OPERATING INSTRUCTIONS

LMS5xx

2D LiDAR sensors

SICK
Sensor Intelligence.

Described product

LMS5xx

Manufacturer

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Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Information on the operating instructions

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

Prerequisites for safe work are:

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

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

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

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

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

1.2 Explanation of symbols

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

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

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

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

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

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

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 LMS5xx is a non-contact optical distance measurement sensor in standalone or network operation based on a 2D-LiDAR sensor. It is suitable for applications which demand precise, non-contact optical measuring contours and dimensioning. It can also be used to implement systems for collision protection, object protection or access monitoring, for example.

The device may only be put into operation by authorized staff and only in industrial environments.

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

2.7 Operational safety and specific hazards

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

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

No. of units	Components	Remarks
1	Device in the version ordered	Type depends on order Put plastic protective caps on all M12 round connectors and cable entries.
1	Printed safety notes, multilingual	Brief information and general safety notes

The actual scope of delivery may differ for special designs, additional orders or due to the latest technical changes.

3.2 Device variants

Table 3: Device variants

Type	Purpose	Sensing range
LMS500-2x000 Lite/PRO	Indoor	Max. 80 m 26 m at 10%
LMS511-1x100 Lite/PRO/Heavy Duty	Outdoor	Max. 80 m 40 m at 10%
LMS511-2x100 Lite/PRO/Heavy Duty	Outdoor	Max. 80 m 26 m at 10%
LMS531-1x100 Lite/PRO	Outdoor Security	Max. 80 m 40 m at 10%
LMS581-10100 PRO	Outdoor	Max. 80 m 40 m at 10%
LMS581-20100 PRO	Outdoor	Max. 80 m 26 m at 10% [1]
LMS511-15100 Heavy Duty Extended Range	Outdoor	Max. 130 m 52 m at 10% [1]
LMS531-15100 Heavy Duty Extended Range	Outdoor Security	Max. 130 m 52 m at 10% [1]

[1] Reflectance

Simplified device designation in the document

In the following instructions, the LMS5xx 2D LiDAR sensor is referred to simply as “device” or “LMS5xx”. except in cases where it is necessary to make a distinction between device variants due to different technical features or functions. In this case, either the designation of the variant series (e.g. LMS511 PRO Outdoor) or the complete type designation according to the type code (e.g., LMS500-20000) is used.

3.2.1 Device views

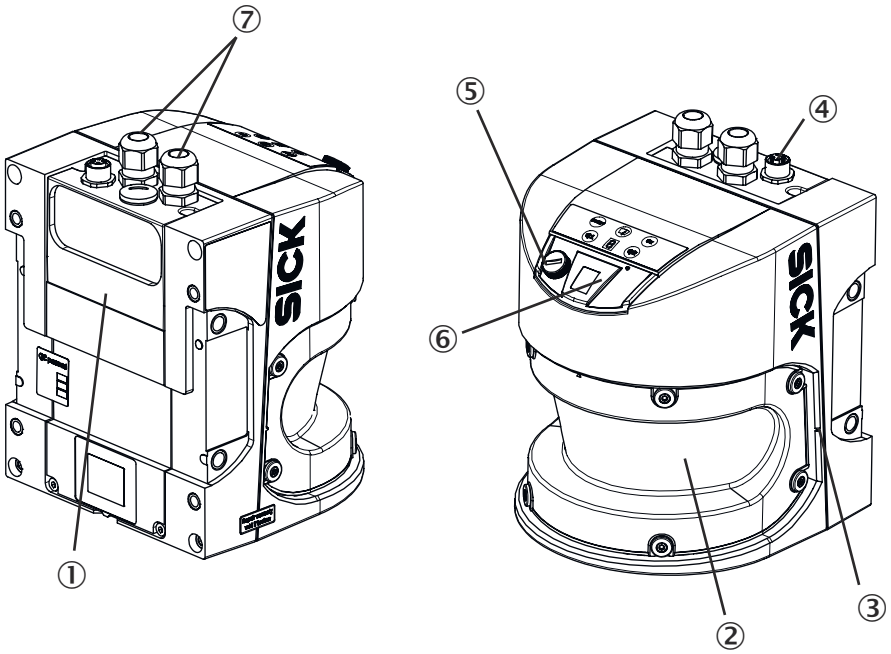


Figure 1: View of the LMS500 Indoor

① System plug (removable) with terminal blocks and cloning parameter memory for device replacement with automated configuration of the replacement device

② Viewing window (laser output aperture)

③ Mark of horizontal measurement origin

④ “Ethernet” connection

⑤ “USB” connection

⑥ Status indicators

⑦ Cable entry

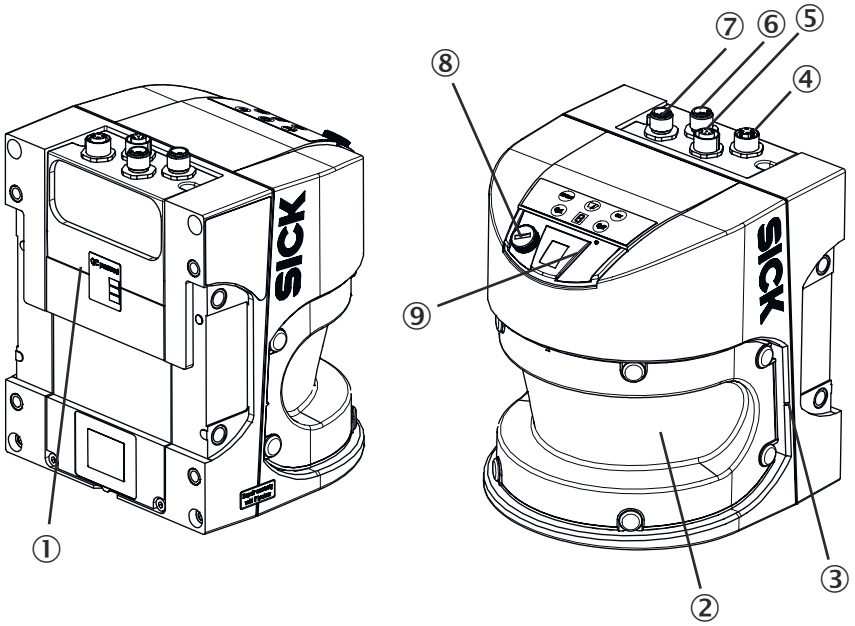


Figure 2: View of the LMS511/581/531 Outdoor

① System plug with cloning parameter memory. Removable only for LMS511 Heavy Duty for device replacement with automated configuration of the replacement device
② Viewing window (laser output aperture)
③ Mark of horizontal measurement origin
④ “Ethernet” connection
⑤ “I/O” connection; LMS531 Security: “Alarm” connection
⑥ “Data” connection; LMS531 Security: “Inputs” connection
⑦ “Power” connection
⑧ “USB” connection
⑨ Status indicators

3.2.2 Functional scope of the different device variants

Device settings

Table 4: Device settings

Function	LMS500 / LMS511	LMS531
Standard mode / **Expert** mode	–	x
Scanning frequency, angular resolution adjustable	x	x
Device time adjustable or via NTP	x	x
Standby mode	x	x
Identify	x	x

Interfaces

Table 5: Interfaces

Function	LMS500 / LMS511	LMS531
Freely definable inputs and outputs	x	–
Expandable outputs via CAN module	x	x
Input for encoder	x	–
Configurable data output format	x	–

Function	LMS500 / LMS511	LMS531
IO mapping	x	x
Process data interface: Serial and Ethernet	x	x
Display can be deactivated	x	x

Filter

Table 6: Filter

Function	LMS500 / LMS511	LMS531
Average filter	x	x
Echo filter	x	x
Particle filter	x	x
Fog filter	x	x
Glare filter	x	x

Status information

Table 7: Status information

Function	LMS500 / LMS511	LMS531
Device status	x	x
Device temperature	x	x
Display of scan data and detection fields	x	x
Field evaluation interruption history	x	x
Adjustable contamination measurement	x	x
Heating status	x	x
Status of synchronization	x	–
Encoder signal status	x	–

Field evaluation

Table 8: Field evaluation

Function	LMS500 / LMS511	LMS531
Preset field sets and detection cases	–	x
Evaluation of blanking size, pixel, reference contour	x	x
Distance-based blanking	x	x
Dynamic adjustment of the field size	x	–
Perpendicular distance	x	x
Teach-in	x	x
EasyTeach LITE	–	x
EasyTeach PRO	–	x
Automatic field adjustment (snow height adjustment)	x	x
Movement shadows monitoring	x	x

Additional functions

Table 9: Additional functions

Function	LMS500 / LMS511	LMS531
Manipulation protection teach-in	–	x

Function	LMS500 / LMS511	LMS531
Manipulation prevention	x	x
Validity check	–	x

The LMS531 variants are specially optimized for security applications and have hardware and software adapted for this purpose. The security variants are optimized for field evaluation applications and are not suitable for measurement data output.

NOTE

For more information about the special functions of the LMS531 see "Parameterizing the LMS531 variants for security applications", page 84.

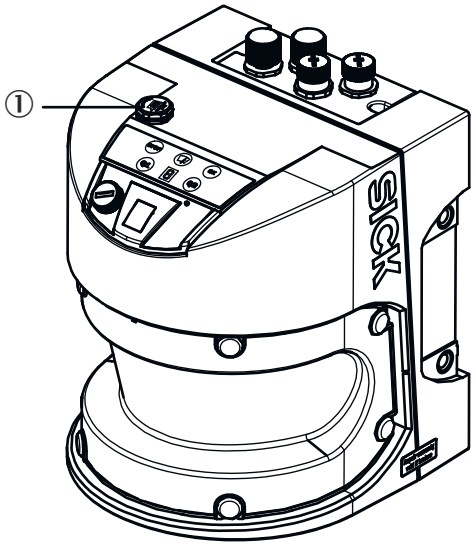
3.2.3 Heavy Duty variants with ventilation element

The ventilation element ensures an improved pressure equalization and allows the exchange of air and heat between the sensor housing and the environment. The breathable membrane allows ambient air to either penetrate into the device, or escape again depending on the prevailing ambient conditions. In particular for applications with frequently changing environmental influences (e.g., large temperature fluctuations or fast temperature changes) or with standing water, the membrane ensures a reliable pressure equalization and thereby relieves the seals and adhesive joints of the sensor housing. This can improve the expected service life of the device in the application.

Table 10: Device variants

Type	Purpose	Sensing range
LMS511-12100S08 Heavy Duty	Outdoor	Max. 80 m 40 m at 10% [1]
LMS511-22100S08 Heavy Duty	Outdoor	Max. 80 m 26 m at 10% [1]
LMS531-10100	Outdoor Security	Max. 80 m 40 m at 10% [1]
LMS531-11100	Outdoor Security	Max. 80 m 40 m at 10% [1]
LMS511-15100 Heavy Duty Extended Range	Outdoor	Max. 130 m 52 m at 10% [1]
LMS531-15100 Heavy Duty Extended Range	Outdoor Security	Max. 130 m 52 m at 10% [1]

[1] Remission factor



① Ventilation element

Notes and recommendations:

- Do not affix any labels or stickers to the ventilation element or paint over the membrane. Longer moist periods and rapid temperature changes may briefly reduce the availability of the device. This applies in particular to previously switched off devices that are started in the application and were previously exposed to the aforementioned environmental influences.
- In some circumstances, therefore, a period of time should be allowed before measurement readiness of the device because any moisture in the housing must first be taken up by the air in the housing, which is heated up through the operation of the device, so that it can then escape via the ventilation element. Depending on the nature of the precipitated moisture, this time period might be several minutes or even up to hours. It is recommended that the LMS5xx variants with a ventilation element be operated continuously during the application (continuous operation).
- It is recommended to connect the integrated sensor heating according to the specifications in the operating instructions to ensure additional heat input at low ambient temperatures.

3.2.4 Extended Range variants

The Extended Range variants feature a higher measuring range as well as an increased sensitivity over the entire measuring range. This enables objects to be measured and detected at larger distances and, in particular, makes it easier to detect objects with a low remission factor.

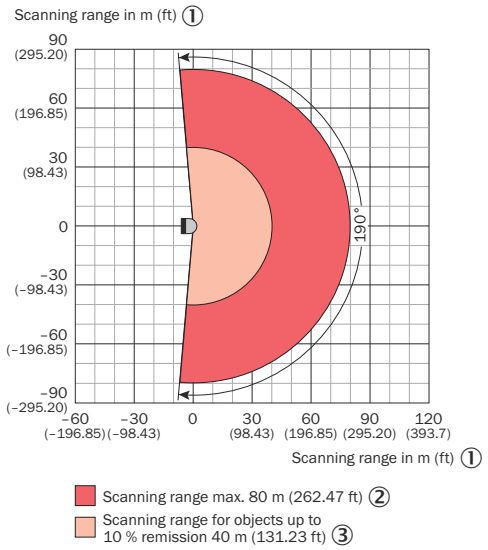


Figure 3: LMS5xx standard resolution working range, unit m (ft), decimal separator: period

① Scanning range in m

② Max. scanning range 80 m

③ Scanning range for objects up to 10% remission 40 m

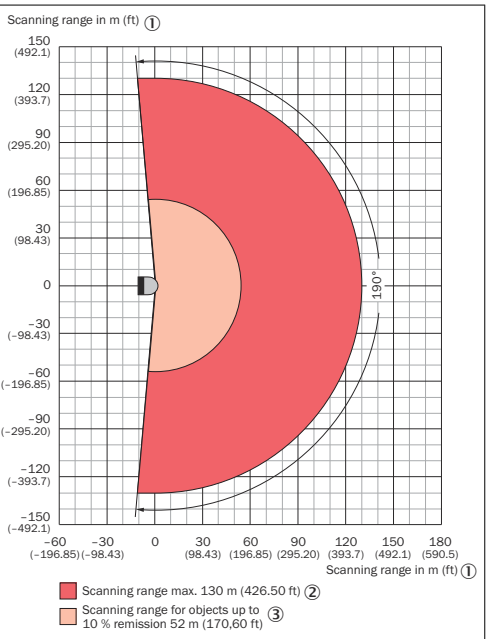


Figure 4: Working range of LMS5xx Standard Resolution Extended Range, unit m (ft), decimal separator: period

① Scanning range in m

② Max. scanning range: 130 m

③ Scanning range for objects up to 10% remission factor: 52 m

The increased sensitivity is a preset, non-changeable device characteristic. This extension can, in some circumstances, result in an increased sensitivity to interference, for example fog, spray or rain, compared to the standard variants. The Extended Range variants are, however, designed to provide a good balance between sensitivity and availability and have been optimized accordingly. Furthermore, the Extended Range variants also feature all of the filtering options described in section Filter for preprocessing and optimizing the measured distance values. This enables the sensor parameterization to be optimally tailored to the application-specific requirements.

The Extended Range variants are Heavy Duty variants with a ventilation element, see "Heavy Duty variants with ventilation element", page 15. For further details on the technical data, see "Technical data", page 104.

NOTE

The Extended Range variants use different scaling factors for the data output via telegrams and differ from the standard variants in this respect.

The distance values received via data output must be multiplied by the specific factor applicable to the Extended Range variants see table 16, page 35.

3.3 Type code

Type code structure

LMS a b c - d e f gg hhhh

Table 11: Type code

Position	Description	Characteristic
a	Device family	5: LMS5xx

Position	Description	Characteristic
b	Type	0: Indoor housing without heating, IP65 1: Outdoor housing with heating, IP65, IP67 3: Security outdoor housing with heating, IP65, IP67 8: Outdoor housing with heating, IP65, IP67, Special
c	Color	0: Blue 1: Gray 2: Black
–		
d	Performance	1: Standard resolution 2: High resolution
e	Variant	0: PRO 1: Lite 2: Heavy Duty 3: PRO Extended Range 4: Lite Extended Range 5: Heavy Duty Extended Range
f	Connectivity	0: PG 1: M12 standard
gg	Application	00: Standard 90: Bulkscan software
hhhh	Device type	(Empty): Standard S: Special device with consecutive number M: Sample device with consecutive number

3.4 Type label

The type label gives information for identification of the product variant.

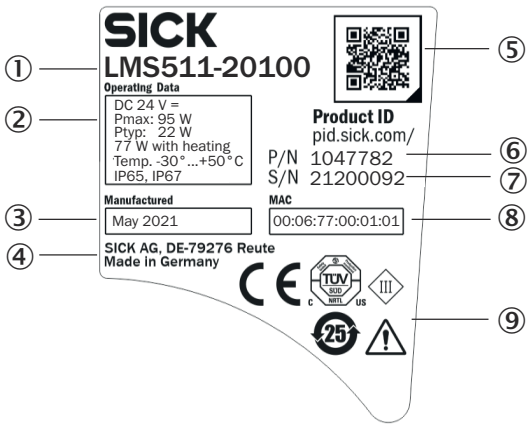


Figure 5: Elements of the type label (example)

① Type code
② Voltage supply, typical power, max. power, operating temperature, enclosure rating
③ Production date
④ Manufacturer and production site
⑤ Data Matrix code with product data and link to product page
⑥ Part number
⑦ Serial number
⑧ MAC address
⑨ Conformity mark/certification mark, symbol: Observe the operating instructions!

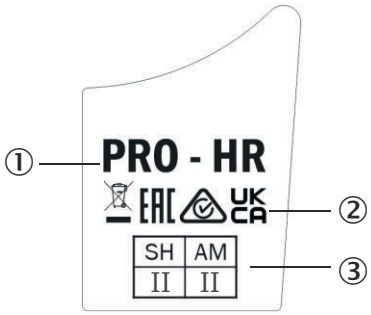


Figure 6: Elements of the type designation label (example)

① Device type
② Conformity mark/certification mark
③ Hardware version

3.5 Status indicators

Operator interface

The device works fully automatically in normal operation and requires no operator intervention.

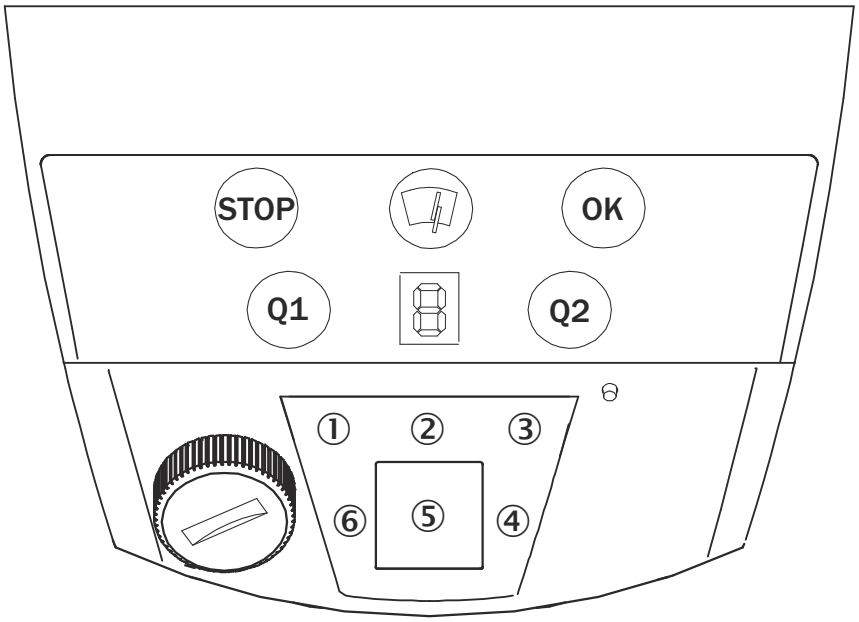
The SOPAS ET configuration software allows interactive configuration. For this, the software runs on a computer which is connected to the device with one of the data interfaces.

The graphical scan display in SOPAS ET is used to verify the generated measured values and the measuring range online.

NOTE
Scans in SOPAS ET are not displayed in real time, but at a limited speed. Not all measured values are displayed for this reason.

Status indicators

The LEDs and 7-segment display indicate the operational status of the device.



Display	Description
①	Device is either not in measuring mode (stopped by the user) or it is running in measurement mode, but errors have occurred
②	Off: No contamination On (lit up) Contamination warning On (flashing): Contamination error
③	Device running in measurement mode without any errors
④	Reserved
⑤	The 7-segment display is used for diagnostics when errors or faults occur see "Indicators in the 7-segment display", page 101.
⑥	At least one field is breached see "Linking of evaluation cases at the output", page 50.

It is recommended to also monitor the **Device Not Ready** operational status as well as messages from the contamination measurement via the digital outputs of the sensor to ensure the device readiness is continuously checked.

NOTE
As well as the standard indicators described below, the indicator functions of the LEDs and the 7-segment display can be configured in SOPAS ET for the device (SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Network/Interfaces/IOs**, **Display**).

For additional information, see "LED fault indicators", page 100.

3.6 Principle of operation

3.6.1 Measurement principle

The device is an opto-electronic LiDAR sensor that scans the outline of its surroundings with the help of laser beams without making contact. The device measures its surroundings in two-dimensional polar coordinates, relative to its measurement origin. This is indicated by small markings on the sides of the optics cover. If a laser beam strikes an object, the position of that object is determined in terms of distance and angle.

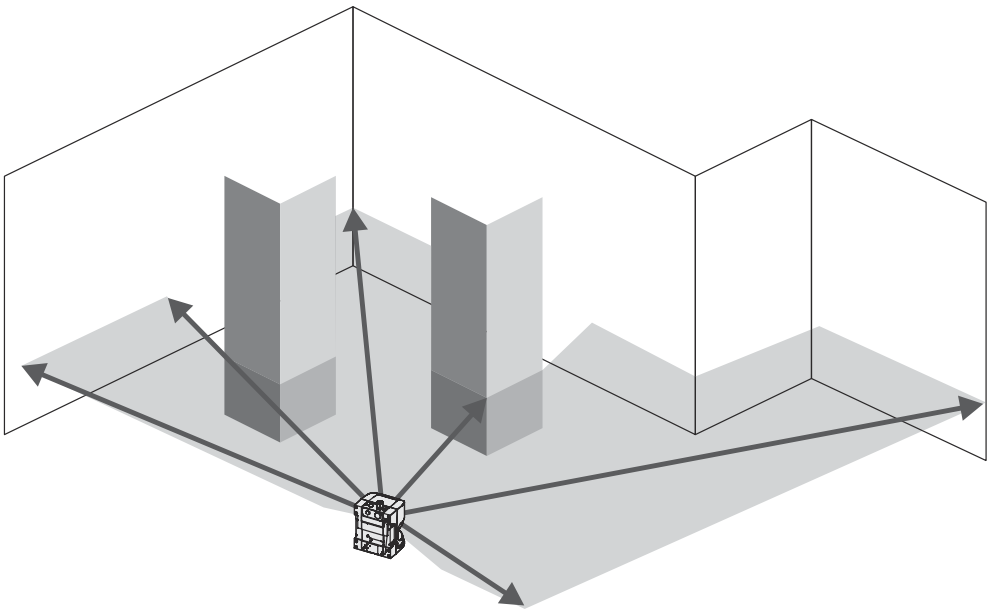
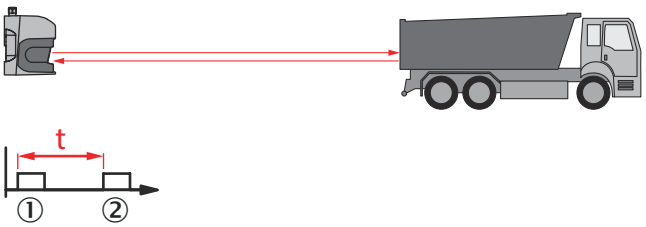


Figure 7: LiDAR sensor with one scan plane

3.6.2 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 Emitted pulse

② Receive pulse

3.6.3 Direction measurement

The emitted laser beams are deflected by an internal rotating mirror and scan the environment in a circular motion. The measurements are triggered by an encoder in regular angle increments.

The LMS5xx PRO/Heavy Duty measures with an adjustable scanning frequency of 25, 35, 50, 75 or 100 Hz. A laser pulse and thus a measurement is triggered continuously after each angle increment of 0.1667°, 0.25°, 0.3333°, 0.5°, 0.6667° or 1°.

In interlaced mode, the start angle of a measurement is cyclically shifted in order to achieve an even finer angular resolution see "Interlaced mode", page 36.

The LMS5xx Lite measures at a configurable scanning frequency of 25, 50 or 75 Hz and at angle increments of 0.25°, 0.5° or 1°.

3.6.4 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.

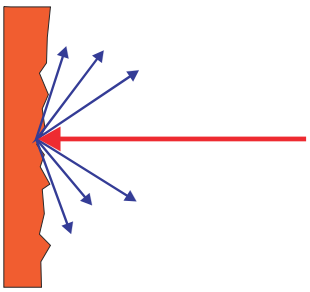


Figure 8: Reflection of light on the surface of the object

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.

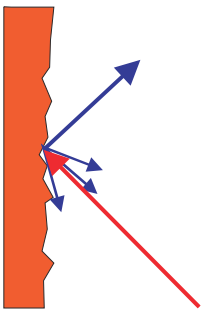


Figure 9: Angle of reflection

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.

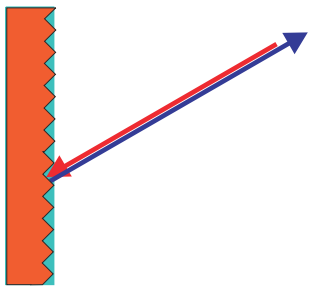


Figure 10: Retroreflection

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.

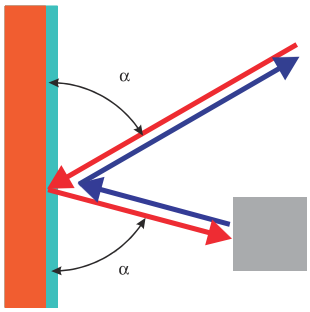


Figure 11: Specular surfaces

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.

If the **All echoes** or **Last echo** option is selected, the portion of the light that does not reach the front object, but is reflected from a surface in the background, can produce a second echo see "Filter", page 38.

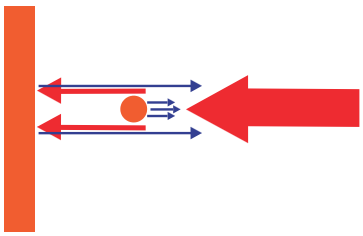


Figure 12: Object smaller than the laser beam diameter

3.6.5 Distance between the device and the object/surface to be monitored

The laser beam expands with increasing distance from the device. This means that the floor or a wall may be continuously detected as a result of it being hit by the laser beam.

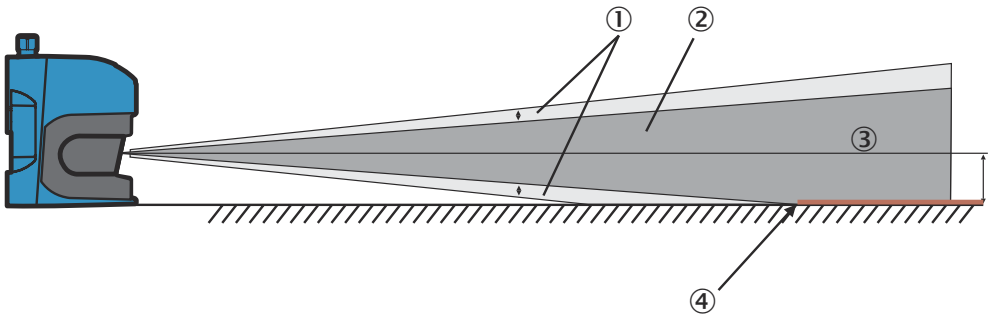


Figure 13: Beam expansion and supplement

① Expanded laser beam
② Supplement 5 mm/m
③ Optical axis
④ Continuous detection from 15 m

The optical axis is located around 63 mm above the lower edge of the housing when the device is mounted vertically. This is used as a reference plane for the distance that must be maintained from the ground/wall.

