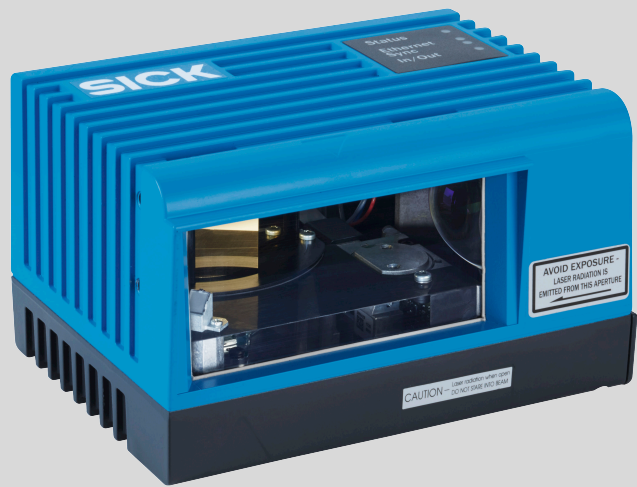


# LMS4000

2D LiDAR sensors

**SICK**  
Sensor Intelligence.



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**Described product**

LMS4000

**Manufacturer**

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**Original document**

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## Contents

<b>1</b>	<b>About this document.....</b>	<b>5</b>
1.1	Information on the operating instructions.....	5
1.2	Explanation of symbols.....	5
1.3	Further information.....	6
<b>2</b>	<b>Safety information.....</b>	<b>7</b>
2.1	Intended use.....	7
2.2	Improper use.....	7
2.3	Cybersecurity.....	7
2.4	Limitation of liability.....	7
2.5	Modifications and conversions.....	8
2.6	Requirements for skilled persons and operating personnel.....	8
2.7	Operational safety and particular hazards.....	9
2.8	Warning signs on the device.....	10
<b>3</b>	<b>Product description.....</b>	<b>13</b>
3.1	Scope of delivery.....	13
3.2	Status indicators.....	13
3.3	Device variants.....	13
3.4	Type label.....	14
3.5	Principle of operation.....	15
3.5.1	Measuring principle.....	15
3.5.2	Ethernet data interface.....	16
3.5.3	Output of measured values.....	16
3.5.4	Laser control.....	19
3.5.5	Angle channel.....	20
3.5.6	Quality channel.....	20
3.5.7	Impact of object surfaces on the measurement.....	21
3.5.8	Filters.....	23
3.5.9	Motor synchronization for measuring range extension.....	27
<b>4</b>	<b>Transport and storage.....</b>	<b>29</b>
4.1	Transport.....	29
4.2	Unpacking.....	29
4.3	Transport inspection.....	29
4.4	Storage.....	29
<b>5</b>	<b>Mounting.....</b>	<b>31</b>
5.1	Mounting instructions.....	31
5.2	Example installation of a conveyor system.....	31
5.3	Mounting the device.....	32
<b>6</b>	<b>Electrical installation.....</b>	<b>33</b>
6.1	Wiring instructions.....	33
6.2	Prerequisites for safe operation of the device.....	34

6.3	Connection diagram.....	36
6.4	Connection options.....	38
6.5	Connecting the device electrically.....	38
<b>7</b>	<b>Operation.....</b>	<b>39</b>
7.1	Operation with SOPAS ET.....	39
7.1.1	Scan recording.....	42
7.2	Output of measured values via terminal program.....	42
<b>8</b>	<b>Maintenance.....</b>	<b>46</b>
8.1	Maintenance plan.....	46
8.2	Cleaning.....	46
<b>9</b>	<b>Troubleshooting.....</b>	<b>48</b>
9.1	General faults, warnings, and errors.....	48
9.2	Repairs.....	50
9.3	Returns.....	50
9.4	Disposal.....	50
<b>10</b>	<b>Technical data.....</b>	<b>52</b>
10.1	Features.....	52
10.2	Mechanics/Electronics.....	54
10.3	Dimensional drawing.....	55
10.4	Performance.....	56
10.5	Interfaces.....	57
10.6	Ambient data.....	58
<b>11</b>	<b>Accessories.....</b>	<b>59</b>
<b>12</b>	<b>Annex.....</b>	<b>60</b>
12.1	Telegram structure.....	60
12.2	Declarations of conformity and certificates.....	65
12.3	Licenses.....	65

# 1 About this document

## 1.1 Information on the operating instructions

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

Prerequisites for safe work are:

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

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



### NOTE

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

---

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

These operating instructions do not provide information on operating the machine or system in which the device is integrated. 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

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### NOTE

Further documentation for the device can be found on the online product page at:

- [www.sick.com/LMS4000](http://www.sick.com/LMS4000)

There, additional information has been provided depending on the product, such as:

- Model-specific online data sheets for device types, containing technical data, dimensional drawing, and specification diagrams
  - Declarations of conformity and certificates of the product family
  - Dimensional drawings and 3D CAD dimension models of the device types in various electronic formats
  - Other publications related to the devices described here
  - Publications dealing with accessories
-

## 2 Safety information

### 2.1 Intended use

The 2D LiDAR sensor LMS4000 is intended exclusively for use in industrial environments. Radio interference may result when used in residential areas.

The device measures objects of any shape during continuous output of measurement data.

The following contour data is output to a computing unit (e.g., industrial PC or SICK Sensor Integration Machine (SIM)) via the Ethernet interface for further processing:

- Distance values: Distance from zero point in the corrected angular position
- Remission values: Remission as a unitless scale value (digit) or a calibrated grayscale value (%) in the corrected angular position
- Angle correction values: Deviation from implicit angular position
- Quality values: Additional information on the respective measured value

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 these operating instructions must be strictly observed.
- Shut down the product immediately in case of damage.

### 2.3 Cybersecurity

To protect against cybersecurity threats, it is necessary to continuously monitor and maintain a comprehensive and holistic cybersecurity concept. A suitable concept comprises organizational, technical, procedural, electronic, and physical levels of defense and provides suitable measures for different types of risks. SICK's products and solutions must be viewed as a component of this concept.

Information on Cybersecurity can be found at: [www.sick.com/psirt](http://www.sick.com/psirt).

### 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.

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

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

The following qualifications are required for various activities:

*Table 1: Activities and technical requirements*

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



Activities	Qualification
Operation of the device for the particular application	<ul style="list-style-type: none"> <li>■ Knowledge of the operation and control of the devices in their particular application</li> <li>■ Knowledge of the software and hardware environment for the particular application</li> </ul>

## 2.7 Operational safety and particular hazards

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



### CAUTION

#### Optical radiation: Class 2 Laser Product

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

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



### WARNING

#### Electrical voltage!

Electrical voltage can cause severe injury or death.

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



### WARNING

#### Risk of injury and damage caused by potential equalization currents!

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

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

2.8 Warning signs on the device

LMS4x1x

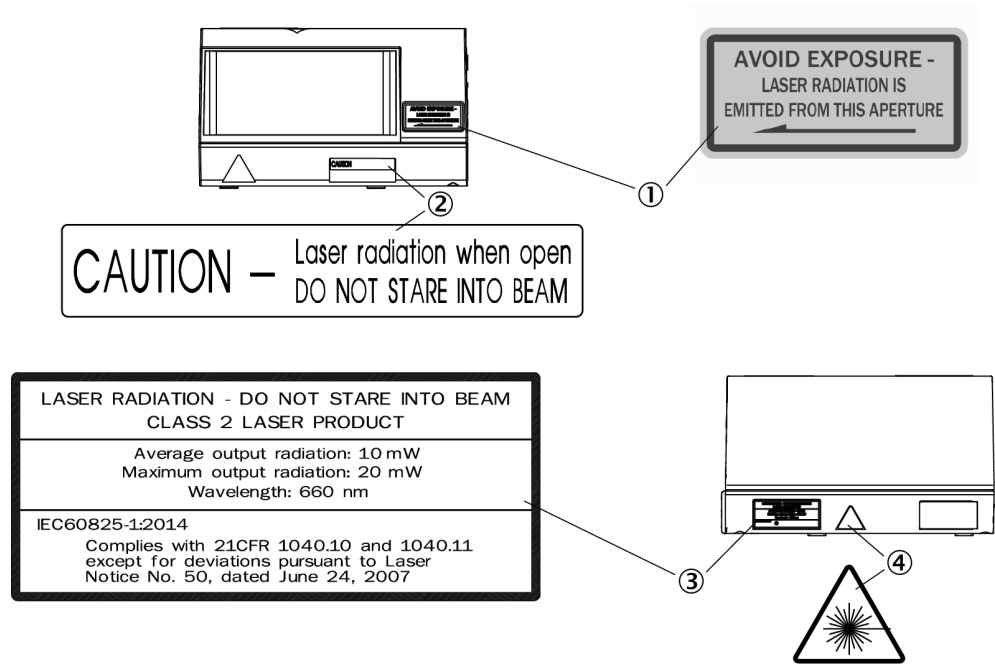


Figure 1: LMS4x1x – Warning signs on the device

- ① Avoid exposure – Laser radiation is emitted from this aperture.  
Laser output aperture corresponds to the front viewing window at the height of the position shown.
- ② Caution – Laser radiation when opened. Do not look into beam.
- ③ Laser radiation – Do not stare into beam. Class 2 laser product  
Average radiation output: 10 mW  
Maximum radiation output: 20 mW  
Wavelength: 660 nm  
IEC 60825-1:2014  
Complies with 21 CFR 1040.10 and 1040.11 except for tolerances according to Laser Notice No. 50 of June 24, 2007.
- ④ Warning symbol: Laser radiation

## LMS4x2x

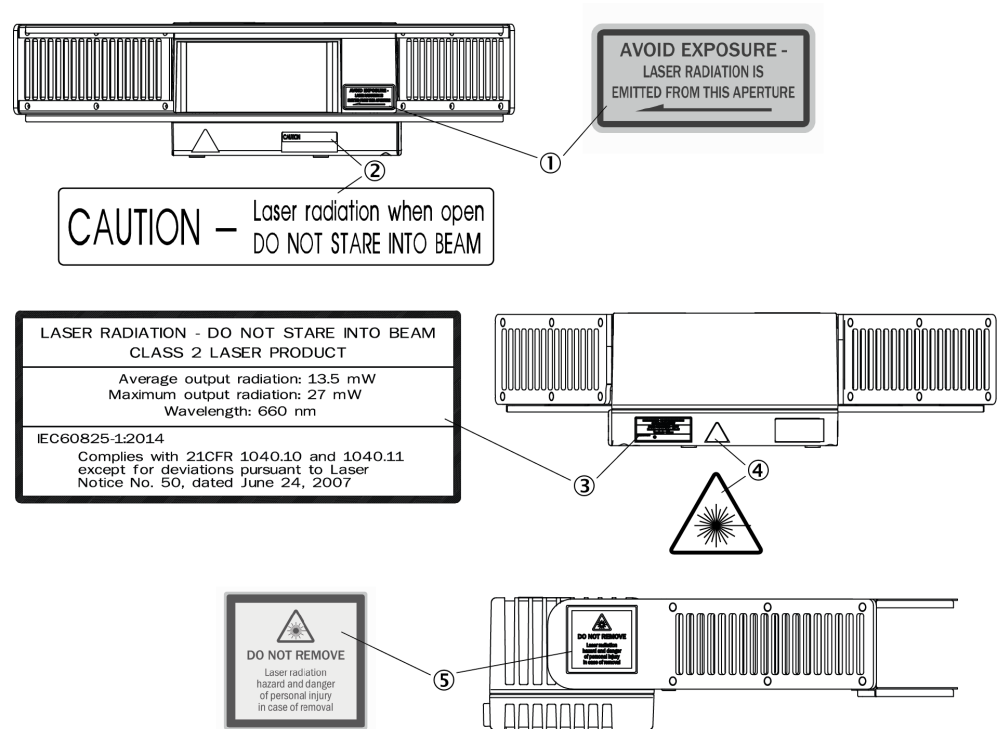


Figure 2: LMS4x2x – Warning signs on the device

- ① Avoid exposure – Laser radiation is emitted from this aperture.  
Laser output aperture corresponds to the front viewing window at the height of the position shown.
- ② Caution – Laser radiation when opened. Do not stare into beam.
- ③ Laser radiation – Do not stare into beam. Class 2 laser product  
Average radiation output: 13.5 mW  
Maximum radiation output: 27 mW  
Wavelength: 660 nm  
IEC 60825-1:2014  
Complies with 21 CFR 1040.10 and 1040.11 except for tolerances according to Laser Notice No. 50 of June 24, 2007.
- ④ Warning symbol: Laser radiation
- ⑤ Do not remove – Hazardous laser radiation and risk of personal injury if the laser protection hood is removed. Limit values of laser class 2 are exceeded.

### Notes on the warning signs

- Before commissioning, the English warning label “LASER RADIATION – DO NOT STARE INTO BEAM” is to be replaced with a warning label in a language that the operators of the system understand. Laser warning labels in German and French are included in the scope of delivery.
- If the devices are installed in a system/casing so that the warning labels are covered, other warning labels (not included with delivery) must be attached to the system/casing next to the laser output aperture.

- When operating with the trigger, the laser diode is switched on by the switch-on signal and switched off again by the deactivation signal. When free output of measured values is set, the laser diode is continuously on.
- The device automatically monitors beam generation and automatically shuts down the laser diode in the event of irregularities. If this happens, the red “Status” LED lights up. The device stops sending measured values and an entry is added to the error memory.

### 3 Product description

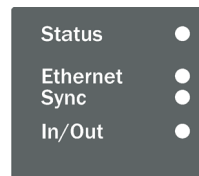
#### 3.1 Scope of delivery

The delivery of the device includes the following components:

Table 2: Scope of delivery

No. of units	Component	Comment
1	Device in the version ordered	Depending on version. Without connecting cables and brackets.
1	Set of protective caps for electrical connections	Attached to the connections.
1	Set of warning labels in German and French.	To replace the English version if needed.
1	Printed safety notes, multilingual	Quick guide and general safety notes

#### 3.2 Status indicators



Four LEDs give a visual indication of the operational status and any errors that occur.

LED	Color	Status
Status	Green	Device is fully functional and the laser is switched on (continuously lit), device is in standby mode and the laser is switched off (flashing)
	Yellow	Warning
	Red	Device is not ready to take measurements Possible reasons: Login via a terminal is active, device is in error state or restarting
Ethernet	Green	LINK path is established (continuously lit), data transmission (flashing)
Sync	Green	Master: Sync signals are being sent (continuously lit) Slave: Sync signals are being received (flashing), sync connection is active and device synchronized (continuously lit)
In/Out	Yellow	Specific digital input or digital output (can be parameterized) is active

#### 3.3 Device variants

Type	Application	Measuring range	Remission range	Connections
LMS4111R-13000	Indoor	0.7 m ... 3 m	3.5% ... 300%	3x M12
LMS4121R-13000	Indoor	0.7 m ... 3 m	2% ... 200%	3x M12

Type	Application	Measuring range	Remission range	Connections
LMS4124R-13000S01	Indoor	0.5 m ... 5.5 m	2% ... 200% <sup>1)</sup>	3x M12

<sup>1)</sup> The LMS4124R-13000S01 is a special variant with extended scanning range. The specified remission range is only applicable for a part of the measuring range. All the special features of the variant see ["Special features of the LMS4124R-13000S01 device variant"](#), page 14.

**Special features of the LMS4124R-13000S01 device variant**

The LMS4124R-13000S01 variant offers an extended measuring range compared to the standard LMS4xx1 variants. This allows monitoring of an area more than 3x larger, namely 18.3 m<sup>2</sup>, instead of 5.2 m<sup>2</sup>. At the same time, however, this extension comes with several limitations compared to the standard devices.

