

# TiM781

2D LiDAR sensors

**SICK**  
Sensor Intelligence.



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**Product described**

TiM781 (part number 1096807)

**Manufacturer**

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**Original document**

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## 1 About this document

### 1.1 Information on the operating instructions

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

Prerequisites for safe work are:

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

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

**NOTE**

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

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

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

### 1.2 Explanation of symbols

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



**DANGER**

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



**WARNING**

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



**CAUTION**

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



**NOTICE**

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



**NOTE**

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

## 1.3 Further information

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### NOTE

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

- [www.sick.com/TiM7xx](http://www.sick.com/TiM7xx)

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 TiM781 2D LiDAR sensor features a scan plane and is designed for the following applications:

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

It is suitable for applications which demand precise, non-contact optical measuring contours and dimensioning. Typical fields of application are, for example, stationary field protection, area monitoring, access control, mobile applications (navigation and anti-collision of mobile platforms).

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

#### **Overview**

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

You will find further information at [www.sick.com/psirt](http://www.sick.com/psirt), e.g.:

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

### 2.4 Limitation of liability

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

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

### 2.5 Modifications and conversions



#### NOTICE

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

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

### 2.6 Requirements for skilled persons and operating personnel



#### WARNING

##### Risk of injury due to insufficient training.

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

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

The following qualifications are required for various activities:

Table 1: Activities and technical requirements

Activities	Qualification
Mounting, maintenance	<ul style="list-style-type: none"><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>
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 specific hazards

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



### CAUTION

#### Optical radiation: Class 1 Laser Product

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

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

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

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



### WARNING

#### Electrical voltage!

Electrical voltage can cause severe injury or death.

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



### WARNING

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

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

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

## 3 Product description

### 3.1 Scope of delivery

The delivery of the device includes the following components:

*Table 2: Scope of delivery*

No. of units	Component	Notes
1	Device in the version ordered 2x fastening clips, 2x M3 x 5 mm screws	Without connecting cables
1	Printed safety notes, multilingual	Quick guide and general safety notes

### 3.2 Setup and dimensions

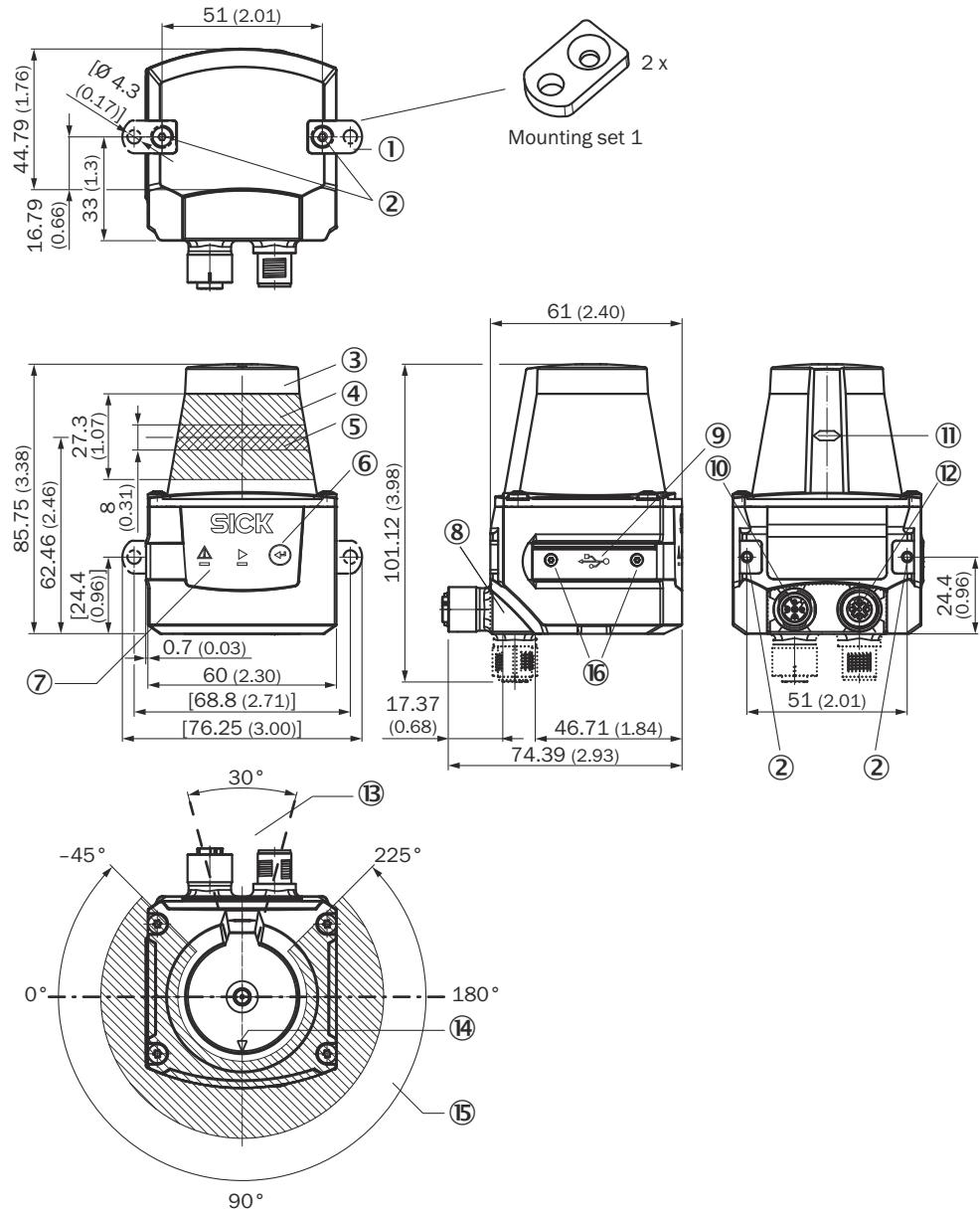


Figure 1: Structure and dimensions, unit: mm (inch), decimal separator: period

- ① 2x fastening clip with M3 x 5 mm countersunk screw, self-locking (included in scope of delivery)
- ② M3 threaded mounting hole, 2.8 mm deep (blind hole thread), max. tightening torque 0.8 Nm
- ③ Optics cover
- ④ Receiving range (light inlet)
- ⑤ Transmission range (light emission)
- ⑥ Function button for teach-in
- ⑦ Red and green LED (status indicators)
- ⑧ Swivel connector unit with electrical connections
- ⑨ Micro USB port, behind the black plastic cover ("Aux interface" connection for configuration with computer)
- ⑩ Connection for power supply, digital inputs/outputs, 12-pin M12 female connector.

- ⑪ Marking for the position of the light emission level
- ⑫ Ethernet connection, 4-pin M12 female connector
- ⑬ Area in which no reflective surfaces are permitted when the device is mounted
- ⑭ Bearing marking to support alignment (90° axis)
- ⑮ 270° aperture angle (visual range)
- ⑯ 2 x countersunk screw (Torx TX 6) M2 x 4 mm

#### 3.3 Display and operating elements



Figure 2: Display and operating elements

- ① Red LED (status indicator)
- ② Green LED (status indicator)
- ③ Teach-in pushbutton

#### Status indicators

LED (red)	LED (green)	Description
-	●	Device ready/monitoring mode
●	●	Object detection within field/fields (if there are lots of object detections in a short space of time, the red LED lighting up might look like flashing)
-	●	Teach-in: start
●	●	Teach-in: End of advance warning phase, 60 seconds Teach-in level
-	●	Teach-in: End of teach-in phase
●	-	Fault
-	-	Device without supply voltage

● = illuminated; ● = flashing

#### 3.4 Type code

The devices of the product family are arranged according to the following type code:

TIM	x	y	z		-	aa	bb	c	dd
1	2	3	4	5		6	7	8	9

Table 3: Type code

Position	Description	Characteristic
1	Device name	TIM: Short range 2D-LiDAR sensor
2	Device type	7: Data supplier + field evaluation
3	Performed by	7: 25 m measuring range, 0.33° angular resolution, performance professional, HDDM 8: 25 m measuring range, 0.33° angular resolution, performance professional, HDDM+
4	Housing	1: Housing IP67 without heating

