scatter.
Triggering	When to make a measurement.
Calibration	If and how sensor data is converted to mm values.

8.3.1 Editing parameters

Tabs: **2D Image**, **3D Image**

When you adjust the parameters, you look at the 2D or 3D image to see the result. You can store the image to the image list in the **Evaluation** tab after each adjustment and compare the images to find the best configuration. You cannot edit the parameters while the camera is acquiring data.

1. Click the stop button to stop acquiring data.
2. In the Parameter settings section (see [page 63](#), select the category the parameter belongs to).
- ✓ The parameters of the selected category are displayed in the right part of the window.
3. If the parameter you want to edit is not shown, select the down-arrow to make more parameters visible.



NOTICE

Always make sure that you have the right knowledge before you make any changes, otherwise the system can work incorrectly.

4. Select the parameter.
- ✓ A description of the parameter is shown in the lower part of the window.
5. Depending on the type of parameter, type or select the new value.
- ✓ The new value is saved automatically when you leave the input field or press Enter on your keyboard.

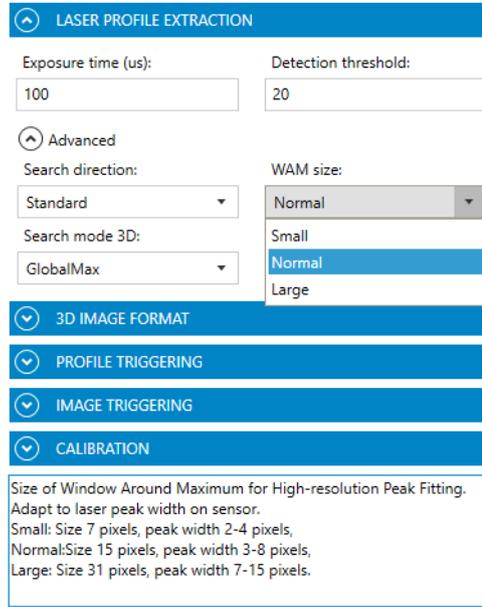


Figure 24: A selected parameter with help text in the lower part of the window.

6. Click the play button to start the data collection.
7. To view the currently displayed image in the **Evaluation** tab, use the **Add image** button.

8.4 Extraction region

Data from the sensor is used to output either the raw data, i.e. a standard 2D image, or the 3D profile data.

The region of interest (ROI) is the area within the laser plane in which the device will look for a profile to capture. The parts of a profile that are outside the ROI are either ignored (if to the right or the left of the ROI) or treated as missing data (if above or below the ROI).

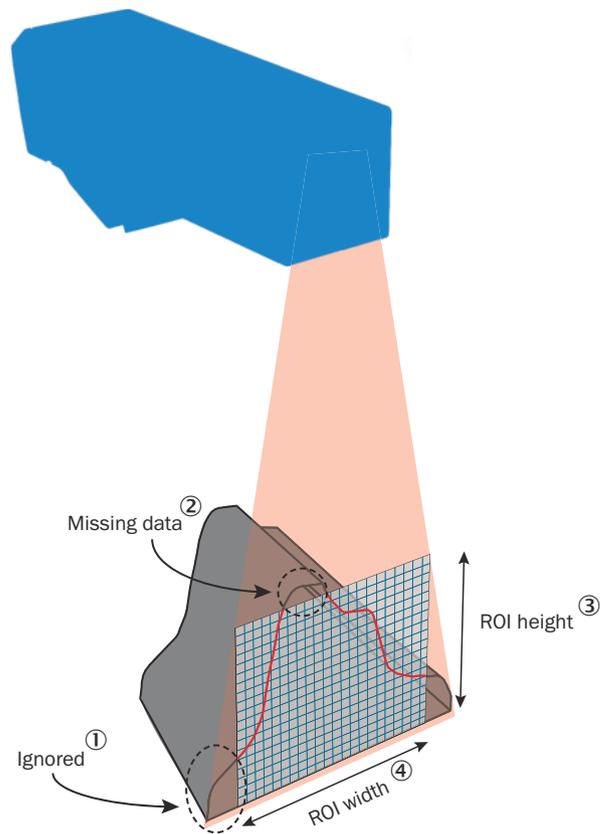


Figure 25: The region of interest and captured profile.

- ① Ignored
- ② Missing data
- ③ Region of interest height
- ④ Region of interest width

Using a smaller region on the sensor enables measurements at a higher rate. The region is specified by the parameters OffsetX, OffsetY, Width, and Height as shown in the figure below.

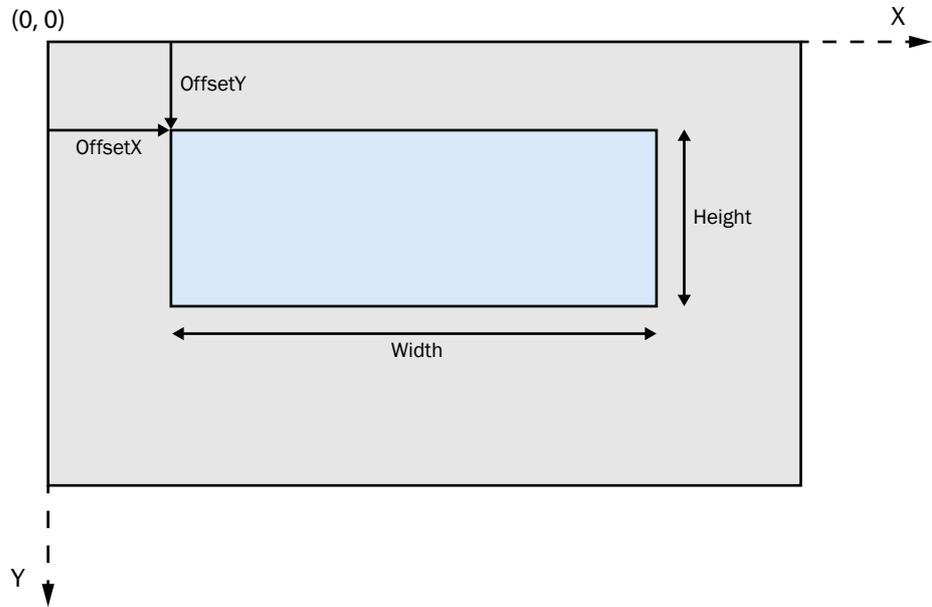


Figure 26: Image area and 2D region of interest.

The resulting image generated by the device will have **Width¹⁾** times **Profiles per image** pixels. **OffsetX** and **OffsetY** are given with respect to the upper left corner of the image area. This corner has the coordinates (0,0) in the imager (x, y) coordinate system. All measures are given in sensor (pixel) or world (mm) coordinates.

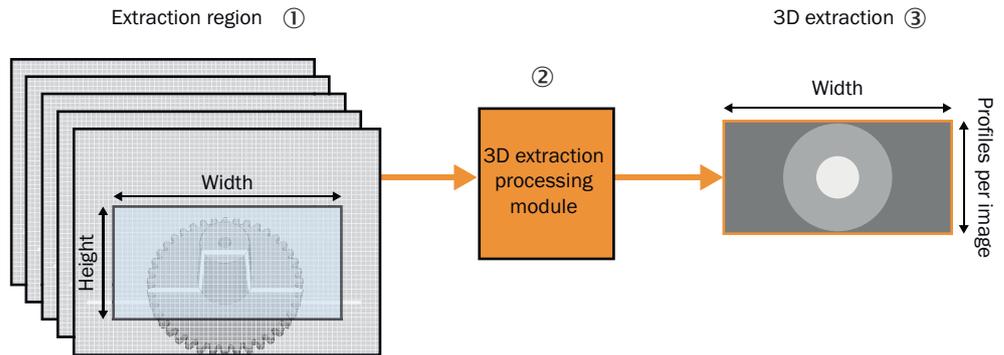


Figure 27: A 3D processing module defines the processing and formatting conditions of the generated 3D profile output data.

- ① Extraction region
- ② 3D extraction processing module
- ③ 3D extraction

1) For a rectified image the width is equal to **Rectification width**.

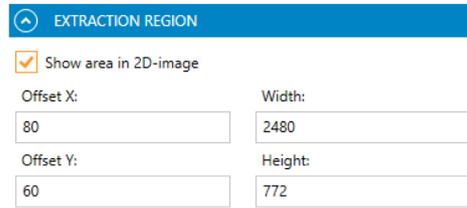


Figure 28: Extraction region GUI reference

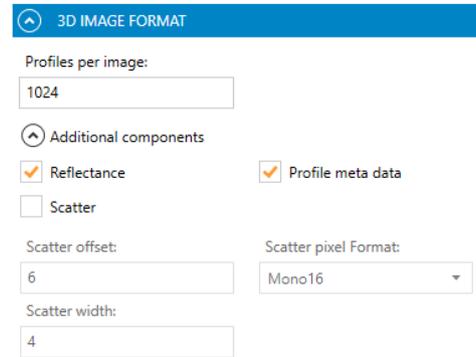


Figure 29: 3D Image format GUI reference

The **Width** and **Height** parameters of the region define the dimensions of the 3D extraction output image. To visualize the region of interest, select the **Show area in 2D-image** checkbox.

To get a 3D image, several 2D images are required. Each 2D image corresponds to one profile, see "Measuring with a 3D camera", page 16. The 2D images are transformed into profiles in the 3D extraction output image. This means that the **Profiles per image** value tells how many 2D images are used to generate the resulting 3D image. The 3D image has Width^2 times **Profiles per image** pixels.

8.4.1 Setting extraction region

Tab: 2D Image

To adjust the height and position of the region that is used to generate the 3D image data follow the steps below.



NOTE

For best image quality, make sure that the whole width of the laser line is within the defined region. Use the **Guaranteed FOV** button to verify that the region is within the field of view guaranteed for the device, see "Visualizing 2D data", page 73.

1. Select the **Show area in 2D-image** checkbox.
- ✓ A blue overlay appears in the 2D image. The overlay represents the parts of the image to be excluded from the generation of 3D image data. The remaining dark area is the extraction region.

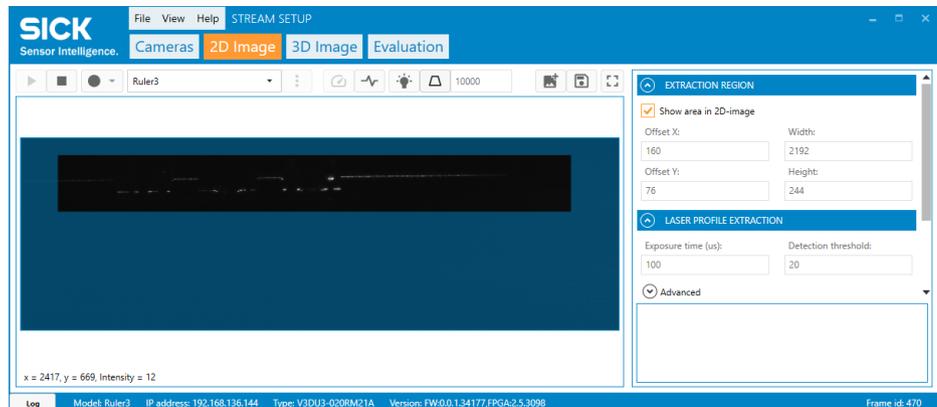


Figure 30: 2D image with blue overlay.

2. Hover over the edges of the extraction area to highlight its handles.

2) For a rectified image the width is equal to **Rectification width**.

3. Click and drag the handles to change the dimensions and offset:
 - Click and drag the top and bottom handles to adjust the **Offset Y** and **Height** parameters.
 - Click and drag the side handles to adjust the **Offset X** and **Width** parameters.
 - Click and drag the cross-shaped handle in the middle to change the position of the entire extraction region.

When a handle is moved, the corresponding parameter values are automatically updated. As an alternative to moving the handles, the parameter values can be updated manually.



NOTE

The **Width** parameter is fixed to factor 16 and **Height** to factor 4 and is automatically handled by **Stream Setup**.

8.4.2 Measurement mode

The camera can be configured to output either the raw data from the image sensor or the 3D profile data. In the user interface, you select **2D Image** to see the raw sensor data as a 2D image or **3D Image** to get the 3D profile data.

8.4.3 Maximum buffer size

The maximum size for an image buffer to be sent from Ruler3000 to the host PC is around 40 MB. The limit is due to the limited GigE Vision retransmission buffer memory in the device.

The maximum buffer height, i.e. **Profiles per image** depends on the data format, the region width or rectification width (if using rectification), and the number of enabled components (e.g. reflectance, see "[Reflectance](#)", page 52). For example: With default settings, i.e. both rectified mode and reflectance enabled, the maximum buffer height is about 8700. When reflectance is disabled, the maximum buffer height increases to about 13000.

If the buffer size is maximized, the camera may block user actions that further increase the size. Examples of such actions are:

- Enabling another component, such as reflectance
- Increasing the region width or rectification width

The user must decrease the buffer size to make the blocked actions available again. This is done by decreasing the region or rectification width or decreasing the number of enabled components. You can also reduce the **Profiles per image** to allow more memory to be used by each profile.

8.5 Laser profile extraction

Figure 31: Laser profile extraction GUI reference

8.5.1 Exposure time

Once the height of the sensor region is set, there are two other settings that affect the profile rate of the camera:

Exposure time (μs)	The time (μs) during which the sensor region is exposed. This controls the duration where the photosensitive cells are exposed to light.
Timed profile rate (Hz)	The rate at which the profiles in an image are captured (Hz). Only applicable when the camera is in free-running mode. (The Timed profile rate is defined in the Profile triggering section.)

The exposure time and the profile rate are inter-dependent. The maximum exposure time cannot be longer than the time between two profiles, minus about three microseconds that are needed for readout and reset.

You can see the maximum profile rate possible for the current configuration by clicking on the **Timed profile rate** field. The maximum profile rate is shown in the information field at the bottom.



NOTE

The maximum exposure time and the maximum profile rate are stored as floating-point values and rounding-off effects may make it impossible to set the exact value returned by the GUI. The maximum deviation is 0.01 μs for the exposure time and 0.01 Hz for the line rate.

8.5.1.1 Setting exposure time

Tab: 2D Image

1. Look at the 2D image and the laser line and adjust the **Exposure time** parameter until the laser line is imaged as a narrow bright stripe and the background is not visible, see the figure in the middle below. The laser line should be approximately 4 to 8 pixels wide.

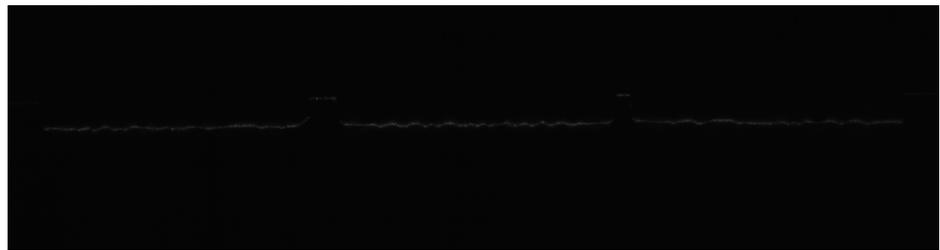


Figure 32: Too short exposure time: Laser line hardly visible.

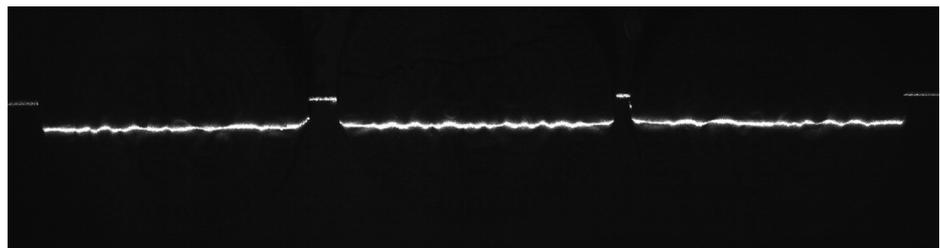


Figure 33: Normal exposure time: Laser line bright but not saturated. No background visible.

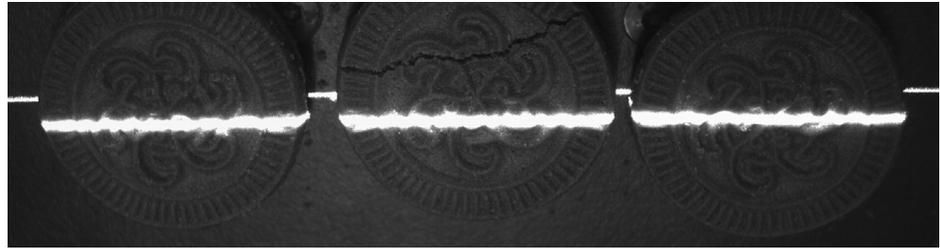


Figure 34: Too long exposure time: Laser line wide and saturated. The background is visible.



NOTE

If reflectance measurements are enabled, the exposure time can also be adjusted using a reflectance image as reference. For details, see ["Setting exposure time using reflectance"](#), page 52.

8.5.2 Detection threshold

The **Detection threshold** defines the minimum reflectance signal that can be detected as a peak position. Ideally, this parameter is set to a value that is higher than the amplitude of the noise, but still low enough to detect the laser signal, see the figure below. If **Detection threshold** is too low, noise will be registered as laser peaks. This will result in bad image quality. If **Detection threshold** is too high, not all laser peaks will be registered. This will result in an image where some parts are missing. Missing data will be registered with pixel value 0 if a laser peak cannot be found in that column.

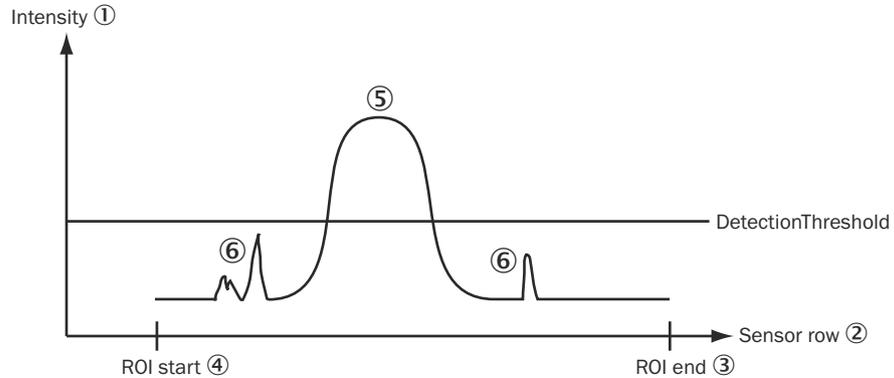


Figure 35: Analog signal with noise

- ① Intensity
- ② Sensor row
- ③ ROI end
- ④ ROI start
- ⑤ Detected peak
- ⑥ Not detected peaks

8.5.3 Advanced

8.5.3.1 Search direction

The search direction is used to define if the first or last peak should be used to represent the impact position of the laser line. The **Search direction** is only relevant when **FirstLocalMax** is used as **Search Mode 3D**.

Setting	Description
Standard	Finds the first peak in the region when searching from the top of the region of interest and down.
Reverse	Finds the last peak in the region when when searching from the bottom of the region of interest and up.

All relevant peaks must be above the given threshold value. The first peak is found when **Search direction** is **Standard** and **Search mode 3D** is set to **FirstLocalMax**. The maximum peak is found if **Search mode 3D** is set to **GlobalMax**. In this case the search direction is not relevant.³⁾ The last peak is found when **Search direction** is **Reverse** and **Search mode 3D** is set to **FirstLocalMax**.

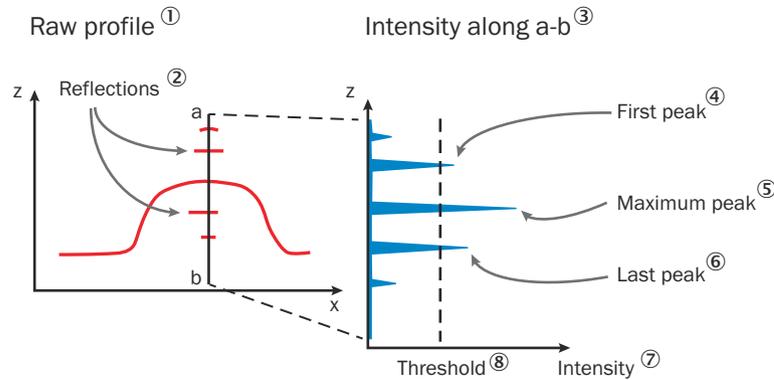


Figure 36: Search direction and possible peaks to find.

- ① Raw profile
- ② Reflections
- ③ Intensity along a-b
- ④ First peak
- ⑤ Maximum peak
- ⑥ Last peak
- ⑦ Intensity
- ⑧ Threshold

8.5.3.2 WAM size

The size of Window Around Maximum (WAM) is used for high-resolution peak fitting. The selected value should correspond to the laser peak width on the sensor.