The distance-dependent beam expansion can be calculated using the formula: Beam diameter (mm) = distance (mm) × divergence (mrad) + light spot size on the viewing window (mm). For values, see "Technical data", page 104.

The following table shows some example values:

Table 12: Beam diameter on the target object (diagonal) at different distances to the device

Distance	LMS5xx (HR)	LMS5xx (SR)
5 m	37 mm	73 mm
10 m	61 mm	133 mm
15 m	85 mm	192 mm
20 m	108 mm	252 mm
50 m	250 mm	609 mm

When assessing whether the laser beam can hit an object or the wall, the distance from the half beam diameter to the optical axis is used.

NOTE
Take into account the supplement of approx. 5 mm per meter.

3.6.6 Sensing 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.

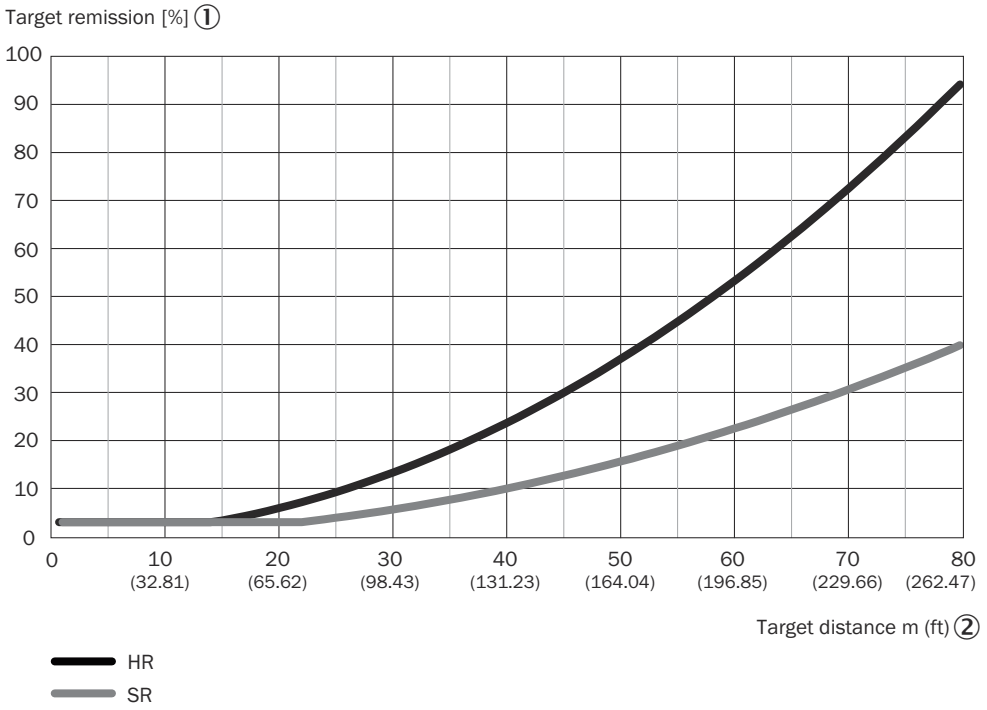


Figure 14: Scanning range as a function of the target remission
Scanning range of the LMS500-20000 (HR)/LMS511-20100 (HR) and LMS511-10100 (SR) (no filters activated; not affected by fog, rain or dust)

① Remission factor of the target [%]

② Object distance [m]

Example for see figure 14, page 25: Up to a distance of 15 m, the LMS5xx (HR) can detect objects with a remission factor of 3% or higher. At a distance of 80 m, only objects with a remission factor > 95% are detected reliably.

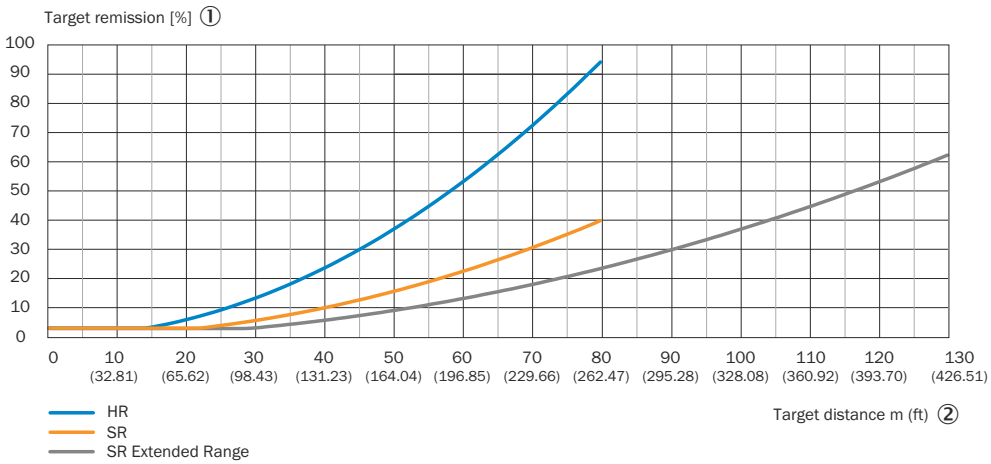


Figure 15: Scanning range as a function of the remission factor of the target
Scanning range of the LMS511-15100 and LMS531-15100 (SR – Extended Range) (no filters activated; no influence from fog, rain or dust)

① Remission factor of the target [%]

② Object distance [m]

3.6.7 Beam diameter and measuring point distance

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

The range-dependent diameter of the measuring point corresponds to the distance (mm) x 0.0047 rad (HR) or 0.0119 rad (SR) + 13.5 mm.

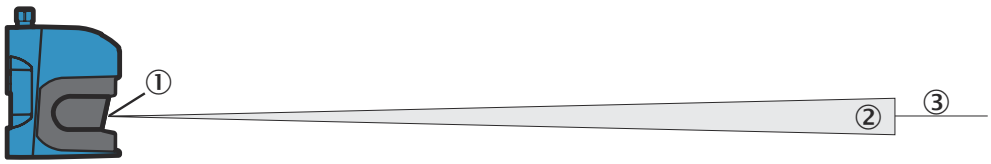


Figure 16: Beam expansion

① Beam diameter at the viewing window = 13.5 mm
② Expanded laser beam
③ Optical axis

Similarly, as the distance from the device increases, the individual measuring points also grow further apart from one another. The distance between the measuring points also depends on the selected angular resolution. With coarser angular resolution (e.g. 1°), the distance is larger, with finer angular resolution (e.g. 0.1667°), the distance is smaller. The range-dependent distance between the measuring points corresponds to the tangent of the angular resolution × distance.

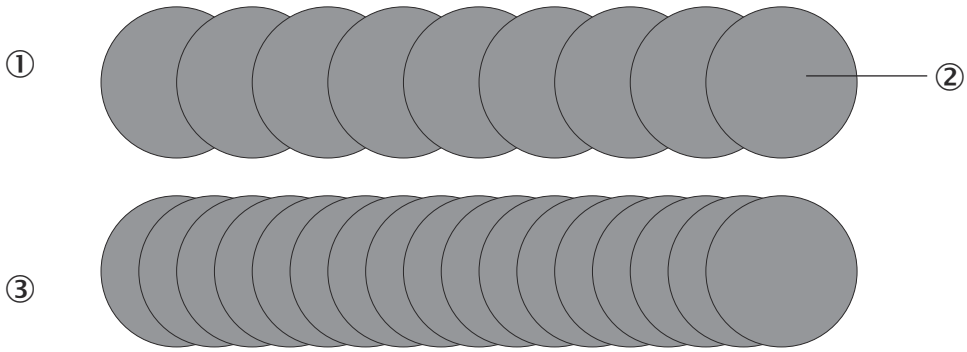


Figure 17: Schematic representation of the measuring point distance at different angular resolutions

① Scan with coarse angular resolution
② Measuring point
③ Scan with fine angular resolution

The following diagrams show the beam diameter and measuring point distance as a function of the distance to the device.

NOTE
The correct selection of sensor type (SR or HR) and angular resolution is required for gapless scanning at a certain distance.

Standard Resolution (SR)

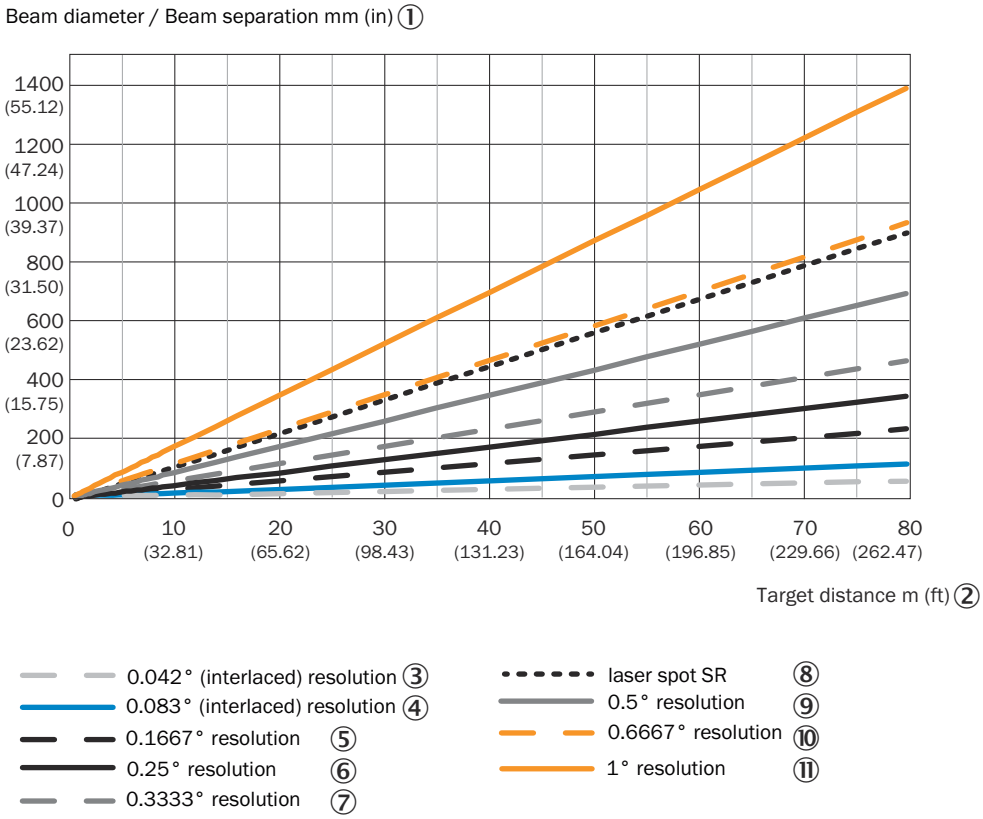


Figure 18: Beam diameter and measuring point distance at 0 to 80 m (SR)

① Beam diameter / beam separation [mm] (in)
② Distance of the target [m] (in)
③ Resolution 0.042° (interlaced)
④ Resolution 0.083° (interlaced)
⑤ Resolution 0.16667°
⑥ Resolution 0.25°
⑦ Resolution 0.3333°
⑧ Beam diameter SR
⑨ Resolution 0.5°
⑩ Resolution 0.6667°
⑪ Resolution 1°

Reading example for an angular resolution of 0.1667° (SR) in figure 18

- Distance intersection point 30 m results in a measuring point distance of approx. 87 mm.
- Distance intersection point 30 m with the characteristic curve for beam diameter results in a beam expansion of approx. 370 mm (SR).

Standard Resolution Extended Range

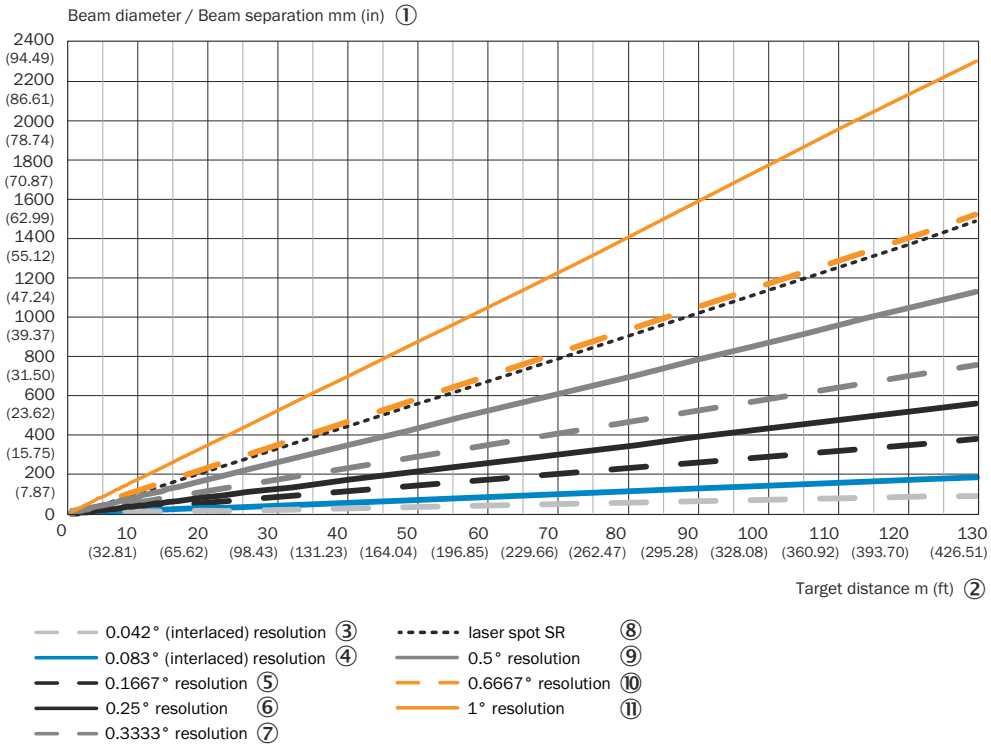


Figure 19: Beam diameter and measuring point distance at 0 to 130 m (SR – Extended Range)

① Beam diameter / beam separation [mm] (in)
② Distance of the target [m] (in)
③ Resolution 0.042° (interlaced)
④ Resolution 0.083° (interlaced)
⑤ Resolution 0.16667°
⑥ Resolution 0.25°
⑦ Resolution 0.3333°
⑧ Beam diameter SR
⑨ Resolution 0.5°
⑩ Resolution 0.6667°
⑪ Resolution 1°

High Resolution (HR)

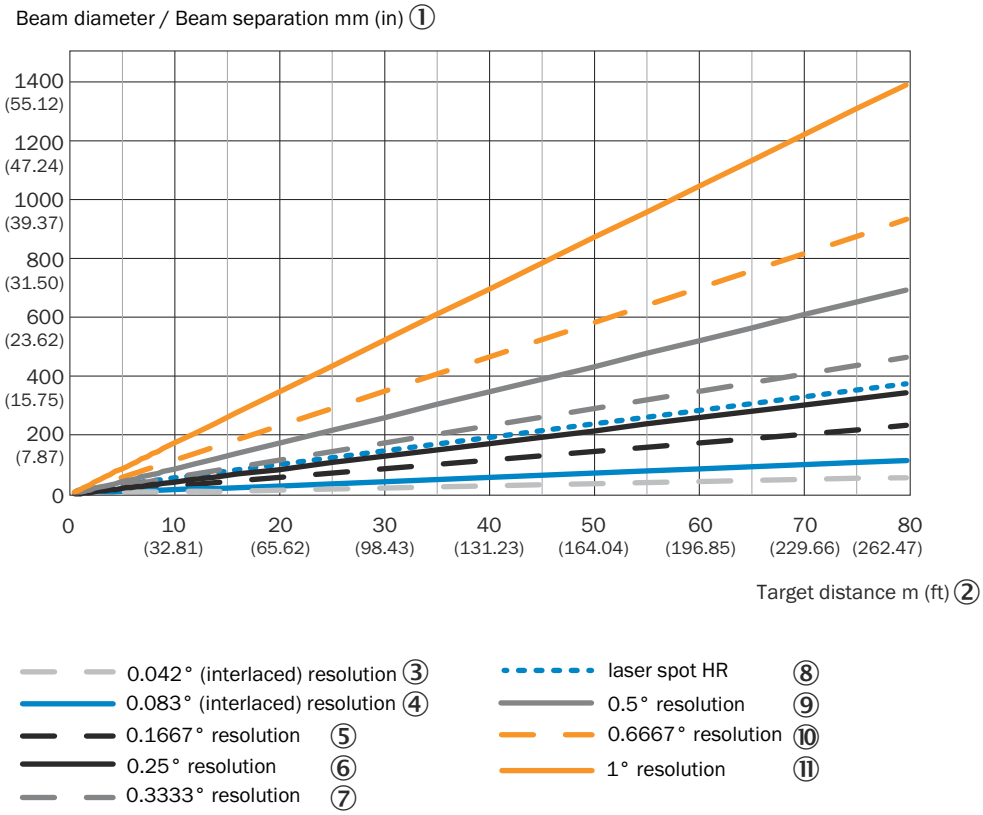


Figure 20: Beam diameter and measuring point distance at 0 to 80 m (HR)

① Beam diameter / beam separation [mm] (in)
② Distance of the target [m] (in)
③ Resolution 0.042° (interlaced)
④ Resolution 0.083° (interlaced)
⑤ Resolution 0.1667°
⑥ Resolution 0.25°
⑦ Resolution 0.3333°
⑧ Beam diameter HR
⑨ Resolution 0.5°
⑩ Resolution 0.6667°
⑪ Resolution 1°

Reading example with angular resolution 0.1667° (HR) in figure 20

- Distance intersection point 30 m results in a measuring point distance of approx. 87 mm.
- Distance intersection point 30 m with the characteristic curve for beam diameter results in a beam expansion of approx. 150 mm (HR).

3.6.8 Minimum object size

For an object to be detected reliably, it must be hit completely by a laser beam once. If the beam only partially hits, less energy may be reflected from the object see "Principle of operation", page 21.

An object is then reliably hit completely at any time if it is at least as large as the measuring point distance plus the beam diameter.

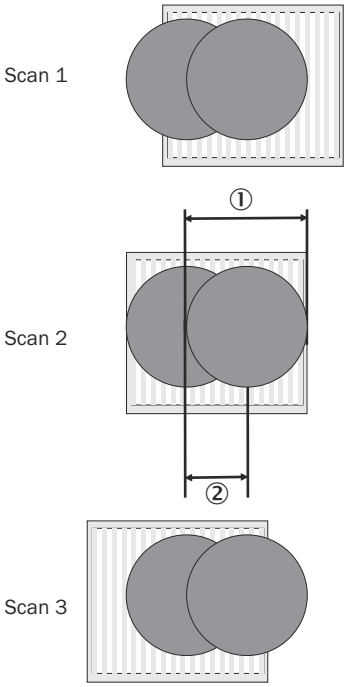


Figure 21: Minimum object size for detection

① Beam diameter

② Measuring point distance

In the example in figure 21, the object is fully hit at least once during each scan. It is therefore reliably detected if it has the necessary remission.

How to calculate the minimum object size:

Beam diameter + measuring point distance = minimum object size

- Beam diameter and measuring point distance as a function of the distance to the device can be seen in the diagram insee figure 18, page 27 or see figure 20, page 29

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 device and the object must not be moving.

3.6.9 Contamination measurement

The device has a viewing window that protects it. This viewing window can become contaminated. 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 device has 6 of its own contamination sensors. Depending on the selected contamination strategy, a certain number of these sensors is evaluated. The 6 contamination sensors are divided up into 2 groups (3 + 3).

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

In the case of the outputs, the **Device Not Ready** function responds and switches the outputs in the event of a contamination error. The device continues to output measurement data. The contamination bit in the measurement data telegram should be checked in this case (available in the Telegram Listing, accessible at www.sick.com/8014631).

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

SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Contamination Measurement**.

- Deactivated: Contamination measurement is not carried out.
- High availability: Contamination warning and contamination errors are only output when the viewing window is uniformly contaminated. This means that all 6 contamination sensors must have reached the limit value for a warning or error.
- Available: Contamination warning and contamination errors are output when the viewing window is partially contaminated.
- Sensitive: Contamination warnings and contamination errors are even output for isolated areas of contamination.
- Semi-sensitive: Contamination warning and contamination errors are output when the viewing window is partially and only slightly contaminated.
- Sensitive: Contamination warning and contamination errors are output even when there is just a little or local contamination.

NOTE

The cleaner the application environment is, the lower you can set the contamination measurement sensitivity. If a high precision of the measured values is required, the contamination measurement must be set to the most sensitive level.

Contamination warnings and contamination errors are displayed on the status indicators of the device see "LED fault indicators", page 100. You can also read these statuses via telegrams (available in the Telegram Listing, accessible at www.sick.com/8014631).

A contamination error can also be reported on a digital output if it is configured as an output for the **Device Ready** or **Contamination** status see "Inputs and outputs", page 50.

*Table 13: **Contamination (flashing)** setting*

Contamination	Digital output
No contamination	Deactivated
Contamination warning flashing	1 Hz 50/50 (on/off)
Contamination error flashing	1 Hz 90/10 (on/off)

To ensure safe operation with deactivated contamination measurement, an external reference contour should be monitored in addition to measurement data recording or the detection field. If the device no longer recognizes this contour, interfering contamination of the viewing window can be assumed.

3.6.10 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 104.

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.

3.6.10.1 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

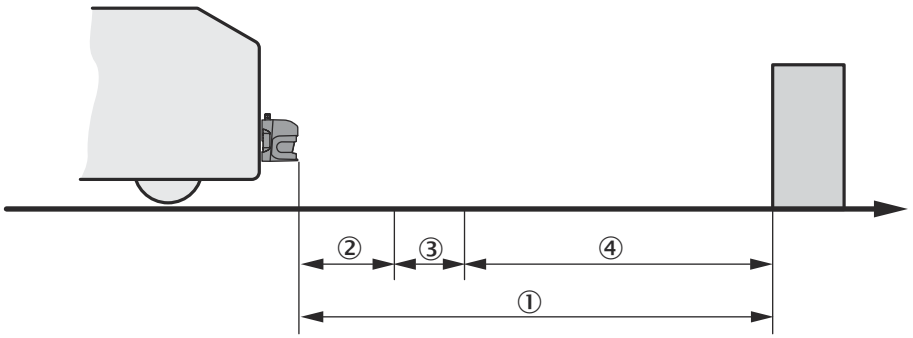
ZG = General supplement of the LiDAR sensor = 100 mm

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.



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 104.

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).

3.6.10.2 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

3.7 Fields of application

In general, the device can be used for two purposes:

- Object measurement see "Object measurement", page 34
- Detection of objects using detection fields see "Field application", page 45

That is why there is a wide range of possible applications. Some of these applications are listed below:

- Container loading/handling/positioning
- Traffic monitoring/management
- Robots/Pick-and-place applications
- Property/Building protection (low faulty alarm rate)
- Collision protection
- Navigation
- Mapping

3.7.1 Object measurement

3.7.1.1 Basic parameters

The LMS5xx PRO/Heavy Duty scans at a scanning frequency of 25 to 100 Hz or at an angular resolution of 0.042° to 1°. The LMS5xx Lite offers a reduced number of possible combinations.

At a high scanning frequency or a finer angular resolution, the device delivers more measured values.

NOTE
A scaling factor is used for some scan configurations. The distance values received via data output must be multiplied by this factor.

NOTE
The scan data displayed in the scan data monitor and the field evaluation monitor is already corrected with the scaling factor.

In the case of the **LFEperpdistresult** telegram, the output distance value corresponds to the actual distance and does not need to be corrected (see Telegram Listing at www.sick.com/8014631).

The following tables provide an overview of the possible configurations.

Table 14: Possible configurations of the LMS5xx Lite

Scanning frequency	Angular resolution			Scaling factor for data output	Max. scanning range	Interlaced
25 Hz	0.25°			x 2	80 m	-
35 Hz		0.5°		x 2	80 m	-
50 Hz		0.5°		x 2	80 m	-
75 Hz		0.5°		x 1	65 m	-
75 Hz			1°	x 2	80 m	-

Table 15: Possible configurations for LMS5xx PRO/Heavy Duty

Scanning frequency	Angular resolution									Scaling factor for data output	Max. scanning range	Interlaced
25 Hz	0.042°									x 1	65 m	4-fold 0.1667°
25 Hz		0.083°								x 1	65 m	2-fold 0.1667°

Scanning frequency	Angular resolution									Scaling factor for data output	Max. scanning range	Interlaced
25 Hz				0.1667°						x 1	65 m	-
25 Hz					0.25°					x 2	80 m	-
35 Hz					0.25°					x 1	65 m	-
35 Hz							0.5°			x 2	80 m	-
50 Hz				0.1667°						x 1	65 m	2-fold 0.3333°
50 Hz						0.3333°				x 1	65 m	-
50 Hz							0.5°			x 2	80 m	-
75 Hz					0.25°					x 1	65 m	2-fold 0.5°
75 Hz							0.5°			x 1	65 m	-
75 Hz									1°	x 2	80 m	-
100 Hz				0.1667°						x 1	65 m	4-fold 0.6667°
100 Hz						0.3333°				x 1	65 m	2-fold 0.6667°
100 Hz							0.5°			x 2	80 m	2-fold 1°
100 Hz								0.667°		x 1	65 m	-
100 Hz									1°	x 2	80 m	-

Table 16: Possible configurations for LMS5xx Extended Range

Scanning frequency	Angular resolution									Scaling factor for data output	Max. scanning range	Interlaced
25 Hz	0.042°									x 2	80 m	4-fold 0.1667°
25 Hz		0.083°								x 2	80 m	2-fold 0.1667°
25 Hz				0.1667°						x 2	80 m	-
25 Hz					0.25°					x 2	130 m	-
35 Hz					0.25°					x 2	80 m	-
35 Hz							0.5°			x 2	130 m	-
50 Hz				0.1667°						x 2	80 m	2-fold 0.3333°
50 Hz						0.3333°				x 2	80 m	-
50 Hz							0.5°			x 2	130 m	-
75 Hz					0.25°					x 2	80 m	2-fold 0.5°
75 Hz							0.5°			x 2	80 m	-
75 Hz									1°	x 2	130 m	-
100 Hz				0.1667°						x 2	80 m	4-fold 0.6667°
100 Hz						0.3333°				x 2	80 m	2-fold 0.6667°
100 Hz							0.5°			x 2	130 m	2-fold 1°

Scanning frequency	Angular resolution									Scaling factor for data output	Max. scanning range	Interlaced
100 Hz								0.667°		x 2	80 m	-
100 Hz									1°	x 2	130 m	-

SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Basic settings**, **Current configuration** and **New configuration** areas.

NOTE

- The device outputs the data after the start of the measurement through the same interface via which the measured values were requested.
- It is only possible to output all measured values of a scan in real time using the Ethernet interface.

3.7.1.2 Interlaced mode

Interlaced mode is available for LMS5xx PRO/Heavy Duty only.

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

The first scan of a sequence is a normal scan. In the following scan, the start angle is offset by a proportional angle increment so that the measuring points are placed in the gaps of the first scan. By combining the individual scans of a sequence, the measurement data is ultimately available with the finer angular resolution.

Table 17: Example of a 2-fold interlaced sequence for 0.3333° at 100 Hz

	Scan number	0°	0.3333°	0.6667°	1°	1.3333°
Sequence	**1**	x		x		x
	2		x		x	
Sequence	**3**	x		x		x
	4		x		x	
	5	...				

Table 18: Example of a 4-fold interlaced sequence for angular resolution 0.042° at 25 Hz

	Scan number	0°	0.042°	0.083°	0.125°	0.1667°	0.2087°	0.2507°
Sequence	**1**	x				x		
	2			x				x
	3		x				x	
	4				x			
Sequence	**5**	x				x		
	6			x				x
	7	...						