Position	Description	Characteristic
5		"Empty": standard
6	Connection	21: Rotating connection unit, 1 x M12 male connector, 12-pin, D-coded (Power + I/O); 1x M12 female connector, 4-pin, A-coded (Ethernet)
7	Application	74: Measurement data supplier and flexible field evaluation with contour fields and particle filters
8	Laser type	1: Pulse power up to 880 mW, pulse width up to 5 ns, pulse rate 1,500 kHz
9	Color	01: Gray

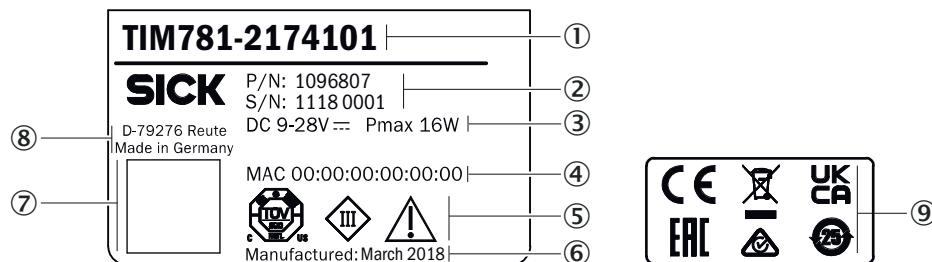
**NOTE**

Not all combinations are possible according to the type code. The available device variants can be found online at:

- [www.sick.com/TiM7xx](http://www.sick.com/TiM7xx)

## 3.5 Product identification

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



- ① Type code
- ② Part number, serial number
- ③ Voltage supply, maximum power consumption
- ④ MAC address
- ⑤ Conformity mark/certification mark, symbol: Observe the operating instructions!
- ⑥ Production date
- ⑦ Data Matrix code with product data (part number, serial number, MAC address)
- ⑧ Manufacturer/production location
- ⑨ Conformity mark/certification mark

## 3.6 Principle of operation

### 3.6.1 Measurement principle

The device is an opto-electronic LiDAR sensor (laser scanner) that uses laser beams for non-contact scanning of the outline of its surroundings on a plane. The device measures its surroundings in two-dimensional polar coordinates, relative to its measurement origin. This is marked by a circular indentation in the center of the optics cover. If a laser beam strikes an object, the position of that object is determined in terms of distance and direction.

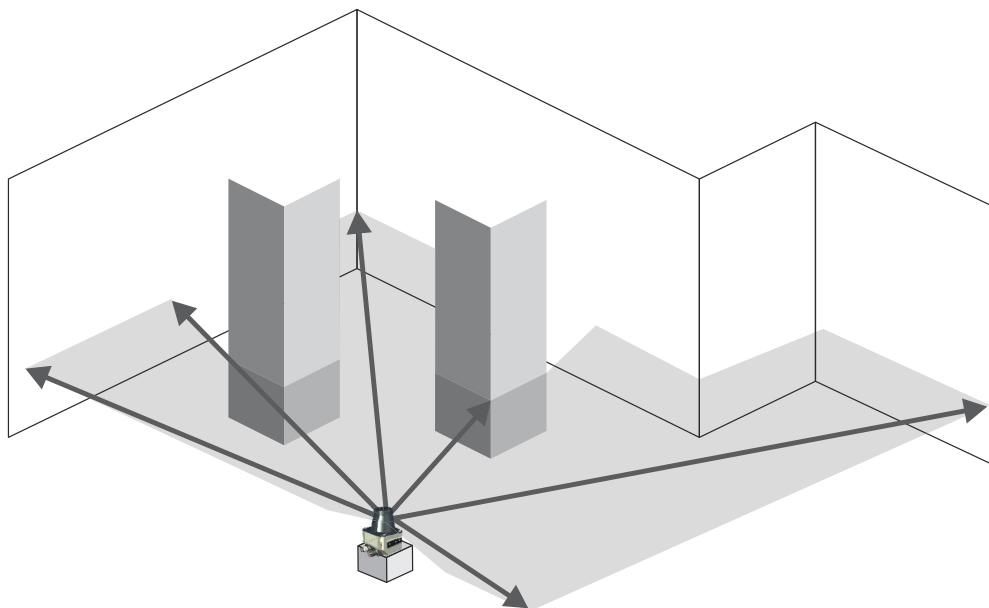


Figure 3: The 2D LiDAR sensor measurement principle

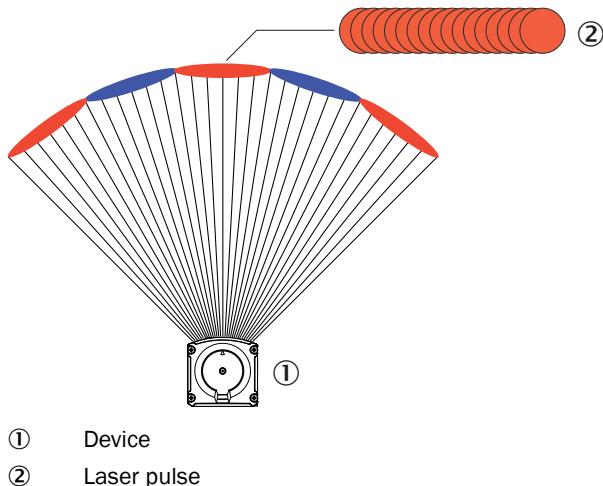
#### 3.6.2 Range finding

The device emits beams pulsed by a laser diode. If a laser pulse hits an object or person, it is reflected on the surface of the object or person in question. The reflection is registered by a photosensitive element in the device receiver. The device uses SICK's own HDDM/HDDM+ (High Definition Distance Measurement) technology. With this measurement process, a measured value is formed by adding together multiple single pulses. The device calculates the distance from the object based on the elapsed time that the light requires between emitting the beam and receiving the reflection. Radar systems apply this "pulse time-of-flight measurement" principle in a similar way.

#### 3.6.3 Direction measurement

The device uses a rotating mirror to deflect the emitted laser beams, thereby scanning its surroundings in a circular pattern. The measurements are triggered internally by an encoder in regular angle increments.

The measuring procedure uses the averaging from multiple pulses to determine individual measured values. A measuring point is the average value of several measurements combined.



### 3.6.4 Object sizes

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



Figure 4: Beam expansion

- ① Expanded laser beam
- ② Optical axis

**Required values for calculating the light spot size and minimum object size:**

- Light spot size on the device cover: 7 mm (rounded up)
- Light spot divergence per single pulse: 0.49 deg (8.6 mrad)
- supplement HDDM/HDDM+ (1 measured value consists of several overlapping single pulses): 5.8 mrad

**Formula for calculating the light spot width:**

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

Calculation example of light spot width at a distance of 4 m, with supplement 5.8 mrad:

$$(8.6 \text{ mrad} + 5.8 \text{ mrad}) * 4,000 \text{ mm} + 7 \text{ mm} = 64.6 \text{ mm}$$

**Formula for calculating the height of the light spot:**

Light spot divergence [mrad] \* Distance [mm] + Light spot size at the device cover [mm] = Light spot width [mm]

Example calculation of the light spot height at a distance of 4 m:

$$8.6 \text{ mrad} * 4,000 \text{ mm} + 7 \text{ mm} = 41.4 \text{ mm}$$

**Formula for calculating the minimum object size:**

$2 * \text{supplement [mrad]} * \text{distance [mm]} + \text{light spot height [mm]} = \text{minimum object size [mm]}$