In particular, the sensor algorithm strives to generate a valid value for each measuring point. Disputed measuring points are therefore also output as valid, which would be marked as invalid by the standard LMS4xx1 variant.

The customer software used to evaluate the measurement data must therefore be reliable enough to be able to ignore measuring points that may have been generated incorrectly. To decide whether the sensor is suitable for a particular application, we recommend a thorough check with a test device provided by SICK.

In particular, note the following:

- If the working range is exceeded or undercut, random measuring points are projected into the affected angular ranges, although no objects are present there. Beam separation for limiting detection can prevent this effect (see ["Example installation of a conveyor system"](#), page 31 and see ["Mounting the device"](#), page 32).
- Highly reflective objects that are orthogonal to the sensor's laser beam are projected up to a few centimeters closer to the sensor in the measurement data.
- The specified measurement accuracy (see ["Performance"](#), page 56) for the extended measuring range is significantly below that of the core measuring range of 0.7 m to 3.0 m. This is due, on the one hand, to the reduced received signal strength in the near and far range and, on the other hand, to the increased probability of edge hits (see ["Edge filter"](#), page 25) when measuring at greater distances.

3.4 Type label

The type label gives information for identification of the sensor.

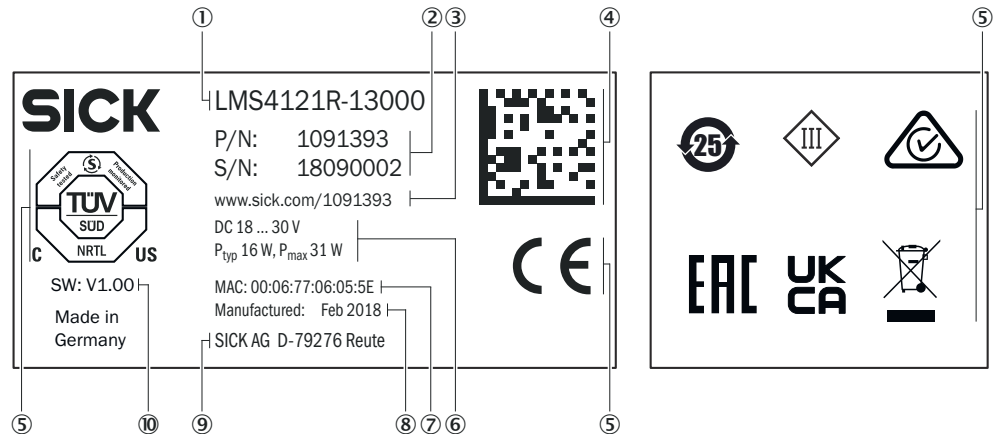


Figure 3: LMS4000 type label (example)

- ① Type code
- ② Part number, serial number

- ③ Web address of product page
- ④ Data Matrix code with product data and link to product page
- ⑤ Conformity mark/certification mark
- ⑥ Supply voltage, typical power consumption/maximum power consumption
- ⑦ MAC address
- ⑧ Production date
- ⑨ Manufacturer/production location
- ⑩ Device software version

### 3.5 Principle of operation

#### 3.5.1 Measuring principle

The device is an opto-electronic LiDAR sensor that scans its surroundings with the help of laser beams without making contact. The device measures its surroundings in polar coordinates (distance, angle) relative to its measurement origin. The measurement origin is marked by a circular indentation on the top and bottom of the housing.

It is an active system featuring a light laser in the visible range (red). It does not require position marks, reflectors, or object illumination.

When a laser beam strikes an object, the distance and measuring angle are determined.

The distance is determined according to the principle of phase shift (continuous wave). There is a phase difference between the sender and receiver beams resulting from the time-of-flight of the light and the wavelength used. This phase difference is used to calculate the distance of the object from the zero point. The measuring angle is the angle at which the laser radiation exits the device.

The device must have a clear view of the object being measured.

#### Working range

The working range of the device is illustrated in the drawing below.

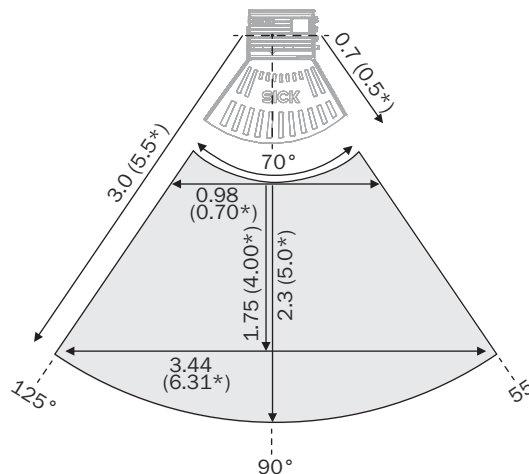


Figure 4: Working range, dimensions in meters, decimal separator: Period (values with \* valid for LMS4124R-13000S01)

#### Notes on measuring objects

The measuring method used can lead to changes in measured values when measuring edges, borders, or protruding parts. Measurement results can stray out of tolerance on smaller surface areas.

### Output of measured values

The device outputs measurement data via an Ethernet interface. It sends measured values to the interface when requested to do so via a telegram.

The following data can be polled individually or in combination:

- Distance values: Distance from zero point in the corrected angular position
- Remission values: Object remission as scale value without unit (digit) or calibrated greyscale value (%) at the corrected angular position. For details, see "Remission value", page 21.
- Angle correction values: Deviation from implicit angular position. For details, see "Angle channel", page 20.
- Quality values: Additional information on the respective measured value. Details see "Quality channel", page 20.

In the event of an error, the output of measured values is terminated immediately and an error code is output which can be evaluated by the connected application. The error code can also be read out with the SOPAS ET software.

### 3.5.2 Ethernet data interface

The device has an Ethernet data interface for configuration and the transmission of measured values.

The Ethernet interface has a data transmission rate of 100/1,000 Mbit/s. The interface is a TCP/IP interface supporting full duplex and half duplex.

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 (CoLa binary)
- TCP port: 2112 (CoLa ASCII)

You might need to adjust the TCP/IP configuration of the Ethernet interface so that a connected computer (client) can communicate with the device via 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 and then restart the device.

---

### 3.5.3 Output of measured values

A fundamental distinction must be made between continuous and triggered output of measured values.





**NOTICE**

A permanent measurement (with or without output of measured values) reduces the service life of the laser diode and thus the device.

There are 3 ways to extend the service life of the laser diode and reduce power consumption:

- 1 Disconnect device from voltage supply or switch off motor via telegram command `sMN LMCstopmeas` (hexadecimal: 73414E204C4D4373746F706D656173, login on device required).
- 2 Use software trigger options of the laser controller via telegram command `sMN LMCstandby` (hexadecimal: 734D4E204C4D437374616E646279). Do not reactivate the laser until immediately before sending the request for measured values with the Start Measurement telegram `sMN LMCstartmeas` (hexadecimal: 734D4E204C4D4373746172746D656173, no login required on the device).
- 3 Use hardware trigger options for laser control.

**3.5.3.1 Continuous output of measured values**

With continuous output of measured values, once the device has received an `sEN LMDscandata 1` telegram (hexadecimal: 73454E204C4D447363616E646174612001) requesting measured values, measured value telegrams are sent until the output of measured values is terminated by the stop telegram `sEN LMDscandata 0` (hexadecimal: 73454E204C4D447363616E646174612000). When the output of measured values stops, the motor continues to turn normally, the laser diode remains switched on, and measurement data continues to be generated and processed inside the device. Laser control must be set to “free-running”.

See "Telegram structure", page 60 for a description of the measured value telegrams.

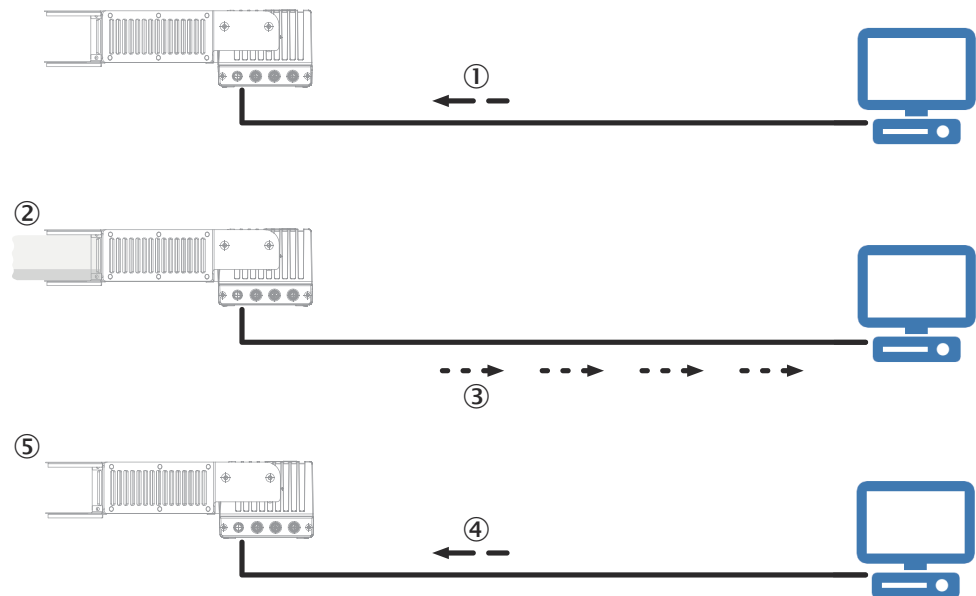


Figure 5: Continuous output of measured values

- ① Start telegram
- ② Start transmission of measured values
- ③ Output measured-value telegrams
- ④ Stop telegram
- ⑤ Stop output of measured values

### 3.5.3.2 Triggered output of measured values

During triggered measurement, the start and end of the measurement are determined by a reading gate.

First, the trigger source is selected via the laser control settings, "[Laser control](#)", [page 19](#).

After this, measured values are initially requested with the `sEN LMDscandata 1` telegram, "[Telegram structure](#)", [page 60](#), in the same way as for the continuous output of measured values.

Measured values are only output if the laser is switched on (to open the reading gate). If the reading gate is closed, the laser will switch off, thereby terminating the measurement process and the output of measured values.

A software trigger or the digital inputs input 1 or 2 can be used for triggering purposes.

### 3.5.3.3 Connecting the incremental encoder

If the device is mounted for mobile use or if the objects to be measured are in motion, the application will usually also need position data to further process the measured values.

Encoders can be connected for this purpose. The encoder data is then available with the other measured values in a single scan and at the same interface. A volume, for example, can be calculated with a backend software by evaluating the measurement data and position data (encoder ticks). The input frequency of the encoder signal must not exceed 50 kHz.

For correct connection see "[Connection diagram](#)", [page 36](#). Minimum switching threshold see "[Interfaces](#)", [page 57](#), 5 V encoders are not sufficient.

The following incremental encoders with a push-pull output stage (HTL) can be used:

- Single-channel, only connected at encoder A, no direction detection.
- Dual-channel (phase), connected at encoder A and encoder B; the pulses have a phase shift of 90°, making direction detection possible. By definition, during forward motion (CW = clockwise) phase A precedes phase B; conversely, during reverse motion (CCW = counterclockwise) edge B rises before edge A.
- Dual-channel (level), connected at encoder A and encoder B; the pulses are at encoder A; at encoder B, the direction is indicated by level 0 or level 1 (rarely used).
- Fixed encoder ticks (1 kHz), allows simulation of a connected encoder. The values are increased by 1,000 ticks per second throughout.

Encoder data is only output by the device if it is activated in the output data format (see "[Output data format](#)", [page 19](#)) and the respective encoder data type has been selected in the encoder settings. There is an overflow of the encoder values at 4.294,967,296 (=2<sup>32</sup>).

The values can also be set back to 0 at any time, e.g. when a defined position is reached; telegram command `sMN LIDrstencodercinc` hexadecimal: 734D4E204C4944727374656E636F646572696E63)



#### NOTE

Incremental encoder transmits a zero index signal often (encoder Z). This signal is not processed by the device. So the signal does not need to be connected to the device.



#### NOTICE

##### Device damage due to incorrect parameterization!

- When connecting an encoder, configure IN1/OUT1 of the device as an input.
-

### 3.5.3.4 Output data format

The composition of the measurement data telegram is configured via the output data format. Individual telegram parts can be activated and deactivated. The sequence is fixed: Information part (incl. serial number, device and I/O status; cannot be deactivated), encoder, distance, remission (RSSI), angle and quality values, device name and time stamp. Distance, RSSI and angle values are each a 16-bit channel, quality values are an 8-bit channel, so that 2 or 1 byte are transmitted per scan, measured value and channel. For more information, see the [see "Telegram structure", page 60](#) or Telegram Listing, no. 8014631.

The remission can be output either as a unitless scale value (digits) or as a percentage, calibrated grayscale value (percent). In addition, it is possible to define an output interval, whereby (following a possible upstream filter in the device), only every nth scan is output via the data interface. "Distance" must be activated so that distance data can be displayed in the Scan view.

In the default setting, no data is output as soon as the laser is switched off (e.g. via the laser controller). However, if the output of e.g. encoder ticks or time stamps is permanently required, this can be explicitly activated in the output data format area. The measured value channels do not contain any data when the laser is switched off.

### 3.5.4 Laser control

Laser control is used to switch the laser on and off. Measurement data is only transmitted when the laser is switched on. To initiate the transmission of measurement data, the telegram command `sEN LMDscandata 1` (hexadecimal: 73454E204C4D447363616E646174612001), ["Telegram structure", page 60](#) must be sent once after switching on the device.

Since the motor turns constantly at the scan speed as long as the device is ready for operation, the device is ready to start taking measurements immediately after the laser has been switched on.

Laser control reduces the data load at the Ethernet interface. Switching the laser on and off specifically when required also increases the service life of the laser diode.

The "switch-on delay" and "switch-off delay" parameters can be set to switch the laser on subject to a time delay and/or to leave it switched on longer for a defined period after the trigger signal has dropped out.

Following login (minimum **Authorized customer**), it is possible to select between various modes on the **Basic settings** tab in SOPAS ET or using a corresponding terminal program.

In free-running mode, the laser is permanently switched on and the device detects measurement data permanently (default setting). This mode is intended specifically for test purposes or for aligning a device with the laser line.

The laser is switched off initially in software trigger mode. The laser is activated with the **Start measuring SOPAS** command or the `sMN LMCstartmeas` telegram (hexadecimal: 734D4E204C4D4373746172746D656173). It is deactivated with the **Standby** command or the `sMN LMCstandby` telegram (hexadecimal: 734D4E204C4D437374616E646279). This mode is designed for the use of telegrams for triggering measurement data output and for setting up the device with the SOPAS ET parameterization software.

A third option for a digital trigger is to use input 1 and input 2 both individually and in an OR link. These three trigger modes are intended for when the device is used with one or more photoelectric sensors. Due to possible restrictions affecting the installation position, the use of switch-on and switch-off delays is advisable in many cases.



#### NOTE

The laser is also switched off when logging in on the device via a terminal with the `sMN SetAccessMode` telegram command (see telegram listing, no. 8014631).

Changes to the device are only taken into account with the `sMN Run log-off` command; this also switches the laser back on.

---

#### 3.5.5 Angle channel

The motor of the device rotates at 100 Hz and reaches a scanning frequency of 600 Hz due to the deflection of the laser beam over the 6 surfaces of its mirror wheel.