Setting of Interlaced mode

- By telegram: Separate activation of Interlaced mode is not necessary. With the **mLMPsetscancfg** telegram, Interlaced modes can also be selected by using valid values of an Interlaced mode as parameters for scanning frequency and angular resolution. The device will automatically scan in Interlaced mode if necessary. The scans are otherwise output directly without an interlaced sequence.
- SOPAS ET: In the **Defaults** menu, interlaced modes can also be selected as scan configurations.

NOTE

Compared to standard scan configurations, the effectiveness of the particle filter may change with interlaced scan configurations, since measurements at different angular positions are then compared. Confirming the effectiveness in the application is recommended.

Use of the interlaced data

- Measurement data output: Starting with the second scan of a sequence, one data point less per scan is output (example: Data point at 190.000 ° can still be output, but a data point at 190.042° is not recorded and can no longer be output). The measurement data are output by telegram (**LMDscandata**) after each scan. The device does not merge the individual scans of a sequence; this can be done by the customer software.
- Field evaluation: Field evaluation is based on the merged scans of a sequence.

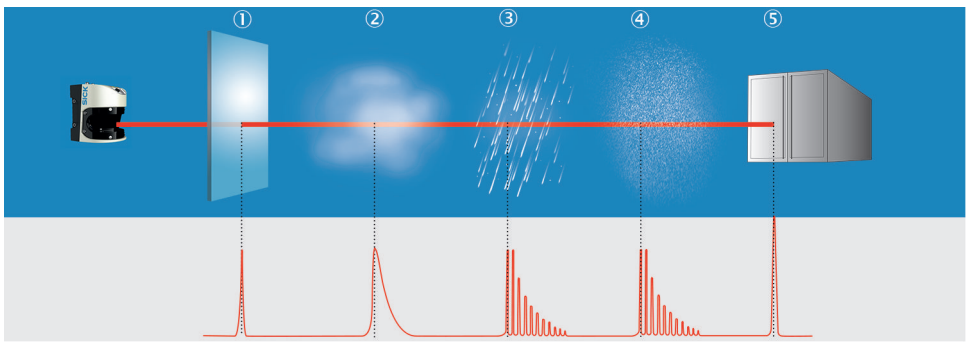
NOTE

This reduces the response time of field evaluation. Example: With 4-fold Interlaced mode 100 Hz / 0.1667°, four scans are merged into one sequence: 100 Hz÷4 = data transfer to field evaluation with 25 Hz.

- SOPAS ET: The **Field evaluation monitor** shows the multiply connected scans. **Scan View Pro** shows the individual scans as they are output with the **LMDscandata** telegram.

3.7.1.3 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 five echo signals for each measuring beam to deliver reliable measurement results, even under adverse ambient conditions.



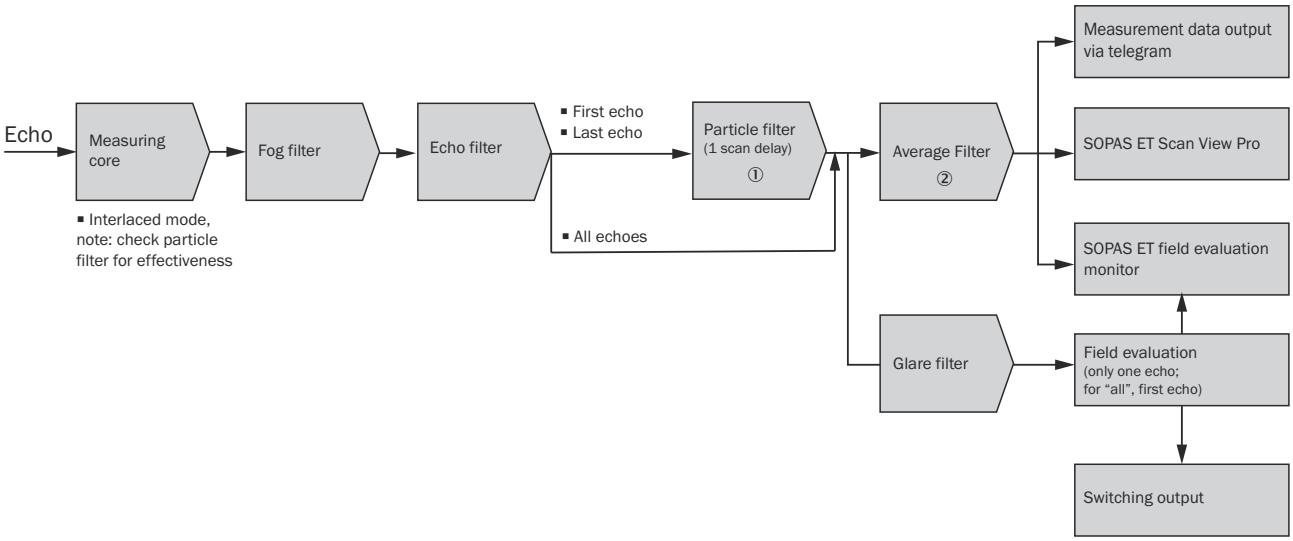
① Glass
② Fog
③ Rain
④ Dust
⑤ Measuring object

3.7.1.4 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.

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, particle filter, average filter. It should be noted, however, that the measurement data output may be delayed due to the multiple calculation steps.

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



① Note: Compared to standard scan configurations, the effectiveness of the particle filter may change with interlaced scan configurations, since measurements at different angular positions are then compared. Confirming the effectiveness in the application is recommended.

② When the interlaced mode is activated, the average filter has no function.

3.7.1.4.1 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.

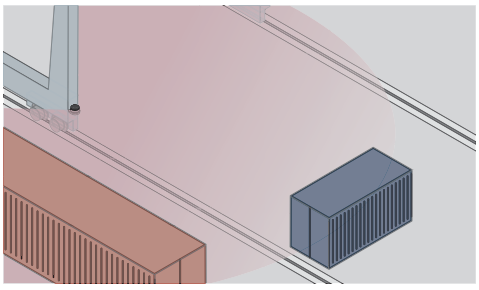


Figure 22: Without the fog filter: objects are difficult to detect through the fog due to reflections.

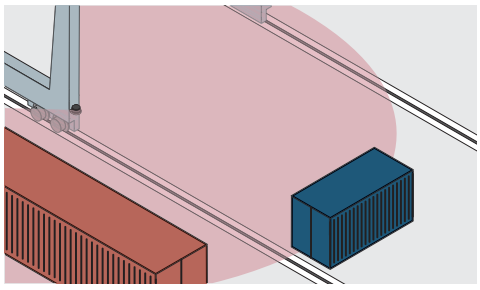


Figure 23: Using the fog filter: objects can be detected reliably because unwanted echoes are screened out.

3.7.1.4.2 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 five echoes are output.

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

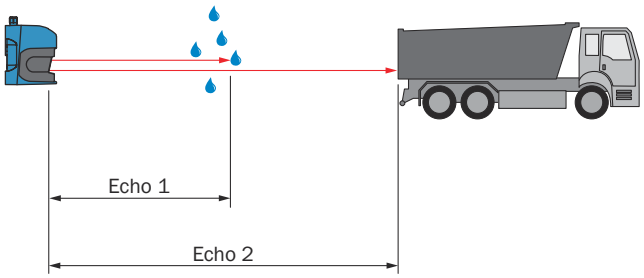


*Figure 24: **All echoes**: The device receives unwanted echoes from ambient conditions such as rain. The field evaluation only responds to the first echo when the **All echoes** setting is selected*

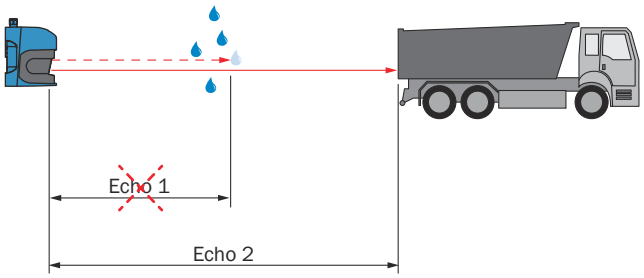


*Figure 25: When using the echo filter (setting: **Last echo**): The device screens out unwanted echoes from ambient conditions as per the settings chosen.*

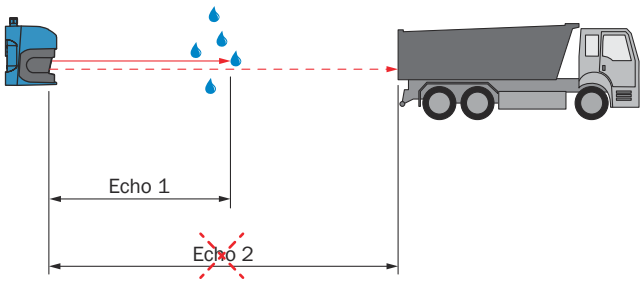


*Figure 26: When using the echo filter (setting: **First echo**): The device uses the first echo and suppresses all following echoes.*

3.7.1.4.3 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.

If the distance between a measured value and its temporal spatial neighbors is greater than a defined threshold value, this measured value is discarded as faulty.

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

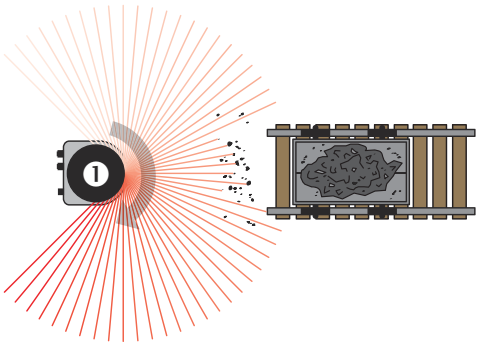


Figure 27: Without the particle filter: Violation of the contour due to dust particles in the vicinity of the object.

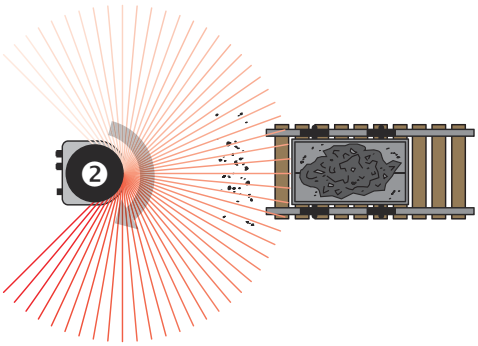


Figure 28: Using the particle filter: The response to dust particles in the detection field is delayed by one scan. Particles can thereby be blanked.

3.7.1.4.4 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.

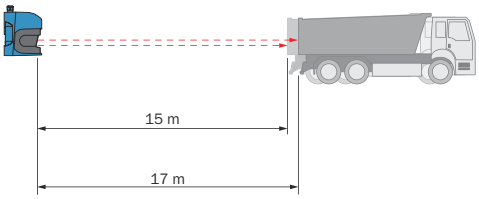


Figure 29: Without the mean filter: The device detects and processes all received signal values.

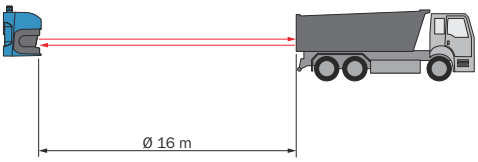


Figure 30: Using the mean filter: The device calculates an average value from several signal values.

3.7.1.4.5 Glare filter

The glare filter provides the ability to ignore invalid measured values resulting from glare in the field evaluation, provided that glare is only present within a contiguous angular range of less than 5°. If the glare exists for an angular range greater than 5°, these measured values will be included in the field evaluation as invalid measured values. In the event of glare, the measurement data output by telegram are marked by transmitting the distance value `DIST = 1` (`LMDscandata`, available in the Telegram Listing at www.sick.com/8014631)

NOTE
Under certain circumstances, glare can falsify surrounding measured values by a few centimeters.

3.7.1.5 Output of measured values

For output of measured values, the device supplies measured values at one of the data interfaces. Prerequisite for data output is that the device is in measurement mode. You have two options for starting the measurement mode:

- Start in SOPAS ET (**Project tree**, **LMS...**, **Parameters**, **Basic settings**, **Measurement** area)
- Start via a telegram (available in the Telegram Listing at www.sick.com/8014631).

NOTE
After starting the measurement mode, the device needs some time to reach status 7 (“measurement”). That is why you should request the status of the device with the sRN STIms 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 telegram – measured data is transmitted until the output of measured values is stopped with the sEN LMDscandata telegram.

Example of one-time output of measured values

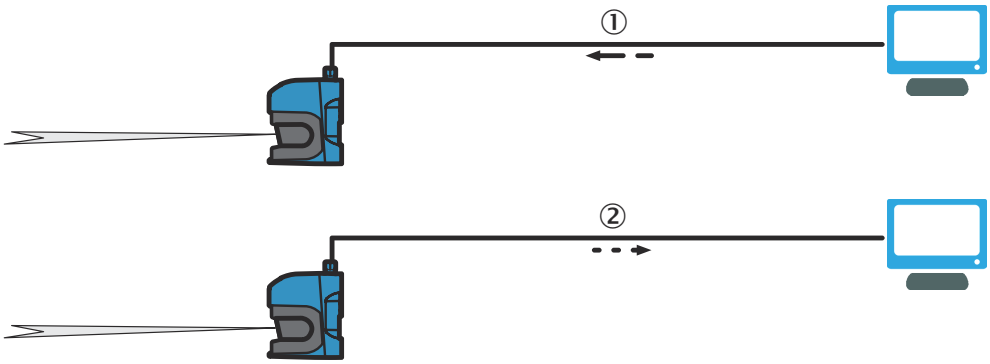


Figure 31: Query of measured value telegram

① Measured value query
② Output of a measured value telegram

1. Log in

Request: <STX>sMN SetAccessMode 03 F4724744<ETX>

Reply: <STX>sAN SetAccessMode <ETX>

2. Start measurement

Request: <STX>sMN LMCstartmeas<ETX>

Reply: <STX>sAN LMCstartmeas 0<ETX>

3. Log out and start device

Request: <STX>sMN Run<ETX>

Reply: <STX>sAN Run 0<ETX>

4. Request measurement status

NOTE
Query the status until status 7 (“measurement”) is achieved in the response.

Request: <STX>sRN STIms<ETX>

Reply: <STX>sRA STIms 7 0 8 00:00:00 8 01.0 1.06 0 0 0<ETX>

NOTE
If the status is less than 7, send request again.

5. Starting output of measured values of a single scan

Request: <STX>sRN LMDscandata<ETX>

Reply: <STX>sRA LMDscandata<ETX>

If an error is present and reported in the response telegram: Depending on the type of error, the device will either stop measurement mode or not.

Example of continuous output of measured values

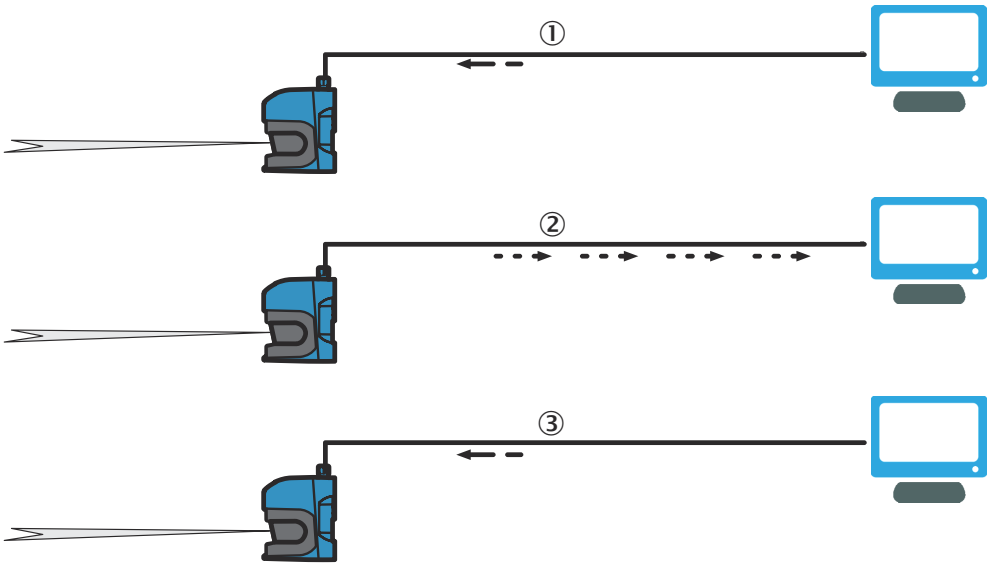


Figure 32: Continuous output of measured values

① Measured value query

② Output measured-value telegrams

③ Command to stop the output

NOTE

If you cannot be sure that the scan data can be processed at the same speed as it is output by the device, you should only query the scan data individually. The scan counter, telegram counter, and time stamp in the output of measured values can serve as an indication that processing is too slow.

1. Log in

Request: <STX>sMN SetAccessMode 03 F4724744<ETX>

Reply: <STX>sAN SetAccessMode <ETX>

2. Start measurement

Request: <STX>sMN LMCstartmeas<ETX>

Reply: <STX>sAN LMCstartmeas 0<ETX>

3. Log out and start device

Request: <STX>sMN Run<ETX>

Reply: <STX>sAN Run 0<ETX>

4. Request measurement status

NOTE

Query the status until status 7 (“measurement”) is reached in the response.

Request: <STX>sRN STIms<ETX>

Reply: <STX>sRA STIms 7 0 8 00:00:00 8 01.0 1.06 0 0 0<ETX>

NOTE
If the status is less than 7, send request again.

5. Starting continuous output of measured values

The scan data is output until output of measured values is over.

Request: <STX>sEN LMDscandata 1<ETX>

Confirmation: <STX>sEA LMDscandata 1<ETX>

Continuous response: <STX>sSN LMDscandata<ETX>

6. Stopping continuous output of measured values

Request: <STX>sEN LMDscandata 0<ETX>

Confirmation: <STX>sEA LMDscandata 0<ETX>

3.7.1.6 RSSI values

RSSI (Received Signal Strength Indicator) is the measure of the energy that the sensor receives. This value is determined for each measurement and has a logarithmic, arbitrary unit. 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 RSSI value. A valid distance measurement has an RSSI of at least 1.

figure 33 and figure 34 show the different approximation curves for the RSSI ranges of the HR and SR variants depending on the remission of the object, with 10% representing the lowest value (black) and 100% the highest value (white paper). A value of > 80.000% stands for one reflector. For this reason, the curve based on this remains constant at 254.

Table 19: RSSI values

RSSI value	Description
0	No signal
1–254	Valid measurement
254	Reflector
255	Dazzled

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 scanning range (> 80 m).
- The target object has an extremely low remission.

Please note that white paper (100%) can have very similar values to a reflector at a short distance.

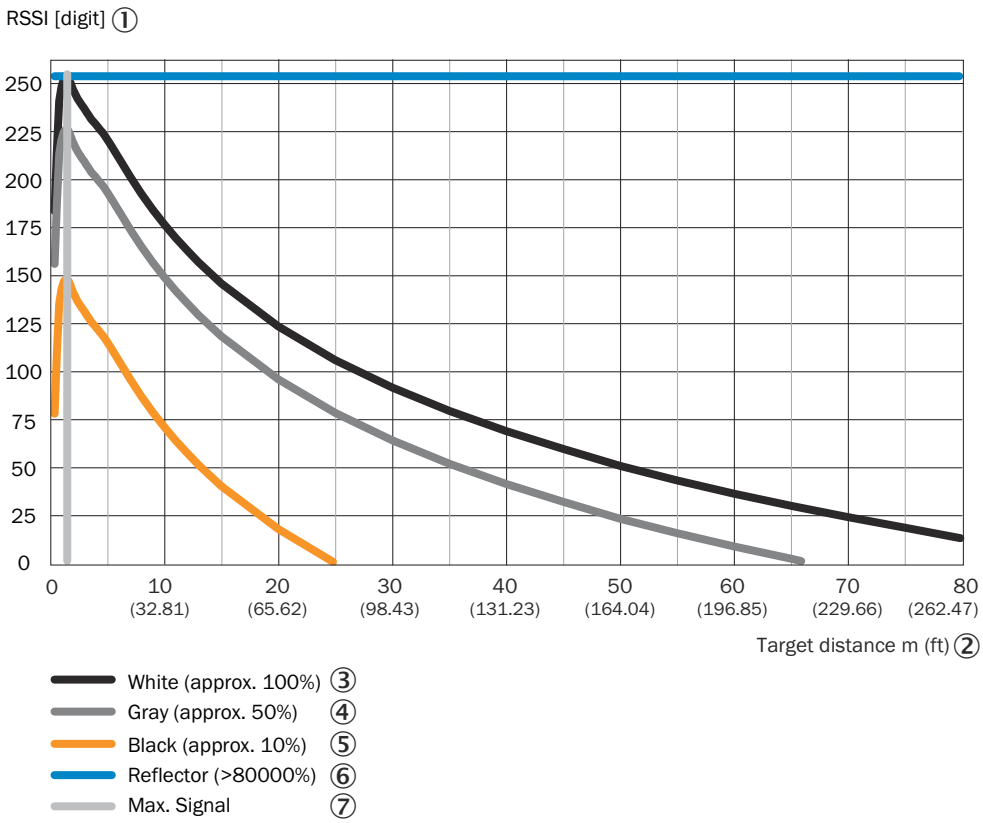


Figure 33: Typical RSSI value HR

① RSSI [number]
② Distance [m]
③ White (approx. 100%)
④ Gray (approx. 50%)
⑤ Black (approx. 10%)
⑥ Reflector (> 80,000%)
⑦ Max. signal

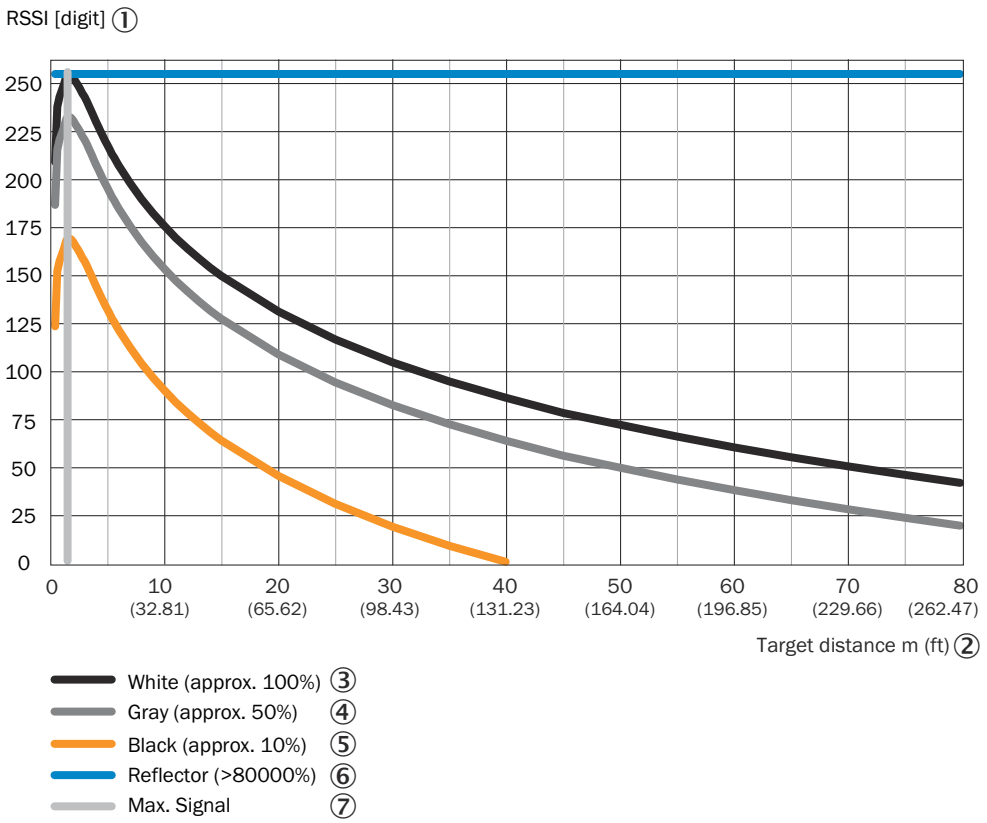


Figure 34: Typical RSSI value SR

① RSSI [number]
② Distance [m]
③ White (approx. 100%)
④ Gray (approx. 50%)
⑤ Black (approx. 10%)
⑥ Reflector (> 80,000%)
⑦ Max. signal

The RSSI values can vary slightly among different devices and during the service life of the sensor.

SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Data processing**, **Output format** area.

3.7.2 Field application

Using the integrated field application, the LMS5xx PRO/Heavy Duty evaluates up to ten detection fields within its scanning range, the LMS5xx Lite up to four. You can use the field application to implement systems for collision protection, object protection or access monitoring, for example.

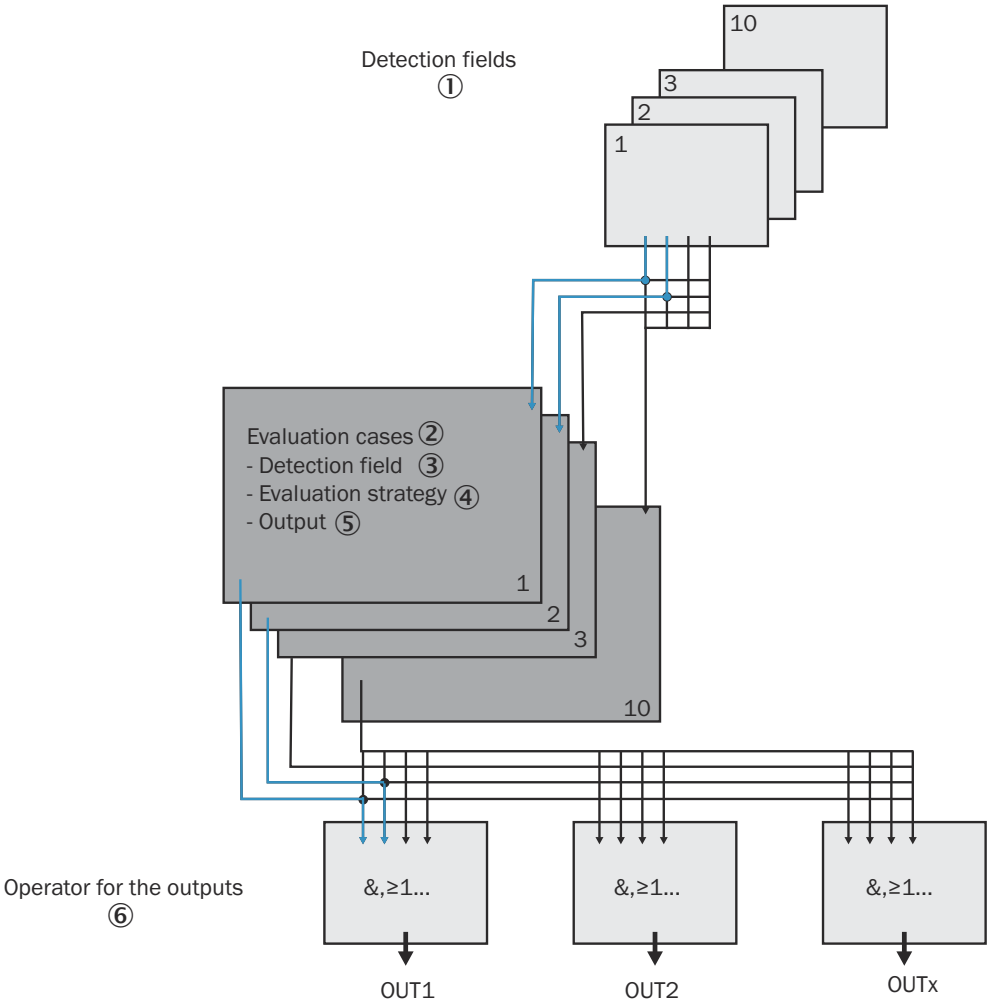


Figure 35: Principle of field application

① Detection fields
② Evaluation cases
③ Detection field
④ Analysis strategy
⑤ Output
⑥ Linking of outputs

The LMS5xx PRO/Heavy Duty is adapted to the evaluation situation using up to ten evaluation cases, and the LMS5xx Lite using up to four. In the evaluation case, one of ten (four) configurable detection fields, an evaluation strategy, an output, and possibly a combination of inputs or time periods that activate the evaluation case are selected. For each output, a link is chosen which determines the result of the output if more than one evaluation case affects the output.