If the laser peak is narrow, the selected **WAM size** should be small. If the laser peak is wide, the selected **WAM size** should be larger.

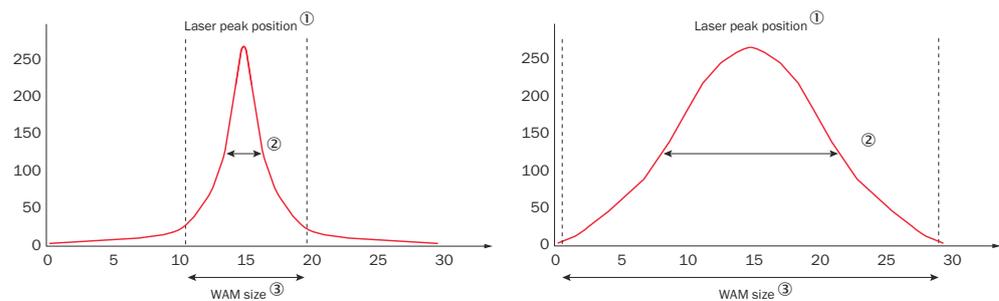


Figure 37: Laser peak width and corresponding WAM size.

- ① Laser peak position
- ② Laser peak width

³⁾ If the image is heavily saturated causing a very wide peak, the Search direction will have an impact also in GlobalMax mode, shifting the peak closer to the first peak depending on the Search mode 3D.

③ WAM size

Setting	Description
Small	Size 7 pixels, peak width 2-4 pixels.
Medium	Size 15 pixels, peak width 3-8 pixels
Large	Size 31 pixels, peak width 7-15 pixels

8.5.3.3 Search mode 3D

The **Search mode 3D** defines the type of peaks to search for. There are two different modes available. For more information, see "[Search direction](#)", page 48.

Setting	Description
GlobalMax	Searches for the maximum intensity peak in each column regardless of Search direction .
FirstLocalMax	Searches for the first peak above the defined threshold in the Search direction .

8.5.3.4 High dynamic range (HDR) imaging

Ruler3000 supports high dynamic range (HDR) imaging, which increases the sensor's ability to adequately reproduce both bright and dark areas in a scene. HDR is suitable for improving the localization of the laser line when acquiring images containing both dark and bright materials, such as bright objects towards a dark background or dark objects with bright prints. The HDR function is on per default.



Figure 38: Acquisition of profiles

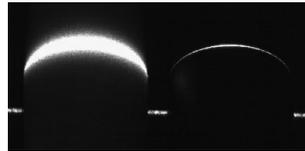


Figure 39: Resulting profile, linear (non-HDR) mode

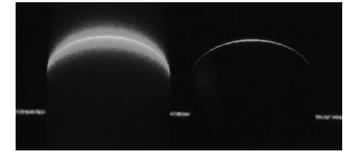


Figure 40: Resulting profile, HDR mode

Ruler3000 uses an HDR principle called multi-slope with one knee-point, which means that the normal linear relationship between the received light and the resulting pixel value (reflectance) is broken into two linear segments. The result is a compressed light-to-pixel value characteristic for high light intensities, according to [figure 41](#).

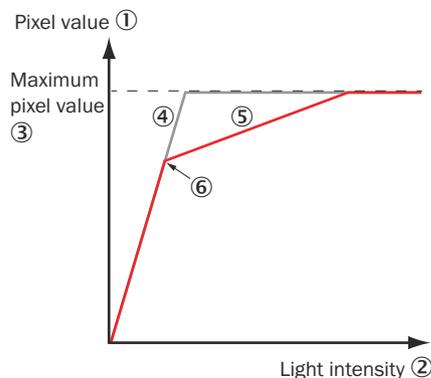


Figure 41: HDR multi-slope principle

- ① Pixel value
- ② Light intensity
- ③ Maximum pixel value
- ④ Linear (non-HDR) mode

- ⑤ HDR mode
- ⑥ Knee-point

The knee-point position and the slope after the knee-point are controllable by the **Multi slope mode (HDR)** setting. There are pre-defined parameter settings (**Off**, **PresetSoft**, **PresetMedium**, and **PresetAggressive**) that correspond to different amounts of compression. These settings result in a dynamic range increase of approximately 2, 6, and 15, respectively. See [figure 42](#).

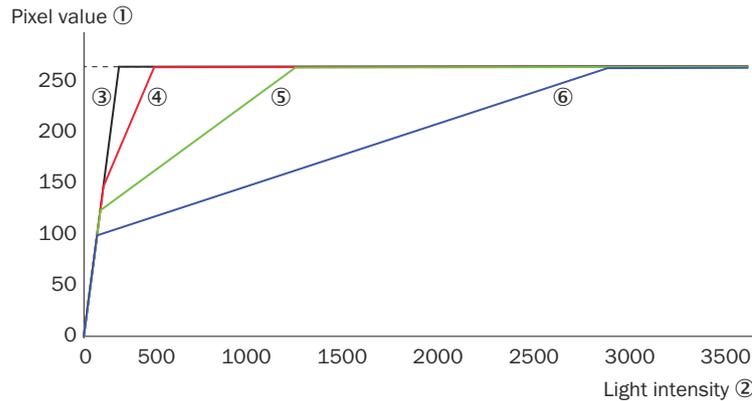


Figure 42: HDR settings for Ruler3000

- ① Pixel value
- ② Light intensity
- ③ Linear (non-HDR) mode
- ④ Soft pre-set
- ⑤ Medium pre-set
- ⑥ Aggressive pre-set

In HDR mode, the sensor readout must be finished before a new exposure can start. The sensor readout time is the time the sensor needs for the readout of the collected data. The minimum cycle time is the sum of the exposure time and the readout time. In linear mode, the sensor readout and a new exposure can be done in parallel.

For example: If the readout time is 33 μ s and the exposure time is 30 μ s, the total cycle time is 33 μ s for linear mode and 63 μ s for HDR, giving a maximum timed profile rate of 30 kHz and 16 kHz respectively.

8.5.3.4.1

Controlling HDR imaging

Tabs: **2D Image**, **3D Image**

To enable HDR imaging:

1. Open the **Laser profile extraction** parameter section.
2. Set **Multi slope mode (HDR)** to **PresetSoft**, **PresetMedium**, **PresetAggressive** or **Off**.
 - **PresetSoft** increases the dynamic range by a factor ~2.
 - **PresetMedium** increases the dynamic range by a factor ~6.
 - **PresetAggressive** increases the dynamic range by a factor ~15.



NOTE

Using HDR affects the maximum exposure time:

- In 2D mode, the maximum exposure time for **PresetSoft**, **PresetMedium** and **PresetAggressive** is about 16, 40 and 100 ms, respectively.
- In 3D mode, the maximum exposure time for **PresetSoft**, **PresetMedium** and **PresetAggressive** is about 4,10 and 26 ms, respectively.

8.6 3D image format

The 3D data is delivered using the full resolution of the pixel format, currently always 16 bits (for calibrated data).

The **Profiles per image** setting indicates how many profiles to include for each 3D image and is set in pixels. This value will be the height of the 3D image.

The pixel value 0 is dedicated to represent missing data, i.e. that no valid peak was found.

3D IMAGE FORMAT

Profiles per image:
1024

Additional components

Reflectance Profile meta data

Scatter

Scatter offset: 6 Scatter pixel Format: Mono16

Scatter width: 4

Figure 43: 3D Image format GUI reference

8.6.1 Additional components

8.6.1.1 Reflectance

The reflectance values along the laser line can be collected in parallel to the 3D data. The reflectance values are saved as an 8-bit grayscale image, with one value corresponding to each point in the range dataset.

The **Reflectance** checkbox enables collection of laser reflectance values in addition to the range data and is on per default.

To view the image with laser reflectance, select **Reflectance** from the drop-down list above the image viewer. [see "Image components", page 74](#) for details.



Figure 44: 3D image with range information as brightness.



Figure 45: Reflectance image for a 3D image.

8.6.1.1.1 Setting exposure time using reflectance

Tabs: 2D Image, 3D Image

Use the reflectance image as an indicator when adjusting the exposure time. Adjust the **Exposure time** in the **Laser profile extraction** parameter section.

- If the exposure time is too low, the objects in the reflectance image contain dark regions or regions with missing data. See [figure 46](#).
- If the exposure time is too high, the objects contain bright saturated areas and artifacts. See [figure 48](#).



Figure 46: Low exposure time



Figure 47: Normal exposure time



Figure 48: High exposure time

8.6.1.2 Scatter

The scatter component measures the intensity of the laser signal in defined parts of the Window Around Maximum (WAM Size), see ["WAM size"](#), page 49. The scatter signal can be explained as the amount of scattered light received in a sampling window at a distance from the peak laser position.

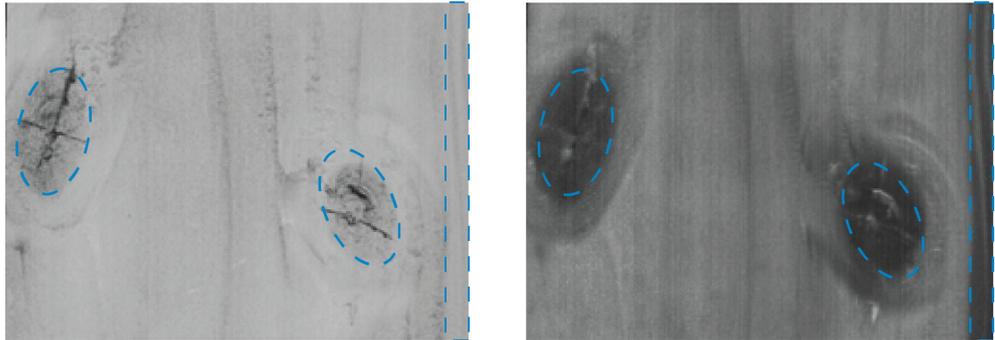


Figure 49: Wooden board displayed with reflectance (left) and scatter (right). The knots and the blue-stained right edge of the board (denoted in blue) appear dark in the scatter image.

Scatter measurements can distinguish material effects, which is useful for organic matters such as wood (wood fibers transmit light along their growth direction, and knots and rot affect this property) and meat (fat, bone, and meat have different scattering properties). In some cases, scattering can reveal sub-surface effects like delamination or the content of cavities beneath a surface.

The default pixel format for scatter is 16 bits. This is due to the large dynamic range of the scatter signal, which sums up to 29 individual 8-bit pixel values.

Basic scatter parameters

The scatter component measures the amount of light received in a defined sampling window, which is part of the extracted 31-row WAM window. The amount of light is added for all rows in the sampling window to get the total scattering value.

Select the **Scatter** checkbox to add scatter data to the image data. The sampling window is defined by the following parameters:

Setting	Description
Scatter offset	The distance (number of pixels) from the laser peak position to the row where the first scatter measurement is made. The offset can be set to 0, which means the center (reflectance) pixel is included and that an odd number of rows is used for summing the scatter data.
Scatter width	The number of rows to sum scatter data from.
Scatter pixel format	The number of bits in the scatter data. The default pixel format is 16 bits. Possible to select Mono8 and Mono16 .

figure 50 illustrates two cases of symmetric sampling, with low scatter to the left and high scatter to the right. The **Scatter offset** and **Scatter width** are denoted in the figure.

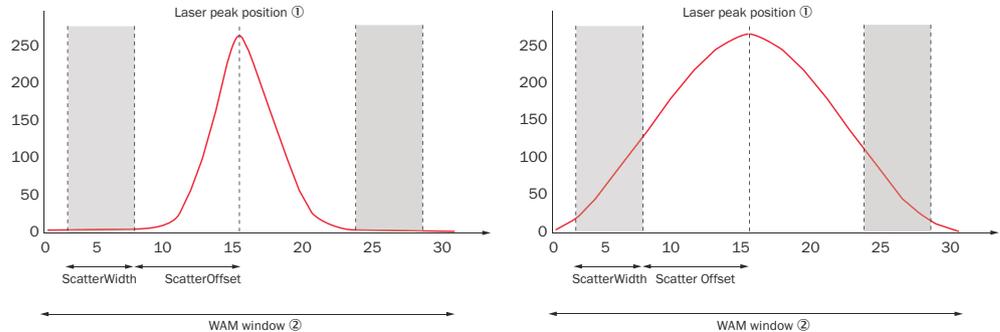


Figure 50: Examples of low scatter symmetric sampling (left) and high scatter symmetric sampling (right). The red line illustrates the laser signal in the extracted WAM window. The sampling window is shown in gray.

- ① Laser peak position
- ② WAM window

You can set additional scatter parameters using GenICam or GenIStream, see "[GenIStream API](#)", page 21.

8.6.1.3 Profile meta data

Profile meta data are tagged blocks of data, that are sent together with the image data. In Ruler3000, profile meta data are used to add additional data to the image data. The profile meta data can only be added for 3D images. The following meta data is available for each buffer:

- The value of the encoder counter for each line in the buffer.
- The timestamp for each line in the buffer.
- The height of the buffer.
- The width of the buffer.
- The scaling information to transform the raw data into mm (calibrated and rectified data) or pixels (uncalibrated data).

To enable profile meta data, select the **Profile meta data** checkbox.

8.6.2 Range (3D) measurements

8.6.2.1 Laser impact position on the sensor

The basic function of the 3D measurements is to compute the impact position of the laser line for all columns of the selected region of interest (ROI). The light intensity distribution from the laser line along a sensor column across the laser line can be described as in the figure below.

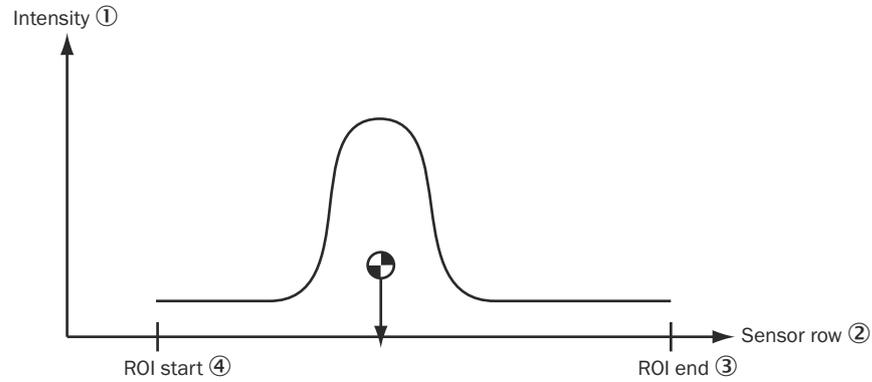


Figure 51: The impact position of the laser in one column

- ① Intensity
- ② Sensor row
- ③ ROI end
- ④ ROI start

The laser line will produce a distinct light peak distributed over a number of pixels along the sensor column. The center of this peak will be defined as the impact position of the laser line on that sensor column, which is the range value.

8.6.2.2 Measurement method

The default algorithm in Ruler3000 is called **Hi3D**. It measures the impact position using a high-resolution peak fitting algorithm based on the pixels in a window around the extracted intensity peak position. The size of the window is defined by the **WAM size** setting.

This method measures range with a resolution of 1/16th pixel.

8.7 Triggering

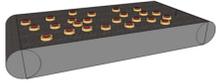
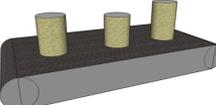
There are different ways to trigger the camera to acquire images and profiles. Triggering is used to control the initiation and rate of data acquisition. You can use an external signal to trigger each image or every single profile. The camera can also be configured to acquire images or profiles with regular time intervals, without an external trigger signal.

Note that when the camera acquires 3D images, each image is a set of profiles. This means that the acquisition of profiles in the Profile triggering concept is only applicable for 3D images, while the Image triggering concept is relevant for both 2D and 3D images.

8.7.1 3D triggering concepts

Different application types require different triggering concepts. Below is a table of the most common triggering situations.

	<p>Continuous flow</p>	<p>No photoelectric switch is used. Profiles are sent continuously to the PC, typically arranged in images of at least a few hundred profiles. Examples: Crushed stone, grain, sawdust.</p>
--	-------------------------------	---

	<p>Continuous flow of discrete objects</p>	<p>No photoelectric switch is used. Profiles are sent continuously to the PC, typically arranged in images of at least a few hundred lines. The resulting image buffers in the PC can be analyzed in a rolling buffer fashion, ensuring that all objects are analyzed completely. Example: Cookies.</p>
	<p>Shorter objects of equal length</p>	<p>A photoelectric switch is used. One image per object. Examples: Bottles, automotive parts, mobile phones.</p>
	<p>Longer objects of variable size</p>	<p>A photoelectric switch is used. Acquire profiles as long as the object remains in front of the camera. Several sub-images can be stitched together in the PC. Examples: Logs, fish, postal packages.</p>

8.7.2 Profile triggering

The camera will acquire each profile based on an external input signal. There are two possibilities:

- Connect an external input signal to the line trigger input of the device. (Activating this mode is only possible using GenICam or GenIStream, see ["GenIStream API", page 21.](#))
- Use an encoder for profile triggering. In that case, pulses are received on the encoder inputs. The distance between the two profiles is determined by the number of pulses received.

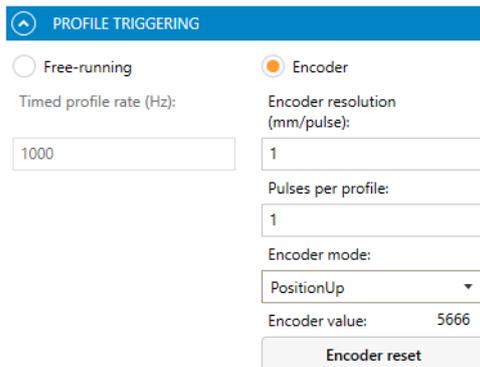


Figure 52: Profile triggering GUI reference

Triggering each profile from an encoder will keep the object proportions if the object motion, tracked by the encoder, changes. Four-phase encoders also allow tracking different motion patterns, see ["Encoder triggering", page 57.](#) The motion pattern is defined by the **Encoder mode** parameter.

When triggering with an encoder the maximum line rate is still controlled by **Timed profile rate** used in **Free-running** mode. Thus you might need to change **Timed profile rate** when in **Encoder** mode to be able to set **Exposure time** to your wanted value.

Select **Free-running** or **Encoder** using the radio buttons.

8.7.2.1 Free-running triggering

When you use **Free-running** as triggering concept, the camera will acquire images or profiles with a regular time interval. The time interval is controlled by the **Timed profile rate (Hz)** parameter.

When the acquisition of profiles is free-running, the distance between two profiles varies if the speed of the object is not constant. This may distort the image. To avoid distortion, you can use an encoder and embed encoder data for each profile. This information makes it possible to calculate a correct image.



NOTE

The exposure time and the profile rate are inter-dependent. The maximum exposure time cannot be longer than the time between two profiles, minus about three microseconds that are needed for readout and reset.

When you use the **Free-running** mode input, profiles are acquired at fixed time intervals independent of the object motion. Note that the profile meta data contains valid encoder position information also in this mode if an encoder is connected and active. The **Encoder mode** parameter is not used.

8.7.2.1.1 Setting free-running triggering

Tabs: **2D Image, 3D Image**

Open the **Profile triggering** category in the parameter settings section.

1. Select the **Free-running** radio button.
2. Set the rate at which the profiles in an image are captured in **Timed profile rate (Hz)** parameter.

For 2D image triggering, the encoder input is always used as trigger source.

8.7.2.2 Encoder triggering

When you use an encoder for triggering, the camera counts the number of pulses received on the encoder inputs using an internal counter. When the specified number of pulses has been received, a profile or a 2D image is triggered and the camera resets the triggering condition counter.

Four-phase (dual-channel) encoder

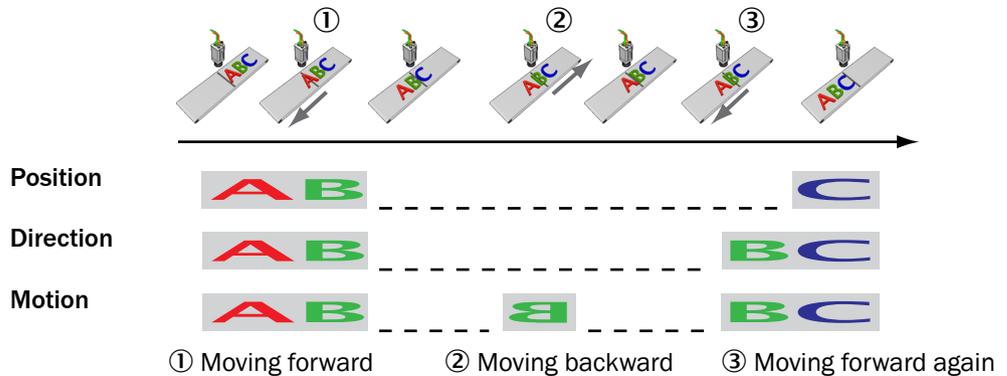
The default definition of a pulse is a full four-phase cycle on the encoder inputs. This gives a pulse counter that is robust to jitter and noise on the inputs. It is also possible to use a high-resolution encoder pulse counting mode, where each flank on an encoder input is counted. In this mode, a 4-times higher resolution is achieved, but in **Direction** and **Motion** modes (see below) jitter on the input may lead to unwanted triggering.