Assuming that the motor turns at a constant speed, the sensor creates every  $1.16 \mu\text{s}$  a new measurement value in order to reach an angular resolution of  $1/12^\circ$ . However, due to hardware limitations there are minor fluctuations in the motor speed. Due to external influences (e.g. high acceleration or deceleration of the device), these ripples can reach a deviation of several tenths of a degree, which may lead in measurement error of some centimeters for object measurement.

The angle channel allows an adjustment of the measurement values to their true angle position. When activated, an additional correction value is provided in the measurement telegram for each measurement point.

Each value describes the deviation from the implicitly assumed angular position in a range of  $\pm 3.2768^\circ$  and is accurate to about  $\pm 0.01^\circ$ . Since the channel can only output positive numbers, the value 32768 (8000h) corresponds to a deviation of exactly  $0^\circ$ . At larger values, from 32,769 to 65,535 (8001h ... FFFFh), the motor ran faster (objects appear narrower). At smaller values, from 0 to 32,767 (0h ... 7999h), the motor ran slower (objects appear wider).

#### 3.5.6 Quality channel

Additional information on each individual measuring point is provided via the quality channel. An evaluation is only possible via the measurement data telegram. By activating **Quality** in the output data format (see "Output data format", page 19), the measurement data is extended by this 8-bit channel.

**The quality channel contains the following information:**

- Bit 1 (e.g. hexadecimal: 1; binary: 0000 0001) = below lower signal threshold; measurement signal strength is too low for the receiver unit, e.g. with an extremely dark measuring object at a great distance.
- Bit 2 (e.g. hexadecimal: 2; binary: 0000 0010) = above upper signal threshold; measurement signal strength is too high for the receiver unit, e.g. due to measurement on a reflector.
- Bit 3 (e.g. hexadecimal: 4; binary: 0000 0100) = below lower distance threshold; object is closer to the sensor than possible with the standard working range.
- Bit 4 (e.g. hexadecimal: 8; binary: 0000 1000) = above upper distance threshold; object is located at a greater distance from the sensor than possible with the standard working range.
- Bit 5 (e.g. hexadecimal: 30; binary: 0001 0000) = normal measuring point; most likely no edge hit or outlier.
- Bit 5+6 (e.g. hexadecimal: 30; binary: 0011 0000) = edge hit identified, with 10b (increased probability) and 11b (very sure).
- Bit 7 (e.g. hexadecimal: 40; binary: 0100 0000) = outlier identified; point is probably not on measuring object.
- Bit 8 (e.g. hexadecimal: 40; binary: 1000 0000) = object partially glossy, e.g. due to a matte coating. As a result, a higher measured value noise is to be expected.

Some combinations of the different bits are possible, which is why the hexadecimal values output in the measurement data telegram must be converted to the binary system for consistent evaluation and then evaluated bit by bit.

For example, the value 71h = 0111 0001b corresponds to an outlier caused by an edge hit and also has insufficient signal strength.

In the standard devices, a measured value is automatically declared invalid if bit 1, 2, 3 or 4 is active (see "LMDscandata - reserved values", page 65). In the special variant LMS4124R-13000S01 (see "Special features of the LMS4124R-13000S01 device variant", page 14), on the other hand, these measurement values are also still output as valid.

### 3.5.7 Impact of object surfaces on the measurement

#### Remission value

Remission is the ability of a material to reflect light. The remission correlates with the amount of laser light emitted by the LiDAR sensor which is reflected by an object (see Lambert's law).

Glossy surfaces have different remissions at the same distance with different angles of impact. In the case of shiny surfaces, maximum remission is achieved when the beam makes vertical impact.

At this point, a multiple of the typical remission of a material can occur, generating invalid measured values. In this case in the output of measured values, distance values are output with 1 and remissions are output with FF FF, see "LMDscandata - reserved values", page 65.

The remission can be output either as a unitless scale value (digits) or as a percentage, calibrated grayscale value (percent).

In the SOPAS ET software, it is possible to visualize the remission in color in the scan display (**Scan view settings / Scan / Active color mode: RSSI**). In addition, **RSSI** must be active for this in the output data format (see "Output data format", page 19).

Matt and dull surfaces have diffuse remission. They therefore exhibit similar relative remissions with the same angle of impact regardless of the distance from the zero point.

Table 3: Typical remissions of frequently used materials

Material	Typ. relative remission
Rubber tires (vulcanized, black)	2%
Foam rubber (black)	2.4%
Photographic board (black, matte)	10%
Cardboard (gray)	20%
Wood (untreated fir, soiled)	40%
PVC (gray)	50%
Paper (white, matte)	80%
Plaster (white)	100%
Aluminum (black anodized)	110 ... 150%
Steel (stainless, shiny)	120 ... 150%
Steel (high gloss)	140 ... 200%

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.

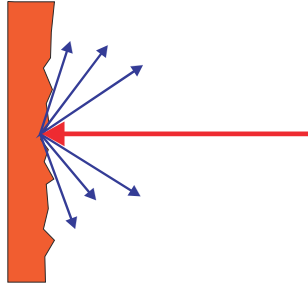


Figure 6: Reflection of light on the surface of the object

#### 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.

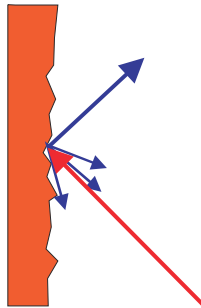


Figure 7: Angle of reflection

#### 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.

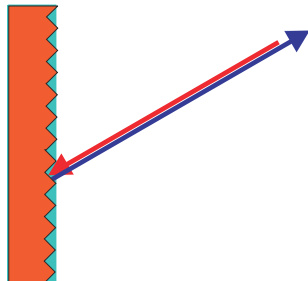


Figure 8: Retroreflection

### 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.

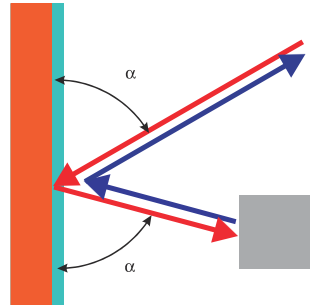


Figure 9: Specular surfaces

### Small objects

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

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

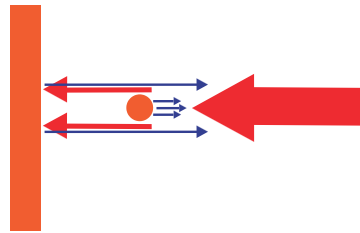


Figure 10: Object smaller than the laser beam diameter

## 3.5.8 Filters

The device has digital filters for pre-processing and optimizing the measured distance values. They enable the device to be adapted to meet the specific requirements of the respective application.

The filters can be combined without restrictions. If several filters are active, then the filters are applied sequentially to the results of the preceding filter. The processing sequence is as follows:

- Scan range filter
- Cubic filter
- Edge filter
- Median filter
- Gloss compensation
- Mean filter
- Angular resolution
- Output interval [see "Output data format", page 19](#)

The active filter functions affect the output measured values. It is not possible to recalculate the original measured values from the filtered output values. For this reason, certain combinations of filters might not be advisable.

For data reduction within a scan, restriction of the scanning range as well as a larger angular resolution (reduction of the measuring points in each case) is particularly well-suited. A good way of reducing data in multiple scans is to use the average filter (reducing the event rate) or, alternatively, to select a higher output interval.

#### 3.5.8.1 Scan range filter

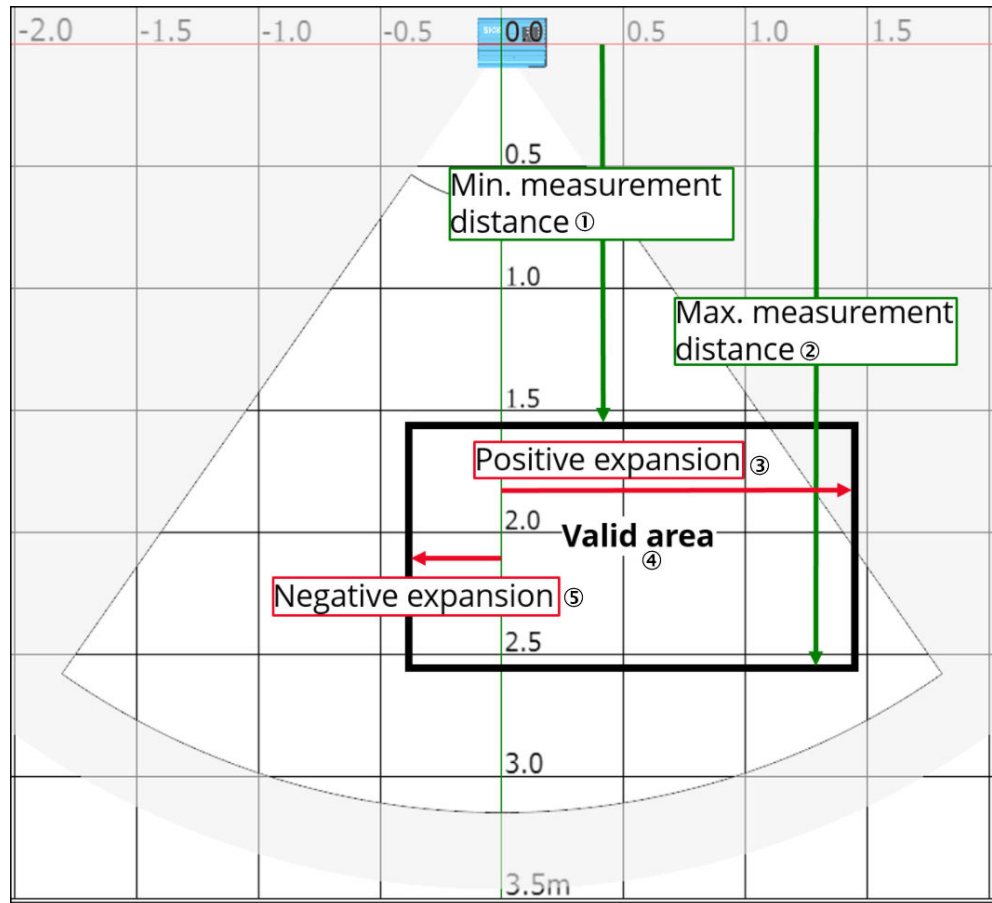
The scan range filter is used to restrict the angular range output per scan.

The maximum range is set to 70° by default. This produces 841 measurement points.

The range can be restricted by increasing the start angle (default setting = 55°) or reducing the stop angle (default = 125°). Please note that the angle beam is defined orthogonally in relation to the front at 90° and the direction of rotation of the device is set to counterclockwise, see figure 4, page 15.

The minimum difference between start angle and stop angle is 1/12°; this is equivalent to the output of a single measurement point. It is not possible to output multiple scan ranges (e.g., 55° ... 70° and 90° ... 110°).

#### 3.5.8.2 Cubic filter



- ① Minimum measuring distance
- ② Maximum measuring distance
- ③ Positive expansion
- ④ Valid range
- ⑤ Negative expansion

Activating the cubic filter causes only those measuring points to be output as valid by the device that are within a defined range. All other points are marked as invalid.



The range can be set in relation to the coordinate system of the sensor and may protrude in parts over the actual measuring range.

Minimum and maximum measurement distance define the area at an orthogonal distance from the viewing window along the longitudinal axis (X-axis). Negative and positive expansion define the area transverse to the device (Y-axis). Y-values for the angular range of < 90° are positive, Y-values for the angular range of > 90° are negative.

In case objects are to be measured in a very narrow area not situated in the middle of the angular range, both Y-values can also be set as either positive or negative.

### 3.5.8.3 Edge filter

The edge filter eliminates erroneous or extreme distance values at edges. These arise as a result of laser light that partially hits an object in the front and partially hits an object farther away, or due to too little light remission at the object itself, [see "Impact of object surfaces on the measurement", page 21](#).

Starting from the device, the filter evaluates the radial distance difference between neighboring points (default value = 30 mm). If the difference is greater than the set value for the maximum neighbor distance, the point is set as invalid.

When the edge filter is activated, the device sets a distance value of 0 at each edge (values in **bold** in the table).

Table 4: Example: Measured values with and without edge filter

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

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

### 3.5.8.4 Median filter

This filter is suitable for excluding individual outliers in the distance values.

The values included in the calculation are defined using a 1 x 3 matrix: 3 measured values, consisting of the distance values of a point and its two adjacent points in the scan, are sorted by size.

The measured value in the middle of this sequence is output as the distance value, along with its remission value and the original angle correction value.

The median values are determined and output as moving values (median angular increment 2 from the unfiltered distances values 1, 2, and 3; median angular increment 3 from the unfiltered distances values 2, 3, and 4, etc.).

A median cannot be determined as the measured value for the first and last angular increments in a scan. The distance value 0 (= invalid) is always output.

Table 5: Example: Median in angular position 2, 3, and 4

	Angle (distance values in mm)					
Scan	1	2	3	4	5	...
<b>Unfiltered measured values</b>						
1	850	852	851	849	850	...
2	849	851	850	853	852	...
3	850	849	853	851	850	...

	Angle (distance values in mm)					
Scan	1	2	3	4	5	...
...	...	...	...	...	...	...
Filtered measured values						
1	0	851	851	850	...	...
2	0	850	851	852	...	...
3	0	850	851	851	...	...
...	...	...	...	...	...	...

When using the median filter, the output of measured values is delayed by one scan.

#### 3.5.8.5 Gloss compensation

The gloss compensation makes measuring points visible that would otherwise be sorted out as invalid by the device due to the received signal being too high. Too much signal is present especially when the laser beam hits metallic or glossy areas exactly orthogonally.

For the affected points, the distance value of the third last valid point is set as the new distance value. The maximum possible value is output as remission in the RSSI channel. This can prevent a corresponding area from being interpreted as a hole or gap or an object as two separate objects in the later evaluation. Since the output measuring points are not actually measured distance values, the following conditions should be met: the area should be as small as possible and lie on a surface that is orthogonal to the device.

#### 3.5.8.6 Mean filter

The mean filter smooths the distance values. It does this by calculating the arithmetic mean from several scans at the same angular position. The number of scans can be configured.

Table 6: Example: Mean filter over 5 scans

	Angle position (distance values in mm)									
Scan	1	2	3	4	5	6	7	8	9	...
1	0	0	1100	1100	1150	1150	1380	1380	0	...
2	0	0	1200	1200	1190	<b>950</b>	1500	1500	0	...
3	0	0	1150	<b>1450</b>	1200	1200	1450	1450	0	...
4	0	0	1280	1280	1180	1180	1430	1430	0	...
5	0	0	1170	1170	1220	1220	1470	<b>1150</b>	0	...
1st output value	0	0	1180	1240	1188	1140	1446	1382	0	...
6	0	0	<b>0</b>	1100	1150	1150	1380	1380	0	...
7	0	0	1200	1200	1190	<b>0</b>	1500	1500	0	...
8	0	<b>730</b>	1150	<b>0</b>	1200	1200	1450	1450	0	...
9	0	0	<b>0</b>	1280	1180	1180	1430	1430	0	...
10	0	0	1170	1170	1220	1220	1470	<b>0</b>	0	...
2nd output value	0	730	1173	1187	1188	1187	1446	1440	0	...
...	...	...	...	...	...	...	...	...	...	...

Individual outliers (shown in **bold** in the table) influence the mean value.

Once the measured value telegram has been confirmed, the first measured value is not output until after the configured number of scans. Therefore, there is always a time delay equivalent to the number of scans configured for averaging. The digit of the first

scan included in the averaging calculation is always output in the scan counter. Invalid distance values (= 0) are not included in the averaging calculation, so that in these places a smaller number of scans is used in the division calculation. The measured values from other channels (remission, angle correction) are not averaged; instead, the value of the first scan from each channel is output.