In the example in figure 35, detection field 1 is used in evaluation case 1, and detection field 2 is used in evaluation case 2. Both evaluation cases act on output OUT1. If the results of the evaluation cases are AND-linked, the output only switches when both evaluation cases report an event.

3.7.2.1 Detection fields

Using the integrated field application, you can configure up to ten detection fields with the PRO version and up to four fields with the Lite version. The size and shape of these detection fields are (almost) freely configurable.

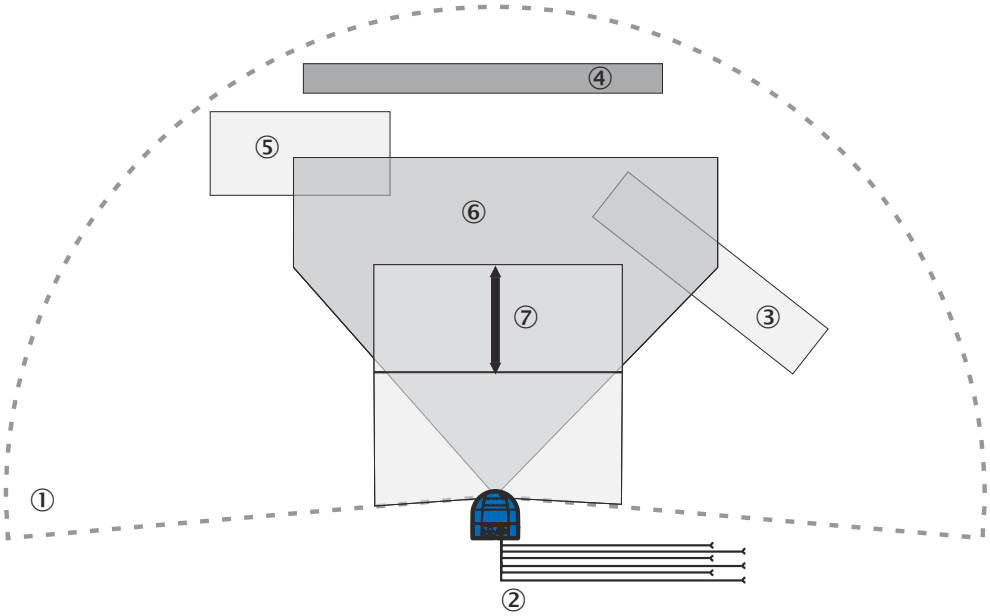


Figure 36: Examples of 4 different detection field shapes

① Measuring range of the device
② Outputs
③ Rotated detection field
④ Detection field for contour monitoring
⑤ Square detection field with distance to the device
⑥ Polygonal detection field
⑦ Dynamic detection field

The detection fields can be drawn using SOPAS ET according to the needs of your application. Detection fields can have the following properties:

- Polygon
- Square
- Beginning on device
- With distance to device (“island field”)
- Dynamic, i.e. the length varies according to the speed detected by the encoder, see "encoder inputs", page 50 (LMS500 / LMS511 PRO/Heavy Duty only)

You configure the detection fields in SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Evaluation fields**.

If the area to be monitored changes, the field can be easily reconfigured using the SOPAS ET configuration software.

3.7.2.2 Evaluation cases

An evaluation case determines which detection field is evaluated in which way and on which output it acts.

With the LMS5xx PRO/Heavy Duty, you can configure up to ten evaluation cases, while the LMS5xx Lite enables up to four evaluation cases.

For each evaluation case, configure in SOPAS ET:

- Inputs or time periods that activate an evaluation case, if applicable. If nothing is specified, the evaluation case is always active.
- The evaluation strategy
- The detection field

- The output affected by the analysis case
- The response time **Project tree**, **LMS...**, **Parameters**, **Evaluation cases.**

Inputs

If the evaluation case is not permanently active, you can configure an input combination that activates the evaluation case.

Table 20: Examples of input combinations for the LMS5xx PRO [1)]

Input 1	Input 2	Input 3	Input 4	Evaluation case
Low	Low	Low	Low	1
Low	Low	Low	High	2
Low	Low	High	Low	3
Low	Low	High	High	4
Low	High	Low	Low	5
Low	High	Low	High	6
Low	High	High	Low	7
Low	High	High	High	8
High	Low	Low	Low	9
High	Low	Low	High	10

1) The initial HIGH state is called “Active HIGH” in SOPAS ET. Accordingly, the initial LOW state is called “Active LOW”.

NOTE

An input combination can also be defined for several evaluation cases, then e.g. two evaluation cases become active simultaneously.

Although the LMS5xx Lite has two inputs, only IN1 can be used for field evaluation.

Analysis strategy

In SOPAS ET, you choose from the following possible detection strategies:

- **Pixel analysis**: The device evaluates the entire area of the field. Each individual beam is taken into account in evaluation. If an object enters the field, this result is forwarded to the corresponding output.
- **Blanking**: The device evaluates the entire area of the field. However, objects that are smaller than the specified size are ignored. An object is only detected if it is larger than the configured blanking size. However, this only applies to objects that are at the maximum distance at which they still meet the criteria for the minimum object size. At greater distances, the set blanking size can no longer be achieved by the optical resolution of the device. The device behaves exactly as with pixel evaluation.
- **Contour**: The device also evaluates the existence of a contour, which has to be fully situated within the detection field at all times. This allows the device to detect, for example, that a door opens outwards or that the position of the device has changed. It is also possible to detect someone crawling beneath a vertical detection field or a laser beam deflected in a mirror. Blanking can be used to hide the missing part of the contour up to a certain size.
- **I/O linking**: The I/O linking evaluation strategy allows you to link the inputs of the device to its outputs see "Inputs and outputs", page 50.
- **Perpendicular distance to the reference line**: The device outputs the perpendicular distance to an object located within the detection field. The perpendicular distance **d** is output in the **LFEperpdistresult** telegram, see Telegram Listing. The response time, blanking size, and alignment of the reference line can be configured in SOPAS ET.

Response time

For the **Pixel analysis**, **Blanking**, **Contour** and **Perpendicular distance to the reference line** evaluation strategies, you define a response time. For the device to detect an object using the **Pixel analysis**, **Blanking** and **Perpendicular distance to the reference line** evaluation strategies, the object must be detected at the same location for at least the duration of the response time. For the **Contour** evaluation strategy, the contour breach must be detected at the same location for at least the duration of the response time.

Manipulation prevention

When **Pixel analysis** is configured, dazzling can cause the device to stop monitoring a field. When **Blanking** is configured, small objects in the vicinity of the device can cause large shadows.

If you use detection fields at a distance to the device, the object or the object erroneously measured due to dazzle lies outside the detection field and is not detected.

To prevent this, you can configure the **Manipulation protection** option.

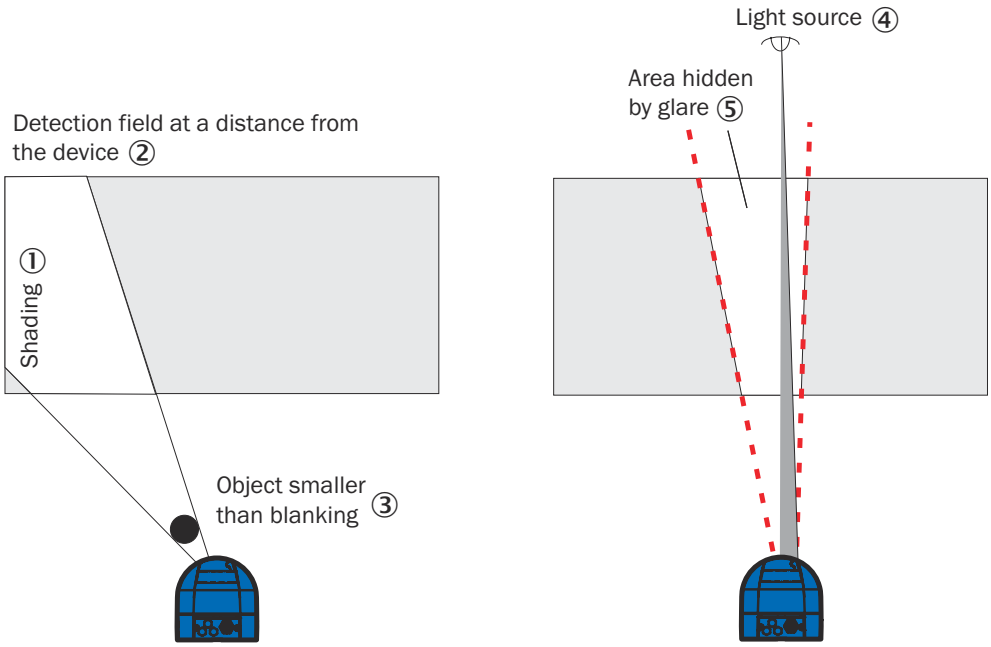


Figure 37: Tamper-proofing against shadowing and dazzle

① Shadowing
② Detection field with distance to the device
③ Object smaller than blanking
④ Light source
⑤ Blanked area

The **Manipulation protection** option switches the detection field:

- If an object less than or equal to the blanked object size is in front of the laser output aperture of the device for the response time configured for manipulation protection.
- If the device is blanked for longer than the response time configured for manipulation protection.

Detection field

For the evaluation case, select a field from the already configured detection fields. Its shape must fit the evaluation strategy see "Detection fields", page 46.

Output

Select one of the outputs for the evaluation case. If several evaluation cases act on one output, you must determine how the results of the evaluation cases are linked see "Linking of evaluation cases at the output", page 50.

NOTE
The respective output must be configured for “Application”.

Negating the result

Negating the result reverses the field evaluation output. The output used is thus switched, for example, if the detection field is free or if the contour is not interrupted.

NOTE
Do not confuse negation of the result with the Active HIGH/Active LOW setting of the outputs see "Linking of evaluation cases at the output", page 50.

3.7.2.3 Linking of evaluation cases at the output

If several evaluation cases act on one output, you must determine how the results of the evaluation cases are linked. The respective results can be linked with AND or OR.

SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Network/Interfaces/IOs**, **Digital outputs**.

The outputs are configured as **Active Low** by default. You can also configure them as **Active High**.

Resetting an output

In the default setting, the outputs are immediately reset to the deactivated state. You can configure a delay of up to 10 s (e.g. to activate a horn or to transmit the output signal to a PLC).

Alternatively, you can also reset the output via an input. The output is only reset when the assigned input assumes the configured status.

3.8 Inputs and outputs

Digital inputs

The LMS5xx Lite has two digital inputs, the LMS531 Lite has three, and the LMS5xx PRO/Heavy Duty has four. These inputs could activate different evaluation cases see "Evaluation cases", page 47.

The inputs can also be used to reset the outputs of the LMS5xx see "Resetting an output", page 50.

encoder inputs

The LMS500/511 PRO/Heavy Duty has two encoder inputs (IN3 and IN4) that can be selected via software.

The encoder pulses can be used to influence the size of so-called dynamic fields, for example for speed-dependent vehicle monitoring. A dynamic field changes its length with the speed measured e.g. by encoders.

SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Network/Interfaces/IOs**, **Digital inputs 3+4/Encoder (HTL)/Sync**.

When stationary (V = 0 m/s), the detection field has the size of the configured basic field. The size increases continuously with increasing speed until the largest field extension is reached at maximum speed.

Digital outputs

The LMS531 Lite has one digital output. The LMS500 / LMS511 Lite has three digital outputs, the LMS500 / LMS511 PRO/Heavy Duty has six.

The outputs can be used as digital outputs to ground or as volt-free outputs see "Wiring the inputs and outputs", page 76.

For the **... / Device Not Ready** setting, the sensor always signals **Device Not Ready** regardless of whether the outputs are switched by the field evaluation application or by SOPAS ET telegrams.

SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Network/Interfaces/IOs**, **Digital outputs**.

If the field evaluation application is being used to switch an output, the LMS5xx may signal object detections or contour interruptions. In SOPAS ET, you can configure which evaluation case affects which output.

External digital outputs

Up to 8 additional digital outputs can be controlled via a CAN extension module (part no. 6038825 or 6041328). To use the additional outputs, the extension module must be activated.

SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Network/Interfaces/IOs**, **External digital outputs**

NOTE
For monitoring the extension module (heartbeat), module ID < 63 must be set.

Relay outputs

The LMS531 Lite has two relay inputs, the LMS531 PRO four. These can optionally be configured to switch to HIGH or LOW when an object or person is detected in the detection field.

SOPAS ET: **Project tree**, **LMS531**, **Parameters**, **Network/Interfaces/IOs**, **Relay outputs**.

There are the following options for configuration:

Table 21: LMS531 Lite/PRO: Status of the outputs in case of object detection

Output	Configured HIGH logic	Configured LOW logic
Relay output	Relay closed	Relay open

Details of the relay outputs see "Parameterizing the LMS531 variants for security applications", page 84.

Synchronization of several LMS5xx units

There may be mutual optical interference between two or more LMS5xx units if they must be mounted on the same scan plane see "Mounting multiple devices", page 57.

Several LMS5xx units arranged in this way can be synchronized to prevent this type of interference. With the help of SOPAS ET, an LMS5xx can be configured according to type and synchronized with other LMS5xx units via assigned outputs and inputs:

Table 22: Overview: Assigned inputs and outputs for synchronization

Variant	Output (as Sync Main)	Input (as Sync Sub)
LMS500 Lite Indoor	Terminal 5: OUT Sync (OUT3)	Terminal 7: OUT IN Sync
LMS500 PRO Indoor	Terminal 26: OUT Sync (OUT6)	Terminal 11: IN Sync (IN4)
LMS511 Lite Outdoor	"I/O" connection Pin 6: OUT Sync (OUT3)	“Data” connection Pin 7: IN Sync
LMS511 PRO Outdoor	"I/O" connection Pin 12: OUT Sync (OUT6)	"I/O" connection Pin 8: IN Sync (IN4)

Variant	Output (as Sync Main)	Input (as Sync Sub)
LMS511 Heavy Duty	"I/O" connection Pin 12: OUT Sync (OUT6)	"I/O" connection Pin 8: IN Sync (IN4)
LMS581 PRO Outdoor	"I/O" connection Pin 12: OUT Sync (OUT6)	"I/O" connection Pin 8: IN Sync (IN4)

LMS500/511 PRO and Heavy Duty: When using synchronization via input 4, input 3 is deactivated.

The synchronization phase value (range: -180 ... +180°) in SOPAS ET can be used to distinguish between the individual main-sub connections.

Synchronization can also be used to increase the scanning frequency of an area by using several units to monitor the same area and setting their phases to alternate scanning.

Linking of inputs and outputs

With the aid of an evaluation case, the inputs and outputs of several LMS5xx units can be linked together see "Evaluation cases", page 47.

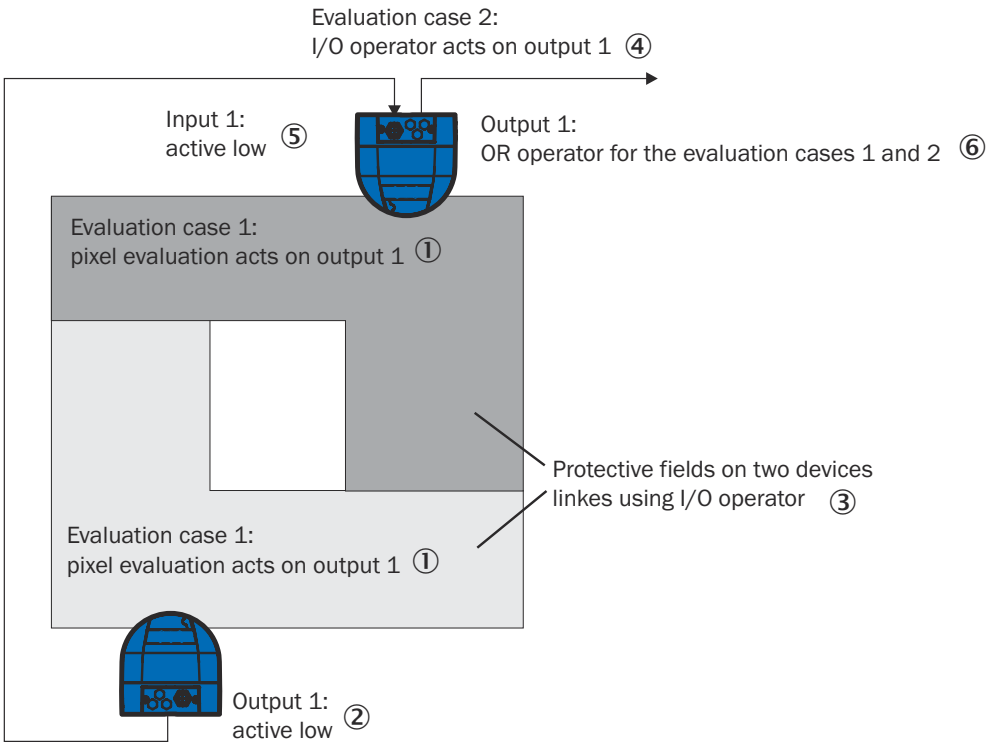


Figure 38: Linking of inputs and outputs

① Evaluation case 1: Pixel evaluation acts on output 1
② Output 1: Active low
③ Protective fields of two devices linked by I/O link
④ Evaluation case 2: I/O link acts on output 1
⑤ Input 1: Active low
⑥ Output 1: OR-link of evaluation cases 1 and 2

In the example above, output 1 of the lower LMS5xx is connected to input 1 of the upper LMS5xx. An interruption of the detection field is thereby reported to the input of the upper LMS5xx. In its evaluation case 2, this LMS5xx links the input to output 1. At

the same time, evaluation case 1 affects the upper LMS5xx and its output 1. By linking the two results with the OR logical operator, object detections in the detection field are reported on both LMS5xx units at output 1 of the upper LMS5xx.

3.9 Data interfaces

The device has different data interfaces for configuration and the transmission of measured values.

NOTE

- It is only possible to output all measured values of a scan in real time using the Ethernet interface.
- The data transmission rate of the RS-232 / RS-422 interfaces is limited to 500 kBd. Therefore these interfaces are not suitable for transmitting scan data in real time.

For a description of the electrical interfaces see "Connections", page 63.

Ethernet interface

The Ethernet interface has a data transmission rate of 10/100 Mbit/s. The interface is a TCP/IP, UDP/IP interface supporting full duplex and half duplex.

- TCP/IP: The device can be used as a server or client in the network to output its data. TCP port 2111 is intended to be used as a configuration interface. TCP port 2112 can be used for the process data. Both ports are equivalent. The device can also send the measurement data via UDP using port 2213.
- Heartbeat: The heartbeat function can be used to cyclically check the communication interface. The device sends a custom text message at regular intervals. This functionality offers the advantage that it closes sockets that have not been closed correctly (e.g., due to connection failures). The device can open up to 10 sockets in parallel per TCP port.
- UDP: The device can output measurement data via UDP using port 2213.

The Ethernet interface allows the configuration of the device as well as the output of measured values.

The factory setting for the Ethernet interface is as follows:

- IP address: 192.168.0.1
- Subnet mask: 255.255.255.0
- TCP port: 2111

You might need to adjust the configuration of the Ethernet interface so that a connected computer (client) can communicate with the device via Ethernet: **Project tree**, **LMS...**, **Parameters**, **Network/Interfaces/IOs**, **Ethernet**.

NOTE

If you change the parameters of the Ethernet interface via the Ethernet interface, you must first save the data permanently to non-volatile memory in the device and then restart the device. A **Restart** button is provided in SOPAS ET for this purpose.

Serial host interface

The serial host interface is an RS-232 / RS-422 interface. The host interface permits the configuration of the device and limited output of measured values.

The interface parameters are freely configurable: SOPAS ET **Project tree**, **LMS...**, **Parameters**, **Network/Interfaces/IOs**, **Serial**, **Serial host interface** area.

The factory setting for the host interface is as follows:

- 57.6 kBd
- 8 data bits
- 1 stop bit
- No parity

NOTE

If you change the parameters for the host interface via the host interface, the connection to the device will be lost. You must then scan for the device again in SOPAS ET (see "Performing a scan", page 82).

USB auxiliary interface

The Mini-USB auxiliary interface permits direct configuration of the device.

NOTE

To access the device via the USB auxiliary interface, the required USB driver must first be installed on the computer. Available for downloading 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).

Parameters can be changed via USB while the device is connected to a host via another interface such as RS or Ethernet. Only the last changes saved in the configuration, both via USB and via RS or Ethernet, are retained.

3.10 Communicating data via telegrams

The device sends telegrams over the interfaces described above to communicate with a connected host. The following functions can be run using telegrams:

- Request measured values via the host and then output them once via the device
- Parameter setting by the host for the configuration of the device
- Parameters and status log querying by the host.

Each telegram comprises a frame and the application data.

A detailed description of the different telegrams can be found in the Telegram Listing, available at www.sick.com/8014631.

Frame and coding of the telegrams

The payload varies depending on the coding.

Table 23: Frame of the telegrams when using ASCII coding (CoLa-A)

	Frame	Telegram	Frame
Designation	STX	Application data	ETX
Length (Byte)	1	≤ 60 kB	1
Description	Start of text character	ASCII coded	End of text character

You can configure the frame of the serial host interface in SOPAS ET: **Project tree**, **LMS...**, **Parameters**, **Network/Interfaces/IOs**, **Serial**, **Serial host interface** area.

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 104.
- Relative humidity: see "Technical data", page 104.
- 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 should be mounted so that the connectors point downwards. This makes it easier for moisture to run off the male connectors. Furthermore, in this orientation the contamination measurement will better reflect the actual contamination of the front screen.
- The connecting cables should be laid with some cable in reserve to act as a drip loop so no moisture (e.g., condensation) is directed towards the device but instead drips off the cable beforehand.
- 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 115.
- Make sure the entire field of view of the device is not restricted, see "Dimensional drawings", page 113.
- Observe maximum torque of the fixing screws: M8 lateral = max. 16 Nm / M6 rear = max. 12 Nm
- 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 115.
- 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.
- 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 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 the device

NOTE

For direct mounting without the SICK mounting bracket:

- There must be a sufficient distance between the housing and the support structure to prevent heat accumulation.
- It must be ensured that no moisture is permanently present on the sealing surfaces and that the housing can dry in a short time.
- In order to prevent bimetallic corrosion, appropriate mounting materials must be used or there must be sufficient distance between the housing (die cast aluminum) and the support structure.

1. Mount the device directly or in a suitably prepared bracket using the fixing holes provided (see "Dimensional drawings", page 113). Mounting brackets are available as optional accessories, see "Accessories", page 115.
2. Make the electrical connection, see "Electrical installation", page 58.
3. Align the vertical center line of the field of view of the device with the center of the area to be monitored.

4. Switch on the supply voltage.
✓ The green **OK** LED lights up after initialization.
5. The device is ready for use. Perform a fine adjustment using a test target and, if necessary, use the alignment aid, see "Accessories", page 115.

5.3 Mounting multiple devices

NOTICE RISK OF INTERFERENCE FROM OTHER DEVICES!
Radiation sources with a wavelength of 905 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 any negative impacts on the measurement accuracy, the devices should be arranged in such a way that the laser beams are not received by another device.

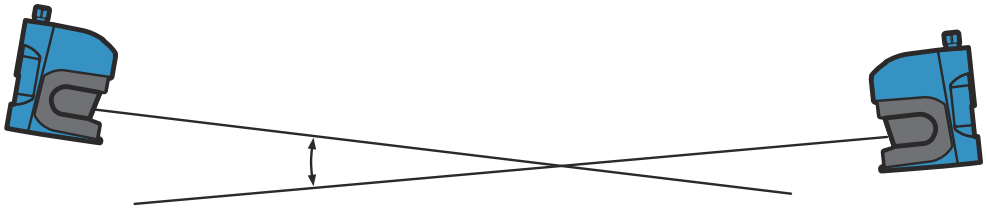


Figure 39: Arrangement for 2 devices

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.

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.

Connect the connecting cables in a de-energized state. Do not switch on the supply voltage until installation is complete and all connecting cables are connected to the device and control.

Wire cross-sections in the supply cable from the customer's power system must be implemented in accordance with the applicable standards.

Take suitable external safety measures to protect the digital inputs, digital outputs and their supply voltage against transient overvoltage.

Only use cables with shielding on both sides for wiring.

6.2 Overview of the installation steps

1. Wire the digital inputs and digital outputs (application-dependent).
2. Connect the computer temporarily (configuration).
3. Wire the data interface for operation.
4. Set up the voltage supply for the device.

6.3 Prerequisites for safe operation of the device

WARNING
Risk of injury and damage caused by electrical current!

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

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

Remedial measures

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

The device is connected to the peripheral devices (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

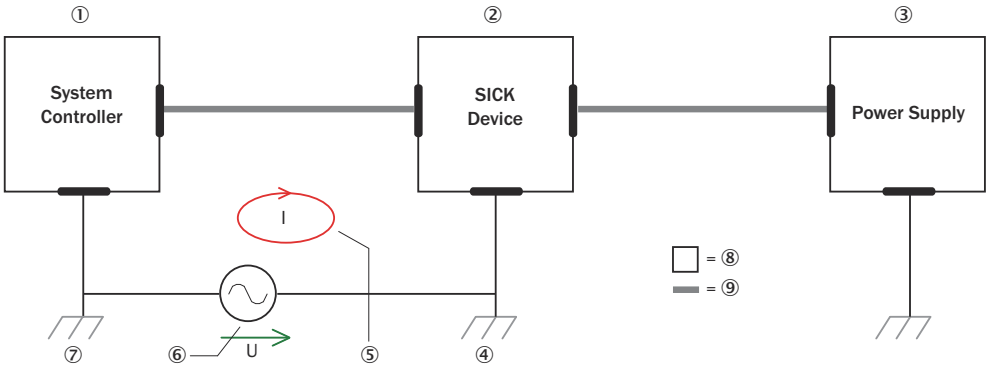


Figure 40: Example: Occurrence of equipotential bonding currents in the system configuration

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.

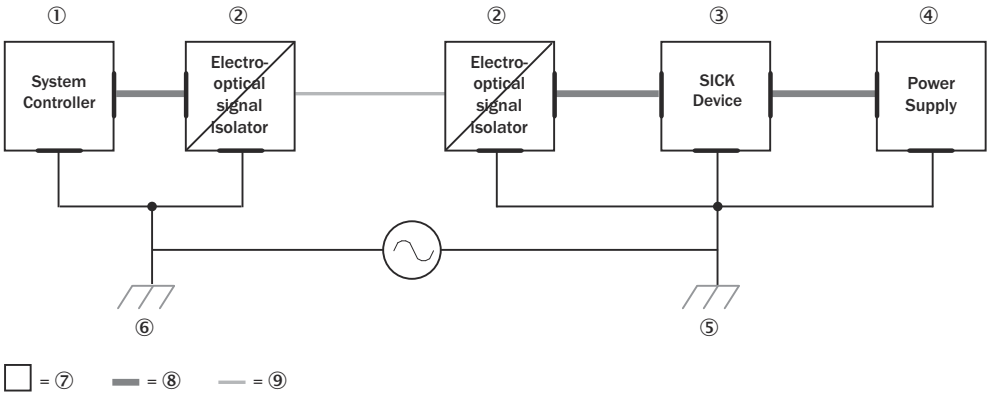


Figure 41: Example: Prevention of equipotential bonding currents in the system configuration by the use of electro-optical signal isolators

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.

