

LMS1104C-111031S01

2D LiDAR sensors

SICK
Sensor Intelligence.



Described product

LMS1104C-111031S01

Manufacturer

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Original document

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1 About this document

1.1 Information on the operating instructions

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

Prerequisites for safe work are:

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

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



NOTE

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

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

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

1.2 Explanation of symbols

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



DANGER

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



WARNING

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



CAUTION

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



NOTICE

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



NOTE

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

1.3 Further information

More information can be found on the product page.

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

The following information is available depending on the product:

- Data sheets
- This document in all available language versions
- CAD files and dimensional drawings
- Certificates (e.g., declaration of conformity)
- Other publications
- Software
- Accessories

2 Safety information

2.1 Intended use

The LMS1000 2D LiDAR sensor features 1 scan plane and is designed for the following applications:

- Detection of objects during continuous output of measurement data as required.
- Field monitoring of freely defined areas with signaling of object detection via digital outputs.

It is suitable for applications which demand precise, non-contact optical measuring contours and dimensioning.

Typical areas of application are e.g. profile detection in traffic monitoring, access monitoring, pass-through monitoring.

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

2.2 Improper use

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

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



WARNING

Danger due to improper use!

Any improper use can result in dangerous situations.

Therefore, observe the following information:

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

2.3 Cybersecurity

Overview

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

You will find further information at www.sick.com/psirt, e.g.:

- General information on cybersecurity
- Contact option for reporting vulnerabilities
- Information on known vulnerabilities (security advisories)

2.4 Limitation of liability

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

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

2.5 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.

2.6 Requirements for skilled persons and operating personnel



WARNING

Risk of injury due to insufficient training.

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

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

The following qualifications are required for various activities:

Table 1: Activities and technical requirements

Activities	Qualification
Mounting, maintenance	<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
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 specific hazards

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



CAUTION

Optical radiation: Class 1 Laser Product

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

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

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

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



WARNING

Electrical voltage!

Electrical voltage can cause severe injury or death.

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



WARNING

Risk of injury and damage caused by potential equalization currents!

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

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

3 Product description

3.1 Scope of delivery

The delivery of the device includes the following components:

Table 2: Scope of delivery

Item	Component	Comment
1	Device in the version ordered	Depending on version Without connecting cables and brackets
1	Set of protective caps for electrical connections	Attached to the connections
1	Printed safety notes, multilingual	Brief information and general safety notes

3.2 Status indicators

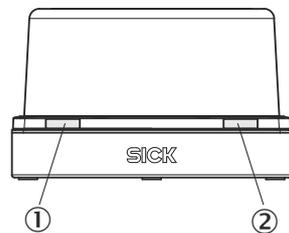


Figure 1: Status indicators

- ① LED1
- ② LED2

LED1 (color)	LED2 (color)	Description
● (Red)	● (Red)	
⦿ (Red)	⦿ (Red)	Fatal error
● (Green)	● (Green)	On / Ready for operation
⦿ (Yellow)	● (Green)	Contamination warning
⦿ (Yellow)	⦿ (Red)	Contamination error
● (Green) ● (Yellow) ● (Red)	● (Green) ● (Yellow) ● (Red)	Identifying the device

● = illuminated; ⦿ = flashing

3.3 Type code

Type code structure

LMS abccd – efg hij

Position	Description	Characteristic
-	Device name type	LMS: Laser Measurement Sensor
a	Device type	1: LMS1000
b	Version (10% range & field of view (FOV))	1: 16m @10%, FOV 275 °
c	Module (sender and receiver units (SRU))	04: 4 SEE (-2.5°; 0°; 2.5°; 5°)
d	Application	C: Combined (detection & ranging)

Position	Description	Characteristic
-		
e	Housing version	0: IP65 enclosure rating 1: IP67 enclosure rating 9: Special version
f	Connection	1: Rotatable connector, 3 x M12 9: Special version
g	Version	1: Standard 9: Special version
h	Laser type	0: Laser class 1, infrared
i	Motor frequency	3: 37.5 Hz
j	Color tone / label	0: blue (RAL 5012) 1: gray (RAL 7042)

3.4 Type label

The type label gives information for identification of the device.

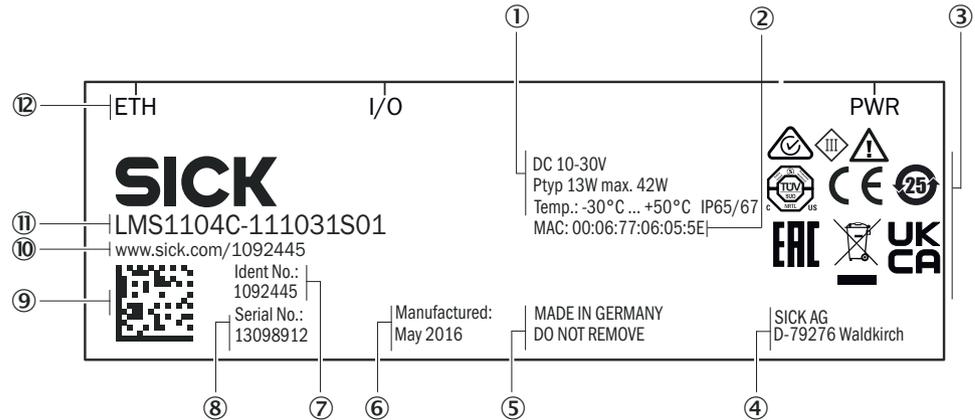


Figure 2: LMS1000 type label (example)

- ① Voltage supply, typical power, max. power, operating temperature, enclosure rating
- ② MAC address
- ③ Conformity mark/certification mark, symbol: Observe the operating instructions!
- ④ Manufacturer
- ⑤ Production location, note: Do not remove type label
- ⑥ Production date
- ⑦ Part number
- ⑧ Serial number
- ⑨ Data Matrix code with product data and link to product page
- ⑩ Web address of product page
- ⑪ Type code
- ⑫ Labeling of connections

3.5 Principle of operation

3.5.1 Measurement principle

The device is an optoelectronic LiDAR sensor that contactlessly scans the outline of its surroundings with the help of laser beams. The device measures its surroundings in two-dimensional polar coordinates, relative to its measurement origin. This is marked by a circular indentation in the center of the optics cover. If a laser beam strikes an object, the position of that object is determined in terms of distance and angle.

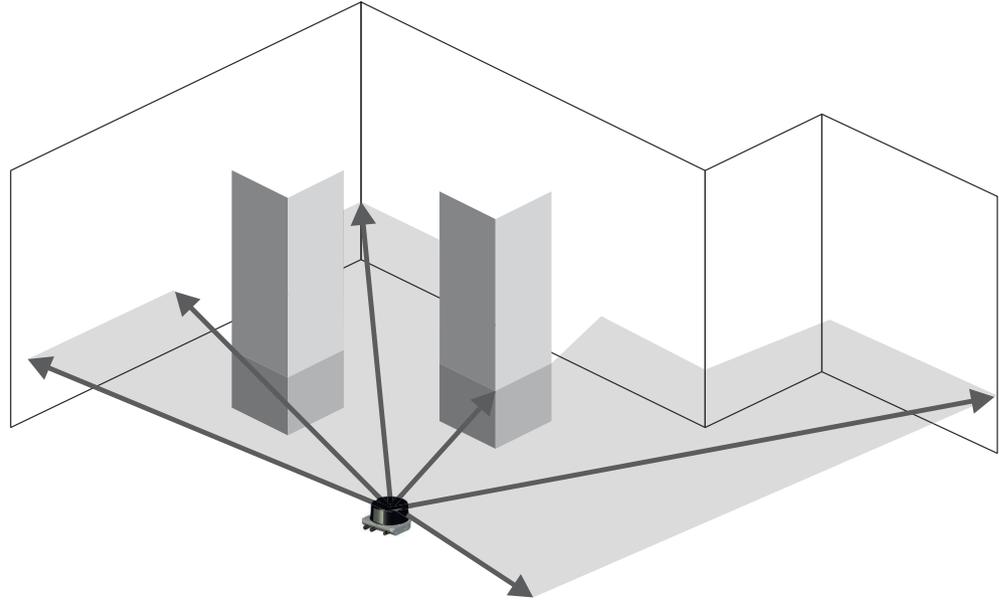
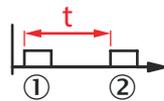


Figure 3: LiDAR sensor with one scan plane

3.5.2 Distance measurement

The device emits beams pulsed by a laser diode. If the laser beam is reflected by an object, the reflected beam is received by the sensor.

The distance to the object is calculated on the basis of the time that the pulsed light beam requires to be reflected and received by the sensor.



- ① Send pulse
- ② Receive pulse

The device uses SICK's own HDDM+ (High Definition Distance Measurement plus) technology. With this measurement process, a measured value is formed statistical evaluation of multiple single pulses. The multi-pulse feature of HDDM+ evaluates up to 165000 echoes per second. Every single HDDM+ measured value output therefore provides even more information because it is not just composed of a single time-of-flight measurement, but includes evaluated information from numerous pulses. In this process, the digitized echoes are compiled into data packages which overlap during evaluation. This ensures a significantly more stable time and distance measurement.

3.5.3 Direction measurement

The laser beams are emitted using internally rotating sender-receiver units (SRUs) and scan the surroundings orbitally. The received measured values are assigned to the associated angular cut and thus to the direction.

3.5.4 Impact of object surfaces on the measurement

The received signal from a perfectly diffuse reflection from a white surface (diffuse Lambertian reflector) corresponds to a remission of 100%. By this definition, surfaces that reflect the light in bundles (specular surfaces, reflectors) have remissions of over 100%.

Reflection

Most surfaces produce a diffuse reflection of the laser beam in all directions. The structure (smooth or rough), shape (flat or curved), and color (light or dark) of the surface determine how well the laser beam is reflected.

On very rough surfaces, a large proportion of the energy is lost due to absorption. Curved surfaces produce a higher diffusion. Dark surfaces reflect the laser beam worse than light ones (brilliant white plaster reflects approx. 100% of the light, while black foam rubber reflects approx. 2.4%). The aforementioned surface characteristics can reduce the scanning range of the device, in particular for surfaces with low remission values.

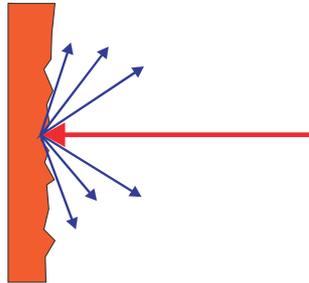


Figure 4: Reflection of light on the surface of the object

Angle of reflection

The angle of reflection corresponds to the angle of incidence. If the laser beam hits a surface at right angles, the energy is optimally reflected. If the laser beam hits a surface at an oblique angle, energy and range are lost accordingly.

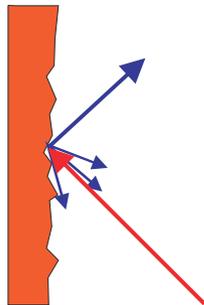


Figure 5: Angle of reflection

Retroreflection

If the reflective energy is greater than 100%, the beam is not reflected diffusely in all directions; instead it is reflected in a targeted way (retroreflection). Thus a large part of the emitted energy can be received by the laser distance measurer. Plastic reflectors (cat's eyes), reflective tape, and triple prisms have these properties.

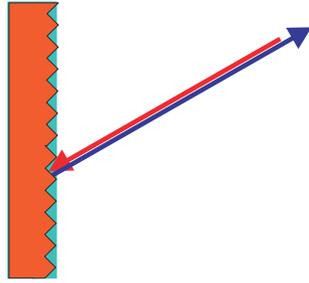


Figure 6: Retroreflection

Reflective surfaces

The laser beam is almost completely deflected on reflective surfaces. This means that an object hit by the deflected beam may be detected instead of the reflective surface.

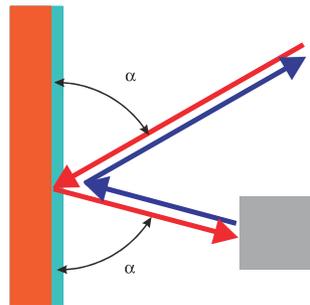


Figure 7: Specular surfaces

Small objects

Objects that are smaller than the diameter of the laser beam cannot reflect the laser light's full energy. The portion of the light beam that does not reach the object is lost. If all of the light reflected to the sensor is insufficient, the object may not be detected.

The portion of the light that does not reach the front object can be reflected by a larger object in the background. If all of the light reflected to the sensor is sufficient, this object is detected. This can lead to a corruption of the measured value.

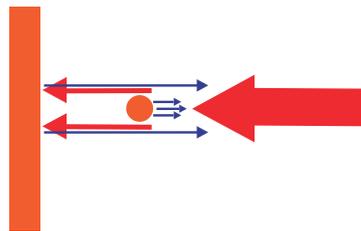


Figure 8: Object smaller than the laser beam diameter

3.5.5 Scanning range

The scanning range of the device depends on the remission of the object to be detected. The better a surface reflects the incident beam back to the device, the greater the scanning range of the device.

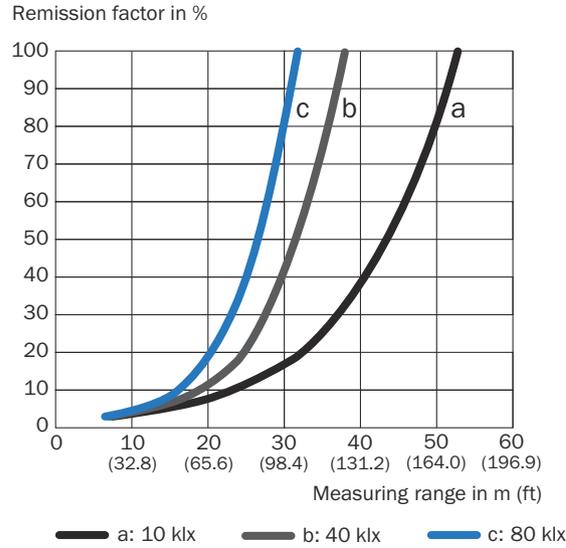


Figure 9: Scanning range as a function of the remission factor for various ambient light influences (no filter activated; no affect from fog, rain or dust)

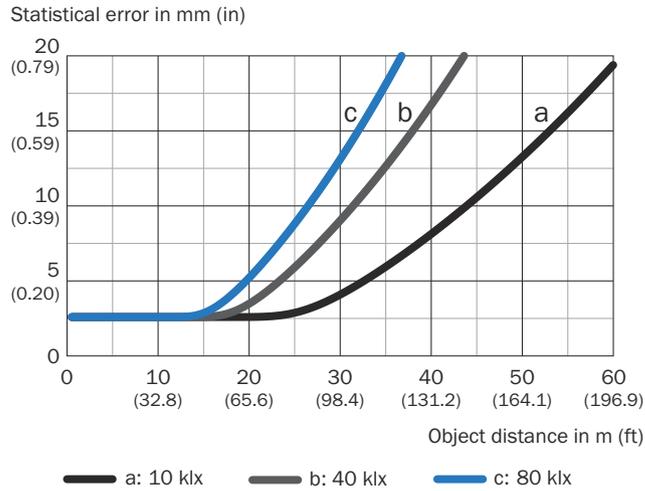


Figure 10: Statistical error for white objects as a function of object distance for various ambient light influences

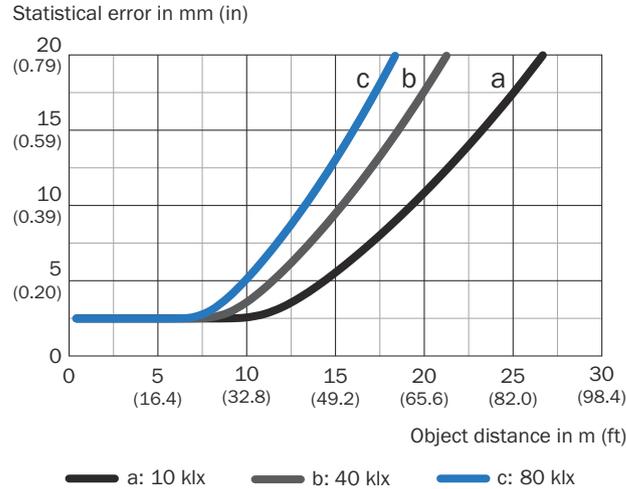


Figure 11: Statistical error for **black objects** as a function of object distance for various ambient light influences

3.5.6 Object sizes

As the distance from the device increases, the laser beam expands. As a result, the diameter of the light spot on the surface of the object increases.