Based on the scanning frequency of 600 Hz, a measured value is generated every 1.67 ms. The time delay affecting data output results from this base value multiplied by the number of averaging operations (e.g., 2 averaging operations = 3.34 ms, 10 averaging operations = 16.67 ms). This time delay is not increased if the median filter is activated at the same time.

### 3.5.8.7 Angular resolution

The angular resolution of the device is constant at  $1/12^\circ$  (displayed as  $0.0833^\circ$ ). It is possible to increase the angular resolution output in the measurement data telegram to multiples of  $1/12^\circ$ .

With an angular resolution of  $1^\circ$ , only 71 instead of 841 measuring points are output over the complete angular range of  $70^\circ$ . This has no effect on data recording or measurement quality; irrelevant measuring points in between are simply not output.

Due to the reduced number of measuring points per scan, the subsequent visualization of the object transverse to the sensor is correspondingly less granular.

### 3.5.9 Motor synchronization for measuring range extension

Based on the technical and geometrical properties of the device, objects up to 1 m in height can be measured continuously on a width of approx. 2.6 m. At a height of up to 2 m, a continuous width of approx. 1.4 m is achievable.

To increase the width of the field for the intended application or to avoid shadowing effects caused by geometrical properties, multiple devices can be mounted side by side at the same level.

To avoid mutual optical interference of adjacent devices (beam dazzle or reflection), the motors can be synchronized. The devices must have the same orientation when doing so.

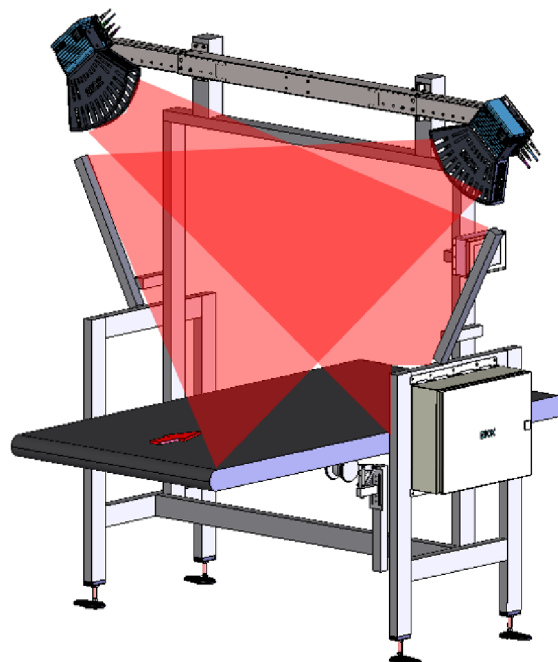


Figure 11: Mounting 2 LMS4000 LiDAR sensors side by side (example)

**If you are using motor synchronization, please note:**

- The slave devices do not send feedback to the master. The **Sync** LED on the master lights up as soon as the sync signal is sent. The **Sync** LED on the slave starts flashing as soon as a sync signal is received and lights up permanently once the motors have been synchronized.
- If devices are mounted exactly in parallel (angle of rotation = 0°), the default setting for the phase at the slave can usually be left unchanged at 0°.
- For devices that are mounted at a specific angle of rotation in relation to each other, direct dazzle can be virtually excluded through motor synchronization. Reflection can occur at certain angles depending on the distance between devices and the measuring distance to the object. Although these effects can be reduced by adjusting the phase, if the objects being scanned are of different heights they cannot be ruled out completely. For an initial test, good results can usually be obtained with a phase angle of 35°.
- The maximum phase angle is 80°; this is approximately equivalent to the angle at which the laser exits the device. Inside the device, the covered angle is 120°.
- There is no fixed upper limit on the number of devices that can be synchronized via the master signal. However, the total length of the transmission cables must not exceed 20 m.

**Setting up motor synchronization:**

1. Connect the motor-sync I/Os and the sensors to be synchronized using shielded cables (in a star configuration) [see "Connection options", page 38](#).
2. Viewed from the front, define the device located furthest to the left as the **master** (set the corresponding parameter value in the **Interfaces** view in the SOPAS ET software).



**NOTICE**

**Device damage due to incorrect parameterization!**

- Ensure that only one device is defined as **master**.
- 
3. Parameterize all other connected devices as **slaves** and set the angle of rotation of each device relative to the master as the phase (the phase specifies the angular offset by which the slave motor lags behind the master motor).
- ✓ After a few seconds, the **Sync** LED on the slave lights up permanently green. The devices are now synchronized.

## 4 Transport and storage

### 4.1 Transport

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



#### NOTICE

##### Damage to the product due to improper transport.

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

### 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

Store the device under the following conditions:

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

- Storage temperature: [see "Technical data", page 52.](#)
- Relative humidity: [see "Technical data", page 52.](#)
- For storage periods of longer than 3 months, check the general condition of all components and packaging on a regular basis.

## 5 Mounting

### 5.1 Mounting instructions

- Observe the technical data.
- Protect the sensor from direct sunlight.
- To prevent condensation, avoid exposing the device to rapid changes in temperature.
- The mounting site has to be designed for the weight of the device.
- The device can be mounted in any position.
- 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 59](#).
- 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.
- If necessary, affix additional laser warning labels to the device and/or replace an English laser warning label with a warning label in another language.

#### Conveyor system requirements (if used)

- The conveyor system must work with a constant conveyor speed, or an incremental encoder must be installed.
- The objects can be moved on a conveyor system with a flat conveyor surface. If the objects rotate, vibrate, roll, or slip on the conveyor system or on uneven conveying surfaces, the accuracy of the measurements may be reduced thereby negatively impacting the analysis.

### 5.2 Example installation of a conveyor system

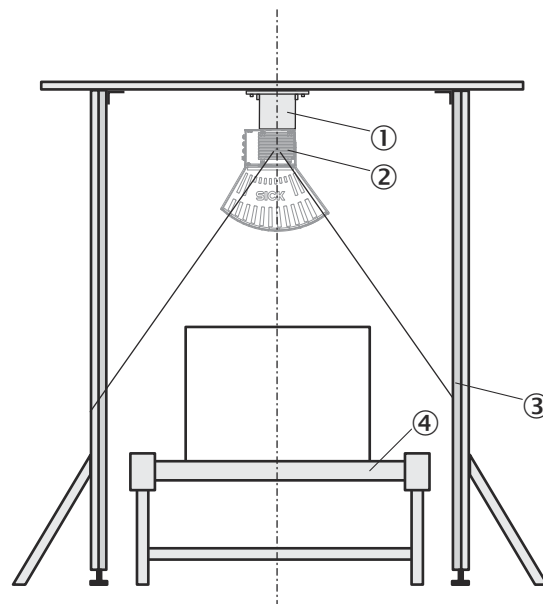


Figure 12: Example installation of a conveyor system

- ① Mounting kit (accessory)
- ② LMS4000
- ③ Beam separation for limiting detection
- ④ Conveyor system

To achieve the best possible measurement result, please note:

- Typical space requirement for the device installation: approximately 700 mm above the tallest object (measured from measured value origin).
- The device must have a clear view of the conveyor system.
- The laser beams of the device should not reach beyond the application space, so that people or goods, which are being transported on an adjacent conveyor system, are not detected (limiting detection by beam separation).
- The maximum detection must be limited to a working range of three meters, as measurement inaccuracies may otherwise result.
- Ensure sufficient distance between the device and curves, induction lines, start/stop areas, areas with upward and downward inclines, and breaks in the conveyor system.
- If two or more devices are mounted one behind the other offset in parallel and are not synchronized, the orthogonal distance of the laser lines must be at least 7 cm.
- There must be no foreign objects in the receiving range of the sensor (see the dimensional drawing).

### 5.3 Mounting the device

1. Mount the device in a suitably prepared bracket using the fixing holes provided and make provision for limiting detection by beam separation.
  2. Tighten the mounting screws to 6 Nm. If you are using coated screws, select a pretension of 5 Nm after screw contact.
  3. Make the electrical connection. Attach a voltage-free cable and tighten to 0.6 Nm (note the tightening torque specified on the cable).
  4. Switch on the voltage supply.
- ✓ The status LED lights up after successful initialization. The device is ready for use.



## 6 Electrical installation

### 6.1 Wiring instructions



#### NOTE

Pre-assembled cables can be found online at:

- [www.sick.com/LMS4000](http://www.sick.com/LMS4000)



#### NOTICE

##### Faults during operation and device or system defects!

Incorrect wiring may result in operational faults and defects.

- Follow the wiring notes precisely.

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

The pins of the voltage supply are reverse polarity protected.

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

- When using shielded cables, place the cable shield in the control cabinet.
- Connect the connecting cables in a de-energized state. Do not switch on the supply voltage until installation is complete and all connecting cables have been connected to the device and control.
- The tightening torque for cables is typically 0.4 Nm or 0.6 Nm. This value must not be exceeded.
- Wire cross-sections in the supply cable from the customer's power system should be designed in accordance with the applicable standards. Protect the device with an external slow-blow fuse of 6.3 A at the beginning of the supply cable, viewed from the voltage supply.
- All electric circuits connected to the device must be designed as SELV or PELV circuits (SELV = Safety Extra Low Voltage, PELV = Protective Extra Low Voltage).
- The specified enclosure rating of the device when mounted is reached only if suitable mating connectors or protective caps are used.
- Do not open the screwed housing of the device and do not remove the laser protection hood (if one has been fitted) as this will invalidate the warranty.
- When configuring the digital inputs/outputs, make sure that the wired pins of two devices are not functioning as an output concurrently (i.e., motor synchronization with two devices configured as a master, or Out 1 concurrent with zero index signal of an incremental encoder).

Table 7: Max. length of cable for device supply at 10% cable loss

Cable cross-section	Supply voltage		
	18 V DC	24 V DC	30 V DC
0.5 mm <sup>2</sup>	30 m	50 m	75 m
0.34 mm <sup>2</sup>	20 m	30 m	50 m
0.25 mm <sup>2</sup>	15 m	25 m	35 m

## 6.2 Prerequisites for safe operation of the device



### WARNING

#### Risk of injury and damage caused by electrical current!

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

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

#### Remedial measures

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

The device is connected to the peripheral devices (voltage supply, any local trigger sensor(s), system controller) via shielded cables. The cable shield – for the data cable, for example – rests against the metal housing of the device.

The device can be grounded through the cable shield or through a blind tapped hole in the housing, for example.

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

This is achieved by complying with the following conditions:

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

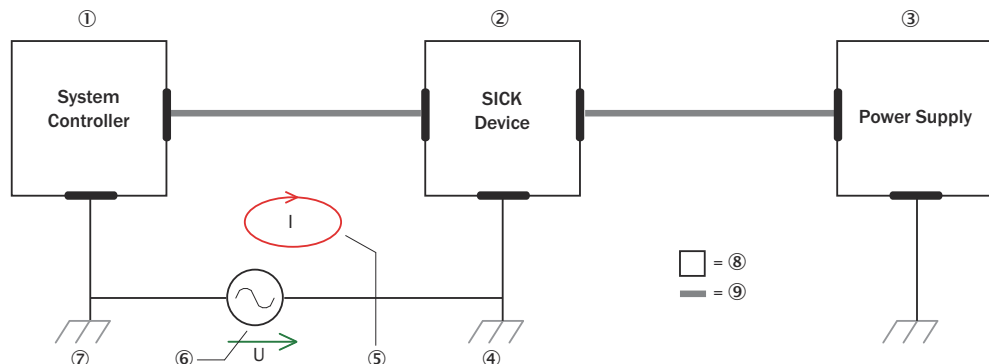


Figure 13: Example: Occurrence of equipotential bonding currents in the system configuration

- 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.

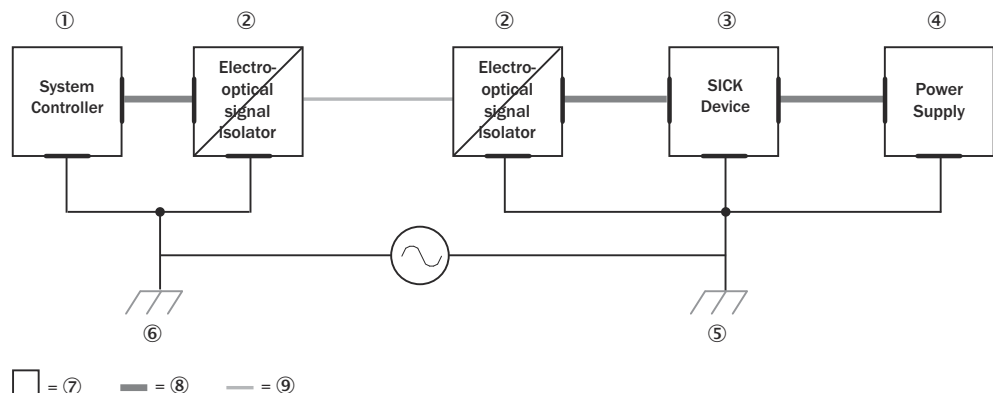


Figure 14: Example: Prevention of equipotential bonding currents in the system configuration by the use of electro-optical signal isolators

- 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.

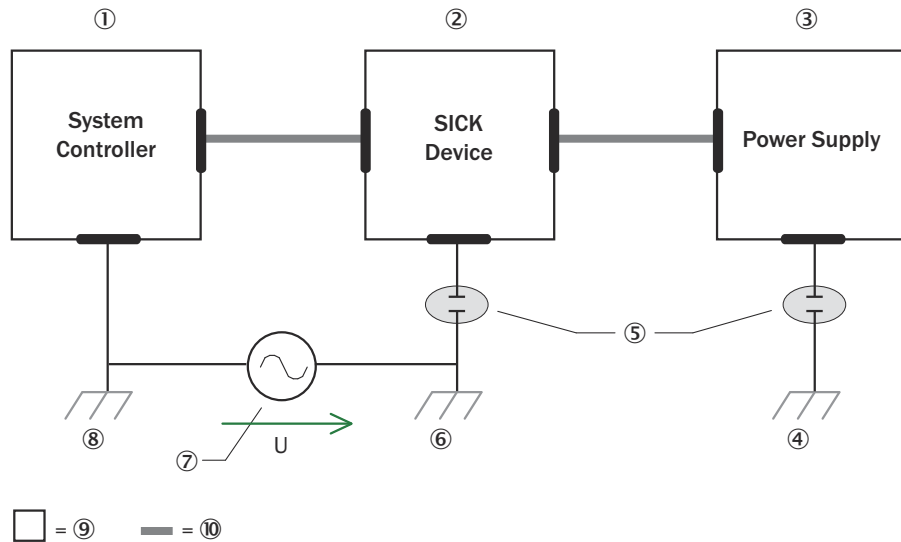


Figure 15: Example: Prevention of equipotential bonding currents in the system configuration by the insulated mounting of the device

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

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



**NOTICE**

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

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

**6.3 Connection diagram**



**NOTE**

The recommended connecting cables and their associated technical data can be found online at:

[www.sick.com/LMS4000](http://www.sick.com/LMS4000)

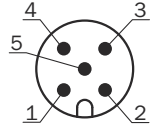
**Power connection**

Figure 16: Male connector M12, 5-pin, A-coded

Pin	Description	Connecting cable wire colors, part no. 6049453 <sup>1)</sup>
1	$V_s$ 24 V DC $\pm$ 25%	Brown
2	Motor Sync	White
3	Ground	Blue
4	IN2/OUT2	Black
5	OUT4	Gray

<sup>1)</sup> Example values when using the specified connecting cable(s). Signal assignment and wire colors can vary when using other connecting cables.