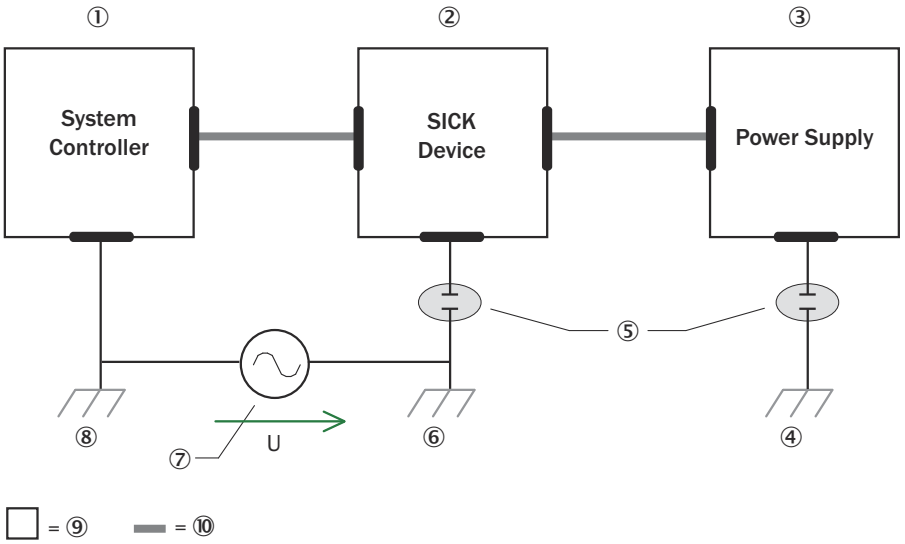


Figure 42: Example: Prevention of equipotential bonding currents in the system configuration by the insulated mounting of the device

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.

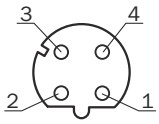
Suitable external safety measures should be taken by the customer to protect the IOs and their supply voltage against transient overvoltage.

6.4 Connections

6.4.1 Connections of the LMS500

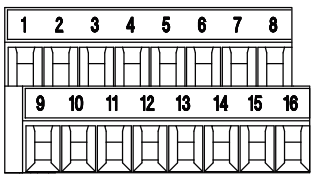
LMS500 Lite and PRO Indoor: “Ethernet” connection on system plug

Table 24: LMS500 Lite and PRO Indoor: Pin assignment of the “Ethernet” connection

Male/female connector	Contact	Short form	Signal description
 *Figure 43: M12 female connector, 4-pin, D-coded*	1	TX+	Sender+
	2	Rx+	Receiver+
	3	TX–	Sender–
	4	Rx–	Receiver–

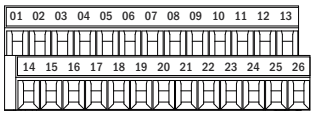
LMS500 Lite Indoor: “Power/Data/I/O” connection in system plug

Table 25: LMS500 Lite Indoor: Terminal assignment of the “Power/Data/I/O” connection

Male/female connector	Contact	Short form	Signal description
 *Figure 44: 2 x terminal strip, 8-pin*	01	V_S	Sensor supply voltage
	02	GND	Ground sensor
	03	OUT1	Digital output 1
	04	OUT2	Digital output 2
	05	OUT3 / OUT Sync	Digital output 3 / Synchronization output
	06	IN1	Digital input 1
	07	IN Sync	Synchronization input
	08	GND IN /IN Sync	Ground of digital input 1 / synchronization input
	09	V_S OUT	Digital output supply voltage
	10	GND V_S OUT	Supply voltage ground of digital outputs
	11	TD+	RS-422 sender
	12	TD–/TxD	RS-422 / RS-232 sender
	13	GND RS	RS-422/RS-232 ground
	14	RD–/RxD	RS-422/RS-232 receiver
	15	RD+	RS-422 receiver
	16	RS shield	RS-422/RS-232 screen

LMS500 PRO Indoor: “Power/Data/I/O” connection in the system plug

Table 26: LMS500 Pro Indoor: Terminal assignment of the “Power/Data/I/O” connection

Male/female connector	Contact	Short form	Signal description
 *Figure 45: 2 x terminal strip, 13-pin*	01	V_S	Sensor supply voltage
	02	GND	Ground sensor
	03	OUT1	Digital output 1
	04	OUT2	Digital output 2
	05	OUT3	Digital output 3
	06	IN1	Digital input 1
	07	IN2	Digital input 2
	08	GND IN1/2	Ground for digital inputs 1 and 2
	09	GND IN3/4/IN Sync	Ground for digital inputs 3 and 4 / Input Synchronization
	10	IN3	Digital input 3
	11	IN4/IN Sync	Digital input 4 / Synchronization input
	12	OUT4	Digital output 4
	13	OUT5	Digital output 5
	14	V_S OUT	Digital output supply voltage
	15	GND V_S OUT	Supply voltage ground of digital outputs
	16	TD+	RS-422 sender
	17	TD–/TxD	RS-422 / RS-232 sender
	18	GND RS	RS-422/RS-232 ground
	19	RD–/RxD	RS-422/RS-232 receiver
	20	RD+	RS-422 receiver
	21	RS shield	RS-422/RS-232 shielding
	22	CAN shield	CAN bus shielding
	23	CAN H	CAN bus HIGH
	24	GND CAN	Ground CAN-BUS
	25	CAN L	CAN bus LOW
	26	OUT6/OUT Sync	Digital output 6 / Synchronization output

Yellow bypass switch at the system connection

By moving the bypass switch, you can select which pins provide the supply voltage for the outputs or which pin provides the ground potential of the inputs.

NOTE

If the bypass switch is set as "bridge", a higher power is consumed via the supply cable of the sensor (supply power for sensor and outputs).

Table 27: Supply voltage outputs

	S1 position SYS(default)	S1 position EXT
		
V_S OUT	Via Vs from Pin1	Via external from Pin14
GND OUT	Via GND from Pin2	Via external from Pin15

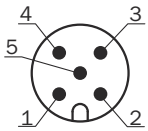
Table 28: Ground inputs

	S2 position V_OUT (S1) (default)	S2 position PIN 8/9
		
GND IN1/2 (PRO, Heavy Duty)	Set via GND supply voltage as with S1	Via Pin8
GND IN3/4/IN Sync (PRO, Heavy Duty)		Via Pin9
GND IN (Lite)		Via Pin8

6.4.2 Connections of LMS511, LMS581 and LMS511 Heavy Duty

LMS511 Lite/PRO/Heavy Duty Outdoor, LMS581 PRO, LMS531 Lite/PRO: “Power” connector

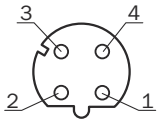
Table 29: LMS511 Lite/PRO/Heavy Duty Outdoor, LMS581 PRO, LMS531 Lite/PRO: “Power” connector

Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 6036159 [1]
 *Figure 46: M12 male connector, 5-pin, A-coded*	1	V_S	Sensor supply voltage	Brown
	2	V_S heat.	Heating supply voltage	White
	3	GND	Ground sensor	Blue
	4	Reserved	Do not use!	–
	5	GND heat.	Ground heating	Black

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.
Required minimum voltage at flying leads for part no. 6036159: 20.3 V

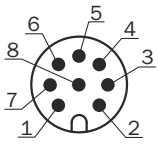
LMS511 Lite/PRO/Heavy Duty Outdoor, LMS581 PRO and LMS531 Lite/PRO: “Ethernet” connection

Table 30: LMS511 Lite/PRO/Heavy Duty Outdoor, LMS581 PRO and LMS531 Lite/PRO: “Ethernet” connection

Male/female connector	Contact	Short form	Signal description
 *Figure 47: M12 female connector, 4-pin, D-coded*	1	TX+	Sender+
	2	Rx+	Receiver+
	3	TX–	Sender–
	4	Rx–	Receiver–

LMS511 Lite Outdoor: “Data” connection

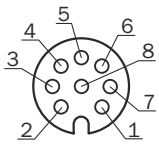
Table 31: LMS511 Lite Outdoor: Pin assignment of the “Data” connection

Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 6036153 [1]
 *Figure 48: M12 male connector, 8-pin, A-coded*	1	RD–/RxD	RS-422/RS-232 receiver	White
	2	TD–/TxD	RS-422 / RS-232 sender	Brown
	3	RD+	RS-422 receiver	Green
	4	TD+	RS-422 sender	Yellow
	5	GND RS	RS-422/RS-232 ground	Gray
	6	Reserved	Do not use!	Pink
	7	IN Sync	Synchronization input	Blue
	8	GND IN Sync	Synchronization ground	Red

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.

LMS511 Lite Outdoor: “I/O” connection

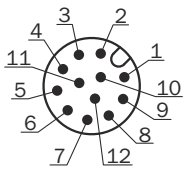
Table 32: LMS511 Lite Outdoor: Pin assignment of the “I/O” connection

Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 2134055 [1]
 *Figure 49: M12 female connector, 8-pin, A-coded*	1	IN1	Digital input 1	White
	2	Reserved	Do not use!	Brown
	3	GND IN1	Ground of digital input 1	Green
	4	OUT1	Digital output 1	Yellow
	5	OUT2	Digital output 2	Gray
	6	OUT3 /OUT Sync	Digital output 3 / Synchronization output	Pink
	7	GND OUT 1 ...3	Ground of digital outputs 1 ... 3 / Synchronization	Blue
	8	V_S OUT	Digital output supply voltage	Red

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.

LMS511 PRO, LMS581 PRO and LMS511 Heavy Duty Outdoor: “Data” connection

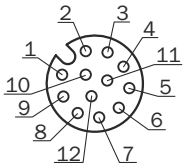
Table 33: LMS511 PRO, LMS581 PRO and LMS511 Heavy Duty Outdoor: Pin assignment of “Data” connection

Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 6042735 [1]
 *Figure 50: M12 male connector, 12-pin, A-coded*	1	V_S OUT	Supply voltage of digital outputs 1 and 2	Brown
	2	RD–/RxD	RS-422/RS-232 receiver	Blue
	3	OUT1	Digital output 1	White
	4	GND RS, CAN	RS-422/RS-232/CAN ground	Green
	5	OUT2	Digital output 2	Pink
	6	Reserved	Do not use!	Yellow
	7	TD–/TxD	RS-422 / RS-232 sender	Black
	8	Reserved	Do not use!	Gray
	9	RD+	RS-422 receiver	Red
	10	TD+	RS-422 sender	Violet
	11	CAN L	CAN bus LOW	Gray+pink
	12	CAN H	CAN bus HIGH	Red+blue

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.

LMS511 PRO, LMS581 PRO and LMS511 Heavy Duty Outdoor: "I/O" connection

Table 34: LMS511 PRO, LMS581 PRO and LMS511 Heavy Duty Outdoor: Pin assignment of "I/O" connection

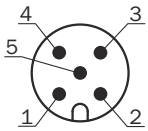
Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 6042732 [1]
 *Figure 51: M12 female connector, 12-pin, A-coded*	1	V_S OUT	Supply voltage of digital outputs 3 ... 6	Brown
	2	GND IN1/2	Ground for digital inputs 1 and 2	Blue
	3	IN1	Digital input 1	White
	4	GND IN3/4/IN Sync	Ground for digital inputs 3 and 4 / Synchronization input	Green
	5	IN2	Digital input 2	Pink
	6	IN3	Digital input 3	Yellow
	7	GND OUT 3 ... 6	Supply voltage ground of digital outputs 3... 6	Black
	8	IN4/IN Sync	Digital input 4 / Synchronization input	Gray
	9	OUT3	Digital output 3	Red
	10	OUT4	Digital output 4	Violet
	11	OUT5	Digital output 5	Gray+pink
	12	OUT6/OUT Sync	Digital output 6 / Synchronization output	Red+blue

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.

6.4.3 Connections of the LMS531 Security Outdoor

Connections of the LMS531 Security Outdoor LMS531 Lite and PRO Security Outdoor: "Power" connection

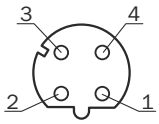
Table 35: LMS531 Lite Security Outdoor: Pin assignment of the "Power" connection

Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 6036159 [1]
 *Figure 52: M12 male connector, 5-pin, A-coded*	1	V_S	Sensor supply voltage	Brown
	2	V_S heat.	Heating supply voltage	White
	3	GND	Ground sensor	Blue
	4	Reserved	Do not use!	–
	5	GND heat.	Ground heating	Black

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.
Required minimum voltage at flying leads for part no. 6036159: 20.3 V

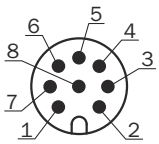
LMS531 Lite and PRO Security Outdoor: “Ethernet” connection

Table 36: LMS531 Lite Security Outdoor: Pin assignment of the “Ethernet” connection

Male/female connector	Contact	Short form	Signal description
 *Figure 53: M12 female connector, 4-pin, D-coded*	1	TX+	Sender+
	2	RX+	Receiver+
	3	TX–	Sender–
	4	RX–	Receiver–

LMS531 Lite Security Outdoor: “Inputs” connection

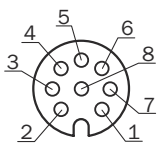
Table 37: LMS531 Lite Security Outdoor: Pin assignment of the “Inputs” connection

Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 6036153 [1]
 *Figure 54: M12 male connector, 8-pin, A-coded*	1	A/DA (IN1)	In focus/Blurry (digital input 1)	White
	2	WT (IN2)	Walk test (digital input 2)	Brown
	3	Reserved	Do not use!	Green
	4	Reserved	Do not use!	Gray
	5	Reserved	Do not use!	Pink
	6	Reserved	Do not use!	Yellow
	7	TEACH (IN3)	EasyTeach (digital input 3)	Blue
	8	GND IN	Ground of all digital inputs	Red

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.

LMS531 Lite Security Outdoor: “Alarm” connection

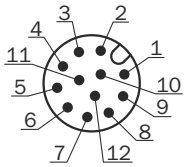
Table 38: LMS531 Lite Security Outdoor: Pin assignment of the “Alarm” connection

Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 2134055 [1]
 *Figure 55: M12 female connector, 8-pin, A-coded*	1	Alarm A (OUT1)	Alarm output (relay), contact A	White
	2	Alarm B (OUT1)	Alarm output (relay), contact B	Brown
	3	Alarm R A	Alarm output, resistance monitoring, contact A	Green
	4	Alarm R B	Alarm output, resistance monitoring, contact B	Yellow
	5	Error A (OUT2)	Error output (relay), contact A	Gray
	6	Error B (OUT2)	Error output (relay), contact B	Pink
	7	Sab (OUT3)	Sabotage output	Blue
	8	GND Sab	Ground of sabotage output	Red

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.

LMS531 PRO Security Outdoor: “Inputs” connection

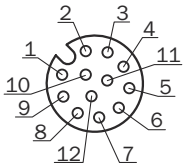
Table 39: LMS531 PRO Security Outdoor: Pin assignment of “Inputs” connection

Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 6042735 [1]
 *Figure 56: M12 male connector, 12-pin, A-coded*	1	A/DA (IN1)	In focus/Blurry (digital input 1)	Brown
	2	RD–/RxD	RS-422 / RS-232 receiver	Blue
	3	GND IN	Ground of all digital inputs	White
	4	GND RS/CAN	RS-422 / RS-232/CAN ground	Green
	5	D/N (IN3)	Day/Night (digital input 3)	Pink
	6	WT (IN2)	Walk test (digital input 2)	Yellow
	7	TD–/TxD	RS-422 / RS-232 sender	Black
	8	TEACH (IN4)	EasyTeach (digital input 4)	Gray
	9	RD+	RS-422 receiver	Red
	10	TD+	RS-422 sender	Violet
	11	CAN L	CAN bus LOW	Gray+pink
	12	CAN H	CAN bus HIGH	Red+blue

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.

LMS531 PRO Security Outdoor: “Alarm” connection

Table 40: LMS531 PRO Security Outdoor: Pin assignment of “Alarm” connection

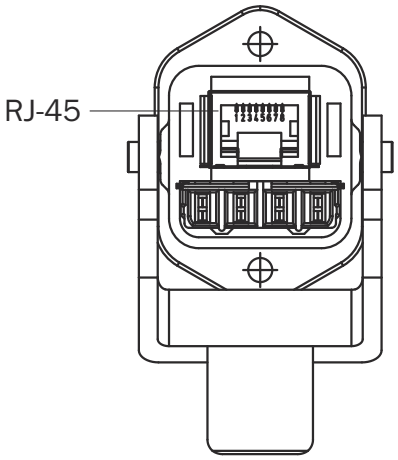
Male/female connector	Contact	Short form	Signal description	Wire colors connecting cable part no. 6042732 [1]
 *Figure 57: M12 female connector, 12-pin, A-coded*	1	Alarm A (OUT1)	Alarm output (relay), contact A	Brown
	2	Sab A (OUT4)	Sab output (relay), contact A	Blue
	3	Alarm B (OUT1)	Alarm output (relay), contact B	White
	4	Alarm R A	Alarm output, resistance monitoring, contact A	Green
	5	Error A (OUT2)	Fault output (relay), contact A	Pink
	6	Alarm R B	Alarm output, resistance monitoring, contact B	Yellow
	7	Disq. A (OUT3)	Disqualification output (relay), contact A	Black
	8	Error B (OUT2)	Fault output (relay), contact B	Gray
	9	Sab B (OUT4)	Sab output (relay), contact B	Red
	10	Disq. B (OUT3)	Disqualification output (relay), contact B	Violet
	11	Sab R A	Sabotage output, resistance monitoring, contact A	Gray+pink
	12	Sab R B	Sabotage output, resistance monitoring, contact B	Red+blue

[1] Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.

6.4.4 Connections of the LMS511 with Harting male connector

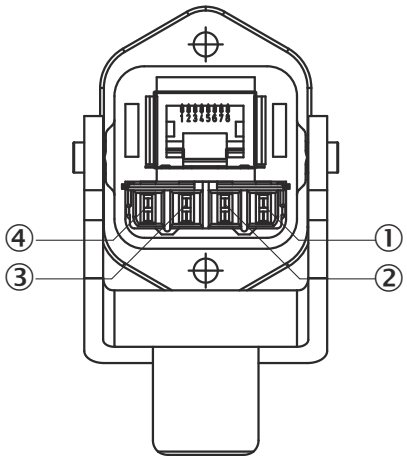
LMS511 with Harting male connector: Pin assignment of the "Ethernet” RJ-45 female connector

Table 41: LMS511 with Harting male connector: Pin assignment of the "Ethernet” RJ-45 female connector

Male/female connector	Contact	Short form	Signal description
	1	TX+	Sender+
	2	TX–	Sender–
	3	RX+	Receiver+
	6	RX–	Receiver–

LMS511 with Harting male connector: Pin assignment of the contact module

Table 42: LMS511 with Harting male connector: Pin assignment of the contact module

Male/female connector	Contact	Short form	Signal description
	1	V_S heat	Power supply heating
	2	V_S	Power supply sensor
	3	GND	Weight
	4	GND heat	Ground heating

6.5 Preparing electrical installation

6.5.1 SELV supply voltage

To commission and operate the device you will need:

- SELV supply voltage DC 19.2 to 28.8 V according to IEC 60364-4-41

More data see "Mechanics/electronics", page 110.

WARNING
Risk of injury due to electric current!

If the supply voltage is produced by a power supply unit, then insufficient electrical separation between input and output current circuit of the power supply unit may lead to an electric shock.

- Only use a power supply unit whose output circuit has safe electrical separation from the input circuit. For example with a safety transformer in accordance with EN 61558-1.

6.5.2 Wire cross-sections for LMS500 Indoor

The Indoor devices have screw terminals which are connected with the following wire cross-sections:

Table 43: Specification of the wire cross-sections for the screw terminals of the LMS500 Lite/PRO Indoor

Cable type	Minimum cross-section	Maximum cross-section
Flexible conductor (fine multi-stranded wires)	0.14 mm^2	1 mm^2
Rigid conductor (single wire)	0.14 mm^2	1.5 mm^2
Flexible conductor (fine multi-stranded wire) with ferrules	0.25 mm^2	0.5 mm^2

Wire cross-section

- All connections must be wired with copper cables.
- All communication cables must be stranded and shielded.
- For the cable calculation see "Example of maximum cable connection", page 73.

NOTE
With the LMS500, the external diameter of the joint cable must not exceed 9 mm due to the cable entry.

6.5.3 Wire cross-sections for LMS5x1 Outdoor

The Outdoor devices can be connected using the following optional accessories, see "Accessories", page 115:

- Standard cables up to 20 m with M12 male connectors
- For particularly long male cable connectors of over 20 m with/without M12 connectors, there is a compact connection unit for each device type.

Example of maximum cable connection

Prerequisites:

- Steady state of the voltage supply
- Only applies for copper cable material
- For the line length calculation, the permissible voltage loss in the particular application must be specified.

Table 44: Length of cable and voltage drop

Cable properties	
$A = 0.75 \cdot 10^{-6}\ m^2$	Cross-section of the cable surface [m^2]
$\rho = 1.72 \cdot 10^{-8}\ \Omega m$	Specific resistance of copper [Ωm]
$\alpha = 3.9 \cdot 10^{-3}\ K^{-1}$	Temperature coefficient of copper [1/K]
Ambient conditions	
$T_0 = 20\ °C$	Reference temperature [°C]
$T = 80\ °C$	Cable temperature [°C]
Cable load	
$I = 2.5\ A$	Load current [A]
Voltage drop on the cable	
$\Delta V = 4.245\ V$	Voltage drop on the cable [V]
Formula for permissible length of cable	
$L = \frac{\Delta V \cdot A}{2 \cdot I \cdot \rho \cdot (1 + \alpha \cdot (T - T_0))} = 30\ m$	Permissible length of cable [m]

To check whether the voltage drop can be maintained with a calculated length of cable, the following calculation is possible:

Table 45: Voltage drop

Formula for the voltage drop to be considered	
$L = 30\ m$	Cable length [m]
$\Delta V = \frac{I \cdot 2 \cdot L}{A} \cdot \rho \cdot (1 + \alpha \cdot (T - T_0)) = 4.245\ V$	Voltage drop ΔV [V] Length of cable L [m] Cross-section of cable surface A [m^2] Specific resistance of copper [Ωm] Temperature coefficient of copper [1/K] Cable temperature [°C]

The minimum voltage with which the device may be operated is the recommended 20 V see "Technical data", page 104.

NOTE

If the heating voltage supply cables are particularly long, it may be necessary to generally increase the input voltage (see formula for voltage drop) and install a 470 µF / 63 V capacitor between 24 V and 0 V (in the connection unit, close to the sensor). This allows for compensation for the voltage drop at the moment of switch-on.

6.5.4 Cable reserve on system plug

Allow for sufficient cable reserve of the supplied cables at the system plug. You can easily exchange the device with the cable reserve if needed.

Keep the cable reserve only long enough that the system plug cannot be accidentally plugged into an adjacent device when replacing the device! This prevents a device with an incorrect configuration being put into operation. Experience has shown that 200 to 300 mm of cable reserve on the device is ideal.

The reserve cable should be laid as a drip loop so no moisture (e.g., condensation) is directed towards the device but instead drips off the cable beforehand.

6.5.5 General conditions for data interfaces

The following table shows the maximum recommended length of cables depending on the selected data transmission rate.

Table 46: Maximum lengths of cables for the data interfaces

Interface type	Transfer rate	Maximum length of cable
RS-232	115.2 kBd	2 m
	38.4 ... 57.6 kBd	3 m
	Max. 19.2 kBd	10 m
RS-422	Max. 115.2 kBd	500 m
	Max. 38.4 kBd	1,200 m

NOTE

Use shielded cables (twisted pairs) with at least 0.25 mm^2.

To prevent interference factors, do not lay data cables over a longer route in parallel with voltage supply cables and motor cables, in cable channels, for example.

6.6 Performing the electrical installation

6.6.1 Connection to the auxiliary interface (USB) and the Ethernet interface of the device

Pre-assembled cables are available for configuring the device using the auxiliary interface (USB) and the Ethernet interface.

NOTE

The USB interface is used in industrial environments only as a service interface for temporary use (e.g., for configuration, troubleshooting). Use as a host interface while the system is in operation is not supported.

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).

6.6.2 LMS500: Wiring system plug

NOTE

Reduced enclosure rating! If the system plug is removed, the LMS500 no longer complies with enclosure rating IP65.

- To prevent damage from penetrating moisture and dirt, only open the system plug in a clean and dry environment.
- If necessary, pre-wire and mount the system plug in a suitable environment.

Prerequisites on device for enclosure rating IP65

- The system plug is attached to the device, its 2 screws are tightened.
- The cables in the cable entries correspond to the suitable diameter and are locked with the coupling nut. An unused cable entry is provided with a protective cap, which is locked with the coupling nut (as in the delivery condition).
- A corresponding cable is plugged into the M12 round connector (Ethernet) and locked. If the connection is not used, it must be covered with a tightly-fastened protective plug (as in the delivery condition).
- The black, round cover of the USB auxiliary interface (“USB” connection) on the front of the device is screwed in vertically and hand tight.

1. Make sure that the voltage supply for the LMS500 is switched off.
2. Remove system plug on the rear side of the device. To do so, loosen the two fixing screws (see figure 71, page 113) and carefully pull the system plug up out of the device vertically.
3. The two M16 cable entries (metal) have a ground connection to the device. If a shielded connecting cable is used, connect the shielding braid of the cable to the cable entry. To do this, shorten the shielding braid before the screw connection of the cable entry and push it back over the plastic insert of the cable entry.
4. Undo screw connection of the M16 cable entry.
5. Feed cables for the supply voltage and the digital outputs with a maximum outer diameter of Ø 10 mm through the plastic insert of the M16 cable entries.
6. Connect the wires to the two terminal blocks without tension and without pulling, see "Connections of the LMS500", page 63.
7. Connect the shielding braid of the cables to the cable entry.
8. Attach and tighten the screw connection of the M16 cable entry.
9. Carefully reattach the system plug to the LMS500.
10. Tighten the fixing screws of the system plug.

6.6.3 LMS511 / LMS531 / LMS581: Connecting M12 round connectors

NOTE

Prerequisites on device for enclosure rating IP67

- The system plug is attached to the device, its 2 screws are tightened.
- The device is only connected to the M12 round connectors provided.
- Use connecting cables with M12 round connectors that are compliant with enclosure rating IP67.
- The SICK cables attached to the M12 round connectors are locked. Any connections that are not being used must be fitted with protective caps or plugs that are screwed tight (as in the delivery condition).
- The black, round cover of the USB auxiliary interface (“USB” connection) on the front of the device is screwed in vertically and hand tight.

Pre-assembled cables can be ordered as accessories for connection to the M12 round connectors. These cables consist of the round connector and a 5, 10, or 20 m cable with an open end.

Torque screwdrivers with a defined torque are available as accessories for tightening and loosening M12 plug connections on the system plug.

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).