Calculation example of minimum object size at a distance of 4 m, with supplement 5.8 mrad:

$$2 * 5.8 \text{ mrad} * 4,000 \text{ mm} + 41.4 \text{ mm} = 87.8 \text{ mm}$$



#### NOTE

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

### 3 PRODUCT DESCRIPTION

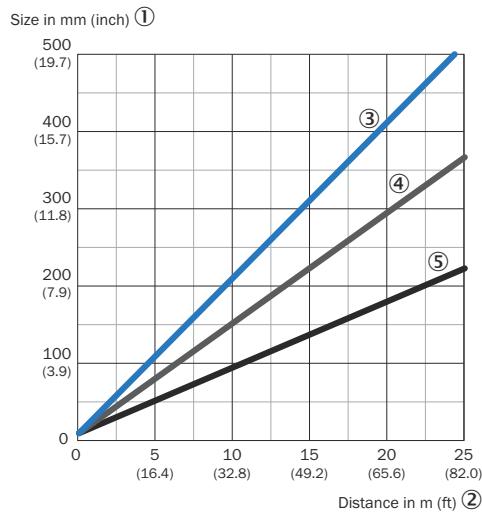


Figure 5: Minimum object size

- ① Size in millimeters (inc)
- ② Distance in meters (feet)
- ③ Minimum object size
- ④ Light spot width
- ⑤ Light spot height

#### 3.6.5 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.

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 4: 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%

### 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.

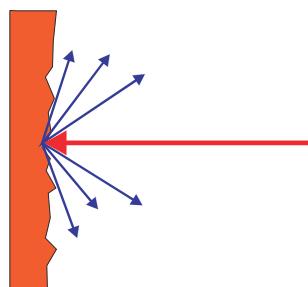


Figure 6: Reflection of light on the surface of the object

### 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.

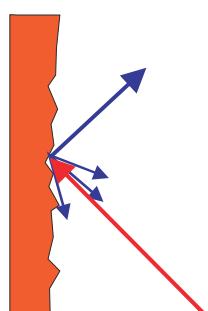


Figure 7: Angle of reflection

### 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.

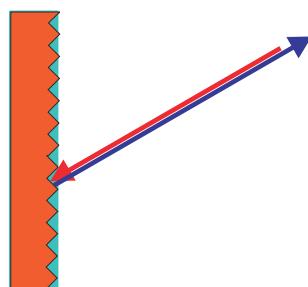


Figure 8: Retroreflection

#### 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.

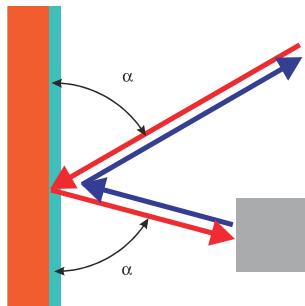


Figure 9: Specular surfaces

#### 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.

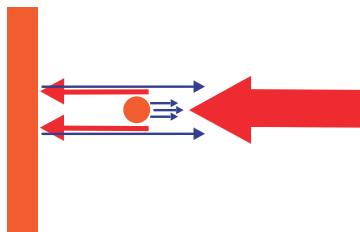


Figure 10: Object smaller than the laser beam diameter

#### 3.6.6 Scanning range

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

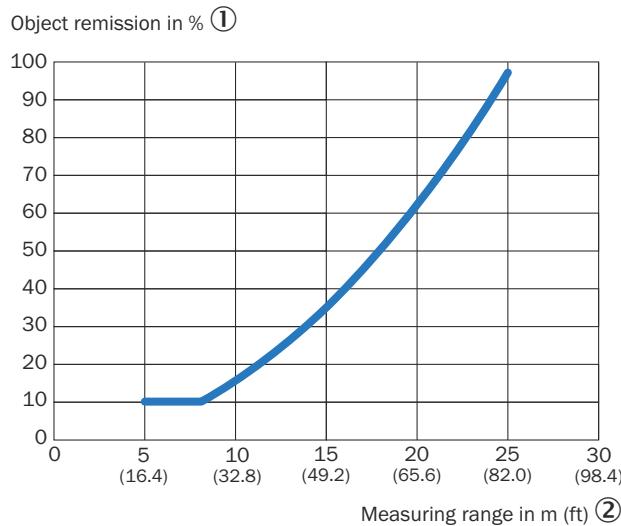


Figure 11: Scanning range rate as a function of object remission

- ① Object remission in percent
- ② Measuring range in meters (feet)

### 3.6.7 Filter

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:

- Edge filter
- Particle filter
- Median filter
- Average filter

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.

A particularly effective way to reduce the data in a scan (reduction of measurement points) is to restrict the scan range ("Data output" > "Output range") or the media filter.

#### 3.6.7.1 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 16](#). The filter evaluates the difference in distance between adjacent points.

The previous and next measurement point are taken into consideration in this. As soon as the configured maximum adjacent distance to the previous **and** next measurement point is exceeded, the device sets the distance value to 0 (value highlighted in [see table 5, page 20 bold](#)). If the maximum adjacent distance is not exceeded, or only exceeded to one of the adjacent measurement points, the measurement point is not filtered. If the measurement point or one of the adjacent measurement points is 0, then the filter is not applied to this measurement point.

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

	Measurement points (distance values in mm)							
	1	2	3	4	5	6	7	...
not filtered	1800	1750	1145	1150	1147	800	871	...
filtered	1800	1750	1145	1150	1147	0	871	...

The edge filter enables points to be entirely suppressed at the outer edges of the object.

#### Maximum edge filter range (range limitation)

The maximum distance can be set to 8,000 mm <sup>1)</sup>. The measurement points within the configured range are taken into account.

##### 3.6.7.2 Particle filter

The particle filter blanks small, irrelevant reflection pulses in dusty environments and in rain or snow which are caused by dust particles, raindrops, snowflakes or the like. In doing so, successive scans are continuously evaluated in order to detect static objects.

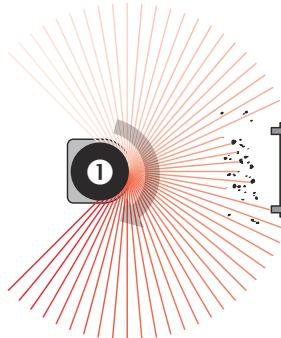


Figure 12: Without the particle filter: Violation of the contour due to dust particles in the vicinity of the object.

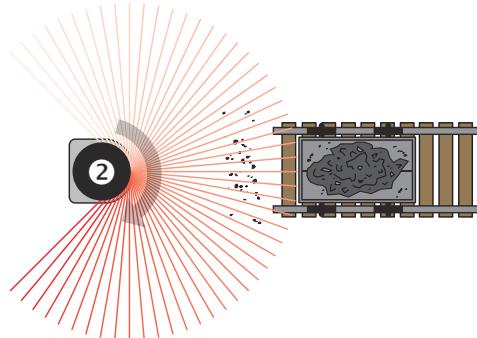


Figure 13: Using the particle filter: The response to dust particles in the field is delayed by one scan. Particles can thereby be blanked.

##### 3.6.7.3 Median filter

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

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.

The calculation and output of the media values are done statically.

By activating the media filter, 3 distance values within a scan can be reduced to one output value, which reduces the number of output values to 1/3 compared to the unfiltered scan.

Table 6: Example: Median for scan 1 and 2

	Angle (distance values in mm)								
Scan	1	2	3	4	5	6	7	8	...
1	850	852	851	849	850	850	851	850	...

<sup>1)</sup> For the variants TiM310 / TiM320, the maximum distance can be set to 4,000 mm.

Scan	Angle (distance values in mm)										
	1	2	3	4	5	6	7	8	...		
Scan 1 output value	850	851	852	849	850	850	...				
2	849	850	850	853	852	852	850	851	...		
Scan 2 output value	849	850	850	852	852	852	...				
...	...	...	...	...	...	...	...	...	...	...	

### 3.6.7.4 Average filter

The sliding average filter smooths the distance value. It does this by calculating the arithmetic mean from several scans of the same point. The number of scans can be configured (maximum 4 scans).

Table 7: Example: Average filter over 5 scans

Scan	Angle (distance values in mm)									
	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	950	1500	1500	0	...
3	0	0	1150	1450	1200	1200	1450	1450	0	...
4	0	0	1170	1170	1220	1220	1470	1150	0	...
1 Output value (scan 1-4)	0	0	1155	1230	1190	1130	1450	1370	0	...
5	0	0	0	1110	1150	1150	1380	1380	0	...
2. Output value (scan 2-5)	0	0	1173	1225	1190	1130	1450	1370	0	
6	0	0	1200	1210	1190	0	1500	1500	0	...
3. Output value (scan 3-6)	0	0	1173	1235	1190	1190	1450	1370	0	
7	0	730	1150	0	1200	1200	1450	1450	0	...
4. Output value (4-7)	0	730	1173	1163	1190	1190	1450	1370	0	
...	...	...	...	...	...	...	...	...	...	...