Figure 12: Beam expansion

- ① Expanded laser beam
- ② Optical axis

Values required to calculate the light spot size:

- Light spot size on the device cover: 7 mm (rounded up)
- Divergence of 1 light spot: 0.59 deg (10.4 mrad)
- HDDM+ supplement (1 spot comprises several superimposed individual pulses): 1.50 deg (26.2 mrad)

Formula for calculating the light spot width:

(Light spot divergence [mrad] + HDDM+ supplement [mrad]) x distance [mm] + light spot size on the device cover [mm] = light spot width [mm]

Example calculation of the light spot width at a distance of 16 m (16000 mm):

$$(10.4 \text{ mrad} + 26.2 \text{ mrad}) * 16,000 \text{ mm} + 7 \text{ mm} = 592.6 \text{ mm}$$

Formula for calculating the height of the light spot:

Light spot divergence [mrad] x Distance [mm] + Light spot height at the n device cover [mm] = Light spot width [mm]

Example calculation of the light spot height at a distance of 16 m (1,600 mm):

$$10.4 \text{ mrad} * 16,000 \text{ mm} + 7 \text{ mm} = 173.4 \text{ mm}$$

Formula for calculating the minimum object size:

(Light spot divergence [mrad] + angular resolution [mrad]) x distance [mm] + light spot height on the device cover [mm] = minimum object size [mm]

Example calculation of the minimum object size at a distance of 16 m (16,000 mm):

$$\text{Angular resolution: } 0.75^\circ \rightarrow 13.1 \text{ mrad}$$

$$(10.4 + 26.2 + 13.1 \text{ mrad}) * 16,000 \text{ mm} + 7 \text{ mm} = 802 \text{ mm}$$

Calculation example with interlaced mode:

- 2-fold: $(10.4 + 26.2 + 13.1/2) * 16,000 \text{ mm} + 7 \text{ mm} = 697 \text{ mm}$
- 4-fold: $(10.4 + 26.2 + 13.1/4) * 16,000 \text{ mm} + 7 \text{ mm} = 645 \text{ mm}$

Minimum object size in mm (inch) ①

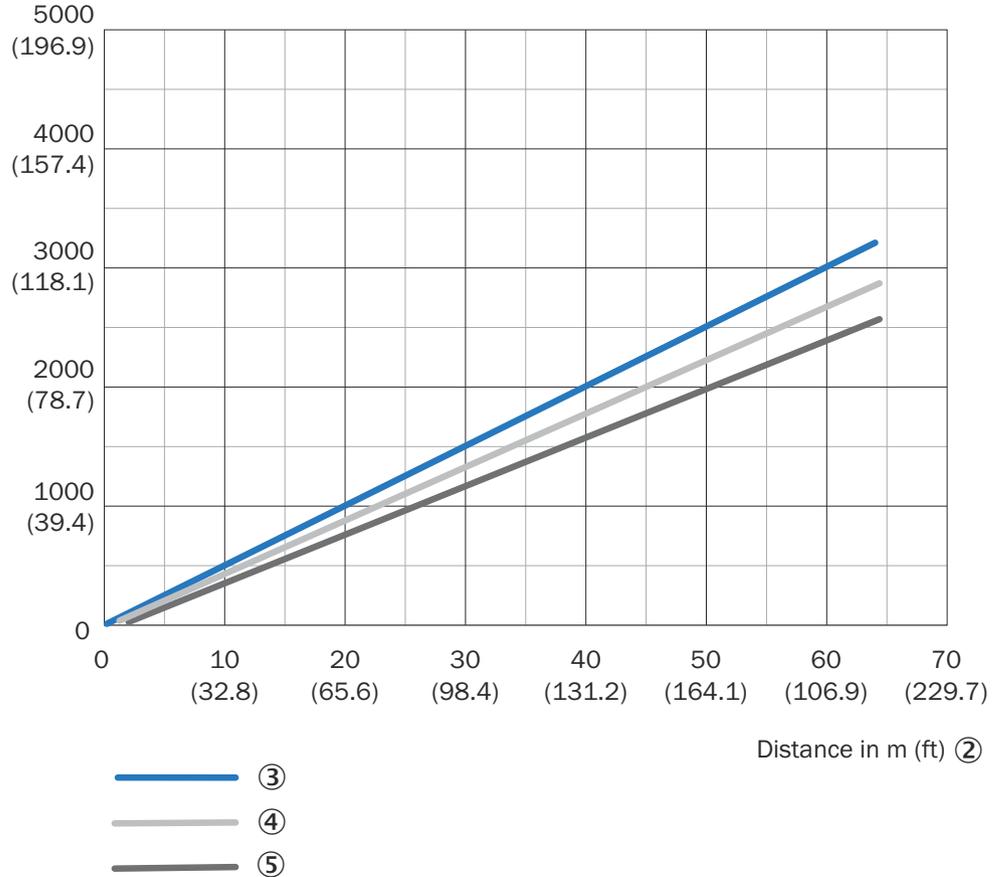


Figure 13: Minimum object size as a function of distance

- ① Minimum object size in mm (inches)
- ② Distance in m (ft)
- ③ Minimum object size
- ④ Minimum object size (2-fold interlaced mode)
- ⑤ Minimum object size (4-fold interlaced mode)



NOTE

For reliable measurement, in particular when using the device to output measured values, the laser needs to hit the object several times. Therefore, the object either needs to be larger than the minimum object size, or both the LiDAR sensor and the object must not be moving.

3.5.7 Multi-echo analysis

The distance between the device and an object is calculated via the time-of-flight of the emitted pulse. The device can evaluate up to three echo signals for each measuring beam to deliver reliable measurement results, even under adverse ambient conditions.

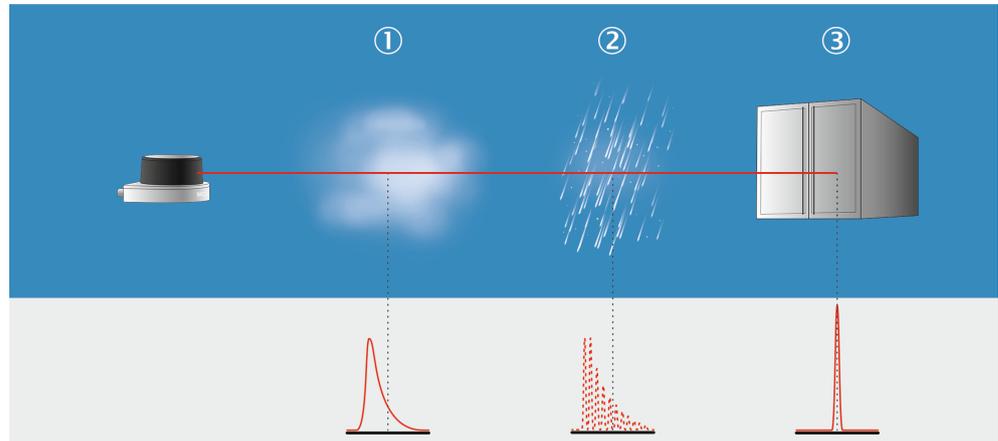


Figure 14: Multi-echo analysis: example industrial application for ports, cranes, and traffic.

- ① Fog
- ② Rain
- ③ Measuring object

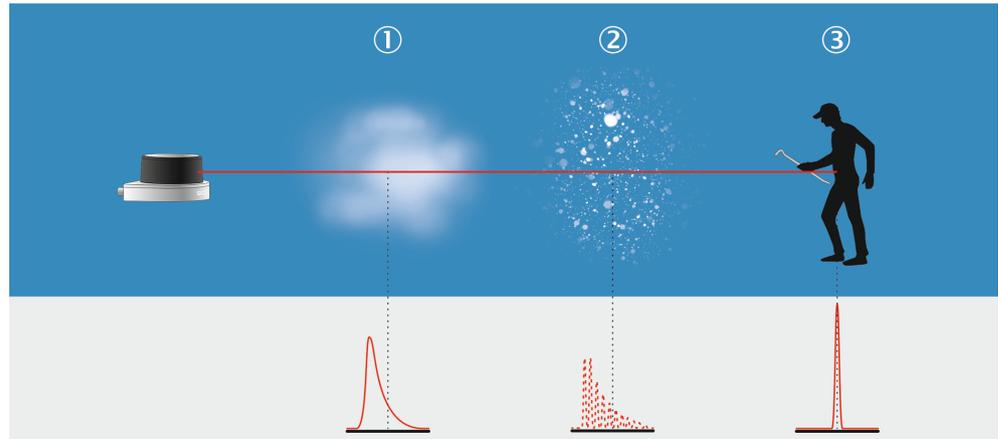


Figure 15: Multi-echo analysis: example industrial application for building management.

- ① Fog
- ② Snow
- ③ Measuring object

3.5.8 Filter

By using digital filters to pre-process and optimize the measured distance values, the device can be tailored to the specific requirements of the respective application. This makes it possible to prevent virtually all faults.

You can arbitrarily combine the filters. If several filters are active, then the filters are applied sequentially to the results of the preceding filter. Processing occurs in the following sequence: echo filter, edge filter, particle filter, median filter, mean filter. It should be noted, however, that the measurement data output may be delayed due to the multiple calculation steps.

For many applications, it is useful to use a combination of the median filter and the mean filter. The median filter can eliminate the larger outliers, which “smooths” the scan line. The values calculated by the median filter are then averaged over a configurable number of scans by the mean filter.

The active filter functions affect the outputted measured values. It is not possible to recalculate the original measured values from the filtered output values.

3.5.8.1 Fog filter

The fog filter enables the device to eliminate unwanted echoes at close range. This considerably lowers the probability of false activations at close range in fog.

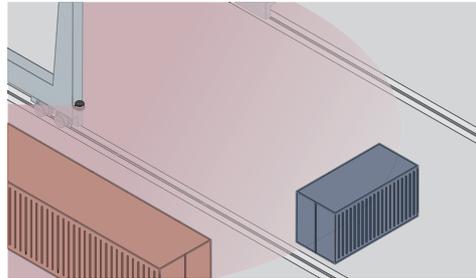


Figure 16: Without the fog filter: objects are difficult to detect through the fog due to reflections.

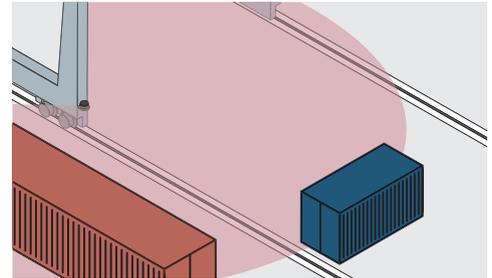


Figure 17: Using the fog filter: objects can be detected reliably because unwanted echoes are screened out.

3.5.8.2 Echo filter

The echo filter screens out unwanted measurement data and signals caused by edge hits, rain, dust, snow and other ambient conditions.

You can set whether the first, the last, or all three echoes are output.

The other pulses triggered by undesirable ambient conditions are not taken into account.

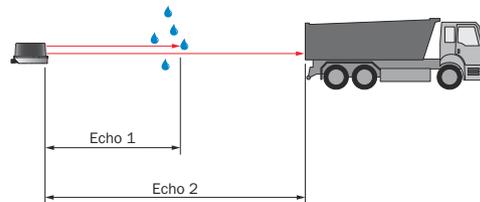


Figure 18: Without the echo filter: The device receives unwanted echoes from ambient conditions such as rain.

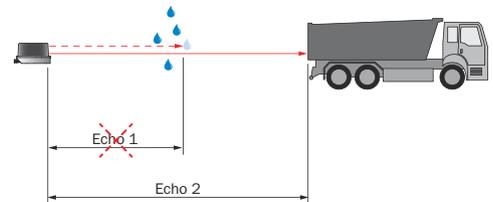


Figure 19: Using the echo filter (setting: last echo): the device screens out unwanted echoes from ambient conditions as per the settings chosen.

3.5.8.3 Particle filter

The particle filter blanks small, irrelevant reflection pulses in dusty environments and in rain or snow which are caused by dust particles, raindrops, snowflakes or the like.

In doing so, successive scans are continuously evaluated in order to detect static objects.



NOTE

If the particle filter is activated, measurement data output or reaction of the field evaluation is delayed by one scan.

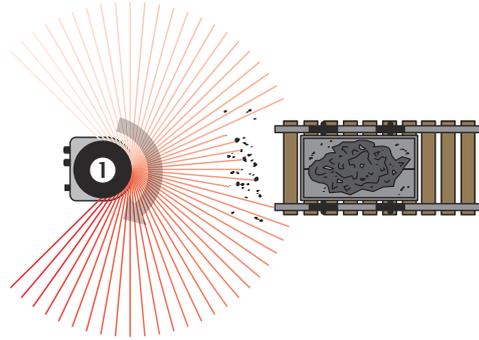


Figure 20: Without the particle filter: Violation of the contour due to dust particles in the vicinity of the object.

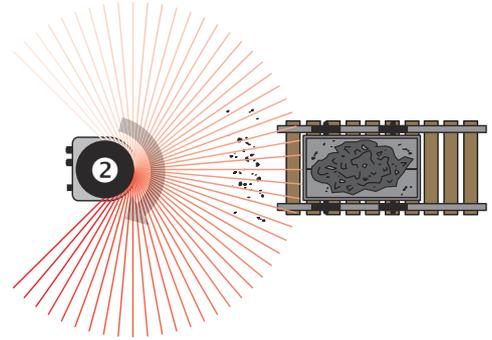


Figure 21: Using the particle filter: The response to dust particles in the detection field is delayed by one scan. Particles can thereby be blanked.