A four-phase encoder can handle movements in both directions (forward and backward). The camera can be configured to react to the pulses in different ways, resulting in different ways to trigger profiles. The different profile triggering modes are illustrated below.

Encoder mode	Description
PositionUp or PositionDown	The encoder triggers a profile for each object position. If the object has moved backward, no profiles are triggered until the object has moved (at least) an equal distance forward. PositionUp: "Forward" is defined as the positive direction. PositionDown: "Forward" is defined as the negative direction.

Encoder mode	Description
DirectionUp or DirectionDown	The encoder triggers profiles when the object is moving forward. If the object has moved backward, new profiles will be triggered as soon as the object moves forward again. DirectionUp: "Forward" is defined as the positive direction. DirectionDown: "Forward" is defined as the negative direction.
Motion	The encoder triggers profiles when the object is moving either backward or forward.

Table 6: Triggering modes



Single-channel encoder

A single-channel encoder uses only one encoder channel. The input from the encoder to the camera is a differential signal, and a profile is triggered each time the signal goes high.

When a single-channel encoder is used, the camera cannot differentiate between forward and backward movement. The single-channel encoder mode is therefore only visible and selectable when the **Encoder mode** (see table 6) is set to **Motion**.

State diagrams and trigger points

The encoder states and the possible transitions for a dual-channel encoder and a single-channel encoder are shown in figure 53. The trigger point depends on the type of encoder used:

- Dual-channel encoder, forward direction: The trigger point occurs when channel B goes from 1 to 0. See figure A.
- Dual-channel encoder, backward direction: The trigger point occurs when channel A goes from 1 to 0. See figure B.
- Single-channel encoder: The trigger point occurs when channel A goes from 0 to 1. See figure C.
- High-resolution encoder: The trigger point occurs for every single rising or falling edge on any channel.

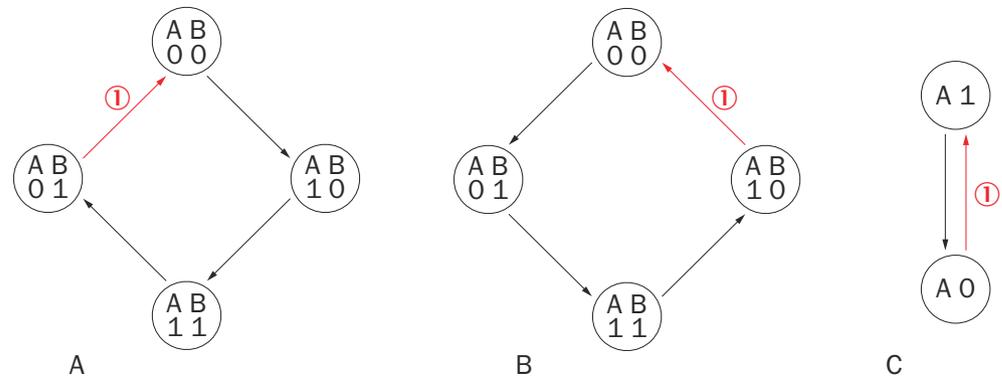


Figure 53: Encoder states and possible transitions

① Trigger point

8.7.2.2.1 Setting encoder triggering

Tabs: 2D Image, 3D Image

Follow the steps below to use encoder triggering. For more information about the encoder modes, see ["Encoder triggering", page 57](#).

Open the **Profile triggering** category in the parameter settings section.

1. Select the **Encoder** radio button.
2. Set the **Encoder resolution (mm/pulse)** parameter. This value defines the resolution of one encoder step and can be a value between 0 and 10 000. The value defines how far in mm the encoder moves per pulse.
3. Set the **Pulses per profile** parameter. This value defines how many encoder increments/decrements are needed to generate a trigger.
4. Set the **Encoder Mode** to the desired mode.

The **Encoder value** is an informational field and can be reset to 0 by clicking the **Encoder reset** button.

Encoder type

Ruler3000 supports the encoder type RS-422. It is only possible to change encoder type using GenICam or GenIStream, see ["GenIStream API", page 21](#).

8.7.3 Image triggering

The camera will acquire 3D images based on an external input signal, for example a photoelectric switch. If the same photoelectric switch is connected to several cameras then synchronization at the microsecond level can be achieved. The acquisition of profiles in the imagecan either be free-running or triggered by an input signal, as described in the sections [Free-running triggering](#) and [Encoder triggering](#).



Figure 54: Image triggering GUI reference

Select the **Image trigger** checkbox to enable image triggering. If **Image trigger** is not selected, the camera acquires images continuously.

When using **Image triggering**, the **Profiles per image** parameter specifies the number of profiles the camera acquires after the image trigger signal goes high. After the specified number of profiles, the camera will either idle or continue to acquire another series of profiles, depending on the state of the image trigger signal and the settings of the acquisition control parameters. See the table and the figure below.

Parameter setting	Description
RisingEdge	The acquisition of a new series of profiles starts on a rising edge on the enable signal. Multiple enable trigs are ignored until all profiles (Profiles per image parameter) have been acquired. When all profiles have been acquired, the camera waits for a new rising edge.
LevelHigh	The acquisition of a new series of profiles starts each time the image trigger input has a high level as input. For the very first profile, the camera requires not only a high level but also a rising edge.

The system adapts the buffer height for the image grabber and the camera to the **Profiles per image** parameter to keep the image synchronized and receive a full image after the image capture is completed. To avoid unnecessary CPU load, set the **Profiles per image** parameter to no less than 100 pixels.

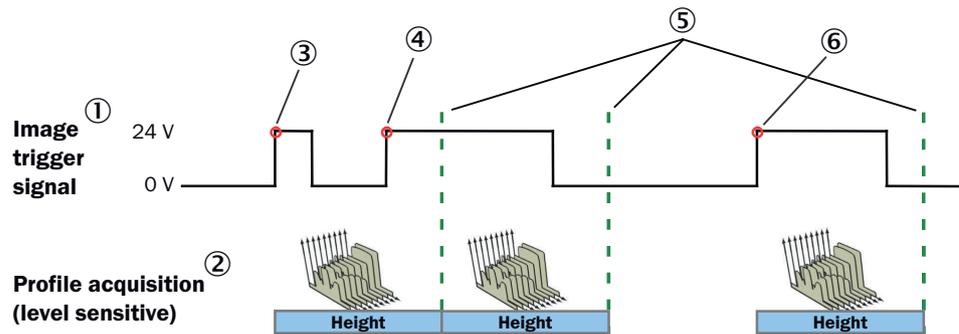


Figure 55: Timing diagram for Image trigger signal

- ① Image trigger signal
- ② Profile acquisition (level sensitive)
- ③ Image trigger signal RisingEdge and LevelHigh. Acquisition of profiles starts.
- ④ Image trigger signal. RisingEdge ignores, LevelHigh acquires.
- ⑤ Acquisition complete. Interpretation of image trigger signal.
- ⑥ Image trigger signal. Both RisingEdge and LevelHigh acquires.

8.7.3.1 Setting image triggering

Tabs: **2D Image**, **3D Image**

Open the **Image triggering** category in the parameter settings section. For information about the triggering concepts, see ["3D triggering concepts"](#), page 55.

Enabling image triggering:

1. Select the **Image trigger** checkbox.
2. Set the triggering option to **RisingEdge** or **LevelHigh**.
3. Follow the steps in the Encoder section (see ["Setting encoder triggering"](#), page 59) to acquire profiles based on encoder input or profile trigger signal input, or in the Free-running (see ["Setting free-running triggering"](#), page 57) section to acquire profiles with a regular time interval.

8.8 Calibration

Calibration of range data refers to the process of turning sensor coordinates (pixel positions) into real-world coordinates in mm. By using the calibration functions the sensor positions are translated into real-world coordinates. All calibration is done in the laser plane. The Ruler3000 delivers calibrated data per default.

Calibrated data is a set of points in real-world coordinates. During the configuration of the calibration when the device is produced, a direct relationship is established between each sensor position and the corresponding real-world coordinate. When applying the calibration to a range profile, each valid (u, v) point in the profile is translated into a calibrated (x, z) point in the real world. This representation is suitable if you need to find e.g. the distance between two points in the real world or measure the height of a certain object. The image below shows an example profile as seen by the sensor (on the left) and the corresponding calibrated points in the real-world coordinate system.

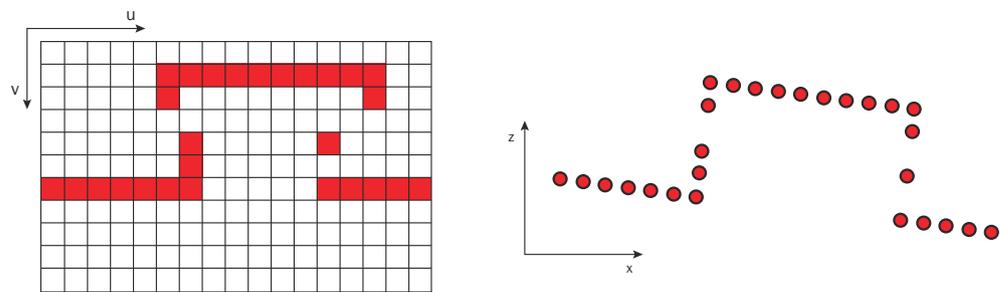


Figure 56: Sensor image and corresponding calibrated (x, z) points

The camera can operate both **Calibrated** and **Uncalibrated**. The default setting is **Calibrated (Camera)**.

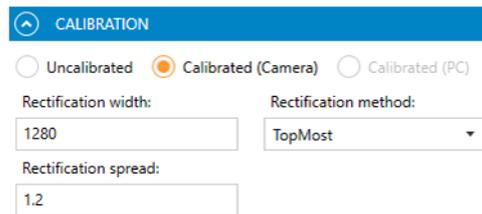


Figure 57: Calibration GUI reference

8.8.1 Rectification

Rectification of data means that a new profile is created by re-sampling the calibrated data onto a regular grid. The rectification is performed along the X-axis only. The new profile is represented in a discrete coordinate system, which is directly related to the real-world coordinate system. This means that the distance in X between two adjacent values (pixels) in the profile is always the same regardless of where in the field of view they are positioned.

The following image shows how a set of calibrated data points translates into a rectified profile. The final z value is represented as a floating-point number to preserve the full resolution. Notice the green and yellow resulting values at the edges of the profile.

Select if the rectification should return the **TopMost** (green) or **BottomMost** (yellow) pixel height within the discrete column. For more information, see [table 7](#).

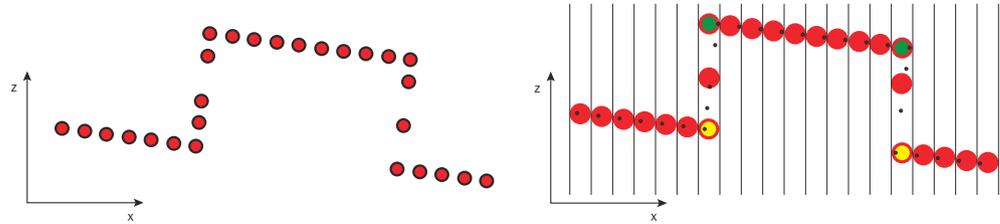


Figure 58: Calibrated points and corresponding rectified profile (to the right).

The rectification is performed on the camera and is controlled via the setting for calibration. If **Calibrated** is selected, rectification will also be performed.

Maximum **Rectification width** for in-device rectification is 4096 and default is 3072. The rectification is made to a higher resolution than the imager resolution to avoid losing X resolution close to the device. The **Rectification width** can be set to a lower value than the width of the **Extraction region**. The image will then be downsampled and data will be lost. The **Rectification width** determines the width of the 3D image.

Select which **Rectification method** to use.

Table 7: Rectification methods

Method	Description
BottomMost	Always pick the lowest range value for each bin.
TopMost	Always pick the highest range value for each bin.

The **Rectification spread** is used to distribute pixel values to neighboring pixels. If the **Rectification Width** is larger than the width of the data, the rectification can give holes in the data. The process of replacing those holes of missing data with neighboring pixel values is called spreading.

Due to the geometry between the laser plane and the camera, the number of holes in the image depends on the range value with typically no holes in the image at one end of the range scale and maximum number of holes at the other. Hence the spreading is adjusted to spread more at range values from the far end of the cameras field of view and less close to the camera where the resolution per mm is higher. It is important not to spread more than necessary since it potentially overwrites valid data with neighboring data.

Setting the **Rectification Spread** to 0 disables spreading. Spreading 1.0 will fill all gaps in the output image in an ideal case, but default spreading is still set to 1.2 since in practice there might still be missing data at spreading 1.0 due to discontinuities in the image. The maximum value depends on other parameters and is typically 1.5 for in-device rectification due to hardware limitations.

8.8.1.1 Setting rectification method

Tabs: **2D Image**, **3D Image**

To enable rectification, follow the steps below:

1. Open the **Calibration** section.
2. Select the **Calibrated** radio button.
3. Set the **Rectification width**, a value between 160 and 4096.
4. Select which **Rectification method** to use. For information about different methods, see ["Rectification", page 61](#).
5. Set the **Rectification spread**, a value between 1 and 10.

9 Operation

9.1 Stream Setup graphical user interface

The **Stream Setup** application is downloaded from the SICK support portal, supportportal.sick.com. Select **Vision/3D vision** and **Ruler3000**. You use its graphical user interface (GUI) to configure camera parameters and evaluate the measurement results.

The GUI offers different ways to visualize the data. You can also store data to file for later use. You can change the settings of the camera and instantly see how the changes affect the measurement result. The GUI is therefore useful for finding the best parameter settings for a certain application.



NOTE

It is not possible to change the parameters while the image acquisition is started.

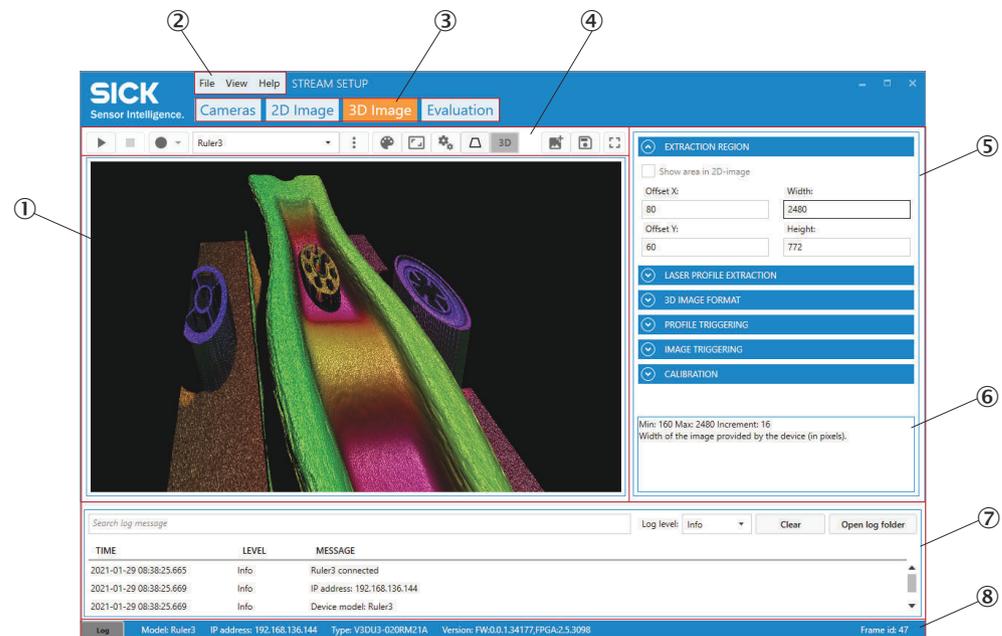


Figure 59: Graphical user interface

- ① Image viewer
- ② Menu bar
- ③ Tab section
- ④ Control bar
- ⑤ Parameter settings pane
- ⑥ Parameter description
- ⑦ Log section
- ⑧ Status bar

Once the camera has been configured, the settings can be saved in a parameter file on the PC or as camera configurations on the camera.

This chapter gives an introduction to **Stream Setup** with its different windows, functionalities, and also exemplifies how to use it to get a 3D image or adjust the data quality. The following different tabs are available: **Cameras**, **2D Image**, **3D Image** and **Evaluation**. In the following sections, each of these tabs is explained.



NOTE

It is possible to open **Calibration** and **Alignment** tabs from the **View** menu. These options are mainly used for Ranger3, hence not covered in this document.

9.1.1 Menu bar

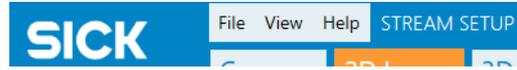


Figure 60: Menus

The **File** menu includes the possibility to save the currently shown image, load images, and exit the application.

The **View** menu includes options to hide or show the **Calibration** and **Alignment** tabs. These additional menus are mainly used for Ranger3, hence not covered in this document.

The **Help** menu includes options to get further help with and knowledge about the application, for example, the application version and dll assembly version.

9.1.2 Tabs

9.1.2.1 General image handling

The procedure of manipulating the view of an image is the same in each tab.

Use a mouse with a scroll wheel to manipulate regions and perspectives when viewing images.

2D Image handling controls

Action	Description
Pan image	Click and drag to pan image.
Zoom	Rotate the mouse scroll wheel.

3D Image handling controls

Action	Description
Rotate around center point	Click and drag to rotate the image around the center point visualized by the crosshair.
Rotate around camera center	Shift + Right-click to rotate the image around the camera center.
Pan (x, y plane)	Right-click and drag to pan camera in x, y plane.
Pan (u,v plane)	Shift + click and drag to pan camera in u, v plane.
Move crosshair	Shift + scroll the mouse wheel to change the position of the crosshair to allow rotation around different positions of the image.
Zoom	Rotate the mouse scroll wheel.

9.1.2.1.1 Pointer information

If you move the mouse pointer over the image area, some information is shown. For a 2D image, the coordinates and the intensity value of each point are displayed. This information is useful, for example when you define the detection threshold, [see "Detection threshold", page 48.](#)

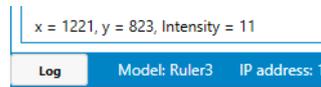


Figure 61: Pointer information (2D image)

For a rectified 3D image, the coordinates (pixel and mm value), the sensor row, and the encoder counter value of each point are displayed.

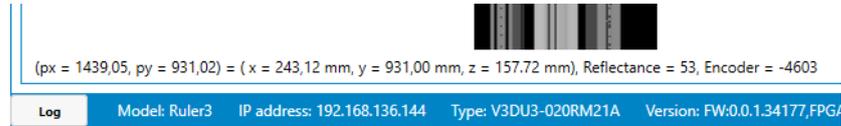


Figure 62: Pointer information (rectified 3D image)

9.1.2.2 Cameras

In this tab, you see the last connected device and can reconnect to it. You can also search the network and see a list of all available devices. You can select a device and connect or disconnect it.

It is also possible to reconfigure the camera IP settings. This is useful, for example when you want to connect to a camera that is not on the same subnet as the NIC, see ["Recommended network card settings", page 113](#). Then you have to reconfigure the camera to the same subnet before you can connect to it.

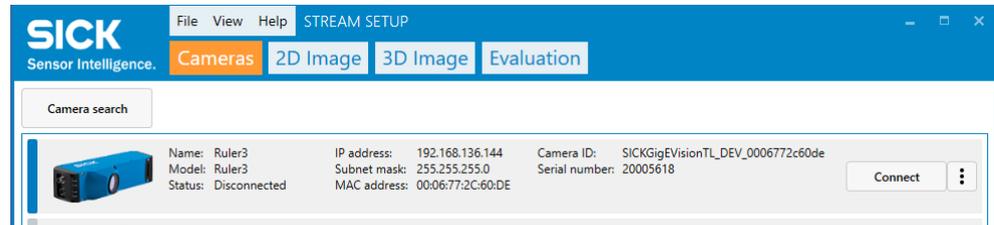


Figure 63: Tab Cameras

9.1.2.2.1 Editing IP settings

Before you connect to the camera, you can set the IP address and subnet mask. Select the **Set persistent** checkbox, and the camera will keep the same IP address after a reboot.