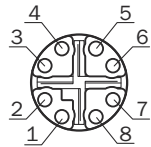
**Ethernet connection**

Figure 17: Female connector M12, 8-pin, X-coded

Pin	Description
1	TRD0_P
2	TRD0_N
3	TRD1_P
4	TRD1_N
5	TRD3_P
6	TRD3_N
7	TRD2_P
8	TRD2_N

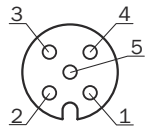
**Encoder**

Figure 18: Female connector M12, 5-pin, A-coded

Pin	Description	Connecting cable wire colors, part no. 2097305 <sup>1)</sup>
1	$V_{out}$ 24 V DC $\pm$ 25% (identical to $V_s$ )	Brown
2	Encoder B	White
3	Ground	Blue
4	Encoder A	Black

Pin	Description	Connecting cable wire colors, part no. 2097305 <sup>1)</sup>
5	IN1/OUT1	Gray

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

### 6.4 Connection options

The following figure shows a connection diagram of a master-slave wiring for motor synchronization (see "Motor synchronization for measuring range extension", page 27) with an encoder (see "Connecting the incremental encoder", page 18).

**Master**

- Set to master in SOPAS ET
- Activate encoder in SOPAS ET. No dependence on ticks/phase/level

**Slave**

- Set to slave and 35° in SOPAS ET
- Activate encoder in SOPAS ET. No dependence on ticks/phase/level

**Encoder**

- Connect using a shielded cable

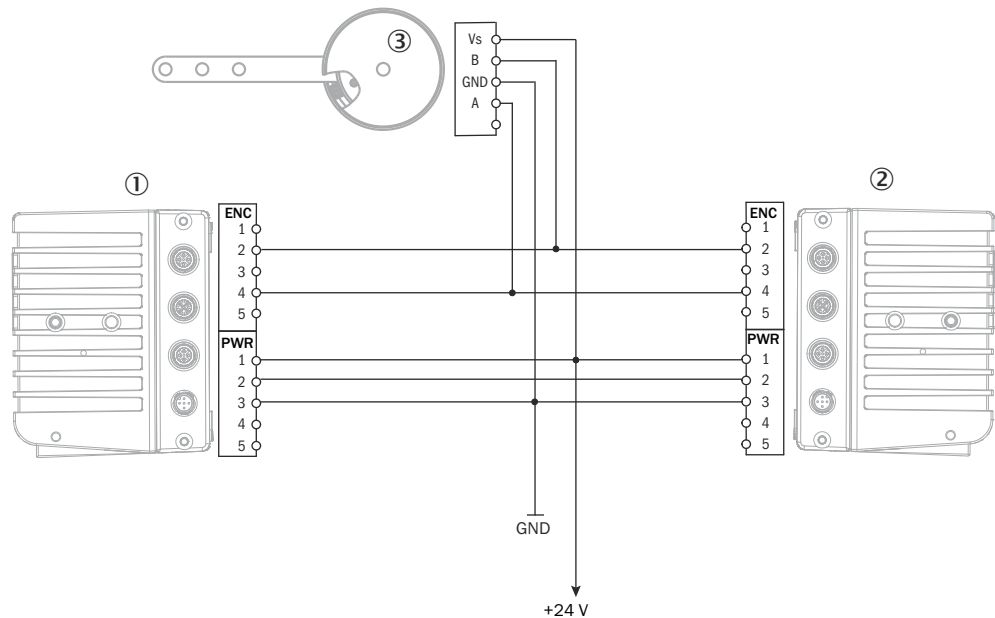


Figure 19: Example wiring of master-slave encoder

- ① Master
- ② Slave
- ③ Encoder

### 6.5 Connecting the device electrically



**NOTICE**

Observe the wiring instructions, see "Wiring instructions", page 33.

1. Ensure the voltage supply is not connected.
2. Connect the device according to the connection diagram, see "Connection diagram", page 36.

## 7 Operation

### 7.1 Operation with SOPAS ET

Version 2018.2 and higher of the SOPAS Engineering Tool (SOPAS ET) software can be used for parameterization of the device and for service and diagnostic purposes.

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



#### NOTE

The most up-to-date version of the SOPAS ET software can be downloaded from [www.sick.com/SOPAS\\_ET](http://www.sick.com/SOPAS_ET). The respective system requirements for installing SOPAS ET are also specified there.

1. Connect the communication interface (Ethernet, 8-pin M12 female connector) of the device to the computer.
2. Switch on and start the computer.
3. Supply the device with voltage.
- ✓ The status LED and the Ethernet LED light up green after successful initialization. The device is ready for use.



#### NOTE

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

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

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

Certain functions (e.g., Edit parameters) require you to be logged in to the device:

**i** > **Device** > **Log In** > Select user level and enter password:

User level	Password
Maintenance personnel	main
Authorized client	client
Service	servicelevel




#### NOTE

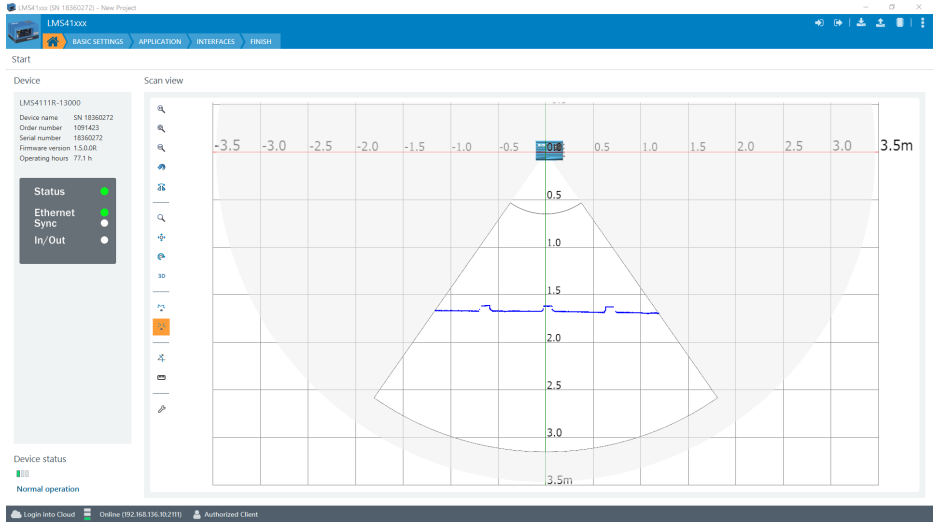
Change the passwords at initial commissioning to ensure your device is protected.

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






**Description of the device window**

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

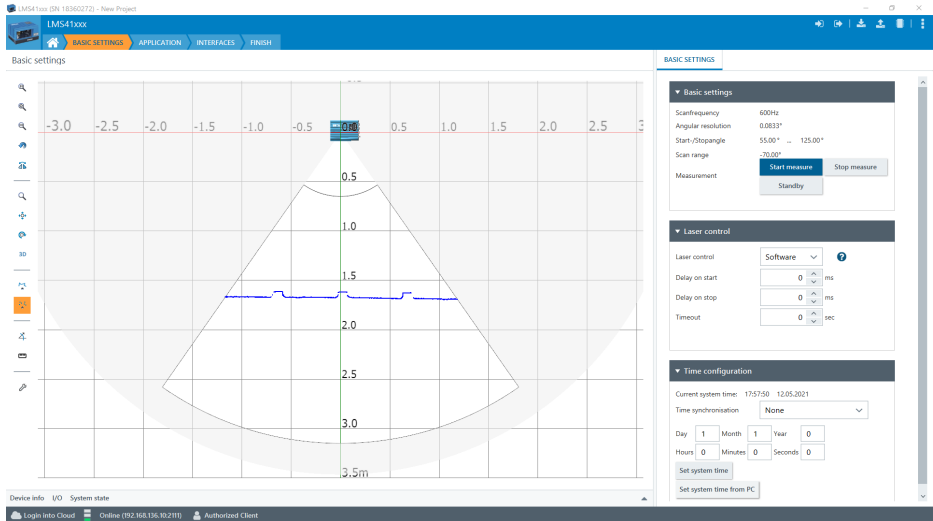
-  (Start): Start device configuration with display of information about the device (left-hand side) and display of the current scan (right-hand side).



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

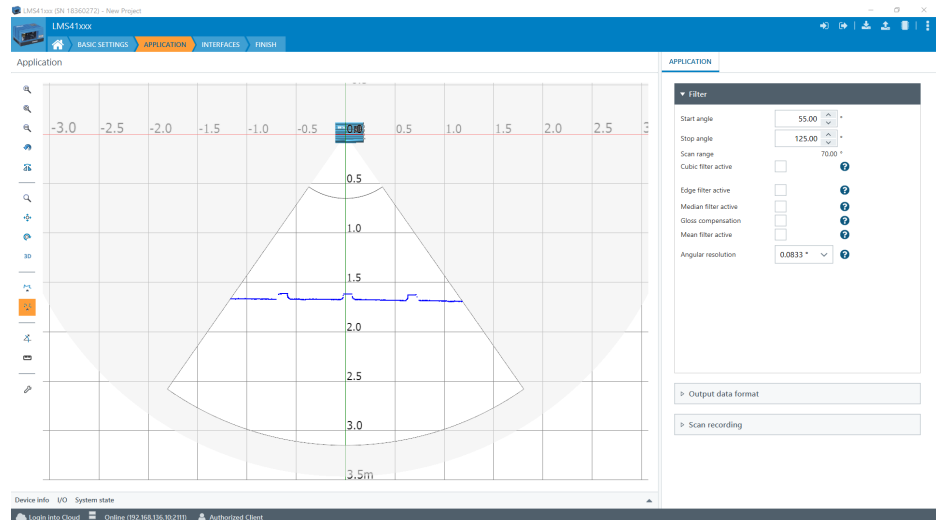
- : Resets scan display to default view.
- : Displays measured values as points or lines.
- : Freely rotates scan display.
- : Display radial distance, angular position and remission of a measuring point.
- : Measure distances in the scan display.

- **Default settings:** Scan display (left-hand side), entry of the basic device parameters (right-hand side):

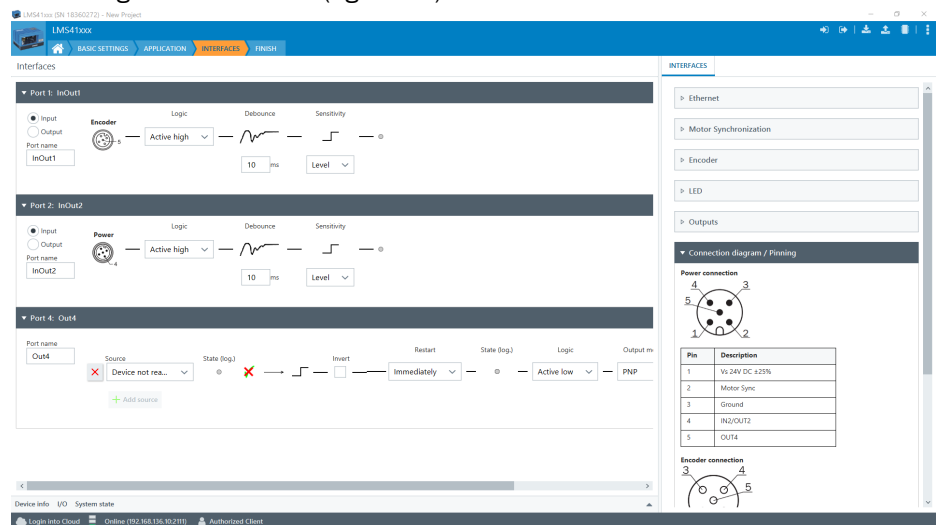


- o Start and stop motor see "Output of measured values", page 16
  - o Laser controller see "Laser control", page 19
  - o System time
- **Application:** Scan display (left-hand side) and entry of more parameters (right-hand side):



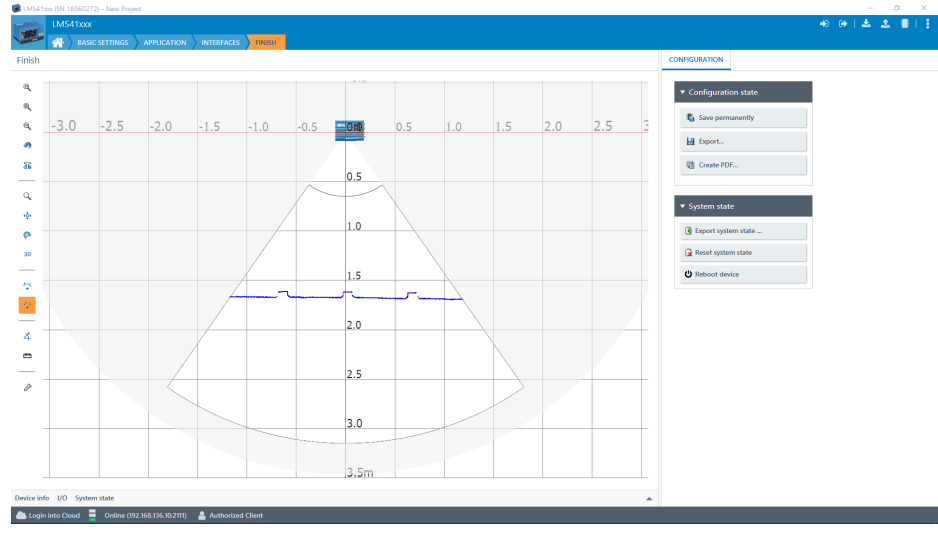


- Filter see "Filters", page 23
- Output data format see "Output data format", page 19
- 3D scan recording see "Scan recording", page 42
- **Interfaces:** Configuration of the interfaces (left side) and input of further parameters for signal transmission (right side):



- Ethernet
- Motor synchronization see "Motor synchronization for measuring range extension", page 27
- Encoder see "Connecting the incremental encoder", page 18
- Housing LED

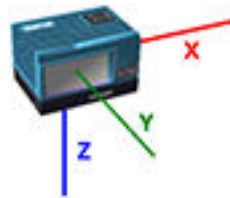
- **Complete:** Scan display (left-hand side) and buttons for finalizing device configuration.



**NOTE**

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

**7.1.1 Scan recording**



Via scan recording, it is possible to generate a 3D image of the surroundings from several 2D scans of the device using the path information of an encoder.

In the **Interfaces** tab, the respective encoder setting has to be selected. If no encoder is physically present, it is possible to simulate an artificial cycle rate of 1 kHz see ["Connecting the incremental encoder", page 18](#). It is possible to select a linear movement of the device (or objects) or a rotational movement as well as a specific encoder resolution. In the latter case, the distance of the device from its pivot point in the Y- and Z-direction (see coordinate system of the sensor) can be specified.

With **Start recording**, scans will be recorded and visualized for the set recording time. The 3D scan can be viewed from various perspectives and also saved, or the view can be reset.

**7.2 Output of measured values via terminal program**

**Example commands for output of measured values**

If the device receives one of the two example commands by telegram via the Ethernet interface, it will start the output of measured values via this data interface. The device must be switched on and in measuring mode.

The detailed structure of the output telegram as well as the flow of requests and outputs is described in the "Measurement output telegram" section in the **Telegram Listing** publication (English, No. 8014631).

**Request for output of measured values:**Table 8: Telegram structure: *sRN LMDscandata*

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

Table 9: Example: *sRN LMDscandata*

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

**Request for continuous output of measured values:**Table 10: Telegram structure: *sEN LMDscandata* measurement start/stop

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

Table 11: Example: *sEN LMDscandata*

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


For the content of the response telegram for the measured value request, see **Telegram Listing** (No. 8014631) under 'Send Data Permanently' in section 4. The telegram consists of one part with information on the configuration of the device and the time stamp, one part with measured data, and a status part with information on the device status and the statuses of the inputs/outputs.