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

Based on the scanning frequency of 15 Hz, a measured value is generated every 67 s. The time delay affecting data output results from this base value multiplied by the number of averaging operations (e.g., 2 averaging operations = 134 ms, 10 averaging operations = 670 ms).

### 3.6.8 Calculation of the field size for mobile applications

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

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

- the braking distance, which can be found in the vehicle documentation
- the distance covered during the vehicle control's response time, which can be found in the vehicle documentation
- The distance covered during the response time of the LiDAR sensor, "[Technical data](#)", page 49.

---

**NOTE**

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

---

**Height of the scan plane**

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

#### 3.6.8.1 Switching field length

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

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

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

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

**SA** = Stopping distance

**ZG** = General supplement of the LiDAR sensor = 100 mm

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

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

##### Stopping distance SA

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

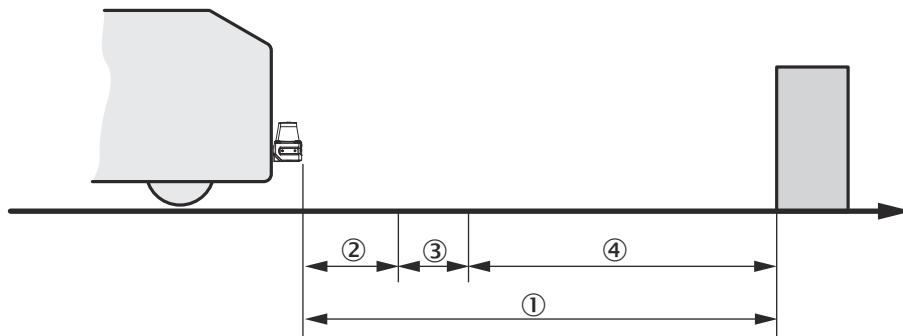


Figure 14: Stopping distance

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



#### NOTE

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

How to calculate the stopping distance  $S_A$ :

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

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

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

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

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

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

For more information on the response time  $T_S$  of the LiDAR sensor, see "Technical data", page 49.

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

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

$T_S$  = Response time of the LiDAR sensor

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

The response time  $T_S$  of the LiDAR sensor depends on:

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

#### ZR supplement

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

#### 3.6.8.2 Switching field width

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

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

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

**FB** = Vehicle width

**ZG** = General supplement of the LiDAR sensor = 100 mm

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

## 4 Transport and storage

### 4.1 Transport

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.

## 4 TRANSPORT AND STORAGE

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- Storage temperature: see "Technical data", page 49.
- Relative humidity: see "Technical data", page 49.
- 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 and indirect 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 53](#).
- In application areas with severe vibrations or shocks caused by vibrations, jolts or abrupt changes in directions (e.g., when mounted to a manned forklift truck), mounting with vibration dampers is to be carried out ([see "Accessories", page 53](#)). Mount the device in a freely suspended manner.
- During mounting, make sure there is no reflective surface behind the reference target, [see "Setup and dimensions", page 11](#).
- To avoid inaccurate measurements when installing multiple devices: Make sure that the laser spot of one device is not in the visible range of another device, [see "Mutual interference", page 28](#).
- 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.
- The M3 x 5 screws included with delivery are intended for mounting the fastening clips via the blind hole threads on the rear or underside of the device, [see "Setup and dimensions", page 11](#). If the mounting clamps are not used or if other screws are used, the screws must not be screwed into the thread by more than 2.8 mm. The maximum tightening torque is 0.8 Nm.

### 5.2 Mounting device

1. Mount the LiDAR sensor using the designated fixing holes, [see "Setup and dimensions", page 11](#).



#### NOTICE

##### Risk of damage to the device

the device will be damaged if the tightening torque of the mounting screws is too high or if the maximum screw-in depth of the blind hole threads is exceeded.

- ▶ Observe maximum tightening torque.
- ▶ Use suitable mounting screws for the blind hole threads of the device.
- Observe the maximum screw-in depth.

2. Make the electrical connection. Attach and tighten a voltage-free cable, [see "Connecting the device electrically", page 34](#).
3. Switch on the supply voltage.  
✓ The green operating LED lights up.
4. Align the vertical center line of the field of view of the device with the center of the area to be monitored. The marking (90° axis) on the upper side of the optics cover serves as a alignment aid.

### 5.3 Mutual interference



#### NOTE

Optical sensors and other IR light sources can influence the measurement and detection capabilities of the device.

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

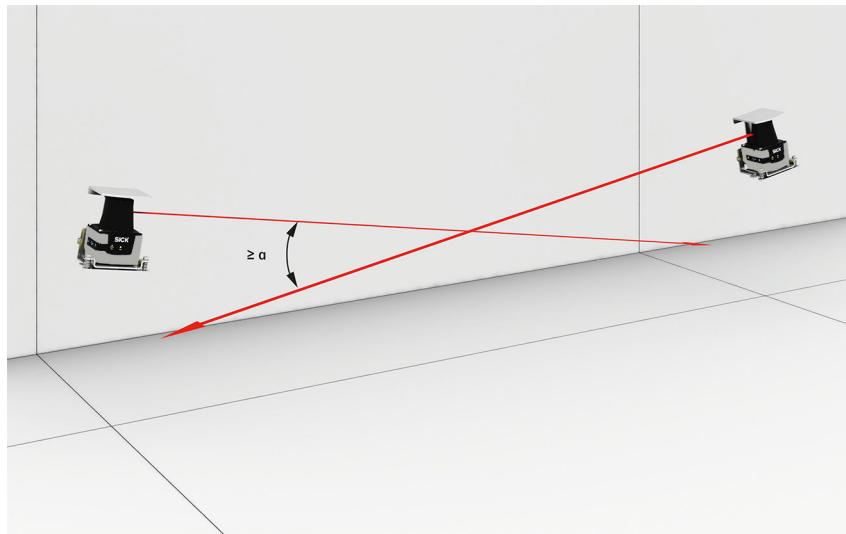


Figure 15: Angle  $\geq 6^\circ$



Figure 16: Distance  $\geq 200 \text{ mm}$

## 6 Electrical installation

### 6.1 Prerequisites for safe operation of the device



#### WARNING

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

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

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

#### Remedial measures

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

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

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

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

This is achieved by complying with the following conditions:

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

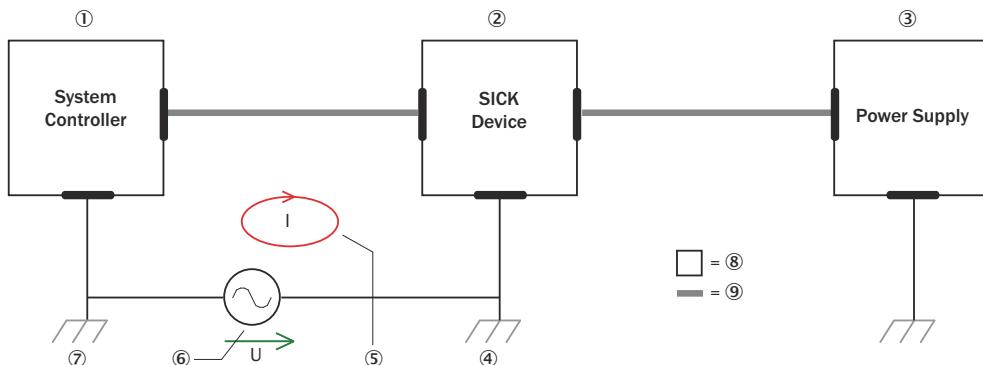


Figure 17: Example: Occurrence of equipotential bonding currents in the system configuration

- (1) System controller
- (2) Device
- (3) Voltage supply

- ④ Grounding point 2
- ⑤ Closed current loop with equalizing currents via cable shield
- ⑥ Ground potential difference
- ⑦ Grounding point 1
- ⑧ Metal housing
- ⑨ Shielded electrical cable