Tab: **Cameras**

1. Select the correct camera and click on the three dots to the right.
2. Select **IP settings**.
- ✓ A new window opens.

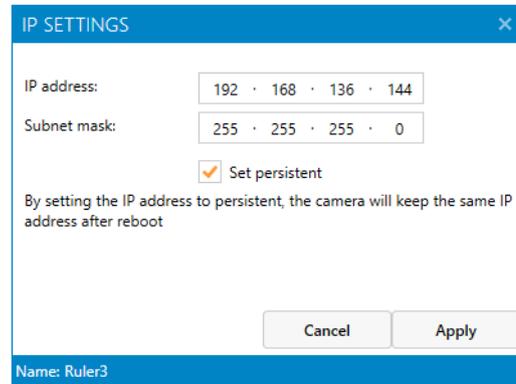


Figure 64: IP settings

3. Edit the IP settings.
4. Select the **Set persistent** checkbox to keep the same IP address after a reboot.
5. To save the IP settings, click **Apply**.

9.1.2.3 2D Image

Here you view and acquire the 2D image data. A 2D image is what the camera sees when it is used as an ordinary camera. You can edit parameter values related to the image acquisition and evaluate the result directly in the image viewer. The list box above the image viewer contains all the cameras possible to select.

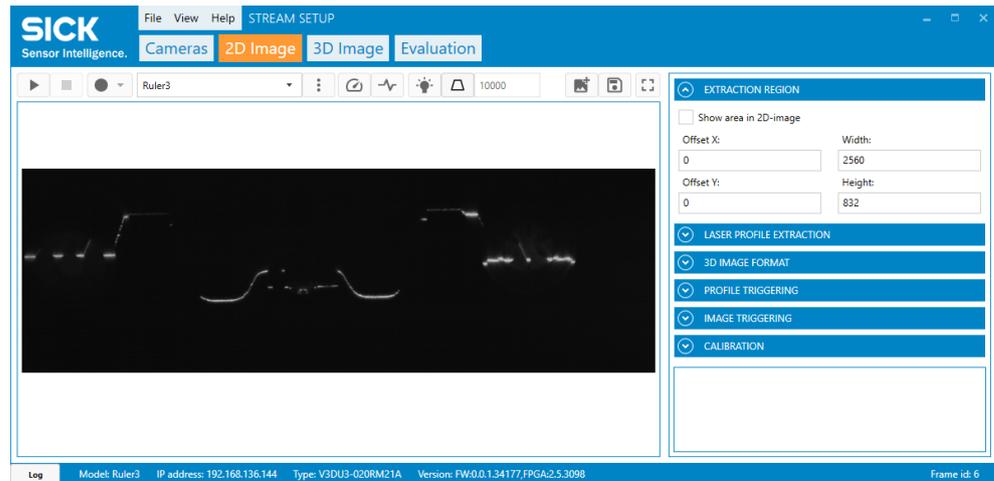


Figure 65: Tab 2D Image

This view shows a grayscale 2D image, which can be useful when adjusting the exposure time, or deciding the region of interest.

9.1.2.4 3D Image

Here you view the 3D image that is the result of using laser triangulation. The list box above the image viewer contains all the cameras possible to select. Click the play button to start acquiring profiles. A 3D image is generated of acquired profiles. You can edit parameter values and evaluate the result directly in the image viewer until the result is satisfactory. You also have several options to visualize the 3D image.

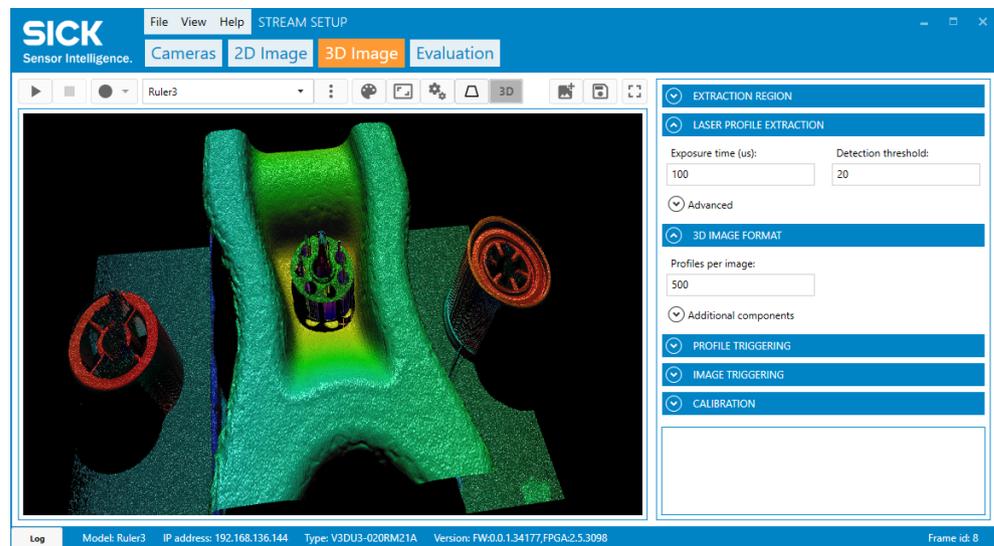


Figure 66: Tab 3D Image

9.1.2.5 Evaluation

In this tab, you can evaluate different images from the camera. You can study both the live image and images which have been saved previously. The list box above the image viewer contains all the cameras possible to select.

Select to study the live image or a previously saved image by selecting the corresponding radio button. The **Image info** section is updated with information about the selected image.

9.1.2.5.1 Process image

The **Evaluation** tab contains a set of simple image processing tools that can be applied to the currently selected image. In the **Select processing tool** list box, you can choose between three different evaluation methods as described below.

Image filtering

Image filtering involves operations that perform useful functions, such as noise removal and image enhancement.

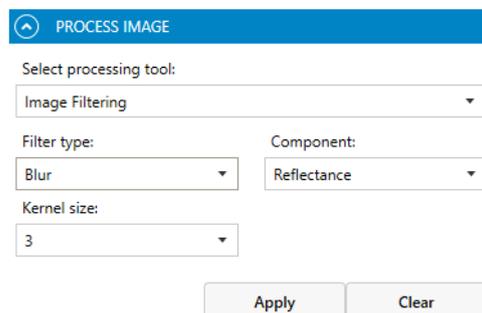


Figure 67: Image filtering GUI reference

Select the **Filter type** and set the **Kernel size** to either 3 or 5. You can set **Component** to either **Range** or **Reflectance**.

Filter type	Description
Blur	Reduces image noise and detail.
Median	Replaces each entry with the median of neighboring entries.

Filter type	Description
Bilateral	Replaces the value of each pixel with a weighted average of nearby pixels.

Extract profile

The **Extract profile** tool shows the profile for each horizontal (X) or vertical (Y) line in the 3D image.

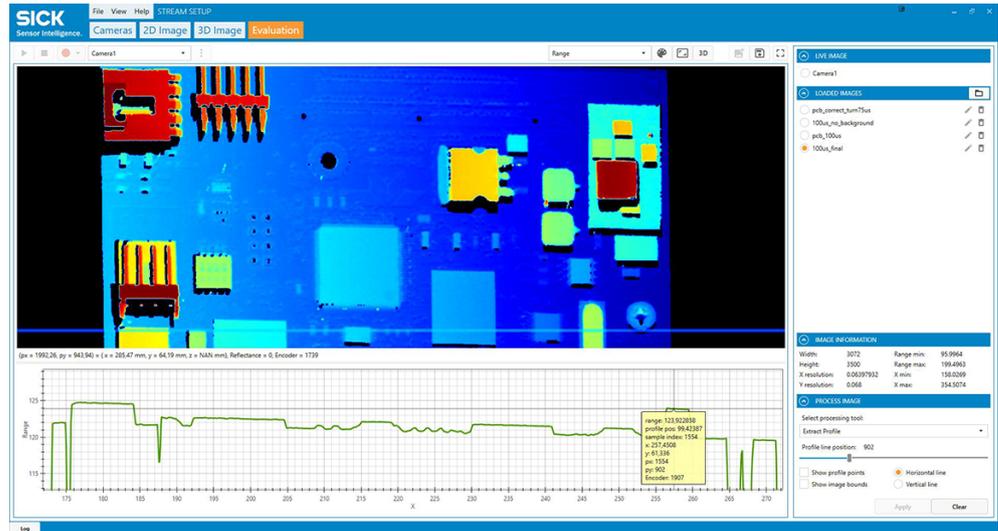


Figure 68: Tab *Evaluation*, showing the extracted profile of the 3D image.

Surface distance

The **Surface distance** tool measures the shortest distance between one plane and the center point in another plane. You can define which pixels to include in the plane estimation for both planes.

9.1.3 Control bar

Depending on the currently active tab, different options are available for the image. This is automatically updated when switching between the tabs.

Recording options

Button	Name	Description
	Start	Start image acquisition.
	Stop	Stop image acquisition.
	Record	Recording a set of images, the button turns red when recording is in progress.

Camera options

Button	Name	Description
	Action menu	The camera action menu, which includes options for configuration handling and firmware updates. Firmware update is only available when the camera is disconnected. The button is located to the right on the Cameras tab, and to the left on the control bar when 2D Image or 3D Image tabs are open.

2D image view options

The list above the image viewer contains all the currently connected cameras.

Button	Name	Description
	Frame rate	Set the frame rate. The acquisition rate in Hz, at which frames are captured when streaming 2D images. This feature is useful for slower PCs, such as laptops.
	Peak visualization	Shows the approximate result of the laser line extraction. The result is indicated with a red line.
	Guaranteed FOV	Shows the guaranteed field of view in the 2D viewer. This feature is only available for Ruler3000 cameras.
	Boost exposure	Brighten up the region of interest by temporarily increase the exposure time for the 2D image. Specify a value in the adjacent field.

3D image view options

The left list above the image viewer contains all the currently connected cameras. The right list contains the view modes.

Button	Name	Description
	Palette	View image in color (various options) or grayscale.
	Aspect ratio	Options for image resolution and sampling of the 3D view.
	Settings	Additional settings for the 3D view.
	Guaranteed FOV	Shows the guaranteed field of view in the 3D viewer. This feature is only available for Ruler3000 cameras.
	3D options	Switch between heightmap view and 3D visualization.

Image options

Button	Name	Description
	Add image	Add the current image to loaded images in the Evaluation tab.

Button	Name	Description
	Save image	Save the current image to disk.
	Fullscreen	Switch to fullscreen mode. This option will hide the parameter settings pane and the Cameras , 2D Image and 3D Image tabs.
	Load image	Opens a folder on the PC. This option is located on the Evaluation tab.

9.1.4 Parameter settings pane

The parameter settings pane retrieves the current parameters from the camera and allows you to modify them.

When you adjust the parameters, you look at the 2D or 3D image to see the result. You can load the image to the image list in the **Evaluation** tab after each adjustment and compare the images to find the best configuration.



NOTE

You cannot edit the parameters while the camera is acquiring data.

The parameter settings pane is located to the right of the image viewer, showing different parameter categories. It also holds a text box showing a description for the currently selected parameter at the bottom. The description gives a brief explanation of the parameter's purpose and its minimum and maximum limits.

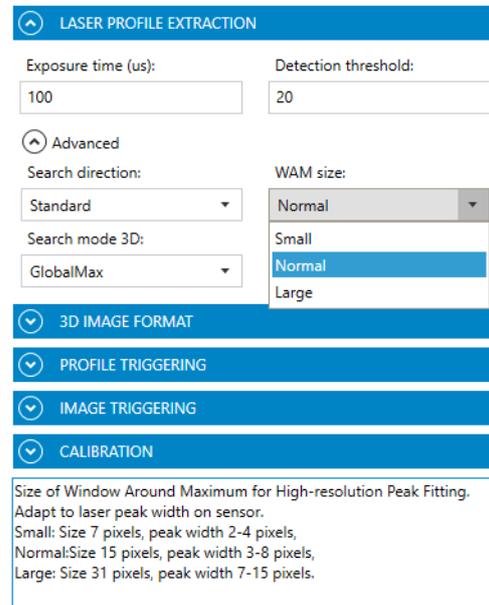


Figure 69: Parameter section GUI reference

The Ruler3000 has a large number of parameters that are not exposed in **Stream Setup** but can be configured using GenICam or GenIStream, see "[GenIStream API](#)", page 21.

9.1.5 Log section

At the bottom of the main window, there is a section where log messages are available. The messages can be hidden and shown by clicking the **Log** button.

The **Log** contains messages from the GUI and the device.

The system assigns each log message a level, either **Error**, **Warning**, or **Info**. You see log messages on the selected level and the levels above it. Selecting **Info** in the list will show all log messages. With the **Search log message** function, it is possible to filter within the selected visible log messages.

The **Open log folder** button opens a file browser at the location of the log file, allowing easy access to the stored log.



TIME	LEVEL	MESSAGE
2021-01-29 08:38:25.665	Info	Ruler3 connected
2021-01-29 08:38:25.669	Info	IP address: 192.168.136.144
2021-01-29 08:38:25.669	Info	Device model: Ruler3

Log Model: Ruler3 IP address: 192.168.136.144 Type: V3DU3-020RM21A Version: FW:0.0.1.34177.FPGA:2.5.3098 Frame id: 47

Figure 70: Log section

9.1.6 Status bar

At the bottom of the screen, the following information about the currently connected and selected device is shown:

- Model of the device
- IP address of the device
- Device type
- Software version
- Firmware version and FPGA
- Frame ID of the image that is currently displayed.



NOTE

The frame ID is reset each time the camera is restarted.

9.2 Using the interface

The common way of working is to iterate until you are satisfied with the configuration and the quality of the received data.

It is assumed that the Ruler3000 and **Stream Setup** are installed and working properly. How to install the Ruler3000 and Stream Setup is briefly described in "[Getting started](#)", [page 12](#). When capturing 3D images, it is beneficial if you also have movement and some kind of photoelectric switch or similar device connected to the camera.

We also assume that you have placed some objects to measure in the laser plane. The object should fit into the field of view of the Ruler3000.

9.2.1 Importing and exporting configuration files

Tabs: **Cameras**, **2D Image**, **3D Image**

Configuration files (.csv format) can be saved and loaded to and from the device. The configuration files use a proprietary text-based format.



Click the camera action menu. The button is located to the right on the **Cameras** tab, and to the left on the control bar when **2D Image** or **3D Image** tabs are open.

Import configuration

To import a .csv file with pre-defined parameter settings, do as follows:

1. In the menu, select **Import configuration**.
 2. Find and select the parameter file and click **Open**.
- ✓ The parameter settings are loaded.

Export configuration

To save the current parameter settings, do as follows:

1. In the menu, select **Export configuration**.
2. Find a place to store the file, name it, and click **Save**.
- ✓ The parameter settings are saved as a .csv file.

9.2.2 Booting the device using a camera configuration

A **Camera configuration** contains a full set of parameter values that can be used for booting and resetting the device to a known configuration state. Up to five camera configurations can be stored on the device.

The device can be programmed to boot from either one of the stored camera configurations, or from the built-in **Default** parameter values. If no camera configuration is selected, the **Default** configuration is used. The Default configuration is read-only and cannot be modified.



NOTE

A **Camera configuration** is only valid for the firmware version that was used when the configuration was saved.

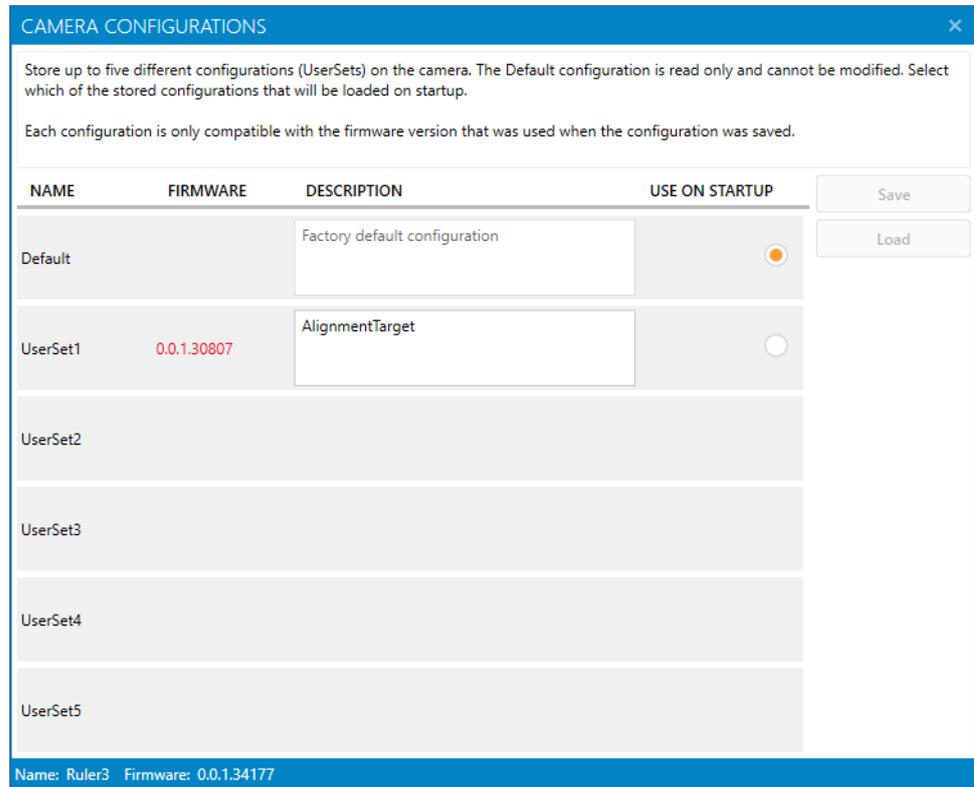


Figure 71: Camera configurations GUI reference



Click the camera action menu. The button is located to the right on the **Cameras** tab, and on the control bar when **2D Image** or **3D Image** tabs are open.

To save a camera configuration:

1. Make sure the parameter values are configured correctly.
2. Select **Camera configurations** from the menu.
3. Select a **UserSet** to use for storing the current parameter values.
4. Click **Save**. You also have the option to enter a description of the **Camera configuration** in the **Description** field.

To boot from a camera configuration:

1. Select **Camera configurations** from the menu.
 2. In the **Use on startup** column, select the **Camera configuration** that you want the device to boot from.
- ✓ Next time the device boots, it will use the parameter values in the selected configuration.

To load a camera configuration to the camera:

1. Select **Camera configurations** from the menu.
 2. Select a configuration.
 3. Click **Load**.
- ✓ The configuration stored in the selected **Camera configuration** is now used on the device.

9.2.3 Visualizing 2D data

The control bar in the **2D Image** window contains visualization options for the acquired 2D image data. The control bar is located above the image viewer in the GUI.

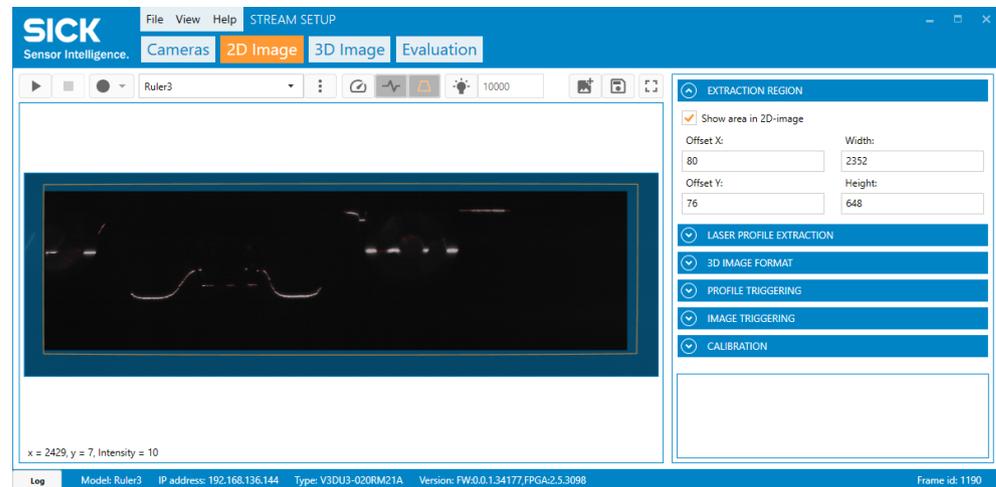


Figure 72: Visualization options for the **2D Image** tab. The black region is the active extraction region. The red line represents the extracted laser line. The orange line represents the extension of the guaranteed field of view.

Show extraction region

Select the **Show area in 2D-image** checkbox to visualize the selected extraction region. When the checkbox is selected, a blue overlay appears in the 2D image. The overlay represents the parts of the image to be excluded from the generation of 3D image data. The remaining dark area is the extraction area.