3.5.8.4 Median filter

This filter is suitable for excluding individual outliers from the calculation of an average value.

The moving median filter sorts the measured values according to their size and selects the middle value from this sequence. The values taken into consideration are defined by a matrix, the size of which is configurable.

A 3 x 3 matrix, for example, takes into consideration 9 measured values consisting of the distance values of a point and its two neighboring points, along with the distances values of these points determined from the preceding and following scan. The fifth largest measured value is outputted as the distance value.

Median calculation: 850 (lowest value) | 850 | 950 | 1,100 | **1150** (median) | 1,150 | 1,200 | 1,200 | 1,250 (highest value)

Table 3: Example: Median for scan 2 and angle 3 (3 x 3 matrix: scan 1 to 3, angle 2 to 4)

	Angle (distance values)					
Scan	1	2	3	4	5	...
1	0	0	850	1100	1150	...
2	0	0	950	1200	1250	...
3	0	0	850	1150	1200	...
...

Median calculation: 0 (lowest value) | 0 | 0 | 850 | **850** (median) | 950 | 1,100 | 1,150 | 1,200 (highest value)

Table 4: Example: Median for scan 2 and angle 4 (3 x 3 matrix: scan 1 to 3, angle 3 to 5)

	Angle (distance values)					
Scan	1	2	3	4	5	...
1	0	0	850	1100	1150	...
2	0	0	950	1200	1250	...
3	0	0	850	1150	1200	...
...

Median calculation: 850 (lowest value) | 850 | 950 | 1,100 | **1150** (median) | 1,150 | 1,200 | 1,200 | 1,250 (highest value)

3.5.8.5 Average filter

Using the mean filter, a blockwise (not moving) arithmetic average is calculated from the configured number of scans and then outputted. The big advantage when using this filter: Potential noise, i.e. minimal deviation of values, is reduced, which also lowers the quantity of data.

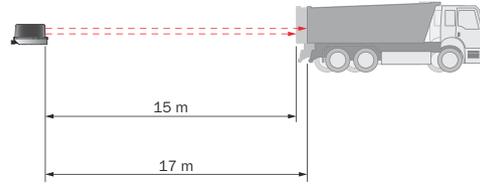


Figure 22: Without the mean filter: The device detects and processes all received signal values.

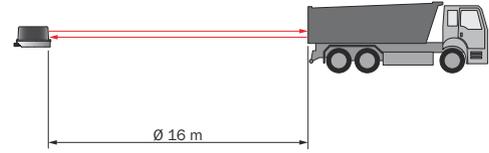


Figure 23: Using the mean filter: The device calculates an average value from several signal values.

3.5.8.6 Edge filter

The edge filter eliminates erroneous or extreme distance values at edges. These arise as a result of laser light that partially hits an object in the front and partially hits an object farther away, or due to too little light remission at the object itself, see "Impact of object surfaces on the measurement", page 13. The filter evaluates the difference in distance between adjacent points.

When the edge filter is activated, the device sets the distance value to 0 at each edge (values in **bold**) as soon as the parameterized neighbor distance has been exceeded in the edge filter area.

Table 5: Example: Measured values with and without edge filter

	Angle (distance values in mm)							
Scan	1	2	3	4	5	6	7	...
1, not filtered	0	750	1145	1150	1147	1500	0	...
1, filtered	0	0	1145	1150	1147	0	0	...

The edge filter enables points to be entirely suppressed at the outer edges of the object. In this case, the width of an object is detected by up to 2× angular resolution too narrow.

Maximum neighboring distance

The maximum distance difference in millimeters between two measuring points on the edge can be parameterized. A measuring point on the edge that has a greater distance difference than the parameterized value to its adjacent measuring point is taken into account.

Maximum edge filter range (range limitation)

The maximum distance can be set up to 16,000 mm. The measuring points in the parameterized range are taken into account.

3.5.9 Scan data output

The device has 4 modules, which are aligned with one plane.

The scan data is always output on a per module basis. The data for a specific module is output every 7 ms. The device requires 28 ms to output the data for all four modules.

In the data message, the individual scans are identified by their time stamp.

Data message:

```
<STX>sSN LMDscandata 1 1 10959BF 0 0 347F CABD 1687D5AD 16884966 0 0 F0 0 0 ...  
<STX>sSN LMDscandata 1 1 10959BF 0 0 3480 CABD 1687EFAE 168862C8 0 0 F0 0 0 ...
```

Time stamp:

- Line 1: **1687D5AD**= 378000813 = 378000.813 ms
- Line 2: **1687EFAE**= 378007470 = 378007.470 ms
- Difference = 7 ms (corresponds to a scan data output at 150 Hz)

3.5.10 Interlaced mode

With Interlaced mode, scan data can be acquired with a fine angular resolution even at high scanning frequencies. Recurring sequences of scans are generated.

- Standard: Angular resolution 0.75°, response time: 7 ms
- Dual evaluation: Angular resolution 0.375°, response time: 14 ms
- Quadruple evaluation: Angular resolution 0.1875°, response time: 28 ms

Raw data via LMDscandata telegram

The first scan of a sequence has one scan point more than the other scans of a sequence. This allows the customer to create a scan from a nested sequence. The device sends a telegram after every single scan (rotation). The individual scans of a sequence are not merged into one telegram. The merging of the telegram must be implemented externally.

Field evaluation

For the field evaluation, the device internally merges the interlaced sequence to an internal telegram. This data telegram is then used internally to evaluate the fields. It is not available as an output for the customer.

SOPAS ET

The **field evaluation monitor** shows the merged data of a sequence. The **ScanView** displays the individual scans, similar to the LMDscandata telegrams sent to the customer controller. Normally, the jitter of the angular position of the scan points is detectable.

Parameterization via SOPAS ET

The interlaced mode must be activated via SOPAS ET in the default settings and added as an additional mode in the drop-down menu.

Parameterization via telegram

The interlaced mode can be activated with the **mLMPsetscancfg** telegram. The scanning frequency and angular resolution can be set as parameters.

If the device can only adjust to the desired combination of scanning frequency and angular resolution in interlaced mode, then interlaced mode is activated. If this combination is also possible without interlaced mode, it is deactivated.

Technical limits

The interlaced mode is implemented so that three modules of the device are in the scan field when the angle switches for the next interlaced scan. This causes some of the measuring points in the switching range to cause uneven angular steps. This jitter varies depending on the set interlaced mode. Depending on the selected interlaced mode, the jittering of the individual measuring points only affects a defined angular range and not the entire scan field. The actual angle is transmitted by telegram to show the correct position of the measuring points.

Module 4 is located directly in the blind zone of the scan field, shown in yellow in figure 24. For this reason, synchronizing the interlaced mode to one of the four modules has no effect.

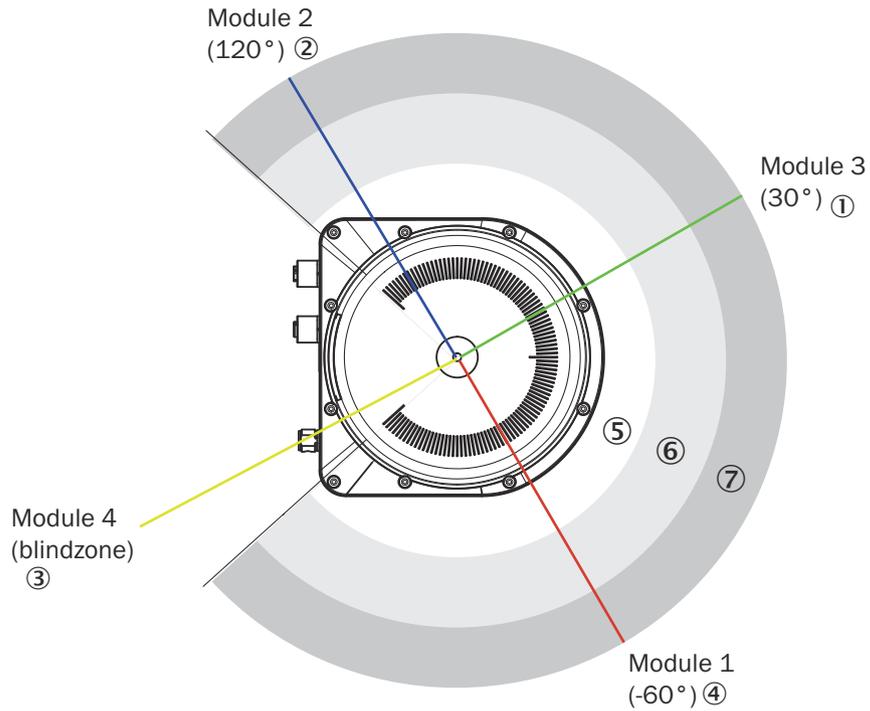


Figure 24: Position of the scan planes when switching to interlaced mode

- ① Module 3 (30°)
- ② Module 2 (120°)
- ③ Module 4 (blind zone)
- ④ Module 1 (-60°)
- ⑤ Near range
- ⑥ Detection zone
- ⑦ Measuring range

- With interlaced mode 2x: $\pm 0.375^\circ$

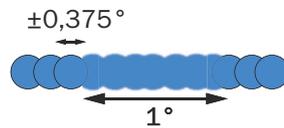


Figure 25: Jittering of the individual measuring points in the affected angular range

- With interlaced mode 4x: $\pm 0.1875^\circ$

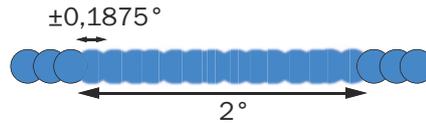


Figure 26: Jittering of the individual measuring points in the affected angular range

Formula for calculating the minimum object size in interlaced mode

For calculation of the minimum object size see "Object sizes", page 16.

With interlaced mode 2x: $(10.4 + 26.2 + 13.1 \text{ mrad} / 2) * 16,000 \text{ mm} + 7 \text{ mm} = 697 \text{ mm}$

With interlaced mode 4x: $(10.4 + 26.2 + 13.1 \text{ mrad} / 4) * 16,000 \text{ mm} + 7 \text{ mm} = 645 \text{ mm}$

3.5.11 RSSI values

RSSI (Received Signal Strength Indicator) is the measure of the signal strength that the device receives. This value is calculated for every measurement. The device therefore provides, for every echo signal, an associated RSSI value for the signal strength.

The RSSI values have a resolution of 8 bits with whole-number values between 1 and 255, where 1 stands for the weakest signal and 254 for the strongest signal (e.g., with one reflector). A value of 255 means "dazzled".

The value 0 (zero) means that the received energy was too low to produce a valid measured value. A valid distance measurement has an RSSI value of at least 1.

If the RSSI value is 0, then no distance measurement is possible. There can be two reasons for this:

- The target object lies outside the sensing range.
- The target object has an extremely low remission.

Please note that white paper can have very similar values as a reflector at a short distance.

The RSSI values are sensor-specific, relative values that can vary slightly between different devices and during the service life of the device.

3.5.12 Contamination indication

The device has a front screen to protect it. This front screen can get dirty. Contamination reduces the energy emitted and received by the laser beam. As a result, scanned objects appear to have a lower remission than they actually have and, with a certain level of contamination, it will no longer be possible to perform measurements.

The contamination is constantly measured by a separate system during operation. A contamination warning is output first for the different degrees of contamination. If the front screen is not cleaned and contamination increases, then a contamination error is output.

Depending on the application in which the device is used, you can choose from different contamination indication strategies.

- **Deactivated:** No indication of contamination.
- **High availability:** Contamination warning and contamination errors are only output when the front screen is uniformly contaminated. This means that all active sectors (e.g., 6 by default) must have reached the limit value for a warning or error.
- **Available:** Contamination warning and contamination errors are output when the front screen is partially contaminated. With this strategy, the front screen is divided into two monitored areas (by default: 3 sectors on the right half and 3 sectors on the left half). Only when all 3 sectors of a monitored area have reached the limit value for warning or error does the contamination warning or contamination error become active.
- **Semi-sensitive:** Contamination warning and contamination errors are output when the front screen is partially and only slightly contaminated. The sensor evaluates all sectors and activates the contamination warning or contamination error using the following strategy:
 - No warning/error: if the sum of sectors with reached limit value for error = 0 and the sum of sectors with reached limit value for warning ≤ 1
 - Warning: if the sum of sectors with reached limit value for error = 1 and the sum of sectors with reached limit value for warning ≥ 2
 - Error: if the sum of sectors with reached limit value for error ≥ 2
- **Sensitive:** Contamination warning and contamination errors are output even when there is just a little or local contamination. When a sector has reached the limit value for warning or error, the contamination warning or contamination error becomes active.

**NOTE**

- The cleaner the application environment is, the lower you can set the contamination indication sensitivity. If a high precision of the measured values is required, the contamination indication must be set to the most sensitive level.
- If a weather protection hood is mounted on the device, the accessory combination used must be communicated to the device in SOPAS ET.

Contamination warnings and contamination errors are displayed on the status indicators of the device [see "Status indicators", page 10](#).

3.5.13 Calculation of the field size for mobile applications

In order to prevent collisions between vehicles, and between vehicles and fixed objects, the switching field must have sufficient length and width.

To calculate the switching field length, you need to take into consideration the stopping distance of the vehicle. This comprises the following:

- the braking distance, which can be found in the vehicle documentation
- the distance covered during the vehicle control's response time, which can be found in the vehicle documentation
- The distance covered during the response time of the LiDAR sensor, ["Technical data", page 50](#).

**NOTE**

- We recommend adding a supplement of at least 100 mm to the protective field length in order to stop the vehicle before a possible collision.
- If retro-reflectors are situated in the path of the vehicles, or if you anticipate that the braking force of the vehicle will diminish over time, you may, under certain circumstances, need to increase the recommended supplement.
- The width of the switching field should cover the vehicle width. You should also configure a supplement of at least 100 mm on every side.

Mounting height

The recommended mounting height for mobile applications is at least 150 mm.

3.5.13.1 Switching field length

You must configure the switching field so that a minimum distance to the vehicle is maintained at all times. This ensures that a vehicle monitored by the LiDAR sensor stops before an object is reached. You can define multiple monitoring cases each with different switching fields. These can be switched over dynamically via static control inputs, for example to adjust the protective field size based on the vehicle speed.

In this kind of application, you must calculate the switching field sizes (in particular the switching field lengths) for all speeds.

The switching field length SL can be calculated using the following formula (guideline values based on a pixel calculation):

$$SL = SA + ZG + ZR + ZB$$

SA = Stopping distance

ZG = General supplement of the LiDAR sensor = 100 mm

ZR = Supplement for application-related influences or the selected application parameters

ZB = Supplement for the decreasing braking force of the vehicle. This can be obtained from the relevant vehicle documentation, or alternatively: 10% of the stopping distance.

Stopping distance SA

The stopping distance comprises the vehicle's braking distance and the distance covered during the response time of the LiDAR sensor and the vehicle control's response time.