6.6.4 Wiring the inputs and outputs

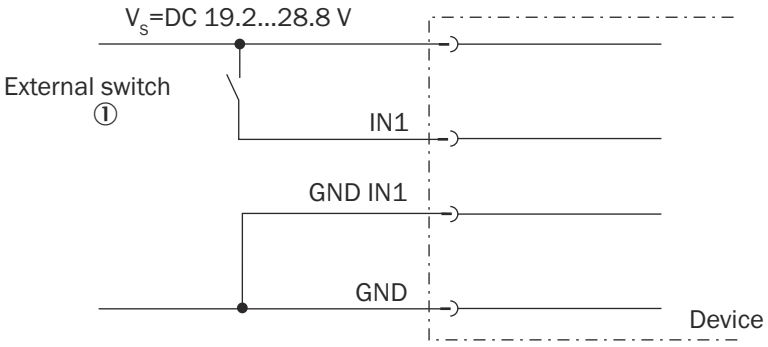


Figure 58: Activating digital inputs, non-floating

① External Switch

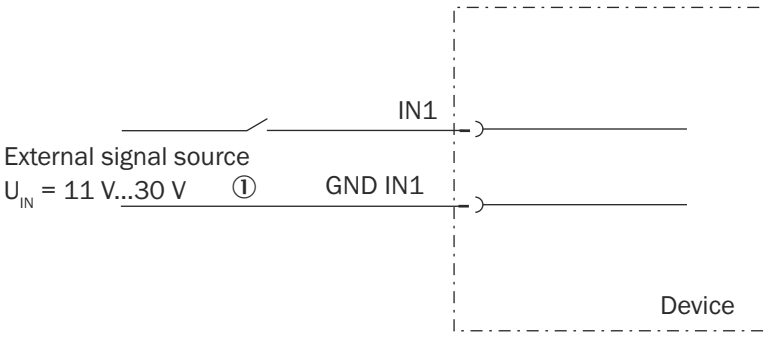


Figure 59: Activating digital inputs, volt-free

① External signal source

NOTE

The inputs require a switching voltage of at least 11 V. For this reason, the supply voltage must be at least 11 V.

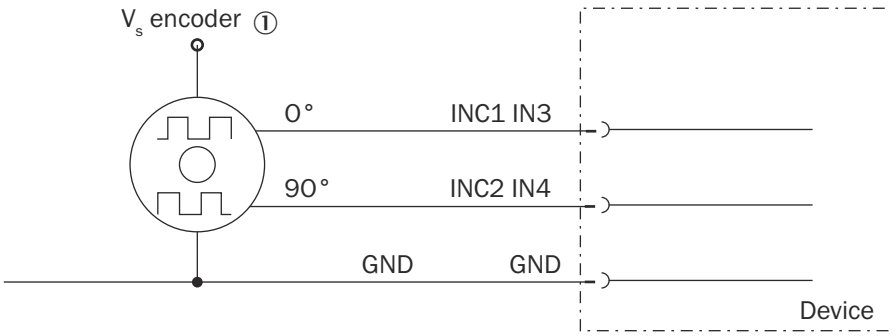


Figure 60: Connection of encoder inputs (LMS511 PRO/Heavy Duty only)

① Encoder

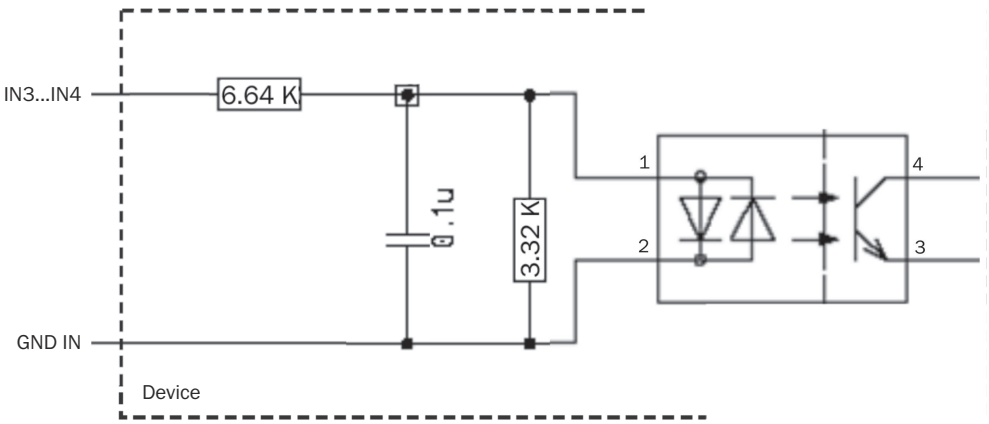


Figure 61: Input circuit IN3 to IN4

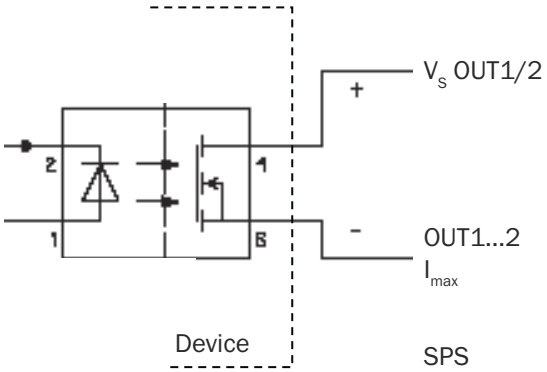


Figure 62: Activating outputs 1 or 2 to a PLC (active LOW)

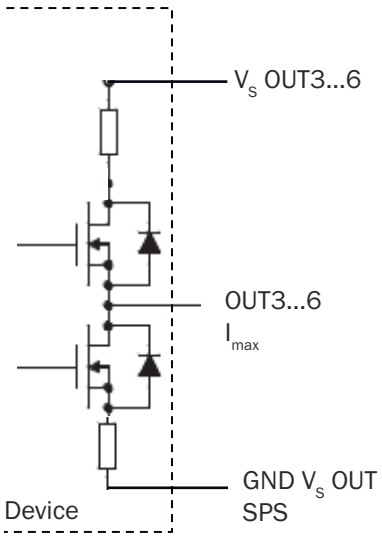


Figure 63: Activating outputs 3 to 6 to a PLC (active HIGH)

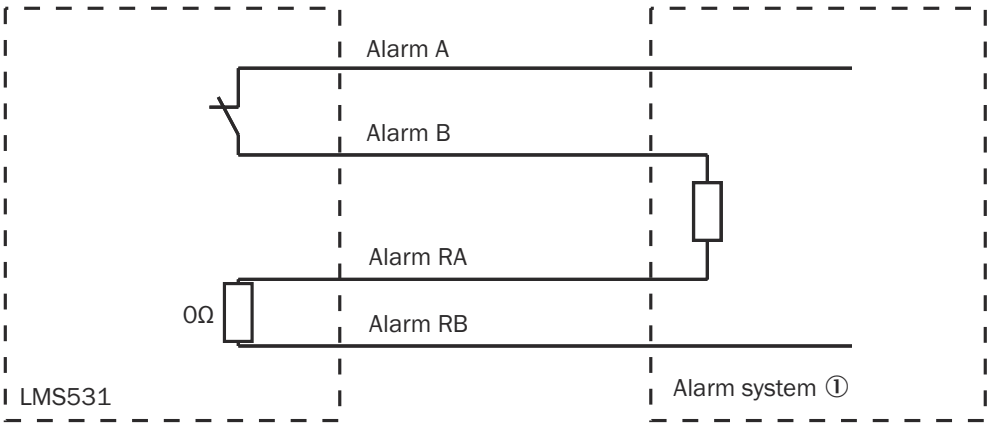


Figure 64: Resistance-monitored connection of the LMS531 Security outputs to an alarm system

① Alarm system

Wiring of the RS232 or RS422 interface

A shielded cable is required for connecting the RS-232 or the RS-422 interface.

NOTE

Observe the maximum length of cable according to see "General conditions for data interfaces", page 74.

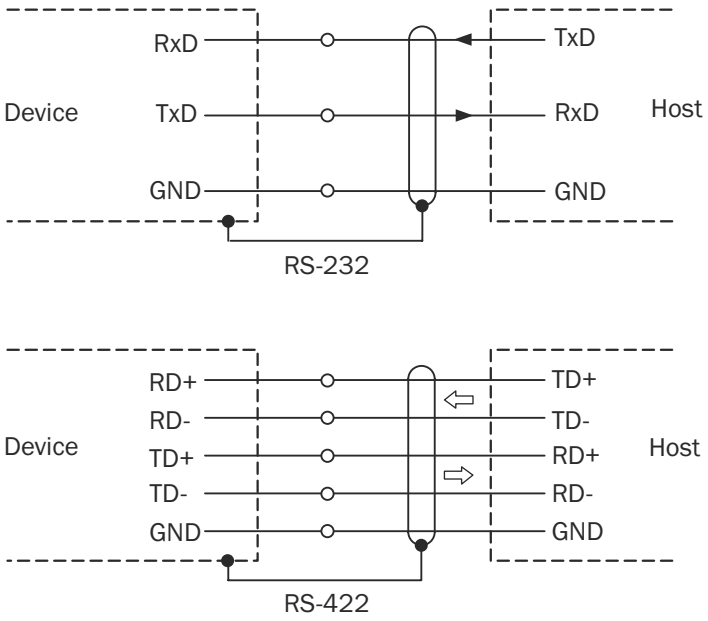


Figure 65: Wiring of the RS232 or RS422 interface

7 Commissioning

7.1 Overview of the commissioning steps

1. Install the SOPAS ET configuration software.
2. Establish communication with the device.
3. Create an application-specific parameter set with SOPAS ET and save it permanently in the non-volatile device memory and on the computer.
4. Test the device for correct functioning.

7.2 SOPAS ET configuration software

The interactive configuration is performed using the SOPAS Engineering Tool (SOPAS ET) software. You can use this configuration software to parameterize and test the measuring properties, evaluation behavior, and output properties of the system as required. The configuration data are stored and archived as a parameter set (project file) on the computer.

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.

Downloading and installing SOPAS ET

1. Start computer.
2. Download and install the latest version of the SOPAS ET configuration software, as well as current device description files (*.sdd) for the device variant from the online product page for the software by following the instructions provided there.
3. In this case, select the “Complete” option as suggested by the installation wizard. Administrator rights may be required on the computer to install the software.
4. When the installation is finished, start the **SOPAS ET** program option. Path: Start > Programs > SICK > SOPAS ET Engineering Tool > SOPAS.
5. Establish a connection between SOPAS ET and the device. In order to do this, select the desired communication interface for searching in the connection wizard. (Default Ethernet address: IP address: 192.168.0.1, subnet mask: 255.255.255.0).

✓ SOPAS ET establishes communication with the device and loads the associated device description file.

SOPAS ET default settings

Table 47: SOPAS ET default settings

Parameters	Value
Program interface language	English (you must restart the software after making any changes)
Units of length	Metric
User group (operating level)	Machine operator
Download the parameters to the device	Immediately after a change, temporarily in the RAM of the device
Upload the parameters from the device	Automated after online switching
Window arrangement	3 (project tree, help, working area)

7.3 Establishing communication with the device

NOTE
To communicate via Ethernet TCP/IP, the TCP/IP protocol on the computer must be active.

When connecting a PC/host, please adhere to the following order:

1. Connect the computer to the device with a data cable.
2. Switch on computer.
3. Switch on supply voltage of the device.

✓ The device performs a self-test and initializes itself.

Connecting data interfaces

Connect the device to the computer via one of the following data interfaces:

- USB
- Ethernet
- RS-232/RS-422

Starting SOPAS ET and calling up scan assistant

1. Start SOPAS ET.
2. In the main window under **Scan Assistant**, click on the **Configuration** button.

✓ The **Scan Assistant** dialog window appears.

Configuring the Ethernet connection

NOTE
Deactivate all programs on your computer to access Ethernet or TCP/IP.

1. In the **Search settings** dialog box, select **Search by device family (recommended)**. Click on **>**.
2. In the device family options, select **LMS5**, **LMS5xx / 25x** and click on **>**.
3. Confirm the selected communication interface by clicking on **>**.
4. If necessary, manually configure the IP addresses using **Add...**. Click on **>**.
5. Select COM ports, if necessary. Click on **>**.
6. To save the search settings, enter a name and click on **Finish**.

NOTE
Save the parameter set as a project file (.sopas file with configuration data) on the computer so that it can be used as a basis for replacing a damaged device if necessary.

Configuring serial connection

1. In the **Scan Assistant** dialog box under **Serial Connection**, **Standard Protocol**, select the **Activate Serial Communication** checkbox.
2. Click the **Advanced...** button.
3. Select the following **PORT Settings**: 8 data bits, no parity, 1 stop bit.
4. Confirm the settings with **OK**.

✓ The **Advanced Scan Settings** dialog window is closed.

5. Confirm the settings in the **Scan Assistant** dialog window by clicking **OK**.

✓ The **Scan Assistant** dialog window closes.

Performing a scan

1. In the **Scan Assistant** dialog window, click the **Start Scan** button.
2. Select the listed devices and confirm by clicking **Add Device.**

✓ The connection is used to search for connected devices. SOPAS ET adds the devices found to the project tree and loads the current parameter set to the device via upload.

7.4 Initial commissioning

The device is adjusted to the situation on site using the SOPAS ET configuration software. To do this, SOPAS ET creates an application-specific parameter set of parameter values. For this purpose, the parameter set can first be loaded from the device (upload, initial commissioning: factory default setting). Or it is created independently, either based on the factory default settings or as a modification of an already existing parameter set of the device of the same type and firmware version.

The parameter set is then loaded into the device (download). This either happens immediately (**Download immediately** option in SOPAS ET) or manually (**Download all parameters to the device** command in SOPAS ET).

NOTE

After completing configuration, the changed parameter set must be permanently stored in the non-volatile memory of the device. As part of a backup concept for the created parameter values, we recommend saving the parameter set as a project file (*.sopas file with configuration data) on the computer for archival purposes.

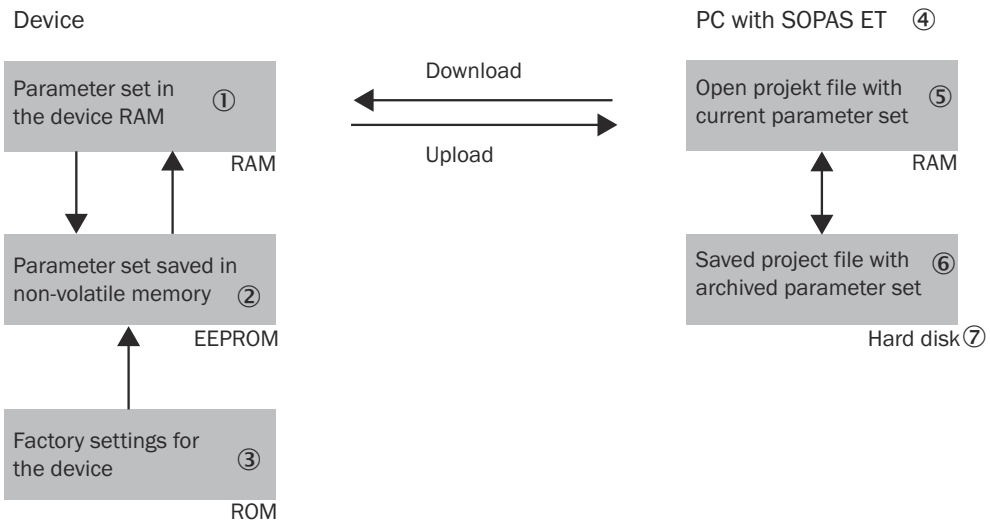


Figure 66: Data storage principle

① Parameter set in the working memory of the device
② Permanently saved parameter set
③ Factory-set pre-settings of the device
④ Computer with SOPAS ET
⑤ Opened project file with current parameter set
⑥ Saved project file with archived parameter set (*.spr)
⑦ Hard drive

Device configuration

You can configure the device in two ways:

- Interactively using SOPAS ET. This section describes the interactive configuration.
- Using configuration telegrams, see "Communicating data via telegrams", page 54.

Interactive configuration with SOPAS ET

All configurable parameters of the device are collected together in a corresponding device description (.sdd file) for SOPAS ET. You can access these parameters via the project tree for the device description.

A content-sensitive explanation of each of the parameters is available directly next to the parameter via the **?** button or in the online help (**F1** key). The **Parameter Info** display window lists the valid range of values and the default setting (right-click when the pointer is located over the parameter).

NOTE

Software access to the device is protected by user levels and passwords. After successfully configuring the device, you should change the passwords so they can fulfill their protective function.

Table 48: Passwords

User levels	Password
Maintenance (Authorized Operator)	`main`
Authorized Client (Integrator)	`client`
Service	`servicelevel`
Operator	–

Table 49: User level and authorization

Operator	An **Operator** level user can view the basic device parameters. • No password required • Read only permissions • Not all parameters are visible
Maintenance (Authorized Operator)	A **Maintenance (Authorized Operator)** level user can view the application-specific device parameters. • Read only permissions • Not all parameters are visible • Can change the password for this user level
Authorized Client (Integrator)	A **Authorized Client (Integrator)** level user can configure the application-specific device parameters. • Access to most parameters • Can change the password for this user level as well as the password of the **Maintenance (Authorized Operator)** user level.
Service	A **Service** level user can configure all device parameters and view the status information. • Access to all parameters (incl. all expert functions) • Can change the password for this user level as well as the password of the **Maintenance (Authorized Operator)** and **Authorized Client (Integrator)** user 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.

NOTE

If the password for the Service user level has been lost: see "Resetting the password for the Service user level", page 102.

Use the project tree in SOPAS ET to configure the necessary parameters for your application.

NOTICE

Loss of configuration data in the connected device

1. Do not switch off the voltage supply during the configuration of the device. Otherwise all parameters not yet saved permanently will be lost.

1. In the **Options** menu, select the **Log into device** command and log in as an **Authorized Client (Integrator)** using the password `client`.
2. Configure the device for the required application using the parameters in SOPAS ET. Help on using the program user interface as well as for the different options can be found in SOPAS ET.

Resetting the configuration

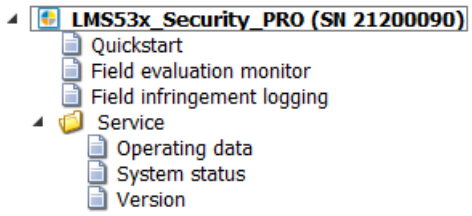
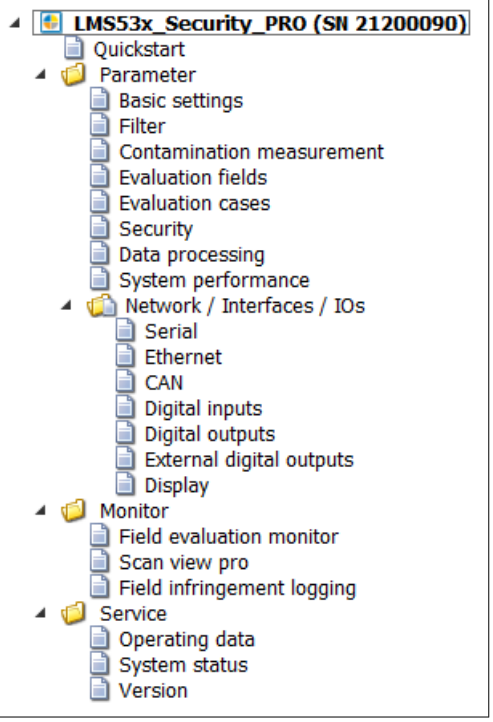
NOTE

To reset the device to the delivery condition, use the **Factory defaults** option in SOPAS ET.

7.4.1 Parameterizing the LMS531 variants for security applications

Parameterization mode

The LMS531 can be parameterized via the simple **Standard** mode or via the more detailed **Expert** view mode. The expansion of the device structure depends on the selected mode.

Standard mode (simplified view)	Expert mode (detailed view)
	

When changing from expert mode back to standard mode, the program asks whether the factory defaults should be reloaded. It is recommended to respond **Yes**.

NOTE
If the factory defaults are not loaded, it is possible that settings on the quick start page no longer correspond to the expected default settings (for example, if the settings of an evaluation case are changed in **Expert** mode or an object size is not parameterized the same for all fields).

Quickstart

The **Quickstart** page contains all parameters that a customer requires to parameterize a standard safety application.

7.4.1.1 Default – Standard mode and Expertmode

Group	Parameter	Properties
Response (standard mode)	object size	40 mm **NOTE** The minimum object size for detection cannot be guaranteed over the entire scanning range due to the distance-dependent absolute measurement resolution. The detectable object size depends on the maximum distance to the outer field boundary. A parameterized field must therefore always be checked using the corresponding object size setting see "Minimum object size", page 29.
	Response time	240 ms
Alarm signal (standard mode)	Holding time	3 s
Error signal (standard mode)	Holding time	3 s
Detection fields (evaluation fields)	9 predefined rectangular fields (PRO) 3 predefined rectangular fields (Lite)	**LMS531 PRO:** • Field 1: Rectangle 40 m x 20 m (symmetrical about a 90° beam) • Field 2-9: Rectangle 40 cm x 20 cm (symmetrical about a 90° beam) **LMS531 Lite:** • Field 1: Rectangle 40 m x 20 m (symmetrical about a 90° beam) • Field 2-3: Rectangle 40 cm x 20 cm (symmetrical about a 90° beam)
Evaluation cases (expert mode)	9 predefined evaluation cases 3 predefined evaluation cases	**LMS531 PRO:** • Evaluation case 1 - 9: Strategy - blanking • Evaluation case 10: Strategy - contour (manipulation protection is always active) **LMS531 Lite:** • Evaluation case 1 - 3: Strategy - blanking • Evaluation case 4: Strategy - contour (manipulation protection is always active)
	Response time	240 ms
	object size	40 mm
	Linked field	Evaluation case 1 is linked to detection field 1. Evaluation case 2 is linked to detection field 2. This logic is repeated for all fields.
	Connected output	Output 1: Alarm

Group	Parameter	Properties
Digital outputs (expert mode)	Function	Output 1 - Alarm: Application Output 2 - Fault: Device Ready
	Logic type	Output 1 - Alarm: Active low Output 2 - Fault: Active high
	Restart	Output 1 - Alarm: Time Output 2 - Fault: Time
	Restart delay	Output 1 - Alarm: 3 s Output 2 - Fault: 3 s

7.4.1.2 Detection fields/monitored areas

The LMS531 PRO contains 9 predefined fields and a tenth non-predrawn field. The LMS531 Lite contains 3 predefined fields and a fourth non-predrawn field.

All predefined fields can be changed.

- Field 1: Rectangle 40 m x 20 m (symmetrical about a 90° beam)
- Field 2 to 9 (LMS531 Lite: Field 2 and 3): Rectangle 40 cm x 20 cm (symmetrical about a 90° beam)
- Field 10 (LMS531 Lite: Field 4): Field not predrawn. **Contour as reference** function predefined in standard mode

For more information on detection fields, see "Field application", page 45.

7.4.1.3 Operating mode

The LMS531 has 3 different operating modes. These can be activated by switching the digital inputs 1 and 2.

- Input 1: Switches between **armed** and **disarmed**
- Input 2: Switches between **Walk-through test active** and **Walk-through test deactivated**

Input 1 Disarmed	Input 2: Walk-through test	Operating mode
0 V	0 V	Armed
24 V	0 V	Not sharp
0 V or 24 V	24 V	Walk-through test active

Meaning of the operating mode

- **Armed**: In this mode, the front panel (LEDs, display and USB interface) is deactivated. Field interruptions are not visible on the LEDs. If a field interruption is present, the alarm output switches and an internal alarm memory is set. The alarm memory is displayed in **Disarmed** mode.
- **Unarmed**: In this mode, the front panel (LEDs, display and USB interface) is active. The Q1 LED is on if the alarm memory has been set in **Armed** mode. If an object detection is detected in **Disarmed** mode, the alarm output switches however the Q1 LED remains off (the alarm memory is not set).
- **Walk-through test**: In this mode, the front panel (LEDs, display and USB interface) is active and an object detection is indicated on the Q1 LED (no alarm memory display). The alarm output switches.

The second **Walk-through test** input has a higher priority than the first **Disarmed** input. Therefore, when **Walk-through test** is activated, the device switches from **Armed** or **Disarmed** mode to **Walk-through test** mode.

7.4.1.4 Day/night switching (LMS531 Pro)

Input 3 is used for day/night switching of the evaluation cases. One or more evaluation cases can therefore be active during the day, while one or more other evaluation cases are used at night. To implement this, input 3 needs to be controlled by the system controller in such a way that, depending on the time of day, it is switched between Low = 0 V during the day and High = 24 V at night. To use day/night switching, activation in the evaluation case must be set to **Input**, and the night switching must be configured as follows:

Day/night switching	Input 3	Setting in evaluation case for night switching
Evaluation case active during the day	0 V	Active low
Evaluation case active at night	24 V	Active high
Evaluation case independent of input 3	0 V or 24 V	Not relevant

In standard mode, all evaluation cases have the same properties. Each evaluation case can be activated separately via input 3 (in standard mode). By default, the evaluation is set to **Always**.

7.4.1.5 Digital outputs and relay outputs

Outputs

By default, all evaluation cases are linked to the alarm output. The LMS531 Lite has two relay outputs and one digital output. The LMS531 PRO has four relay outputs.

	Lite	PRO	Function
Output 1	Alarm	Alarm	Relay
Output 2	Fault	Fault	Relay
Output 3	Sabotage	–	Digital
	–	Disqualification	Relay
Output 4	–	Sabotage	Relay

The relay outputs can be used as voltage-free outputs. Output 1 (alarm) as well as output 4 (sabotage) of the LMS531 PRO can be resistance monitored outputs see figure 64, page 78.

Alarm

All existing fields are linked to digital output 1 (alarm) using the “OR” logic operator. The reset time can be parameterized. In **Standard** mode, this output assignment cannot be changed.

The duration of the switched alarm output can be set in different steps:

- 1 second
- 3 seconds (factory default)
- 10 seconds

In **Expert** mode, the evaluation result can be assigned to any output.

Fault

There are 2 ways to use this output.

- This signal is activated when an error occurs with the device.
- If the **Validity check** function is activated and has not yet finished with a “valid” result see "Security - validity check", page 92. This is also activated optionally to 1.

This corresponds to the “Device Ready” function of the standard devices.

In **Standard** mode, the fault message is linked to output 2 (Fault) and cannot be changed.

The duration of the switched fault output can be set in different steps:

- 1 second
- 3 seconds (factory default)
- 10 seconds

In **Expert** mode, the fault message can be set for each evaluation case.

Disqualification

Freely available output. Not visible in **Standard** mode. In **Expert** mode, the disqualification message can be set in each evaluation case.

Sabotage

Freely available output. Not visible in **Standard** mode. In the **Expert** mode, the sabotage message can be set in each evaluation case.

7.4.1.6 EasyTeach

Configuration is performed by teaching in (EasyTeach) of the surrounding contour in order to automatically generate a field with any shape, including complex shapes. The device stores the shortest value measured during the teach-in phase as a field boundary for each angle.

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.

LITE mode

The EasyTeach function allows the customer to design a field by walking the field boundaries to be saved. It is important to make sure that the person doing the walkthrough is clearly detected at all times during the teach-in phase.

PRO mode

In PRO mode, the EasyTeach LITE function is available within a predefined field. EasyTeach can be activated via digital input 4 on the LMS531 PRO variant, and via digital input 3 on the LMS531 Lite variant. There are three modes for EasyTeach – they are INACTIVE, LITE and PRO (for LMS531 PRO only) and can be selected in the **Authorized customer (installer)** user level as well as in higher user levels.

Using the **Start EasyTeach** button, the respective input can be simulated and, as a result, the EasyTeach process can also triggered via SOPAS ET.

Input 3/4 - EasyTeach	EasyTeach activation
0 V	EasyTeach teach-in stopped
24 V	EasyTeach teach-in started

The **Minimum duration** parameter defines how long the teach-in process takes once the trigger (input 4 / input 3) has been activated.

NOTE
If the user has configured the Debounce Time value of the digital input, the length of the pulse for the EasyTeach trigger must be longer.

During teach-in, the **Q2** LED on the front of the device is switched on. Once the teach-in process has finished, the **Q2** LED flashes for 10 seconds and the field is saved permanently. If the **Automatic EasyTeach at device startup** option is activated, an EasyTeach is performed each time the device is restarted.

7.4.1.6.1 EasyTeach LITE

EasyTeach LITE mode can be used to define a field. This is done by specifying the angle range, field number, field name, mode, and minimum distance to the contour of the field. This mode has two functions: **Evaluation field** or **Reference contour**.

7.4.1.6.2 EasyTeach PRO

In EasyTeach PRO mode (LMS531 PRO), up to five EasyTeach fields can be created automatically as long as the EasyTeach input is active. These EasyTeach fields are taught in within previously defined boundaries (template fields).