Simulate laser line extraction

Select the **Peak visualization** button to visualize an approximation of the extracted laser line. The visualization shows where the laser line is detected in the selected extraction region. This visualization aid is useful for tuning laser line extraction parameters such as the **Exposure time**, **Multi slope mode (HDR)**, **Detection threshold**, **Search direction** and **Search mode 3D**.

Simulate guaranteed field of view

Select the **Guaranteed FOV** button to visualize the guaranteed field of view for the device. The orange line shows the region guaranteed to be covered by the device.

9.2.4 Collecting 3D data

Tab: 3D Image

New 3D profiles are being collected constantly, overwriting what is displayed in the visualization window. In order to get an entire 3D image of the object, an external enable signal can be used. A photoelectric switch or similar device can be connected to the device. For information on electrical connections and pin configuration, see ["Electrical connections"](#), page 34.

1. Click the start button to start the collection of 3D image data.
2. To adjust the number of profiles in each grabbed 3D image, edit the **Profile per image** parameter in the **3D image format** section.
3. To save the 3D image, there are several options:
 - Click the **Add image** button to save the image to the **Evaluation** window.
 - Click the **Save image** button, to save the image to disk.
 - Use the **Record** functionality to record all or selected images to disk.
4. Use the image handling controls to move, rotate, and zoom while you inspect the image, see ["General image handling"](#), page 64.
5. Use the **View** drop-down menu to select view mode, see ["Image components"](#), page 74.
6. To change the color range, click the Options button and select the **Aspect ratio** button, see ["Aspect ratio"](#), page 76.
7. To select data presentation, click the Additional settings button and select **Surface** or **Points**, see ["Data rendering mode"](#), page 77.
8. To adjust the scene lighting, use the menus and sliders in the GUI, see ["Light settings"](#), page 78.

9.2.5 Image components and visualization

9.2.5.1 Image components

A 3D Image can either be visualized as a heightmap, or rendered in the 3D view.

View as heightmap

The drop-down list contains all image components available in the current setup. It is possible to select between **Range** (3D data), **Reflectance** and **Scatter**, if the data is available. In **Reflectance** mode, color is proportional to the intensity values of the pixels. Select the **Palette** button for available color maps. The image can be viewed in both grayscale and color, with the option to adjust contrast. Data outside the contrast range is dark if too low and bright/red if too high.

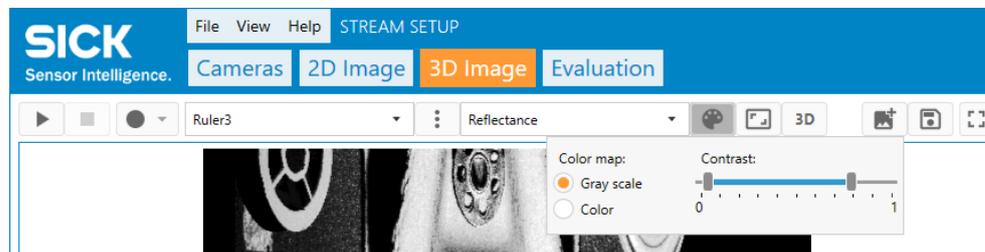


Figure 73: 3D image **Reflectance** component.

View as rendered 3D image

Click the **3D** button to switch to the rendered 3D image. When you view a rendered 3D image, you can select different ways to color it. Select the **Palette** button for available color maps, and the option to adjust contrast and light. Data outside the contrast range is visualized with a rotating color palette instead of a fixed color. For more information about light adjustments, see ["Light settings"](#), page 78.

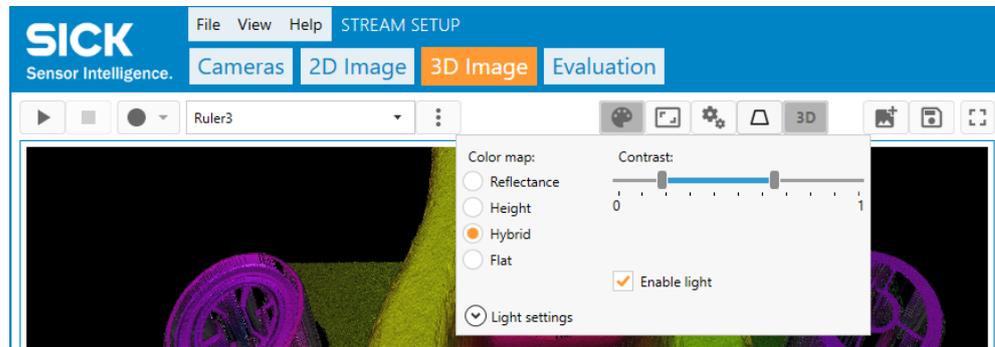


Figure 74: 3D image shown in Hybrid color map.

Color map	Description	Example
Reflectance	Grayscale intensity is proportional to the reflectance values of the pixels along the laser line. Suitable to show the surface details of an object, such as a print.	
Height	Color is proportional to depth (z-coordinate). Suitable to show large variations in depth.	
Hybrid	Color hue is proportional to depth (z-coordinate), color brightness is proportional to the laser reflectance. The Hybrid color map combines the Reflectance and Height color maps. Suitable to show large variations in depth together with surface details.	

Color map	Description	Example
Flat	Uses a solid color rendering.	

9.2.5.2 Aspect ratio

Using the **Aspect ratio** button, you can change the resolution and sampling of your data. Use the **Y resolution** (Profile distance) slider to set the distance between two rows in the image. For an uncalibrated image, the value is in pixel units, and for a calibrated image the value is in millimeters. If using encoder triggered mode the **Y resolution** defaults to the result given by the **Encoder resolution** multiplied by **Pulses per profile**.

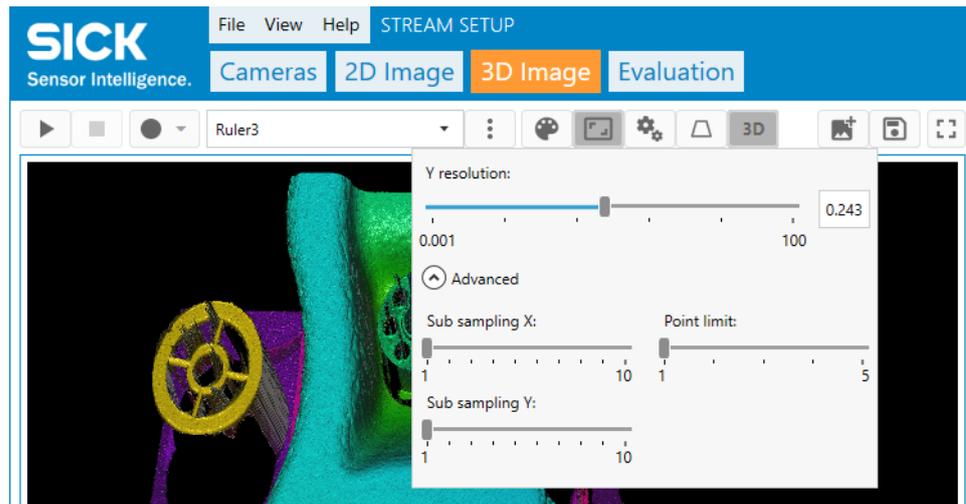


Figure 75: Aspect ratio GUI reference

Using the advanced options you can define if data should be skipped when showing the 3D image. Subsampling reduces the amount of data and gives a more responsive 3D display, especially for large data sets and a slow PC.

Parameter	Description
Sub sampling X	Defines how many samples in the direction across the sensor to skip. One means that all samples are displayed. This parameter could force the Sub sampling Y to be increased in case the data set is large.
Sub sampling Y	Defines how many samples in the transportation direction to skip. One means that all samples are displayed. This could be limited if the data size is large.
Point limit	Defines how much GPU memory is the maximum allowed to use. Can only be changed for PCs with certain graphics board properties.

9.2.5.3 Data rendering mode

Using the **Settings** button, you can select different ways to render the image data, see [table 8](#). Use **Shift** and the mouse wheel to move the crosshair towards or from the viewer, allowing rotation around different positions of the data. The 3D visualization has a center point for object rotation and zoom. This is displayed as a crosshair which can be disabled.

The **Reset** button resets the rendered view to default.

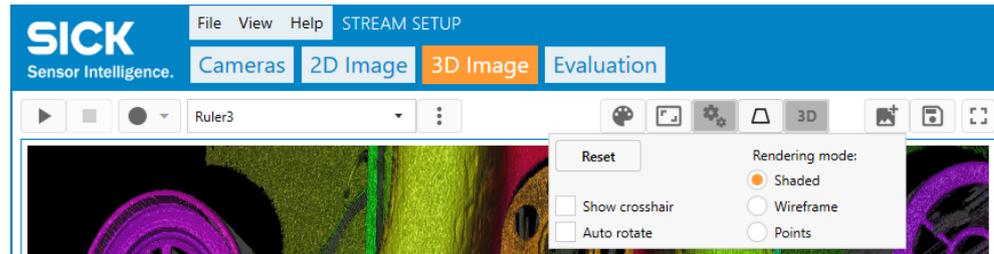
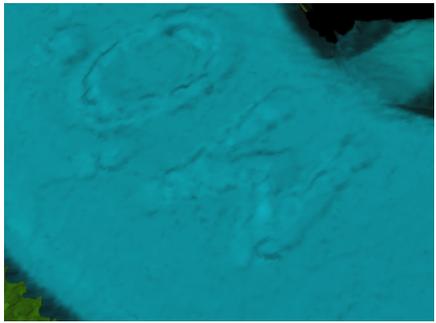
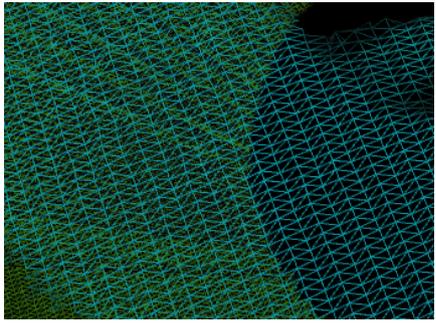
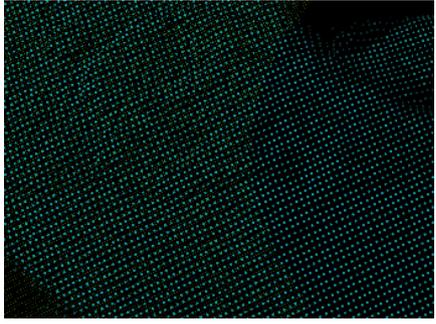


Figure 76: 3D image Settings options

Table 8: Rendering modes

Rendering mode	Description	Example
Shaded	Shows the data as a shaded mesh.	
Wireframe	Shows the data as a wireframe mesh.	
Points	Shows the data as a point cloud. This visualization requires more processing and can be slower in response than the others.	

9.2.5.4 Light settings

In the **Light settings** section, you can select lighting effects for the dataset. Select the **Enable light** checkbox to adjust the settings.

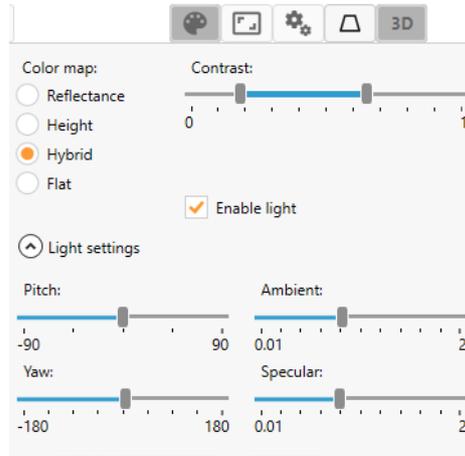


Figure 77: Light settings GUI reference

Parameter	Description
Pitch	Use the slider to control the vertical position of the light source.
Yaw	Use the slider to control the rotation of the light source around the vertical axis.
Ambient	Use the slider to adjust the ambient light level of the illumination model. The ambient light affects all objects equally.
Specular	Use the slider to adjust the specular light level of the illumination model. The specular light appears as a bright spot of light on shiny objects when illuminated.

9.2.6 Loading and saving image buffers

Tabs: **2D Image**, **3D Image**, **Evaluation**

When you save a 2D or 3D buffer, two separate files are created:

- A binary file that contains the image data (*.dat).
- An XML file that describes the binary file (*.xml).

In the **2D Image** tab, the currently displayed 2D image is saved. In the **3D Image** tab, the complete buffer of the currently displayed image is saved. This applies also if you have zoomed in so that only a part of the image is shown in the window.

Save image data

To save a single 2D image or 3D image, do as follows:

1. To save the currently displayed image, you have two options:
 - Click the **Add image** button, to load the image to the list on the **Evaluation** window.
 - Click the **Save image** button, to save the image to disk.
2. Open the **Evaluation** window to view the image.

Record buffers during the data collection

Use the record function in the user interface to record 2D or 3D buffers. When recording is active, i.e. the record button turns red, each acquired buffer is streamed to the connected PC and saved in a selected target folder.

**NOTE**

The record button is automatically released when the image acquisition stops.

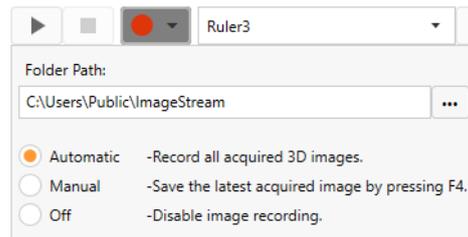


Figure 78: Recording images to file

1. Click the correct tab: **2D Image** for recording of 2D buffers, **3D Image** for recording of 3D buffers.
2. Click the record button and select a **Folder path**.
3. Enter a file name. The file name will be used as the folder name where all images will be saved.
4. Click **Save** to close the dialog box.
5. Click the record button to select **Automatic** or **Manual** image acquisition.
6. Click the start button to start the image acquisition.
- ✓ Each acquired buffer is saved in the selected target folder on the PC.

Load image data

You can load a 2D or 3D image that has been saved to disk, either by a recording or saved as a single image.

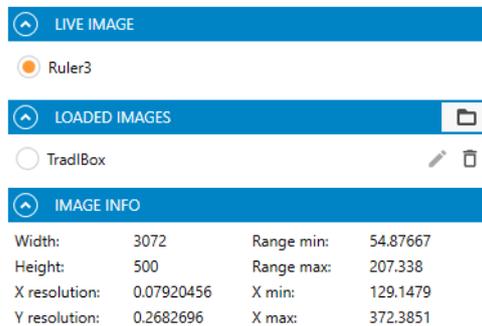


Figure 79: Loading and selecting an image GUI reference

To load a single 2D or 3D image, do as follows:

1. Open the **Evaluation** window.
 - The **Live image** section, shows the current 3D image.
 - The **Loaded images** section, shows previously loaded images.
2. Click the **Folder** button to load a new image.
3. Find and select the image file (*.dat) and click **Open**.
- ✓ The image is added to the **Loaded images** section.
4. Select an image using the corresponding radio button.

9.2.7 Handling log messages

1. Search for log messages by typing in the **Search Log Message**. Possible matches will automatically appear.
2. In the **Log level** drop-down list, select which type of log messages you want to see and search for.

You see log messages on the selected level and the levels above it. For example, if you select **Warning**, only log messages on level **Error** and **Warning** will be shown.

3. To delete all log messages, click **Clear**.

The log messages are always automatically saved as a log file. The saved log messages can be viewed when you use the **Open log folder** button. This will open the folder where the log file is stored and you can open the file in a text editor.

9.2.8 Camera files

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

1. In the **Cameras** tab, select **Camera files** by clicking the **Camera action menu** button, i.e the three dots to the right. You can also access the **Camera action menu** from the **2D Image** and **3D Image** tabs.
- ✓ The **Camera files** window opens and different files and actions are displayed in a list.

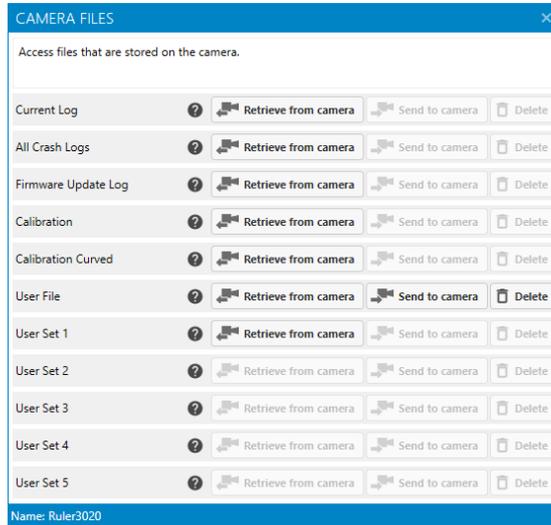


Figure 80: Camera files GUI reference.

2. Choose the file to process and click the button corresponding to the desired action.

9.2.9 Updating firmware

Follow the steps below to update the camera's firmware:



NOTE

The camera cannot be connected when updating the firmware.

1. In the step **Cameras**, select **Firmware update** by clicking the **Camera action menu** button, i.e the three dots to the right.
2. Find and select the firmware file (.aes) and click **Open**.
- ✓ The **Firmware update** window opens and the firmware update starts automatically.

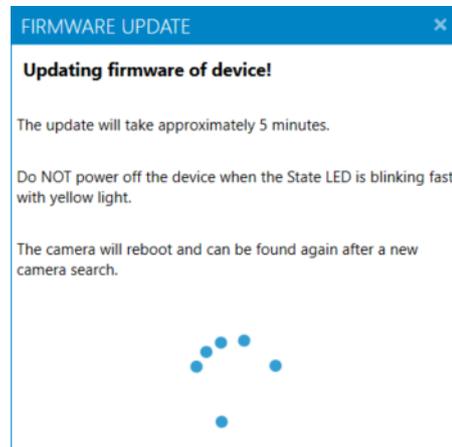


Figure 81: Firmware update GUI reference.

- ✓ When the update is finished, the device restarts automatically.
- 3. Click **Close**.
- 4. Reconnect to the device, see ["Connecting the camera"](#), page 40.

10 Maintenance

10.1 Maintenance plan

During operation, the device works maintenance-free.



NOTE

No maintenance is required to ensure compliance with the laser class.



NOTE

No maintenance is required to ensure compliance with the LED risk group.

Table 9: Maintenance plan

Maintenance work	Interval	To be carried out by
Check device and connecting cables for damage at regular intervals.	Depends on ambient conditions and climate.	Specialist
Clean housing.	Depends on ambient conditions and climate.	Specialist
Check the screw connections and plug connectors.	Depends on the place of use, ambient conditions or operating requirements. Recommended: At least every 6 months.	Specialist
Check that all unused connections are sealed with protective caps.	Depends on ambient conditions and climate. Recommended: At least every 6 months.	Specialist

10.2 Cleaning



NOTICE

Equipment damage due to improper cleaning.

Improper cleaning may result in equipment damage.

- Only use recommended cleaning agents and tools.
- Never use sharp objects for cleaning.

- ▶ Clean the housing with a soft cloth, dry or dampened with a mild water-diluted cleaning agent without powder additives.
- ▶ Keep the windows clean to maintain the performance of the device. Regularly check the windows for contamination such as dust or humidity. If there is contamination, gently clean the windows with a soft, damp cloth. Use a mild cleaning agent if needed.

Cleaning procedure:

Operating the product in conjunction with external illumination systems may result in hazardous radiation exposure. Please note the accompanying production documentation.



CAUTION

Optical radiation: 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.

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

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

10.3 Laser lifetime

Ruler3000 is equipped with an internal laser light source. As with any light source, the laser of the Ruler3000 also has a limited lifetime. The lifetime can be prolonged by considering and acting on the recommendations stated in this document.

10.3.1 About laser lifetime

The total lifetime of a laser module is dependent on the time the laser is lit. By reducing the time the laser is lit, the total lifetime will increase proportionally. Further, the ambient temperature also affects the laser lifetime. The lower the temperature, the longer the lifetime. For more information, see ["Reducing the ambient temperature", page 84](#).

10.3.1.1 Reducing the time the laser is lit

There are two main ways to minimize the time the laser is lit in an application. These are listed in the table below. Using the laser strobe function is the most efficient way to increase the laser lifetime.

Method	Description
Laser strobe function	The laser is only lit during the exposure time of profile acquisition. This is valid in both Free-running mode and Encoder triggered mode. If Encoder triggered mode is used, the laser will not be lit when the objects are not moving. This method is the default behavior of the Ruler3000.
Frame trigger input signal	Profile acquisition is only activated when the frame trigger signal is active. For instance, using a photoswitch as the frame trigger signal source will only enable profile acquisition when an object is in the field of view.

10.3.1.2 Reducing the ambient temperature

Ruler3020

- Control the ambient temperature and keep it as low as possible still above 0 °C. For more information, see ["Ambient data", page 90](#).
- Avoid temperature peaks caused by direct sunlight or electrical heaters that may heat up the housing.