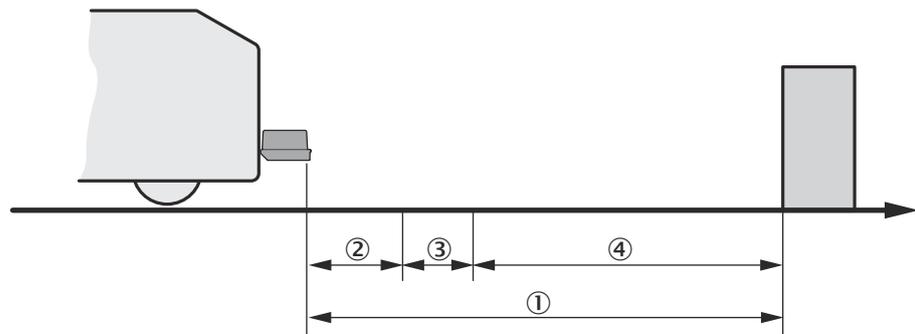


Figure 27: Stopping distance

- ① S_A
- ② S_{AnF}
- ③ S_{AnS}
- ④ S_{Br}



NOTE

Please note that a vehicle's braking distance does not increase linearly with increasing speed, but rather in a squared relationship. This is particularly important if you switch between different-sized switching fields depending on the speed.

How to calculate the stopping distance SA:

$$SA = S_{AnF} + S_{AnS} + S_{Br}$$

S_{AnF} = The distance covered during the vehicle control's response time, which is specified in the vehicle documentation

S_{AnS} = The distance covered during the response time of the LiDAR sensor

S_{Br} = The braking distance, found in the vehicle documentation

The distance S_{AnS} covered during the response time of the LiDAR sensor depends on:

- the response time of the LiDAR sensor
- the maximum speed of the vehicle in your mobile application

For more information on the response time T_S of the LiDAR sensor, see "Technical data", page 50.

How to calculate the distance S_{AnS} covered during the response time of the LiDAR sensor:

$$S_{AnS} = T_S \times V_{max}$$

T_S = Response time of the LiDAR sensor

V_{max} Maximum speed of the vehicle, from the relevant vehicle documentation

The response time T_S of the LiDAR sensor depends on:

- the base response time of the LiDAR sensor
- whether multiple sampling is set
- Filter settings (e.g., particle filter)

ZR supplement

This supplement must be determined on an application-specific basis and taken into account appropriately. The following factors can make it necessary to use a supplement: reflectors or shiny objects on the scan plane, multi-echo analysis, blanking size, device filter (e.g., particle filter).

3.5.13.2 Switching field width

The width of the switching field must cover the width of the vehicle and take into account the supplements for the measurement error.

The switching field width SB can be calculated using the following formula (guideline values based on a pixel calculation):

$$SB = FB + 2 \times (ZG + ZR)$$

FB = Vehicle width

ZG = General supplement of the LiDAR sensor = 100 mm

ZR = Supplement for application-related influences or the selected application parameters

4 Transport and storage

4.1 Transport



NOTICE

Damage due to improper transport!

- The product must be packaged with protection against shock and damp.
 - Recommendation: Use the original packaging.
 - Note the symbols on the packaging.
 - Do not remove packaging until immediately before you start mounting.
-

4.2 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 elements, e.g. protective caps of the electrical connections just before attaching the connecting cable.

4.3 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.

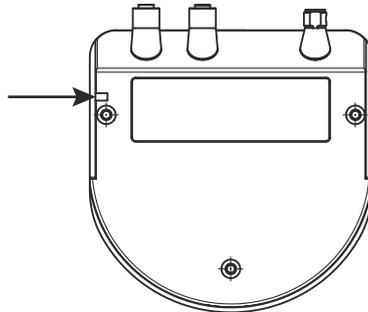
4.4 Storage

- Electrical connections are provided with a protective cap.
- Do not store outdoors.
- Store in a place protected from moisture and dust.
- Recommendation: Use the original packaging.
- 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 50](#).
- Relative humidity: [see "Technical data", page 50](#).
- For storage periods of longer than 3 months, check the general condition of all components and packaging on a regular basis.

5 Mounting

5.1 Mounting instructions

- Observe the technical data.
- Protect the sensor from direct sunlight.
- 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.
- The device can be mounted in any position.
- When mounting the device upside down, make sure that the ventilation duct of the ventilation element remains free of water and contamination.



- 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 55](#).
- Regularly check the tightness of the fixing screws.
- For indoor mounting, use a protection hood if necessary, for outdoor installation use a weather protection hood if necessary (both optional accessories), [see "Accessories", page 55](#).
- Do not mount the device on or directly in front of a bright metallic surface or other reflective surface, since reflections can falsify the measurements.
- Do not place magnetic objects on the optics cover, since they can disturb the angular measurement.
- Avoid having shiny or reflective surfaces in the scanning range, e.g., stainless steel, aluminum, glass, reflectors, or surfaces with these types of coatings.
- Protect the device from moisture, contamination, and damage.
- Make sure that the status indicator is clearly visible.
- Do not affix any labels or stickers to the optics cover.
- Do not subject the device to excessive shock or vibrations. In systems subjected to heavy vibrations, secure the fixing screws with screw-locking devices.
- When mounting the device up high, and in particular to secure the device during mounting, a retaining cable for fastening is available as an accessory.

5.2 Mounting device

1. Mount the device in a suitably prepared bracket using the fixing holes provided ([see "Dimensional drawing", page 52](#)). Mounting brackets are available as accessories, [see "Accessories", page 55](#).
 2. Make the electrical connection. Attach and tighten a voltage-free cable, [see "Connecting the device electrically", page 38](#).
 3. Align the vertical center line of the field of view of the device with the center of the area to be monitored. The marking on the upper side of the optics cover serves as a bearing alignment aid.
 4. Switch on the supply voltage.
- ✓ After successful initialization, the two status LEDs light up green. The device is ready for use.

5. Perform a fine adjustment using a test target and, if necessary, use the alignment aid.

5.3 Mounting multiple devices



NOTICE RISK OF INTERFERENCE FROM OTHER DEVICES!

Radiation sources with a wavelength of 850 nm can cause interference if they affect the device directly.

The device has been designed to minimize the probability of mutual interference, including between different LiDAR sensors. To rule out even the slightest effects on the measurement accuracy, the devices should be arranged such the laser beams are not received by another device.

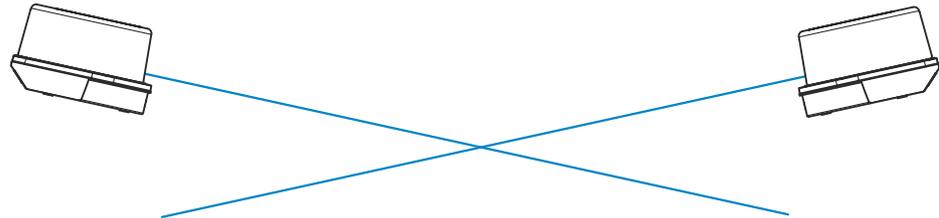


Figure 28: Arrangement for 2 devices

6 Electrical installation

6.1 Wiring instructions

**NOTE**

Pre-assembled cables can be found on the product page.

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

**NOTICE****Faults during operation and defects in the device or the system**

Incorrect wiring may result in operational faults and defects.

- Follow the wiring notes precisely.

All electrical connections of the device are configured as M12 round connectors.

The enclosure rating stated in the technical data is achieved only with screwed plug connectors or protective caps.

All circuits connected to the device must be configured as SELV or PELV circuits. SELV = safety extra-low voltage, PELV = protective extra-low voltage.

Observe the following notes to ensure safe and trouble-free operation:

- Connect the connecting cables in a de-energized state. Do not switch on the supply voltage until installation is complete and all connecting cables have been connected to the device and control.
- Wire cross-sections in the supply cable from the customer's power system should be designed in accordance with the applicable standards. Protect the device with an external slow-blow fuse of 5 A at the beginning of the supply cable, viewed from the voltage supply.
- The specified enclosure rating of the device when mounted is reached only if suitable mating connectors or protective caps are used.
- Do not open the screwed housing of the device, since the warranty will then become void.
- Turn the rotatable electrical connections max 270° from end position to end position.
- Prior to connecting the I/O line, check the device configuration for the inputs/outputs.
- Avoid tensile loads to the connecting cables.
- Maximum cable lengths for the voltage supply depending on the power supply voltage used (conditions: cable cross-section 0.34 mm², 20 °C cable temperature, 10 V applied to the device, max. power consumption as per type label): 5.5 m at 12 V; 40 m at 24 V; 57 m at 30 V.

6.2 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 (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

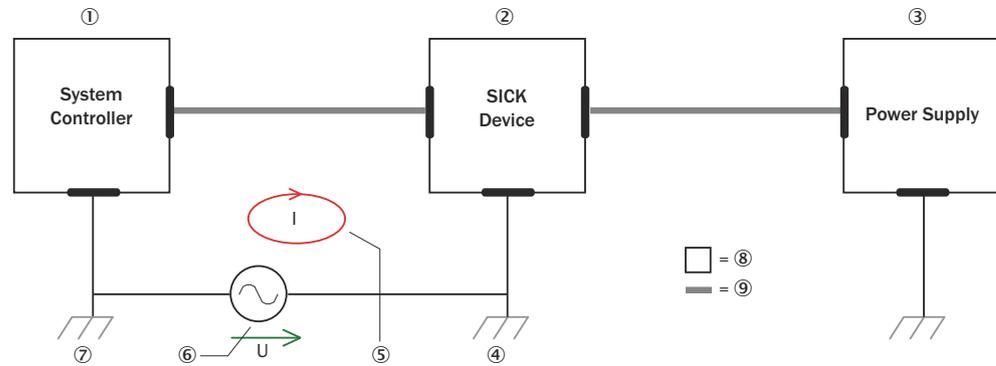


Figure 29: Example: Occurrence of equipotential bonding currents in the system configuration

- 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.

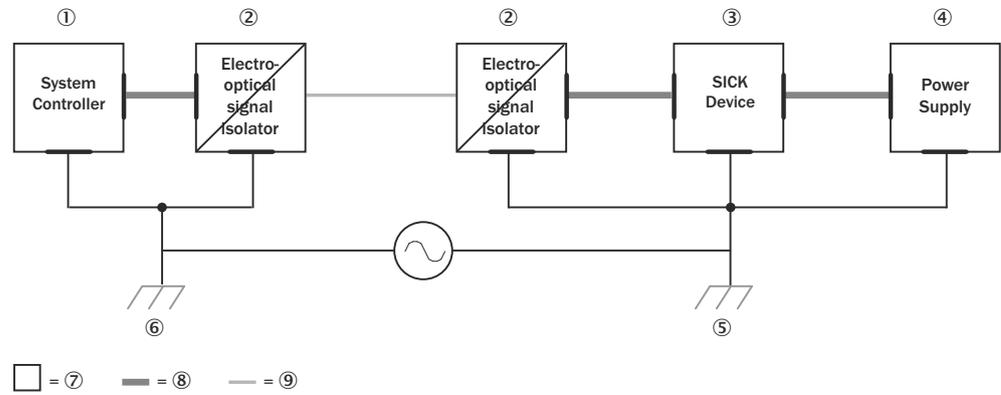


Figure 30: Example: Prevention of equipotential bonding currents in the system configuration by the use of electro-optical signal isolators

- 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.

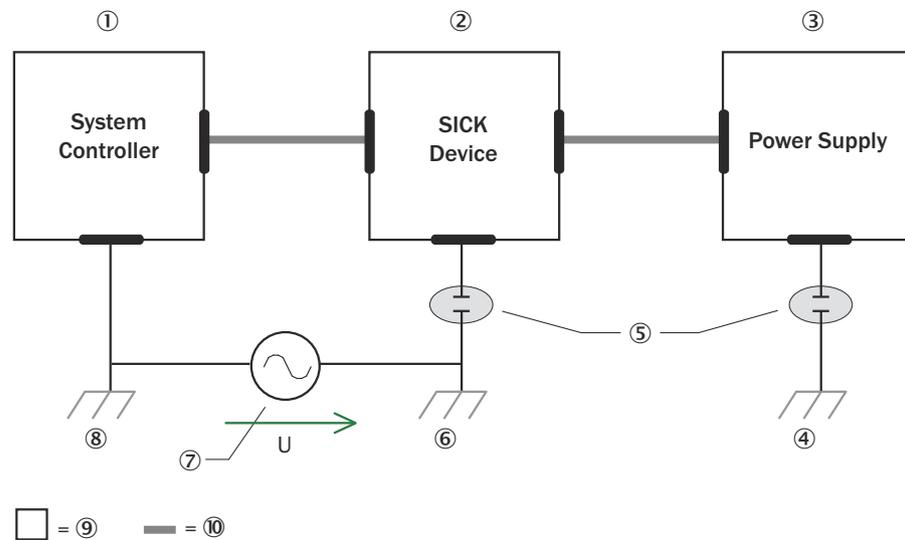


Figure 31: Example: Prevention of equipotential bonding currents in the system configuration by the insulated mounting of the device

- 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.

6.3 Connection diagram



NOTE

The recommended connecting cables and their associated technical data can be found on the online product page.

The page can be accessed via the SICK Product ID: pid.sick.com/{P/N}/{S/N}

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

PWR connection

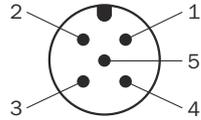


Figure 32: Male connector M12, 5-pin, A-coded

Table 6: Pin assignment for PWR connection

Pin	Identification	Description	Wire color, part number 2095733
1	Vs	Supply voltage: +10 ... +30 V DC	Brown
2	- -	Reserved	White
3	GND	Supply voltage: 0 V	Blue
4	IN8 / OUT8	Digital input 8 / digital output 8	Black
5	-	Reserved	Gray

1) Information only valid when using the specified open-ended connecting cable which is available as an accessory

Ethernet connection

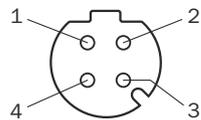


Figure 33: M12 female connector, 4-pin, D-coded

Table 7: Pin assignment for Ethernet connection

Pin	Identification	Description
1	TX+	Sender+
2	RX+	Receiver+
3	TX-	Sender-
4	RX-	Receiver-

Connection I/O

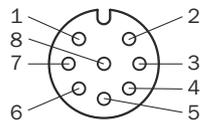


Figure 34: Female connector, M12, 8-pin, A-coded

Table 8: Pin assignment for I/O connection

Pin	Identification	Description	Wire color, part number 2134055 ¹⁾
1	IN1 / OUT1	Digital input 1 / Digital output 1	White
2	IN2 / OUT2	Digital input 2 / digital output 2	Brown
3	IN3 / OUT3	Digital input 3 / digital output 3	Green
4	IN4 / OUT4	Digital input 4 / digital output 4	Yellow
5	IN5 / OUT5	Digital input 5 / digital output 5	Gray
6	IN6 / OUT6	Digital input 6 / digital output 6	Pink
7	GND INx / OUTx	Ground for all digital inputs / outputs	Blue

Pin	Identification	Description	Wire color, part number 2134055 ¹⁾
8	IN7 / OUT7	Digital input 7 / digital output 7	Red

¹⁾ Information only valid when using the specified open-ended connecting cable which is available as an accessory

6.4 Connection options

The following illustrations show several wiring examples based on the different types of inputs and outputs used.