Each EasyTeach PRO field is assigned its own template field.

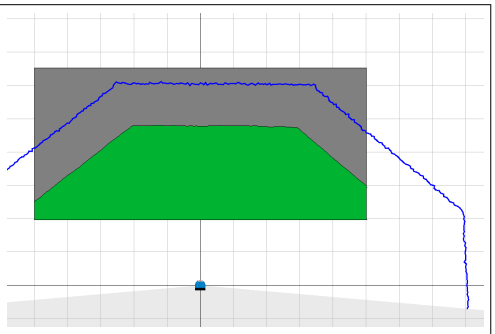
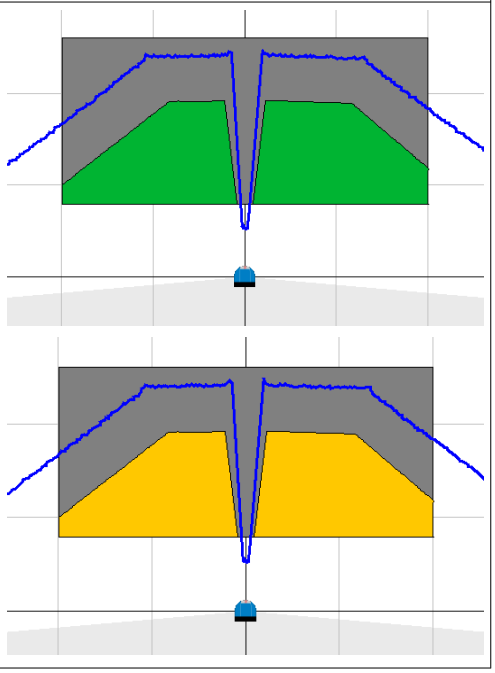
Template field	EasyTeach PRO field
Field 1	Field 6
Field 2	Field 7
Field 3	Field 8
Field 4	Field 9
Field 5	Field 10

Application example: Entry to the company premises is to be monitored and reported at night. The field of view of the LMS531, however, is larger than the area to be monitored and limiting the scanning angle is not sufficient. The maximum area to be monitored is created as a template field. At the beginning of the night, the EasyTeach PRO function is used to teach the actual area to be monitored within the company premises (template field). Objects placed in the field of view during the day are detected and excluded from monitoring.

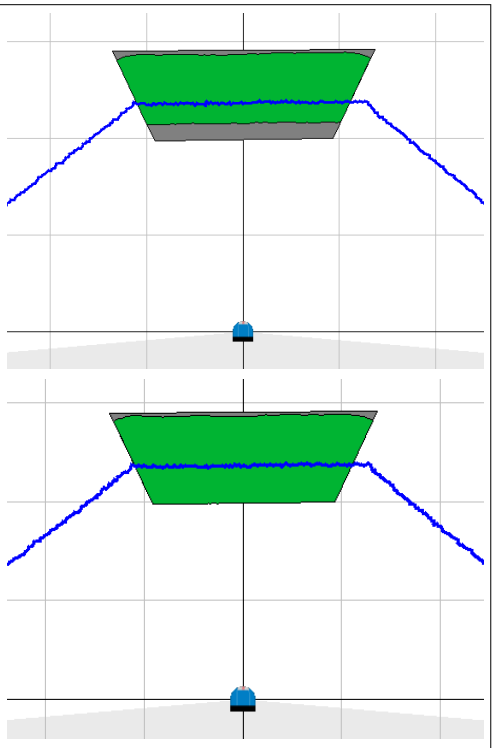
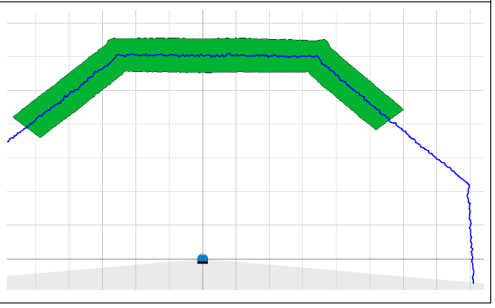
The first step is to create one or more template fields that define the maximum extent and boundaries of the EasyTeach fields. These can be created in the SOPAS ET field editor, or also generated using EasyTeach LITE. Next, all EasyTeach fields to be created must be defined or configured. Each EasyTeach field has its own parameters (see "Examples of the EasyTeach PRO Detection field mode", page 90). All activated fields are taught-in together as soon as input 4 has been activated.

The **Automatic reset to template field** option allows you to automatically reset a taught-in EasyTeach PRO field to the template field after a configured time. The condition for this is that the template field recognizes a status change from interrupted to clear.

Examples of the EasyTeach PRO Detection field mode

Area between the scanner and template field is clear: EasyTeach PRO field (green). Created within a template field (gray) and with a separation of 200 mm to the scan line.	
Object present in the area between the scanner and template field: EasyTeach PRO field is created while an object is between the scanner and template field. No detection field is created in the shadow of the object. EasyTeach PRO field (green): The evaluation case is parameterized with the manipulation protection disabled. The detection field remains free (green), even if an object is located between the device and detection field. EasyTeach PRO field (yellow): The evaluation case is parameterized with the manipulation protection enabled. The detection field is interrupted (yellow) as soon as an object is located between the device and template field.	

Example of the EasyTeach PRO Reference contour mode

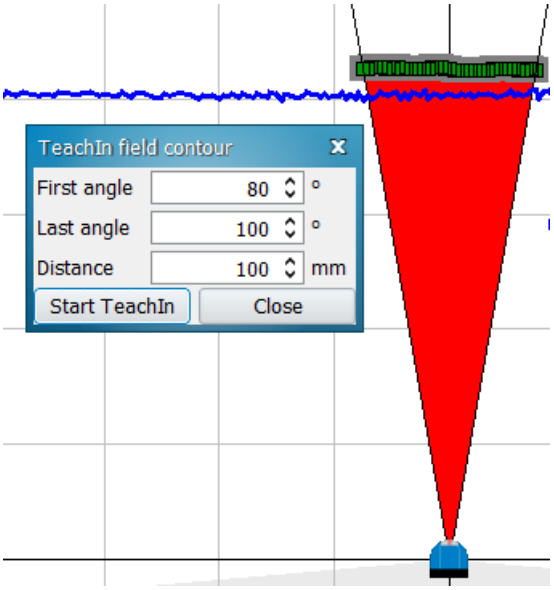
Reference contour taught-in within a template field: For Reference Contour mode, it is recommended to teach in a segmented template field as the reference contour. It is only necessary to ensure that the distance to the contour is within a sufficient tolerance of the desired value. This ensures that the scanning angles of the EasyTeach PRO field match those of the template field. The scan line is a sufficient distance from the edge of the template field (gray) everywhere. The detection field is clear (green). The scan line is closer to the front edge of the template field (gray) than defined in the teach-in parameters of the reference field contour. The EasyTeach PRO field (green) is drawn up to the edge of the template field.	
For comparison: Reference contour created, limited by the start and stop angles and without using the limitation by a template field with EasyTeach PRO.	

7.4.1.7 Special functions

Field editor - Teach-in manipulation protection

The field editor has an additional **Teach-in manipulation protection** teach-in mode.

This manipulation protection field is designed to detect when the front screen of the LMS531 has been covered or when the LMS531 has been moved from its original position.



Basically, a contour is created as a reference field that always starts from the LMS531. In “Expert mode”, this field can be changed in the **Evaluation fields** section. The **Contour** evaluation strategy must be selected in the evaluation case.

In the following settings, the **Distance** parameter controls how far the teach-in points can be from the contour (positive distance). In the figure above, the offset distance to the contour is 100 mm.

This **Distance** setting allows a tolerance in case of vibrations of the LMS531 (e.g., mounted on the pole) or the reference object (e.g., fence). If the LMS531 is rotated or moved from its original position and the new target is outside the boundary of the manipulation protection contour (green line on the image above), the output 1 **Alarm** is triggered.

Security - validity check

This function can be used to detect manipulation within the monitored field areas.

This function is used for final testing and prevents an incorrect setup of the detection fields. The validity check confirms that all programmed fields and contours of the LMS531 are free of obstacles or shadows and are fully visible from the position of the sensor. This operation can only be performed if there is a connection to the LMS531. The “Teach-in validity area” function must be run once at the end. The validity check is a part of the VdS certification. If no additional validation of the valid measurement points is required, the validity check can remain disabled.

In **Expert** mode, this function is located under the main menu **Parameters**, **Security** or directly on the **Quickstart** page in **Standard**mode.

The following status can be displayed:

- Pending: The validity check has not yet been performed (new fields have been defined, existing fields have been changed or deleted).
- Invalid: The taught-in contour is invalid (e.g., the required number of valid measuring beams in succession (50%) has not been reached.
- Valid: The contour was taught in successfully. Validity means that each laser beam is checked for valid and stable measured values. This test is only performed, however, for the angular ranges in which detection fields have been defined. This ensures that sufficient measured values are available for the sensor to evaluate.

During the validity check, all setup fields are checked for validity.

If all fields are valid, the fault output is cleared and therefore the fault signal is removed. If the configured detection fields are not found to be valid, the error output at the fault output remains activated and generates an error message.

The outputs change from yellow to gray in the SOPAS ET user interface. Manipulations within the monitored field areas are detected and prevented by this function. If a manipulation (masking) lasts at least 10 seconds, an error is triggered. As soon as the manipulation is no longer present, the error signal is canceled and the error output of the sensor becomes free again. If the scan configuration is changed, the validity check is set to inactive and must be taught in again.

Flashing of Q2 LED - When the validity check is triggered in the **Armed** state. If the device is covered or the front screen is removed during a valid validity check, this is indicated by the Q2 LED flashing in **Disarmed** mode.

NOTE

If new fields are defined or existing fields are changed or deleted, the validity check must be performed again. If this action is not performed by the installer, the error output remains active.

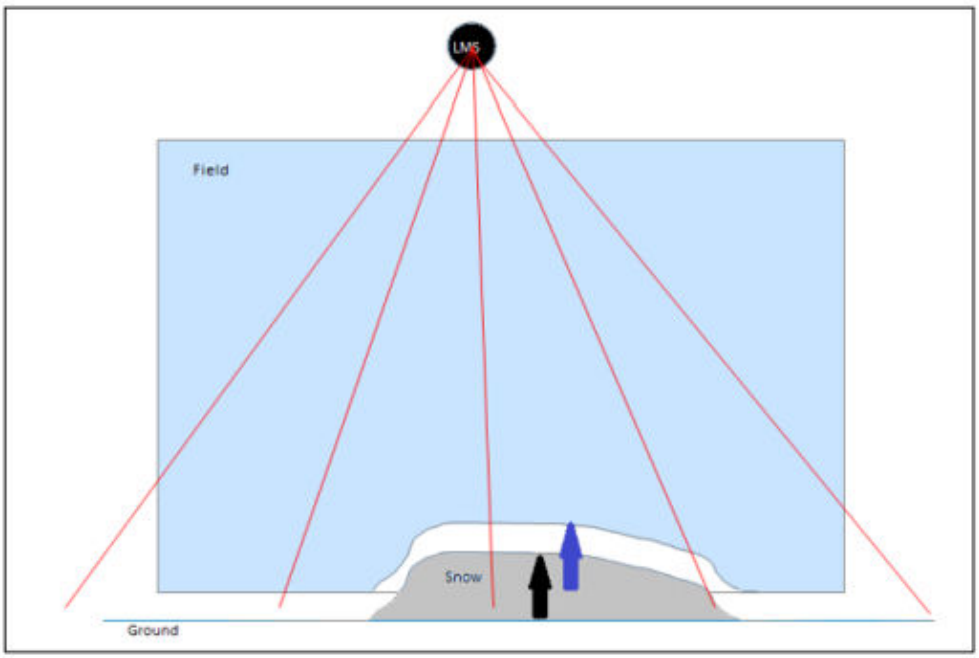
Front panel - display activation

The front panel display can be activated/deactivated depending on the operating mode, i.e. it is deactivated in **Armed** mode and activated in **Disarmed** and **Walk-through test** mode.

Automatic field adjustment

This function was developed for specific scenarios. When the LMS531 is used to monitor a facade, for example, a field is viewed down to ground level. In case of snowfall, the snow will gradually build up in such a way that it could interrupt the detection field.

With the **Automatic field adjustment** function, the field automatically adjusts to the shape of the slow-growing snow.



An evaluation case can be configured to automatically adjust the linked field under certain circumstances (e.g., grass growth or snow accumulation).

The following settings are displayed in the parameterization wizard of an evaluation case:

- Enable/disable automatic field adjustment
- Configured the output to signal field adjustment
- Setting the maximum possible speed

When this feature is enabled, the LMS531 evaluates the field edge for any slow encroachment into the setup field. The speed of encroachment is determined by the speed setting. If the specified speed is exceeded, the selected evaluation output is triggered.

When snow or grass begins to “touch” the field, the automatic field adjustment is triggered. When this triggering occurs, the sensor can signal this triggering via the selected output.

The adjustment of field points is triggered by at least one scan point “touching” the edge of the field.

The following field points are adjusted in this case:

- All field points that “touch” the edge of the field and at the same time do not exceed the speed (Note: The speed is only taken into account if the field is adapted to the sensor)
- All surrounding field points in the near range are adjusted to smooth the shape.

NOTE

If a point is displayed in the center of the field and not at the edges, it is considered an intrusion and the alarm output is triggered.

Recording of object detections

Each interruption in a defined detection field is recorded in the object detections table. The details of the interruption include the position and angle values as well as a time stamp.

To make the object detections visible in the field evaluation monitor, they must be enabled in the **Object detections** tab. The parallel view of the field evaluation monitor and the object detections table allows individual or even multiple field interruption points to be marked and made recognizable by a red color.

7.5 Connecting and performing a test measurement

Use the graphic scan view in SOPAS ET to verify the generated measured values and the measuring range online.

1. In the project tree, select **LMS...**, **Monitor**, **Scan view pro**.
2. Compare the measurement line with the required result.

NOTE

- The **Pro scan display** in the **Monitor** depends on the available processing power of the computer and is not a real time display. For this reason not all measured values are displayed. The same restriction also applies to saving the displayed measured values in a file.

3. After successful completion of the test measurement, save the configuration permanently in the device: Menu **LMS...**, **Parameters**, **Save permanently**.

Commissioning tests

The commissioning tests can be used to check whether the cables are correctly connected to the device.

1. Log in at the **Service** user level
2. Menu: **LMS5xx.../Commissioning acceptance tests.**
3. In the window for the commissioning tests, you can query or control specific connection pins:
   - Check the status of the digital inputs
   - Switch the outputs “high” or “low”
   - Check the voltage supply for the integrated heater
   - Check the 7-segment display

NOTE
At the start of the commissioning test, all outputs are set “low”.

8 Maintenance

8.1 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 viewing window at regular intervals and in the event of contamination. First, remove any solid deposits with oil-free compressed air or, if necessary, with a mixture of water and a few drops of a commercially available rinsing agent and a soft brush, and then rinse. If required, remove the drying residue with cleaning cloths that are suitable for optics and plastic cleaning agent.

NOTICE
If the inspection window is scratched or damaged (cracked or broken), the lens must be replaced. Contact SICK Support to arrange this.

- If the inspection window is cracked or broken, take the device out of operation immediately for safety reasons and have it repaired by SICK.

8.2 Maintenance plan

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

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

Table 50: 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 viewing window.	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 the mounting accessories and vibration dampers used.	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

8.3 Device replacement

Faulty or damaged devices must be dismantled and replaced with new or repaired devices of the **same type**.

As all external cable connections terminate in the system plug or the round connectors, there is no need to repeat the electrical installation when the device is replaced. The replacement device can simply be connected.

NOTE

Disconnect the power to the system!

While the device is connected, the system may start unintentionally.

Make sure that the entire system is disconnected from the voltage supply during all exchange processes.

8.3.1 Exchange of the LMS500 Lite/PRO or LMS511 Heavy Duty when reusing the previous system plug (parameter cloning)

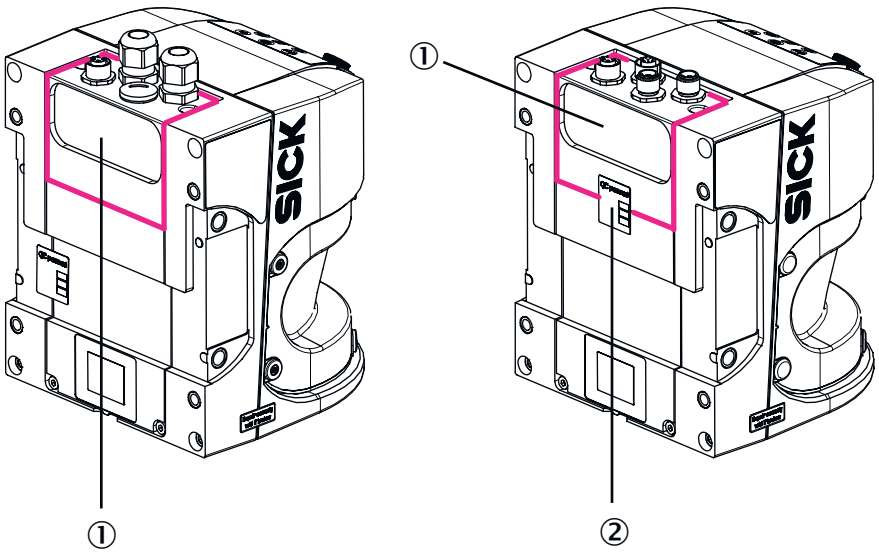


Figure 67: Removing system plug

① System plug

② Seals

NOTE

When the **QC passed** seal is broken, the device loses its warranty.

If your device is still within the warranty period, weigh up if you should replace the system plug yourself or send the device to SICK for repair. After the warranty period has expired, the seal can be broken without a second thought.

NOTICE

Danger of damage due to environmental influences!

While the system plug is removed from the device, the device and contacts are unprotected and the enclosure rating no longer meets IP65, IP67.

- Replacement of devices with removable system plug (its removal and installation) must only be performed in a clean, dry and dust-free environment. For this purpose, move the device from the outdoor area to a corresponding indoor area, if necessary.
- To prevent damage to the devices, firmly attach the existing system plug to the replacement device immediately after replacement.
- Also, immediately attach the remaining, non-wired system plug for the replacement device firmly to the removed (and potentially defective) device.
- Make sure that the inlay sealing, the supporting surface opposite, and all the electrical contacts of the system connector are free from dirt and moisture.

1. Switch off the voltage supply to the LMS5xx.
2. Dismantle the device from the bracket. If necessary, mark the alignment appropriately.
3. If the device is provided with a protection hood/weather protection hood, remove it from the LMS5xx.
4. LMS511 Heavy Duty: Break the **Remove for cloning** seal at the rear on the device system plug.
5. Recommendation: Turn the device upside down while disconnecting the system plug to avoid dirt falling into the electrical connections.
6. Loosen 2 screws and remove the old system plug including wired cables/fixed cables at the sensor.
7. Make sure that the inlay sealing, the supporting surface opposite, and all the electrical contacts are undamaged and free from dirt and moisture. If necessary, clean the corresponding elements.
8. Remove the unwired system plug from the corresponding replacement device.
9. Replace the previous system plug including cables at the rear of the replacement device and mount it.
10. If necessary, remount the protection hood/weather protection hood to the replacement device.
11. Re-mount the replacement device to the bracket see "Mounting", page 56 and check alignment.
12. Automatically configure replacement device see "Parameter cloning (LMS500 Lite/PRO and LMS511 Heavy Duty)", page 99.

NOTE

In the case of a complete device replacement, including the system connector (LMS500: rewiring!), the replacement device must be configured manually. This is done using the parameter set of the previous device stored on your computer according to the safety concept see "Commissioning", page 80.

8.3.2 Complete replacement of the LMS5x1 (without reuse of the previous system plug)

1. Switch off the voltage supply.
2. Loosen round connectors on device and remove connecting cables.
3. Dismantle the device from the bracket. If necessary, mark the alignment appropriately.
4. If the device is provided with a protection hood/weather protection hood, remove it.
5. If necessary, remount the protection hood/weather protection hood to the respective replacement device.

6. Mount the replacement device to the bracket (see "Mounting", page 56) and check alignment.
7. Reconnect and tighten all connecting cables on the replacement device.
8. Manually configure the replacement device using the parameter set of the previous device stored on your computer according to the backup concept (see "Commissioning", page 80).

8.3.3 Parameter cloning (LMS500 Lite/PRO and LMS511 Heavy Duty)

NOTE
The parameter cloning function can only be used between devices of the same type.

Functionality

When the supply voltage is switched on, the device starts up and organizes its current parameter values as follows:

- Initial commissioning of a brand-new device: The device starts up with the default setting. The cloning parameter memory of the system connector contains the default setting.
- For each adjustment to the function configuration of the device: The device saves the parameter values permanently in its internal, non-volatile parameter memory. Additionally, it always saves a permanent copy of the parameter set in the cloning parameter memory of the system plug. (This is initiated using SOPAS ET and the **Save permanently** function.) The parameter set remains saved in the system plug even if the voltage supply is interrupted.
- The next time it is started up, the device transfers the parameter set from the cloning parameter memory to its RAM see "Initial commissioning", page 82.

If a device is replaced, after start-up the replacement device checks whether there is a plausible parameter set in the system plug. If so, the device loads this parameter set to its RAM ("cloning plug gains" strategy).

As the existing system plug continues to be in use, the LMS500 Lite/PRO and the LMS511 Heavy Duty therefore make it possible for the last parameter values used in the system plug to be passed on to a replacement device of the same type automatically (cloning).

Cloning involves the replacement device accepting all the adjustable parameters, including field evaluation settings and the IP address. Accordingly, the process overwrites all the existing parameter values in the device. The exceptions in this case are the following parameters, which are always device-specific: serial number, MAC address, operating hours counter, and error memory.

NOTE
Testing the device for application suitability by means of acceptance after device replacement

If the replacement device is going on to be used unchanged, with the existing system plug and the parameter values saved in it for the application, acceptance by qualified safety personnel is not required. However, a test based on the regulations for daily testing, or a functional test, must be carried out.

If the replacement device will continue to be used with a system plug that is different from the previous one, the existing configuration must be transferred to the sensor using SOPAS ET. In this case, acceptance by qualified safety personnel may be required (depending on the system; e.g., Security).

9 Troubleshooting

9.1 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.

9.2 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

9.3 General faults, warnings, and errors

The following sections describe possible faults and troubleshooting measures to correct them. For faults that cannot be rectified using the information below, please contact SICK Service. 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 assistance.

9.3.1 LED fault indicators

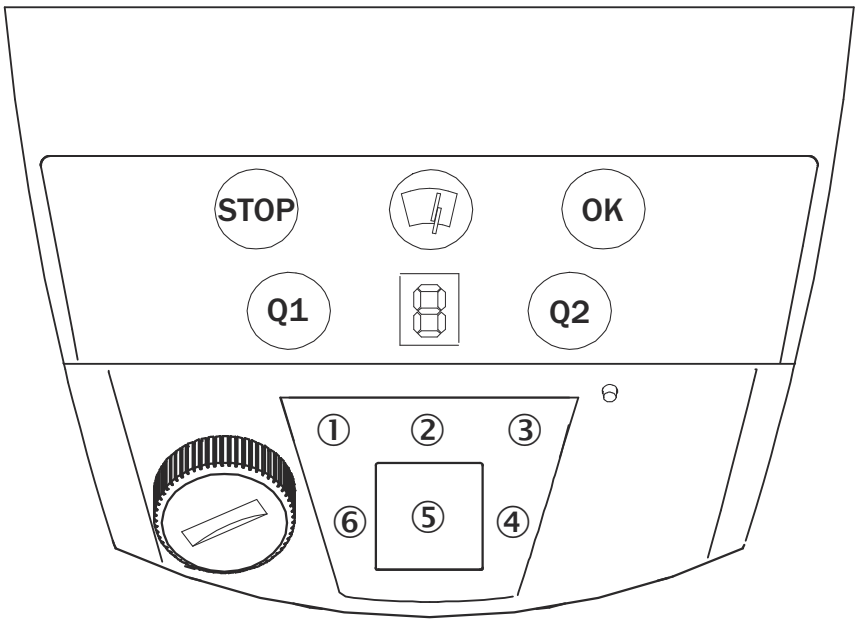


Table 51: LED fault indicators

Display	Possible causes	Troubleshooting
③ and ① off	Supply voltage missing or too low	• Check the voltage supply and activate, if necessary.
① lights up	Device not ready	• Note the error indicated on the 7-segment display or run diagnostics using SOPAS ET. • Switch off the device and turn it on again, if necessary.
② lights up	Viewing window slightly contaminated (warning)	• Clean the viewing window.
① lights up and ② flashes at 1 Hz	Viewing window heavily contaminated (error)	• Clean the viewing window.

9.3.2 Indicators in the 7-segment display

Display	Possible causes	Troubleshooting
–	Not an error	• Device is in measuring mode
`P` flashes	Firmware update is being run	• Wait until firmware update has finished.
`E` and `Zahl` alternating	Device error	• Contact SICK Service.
`0`	Connection to synchronization main interrupted	• Reconnect to the synchronization sub.
`1`	Temperature too low (only for Indoor device)	• The ambient temperature is too low for measurement mode.
`3`	Heating not connected or temperature too low (only for Outdoor device)	• Wait until the device has warmed up. • Check heating connection. • Contact SICK Service.
Each segment flashes once in sequence	Device powers up.	• Wait until the device has started.
Other displays	Display is controlled by system controller	• See the system controller documentation or contact the supplier of the system controller.

9.3.3 Detailed fault analysis

The device reports any errors that occur in a number of ways. Fault output is staggered, allowing for an increasingly detailed level of analysis:

Telegram

Communication errors can occur when transmitting telegrams to the device. The device then returns a fault code. A description of the communication errors can be found in the Telegram Listing (available at www.sick.com/8014631).

System log

Information about the status of the device is displayed in the system log.

SOPAS ET: **Project tree**, **LMS...**, **Service**, **System Status**

Reserved distance values

A description of the reserved distance values can be found in the Telegram Listing (**LMDscandata - reserved values**, Telegram Listing available at www.sick.com/8014631).

Field evaluation monitor

With the field evaluation monitor, you can analyze if and how detection fields are interrupted and how the outputs of the device behave.

SOPAS ET: **Project tree**, **LMS...**, **Monitor**, **Field evaluation monitor**.

Field evaluation logging

With field evaluation logging, you can record any object detection that occurs. The field evaluation logging helps with diagnosing longer periods of time, analyzing faults, or optimizing processes.

SOPAS ET: **Project tree**, **LMS...**, **Monitor**, **Recording of object detections**.

9.3.4 Resetting the password for the Service user level

If you have forgotten the password of the **Service** user level, you can reset it with the assistance of SICK.

NOTE

The responsible SICK sales company or the responsible SICK service partner carefully checks each code request to reset the password. A risk of deception by third parties nevertheless exists. The operating entity should therefore take suitable security measures.

The operating entity should also take suitable measures to limit, as best as possible, access to the product. This includes, in particular, physical access as well as access to the software interfaces of the product.

Requesting an unlock code

1. Open SOPAS ET.
2. Open the device window.
3. Open the device name (LMS5xx_...) > **Password** > **Reset Service password**.

✓ The **Reset password** window appears.

4. Enter the relevant data.

   NOTE | Do not press **Generate** if an unlock code has already been requested from SICK. Only press this button if a new device code is required when inquiring again.

5. Click **Generate e-mail with data**.

✓ Your SICK subsidiary will create the unlock code based on the information provided and send it to you.
The code is only valid once for the reset process. You can close the window by clicking on the **x** without interrupting the reset process. If you select **Cancel** or enter an incorrect code several times, the current reset process is terminated. The requested code is no longer valid. The process must be restarted.