At higher ambient temperatures the expected lifetime for the laser diode will decrease according to the Arrhenius equation.

11 Troubleshooting

11.1 Over triggering

When you use Ruler3000 with an external line trigger source it is possible to overtrigger the camera. This means that a new trigger arrives before the sensor can acquire new data. When configuring Ruler3000, the max value of the **Timed profile rate (Hz)** parameter indicates how fast the camera can be triggered. If the trig rate exceeds this, an overtrigger occurs.

When a single overtrigger occurs, the triggering of the profile is delayed until the sensor is ready. If several overtriggers occur before the sensor is ready, only the first overtrigger will cause a trig, and the others will be discarded. The camera will signal an error of class WARNING with information about the over triggering event. This is also followed later by INFO messages giving details of the error. The details can be logged for further error analysis by technical support but contain no further user information.

If overtrigger occurs when it is not expected there might be noise on the trigger inputs.

11.2 Encoder line trigger setup tips

In the **Profile triggering** section the **Encoder value** parameter can be used to see how the encoder input signals are counted by the camera. The **Encoder reset** button will reset the counter to 0.

11.3 Network card settings

For problems related to the network card settings, see ["Recommended network card settings", page 113](#).

11.4 Rescue mode

If the State LED on the device turns red, it means that the device has entered rescue mode and does not allow any data acquisition. There are two possible reasons:

- The device has discovered a problem with the installed application firmware.
- The device is overheated.

In **Stream Setup**, open **Camera files** and select **Retrieve from camera** for **All Crash Logs** to export log files with details about the error that put the device into rescue mode. For more information, see ["Camera files", page 80](#).

To exit rescue mode, try one of the following options:

- Disconnect and then re-connect the power to the device.
- Upload new valid firmware, see ["Updating firmware", page 80](#).



NOTICE

If the device enters rescue mode on multiple occasions and the reason is unknown, please contact SICK support.

11.5 Repairs

Repair work on the device may only be performed by qualified and authorized personnel from SICK AG. Interruptions or modifications to the device by the customer will invalidate any warranty claims against SICK AG.

11.6 Returns

- ▶ Do not dispatch devices to the SICK Service department without consultation.
- ▶ The device must be sent in the original packaging or an equivalent padded packaging.



NOTE

To enable efficient processing and allow us to determine the cause quickly, please include the following when making a return:

- Details of the contact person
 - Description of the application
 - Description of the fault that occurred
-

12 Decommissioning

12.1 Disposal

If a device can no longer be used, dispose of it in an environmentally friendly manner in accordance with the applicable country-specific waste disposal regulations. Do not dispose of the product along with household waste.



NOTICE

Danger to the environment due to improper disposal of the device.

Disposing of devices improperly may cause damage to the environment.

Therefore, observe the following information:

- Always observe the national regulations on environmental protection.
 - Separate the recyclable materials by type and place them in recycling containers.
-

13 Technical data



NOTE

The relevant online data sheet for your product, including technical data, dimensional drawing, and connection diagrams can be downloaded, saved, and printed from the Internet:

- www.sick.com/Ruler3000

Please note: This documentation may contain further technical data.

13.1 Product data

Device type	Ruler3020
Device type code	V3DU3-020RM21A
Part number	1106166

13.2 Features

Product	Ruler3020
Task	Quality inspection, high-speed measuring, 3D
Technology	3D line scanning
Working distance (measured from bottom of device, laser side)	245.5 mm ... 370.5 mm
Example field of view ¹	190 mm x 50 mm
Width at minimum working distance	155 mm
Width at maximum working distance	220 mm
Maximum height range	125 mm
Factory calibrated	Yes
Light source	Visible red light (laser, 660 nm) Divergence, fan angle 40° Output power, <22 mW Can be pulsed or cw NOHD for class 1 > 750 mm
Laser class	2 (EN/IEC 60825-1:2014) Complies with FDA performance standards for laser products except for conformance with IEC 60825-1 Ed.3., as described in Laser Notice No.56, dated May 8, 2019.
Data synchronization	Free running / Encoder triggered / Externally triggered
3D measurements	Yes
Scatter measurements	Yes
Reflectance measurements	Yes
Ambient light suppression	Yes ²
Exposure modes	Linear / HDR
Shutter technology	Global-Shutter

¹ See "Field of view diagram", page 28.

² Red bandpass filter.

13.3 Performance

Product	Ruler3020
Image sensor	SICK CMOS with ROCC technology, M30
Sensor resolution	2560 px x 832 px
Pixel size	6 μm x 6 μm
Max scan/frame rate	46000 3D profiles/s in reduced ROI
Scan/frame rate full format	7000 3D profiles/s
Z resolution (height)	14 μm ... 23 μm
X resolution (width)	63 μm ... 88 μm
Linearity	0.001%

13.3.1 Signal dynamic range

The M30 imager has an 8-bit signal range, which means that it can deliver 0 - 255 AD units in linear or multi-slope HDR mode. The sensor contains fixed-pattern noise (FPN) correction, which removes gradients from the image data. The FPN correction causes a small reduction of the resulting signal range, and the expected useful signal range is around 240 AD units.

When the imager is saturated, residual FPN may appear.

13.3.2 Light sensitivity

The peak sensitivity is located in the interval from 600 to 650 nm.

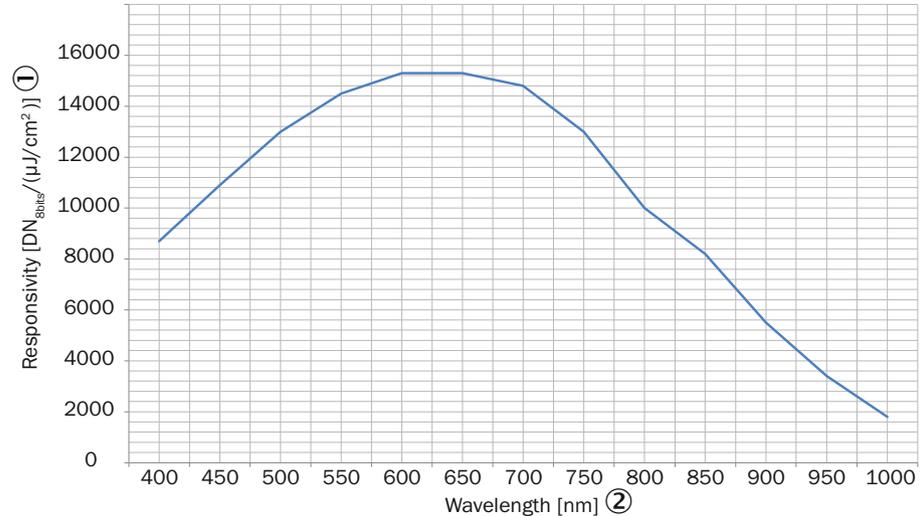


Figure 82: Spectral response for the M30 sensor

- ① Responsivity [DN_{8bits}/(μJ/cm²)]
- ② Wavelength [nm]

13.3.3 Maximum line rate

The maximum line rate as a function of the number of used sensor rows for Ruler3000 is shown in [figure 83](#).

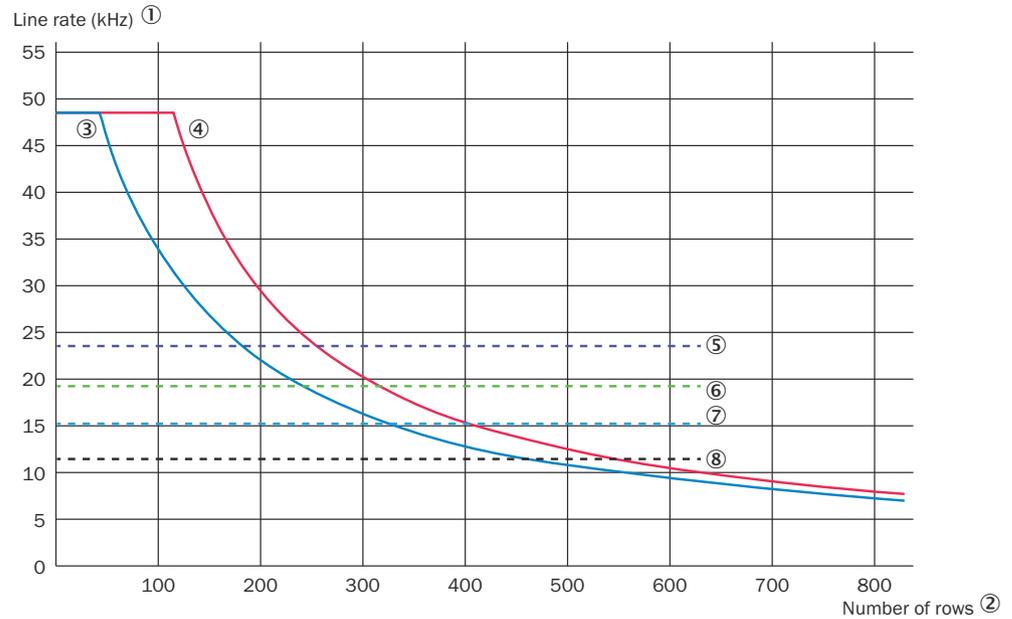


Figure 83: The maximum line rate as a function of the number of sensor rows used.

- ① Line rate (kHz)
- ② Number of rows
- ③ Ruler3000 with HDR enabled
- ④ Ruler3000 without HDR enabled
- ⑤ Bandwidth limitation for image width 2560, only Range
- ⑥ Bandwidth limitation for image width 3072, only Range
- ⑦ Bandwidth limitation for image width 2560, Range and Reflectance
- ⑧ Bandwidth limitation for image width 3072, Range and Reflectance

13.4 Interfaces

Product	Ruler3020
Ethernet	UDP/IP 1 Gbit/s (data transmission rate)
Configuration software	Stream Setup
Communication interfaces	Gigabit Ethernet/GigE Vision
Operating system	Windows 10
Programming interface	GenAPI, GenTL, proprietary SICK GenIStream
Configurable digital inputs	4 x HTL = 10 V ... 28.8 V
Configurable digital outputs	1 x HTL, 2 x TTL
Encoder interface	RS-422 or 2 x HTL single-ended
External illumination control	RS-422 5 V TTL or HTL 24V

13.5 Ambient data

Product	Ruler3020
Shock load	15 g, 3 cycles per axis
Vibration load	5 g, 10 Hz ... 150 Hz

Product	Ruler3020
Ambient operating temperature ¹	0 °C ... +50 °C ²
Ambient storage temperature	-30 °C ... +70 °C ²

¹ Notes regarding adequate dissipation of lost heat: see "Mounting instructions", page 26

² Non-condensing

13.6 Mechanics and electronics

Product	Ruler3020
Connections	Power I/O: M12, 17-pin male Gigabit Ethernet: M12, 8-pin female, X-coded
Connector material	Nickel-plated brass
Supply voltage	24 V DC +/-10%
Ripple	<5 V _{pp}
Power consumption	12 W maximum
Current consumption	1.5 A maximum
Enclosure rating	IP65 / IP67
Protection class	III
Housing material	Aluminum
Housing color	Blue
Window material	Float glass, anti-reflective coated glass
Weight	1800 g
Dimensions (L x W x H)	245 mm x 65 mm x 108 mm

13.7 Dimensional drawings

Ruler3020

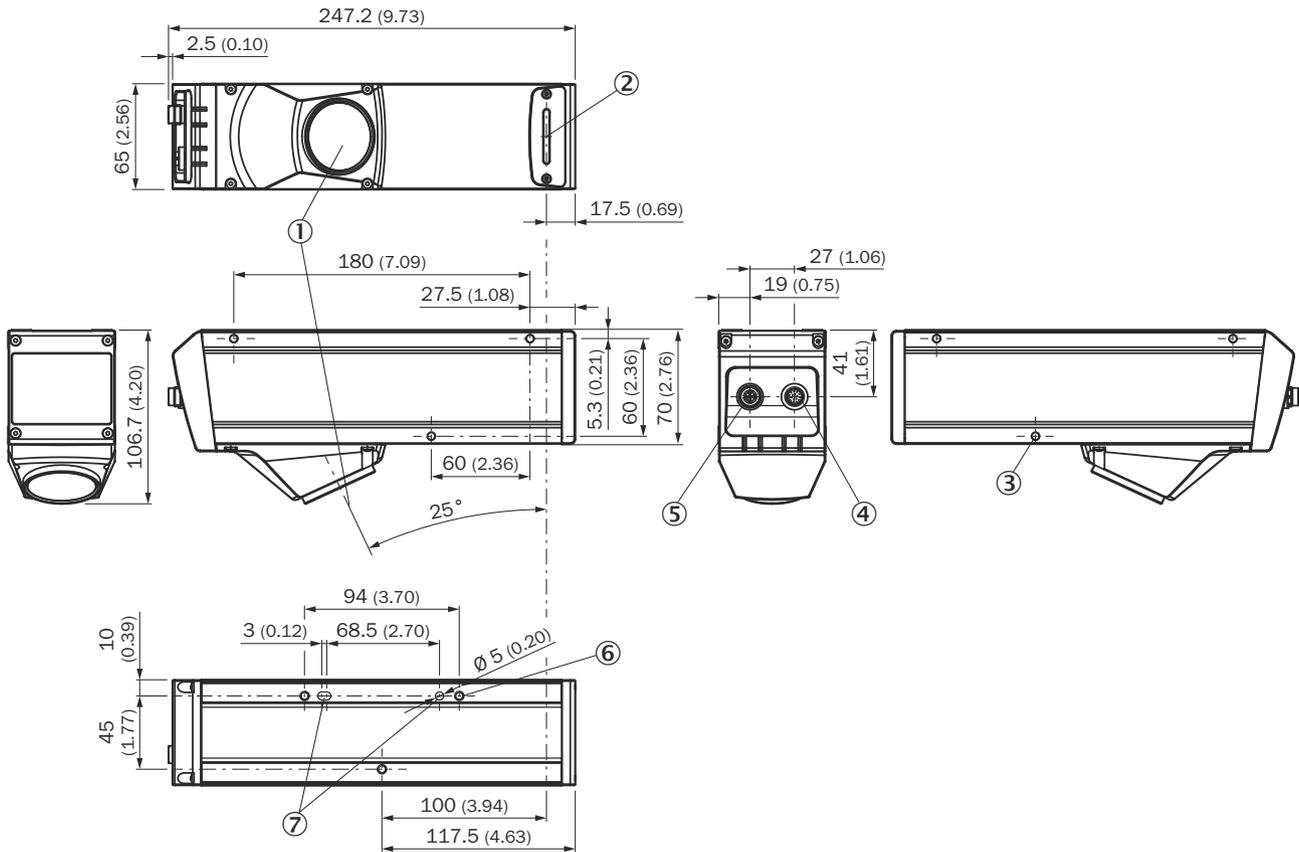


Figure 84: Ruler3020 dimensions

- ① Optical receiver
- ② Optical sender
- ③ Fastening threads (M5 x 12 mm deep, with through-hole (\varnothing 4.2 mm))
- ④ Connector Power I/O
- ⑤ Connector Gigabit Ethernet (GigE)
- ⑥ Fastening threads (M5 x 9 mm deep)
- ⑦ Position and alignment hole for dowel pins (\varnothing 5 mm)

14 Accessories



NOTE

Accessories and where applicable mounting information can be found online at:

- www.sick.com/Ruler3000
-

15 Glossary

15.1 Terms and abbreviations

3D image	A point cloud where the object shape is represented by three coordinates or a rectified image where x and y coordinates are given by the image pixel locations and the image value gives the z coordinate.
block	In the GigE Vision transport protocol, a frame (image) is named block.
buffer	Each frame will be received in the PC as one buffer.
depth map	An image where the values represent height or depth and not intensity. Same thing as height map.
FPGA	Field Programmable Gate Array
frame	In Areascan mode: One 2D image. In Linescan3D mode: A set of 3D profiles and optionally additional data e.g. reflectance. Each line in the frame is created from one 2D image.
frame rate	The rate at which the frames are captured (Hz) in Areascan mode.
GUI	Graphical User Interface
height map	An image where the values represent height or depth and not intensity. Same thing as depth map.
intensity	The intensity value of the pixels in a 2D sensor image.
line	Contains one value for each measured point along a cross-section of the object of each acquired type. Same thing as profile.
line rate	The rate at which the profiles in an image are captured (Hz).
MTTF	Mean Time To Failure
NIC	Network Interface Card
PELV	Protective Extra Low Voltage
profile	Contains one value for each measured point along a cross-section of the object of each acquired type. Same thing as line.
profile rate	The rate at which the profiles in an image are captured (Hz).
reflectance	The reflected peak intensity of the laser line when measuring 3D profiles.
ROI	Region Of Interest, the selected range, area or volume of measured data.
scan (verb)	To collect measurements made by the 3D camera at one point in time. That is the same thing as capturing one single profile.
scatter	The intensity of the laser signal in defined parts of the WAM size.
SELV	Safety Extra Low Voltage
SoC	System on Chip
WAM	Window Around Maximum. A pixel region centered around a global or local peak used for high precision peak finding and laser scatter measurement.

16 Annex

16.1 Range (3D) measurement

The 3D camera measures range using triangulation. This means that the object is illuminated with a line light from one direction, and the camera is measuring the object from another direction.

The camera analyzes the sensor images to locate the laser line in them. The higher up the laser line is found for a point along the x-axis (the width of the object), the higher up is that point on the object.

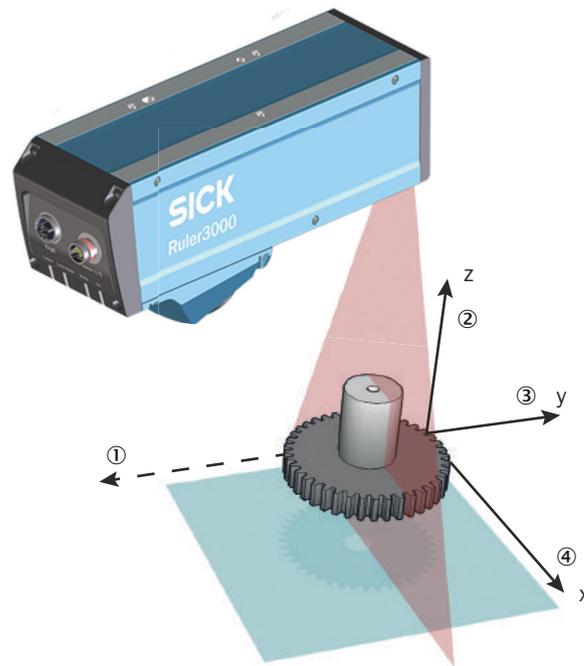


Figure 85: Coordinate system when measuring range

- ① Transport direction
- ② Range (Z)
- ③ Negative transport direction (Y)
- ④ Width (X)

The following is important to get correct measurement results:

- The laser line is orthogonal to the movement direction of the object.

16.1.1 Occlusion

Occlusion occurs when there is no laser line for the 3D camera to detect in the sensor image. Occlusion will result in missing data for the affected points in the measurement result.

There are two types of occlusion:

Camera occlusion

When the laser line is hidden from the camera by the object.

Laser occlusion

When the laser cannot properly illuminate parts of the object.

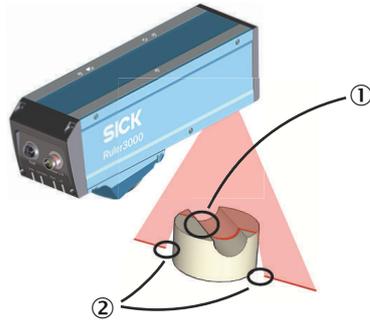


Figure 86: Different types of occlusion

- ① Camera occlusion
- ② Laser occlusion

16.1.2 Width resolution and resolution in the motion direction

In a laser triangulation system the camera placement and optics determine the width of the field-of-view (FOV). The resolution across the object (ΔX) is the FOV width divided with the number of pixels.

The resolution along the motion direction (ΔY) is a direct function of the measurement frequency and the object speed.

16.1.3 Sensor coordinate system

This section is only relevant for 2D images and uncalibrated data. Normally a Ruler3000 uses the built-in calibration and receives 3D data as rectified Z data with Z pointing towards the device, i.e. inverse to the sensor v axis.

The camera views the object and the laser line from above, with a certain angle between the camera and the laser, as described in this document. The 2D image has its origo in the top left corner when you view the image on the screen, see the figure below. This means that the v-coordinate of a point that is close to the bottom of the screen (v_1) is greater than the v-coordinate of a point that is higher up on the screen (v_2).