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

### Remedial measures

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



#### NOTICE

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

### Measures for widely distributed system installations

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

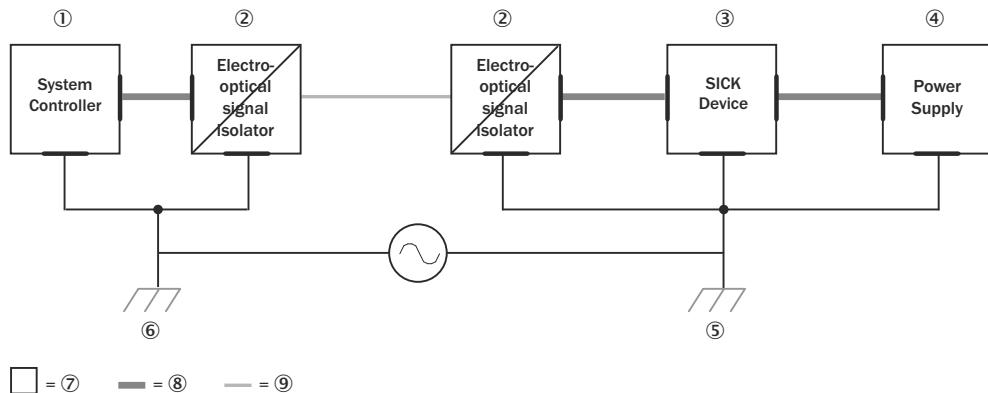


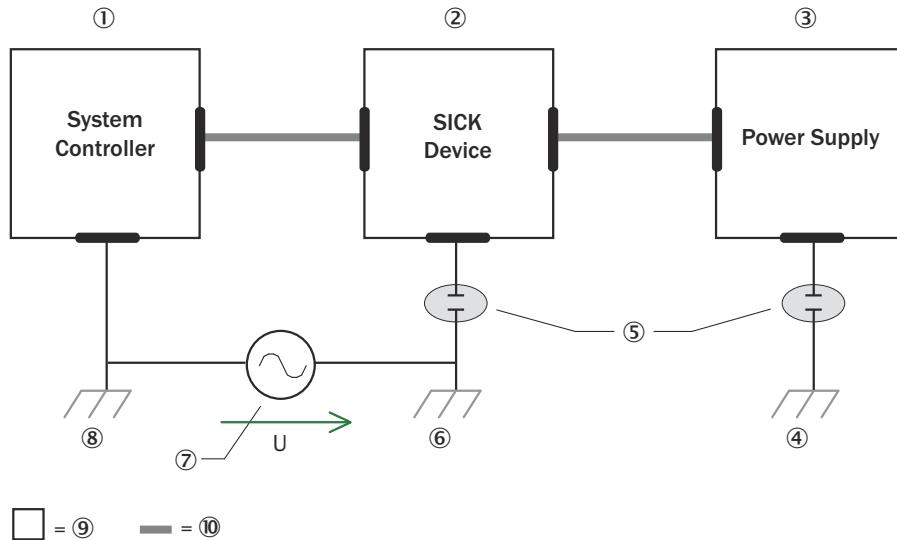
Figure 18: Example: Prevention of equipotential bonding currents in the system configuration by the use of electro-optical signal isolators

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

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

#### Measures for small system installations

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



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

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

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



#### NOTICE

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

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

### 6.2 Electrical block diagram for commissioning

TiMxxx-21xxxx

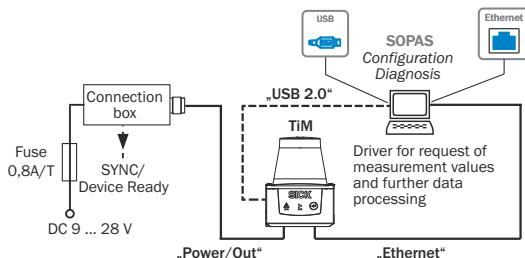


Figure 20: "Power, I/O" connection: With M12 male connector, 12-pin, A-coded; "Ethernet" connection: With M12 female connector, 4-pin, D-coded

### 6.3 Wiring instructions



#### NOTE

Pre-assembled cables can be found online at:

- [www.sick.com/TiM7xx](http://www.sick.com/TiM7xx)



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

Protect the device from dust and moisture when the plastic USB cover is open.

The USB interface is only for parameterization. Remove the USB cable for problem-free operation of the device.

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

Protect the device with an external 0.8 A slow-blow fuse at the beginning of the supply cable.

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

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

### 6.4 Connection diagram



#### NOTE

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

[www.sick.com/TiM7xx](http://www.sick.com/TiM7xx)

#### 6.4.1 TiMxxx-21xxxxx

##### "Power/I/O" connection

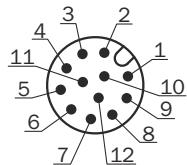


Table 8: Male connector, M12, 12-pin, A-coded

Pin	Signal	Function	Wire colors of connecting cable with flying leads <sup>1)</sup>
1	GND	Ground	Blue
2	V <sub>S</sub>	Supply voltage	Brown
3	IN 1	Digital input 1 (field set selection)	Red
4	IN 2	Digital input 2 (field set selection)	Green
5	OUT 1	Digital output 1 (object detection)	Pink
6	OUT 2	Digital output 2 (object detection)	Yellow
7	OUT 3	Digital output 3 (object detection)	Black
8	OUT 4	Digital output 4 (index/error)	Gray
9	IN <sub>GND</sub>	Common ground for all inputs	White
10	IN 3	Digital input 3 (field set selection)	Violet
11	IN 4	Digital input 4 (field set selection)	Gray and pink
12	-	Reserved, do not wire this PIN!	Rot and blue
-	-	Screen	-

<sup>1)</sup> Example values when using the connecting cables part numbers 6054974 (5 m), 6054973 (10 m), 6054972 (20 m). Signal assignment and wire colors can vary when using other connecting cables.

##### "Ethernet" connection

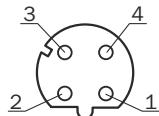


Table 9: Female connector, 4-pin, D-coded

Contact	Labeling	Description
1	TX+	Sender+
2	RX+	Receiver+
3	TX-	Sender-
4	RX-	Receiver-

#### 6.4.2 USB interface

The Ethernet interface is recommended as a communication interface.

##### If using the USB interface, please note:

- Use a high-speed USB cable, maximum length of cable: 3 m.
- The connection may be interrupted due to ESD/EMC influences. If necessary: Disconnect USB cable from the device, then reconnect it. Restart communication via SOPAS ET software ("Online" button).

### 6.5 Connecting the device electrically



#### NOTICE

Observe the wiring instructions, see "Wiring instructions", page 32.

1. Ensure the voltage supply is not connected.
2. Connect the device according to the connection diagram, see "Connection diagram", page 32.

### 6.6 Wiring digital inputs / digital outputs

#### Digital inputs

The 4 switching digital inputs activate one of the 16 field sets in a binary combination as an evaluation case.

The digital inputs are decoupled from the supply voltage of the device. They have a common reference point ( $IN_{GND}$ ), meaning they are not decoupled from one another.

The structure and wiring principle of the digital inputs are shown below.