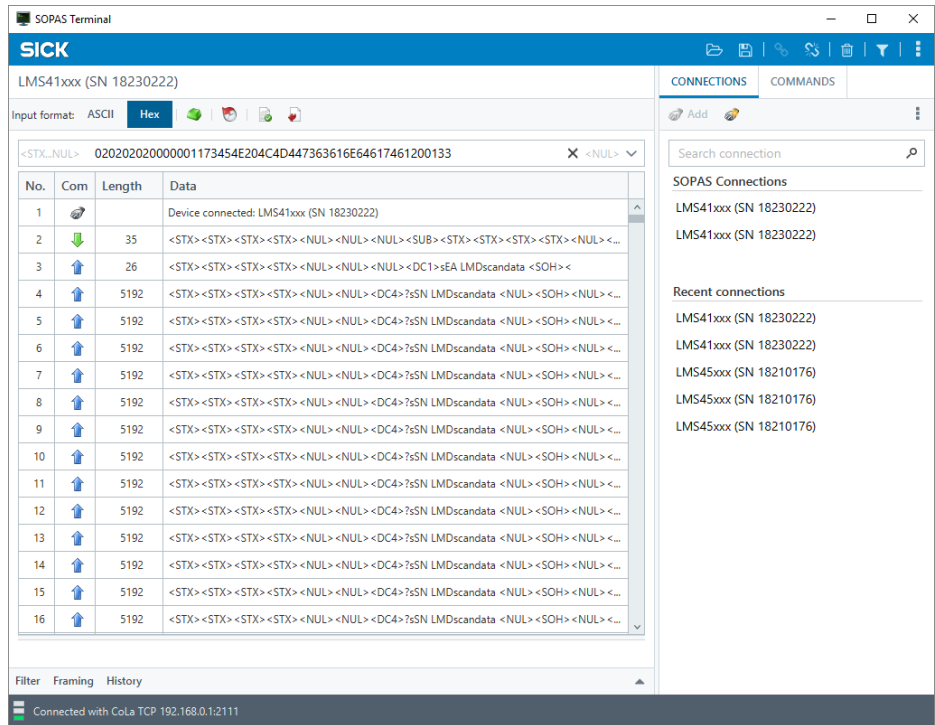
After starting the measurement mode, the device needs some time to reach status 1 ("ready"). You should, therefore, query the status of the device using the *sRN SCdevi-cestata* telegram.

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 telegram with the *sRN LMDscandata* telegram (hexadecimal: 73524E204C4D447363616E64617461) – the last measured scan is transmitted.
- Continuous request of measurement data with the *sEN LMDscandata* 1 telegram (hexadecimal: 73454E204C4D447363616E646174612001) – measurement data is transmitted until the output of measured values is stopped with the *sEN LMDscandata* 0 telegram (hexadecimal: 73454E204C4D447363616E646174612000).

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

1. Start the terminal emulator: **I** > **Tools** > **Terminal**.
2. In the dialog window in the **Connections** menu, select the **Create new connection** function.
3. In the connection wizard, select the communication interface (**Ethernet**) and connection settings (default IP address: 192.168.0.1) and establish the connection (**Finish** button).
4. Make the following settings in the connection wizard: communication interface (**Ethernet**), communication protocol (**CoLa A/B**), and connection settings (default IP address: 192.168.0.1; **TCP port: 2112** (for CoLa ASCII) or **2111** (for CoLa binary); **SOPAS hub address: 0**; **CoLa dialect: ASCII** or **binary**; **CoLa addressing mode: by name**; **Duplex mode: full-duplex**; **Byte order: big-endian**; **Connection timeout: 1500 ms**; **Additional timeout: 0 ms**). Then establish the connection (**Finish** button).
5. Enter in the input line one of the two example telegrams from the annex as they appear (automatically framed by **STX** and **ETX** when sending in the default setting). Pay attention to blank characters in the string.
6. Use the  button to send the telegram to the LMS4000.
- ✓ The LiDAR sensor responds by providing the data as a one-off or continuously in the display area of the terminal emulator.



**NOTE**

We recommend using CoLa binary for the output of measurement data in the application. CoLa ASCII is suitable in particular for device parameterization. However, depending on the parameter settings, there is a risk that errors will occur for data output when using this command language, as the data load is almost doubled, which can lead to problems especially on the receiving computer.

**Data output format of the measured values**

The data output format for each scan comprises:

- Configuration information
- Measured values (radial distance (DIST))
- Remission (RSSI/REFL)

- Angle correction (ANGL)
- Quality (QLTY)
- Device and status information
- Time stamp

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

**To output more measured values or information in the telegram:**

1. Open the device window: **☰** > **Device** > **Open**.
2. Check the corresponding box under **Output format**.

The telegram output interval can also be changed here, so that only every second or third telegram is sent via the data interface during the output of measured values, for example.

## 8 Maintenance

### 8.1 Maintenance plan

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

Table 12: 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

### 8.2 Cleaning



#### NOTICE

##### Damage to the inspection window.

Reduced analysis performance due to scratches or streaks on the window!

- Clean the window only when wet.
- Use a mild cleaning agent that does not contain powder additives. Do not use aggressive cleaning agents, such as acetone, etc.
- Avoid any movements that could cause scratches or abrasions on the window.
- Only use cleaning agents suitable for the screen material.



#### 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.

#### Cleaning the inspection window

Check the viewing window of the device for accumulated dirt at regular intervals. This is especially relevant in harsh operating environments (dust, abrasion, damp, fingerprints, etc.).

The inspection window lens must be kept clean and dry during operation.



#### NOTE

Static charging may cause dust particles to stick to the viewing window. This effect can be avoided by using an anti-static cleaning agent in combination with the SICK lens cloth (part no. 4003353) (can be obtained from [www.sick.com](http://www.sick.com)).

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**Cleaning procedure:**

---

**CAUTION****Optical radiation: Class 2 Laser Product**

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

- Do not look into the laser beam intentionally.
  - Never point the laser beam at people's eyes.
  - If it is not possible to avoid looking directly into the laser beam, e.g., during commissioning and maintenance work, suitable eye protection must be worn.
  - Avoid laser beam reflections caused by reflective surfaces. Be particularly careful during mounting and alignment work.
  - Do not open the housing. Opening the housing may increase the level of risk.
  - Current national regulations regarding laser protection must be observed.
- 
- ▶ Switch off the device for the duration of the cleaning operation. If this is not possible, use suitable laser protection goggles. These must absorb radiation of the device's wavelength effectively.
  - ▶ Clean the viewing window only with a clean, damp, lint-free cloth, and a mild anti-static lens cleaning fluid.
- 

**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.
-

## 9 Troubleshooting

### 9.1 General faults, warnings, and errors

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



#### NOTE

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

Question/Problem	Possible causes	Troubleshooting
Unable to switch on device, LEDs not responding	<ul style="list-style-type: none"> <li>• Pins have been wired incorrectly</li> <li>• Voltage supply is not switched on</li> <li>• Permissible supply voltage not adhered to</li> </ul>	<ul style="list-style-type: none"> <li>• Check pin assignments and voltage supply</li> <li>• Check the supply voltage</li> </ul>
Device starts initially (LEDs are on, motor starts to turn) but then stops and restarts after a few seconds	<ul style="list-style-type: none"> <li>• Power supply unit not powerful enough</li> <li>• Applied voltage is almost out of range</li> <li>• Current limiting set to less than 1.7 A</li> <li>• Voltage drop on cable when using longer lengths of cable</li> </ul>	<ul style="list-style-type: none"> <li>• Check dimensioning of system with connected sensors, lengths of cables, voltage, current limiting, and power loss</li> <li>• Check the supply voltage</li> </ul>
Unable to find device in SOPAS ET	<ul style="list-style-type: none"> <li>• Ethernet cable not connected</li> <li>• IP address range for network adapter configured incorrectly</li> <li>• Unsuitable search settings selected in the device search</li> <li>• Non-compatible SOPAS ET version used</li> </ul>	<ul style="list-style-type: none"> <li>• Check the Ethernet connection (if you know the IP address, check with a ping CMD)</li> <li>• Set the network adapter (TCP/IPv4) to the IP address range and subnet mask of the sensor (sensor default: 192.168.0.1; 255.255.255.0)</li> <li>• Check the selected search settings or use the default search</li> <li>• Update SOPAS ET</li> </ul>
Device is configured as a DHCP client (dynamic IP address), but cannot be found in the network	<ul style="list-style-type: none"> <li>• Device has not received an IP address (no DHCP server present or reachable)</li> <li>• Device is not directly connected to the network (e.g., direct PC connection only)</li> </ul>	<ul style="list-style-type: none"> <li>• Device is in fallback mode: If “static IP” mode was previously selected, the device can only be reached via that IP (default: 192.168.0.1; 255.255.255.0).</li> <li>• Device is in repeat mode: Still waiting for a DHCP server. In this case the device can be found using the default search in SOPAS ET (IP 0.0.0.0) and reconfigured to a different IP address.</li> <li>• Connect the device directly to the network via a patched network socket or a switch. Run the default search in SOPAS ET.</li> <li>• Have the network checked by a system administrator and any faults eliminated. Disconnect the device from the voltage supply for 10 seconds, then restart it.</li> </ul>



Question/Problem	Possible causes	Troubleshooting
Unable to establish connection to device in SOPAS ET	<ul style="list-style-type: none"> <li>Missing device drivers</li> </ul>	<ul style="list-style-type: none"> <li>Click on the warning symbol in the device tile. Follow the instructions in the wizard and load the drivers from the device</li> </ul>
Connection LED in SOPAS ET is red	<ul style="list-style-type: none"> <li>Device is offline in SOPAS ET</li> </ul>	<ul style="list-style-type: none"> <li>Click on the "Offline" field in the device tile. If the project is new, load the parameters from the device. To transmit existing settings, write the parameters to the device</li> </ul>
Unable to make any settings in the device window in SOPAS ET	<ul style="list-style-type: none"> <li>Insufficient user level</li> <li>Device is offline in SOPAS ET</li> </ul>	<ul style="list-style-type: none"> <li>Log in as "Authorized client"</li> <li>Click on the "Offline" field in the device tile in the main window</li> </ul>
No measurement points are displayed in the scan view in SOPAS ET	<ul style="list-style-type: none"> <li>The laser is switched off</li> <li>No objects in the working range</li> <li>Obstacles in the field of view</li> <li>Data channel for distance values is deactivated</li> </ul>	<ul style="list-style-type: none"> <li>Check the laser control settings</li> <li>Check the settings for the angular and distance ranges</li> <li>Check that objects are positioned correctly in relation to the sensor and that the field of view is not being blocked by other objects</li> <li>Activate distance in output data format</li> </ul>
No transmission of measurement data via the Ethernet interface	<ul style="list-style-type: none"> <li>Measurement data not subscribed</li> <li>The laser is switched off</li> <li>All channels deactivated in the output data format</li> </ul>	<ul style="list-style-type: none"> <li>Check that the LMDscandata command has been sent and confirmed by the device</li> <li>Check the laser control settings</li> <li>Check the output data format settings (in the application)</li> </ul>
Status LED lights up green but problem persists	<ul style="list-style-type: none"> <li>Device is unable to detect errors</li> </ul>	<ul style="list-style-type: none"> <li>Device is ready to take measurements; check other sources of the problem</li> </ul>
Status LED lights up yellow, device continues to be able to take measurements	<ul style="list-style-type: none"> <li>Warning, e.g., due to problem with device synchronization or I/O configuration</li> </ul>	<ul style="list-style-type: none"> <li>Read the description of the problem under System status in SOPAS ET and take action if appropriate</li> </ul>
Status LED lights up red, device is no longer able to take measurements	<ul style="list-style-type: none"> <li>Error, e.g., due to internal or external factors. The primary function of the device cannot be fulfilled at the current time.</li> </ul>	<ul style="list-style-type: none"> <li>Read the description of the problem under System status in SOPAS ET</li> <li>If the error persists, disconnect the device from the voltage supply for 10 seconds and then restart</li> </ul>
Motor synchronization fails, synchronization LED on slave does not light up green permanently	<ul style="list-style-type: none"> <li>No device configured as master</li> <li>No device configured as slave</li> <li>Do not link the sync I/Os and GND</li> <li>Sync signal corrupted</li> </ul>	<ul style="list-style-type: none"> <li>Check the master and slave settings</li> <li>Check connections and cables</li> </ul>

Question/Problem	Possible causes	Troubleshooting
Encoder ticks not being output in data telegram or are not incrementing	<ul style="list-style-type: none"> <li>Encoder not connected or signal corrupted</li> <li>Unsuitable encoder in use (e.g., no push-pull output stage or supply voltage does not match LMS4000)</li> <li>No encoder configured</li> <li>Encoder ticks deactivated in output data format</li> </ul>	<ul style="list-style-type: none"> <li>Check the encoder connection, data sheet, and pin assignment</li> <li>Check the settings for the encoder (interfaces) in SOPAS ET</li> <li>Check the output data format settings (in the application)</li> </ul>
Data transmission rate is less than 600 Hz	<ul style="list-style-type: none"> <li>Output interval is greater than 1</li> <li>Mean filter activated</li> </ul>	<ul style="list-style-type: none"> <li>Check the output data format settings (in the application)</li> <li>Check the filter settings</li> </ul>
Computer processor load for data reception and processing very high, partial loss of individual scans	<ul style="list-style-type: none"> <li>Measurement data is requested in CoLa ASCII instead of CoLa Binary.</li> <li>Unused data channels (e.g. angle or quality values) are activated.</li> <li>Computer is not powerful enough</li> </ul>	<ul style="list-style-type: none"> <li>Implement measurement data processing for CoLa Binary</li> <li>Deactivate all unused data channels in the output data format</li> <li>Reduce the data rate via median filter or output interval (if the speed of the application allows this)</li> <li>Limit scanning range and/or set larger angular resolution (if object size and required scanning density allow this)</li> <li>Use more powerful computer</li> </ul>

## 9.2 Repairs

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

## 9.3 Returns

- ▶ Only send in devices after consulting with SICK Service.
- ▶ The device must be sent in the original packaging or an equivalent padded packaging.



### NOTE

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

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

## 9.4 Disposal

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

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

Disposing of devices improperly may cause damage to the environment.

Therefore, observe the following information:

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

## 10 Technical data



### NOTE

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

- [www.sick.com/LMS4000](http://www.sick.com/LMS4000)

Please note: This documentation may contain further technical data.