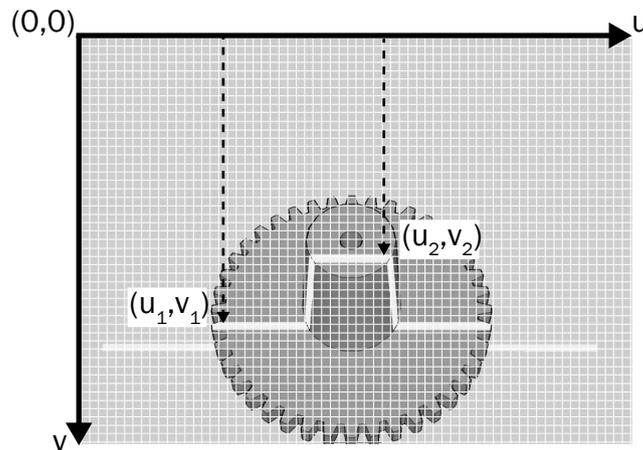


Figure 87: Sensor image and coordinate system

When the coordinates from the sensor image are used as 3D data, a high value of the v-coordinate will give a high range value.

In the coordinate system above, parts of the object that are far away from the camera will get a high range value, and parts that are close to the camera will get a low range value. That is, the range value represents distance from the camera. If you view the 3D image in a coordinate system that has its origo in the lower left corner, the 3D image will appear upside down.

16.2 Features

The GenICam™ standard uses "feature" as a common word for parameters, commands, and selectors.

The features that are used for Ruler3000 are listed in the following sections. Most of the features comply with GenICam™ SFNC. There are also some custom features that are described in separate tables.

The "Type" column defines the data type for a feature. GenICam defines a number of interface classes for SFNC features, where each interface class corresponds to a data type. For example, the interface class **IBoolean** corresponds to the data type **boolean**.

The "Access" column defines if the feature is readable ("R"), writable ("W"), or both ("RW"). "R(W)" means that for some selector values the feature is both read- and writable, but for other selector values, it is just readable. In some cases, the read- and writability of a certain parameter depends on the model and version of the device.

For further information, including detailed descriptions of the standard parameters, see www.emva.org/standards-technology/genicam/.



NOTE

There are parameter dependencies both within and between the feature groups, which means that changing the value of one parameter might also change the value of others. Examples:

- The maximum **AcquisitionLineRate** value depends on the **Height** value (a larger number of rows gives a lower maximum speed).
- The maximum **ExposureTime** value (a longer exposure time gives a lower maximum speed) depends on the **AcquisitionLineRate** value (see "Exposure time", page 47 and "High dynamic range (HDR) imaging", page 50). In some cases, it depends on **Width/RectificationWidth** and data format/number of components when the bandwidth on the gigabit link is the limit.



NOTE

The parameters for 3D fully utilize the features of SFNC and use e.g. scale and offset (and their chunk meta data counterparts) for all data to allow the receiver to transform the data on the wire to the actual world or pixel coordinate systems.

16.2.1 Setting parameters in GenICam

16.2.1.1 Parameter categories

The parameters are grouped into categories, for instance, **Device control**, **GigEVision**, **Firmware update** and **Acquisition control**. These groups can be used by a configuration GUI to show the parameters in a user-friendly way.

16.2.1.2 Selectors

ExposureTime[RegionSelector]

GenICam has a type of array mechanism called selectors. Instead of having several similar parameters (one for each corresponding region), e.g **ExposureTime0**, **ExposureTime1**, **ExposureTime2**, a selector can be used. Parameter arrays are shown in the feature tables below like this: **ExposureTime[RegionSelector]**.

By first setting **RegionSelector** to 1, **ExposureTime** will now point to the second value in the **ExposureTime** array.

To set a parameter you need to know if the parameter is controlled by a selector (or several), see **PixelFormat** in "[Image format control](#)", page 100. If the parameter is not controlled by a selector it can be set directly, otherwise, you need to first set the selector and then set the parameter.

16.2.1.3 Setting parameters examples

Setting auto strobe of the laser

LineSource determines the behavior of an I/O pin (in this case the laser strobe output) and is controlled by the **LineSelector**:

1. Set the **LineSelector** to **LaserStrobe10Output**. This setting selects the laser strobe output for configuration.
2. Set the **LineSource** to **Region1Exposure**. **Region1Exposure** means that the laser strobe output will automatically follow the exposure time of **Region1**.

Setting several dependent parameters

Sometimes there are complex dependencies between parameters and changing them in the correct order can be hard. It can be useful to turn off the parameter validation that controls/checks the dependencies temporarily, set several parameters, and then turn on the validation again.

1. Temporarily turn off parameter validation by executing the command parameter **DeviceRegistersStreamingStart**.
2. Set several parameters.
3. Turn on parameter validation again by executing the command parameter **DeviceRegistersStreamingEnd**.

16.2.2 Device control

Table 10: Device control standard SFNC selector

Selector	Type	Description
DeviceTemperatureSelector	enum	Selects the location within the device, where the temperature will be measured. Values: Sensor SensorBoard MainBoard Laser ZpmSoc Zpm1 Zpm2 Zpm3 Zpm4 Filter

Table 11: Device control standard SFNC parameters

Parameter	Type	Description	Access
DeviceScanType	enum	Scan type of the sensor of the device. Ranger3 uses this parameter to control if 2D images (Areascan) or 3D profiles (Linescan3D) are acquired. Changing the DeviceScanType automatically sets the relevant device features for the selected mode. Values: Areascan Linescan3d	R(W)
DeviceVendorName	string	Name of the manufacturer of the device.	R
DeviceModelName	string	Model of the device.	R
DeviceVersion	string	Version of the device. Used to note hardware version.	R
DeviceFirmwareVersion	string	Version of the firmware in the device.	R
DeviceManufacturerInfo	string	Manufacturer information about the device.	R
DeviceSerialNumber	string	Device's serial number.	R
DeviceUserID	string	User-programmable device identifier.	RW
DeviceSFNCVersionMajor	int	Major version of the Standard Features Naming Convention that was used to create the device's GenICam XML.	R
DeviceSFNCVersionMinor	int	Minor version of the Standard Features Naming Convention that was used to create the device's GenICam XML.	R
DeviceSFNCVersionSubMinor	int	Sub minor version of Standard Features Naming Convention that was used to create the device's GenICam XML.	R
DeviceTLType	enum	Transport Layer type of the device. Values: GigEVision	R
DeviceTLVersionMajor	int	Major version of the Transport Layer of the device.	R
DeviceTLVersionMinor	int	Minor version of the Transport Layer of the device.	R
DeviceTLVersionSubMinor	int	Sub minor version of the Transport Layer of the device.	R
DeviceLinkThroughputLimit	int	Limits the maximum bandwidth of the data that will be streamed out by the device on the selected Link.	RW
DeviceRegistersValid	bool	Returns if the current register set is valid and consistent. Updated after the DeviceRegistersStreamingEnd command.	R
DeviceTemperature[DeviceTemperature-Selector]	float	Device temperature in degrees Celsius (C).	R

Table 12: Device control custom parameters

Parameter	Type	Description	Access
DeviceRegistersStreamingActive	bool	True if a register's streaming session is active.	R
DeviceTemperatureMin	int	The minimum temperature ever registered in degrees Celsius (C) measured at the location selected by DeviceTemperature-Selector.	R
DeviceTemperatureMax	int	The maximum temperature ever registered in degrees Celsius (C) measured at the location selected by DeviceTemperature-Selector.	R

Parameter	Type	Description	Access
DeviceCurrentBootPath	enum	The booted software path, i.e., bootloader, kernel, application etc. Primary is the normal path and Secondary is used for rescue purposes if the primary path fails. Values: Primary Secondary	R
DeviceNextBootPath	enum	The boot path that will be used after the next soft reset ¹ . This is normally set to secondary to boot the rescue version of the system if an unexpected reset occurs. Values: Unknown Primary Secondary	R
DeviceBootCount	int	Accumulated number of times the device has been booted.	R
DeviceOperationTime	int	Accumulated operation time of the device, in seconds.	R
LaserOnDelayTime	float	The estimated internal activation delay of the laser module. This delay is propagated as the minimum of the Trigger Delay for ExposureStart.	R

¹ A soft reset is an unwanted reboot of the device.

Table 13: Device control standard SFNC commands

Command	Description	Access
DeviceReset	Resets the device to its power up state.	W
DeviceRegistersStreamingStart	Prepare the device for registers streaming without checking for consistency. DeviceRegistersStreaming is used when loading and saving a device's configuration to/from file on the host.	W
DeviceRegistersStreamingEnd	Announce the end of registers streaming. After this command DeviceRegistersValid is updated to reflect the status of the device settings.	W

16.2.3 Image format control

Table 14: Image format control standard SFNC selectors

Selector	Type	Description
RegionSelector	enum	Selects the Region of interest to control. Values: Region0 Region1 Scan3dExtraction1
ComponentSelector	enum	Selects a component to activate/deactivate its data streaming. Values: Intensity Range Reflectance Scatter

Table 15: Image format control standard SFNC parameters

Parameter	Type	Description	Access
ExposureTime[RegionSelector] ¹	float	Sets the Exposure time (in μ s).	R(W)
Width[RegionSelector]	int	Width of the image provided by the device (in pixels).	R(W)
Height[RegionSelector]	int	Height of the image provided by the device (in pixels).	R(W)

Parameter	Type	Description	Access
OffsetX[RegionSelector]	int	Horizontal offset from the origin to the region of interest (in pixels).	R(W)
OffsetY[RegionSelector]	int	Vertical offset from the origin to the region of interest (in pixels).	R(W)
RegionMode[RegionSelector]	enum	Controls if the selected region of interest is active and streaming. Values: Off On	R
ComponentEnable[RegionSelector][ComponentSelector]	bool	Controls if the selected component streaming is active.	RW
PixelFormat[RegionSelector][ComponentSelector]	enum	Format of the pixels provided by the device. Values: Mono8 Coord3D_C8 Mono12p Mono16 Coord3d_C16 Coord3D_C12p Coord3D_AC16_Planar	R(W)
TestPattern[RegionSelector][ComponentSelector]	enum	Selects the type of test pattern that is generated by the device as image source. Values: Off GreyHorizontalRampMoving	R(W)
RegionIDValue[RegionSelector]	int	The unique identifier value corresponding to the Region.	R
ComponentIDValue[ComponentSelector]	int	The unique identifier value corresponding to the selected Component type.	R

¹ According to GeniCam™ SFNC, the **ExposureTime** parameter belongs to the **AcquisitionControl** category. Here it is moved to the **ImageFormatControl** category because it is selected by the **RegionSelector** parameter.

Table 16: Image format control custom parameter

Parameter	Type	Description	Access
RegionDescription[RegionSelector]	String	Describes the usage of a specific region in the device.	R

16.2.4 Scan 3D control

Table 17: Scan 3D control standard SFNC selectors

Selector	Type	Description
Scan3dExtractionSelector	enum	Selects the 3DExtraction processing module to control (if multiple ones are present). Value: Scan3dExtraction1
Scan3dCoordinateSelector[Scan3dExtractionSelector]	enum	Values: CoordinateA CoordinateB CoordinateC

Selector	Type	Description
Scan3dCoordinateReferenceSelector[Scan3dExtractionSelector]	enum	Values: RotationX RotationY RotationZ TranslationX TranslationY TranslationZ

Table 18: Scan 3D control standard SFNC parameters

Parameter	Type	Description	Access
Scan3dExtractionSource[Scan3dExtractionSelector]	enum	Selects the sensor's data source region for 3D Extraction module. This is hardcoded to a specific sensor region for each extraction module. Value: Region1	R
Scan3dExtractionMethod[Scan3dExtractionSelector]	enum	Selects the method for extracting 3D from the input sensor data. Value: Hi3D	R(W)
Scan3dInvalidDataFlag[Scan3dCoordinateSelector]	bool	Enables the definition of a non-valid flag value in the data stream.	R
Scan3dInvalidDataValue[Scan3dCoordinateSelector]	float	Value which identifies a non-valid pixel if Scan3dInvalidDataFlag is enabled.	R
Scan3dOutputMode[Scan3dExtractionSelector]	enum	Value: UncalibratedC RectifiedC RectifiedC_Linescan CalibratedC CalibratedC_Linescan CalibratedAC CalibratedAC_Linescan	RW
Scan3dCoordinateSystem[Scan3dExtractionSelector]	enum	Value: Cartesian	R
Scan3dDistanceUnit[Scan3dExtractionSelector]	enum	Value: Pixel Millimeter	R
Scan3dCoordinateScale[Scan3dExtractionSelector][Scan3dCoordinateSelector]	float	Scale factor when transforming a pixel from relative coordinates to world coordinates.	R
Scan3dCoordinateOffset[Scan3dExtractionSelector][Scan3dCoordinateSelector]	float	Offset when transforming a pixel from relative coordinates to world coordinates.	R
Scan3dAxisMin[Scan3dExtractionSelector][Scan3dCoordinateSelector]	float	Minimum valid transmitted coordinate value of the selected axis.	R
Scan3dAxisMax[Scan3dExtractionSelector][Scan3dCoordinateSelector]	float	Maximum valid transmitted coordinate value of the selected axis.	R
Scan3dCoordinateReferenceValue[Scan3dExtractionSelector][Scan3dCoordinateReferenceSelector]	float	Returns the reference value selected. Reads the value of a rotation or translation value for the current (Anchor or Transformed) coordinate system transformation to the Reference system.	R

Table 19: Scan 3D control custom parameters

Parameter	Type	Description	Access
WAMSize[Scan3dExtractionSelector]	enum	Size of Window Around Maximum (WAM) for high-resolution peak fitting. Adapt to the laser peak width on the sensor. Values: Small: size 7 pixels, peak width 2-4 pixels Normal: size 15 pixels, peak width 3-8 pixels (default) Large: size 31 pixels, peak width 7-15 pixels	RW
DetectionThreshold[Scan3dExtractionSelector]	int	Minimum reflectance signal that can be detected as a peak position. A higher value reduces detectability of weak peaks (reflections on dark material) and a lower value increases the risk of detected noise peaks. Values 0-255. Default value 20.	RW
SearchMode3D[Scan3dExtractionSelector]	enum	What peak type(s) to search for. Values: GlobalMax FirstLocalMax	RW
SearchDirection[Scan3dExtractionSelector]	enum	In FirstLocalMax this defines "first" or "last" peak in Region. Values: Standard (increasing rows) Reverse	RW
RangeAxis[Scan3dExtractionSelector]	enum	Defines the direction of the Z-axis when visualizing 3D data. Use this parameter to flip the co-ordinate axis of the range values, depending on how the camera is mounted in relation to the laser line. Values: Standard Reverse	RW
ReflectanceFilter[Scan3dExtractionSelector]	bool	Speckle reduction smoothing of reflectance.	RW
Scan3dRectificationWidth[Scan3dExtractionSelector]	int	Rectification can be made to a higher or lower resolution than the resolution from the calibration step. A higher resolution avoids losing detail in the region close to the camera, a lower resolution gives smoothing filters. Values: TopMost BNotomMost	RW
Scan3dRectificationMethod[Scan3dExtractionSelector]	enum	Defines how the rectification output in a bin is created from (potentially) multiple calibrated entries.	RW
Scan3dRectificationSpread[Scan3dExtractionSelector]	float	To avoid missing data in rectified regions, each calibrated data point can be spread to multiple adjacent rectification bins. This parameter controls the spread width. A higher value includes more bins. Setting this parameter to 0 disables spreading. A value of 1 gives no holes in the ideal case.	RW
ScatterMode[Scan3dExtractionSelector]	enum	Mode for laser scatter, both sides, front (lower rows), back (higher rows) Values: SymmetricSideBand FrontSideBand BackSideBand	RW
ScatterOffset[Scan3dExtractionSelector]	int	Distance in pixels from the center of the window to start of scatter measurement. A distance of 0 includes the center pixel.	RW

Parameter	Type	Description	Access
ScatterWidth[Scan3dExtractionSelector]	int	Number of pixels to add in scatter measurement side band.	RW
ScatterReductionCurve[Scan3dExtractionSelector]	enum	Select mode for reducing scatter values from 16 to 8 bits. Values: Linear OneKnee TwoKnees	RW
ScatterReductionLowerLimit[Scan3dExtractionSelector]	int	Scatter values below this value will be clipped to zero.	RW
ScatterReductionUpperLimit[Scan3dExtractionSelector]	int	Scatter values above this value will be clipped to 255.	RW
ScatterReductionKnee1Input[Scan3dExtractionSelector]	int	Input coordinate of the first knee, expressed as a percentage of the specified input range.	RW
ScatterReductionKnee1Output[Scan3dExtractionSelector]	int	Output coordinate of the first knee, expressed as a percentage of the output range.	RW
ScatterReductionKnee2Input[Scan3dExtractionSelector]	int	Input coordinate of the second knee, expressed as a percentage of the specified input range.	RW
ScatterReductionKnee2Output[Scan3dExtractionSelector]	int	Output coordinate of the second knee, expressed as a percentage of the output range.	RW

16.2.5 Acquisition control

Table 20: Acquisition control standard SFNC selector

Selector	Type	Description
TriggerSelector	enum	Selects the type of trigger to configure. Value: LineStart FrameStart ExposureStart AreaScanFrameStart

Table 21: Acquisition control standard SFNC parameters

Parameter	Type	Description	Access
AcquisitionMode	enum	Sets the acquisition mode of the device. Values: SingleFrame Continuous	RW
AcquisitionStopMode	enum	Controls how the AcquisitionStop command and the acquisition stopped using a trigger (e.g. AcquisitionActive, FrameBurstActive, FrameActive or FrameEnd trigger), ends an ongoing frame. Complete: When stopped using the AcquisitionStop command during a frame, the device stops acquisition of lines but always reports the full Height in the trailer. This is suitable for legacy receivers that expect only full height frames. When using frame trigger input, the device will continue acquisition of lines until the specified Height is reached to deliver a full height frame. Immediate: Acquisition stops immediately even during a frame and only the lines acquired at the time are delivered.	RW
AcquisitionFrameRate	float	Controls the acquisition rate (in Hertz) at which the frames are captured. Valid if DeviceScanType is Areascan.	RW

Parameter	Type	Description	Access
AcquisitionLineRate	float	Controls the rate (in Hertz) at which the lines in a frame are captured. Valid if DeviceScanType is Linescan3D and no external line trigger is active.	RW
TriggerMode[TriggerSelector]	enum	Controls if the selected trigger is active. Values: On Off	RW
TriggerSource[TriggerSelector]	enum	Specifies the internal signal or physical input line to use as the trigger source. The selected trigger must have its TriggerMode set to On. Values: Encoder FrameTriggerInput LineStart LineTriggerInput	R
TriggerActivation[TriggerSelector]	enum	Specifies the activation mode of the trigger. Values: RisingEdge LevelHigh	R(W)
TriggerDelay	float	Specifies the delay (in microseconds) to apply after the trigger reception before activating it.	RW
MultiSlopeMode[TriggerSelector]	enum	Increases the dynamic range Values: Off PresetSoft PresetMedium PresetAggressive	RW
MultiSlopeKneePointCount	int	The number of knee-points as well as the number of additional exposure slopes used for multi-slope exposure.	R

Table 22: Acquisition control standard SFNC commands

Command	Description	Access
AcquisitionStart	Starts the acquisition of the device.	W
AcquisitionStop	Stops the acquisition of the device at the end of the current frame.	W

16.2.6 Digital I/O control

Table 23: Digital I/O control standard SFNC selectors

Selector	Type	Description
LineSelector	enum	<p>Selects the physical line (or pin) of the external device connector or the virtual line of the transport layer to configure.</p> <p>Values: LineTriggerInput FrameTriggerInput FrameSynchronizationOutput LaserStrobe1Output LaserStrobe2Output EncoderAInput EncoderBInput EncoderResetInput</p>

Selector	Type	Description
IOPinSelector	enum	LineTriggerInput Values: IO1 IO2 IO3 IO4

Table 24: Digital I/O control standard SFNC parameter

Parameter	Type	Description	Access
LineStatus[LineSelector]	bool	Returns the current status of the selected input or output line.	R
LineMode[LineSelector]	enum	Controls if the physical Line is used to Input or Output a signal. Values: Input Output	R(W)
LineSource[LineSelector]	enum	Selects which internal acquisition or I/O source signal to output on the selected Line. LineMode must be Output. Values: Off AlwaysActive Region1Exposure LaserStrobe1Timer LaserStrobe2Timer	RW
LineInverter[LineSelector]	bool	Controls the inversion of the selected input or output line. The line signal is inverted if checked (i.e. set to true).	R(W)
LineFormat[LineSelector]	enum	Controls the current electrical format of the selected physical input or output Line. For encoder Lines: RS422 corresponds to differential 5V (TTL) logic mode. Line24V corresponds to single-ended 24V (HTL) logic mode. Since encoder input B uses the same signal level as encoder input A, EncoderBInput is automatically changed when EncoderAInput is changed, and vice versa. Values: RS422 Line24V	RW