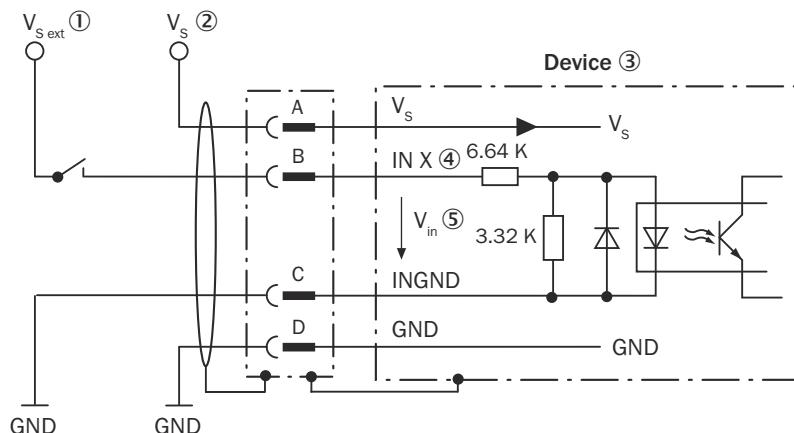


Figure 21: Wiring of digital input (PNP version)

- ① External supply voltage  $V_{S\ ext}$
- ② Supply voltage  $V_s$  for device
- ③ Device
- ④ Signal  $IN\ X$
- ⑤ Input voltage  $V_{in}$

Position	Signal	TiM7xx-21xxxx (male connector M12, 12-pin): PIN
A	$V_s$	2
D	GND	1
C	$IN_{GND}$	9
B1	$IN\ 1$	3
B2	$IN\ 2$	4
B3	$IN\ 3$	10
B4	$IN\ 4$	11

Switching behavior	Current to the input starts the assigned function in the device. Default: Active high level, debounce 10 ms
--------------------	--

<b>Properties</b>	Opto-decoupled Switchable with an electronic switch (PNP output) or mechanical switch
<b>Electrical values</b>	<a href="#">see "Mechanics/electronics", page 51</a>

### Digital outputs

The device has 4 switching digital outputs.

In combination, the digital outputs OUT 1 to OUT 3 signal the breach of the individual fields of a field set.

The digital output OUT 4 is used to issue an error and a regular index pulse.

The structure and wiring principle of the digital outputs are shown below.

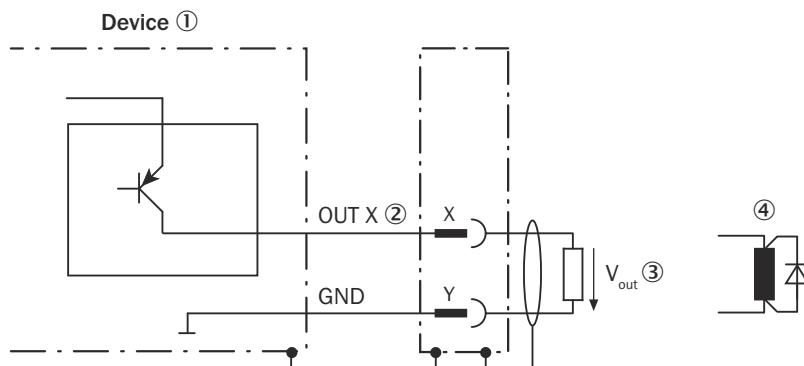


Figure 22: Wiring of digital output (PNP version)

- ① Device
- ② Signal OUT X
- ③ Output voltage  $V_{out}$
- ④ If inductive load is present: Provide an arc-suppression switch at the digital output. Attach a freewheeling diode directly to the load for this purpose.

Position	Signal	TiM7xx-21xxxx (male connector M12, 12-pin): PIN
X1	OUT 1	5
X2	OUT 2	6
X3	OUT 3	7
X4	OUT 4	8
Y	GND	1

<b>Switching behavior</b>	PNP switching against supply voltage UV <b>OUT 1 ... OUT 3:</b> Resting level: High (no object detection), working level: Low (object detection) Response time: 134 ms ... 30 s (configurable via SOPAS ET ), holding time: 0 ms ... 10 s (configurable via SOPAS ET ) <b>OUT 4:</b> Resting level: High (device ready) working level: Low (error), low pulse (15 Hz, index, corresponds to measurement at 90°)
<b>Properties</b>	Short-circuit protected and temperature protected Not electrically isolated from supply voltage $U_v$
<b>Electrical values</b>	<a href="#">see "Mechanics/electronics", page 51</a>

Longer connecting cables at the digital outputs of the device should be avoided due to the resulting fall in voltage. This is calculated as follows:

$$\Delta U = (2 \times \text{length} \times \text{current}) : (\text{conductance value} \times \text{cross-section})$$

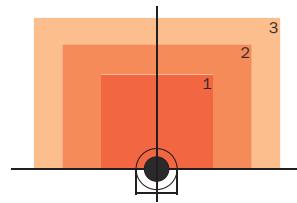
Conductance value for copper: 56 m/ $\Omega$  mm<sup>2</sup>.

### Assignment of infringed fields – digital outputs

Output level: The level of the digital outputs OUT 1 ... OUT 3 is active low (in resting position: high, in working position: low (field infringed)).

All fields of a field set are considered infringed upon switching on, booting, in the event of an error and when the device is switched off.

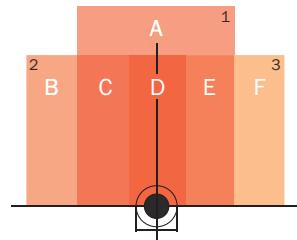
#### Example 1: 3 fields, rectangular, nested inside each other



Infringed fields	Digital outputs		
	OUT 1	OUT 2	OUT 3
Fields 1, 2, and 3 infringed	Active	Active	Active
Fields 2 and 3 infringed	Deactivated	Active	Active
Field 3 infringed	Deactivated	Deactivated	Active
No field infringed:	Deactivated	Deactivated	Deactivated

#### Example 2: 3 fields, rectangular, overlapping

The overlapping fields create areas that can be used as additional fields.



Infringed areas (fields)	Digital outputs		
	OUT 1	OUT 2	OUT 3
A (field 1 infringed)	Active	Deactivated	Deactivated
B (field 2 infringed)	Deactivated	Active	Deactivated
C (fields 1 and 2 infringed)	Active	Active	Deactivated
D (fields 1, 2, and 3 infringed)	Active	Active	Active
E (fields 1 and 3 infringed)	Active	Deactivated	Active
F (field 3 infringed)	Deactivated	Deactivated	Active
- (no field infringed)	Deactivated	Deactivated	Deactivated

## 7 Operation

### 7.1 SOPAS ET

The following activities are normally performed using the SOPAS ET configuration software:

- Measurement data output application: displaying the surrounding contour (measured line) detected by the device.
- Field evaluation application: adjusting the 3 fields of a field set.
- Parameterization: tailoring other device parameters to the application.
- Diagnosis: determining the cause of a fault.

To parameterize the device, you will require a computer with SOPAS ET installed and a free Ethernet connection (recommended) or, alternatively, a free USB interface.

#### NOTE

The most up-to-date version of the SOPAS ET software can be downloaded at [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 of the device to the computer.
2. Switch on and start the computer.
3. Supply the device with voltage.
- ✓ Following successful initialization, the green status LED lights up. 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 in 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:

 > Device > Login > Select user level and enter password:

User levels	Password
Maintenance staff	main
Authorized client	client
Service	servicelevel

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

#### 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.

### Tools

Depending on the selected view, different tools are available to help you perform configurations or customize the display.

The following are examples of some of the tools for customizing the display:

- Button : Display fields in the polar coordinates system.
- Button : Change over the view of the device/fields. Device black: View from above, device blue: View from below.
- Button  or : Switch off display of the full measuring line or display measuring line as dotted.

#### 7.1.1 Parameter - network

The network area has input screens for configuring the Ethernet connection, the digital inputs / digital outputs and the device.

For Ethernet configuration, note that the IP-Address / subnet-mask must correspond with the address space of the subsequent application.

Table 10: IP-Address factory setting

Parameter	Value
IP-Address	192.168.0.1
Subnet mask	255.255.255.0

#### 7.1.2 Parameter - filters

When selecting the filter, consider filter mutual interference, [see "Filter", page 19](#).

## 7.2 Field evaluation

If the field shape of field set 1 has been taught in without a computer using the teach-in pushbutton, SOPAS is generally used to continue the configuration.

This includes the following:

- Setting of field shapes/sizes and, if applicable, non-programmable field sets based on the default setting and the setting of response time of the fields
- Setting of the blanking size and the holding time of the assigned digital outputs OUT 1 ... OUT 3

#### 7.2.1 Teach-in / Field set selection

For the field evaluation application, it is possible to configure the device as follows rather than configuring it via SOPAS:

- Selection of one of 16 field sets, each with 3 fields of the same size nested into one another, by means of input wiring.
- Teach-in of the surrounding contour to automatically generate the outer field with any shape, including more complex shapes, and to deduce the two inner fields.