Inputs:

- IN1-3: Field set switching
- IN4: EasyTeach teach-in

Outputs (maximum output current, "Technical data", page 50):

- OUT5: EasyTeach cut-off path (evaluation)
- OUT6: Cut-off path for subsequent evaluations
- OUT7: EasyTeach confirmed indicator (signals teach-in)
- OUT8: Device ready indicator

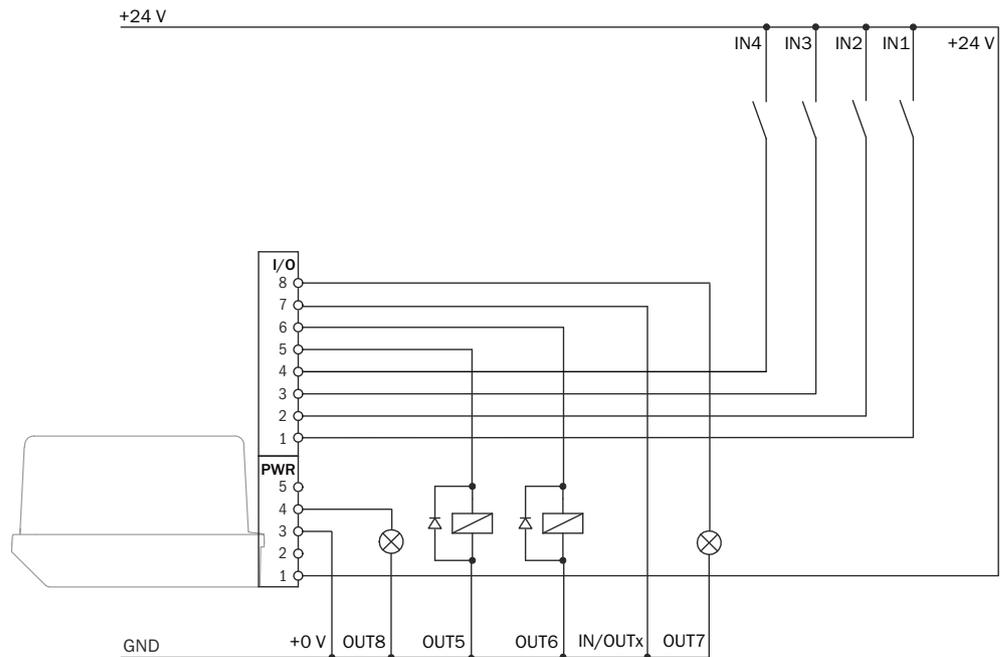


Figure 35: Connection example with PNP outputs and active high inputs (default)

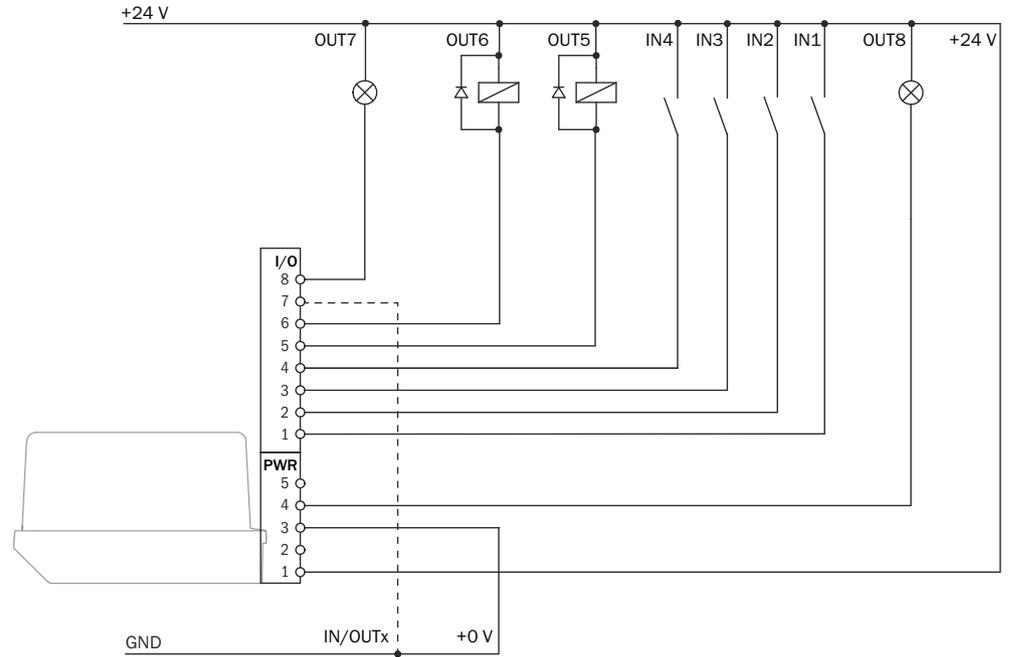


Figure 36: Connection example with NPN outputs and active high inputs

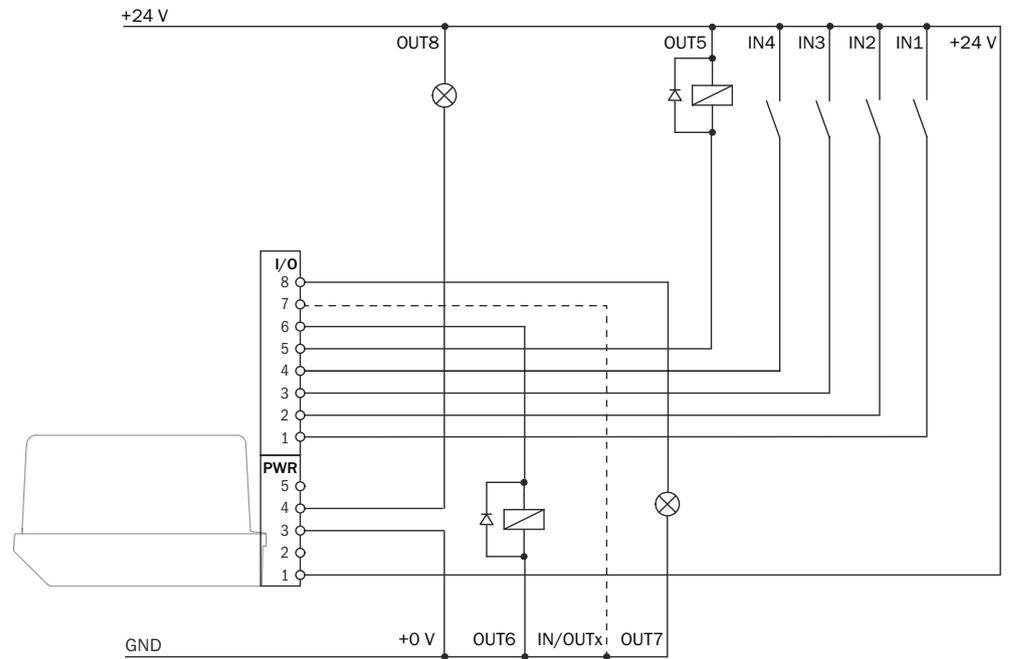


Figure 37: Connection example with push-pull outputs and active high inputs

6.5 Connecting the device electrically



NOTICE

Observe the wiring instructions (see "Wiring instructions", page 31) and prerequisites for safe operation (see "Prerequisites for safe operation of the device", page 32).

1. Ensure the voltage supply is not connected.
2. Connect the device according to the connection diagram, see "Connection diagram", page 35.

7 Operation

7.1 Operation with SOPAS ET

Version 4.1 and higher of the SOPAS Engineering Tool (SOPAS ET) software can be used to parameterize the device and for service and diagnostic purposes.

To configure the device, you will require a computer with SOPAS ET installed and a free Ethernet connection. Alternatively, the connection can be established via a USB connection using an Ethernet USB adapter.



NOTE

The most up-to-date version of the SOPAS ET software can be downloaded from www.sick.com/SOPAS_ET. The respective system requirements for installing SOPAS ET are also specified there.

1. Connect the communication interface (Ethernet, 4-pin M12 female connector) of the device to the computer.
 2. Switch on and start the computer.
 3. Supply the device with voltage (5-pin M12 male connector, supply voltage 10 ... 30 V DC).
- ✓ After successful initialization, the two status LEDs light up green. The device is ready for use.



NOTE

To use SOPAS ET with the device, you need a device description file (SDD, SOPAS Device Description) for this device. You can install this within SOPAS ET using the device catalog. The device description file is saved on the device and can be installed there. Alternatively, installation is possible from the SICK website (Internet connection required).

Following installation of the device description file, the device can be selected from the device catalog and added to a project.

A connection to the device is established via the communication interface. The connection must be activated for data transmission (**online**).

Certain functions (e.g., Edit parameters) require you to be logged in to the device (**Device > Log In** menu, **User Level**: Authorized customer, **Password** (factory default): client).

Table 9: Passwords

User levels	Password
Maintenance	main
Authorized client	client
Service	service level



NOTE

Change the passwords during initial commissioning to protect your device. A higher user level can change the password of a lower user level.

The factory-assigned passwords can be changed in the device window (**Device > Change password** menu).

Information about the device is displayed in the device window and the device can also be configured here (**Device > Open** menu).

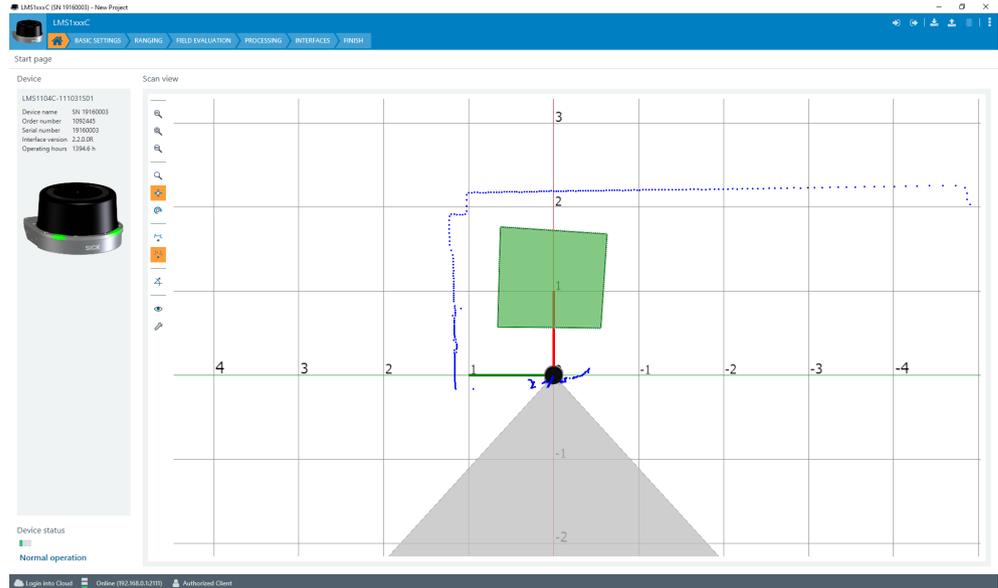
7.1.1 Description of the device window

Overview

The device window features various views supporting a selection of functions.

Start

Start device configuration with display of information about the device (left-hand side) and display of the current scan (right-hand side).



The scan view can be customized with the assistance of various tools (to the left of the scan view), for example:

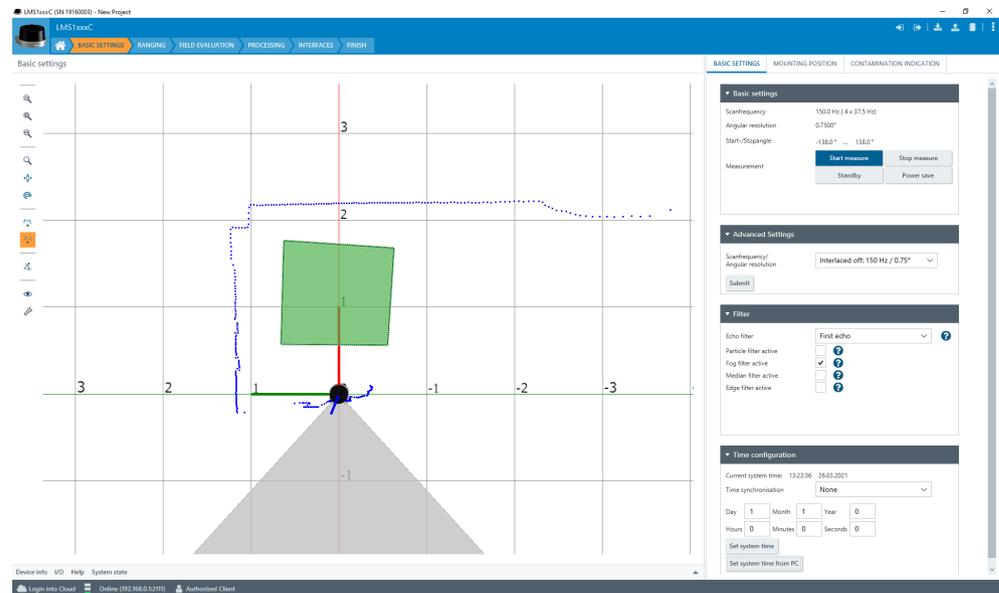
: Resets scan display to default view.

: Displays measured values as points or lines.

: Freely rotates scan display.