### 10.1 Features

<b>Version</b>	Short range
<b>Application</b>	Indoor
<b>Viewing window/laser output aperture</b>	On the front
<b>Light source/laser diode</b>	Visible light (wavelength 660 nm; LMS4x11: max. output power 20 mW, average power 10 mW; LMS4x21: max. output power 27 mW, average power 13.5 mW)
<b>Laser class</b>	2 (IEC 60825-1:2014&2007)
<b>Spot size/laser spread</b>	Typically 4 x 3 mm (viewing window) 2.5 x 2 mm (3 m distance)
<b>Aperture angle</b>	70°
<b>Scan frequency</b>	600 Hz
<b>Angular resolution</b>	1/12° (0.0833°)
<b>Operating range</b>	0,7 m ... 3 m
<b>Scanning range</b>	3 m (LMS4x2x: 2% remission; LMS4x11: 3.5% remission) 3 m (LMS4xx1: 10% remission) 4 m (LMS4xx4: 10% remission)
<b>Number of devices for motor synchronization</b>	Virtually unlimited, length of sync cable max. 20 m

**Working range diagram**

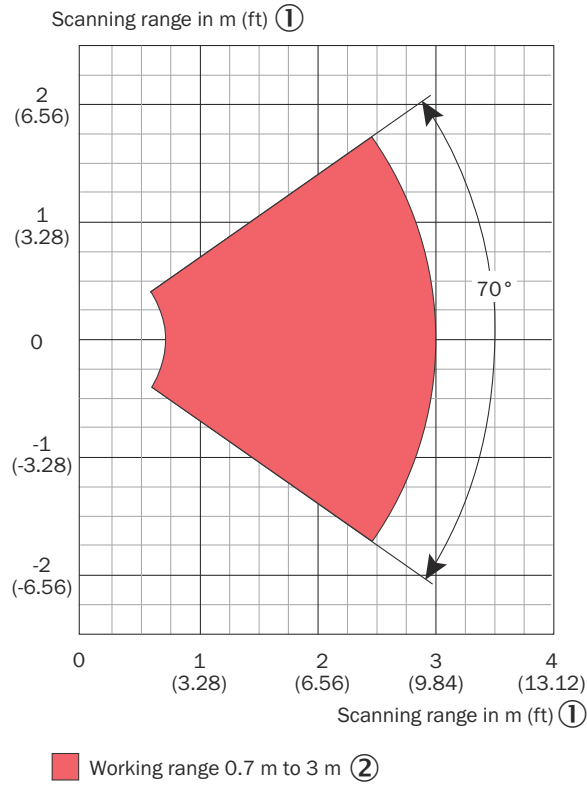


Figure 20: LMS4xx1 working range diagram

- ① Scanning range in m (ft)
- ② Working range 0.7 m to 3 m

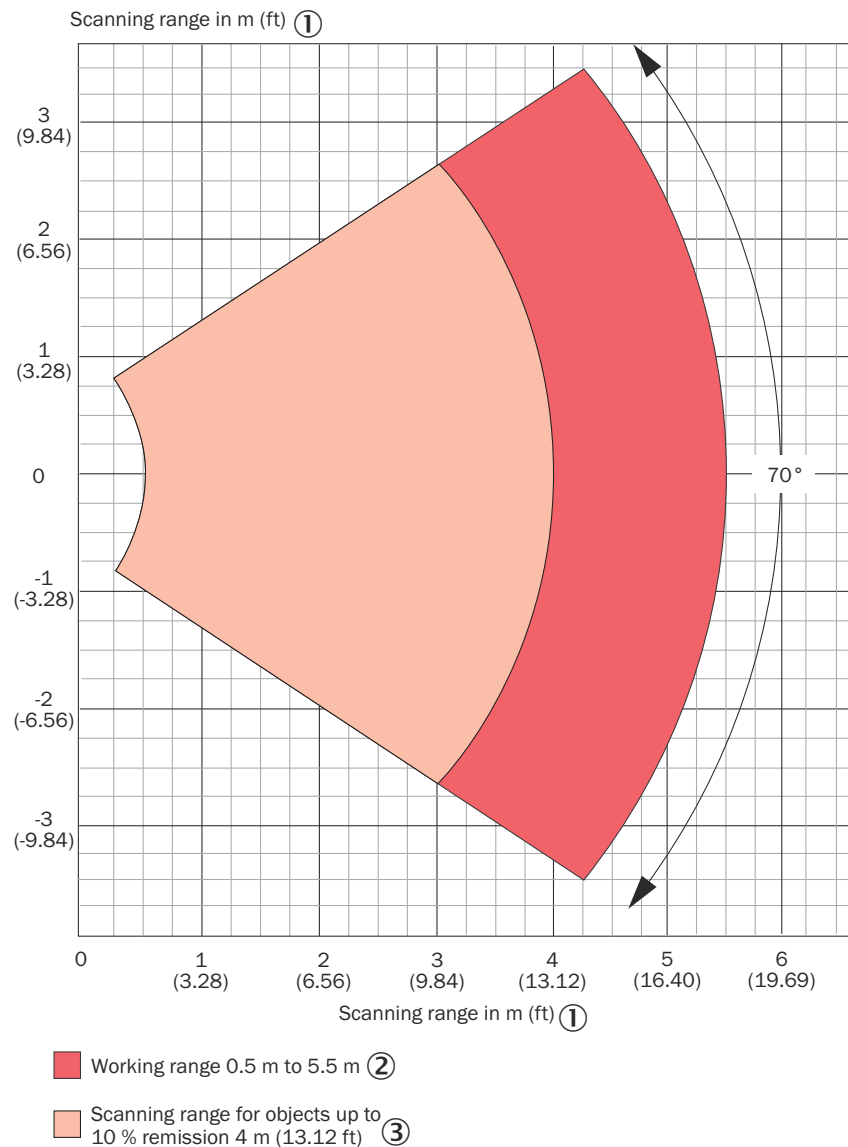


Figure 21: LMS4xx4 working range diagram

- ① Scanning range in m (ft)
- ② Working range 0.5 m to 5.5 m
- ③ Scanning range for objects up to 10% remission 4 m

## 10.2 Mechanics/Electronics

<b>Electrical connection</b>	1 x M12, 5-pin male connector (power + I/O + sync) 1 x M12, 8-pin female connector (Ethernet) 1 x M12, 5-pin female connector (encoder + I/O)
<b>Supply voltage (<math>V_s</math>)</b>	24 V DC $\pm$ 25%
<b>Permissible residual ripple</b>	$\leq$ 5%
<b>Voltage output (<math>V_{out}</math>)</b>	24 V DC $\pm$ 25% (identical to $V_s$ ) Output current $\leq$ 1.5 A and dependent on external power supply unit
<b>Power consumption</b>	$\leq$ 16 W (typical, at 24 V DC) $\leq$ 29 W (start-up current) 26 W (max. continuous, all outputs loaded)

<b>Output current</b>	≤ 100 mA per output
<b>Housing</b>	Aluminum die cast
<b>Viewing window material</b>	Float glass
<b>Housing color</b>	Light blue (RAL 5012)
<b>Enclosure rating</b>	IP65 (IEC 60529:1989+AMD1:1999+AMD2:2013)
<b>Protection class</b>	III (IEC 61140:2016-01)
<b>Electrical safety</b>	IEC 61010-1:2011
<b>Weight</b>	LMS4x1x: 2.4 kg LMS4x2x: 3.7 kg
<b>Dimensions (L x W x H)</b>	LMS4x1x: 192 mm x 130 mm x 107 mm LMS4x2x: 397 mm x 370 mm x 107 mm

### 10.3 Dimensional drawing

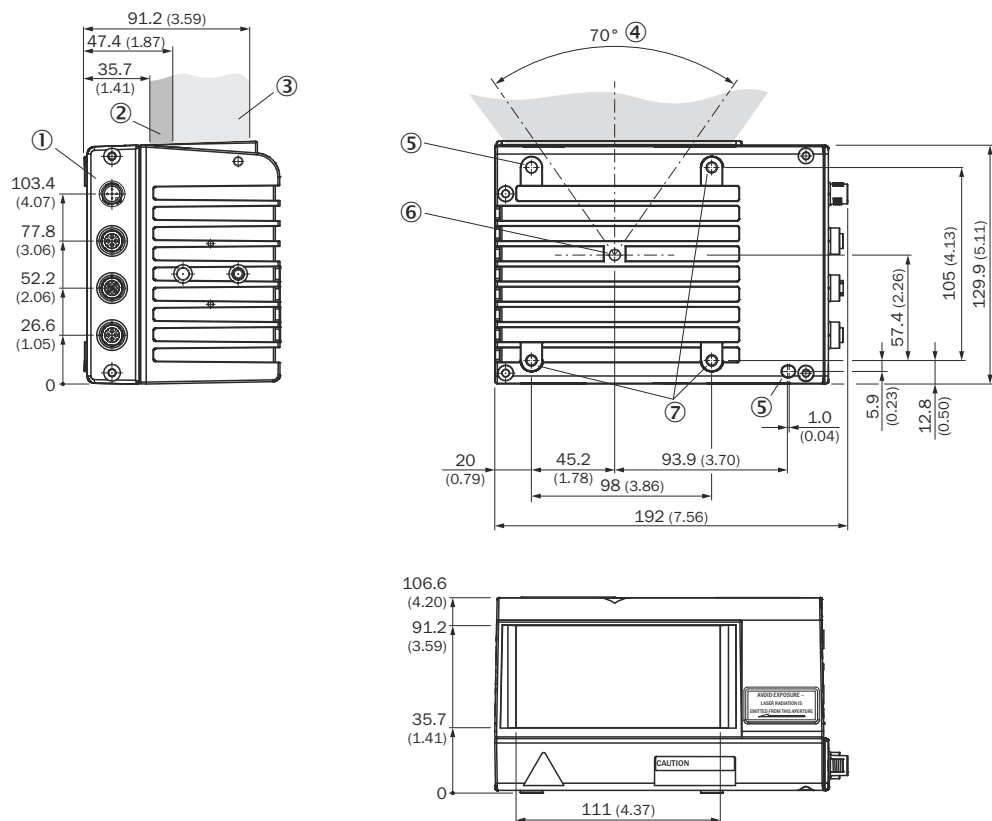


Figure 22: Dimensional drawing of the LMS4x1xx; dimensions in mm (inch), decimal separator: period

- ① Interfaces, types and number can vary
- ② Transmission range
- ③ Receiving range
- ④ Aperture angle
- ⑤ Alignment hole for the locating pin of the alignment bracket
- ⑥ Zero point of the distance measurement (marking on the top and the bottom side of the device)
- ⑦ Threaded mounting hole M6 x 6, max. screw length 7.5 mm

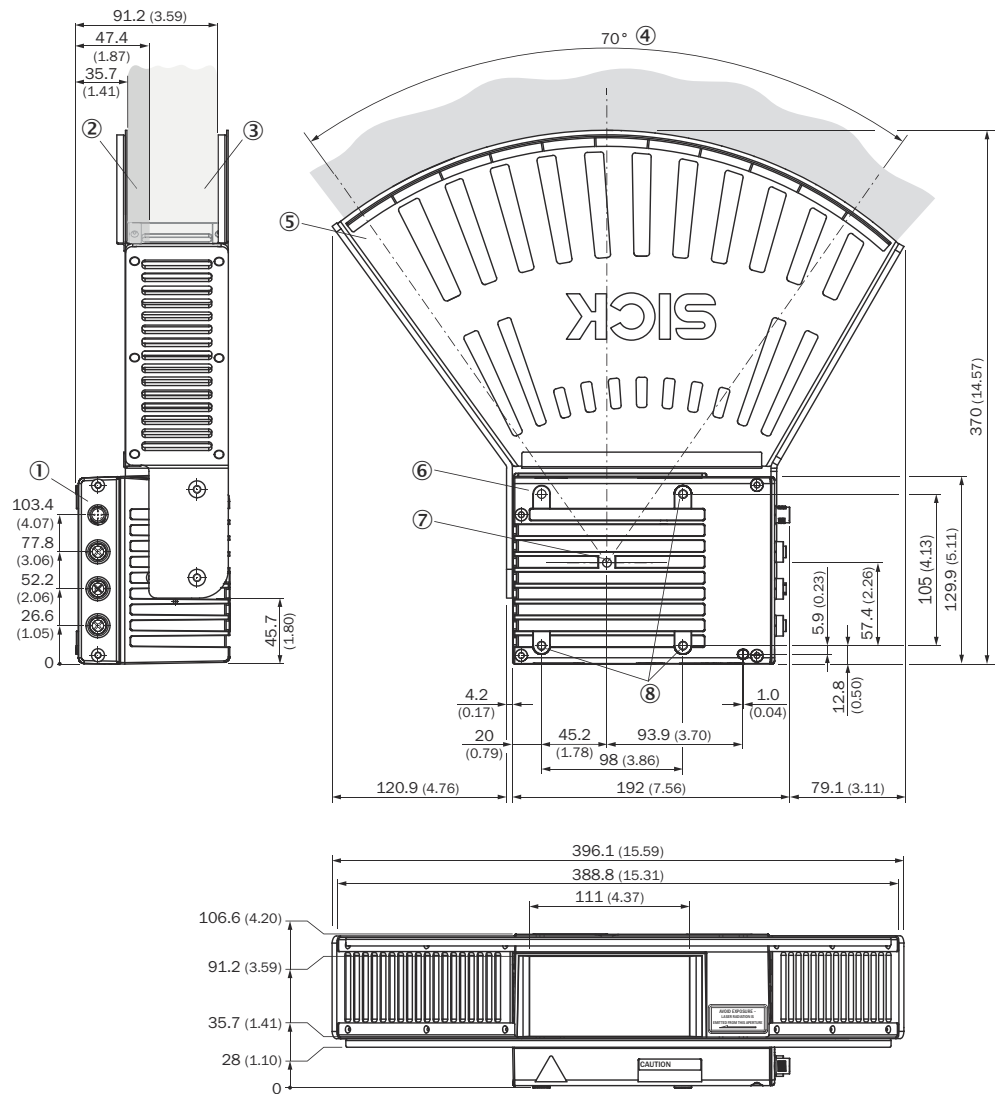


Figure 23: Dimensional drawing of the LMS4x2xx with laser protection hood; dimensions in mm (inch), decimal separator: period

- ① Interfaces, types and number can vary
- ② Transmission range
- ③ Receiving range
- ④ Aperture angle
- ⑤ Laser protection hood
- ⑥ Alignment hole for the locating pin of the alignment bracket
- ⑦ Zero point of the distance measurement (marking on the top and the bottom side of the device)
- ⑧ Threaded mounting hole M6 x 6, max. screw length 7.5 mm

## 10.4 Performance

<b>Scan/frame rate</b>	504,600 measurement points/second
<b>Response time</b>	≥ 4.8 ms
<b>Detectable object shape</b>	Almost any



<b>Systematic error (typ.)</b>	LMS4x11: ± 1.5 mm LMS4x21: ± 1 mm LMS4x24: ± 1 mm (0.7 m ... 3 m); ± 4 mm (0.5 m ... 0.7 m; 3 m ... 5.5 m)
<b>Statistical error (1 σ)</b>	<b>LMS4x11:</b> 1.25 mm (@ ≥ 90% 0.7 m ... 3 m) 2.5 mm (@ 40% 0.7 m ... 3 m) 6.5 mm (@ 6.5% < 1 m & > 2.5 m) 5 mm (@ 6.5% 1 m ... 2.5 m) 14 mm (@ 3.5% < 1 m & > 2.5 m) 10 mm (@ 3.5% 1 m ... 2.5 m) <b>LMS4x21:</b> 0.75 mm (@ ≥ 90% 0.7 m ... 3 m) 1.5 mm (@ 40% 0.7 m ... 3 m) 4.5 mm (@ 6.5% < 1 m & > 2.5 m) 3.5 mm (@ 6.5% 1 m ... 2.5 m) 12 mm (@ 3 % < 1 m & > 2.5 m) 9 mm (@ 2% 1 m ... 2.5 m) <b>LMS4x24:</b> 4.5 mm (@ ≥ 90% 0.5 m ... 0.7 m; 3 m ... 5.5 m) 0.75 mm (@ ≥ 90% 0.7 m ... 3 m) 9 mm (@ 40% 0.5 m ... 0.7 m; 3 m ... 5.5 m) 1.5 mm (@ 40% 0.7 m ... 3 m) 12 mm (@ 6.5% 0.5 m ... 1 m & 2.5 m ... 4.0 m) 3.5 mm (@ 6.5% 1 m ... 2.5 m) 12 mm (@ 3% 0.7 m ... 1 m & 2.5 m ... 3.0 m) 9 mm (@ 2% 1 m ... 2.5 m)
<b>Temperature drift (systematic)</b>	0.03 mm/K
<b>Angle error</b>	0.05°
<b>Integrated application</b>	Data output
<b>Filters</b>	Rectangular filter, edge filter, median filter, gloss compensation, mean filter

<sup>1)</sup> Typical value in the following ambient conditions: measuring range and remission as quoted (otherwise full range), scan range 60° ... 120°, ambient temperature 18 °C ... 28 °C, ambient light ≤ 2,000 lux. The actual measured values might deviate from the quoted value depending on the application setup.