Table 25: Digital I/O control custom parameter

Parameter	Type	Description	Access
SignalConfiguration	enum	Configure the IO as input or output and select which source should drive the outputs. Values: Input OutputFrameSynchronization	RW

16.2.7 Counter and timer control

Table 26: Test control standard SFNC selectors

Selector	Type	Description
TimerSelector	enum	Select the laser or sensor trigger output to configure. Values: LaserStrobe1Timer LaserStrobe2Timer FrameSynchronizationTimer

Selector	Type	Description
CounterSelector	enum	Select the counter to read. Values: FrameTriggerCounter

Table 27: Test control standard SFNC parameters

Parameter	Type	Description	Access
TimerDuration[TimerSelector]	float	Sets the duration (in microseconds) of the Timer pulse.	RW
TimerDelay[TimerSelector]	float	Sets the duration (in microseconds) of the delay to apply at the reception of an internal trigger before starting the Timer. The maximum value depends on AcquisitionLineRate .	RW
TimerTriggerSource[TimerSelector]	enum	Selects the source of the trigger to start the Timer. Values: Off FrameStart FrameEnd	RW
CounterReset[CounterSelector]	int	Does a software reset of the selected Counter and starts it.	RW
CounterValue[CounterSelector]	int	Reads or writes the current value of the selected Counter.	R

16.2.8 Encoder control

Table 28: Encoder control standard SFNC parameters

Parameter	Type	Description	Access
EncoderResolution	float	Defines the resolution of one encoder tick in the used coordinate system.	RW
EncoderMode	enum	FourPhase mode is the standard encoder mode where the EncoderValue increments on each full four phase sequence which suppresses jitter. Values: FourPhase HighResolution	RW
EncoderDivider	int	Sets how many encoder increment/decrements that are needed to generate an encoder output pulse signal.	RW
EncoderOutputMode	enum	Selects the conditions for the encoder interface to generate a valid encoder output signal. Values: PositionUp PositionDown DirectionUp DirectionDown Motion	RW
EncoderValue	int	Reads the current value of the position counter of the selected encoder.	R
EncoderResetSource	enum	Selects the signals that will be the source to reset the Encoder. Value: Off EncoderResetInput	RW
EncoderResetActivation	enum	Selects the Activation mode of the Encoder Reset Source signal. Value: RisingEdge	RW

Table 29: Encoder control standard SFNC command

Command	Description	Access
EncoderReset	Resets the EncoderValue of the selected Encoder. The Encoder starts counting events immediately after the reset. EncoderReset can be used to reset the Encoder independently from the EncoderResetSource.	W

16.2.9 Event control

Table 30: Event control standard SFNC selector

Selector	Type	Description
EventSelector	enum	Selects which Event to signal to the host application. Value: LogMessage

Table 31: Event control standard SFNC parameter

Parameter	Type	Description	Access
EventNotification[EventSelector]	enum	Activate or deactivate the notification to the host application of the occurrence of the selected Event. Values: Off: The selected Event notification is disabled. On: The selected Event notification is enabled.	RW

16.2.10 User Set control

Table 32: User Set control standard SFNC selector

Selector	Type	Description
UserSetSelector	enum	Selects the feature User Set to load, save or configure. Default User Set is read-only and cannot be modified. Values: Default UserSet1 UserSet2 UserSet3 UserSet4 UserSet5

Table 33: User Set control standard SFNC parameters

Parameter	Type	Description	Access
UserSetDefault[UserSetSelector]	enum	Selects the feature User Set to load and make active by default when the device is reset. Values: Default UserSet1 UserSet2 UserSet3 UserSet4 UserSet5	RW

Table 34: User Set control custom parameters

Parameter	Type	Description	Access
UserSetDescription[UserSetSelector]	string	Description of the content of a User Set.	RW
UserSetFirmwareVersion[UserSetSelector]	string	The firmware version for which the configuration was created. It is only possible to load user sets that are created for the currently running firmware version.	R

Table 35: User Set control standard SFNC commands

Command	Description	Access
UserSetLoad[UserSetSelector]	Loads the User Set specified by UserSetSelector from the device's non-volatile memory and makes it active.	W
UserSetSave[UserSetSelector]	Saves the User Set specified by UserSetSelector to the non-volatile memory of the device.	W

16.2.11 File access control

Normally, the user must not edit these features. They are used by system GUI functions such as firmware update and PC side calibration.

Table 36: File access control standard SFNC selectors

Selector	Type	Description
FileSelector	enum	Selects the target file in the device. Values: Testfile Update CurrentLog AllCrashLogs FirmwareUpdateLog Calibration CalibrationCurved UserFile UserSet1-5
FileOperationSelector	enum	Selects the target operation for the selected file in the device. Values: Open Close Write Read Delete

Table 37: File access control standard SFNC parameters

Parameter	Type	Description	Access
FileAccessOffset[FileSelector][FileOperationSelector]	int	Controls the Offset of the mapping between the device file storage and the FileAccessBuffer.	RW
FileAccessLength[FileSelector][FileOperationSelector]	int	Controls the Length of the mapping between the device file storage and the FileAccessBuffer.	RW
FileOperationStatus[FileSelector][FileOperationSelector]	enum	File operation execution status. Values: Success Failure	R
FileOperationResult[FileSelector][FileOperationSelector]	int	File operation result. For Read or Write operations, the number of successfully read/written bytes is returned.	R
FileOpenMode[FileSelector]	enum	Selects the access mode in which a file is opened in the device. Values: Read Write ReadWrite	RW
FileSize[FileSelector]	int	The size of the selected file, in bytes.	RW

Table 38: File access control standard SFNC commands

Command	Description	Access
FileOperationExecute[FileSelector][FileOperationSelector]	Executes the operation selected by FileOperationSelector on the selected file.	W

16.2.12 Chunk data control

Table 39: Chunk data control standard SFNC selectors

Parameter	Type	Description
ChunkSelector	enum	Selects which Chunk metadata feature to control. Values: Scan3dOutputMode Scan3dDistanceUnit Scan3dAxisMin Scan3dAxisMax Scan3dCoordinateScale Scan3dCoordinateOffset Scan3dInvalidDataValue Scan3dCoordinateReferenceValue Timestamp OvertriggerCount FrameTriggerActive LineTriggerActive EncoderResetActive EncoderA EncoderB EncoderValue FrameTriggerCounter Height
ChunkScan3dCoordinateSelector	enum	Selects which Coordinate to retrieve data from. Values: CoordinateA CoordinateB CoordinateC
ChunkScan3dCoordinateReferenceSelector	enum	Selector for transform values. Values: RotationX RotationY RotationZ TranslationX TranslationY TranslationZ

Table 40: Chunk data control standard SFNC parameters

Parameter	Type	Description	Access
ChunkModeActive	bool	Activates the inclusion of Chunk data in the payload of the image.	RW
ChunkEnable[ChunkSelector]	bool	Indicates whether the selected Chunk metadata is included in the payload of the image.	R
ChunkScanLineSelector	int	Index for vector representation of one chunk value per line in an image.	R
ChunkWidth	int	The width of the image included in the payload.	R

Parameter	Type	Description	Access
ChunkScan3dOutputMode	enum	Returns the Calibrated Mode of the payload image. Values: UncalibratedC CalibratedC CalibratedAC CalibratedC_Linescan CalibratedAC_Linescan RectifiedC RectifiedC_Linescan	R
ChunkScan3dDistanceUnit	enum	Returns the Distance Unit of the payload image. Values: Millimeter Pixel	R
ChunkScan3dAxisMin[AxisSelector]	float	Minimum valid transmitted coordinate value of the selected axis.	R
ChunkScan3dAxisMax[AxisSelector]	float	Maximum valid transmitted coordinate value of the selected axis.	R
ChunkScan3dCoordinateScale[AxisSelector]	float	Returns the Scale for the selected coordinate axis of the image included in the payload.	R
ChunkScan3dCoordinateOffset[AxisSelector]	float	Returns the Offset for the selected coordinate axis of the image included in the payload.	R
ChunkScan3dInvalidDataFlag[AxisSelector]	bool	Returns if a specific non-valid data flag is used in the data stream.	R
ChunkScan3dInvalidDataValue[AxisSelector]	float	Returns the Invalid Data Value used for the image included in the payload.	R
ChunkScan3dCoordinateReferenceValue[ReferenceSelector]	float	Transform value.	R
ChunkTimestamp[LineSelector]	int	Timestamp of the line start for each scan line included in the payload (1 GHz clock).	R
ChunkEncoderValue[LineSelector]	int	The encoder counter's value when the profile exposure is triggered for each scan line included in the payload.	R
ChunkHeight	int	The height/number of scan lines of the image included in the payload.	R

Table 41: Chunk data control custom parameters

Parameter	Type	Description	Access
ChunkOvertriggerCount[LineSelector]	int	1 if a line trigger has been requested before the sensor was actually ready for a new trigger.	R
ChunkFrameTriggerActive[LineSelector]	int	1 if frame trigger pin (IO pin 1) is high, otherwise 0.	R
ChunkLineTriggerActive[LineSelector]	int	1 if line trigger pin (IO pin 2) is high, otherwise 0.	R
ChunkEncoderResetActive[LineSelector]	int	1 if Encoder Reset (IO pin 3) is high, otherwise 0.	R
ChunkEncoderA[LineSelector]	int	Value 0 (for low) or 1 (for high) at encoder channel A.	R
ChunkEncoderB[LineSelector]	int	Value 0 (for low) or 1 (for high) at encoder channel B.	R
FrameTriggerCounter	int	The number of rising edges that have arrived on the frame trigger I/O pin at the point of triggering the first line in the frame. The counter is reset at device boot or with the Counter-Reset[CounterSelector=FrameTriggerCounter] command.	R

16.2.13 Test control

Normally, the user must not edit this feature. It is only intended for standard compliance testing.

Table 42: Test control standard SFNC parameters

Parameter	Type	Description	Access
TestPayloadFormatMode	enum	Tests the device's pending acknowledge feature. Values: Off MultiPart TestPendingAck	RW

Table 43: Test control standard SFNC command

Command	Description	Access
TestEventGenerate	Generates a Test Event. Used for GenICam standard compliance event testing.	W

16.2.14 Transport layer control

The user cannot edit these features.

Table 44: Transport layer control standard SFNC parameters

Parameter	Type	Description	Access
PayloadSize	int	Provides the number of bytes transferred for each image or chunk on the stream channel.	R

16.2.14.1 GigEVision

Normally, the user must not edit these features. Changing them can cause errors.

Table 45: GigEVision control standard SFNC parameters

Parameter	Type	Description	Access
GevMCPHostPort	int	Controls the port to which the device must send messages.	R
GevMCDA	int	Controls the destination IP address for the message channel.	R
GevMCTT	int	Provides the transmission timeout value in milliseconds.	R
GevMCRC	int	Controls the number of retransmissions allowed when a message channel message times out.	R
GevMCSP	int	Indicates the source port for the message channel.	R
GevSCPHostPort	int	Controls the port of the selected channel to which a GVSP transmitter must send data stream or the port from which a GVSP receiver may receive data stream.	R
GevSCSPPacketSize	int	Specifies the stream packet size, in bytes, to send on the selected channel for a GVSP transmitter (set by negotiation between the device and PC during connection) or specifies the maximum packet size supported by a GVSP receiver.	R(W)
GevSCPD	int	Controls the delay (in GevTimestampTickFrequency) to insert between each packet for this stream channel. This feature can be used as a crude flow-control mechanism if the application or the network infrastructure cannot keep up with the packets coming from the device.	RW
GevSCDA	int	Controls the destination IP address of the selected stream channel to which a GVSP transmitter must send data stream or the destination IP address from which a GVSP receiver may receive data stream.	R
GevSCSP	int	Indicates the source port of the stream channel.	R
MultiPartSupport	bool	Manual Enable/Disable of multipart-configuration bit (25) in SCCFGx register for testing.	RW
GevMACAddress	int	MAC address of the logical link.	R

Parameter	Type	Description	Access
GevCurrentIPConfigurationPersistent IP	bool	Controls whether the PersistentIP configuration scheme is activated on the given logical link.	RW
GevCurrentIPConfigurationDHCP	bool	Controls whether the DHCP IP configuration scheme is activated on the given logical link. The device falls back to Link Local Address in case no DHCP response is received after several timed out requests.	RW
GevCurrentIPConfigurationLLA	bool	Controls whether the Link Local Address IP configuration scheme is activated on the given logical link.	R
GevCurrentIPAddress	int	Reports the IP address for the given logical link.	R
GevCurrentSubnetMask	int	Reports the subnet mask of the given logical link.	R
GevCurrentDefaultGateway	int	Reports the default gateway IP address to be used on the given logical link.	R
GevPersistentIPAddress	int	Controls the Persistent IP address for this logical link. It is only used when the device boots with the Persistent IP configuration scheme.	RW
GevPersistentSubnetMask	int	Controls the Persistent subnet mask associated with the Persistent IP address on this logical link. It is only used when the device boots with the Persistent IP configuration scheme.	RW
GevPersistentDefaultGateway	int	Controls the persistent default gateway for this logical link. It is only used when the device boots with the Persistent IP configuration scheme.	RW
GevDiscoveryAckDelay	int	Indicates the maximum randomized delay the device will wait to acknowledge a discovery command.	R

Table 46: GigEVision control custom commands

Command	Description	Access
GevNetworkInterfaceReconfigure	Reconfigures the network interface according to the settings made. If the settings have changed the connection will be lost to the device and it may get a new IP address.	RW

16.3 Recommended network card settings

Due to the large amount of data that Ruler3000 delivers per second, it is required to connect the camera(s) to the PC using a separate Gigabit Ethernet network, without other interfering traffic.

The Network interface card (NIC) must support Gigabit Ethernet, and it is recommended that the NIC supports Ethernet Jumbo frames. Ethernet Jumbo frames are frames with more than 1500 bytes of Ethernet payload. Sending and receiving Ethernet Jumbo Frames can give a performance increase due to lower PC CPU usage.

The Ruler3000 camera has mainly been tested using network interface cards from Intel. See the tables below for recommended network settings. Note that the names of the settings may differ depending on NIC or driver version.

Receive buffers	
Recommended setting	512 or more
Default setting	256
Maximum setting	2048

Jumbo frames	
Recommended setting	>4200
Default setting	disabled
Maximum setting	16128

When using Jumbo frames the camera can support up to 4096 bytes of image data in each data package, which corresponds to 4200 bytes per Ethernet frame.

Camera IP settings

The GigE Vision® standard dictates that the factory default setting for devices is IP configuration using DHCP. If no DHCP server is found, the default for devices is to assign a Link-Local Address (LLA), also called a Zero Configuration IP, on the format 169.254.x.y.

It is recommended to define a persistent IP address which can be used when a device boots.

Ruler3000 also supports setting a static IP using the GigE Vision® forceIP method. This IP address is not persistent, which means it is lost at power-off, see ["Editing IP settings", page 65](#).

Symptoms of possible problem

Receive buffers	Symptoms of too low setting: Multiple consecutive packets are lost, e.g. 31 consecutive packets are lost. Symptoms of too high setting: Use of memory increases.
Jumbo frames	Symptoms of too low setting: The camera will use a smaller frame size, which implies higher CPU load on the PC. Symptoms of too high setting: If you use a switch that is unable to support Jumbo Frames connected between the camera and the PC, it is impossible to receive streaming data from the camera.
IP settings	If the device and the NIC are not connected to the same DHCP server, or only one end is connected to a DHCP server, the device can not assign a correct IP.

16.3.1 Connecting multiple cameras

When you connect multiple cameras to the PC, you get the best performance if each camera is connected to a separate NIC. The camera and the NIC must be on the same subnet. You can also connect multiple cameras to the same NIC, using a switch. In that case, both the NIC and all the cameras that are connected to it must be on the same subnet.

If the PC has multiple NICs, all the NICs must be on different subnets. The subnet is indicated by the third section of the IP address, see an example in the figure below. This figure also shows that other equipment, such as network printers, should be connected to a separate NIC.

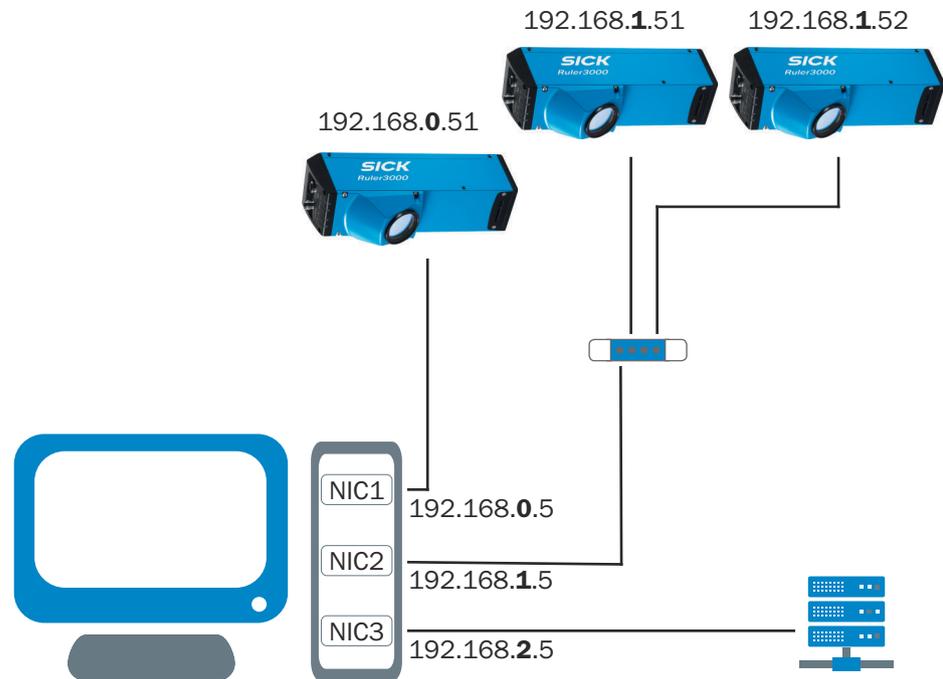


Figure 88: PC connected to three cameras and external network, using three separate NICs and one switch

16.4 Connecting encoders

The RS-422 inputs on the camera have internal termination, which makes it possible to connect an RS-422 encoder to the camera without requiring any external termination. With this termination it is possible to directly connect up to two cameras to the same encoder.

Use an incremental encoder with two channels (A+/A- and B+/B-) and connect all four outputs. It is not possible to connect an index channel (Z) to the camera.

The drawing below shows an example for connecting one SICK Stegmann RS-422 encoder (DRS-60 with TTL output levels) to two cameras.

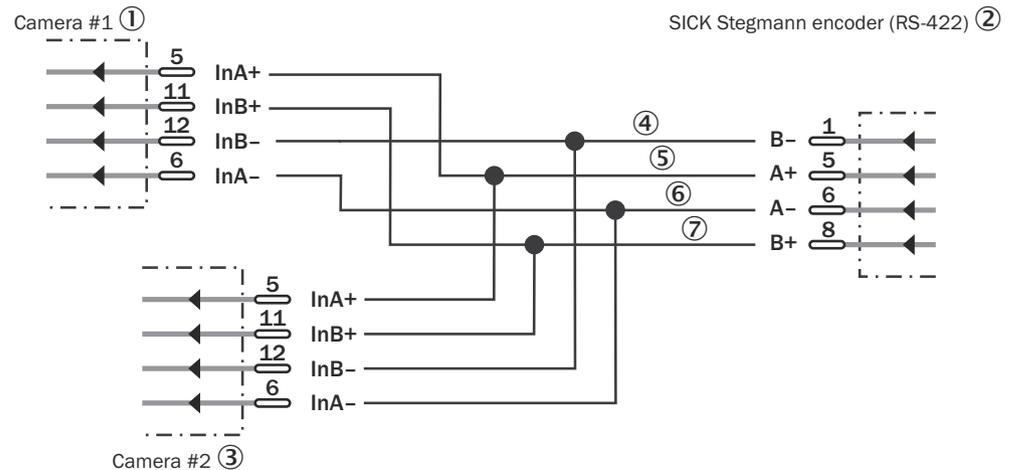


Figure 89: Wiring example

- ① Camera #1
- ② SICK Stegmann encoder (RS-422)
- ③ Camera #2

- ④ Phase2 RS-422-
- ⑤ Phase1 RS-422+
- ⑥ Phase1 RS-422-
- ⑦ Phase2 RS-422+

16.5 EU declaration of conformity/Certificates

The EU declaration of conformity and other certificates can be downloaded from the Internet at:

- www.sick.com/Ruler3000

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