Defaults

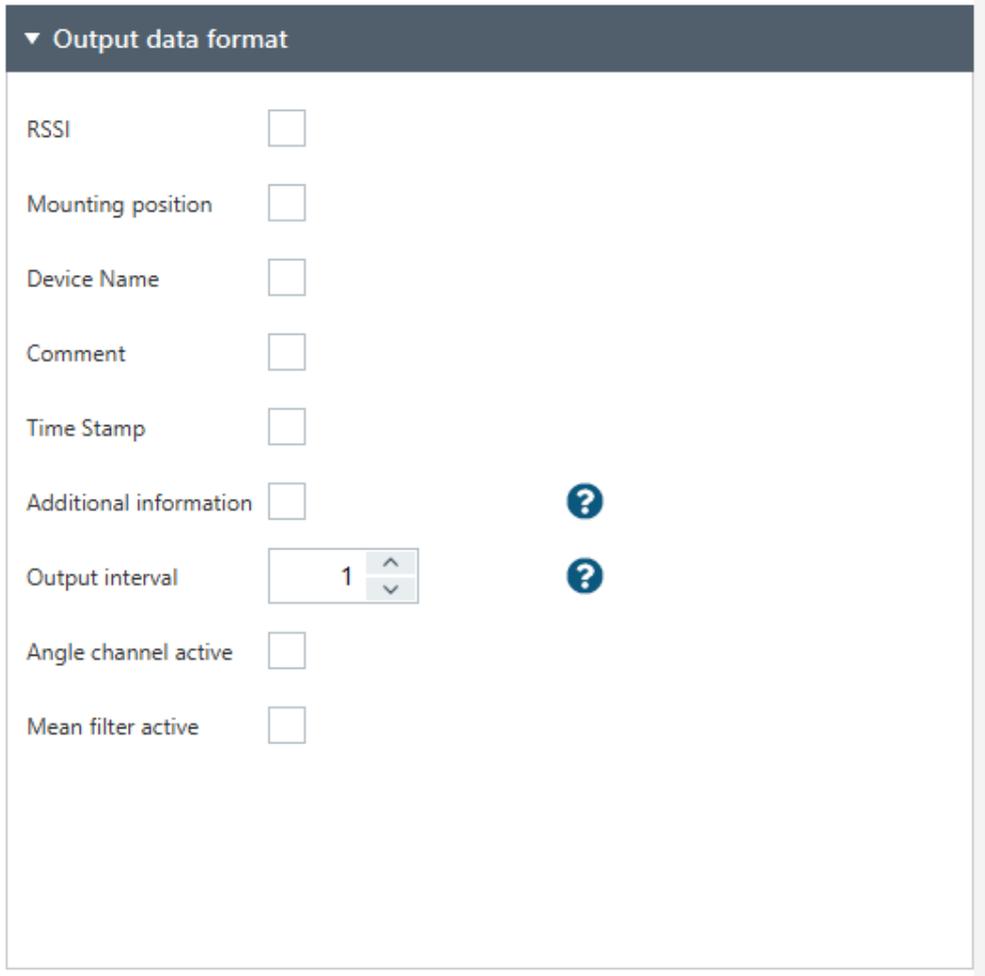
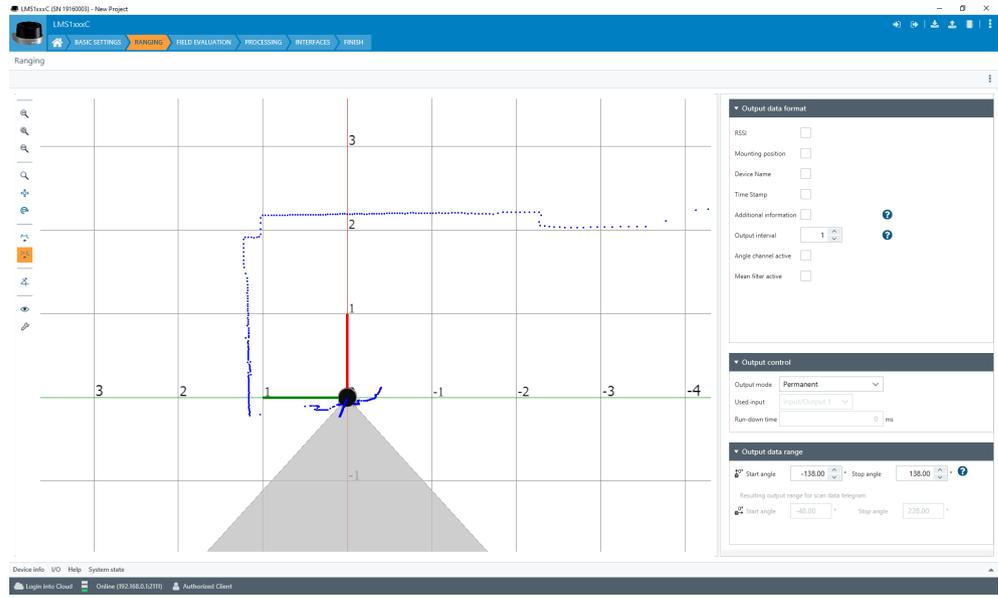
Scan display (left-hand side), entry of the device parameters as well as display of the IMU (Inertial Measuring Unit) data, entry of the mounting position as well as parameterization of the contamination indication (right-hand side):



The device is equipped with an inertial measuring unit (IMU). This can be used to output the actual inclination of the device. The IMU can output accelerations in X, Y and Z as well as the position angle in yaw, pitch and roll. These data can also be used to display and evaluate the mounting position.

Distance measurement

Input fields for output data format, output control, and output range (right-hand side).



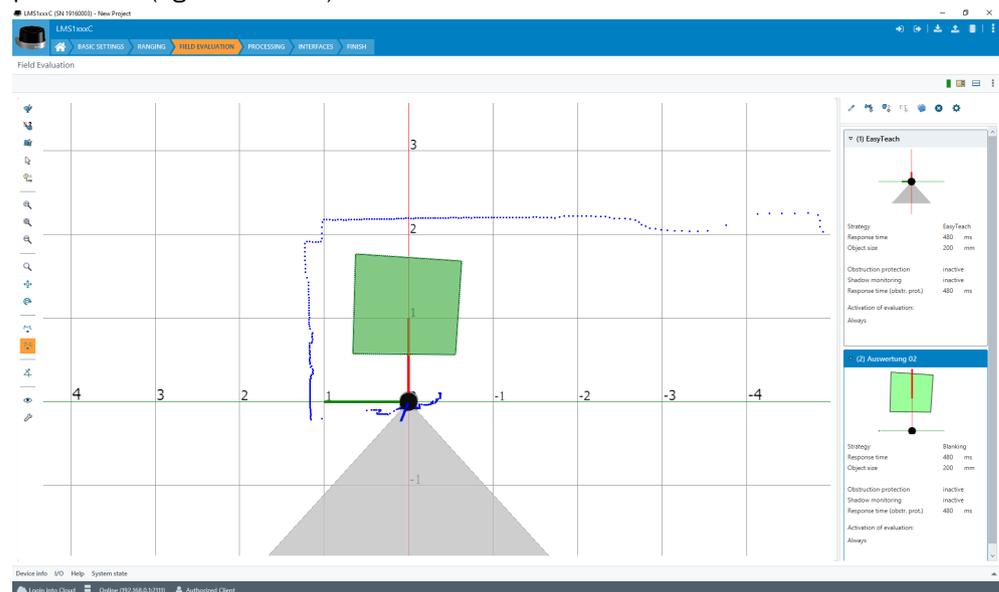
Supplementary information: The supplementary information bits can output an ambient light indication (bit 5...7) with the LMSscandata telegram ($A_{IN}F 1:0000*101*00$).

The ambient light is determined for the 0° layer. The higher the transmitted value, the larger the amount of ambient light. 0= little ambient light, 1C= a lot of ambient light

Angle channel active: The motor of the device rotates at 37.5 Hz and achieves a scanning frequency of 150 Hz due to the 4 modules. Assuming that the motor rotates at a constant and uniform speed at all times, a measured value is generated every 7 ms at an angular resolution of 0.75° . The motor speed is subject to minor fluctuations, however, for hardware limitation reasons. Due to external influences (e.g., strong acceleration or abrupt deceleration of the device), these fluctuations can amount to several tenths of a degree which can result in deviations in the centimeter range when measuring objects. The angle channel enables these fluctuations to be corrected to obtain the true angular position. When activated, an additional angle correction value is output in the measurement data telegram for each measurement point. Each value describes the deviation from the implicitly assumed angular position in a range of $\pm 3.2768^\circ$ and is accurate to about $\pm 0.01^\circ$. Since the channel can only output positive numbers, the value 32768 (8000h) corresponds to a deviation of exactly 0° . At larger values, from 32,769 to 65,535 (8001h ... FFFFh), the motor ran faster (objects appear narrower). At smaller values, from 0 to 32,767 (0h ... 7999h), the motor ran slower (objects appear wider).

Field evaluation

Scan display for adapting the field geometry (left-hand side) and entering detection parameters (right-hand side):



The **Edit field points** tool (mouse pointer in the list of tools to the left of the scan view) can be used to customize the field geometry using the mouse pointer. Alternatively, the field vertices can also be customized by entering the coordinate values in the **Field coordinates** mask.

Table 10: Options for editing the field geometry using the mouse pointer

Function	Procedure
Scale field	Drag square red handle.
Rotate field	Drag round black handle.
Customize field shape	Drag square green handle.
Add field vertices	Double-click in required position.
Remove field vertex	Click to select square green handle and press the [del] key.
Delete field	Press the [del] pushbutton without first selecting a green handle.
Insert new field (function is only available if a field has not been created)	Select Insert field points tool, click to set field vertices, and double-click last field vertex to close the field.



NOTE

Fields are defined on the y global plane.

Depending on the mounting location of the device (specified in the Default view), the fields are then projected onto the scan plane.

The following options for evaluation switchover are available:

- Always
- Via digital input
- Time
- Telegram for FW. 2.3.0.0 and above
- Deactivated

For switchover via telegram (ActivateEvaluation available in the Telegram Listing at www.sick.com/8014631)



NOTE

Monitoring of case switching (expert function) : The behavior of the sensor when switching detection fields can be customized.

Processing

Processing

Field evaluation processing

(1) EasyTeach	<input type="text" value="Min. perp. distance ..."/>	Layer	<input type="text" value="Layer 1"/>
		Reference line	<input checked="" type="radio"/> 0° <input type="radio"/> 90° <input type="radio"/> Custom <input type="text" value="0"/> °
		Visibility	<input type="checkbox"/> Show minimum perp. distance in scan view
		Output mode	<input type="text" value="Substitute by 0"/>
		Substitute distance	<input type="text" value="0"/> mm

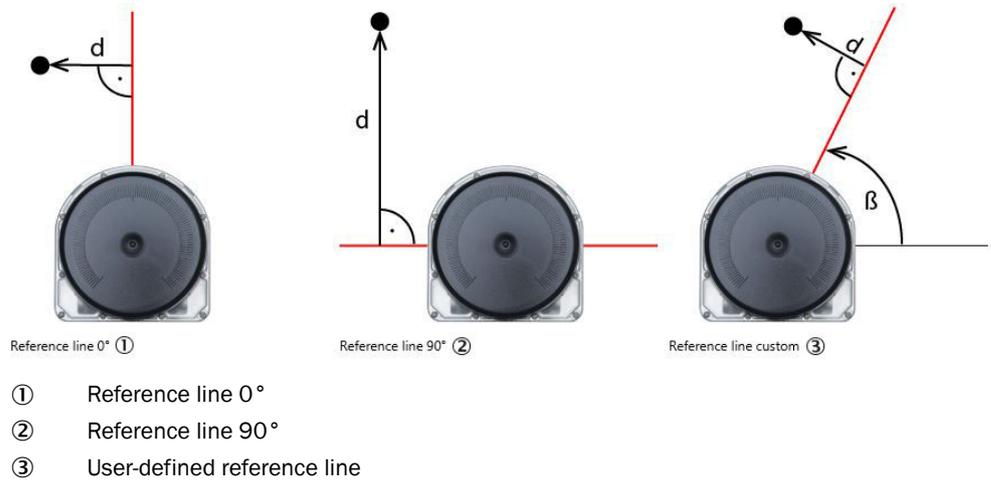


NOTE

To obtain the data, a field needs to be created. The data are only output when an object detection occurs. This is configured on this tab.

Further input fields for field evaluation processing (e.g., minimum perpendicular distance to reference line).

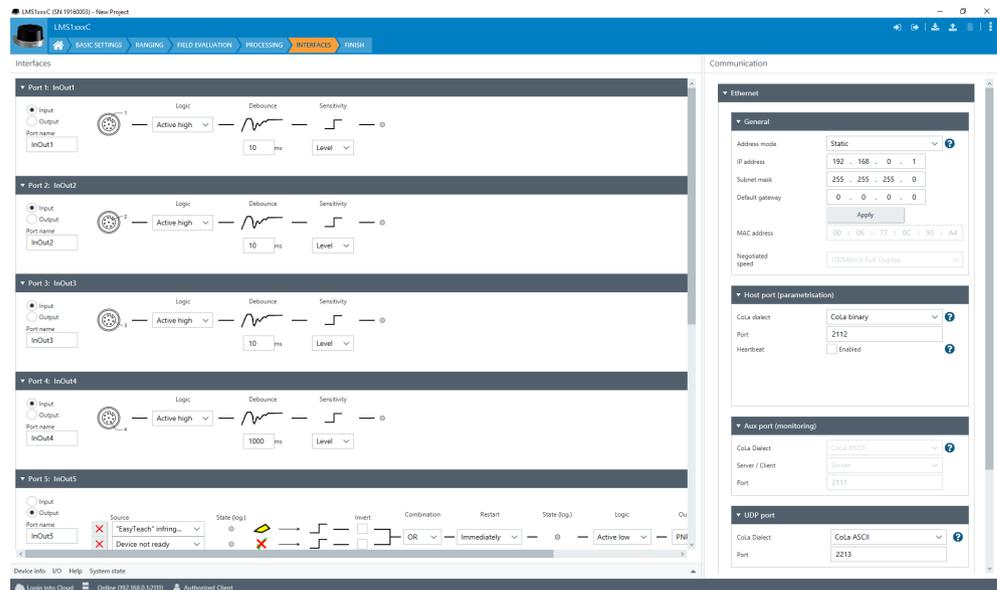
The functions **Minimum perpendicular distance** and **Maximum perpendicular distance** can be used to determine the minimum or maximum distance of an object that triggers an object detection.



Available via telegram [LFEperpdistresult](https://www.sick.com/8014631) in the Telegram Listing www.sick.com/8014631.

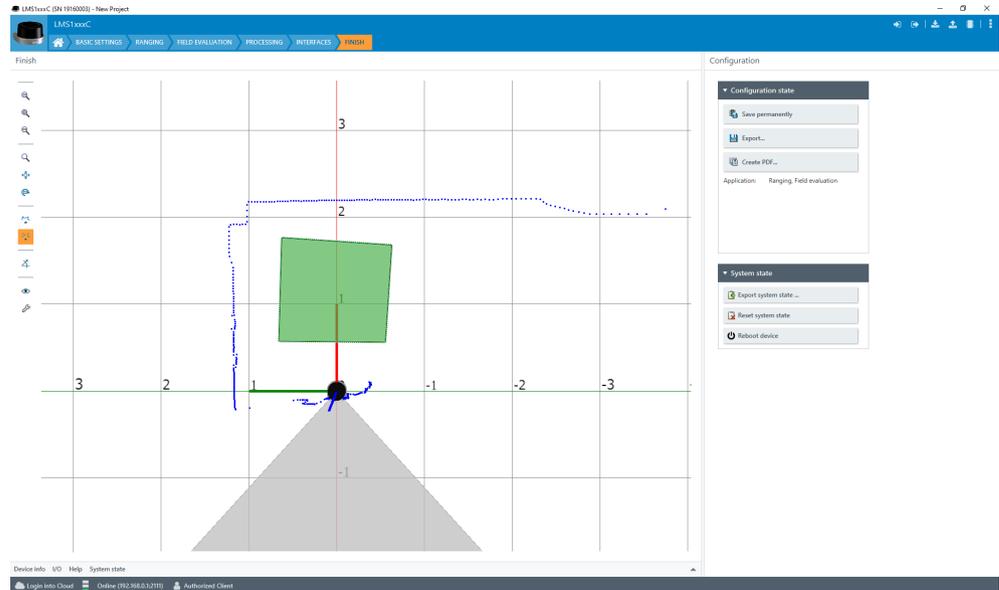
Interfaces

Configuration of the interfaces (left-hand side) and input of communication parameters (right-hand side).