## 10.5 Interfaces

<b>Ethernet – function</b>	TCP/IP UDP/IP Measurement data output (distance, angle, RSSI)
<b>Ethernet – data transmission rate</b>	100/1,000 Mbit/s, full duplex, half duplex
<b>Digital inputs</b>	2 (2 x I/O) Max. 50 kHz <sup>1)</sup>
<b>encoder inputs</b>	2 (phase A, phase B), max. 50 kHz <sup>1)</sup>
<b>Digital outputs</b>	3 (1 x OUT, 2 x I/O) <sup>2)</sup> max. 100 mA per output Max. 2 V voltage drop to V <sub>s</sub>
<b>Synchronization input/output</b>	1 (master/slave) max. 100 mA at the output (parameterization as master) Max. 2 V voltage drop to V <sub>s</sub>
<b>Optical displays</b>	4 LEDs

<b>Configuration software</b>	SOPAS ET, version 2018.2 or higher
<b>Telegram language</b>	CoLa ASCII CoLa binary

- 1) Voltage for High 13 V ... 30 V; voltage for Low 0 V ... 8 V; static input current typ. 1 mA
- 2) Overcurrent and short-circuit protected; inductive load ≤ 2.2 H, capacitive load ≤ 2.2 μF; time delay before availability after device restart < 25 s

## 10.6 Ambient data

<b>Radiance factor</b>	LMS4x1x: 3.5% ... 300% LMS4x2x: 2% ... 200%
<b>Electromagnetic compatibility (EMC)</b>	EN 61000-6-3:2007+A1:2011 / IEC 61000-6-3:2006+AMD 1:2010
<b>Vibration resistance</b>	Vibration, sinusoidal (EN 60068-2-6:2007): 10 Hz ... 100 Hz, 0.35 mm, 5 g, 20 cycles
<b>Shock resistance</b>	Non-repetitive shock (EN 60068-2-27:2008): 15 g, 11 ms, 6 shocks per axis 10 g, 16 ms, 1,000 shocks per axis
<b>Ambient operating temperature</b>	-10 °C ... +50 °C (initialization phase: 0 °C ... +50 °C)
<b>Storage temperature</b>	-20 °C .. +70 °C
<b>Permissible relative humidity</b>	Max. 90% (non-condensing)
<b>Ambient light immunity</b>	2,000 lx <sup>1)</sup>

- 1) Illumination strength of the measuring object; specification with unrestricted measuring performance; maximum value approx. 60,000 lx

## 11 Accessories

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**NOTE**

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

- [www.sick.com/LMS4000](http://www.sick.com/LMS4000)
-

## 12 Annex

### 12.1 Telegram structure

#### Example: Send data permanently



#### NOTE

When the device is starting up and during a restart, no data telegrams or responses are sent by the device for a period of up to 30 seconds. The blank spaces (hexadecimal: 20) must be added to the calculation of the telegram length when both sending and receiving telegrams.

The recommended CoLa binary is structured as follows:

- 4 bytes STX (hexadecimal: 02)
- 4 bytes telegram length
- Telegram content
- 1 byte XOR checksum (calculated from the content)

For more information, see the **Telegram Listing** publication (no. 8014631).

Table 13: Telegram structure: sEN LMDscandata

Telegram part	Description	Variable	Length	Values CoLa A (ASCII)	Values CoLa B (binary)
Command type	Event	String	3	sEN	73 45 4E
Command	Data telegram	String	11	LMDscandata	4C 4D 44 73 63 61 6E 64 61 74 61
Measurement	Start/stop	Enum_8	1	Stop: 0 Start: 1	Stop: 00 Start: 01

Table 14: Example: sEN LMDscandata

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

Table 15: Telegram structure: sEA LMDscandata

Telegram part	Description	Variable	Length	Values CoLa A (ASCII)	Values CoLa B (binary)
Command type	Answer	String	3	sEA	73 45 41
Command	Data telegram	String	11	LMDscandata	4C 4D 44 73 63 61 6E 64 61 74 61
Measurement	Start/stop	Enum_8	1	Stop: 0 Start: 1	Stop: 00 Start: 01

Table 16: Example: Confirmation of sEA LMDscandata

Telegram type	Command	
CoLa A	ASCII	<STX>sEA{SPC}LMDscandata{SPC}1<ETX>
	Hex	02 73 45 41 20 4C 4D 44 73 63 61 6E 64 61 74 61 20 31 03
CoLa B	Binary	02 02 02 02 00 00 00 11 73 45 41 20 4C 4D 44 73 63 61 6E 64 61 74 61 20 01 33

#### Telegram data stream

The response to the telegram is followed by the scan data.

**NOTE**

Leading zeros are not displayed in ASCII.

Table 17: Telegram structure: Data stream from sRA LMDscandata

Telegram part		Description	Variable	Length	Values CoLa A (ASCII)	Values CoLa B (binary)
Command type		Read	String	3	sRA	73 52 41
Command		Data telegram	String	11	LMDscandata	4C 4D 44 73 63 61 6E 64 61 74 61
Version number		For detecting format changes by the version. Version is always 1 up to now.	Uint_16	2	1	00 01
Device	Device number	Defined with SOPAS	Uint_16	2	0h ... FFFFh	00 00 ... FF FF
	Serial number	Defined in factory	Uint_32	4	0h ... FFFFFFFFh	00 00 00 00 ... FF FF FF FF
	Device status	(See values column)	Uint_8	2 × 1	Ok: 0 0 Error: 0 1	Ok: 00 00 Error: 00 01

Telegram part		Description	Variable	Length	Values CoLa A (ASCII)	Values CoLa B (binary)
Status info	Telegram counter	Number of measurement telegrams finished in the scanner and given to the interface. <sup>1</sup>	Uint_16	2	0h ... FFFFh	00 00 ... FF FF
	Scan counter	Number of scans which were created in the device; counts how many scans were really done.	Uint_16	2	0h ... FFFFh	00 00 ... FF FF
	Time since start up in $\mu$ s	Counting the time since power up the device; starting with 0. In the output telegram this is the time at the zero index before the measurement itself starts.	Uint_32	4	0h ... FFFFFFFFh	00 00 00 00 ... FF FF FF FF
	Time of transmission in $\mu$ s	Time in $\mu$ s when the complete scan is transmitted to the buffer for data output; starting with 0 at scanner bootup.	Uint_32	4	0h ... FFFFFFFFh	00 00 00 00 ... FF FF FF FF
	Status of digital inputs	Low byte represents input 1	Uint_8	2 × 1	All inputs low: 0 0 IN1 high: 1 0 IN2 high: 2 0 IN1+2 high: 3 0	All inputs low: 00 00 IN1 high: 01 00 IN2 high: 02 00 IN1+2 high: 03 00
	Status of digital outputs	Low byte represents output 1	Uint_8	2 × 1	All outputs low: 0 0 OUT1 high: 1 0 OUT2 high: 2 0 OUT1+2 high: 3 0 OUT4 high: 8 0 OUT1+4 high: 9 0 OUT2+4 high: A 0 OUT1+2+4 high: B 0	All outputs low: 00 00 OUT1 high: 01 00 OUT2 high: 02 00 OUT1+2 high: 03 00 OUT4 high: 08 00 OUT1+4 high: 09 00 OUT2+4 high: 0A 00 OUT1+2+4 high: 0B 00
	Layer angle	-	Uint_16	2	0	00 00
Frequencies	Scan frequency	Output format: 1/100 Hz	Uint_32	4	600 Hz: EA60h	600 Hz 00 00 EA 60
	Measurement frequency	Inverse of the time between two measurement shots (in 1/100 Hz): LMS4000 = 864000 Hz	Uint_32	4	21C0	00 00 21 C0
<b>Amount of encoder</b>		If 0, then next two values are missing.	Enum_16	2	0 External encoder: 1	00 00 External encoder: 00 01
Values	Encoder position	Info in ticks	Uint_32	4	0h ... FFFFFFFFh	00 00 00 00 .. FF FF FF FF
	Encoder speed	Ticks/mm	Uint_16	2	0	00 00

Telegram part		Description	Variable	Length	Values CoLa A (ASCII)	Values CoLa B (binary)
<b>Amount of 16 bit channels</b>		Number of 16 bit channels that provide measured data	Uint_16	2	Output channels: 1 ... 3	Output channels: 00 01 ... 00 03
Output channel (16 bit)	Content	Defines the content of the output channel Radial distance values (DIST) in 1/10 mm, as the scale factor is 0.1 (see below)	String	5	Distance values: DIST1 Energy values in digit: RSSI1 Calibrated energy values in %: REFL1 Angle Offset values: ANGL1	Distance values 44 49 53 54 31 Energy values in digit 52 53 53 49 31 Calibrated energy values in % 52 45 46 4C 31 Angle Offset values 41 4E 47 4C 31
	Scale factor	Scale factor or factor of the measurement values	Real as float according to IEEE754	4	Factor 0.1 (DIST1): 3DCCCCDh Factor 1 (RSSI1): 3F800000h Factor 1 (REFL1): 3F800000h Factor 1 (ANGL1): 3F800000h	Factor 0.1 (DIST1) 3D CC CC CD Factor 1 (RSSI1) 3F 80 00 00 Factor 1 (REFL1) 3F 80 00 00 Factor 1 (ANGL1) 3F 80 00 00
	Scale factor offset	Sets starting point of measurement	Real As float according to IEEE754	4	DIST1: 0h RSSI1: 0h REFL1: 0h ANGL1 (-32768): C7000000h	DIST1: 00 00 00 00 RSSI1: 00 00 00 00 REFL1: 00 00 00 00 ANGL1 (-32768): C7 00 00 00
	Start angle	Output format: 1/10000°	Uint_32	4	55.0000° ... 125.0000°: 86470h ... 1312D0h	55,0000° ... 125,0000°: 00 08 64 70 ... 00 13 12 D0
	Size of single angular step	Output format: 1/10000°	Uint_16	2	0.0833°: 341h	0.0833° 03 41
	Amount of data	Defines the number of items on measured output	Uint_16	2	0 ... 841 values: 0h ... 349h	0 ... 841 values: 00 00 .. 03 49
	Data_1 Data_n	Data stream starting Data_1 to Data_n Distance measurement values from 0.65 m ... 3.15 m	Uint_16	2	DIST1: 0h ... FFFFh RSSI1: 0h ... FFFFh REFL1: 0h ... FFFFh ANGL1: 0h ... FFFFh	DIST1: 00 00 .. FF FF RSSI1: 00 00 .. FF FF REFL1: 00 00 .. FF FF ANGL1: 00 00 .. FF FF
	<b>Amount of 8 bit channels</b>		Amount of 8 bit channels, giving out the measured data	Enum_16	2	Output channels 0 or 1

Telegram part		Description	Variable	Length	Values CoLa A (ASCII)	Values CoLa B (binary)
Output channel (8 bit)	Content	Defines the content of the output channel	String	5	QLTY1	51 4C 54 59 31
	Scale factor	Scale factor or of the measurement values	Real as float according to IEEE754	4	0h	00 00 00 00
	Scale factor offset	Sets starting point of measurement	Real as float according to IEEE754	4	0h	00 00 00 00
	Start angle	Output format: 1/10000°	Int_32	4	+550000d... +1250000d (86470h ... 1312D0h)	00 08 64 70 ... 00 13 12 D0
	Size of single angular step	Output format: 1/10000°	Uint_16	2	0.0833° +833 (341h)	0.0833° 03 41
	Amount of data	Amount	Uint_16	2	0000h ... FFFFh	00 00 ... FF FF
	Data_1	Data stream	Uint_8	1	00h ... FFh	00 ... FF
	Data_n	starting Data_1 to Data_n			8-bit Quality Channel Bit 1 (below lower signal threshold): e.g 1h (0000 0001) Bit 2 (above upper signal threshold): e.g 2h (0000 0010) Bit 3 (below lower distance threshold): e.g 4h (0000 0100) Bit 4 (above upper distance threshold): e.g 8h (0000 1000) Bit 5 (normal hit): e.g 10h (0001 0000) Bit 6 (edge hit): e.g 30h (0011 0000) Bit 7 (possible outlier): e.g 40h (0100 0000) Bit 8 (partial gloss): e.g 80h (1000 0000)	00 ... FF 8-bit Quality Channel Bit 1 (below lower signal threshold): e.g 01 Bit 2 (above upper signal threshold): e.g 02 Bit 3 (below lower distance threshold): e.g 04 Bit 4 (above upper distance threshold): e.g 08 Bit 5 (normal hit): e.g 10 Bit 6 (edge hit): e.g 30 Bit 7 (possible outlier): e.g 40 Bit 8 (partial gloss): e.g 80
<b>Position</b>		Output of position data	Enum_16	2	No position data: 0	No position data: 00 00
<b>Name</b>		Device name	Uint_16	2	No name: 0 Name: 1	No name 00 00 Name 00 01
Name information	Length	Length of name	Uint_8	1	0h ... Fh	00 ... 0F
	Name	Device name in characters	String	16	20h ... 7Ah	20 ... 7A
<b>Comment</b>		Comment	Uint_16	2	No comment: 0	No comment 00 00
<b>Time</b>		Transmits a time stamp	Uint_16	2	No time: 0 Time: 1	No time: 00 00 Time: 00 01



Telegram part	Description	Variable	Length	Values CoLa A (ASCII)	Values CoLa B (binary)	
Time info	Year	1970 to 2037	Uint_16	2	7B2h ... 7F5h	07 B2 ... 07 F5
	Month	1 to 12	Uint_8	1	1 ... C	01 ... 0C
	Day	Day of month 1 to 31	Uint_8	1	1 ... 1Fh	01 ... 1F
	Hour	0 to 23	Uint_8	1	0 ... 17h	00 ... 17
	Minute	0 to 59	Uint_8	1	0 ... 3Bh	00 ... 3B
	Second	0 to 59	Uint_8	1	0 ... 3Bh	00 ... 3B
	Microsecond	0 to 999999	Uint_32	4	0h ... F423Fh	00 00 00 00 ... 00 0F 42 3F
Event info	Display event info	Uint_16	2	No info: 0	No info: 00 00	

<sup>1</sup> Does not count how many telegrams were really given out; is relevant if not all scans are delivered from the scan core.

### LMDscandata - reserved values

Distance values are only valid starting from 16d and higher. Lower values have the following meaning:

DIST	RSSI	Description
0d	0h	Invalid measurement value; caused by very low remission (extremely dark object), object distance not within measurement range (too close or too far away) or selected filter settings at device
1d	FFFFh (16Bit output)	Invalid measurement value, device was dazzled or blinded, e.g. by measuring on reflector
4d - 15d	0h	Reserved, currently not in use
≥ 16d	> 0h	Valid measurement values

## 12.2 Declarations of conformity and certificates

The declarations of conformity and certificates can be downloaded from the Internet at:

- [www.sick.com/LMS4000](http://www.sick.com/LMS4000)

## 12.3 Licenses

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

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