The field sets are organized into groups in segmented field shapes. The shape can be changed at will, the default is rectangular.

In the factory setting, the 3 origin-oriented fields of a field set are nested inside one another. The size of field 2 corresponds to field 1 plus 25%. The size of field 3 corresponds to field 1 plus 52%.

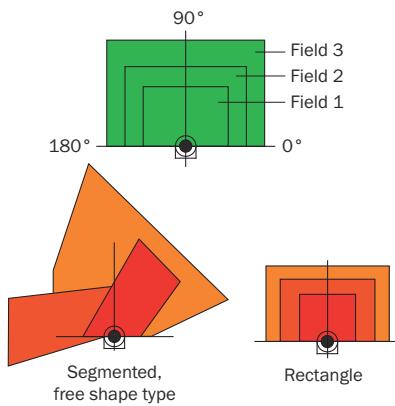


Figure 23: Structure of the fields of a field set and possible field shapes

- ① Segmented, free field shape
- ② Nested together, rectangle

### 7.2.1.1 Teach-in

#### Preparation

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

#### Teaching in the field contour

The device uses field set 1 (segmented, initial shape: rectangle) to adjust the field shape and size to the surrounding contour that was detected. The digital inputs are not allowed to be supplied with current during this process.

The device forms the outer field 3 from the surrounding contour with a negative offset of 100 mm, and derives from this the limits of the two inner fields: field 1 = field 3 minus 33%, and field 2 = field 3 minus 17%.

The device stores the shortest value measured during the teach-in phase as a field limit for each angle.

A parameter upload is required in order to display the newly taught-in field contour in SOPAS.

1. Press and hold the Teach-in pushbutton for 3 s to start the teach-in process.
2. The field shape to be formed can be defined by pacing out the limits during the teach-in phase. Do not wear black clothing during this process!

The LEDs display the individual phases of the teach-in process:

LED (red)	LED (green)	Phase
-		<b>Teach-in pre-warning:</b> LED flashes slowly at first (0.5 Hz)
-		LED flashes increasingly rapidly within 15 s
		<b>Teach-in:</b> Duration 60 seconds
-		<b>Teach-in completion:</b> LED flashes increasingly rapidly within 15 s

LED (red)	LED (green)	Phase
-		<b>Monitoring mode:</b> Automated return after teach-in complete All fields free
		<b>Monitoring mode:</b> If an object detection has occurred

= illuminated; = flashing

The taught-in field contour is automatically and permanently saved as a new field set 1.

### 7.2.1.2 Field set selection via input wiring

One of the predefined field sets can be activated by wiring the digital inputs.

To select field sets via digital inputs, the **Digital inputs** field set selection method must be set in the device. This is the case by default.

#### Field set factory settings – digital inputs

Field set	Digital inputs				Field shape Default size of field 1
	IN 1	IN 2	IN 3	IN 4	
1	0	0	0	0	Rectangle, segmented L: 1 m, W: 2 m
2	1	0	0	0	Rectangle, segmented L: 1.25 m, W: 2 m
3	0	1	0	0	Rectangle, segmented L: 1.5 m, W: 2 m
4	1	1	0	0	Rectangle, segmented L: 1.75 m, W: 2 m
5	0	0	1	0	Rectangle, segmented L: 1 m, W: 2 m
6	1	0	1	0	Rectangle, segmented L: 1.25 m, W: 2 m
7	0	1	1	0	Rectangle, segmented L: 1.5 m, W: 2 m
8	1	1	1	0	Rectangle, segmented L: 1.75 m, W: 2 m
9	0	0	0	1	Rectangle, segmented L: 1 m, W: 2 m
10	1	0	0	1	Rectangle, segmented L: 1.25 m, W: 2 m
11	0	1	0	1	Rectangle, segmented L: 1.5 m, W: 2 m
12	1	1	0	1	Rectangle, segmented L: 1.75 m, W: 2 m
13	0	0	1	1	Rectangle, segmented L: 1 m, W: 2 m
14	1	0	1	1	Rectangle, segmented L: 1.25 m, W: 2 m
15	0	1	1	1	Rectangle, segmented L: 1.5 m, W: 2 m
16	1	1	1	1	Rectangle, segmented L: 1.75 m, W: 2 m
Output form (rectangle), can be changed as desired, L = length, W = width					

Input level: Low (in resting position):  $\leq 2$  V, high (in working position):  $\geq 8$  V

### 7.2.1.3 Field set selection via telegram

One of the predefined field sets can be activated by means of a telegram sent via the Ethernet interface on the device. To select field sets via telegram, the “SOPAS telegram” field set selection method must be set in the device. This can be done using a telegram or via settings in SOPAS ET. The device can then be instructed via a telegram of the predefined field set that is to be activated. Field set 1 is preselected by default.

#### Overview of the telegram functionality for field set selection:

- Select the field set selection method (`sWN FieldSetSelectionMethod [0;1]`)
- Read the field set selection method (`sRN FieldSetSelectionMethod`)

- Select the active field set (sWN ActiveFieldSet [0x01...0x10])
- Read the active field set (sRN ActiveFieldSet)

### **NOTE**

The detailed structure of the telegrams can be found in the Telegram Listing publication (no. 8014631).

#### 7.2.2 Monitor - field evaluation monitor

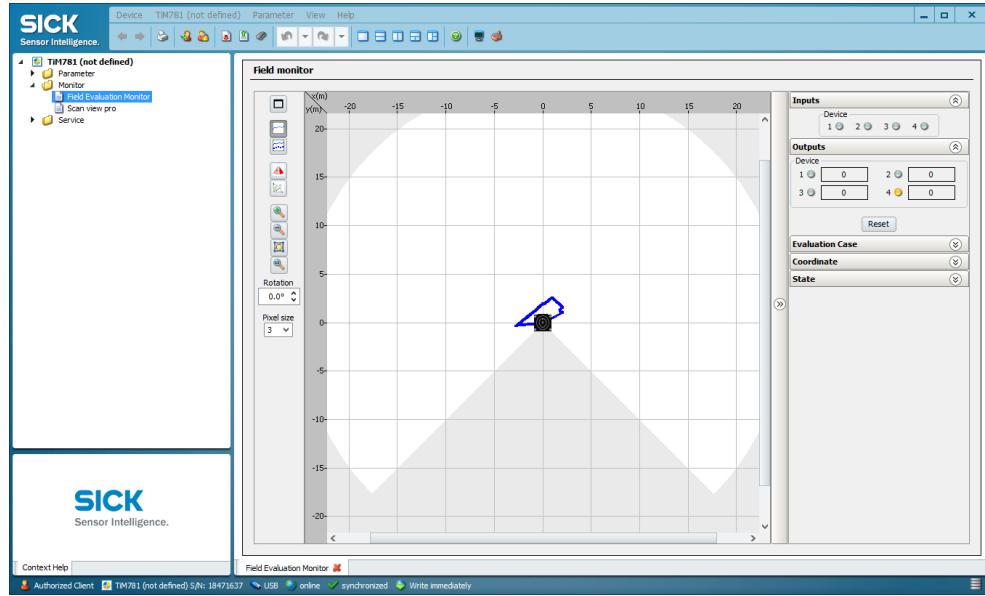


Figure 24: Device window: Monitor - field evaluation monitor

In the **Field evaluation monitor** window, SOPAS displays the field contour (scan line) currently seen by the device through ambient reflection in blue.

If the 4 digital inputs are not energized, SOPAS displays the following for field set 1 according to the default setting of the device:

- 3 evaluation fields (segmented rectangles) or the field shape generated with the aid of teach-in with its dimensions
- Status of the digital inputs/outputs
- Position of the mouse pointer

SOPAS displays the fields as green if no object detection is present.

If objects of a certain size are located for a certain duration in the part of the visual range that is covered by fields, the device will recognize this as an object detection. SOPAS displays this separately in yellow for the individual fields.

Click the “Reset” button to make SOPAS reset the digital output counters.