Conclusion

Scan display (left-hand side) and buttons for finalizing the device parameterization and for system status/system diagnosis.

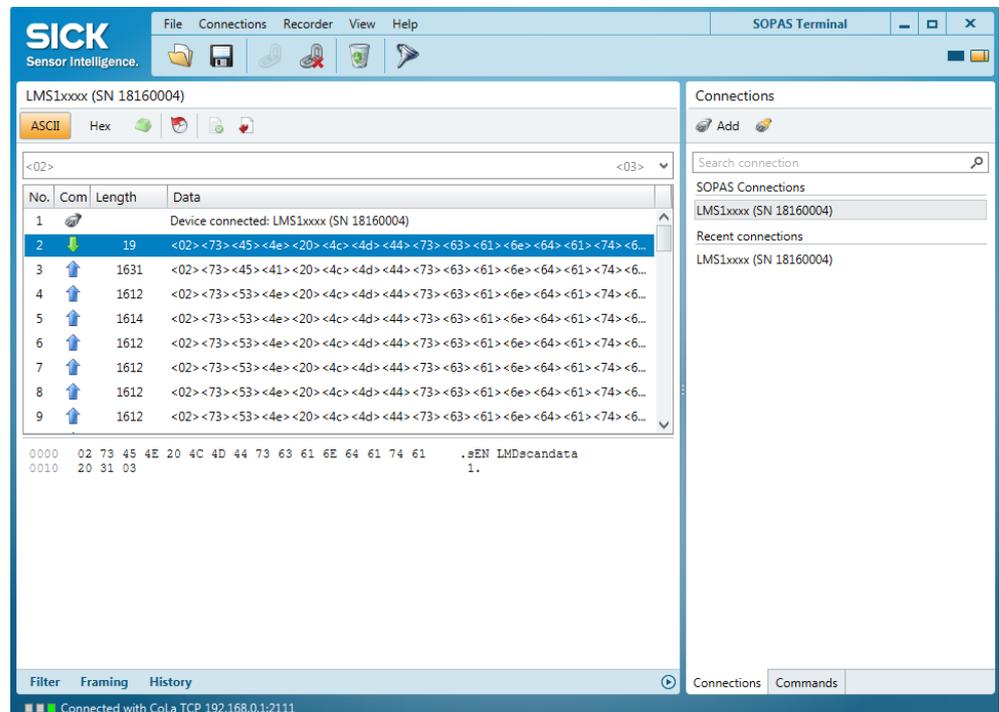


NOTE Changes to parameters that are made in SOPAS ET are not saved automatically in the device. After you have completed the configuration, you must save it in the device permanently by pressing the **Save permanent** button.

NOTE For examples of using the software and the configuration options in the device window, refer to the annex, see ["Configuration with computer"](#), page 57.

7.1.2 Terminal program description

The terminal program is started in the main window of SOPAS via the **Tools > Terminal** menu.



**NOTE**

For examples of using the software and the configuration options in the terminal program, refer to the annex, "[Output of measured values via terminal program](#)", page 57.

7.2 Operation with teach-in (EasyTeach)

For the field evaluation application, it is possible to configure the device using the field contour teach-in (EasyTeach) function rather than configuring it via SOPAS. The teach-in phase can be activated / deactivated via an input circuit or SOPAS.

**NOTE**

For an example of configuring the device using EasyTeach and for an input circuit, refer to the annex, "[Configuration without computer](#)", page 56.

7.3 Opening the web server user interface (SOPASair)

Before opening the user interface, perform the following work steps:

- Connect the device to the computer via Ethernet.
- Set up the voltage supply for the device.
- Ensure that the computer and device are located in the same network.
- Ensure that the computer uses a different IP address than the device, but is in the same IP address range (e.g. 192.168.0.xxx)

Opening user interface:

1. Open web browser (recommendation: Google Chrome).
 2. Enter the device IP address into the address line. The standard IP address is:
192.168.0.1
- ✓ The SOPASair user interface is displayed.

8 Maintenance

8.1 Maintenance plan

During operation, the device works maintenance-free.

Depending on the assignment location, the following preventive maintenance tasks may be required for the device at regular intervals:

Table 11: 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 and optics cover.	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

8.2 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 optics cover at regular intervals and in the event of contamination with a lint-free lens cloth and plastic cleaning agent. Rinse off coarse dirt first with water. The cleaning interval essentially depends on the ambient conditions.

9 Troubleshooting

9.1 General faults, warnings, and errors

Possible errors and corrective actions are described in the table below. In the case of errors that cannot be rectified using the information below, please contact the SICK Service department. To find your agency, see the final page of this document.



NOTE

Before calling, make a note of all type label data such as type designation, serial number, etc., to ensure faster telephone processing.

Table 12: Troubleshooting questions and replies

Question / status	Response / remedial actions
Measurement data show anomalies.	Optics cover contaminated: Clean the optics cover.

9.2 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.

9.3 Returns

- ▶ Only send in devices after consulting with SICK Service.
- ▶ 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

9.4 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.

10 Technical data



NOTE

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

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

Please note: This documentation may contain further technical data.

10.1 Features

Measurement principle	HDDM+
Application	Outdoor
Light source	Infrared (wavelength 850 nm; max. output power 1.26 W; pulse duration 3.5 ns; average power 4.0 mW)
Laser class	Laser class 1 (EN 60825-1:2014+A11:2021, IEC 60825-1:2014, EN/IEC 60825-1:2007) Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.
Horizontal aperture angle	275°
Scan field flatness	Conical error: ± 0.6° Tilt: ± 0.6°
Scanning frequency	150 Hz, 4 x 37.5 Hz
Angular resolution	0.75°, 0.1875° (interlaced mode), 0.375° (interlaced mode)
Heating	Self-heating
Working range	0.2 m ... 64 m
Scanning range with 10% remission	16 m
Scanning range with 90% remission	30 m
Spot divergence	10.4 mrad x 26.2 mrad
Light spot size at front screen	7 mm rounded
Number of echoes evaluated	3

Working range diagram

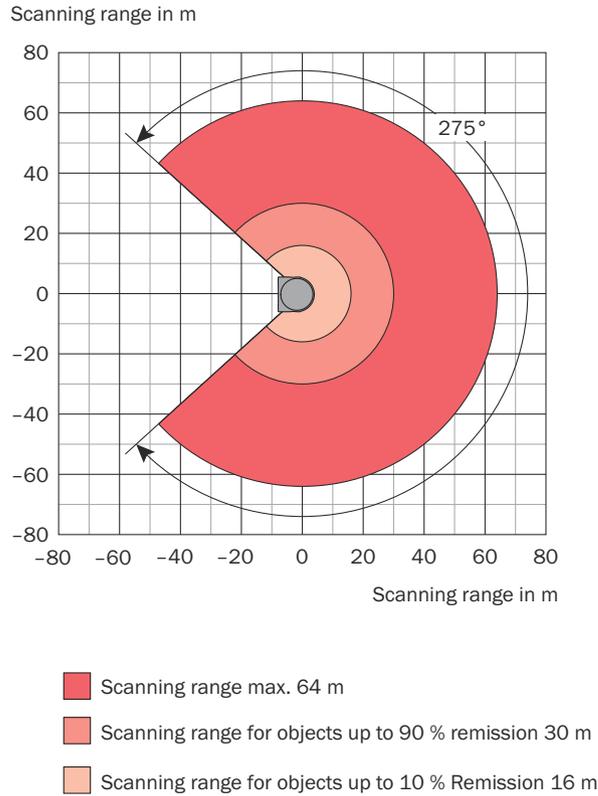


Figure 38: Working area diagram, top view

10.2 Mechanics/electronics

Connection type	3 x M12 round connectors with swivel connector
Supply voltage	10 V DC ... 30 V DC
Permissible residual ripple	±5%
Power consumption	$P_{typ} = 18 \text{ W}$ $P_{start} = 35 \text{ W}$ for 5 s (motor start-up) $P_{max} = 42 \text{ W}$ (with full specified current at all outputs)
Housing	ALSi12 Optics cover: PC
Housing color	Gray (RAL 7042)
Enclosure rating	IP65 (IEC 60529:1989+AMD1:1999+AMD2:2013) IP67 (IEC 60529:1989+AMD1:1999+AMD2:2013)
Protection class	III (IEC 61140:2016-11)
Electrical safety	IEC 61010-1:2010-06
Weight	1.2 kg
Dimensions (L x W x H)	151.9 mm x 150 mm x 92.5 mm
Encoder input frequency	not available
Maximum output current	max. 100 mA per output

1) E.g. 30 V*100 mA = 3 W

10.3 Dimensional drawing

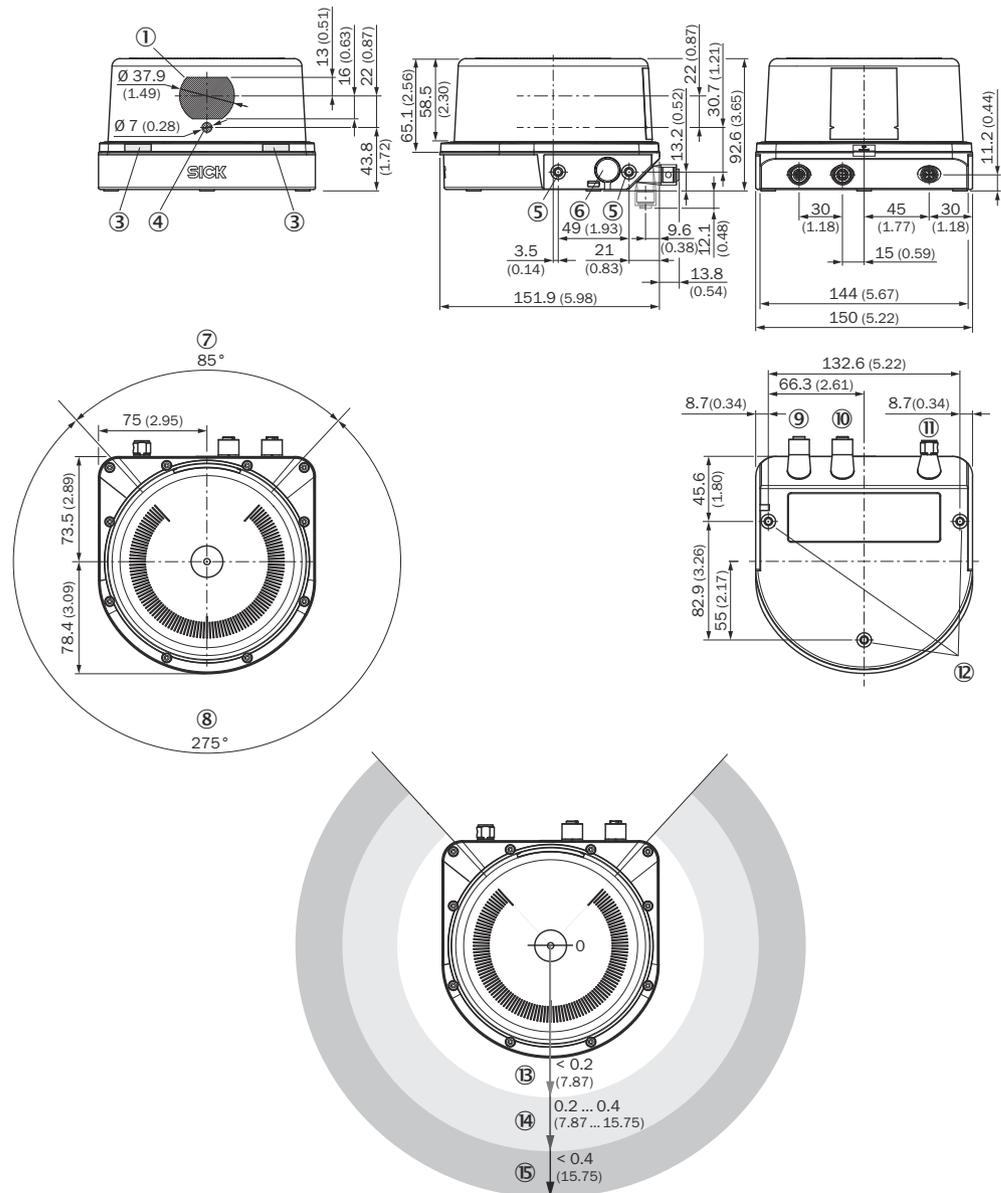


Figure 39: LMS1000 device structure and dimensions, dimensions in mm

- ① Receiver
- ② -
- ③ Status LEDs
- ④ Sender
- ⑤ M5x7.5 fixing holes
- ⑥ Ventilation element
- ⑦ Blind spot
- ⑧ Field of view
- ⑨ Ethernet connection
- ⑩ I/O connection
- ⑪ PWR connection (supply voltage)
- ⑫ M5x7.5 fixing holes
- ⑬ Close range (no detection or measurement possible)

- ⑭ Detection area
- ⑮ Measuring range

10.4 Performance

Scan/frame rate	55000 ... 165000 measuring points/second
Response time	7 ms
Systematic error	± 60 mm Temperature drift: typically ± 0.5 mm/K
Statistical error	≤ 30 mm

1)

10.5 Interfaces

Ethernet	✓, TCP/ IP Measurement data output (distance, RSSI, supplementary data) Data transmission rate: 10/100 Mbit/s
digital inputs/outputs	I/O (8 (multiport))
Digital inputs	Input voltage: $V_s - 30\text{ V} \dots +30\text{ V}$ (V_s : device supply voltage) Static input current <ul style="list-style-type: none"> • Logical "Active HIGH" (PNP compatible): Typ. 0.3 mA, Max. 1 mA • Logical "Active LOW" (NPN compatible): Typ. -0.3 mA, Max. -1 mA Level for HIGH <ul style="list-style-type: none"> • $V_s \geq 18\text{ V}$: +12.5 V ... +30 V • $V_s < 18\text{ V}$: $0.75 \cdot V_s \dots +30\text{ V}$ (at 12 V this means: $0.75 \cdot 12 = 9\text{ V} \rightarrow 9\text{ V} \dots 30\text{ V}$) Level for LOW <ul style="list-style-type: none"> • $V_s \geq 18\text{ V}$: $V_s - 30\text{ V} \dots +10.5\text{ V}$ (at 24 V this means: $24\text{ V} - 30\text{ V} = -20\text{ V} \rightarrow -20\text{ V} \dots +10.5\text{ V}$) • $V_s < 18\text{ V}$: $V_s - 30\text{ V} \dots 0.4 \cdot V_s$ Input capacity: 2.5 nF
Digital outputs	Typ. Output voltage <ul style="list-style-type: none"> • LOW: $\leq 1\text{ V DC}$ • HIGH: $\geq V_s - 1\text{ V}$ (V_s = device supply voltage) Max. switching current per pin under continuous load/current limiting (after 5 ms) <ul style="list-style-type: none"> • Max. switching current: 100 mA • Current limiting: 200 mA • Internal resistance: 2.3 Ohm ... 4.6 Ohm • Max. power loss: 1.5 W (total for digital inputs/outputs)
Output data	Contamination indication, IMU (secondary sensor data)
Optical indicators	2 LEDs

10.6 Ambient data

Remission factor	2% ... > 1,000% (reflector)
Electromagnetic compatibility (EMC)	EN 61000-6-2:2005 EN 61000-6-3:2007+A1:2011
Vibration resistance	According to IEC 60068-2-6:2007-12: 10 Hz ... 150 Hz: amplitude 0.35 mm to 5 g, 20 cycles

Shock resistance	Single shock according to IEC 60068-2-27:2008-02: 15 g, 11 ms, 6 shocks per axis Continuous shock according to IEC 60068-2-27:2008-02: 10 g, 16 ms, 1000 shocks per axis
Harmful gas resistance	Test for determining the resistance to flowing mixed gas according to DIN EN 60068-2-60:2016-06, Ke test, method 1
Chemical resistance	Salt spray test: DIN EN IEC 60068-2-52 (2018/08), test method 4
Ambient operating temperature	-30 °C ... +50 °C
Storage temperature	-40 °C ... +75 °C
Operating and storage air humidity	Max 90% air humidity (non-condensing)
Ambient light immunity	80 klx

11 Accessories

**NOTE**

On the product page you will find accessories and, if applicable, related installation information for your product.