6. Wait for the unlock code: The dialog box can be closed and the device switched off.

Entering the unlock code

Prerequisite

- SICK has sent an unlock code.

1. Open SOPAS ET.
2. Open the device window.
3. Open the device name (LMS5xx_...) > **Password** > **Reset Service password**.

✓ The **Reset password** window appears.

4. Click **Next**.
5. Enter the code sent by SICK.

6. Click **Ok**.
✓ Password has been reset to the default password `servicelevel`. Parameters are not changed.

Assigning a new password for the Service user level

1. Open SOPAS ET.
2. Log on to the device with the **Service** user level and the default password `servicelevel`.
3. Open the device name (LMS5xx_...) > **Password** > **Change password**.
4. Assign the new password for the **Service** user level.

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

	LMS500	LMS511/LMS581	LMS531
Application	Indoor	Outdoor	Outdoor, Security
Resolution	High resolution	Standard resolution, high resolution (type-dependent)	Standard resolution
Light source	Infrared (905 nm ± 10 nm)		
Laser class	Laser class 1, EN 60825-1:2014+A11:2021; IEC 60825-1:2014; CAN/CSA-E60825-1:2015-11 Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3 as described in Laser Notice No. 56, dated May 8, 2019.		
Aperture angle	190°		
Scanning frequency	**Lite:** 25 Hz ... 75 Hz **PRO/Heavy Duty:** 25 Hz ... 100 Hz		
Angular resolution	**Lite:** 0.25°, 0.50°, 1° **PRO/Heavy Duty:** 0.1667°, 0.25°, 0.3333°, 0.5°, 0.6667°, 1° Exclusively in Interlaced mode: 0,042°, 0,083°		
Scan field flatness	Scan field flatness combined: ± 0.72° Typical conical error: 1 sigma value -0.11° ± 0.10° Typical tilt: 1 sigma value +0.15° ± 0.08°		
Field sets	**Lite:** 4 **PRO/Heavy Duty:** 10		
Simultaneous evaluation cases	**Lite:** 4 **PRO/Heavy Duty:** 10		
Heating	self-heating	Self-heating with additional integrated heating	
Working range	0.2 m ... 80 m (HR and SR) 0.2 m ... 130 m (SR Extended Range)		
Scanning range with 10% radiance factor	0.7 m ... 26 m	0.7 m ... 26 m (HR) 1.0 m ... 40 m (SR) 1.0 m ... 52 m (SR Extended Range)	1.0 m ... 40 m (SR) 1.0 m ... 52 m (SR Extended Range)
High resolution measurement accuracy [1]	± 12 mm		–
Standard resolution measurement accuracy [2]	–	± 24 mm	

	LMS500	LMS511/LMS581	LMS531
High resolution spot size	Divergence: 4.7 mrad at the viewing window: 13.5 mm in 26 m: 136 mm in 40 m: 202 mm		–
Standard resolution spot size	–	Divergence: 11.9 mrad at the viewing window: 13.5 mm in 26 m: 322 mm in 40 m: 489 mm	
Number of echoes evaluated	**Lite:** 2 **PRO/Heavy Duty:** 5		

1) Measured in test environment (like LMS2xx): Temperature = 23 °C, Remission = 100% at 6 m distance
2) Measured in test environment (like LMS2xx): Temperature = 23 °C, Remission = 10% at 20 m distance

Working range diagrams

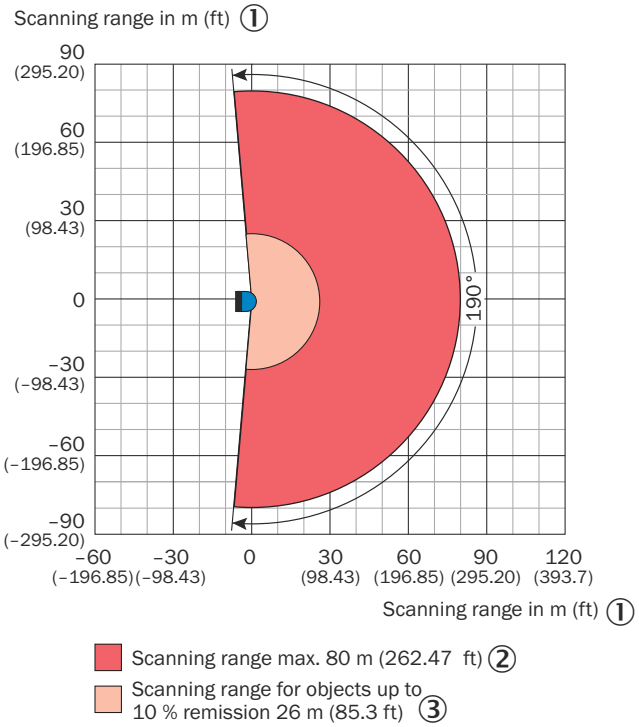


Figure 68: LMS5xx high resolution working range, unit m (ft), decimal separator: period

① Scanning range in m
② Max. scanning range 80 m
③ Scanning range for objects up to 10% remission 26 m

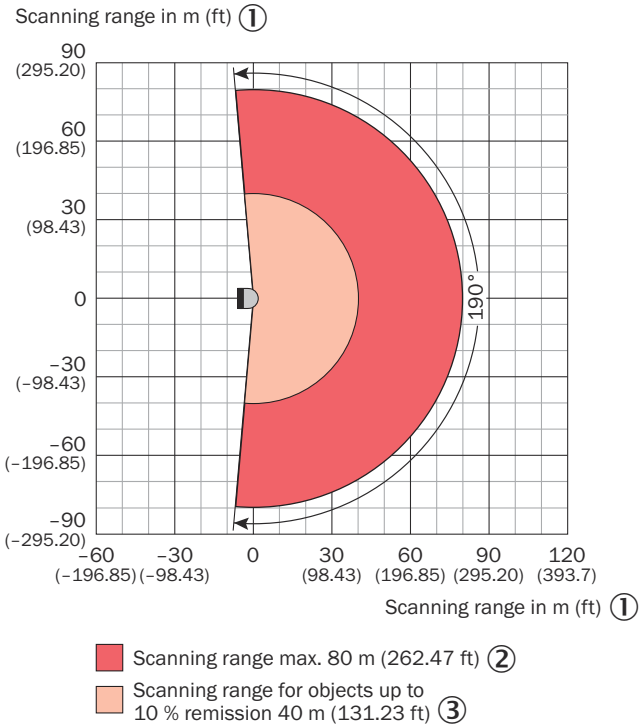


Figure 69: LMS5xx standard resolution working range, unit m (ft), decimal separator: period

① Scanning range in m

② Max. scanning range 80 m

③ Scanning range for objects up to 10% remission 40 m

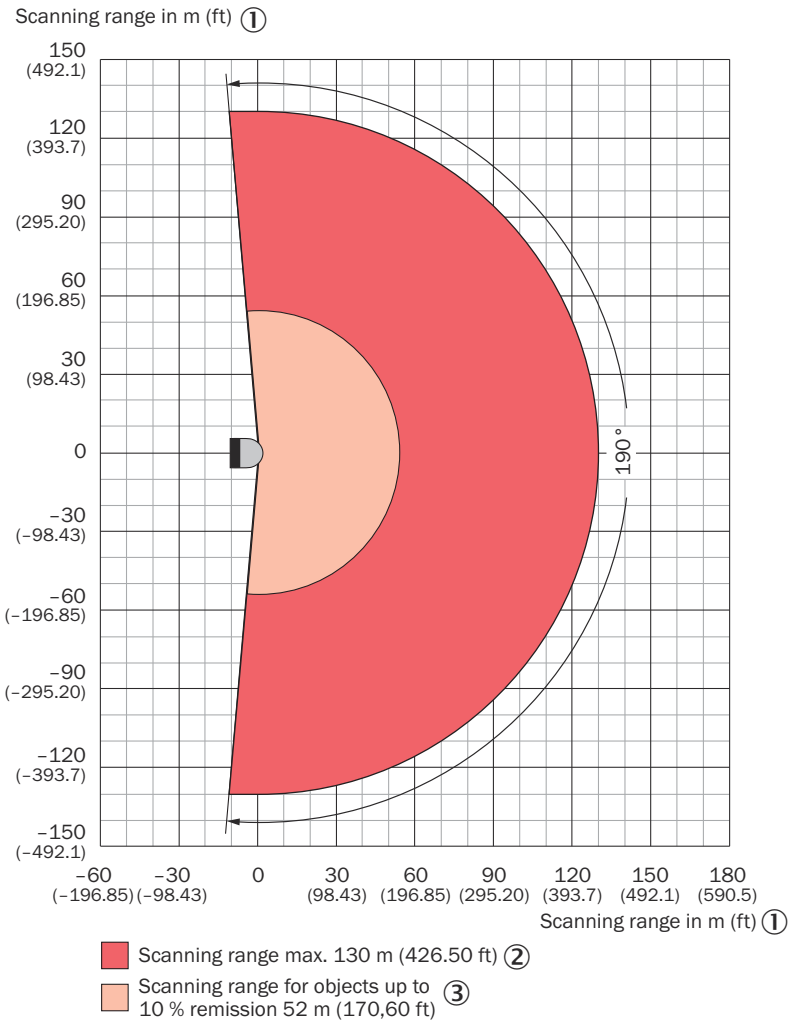


Figure 70: Working range of LMS5xx Standard Resolution Extended Range, unit m (ft), decimal separator: period

① Scanning range in m

② Max. scanning range: 130 m

③ Scanning range for objects up to 10% remission factor: 52 m

10.2 Performance

	LMS500	LMS511/LMS581	LMS531
Response time [1]	**Lite:** typ. ≥ 13 ms **PRO/Heavy Duty:** typ. ≥ 10 ms		
Power-up delay	25 s – 60 s (above 0° C)		
Systematic error 1 Echo High Resolution [2]	± 25 mm (1 m ... 10 m) ± 35 mm (10 m ... 20 m)		–
Systematic error 1 Echo Standard Resolution [2]	–	± 25 mm (1 m ... 10 m) ± 35 mm (10 m ... 20 m) ± 50 mm (20 m ... 30 m)	
Statistical error 1 Echo High Resolution [2]	7 mm (1 m ... 10 m) 9 mm (10 m ... 20 m)		–
Statistical error 1 Echo Standard Resolution [2]	–	6 mm (1 m ... 10 m) 8 mm (10 m ... 20 m) 14 mm (20 m ... 30 m)	

	LMS500	LMS511/LMS581	LMS531
Integrated application	Field evaluation with flexible fields, data output		
Filter	Echo filter, fog filter, particle filter, fixed average filter, glare filter		
Parameter cloning via system plug	Lite, PRO	Heavy Duty	–

1) Depending on the selected filter settings, scanning frequency, angular resolution and the object size.
2) After what distance from the first echo full accuracy measurements can be taken again depends on the target that reflected the first echo.
Ambient conditions: Good visibility, temperature range = 0 °C to 60 °C, remission = 10 to 20,000%, ambient brightness < 70 klux.

10.3 Interfaces

	LMS500	LMS511/LMS581	LMS531
Ethernet	TCP/IP, UDP/IP Function: Host/AUX, OPC, NTP Data transmission rate: 10/100 Mbit/s Standard IP address: 192.168.0.1		
Serial (RS-232, RS-422) [1]	Function: Host/AUX Data transmission rate: 9.6 kBaud ... 500 kBaud Galvanic separation: yes Length of cable at 38.4 kBd and a cable cross-section of 0.25 mm^2: 15 m		
CAN-Bus [1]	**PRO, Heavy Duty** Function: Output extension [1] Synchronization of data transmission rate: 20 kBit/s, 500 kBit/s, 1 MBit/s		
USB	Mini-USB Function: AUX		

	LMS500	LMS511/LMS581	LMS531
Digital inputs [1]	**Lite** Quantity: 2 Function: Digital input		**Lite** Quantity: 3 Function: Digital input
	PRO, Heavy Duty Quantity: 4 Function: Digital input, encoder (HTL), synchronization		**PRO, Heavy Duty** Quantity: 4 Function: Digital input
	Input 1/2 Input voltage: 11 V ... 30 V Voltage for HIGH: 11 V ... 30 V Voltage for LOW: 0 V ... 5 V Input capacity: 15 nF Static input current: 6 mA ... 15 mA **Input 3/4** Input voltage: 11 V ... 30 V Voltage for HIGH: 11 V ... 30 V Voltage for LOW: -3 V ... 5 V Input capacity: 1 nF Duty cycle (Ti/T): 0.5 Input frequency: 100 kHz **Encoder** HTL / dual-channel incremental encoder with 90° phase offset Speed range that can be sampled: from +100 mm/s to +20,000 mm/s From -100 mm/s to -20,000 mm/s Number of pulses per cm: At least 50 Recommended length of cable of the incremental encoder: max. 10 m		

	LMS500	LMS511/LMS581	LMS531
Digital outputs [1]	**Lite** Quantity: 3 Function: Digital output		**Lite** Quantity: 3 Function: 2x relay, 1x digital output
	PRO, Heavy Duty Quantity: 6 Function: Digital output		**PRO, Heavy Duty** Quantity: 4 Function: Relay
	LMS500/511/531 digital outputs 1+2 [2] Typ. Output voltage DC: V_SOUT - 1,5 V Max. switching current under continuous load: 0.25 A Internal resistance: 0.55 Ω ... 2.0 Ω Maximum loss power: 500 mW **LMS500/511 digital outputs 3-6** [3] Typ. Output voltage DC: V_SOUT - 2 V Max. switching current: 100 mA **LMS531 Lite digital output 3** [3] Typ. DC output voltage: V_SOUT - 2 V Max. switching current: 100 mA **LMS531 relay outputs** Max. load voltage DC: 40 V Max. switching current under continuous load: 0.5 A Internal resistance: 0.34 Ω ... 0.7 Ω Maximum loss power: 400 mW Output capacity: 450 pF Power-up delay: 1.3 ms ... 5 ms Switch-off time: 0.1 ms ... 0.5 ms Max. switching frequency: 5 Hz		
Optical indicators	5 LEDs (additional 7-segment display)		

1) Not applicable to LMS511 with Harting connector see "Connections of the LMS511 with Harting male connector", page 71.
2) To increase the number of outputs, an extension module is required, which is available as an accessory.
3) Outputs are short-circuit protected (no overload protection).

10.4 Mechanics/electronics

	LMS500	LMS511/ LMS581 [1]	LMS531
Electrical connection	1 system plug with screw terminal 1 x Mini USB port behind a screw connection	4 x M12 round connectors[2] 1 x Mini USB port behind a screw connection	
Electrical safety	According to IEC 61010-1:2010 as well as UL 61010-1:2012 / R:2015-07		
Supply voltage (V_S out)	24 V DC ± 20% SELV supply voltage according to IEC 60364-4-41		
Permissible residual ripple	± 5%		
Power consumption	P_{max} combined: 35 W P_{max} sensor: 22 W P_{max} heating: - P_{max} output: 13 W (total output of all OSSDs)	P_{max} combined: 95 W P_{max} sensor: 22 W P_{max} heating: 60 W P_{max} output: 13 W (total output of all OSSDs)	P_{max} combined: 83 W P_{max} sensor: 22 W P_{max} heating: 60 W P_{max} output: 1 W (total output of all OSSDs)

	LMS500	LMS511/ LMS581 [1]	LMS531
Start-up current	The start-up current depends on the supply voltage and the length of cable. This will be a multiple of the continuous load current. Example: For 24 V on the device and a 5 m cable, the peak start-up current is approx. 14 A. The rise/fall time ratio is approx. 12 µs / 240 µs.		
Screw terminal	Rigid wire cross-circuit: 0.14 ... 1.5 mm^2 Flexible wire cross-circuit: 0.14 ... 1.0 mm^2 Stripping length of the wires: 5 mm Screw tightening torque 0.22 ... 0.3 Nm	–	
Housing material	AlSi12		
Housing color	Light blue (RAL 5012) Black (RAL 9005)	Grey (RAL 7032) Black (RAL 9005)	
Viewing window	Material: Polycarbonate, scratch-resistant coating on the exterior		
M12 round connector [2]	**Lite, PRO:** Brass, nickel-plated **Heavy Duty:** Stainless steel 1.4404 (V4A)		**Lite:** Brass, nickel-plated **PRO, Heavy Duty:** Stainless steel 1.4404 (V4A)
Enclosure rating	IP65 (EN 60529, Section 14.2.7)	IP65 (EN 60529, Section 14.2.7) IP67 (EN 60529, Section 14.2.7)	
Protection class	III (DIN EN 61140:2016-11)		
Weight	3.7 kg		
Dimensions	160 mm x 155 mm x 185 mm		

1) For connecting the sensor voltage supply, heating voltage supply, Ethernet. Suitable for Harting Han® 3 A RJ45 +4p type cable plug connector.

2) Table content not applicable to LMS511 with Harting connector see "Connections of the LMS511 with Harting male connector", page 71.

This variant comes with:

- 1x Harting connector, suitable for Harting Han® 3 A RJ45 +4p type cable plug; material zinc
- 1 x Mini USB port behind a screw connection

10.5 Ambient data

	LMS500	LMS511/LMS581	LMS531
Radiance factor	2% ... > 1,000% (reflectors [1])		
Electromagnetic compatibility (EMC) [2]	Radiation emitted: IEC 61000-6-3:2020 / EN 61000-6-3:2007+A1:2011 Electromagnetic immunity: IEC 61000-6-2:2016 / EN IEC 61000-6-2:2019		

	LMS500	LMS511/LMS581	LMS531
Chemical resistance	Salt spray test according to DIN EN ISO 9227 NSS: 2006-10-01 test duration: 240 h, test temperature: 35 °C, 5% NaCl solution Kesternich test according to DIN EN ISO 6988: 1997-3 - KFW 0.2 S test cycle duration: 24 h, number of cycles: 5, concentration: 0.067% SO2		
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, 1,000 shocks per axis		
Impact resistance	IK05, IK06, IK07 according to DIN EN 50102-09.1997		
Ambient operating temperature	0 °C ... +50 °C	**LMS511 Lite/PRO, LMS531 Lite**: -30 °C ... +50 °C Without heating, at switch-on: 0 °C ... +50 °C Without heating, during operation: -10 °C ... +50 °C [3] **LMS511 Heavy Duty, LMS531 PRO, LMS531 Heavy Duty**: -40 °C ... +60 °C Without heating, at switch-on: 0 °C ... +60 °C Without heating, during operation: -10 °C ... +60 °C [3]	
Storage temperature	–40 °C ... +70 °C (max. 24 h)		
Relative humidity	Max. 95%, non-condensing according to DIN EN 60068-2-61, method 1		
Ambient light immunity	70 klx		

1) Corresponds to Diamond Grade 3000X™ (approx. 1,250 cd/lx × m^2)

2) This specification applies to all devices with hardware version II.
For all devices with hardware version I or an unspecified hardware version, the following applies:
- Radiation emitted: EN 61000-6-4:2007+A1:2011, IEC 61000-6-4:2018 / EN IEC 61000-6-4:2019
- Electromagnetic immunity: EN 61000-6-2:2005+AC:2005, IEC 61000-6-2:2016 / EN IEC 61000-6-2:2019

The hardware version of device can be found on the type designation label see figure 6, page 19.

3) When operating the device without heating, a warning message may occur due to no voltage supply for the heating being connected.

10.6 Dimensional drawings

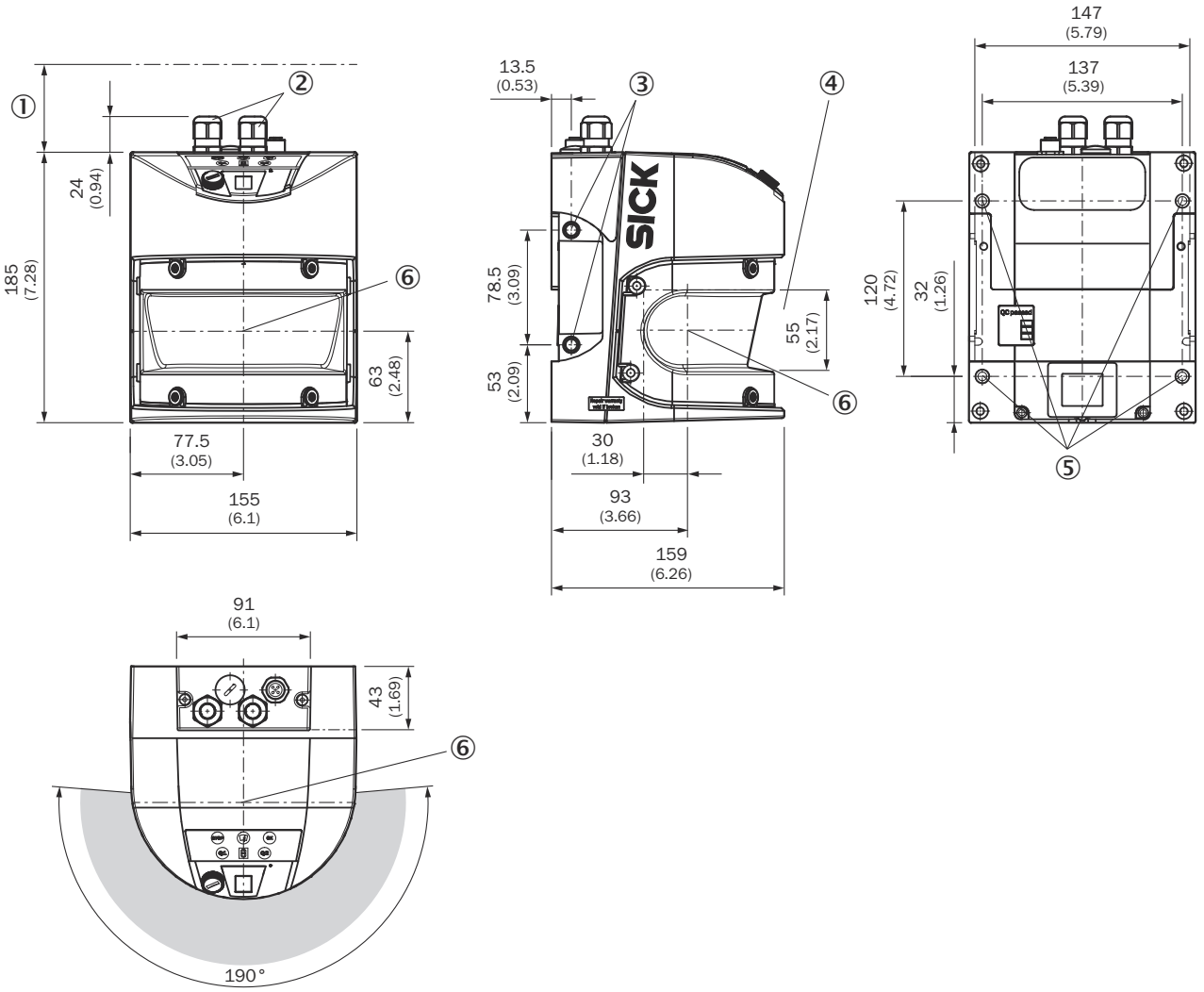


Figure 71: Device dimensions LMS500; unit: mm (inch), decimal separator: period

① Area to be kept free while mounting the device: approx. 100 mm
② 2x cable glands for cables from 5-12 mm
③ 4x threaded mounting hole M8x9 (glued in with high-strength screw adhesive)
④ Minimum area to be kept free during operation of the device
⑤ 4x threaded mounting hole M6x8 (glued in with high-strength screw adhesive)
⑥ Horizontal measurement origin

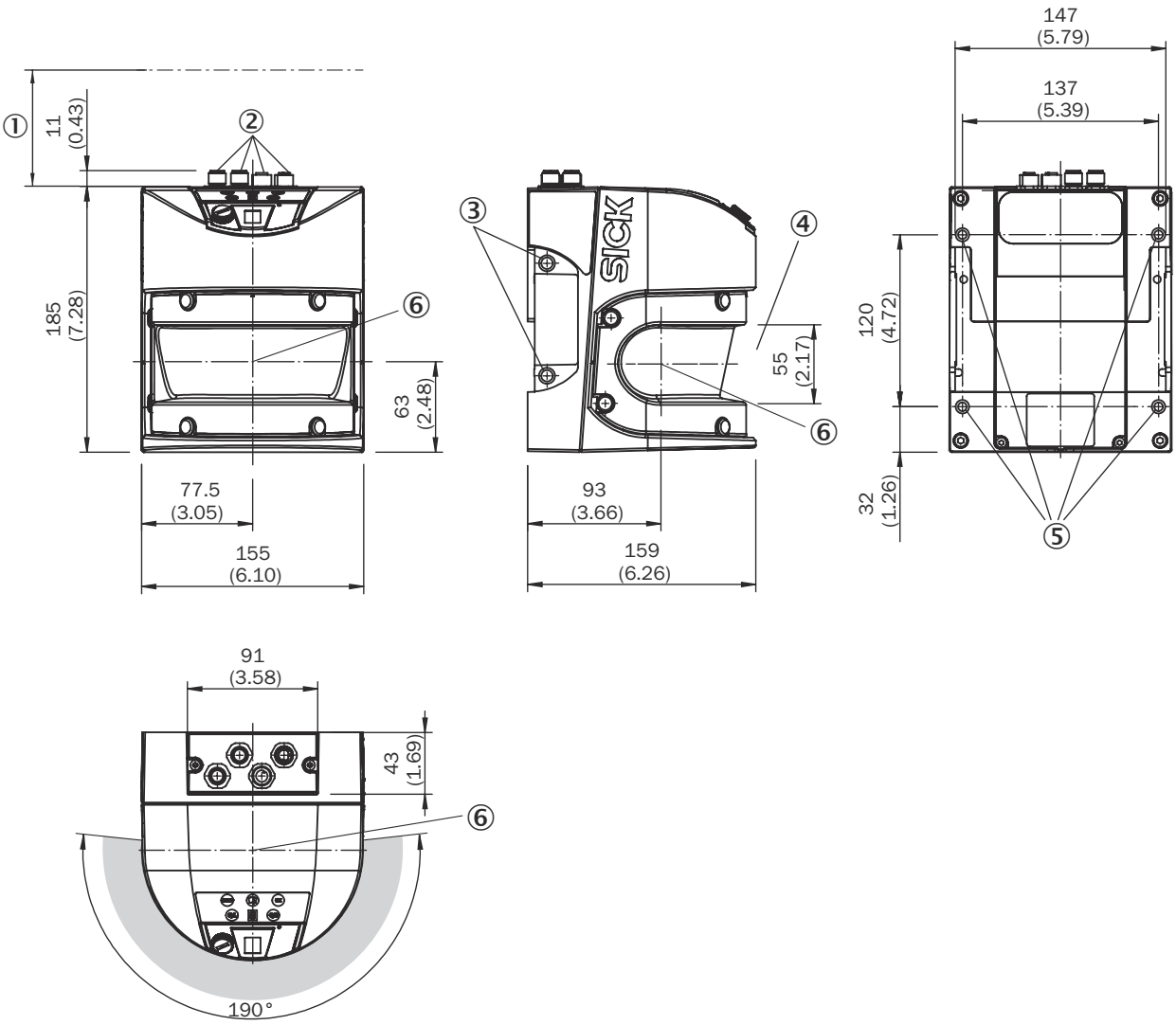


Figure 72: LMS511 / LMS531 / LMS581 device dimensions; unit: mm (inch), decimal separator: period

① Area to be kept free while mounting the device: approx. 100 mm
② 4x M12 round connector
③ 4x threaded mounting hole M8x9 (glued in with high-strength screw adhesive)
④ Minimum area to be kept free during operation of the device
⑤ 4x threaded mounting hole M6x8 (glued in with high-strength screw adhesive)
⑥ Horizontal measurement origin

NOTE

Dimensional drawings of accessories such as mounting kits and protection hoods 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).

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).

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