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

Support Portal**NOTE**

In the SICK Support Portal (supportportal.sick.com, registration required) you will find, besides useful service and support information for your product, further detailed information on the available accessories and their use.

12 Annex

12.1 Declarations of conformity and certificates

You can download declarations of conformity and certificates via the product page.

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

12.2 Licenses

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

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

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

For license texts see www.sick.com/licensetexts.

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

12.3 Configuration without computer

12.3.1 Field evaluation

Configuration is performed by teaching in (EasyTeach) of the surrounding contour in order to automatically generate a field with any shape, including more complex shapes. In the as-delivered configuration, the teach-in phase is activated and deactivated using the wiring for input IN4.

Preparing EasyTeach

- Remove all objects that will not permanently be in the field of view in monitoring mode later on.
- Distance yourself sufficiently from the device during the teach-in phase and do not enter the monitored area, so that you are not detected as part of the field contour.

Teaching in the field contour

- The device creates the field from the surrounding contour with a negative offset of 250 mm.
- The field shape to be formed can be defined by pacing out the limits during the teach-in phase. It is important to make sure that the person can always be unequivocally detected.
- The device stores the shortest value measured during the teach-in phase as a field limit for each angle.
- Note: A parameter upload is required in order to display the newly taught-in field contour in SOPAS.

1. Install the device.
2. Carry out the EasyTeach wiring.

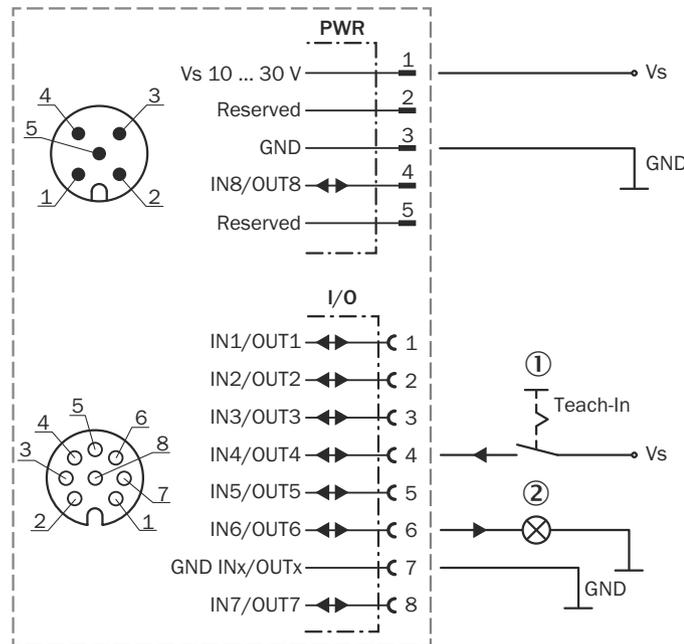


Figure 40: Wiring for EasyTeach (example)

- ① Teach-in via an external signaling device such as a pushbutton, at input IN4/OUT4 in this example.
 - ② Feedback for object detection; At output IN6/OUT6 in this example
3. Set the EasyTeach input signal to start the teach-in phase (active high).
 4. Define the field (e.g., using the existing surrounding contour or by pacing out the field).
 5. Remove the EasyTeach input signal to end the teach-in phase (active high).
 6. Thoroughly check correct detection of the field borders by performing a functional check in which For this purpose, deliberately induce object detections.

12.4 Configuration with computer

The SOPAS ET configuration software (from Version 4.1) is used as standard to display the surrounding contour (measuring line) recorded by the LiDAR sensor, as well as diagnostic information in the event of an error.

12.4.1 Output of measured values via terminal program

Example commands for output of measured values

If the LiDAR sensor receives one of the two example commands by telegram through the Ethernet interface, it will start the output of measured values through this data interface.

The detailed structure of the output telegram as well as the flow of requests and outputs is described in the “Measurement output telegram” section in the Telegram Listing available at www.sick.com/8014631.

Request for output of measured values:

Table 13: Telegram structure: sRN LMDscandata

Telegram part	Description	Variable type	Length (byte)	Value range
Command type	Request (SOPAS read by name)	string	3	sRN
Command	Request data	string	11	LMDscandata

Table 14: Example: **sRN LMDscandata**

Telegram type	Command
ASCII	<STX>sRN{SPC}LMDscandata<ETX>
HEX	02 73 52 4E 20 4C 4D 44 73 63 61 6E 64 61 74 61 03
Binary	02 02 02 02 00 00 00 0F 73 52 4E 20 4C 4D 44 73 63 61 6E 64 61 74 61 05

Request for continuous output of measured values:Table 15: Telegram structure: **sEN LMDscandata** measurement start/stop

Telegram part	Description	Variable type	Length (byte)	Value range
Command type	Request (SOPAS event by name)	string	3	sEN
Command	Request data	string	11	LMDscandata
StartStop measurement		Enum8	1	0: Stop output of measured values 1: Start output of measured values

Table 16: Example: **sEN LMDscandata**

Telegram type	Command
ASCII	<STX>sEN{SPC}LMDscandata{SPC}1<ETX>
HEX	02 73 45 4E 20 4C 4D 44 73 63 61 6E 64 61 74 61 20 31 03
Binary	02 02 02 02 00 00 00 11 73 45 4E 20 4C 4D 44 73 63 61 6E 64 61 74 61 20 01 33

Note:

For the content of the response telegram for the measured value request, see the Telegram Listing at www.sick.com/8014631, under 'Send Data Permanently' in Section 4. The telegram consists of one part with information on the configuration of the device and the time stamp, one part with measured data, and a status part with information on the device status and the statuses of the inputs/outputs.

After starting the measurement mode, the device needs some time to reach status 1 ("ready"). You should therefore query the status of the device using the **sRN SCdevicestate** telegram.

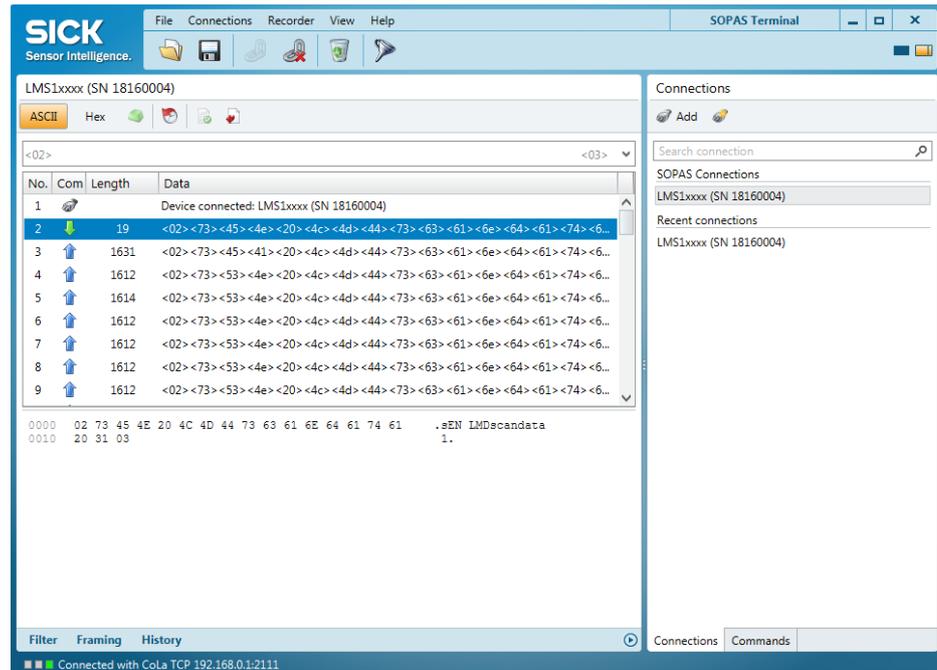
Then request measured data via telegram at the data interface from which you want to receive measured data. This can be achieved in two ways:

- The request of exactly one measured value with the **sRN LMDscandata** telegram – the last measured scan is transmitted.
- Continuous request of measured data with the **sEN LMDscandata 1** telegram – measured data is transmitted until the output of measured values is stopped with the **sEN LMDscandata 0** telegram.

Activating the output of the measured values in SOPAS on a test basis:

1. Start the terminal emulator: **Tools** menu > **Terminal**.
2. In the dialog window in the **Connections** menu, select the **Create new connection** function.
3. In the connection wizard, select the communication interface (**Ethernet**) and connection settings (default IP address: 192.168.0.1) and establish the connection (**Finish** button).
4. Enter in the input line one of the two example telegrams from the annex as they appear (automatically framed by **STX** and **ETX** when sending in the default setting). Pay attention to blank characters in the string.

5. Use the  button to transmit the telegram to the LiDAR sensor.
- ✓ The LiDAR sensor responds by providing the data as a one-off or continuously in the display area of the terminal emulator.



Data output format of the measured values

The data output format per scan is comprised of the configuration information, measured values, radial distance, RSSI, , device and status information, and time stamp.

In the default settings, the distance is output as a measured value (in mm).

To output the reflectance values in the telegram: Open the device window (**Device> Open** menu) and, in the **Distance measurement** view, select the **RSSI** check box under **Output data format**.

12.4.2 Measured value display and configuration via start window

- ▶ Open start window: **Device > Open** menu.
- ✓ The **Start** view with information on the **device**, **device status**, and the **graphic scan display** opens.

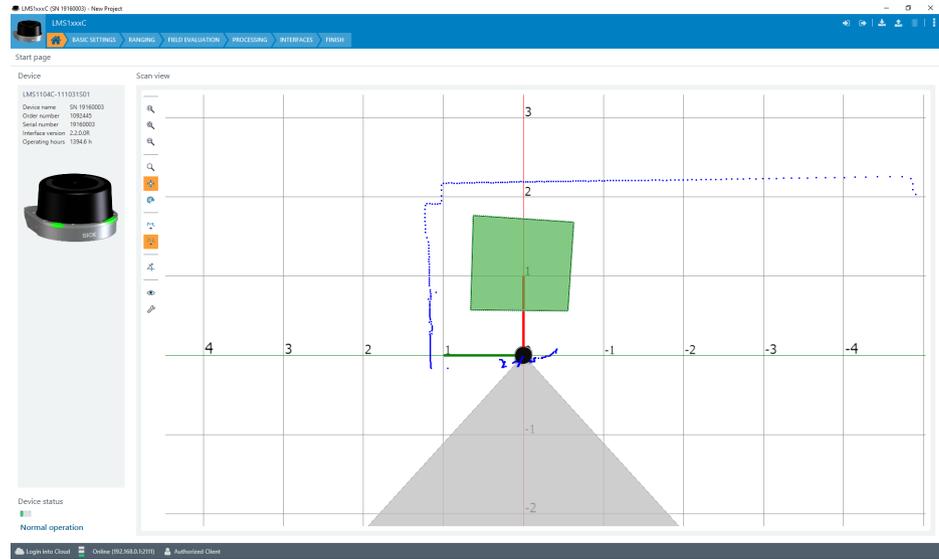


Figure 41: SOPAS ET: Start window

12.4.3 Field evaluation

Creating a new evaluation

- ▶ Click the button.

Entering evaluation parameters

- ▶ Click the button and enter evaluation parameters.

Inserting field points

1. Click the button.
2. Insert field points by clicking.
3. Double-click to close the field.

Editing field points

The Edit field points tool () can be used to customize the field geometry with the assistance of the mouse pointer. Alternatively, the field vertices can also be customized by entering the coordinate values in the Field coordinates mask.

Function	Procedure
Scale field	Drag square red handle.
Rotate field	Drag round black handle.
Customize field shape	Drag square green handle.
Add field vertices	Double-click in required position.
Remove field vertex	Click to select the square green handle and press the [del] key.
Delete field	Press the [del] key without first selecting a green handle.

Important information about fields

It is possible to define up to 10 fields and 10 evaluations.

12.4.4 Configuring interfaces

Settings for using the multifunctional I/Os can be made in the **Interfaces** area. In addition, the current status and saved function of the input/output are displayed.

The multifunctional I/Os are switchable and can therefore each be used as either a digital input or output. The factory settings are as follows: multifunctional I/Os 1-4 preset as inputs and multifunctional I/Os 5-8 preset as outputs.

The inputs may switch on, switch off, and switch over analysis cases, for example. The inputs can also be used to activate other functions, such as EasyTeach or measurement data output triggering.

The outputs can be used as digital switching outputs, for example to ground (PNP) (depending on the device type). For each output, it is necessary to define whether it is to be switched by the field evaluation application or by means of SOPAS ET telegrams, or whether it is being used to signal device readiness. If the field evaluation application is being used to switch an output, the sensor may signal evaluation field breaches or contour breaches. In SOPAS ET, you can configure which evaluation affects which output.

12.4.5 Some useful functions

 button: Resets scan display to default view.

 And  button: Displays measured values as points or lines.

 button: Freely rotates scan display.

12.4.6 Configuring the device

1. Set the desired configuration data in the **Basic settings** and **Interfaces** views (buttons under the menu bar).
2. Finally, permanently save the configuration in the **Finish** view:
 - o Click the **Save permanent** button to save the parameter set in the device.
 - o Click the **Export...** button to save the parameter set on the computer.

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