#### 7.2.3 Parameter - evaluation cases

##### **Response time, blanking size and digital output holding time**

The blanking size is the smallest size from which an object can be detected in a field by the device and lead to an object detection. All objects that are smaller than the minimum size are blanked out.

Like the response time and the holding time, the blanking size applies to all field sets and their fields.

Parameter	Factory setting
Blanking size	Cross-section 200 mm
Response time of the fields	335 ms (5 scans)
Digital output holding time	335 ms (5 scans)

When selecting the response time, note that the device internal reaction time must also be added (max. 67 ms).

To test the effects of the changed settings, change to the **Field evaluation monitor view**.

If the changed fields have been transferred to the device as described, SOPAS will also display these in the monitor, displaying the infringed fields in yellow. If you wish to observe another field set, it must first be activated accordingly using the digital inputs.

### 7.2.4 Parameter - fields

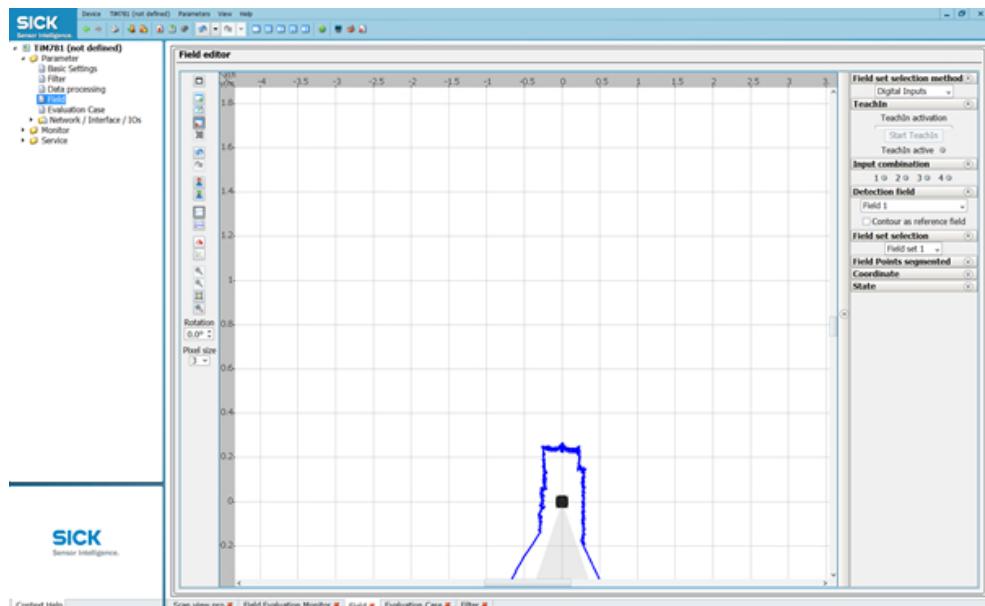


Figure 25: Device window: Parameter - fields

The user can change parameters in the right part of the window. SOPAS immediately transfers these changes to the device (default setting).

However, evaluation fields that have been changed in size and shape must always be manually transferred to the device using the button. All changed parameters are only temporarily stored in the device for the time being and are not stored on the computer.

In order to optimize the dimensions of the monitoring fields:

1. Under Field selection, for example, select field set 1.
2. Select the field to be configured.
3. Make the required optimizations, see description in the following sections.

#### Shifting field positions

1. Button .
2. Click on the green marking rectangle of the desired field position in the outer field.  
✓ The color of the marker square changes to blue.
3. Re-click the rectangle and drag it to the desired position, then release the push-button.  
✓ SOPAS controls the available positioning area during shifting.

### Inserting additional field positions

1. Button .
2. Click on the desired position on the limits of the outer field.
- ✓ SOPAS inserts a new green marker square. This can also be shifted.

### Deleting field points

1. Button .
2. Click on the green marking rectangle of the field position to be deleted in the outer field.
- ✓ The color of the marking rectangle changes to red.
3. Re-click the marking rectangle.
- ✓ SOPAS removes the marker square and instead connects the two nearest marker squares with a new line.

### Rotating the field pair and device around the central axis

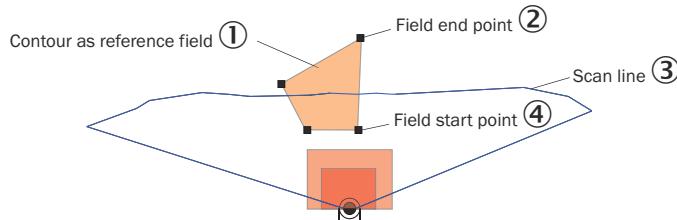
- In order to align the position of the field pair in SOPAS to the conditions on site from the user's perspective, enter and confirm the desired angle of rotation in the 0.0° input. A negative “-” sign sets the turning direction to the right.

### Setting up the contour as reference field

In each field set, any field can be selected as a contour as reference field.

The contour as reference field is used to monitor contours. This can be used to check whether the background is still recognized correctly. If this is no longer the case, possible reasons are that the device is covered or rotated.

The same evaluation strategy is used for all contour as reference fields (evaluation time and blanking size).



- ① Contour as Reference field
- ② End point of contour
- ③ Scanning line
- ④ Start point of contour

1. Select the required field in the field set.
2. Select the **contour as reference field** check mark under **Field selection**.
3. Delete the two field positions closest to the device.
4. Mark the two remaining field positions and shift them outside of the required reference contour area.
5. The button  switch to the configuration for the contour as reference field start points.

The field starting points must lie between the scan line and the device so that the scan line passes between the start and end points of the contour as reference field.

6. Depending on the required shape of the reference contour field, create additional field points between the device and the reference contour field. The distance between the start and end points of the contour as reference field should be approximately 20 cm.

The button can  be used to switch between the start and end points of the contour as reference field for editing purposes. The active points are highlighted in light green while the deactivated points are dark green.

### 7.3 Measurement data output

#### 7.3.1 Monitor - scan view pro

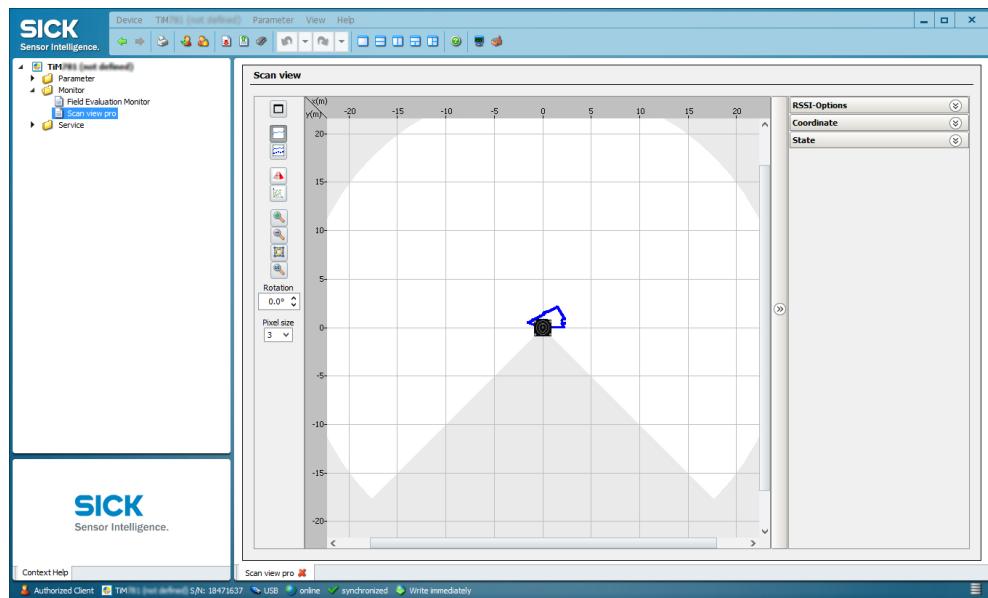


Figure 26: Device window: Monitor - scan view pro

In the Pro scan display window, SOPAS displays the field contour (scan line) currently seen by the device through ambient reflection in blue.

The user can change parameters in the right part of the program window under Settings & Device Status. SOPAS immediately transfers these changes to the device (default setting).

#### 7.3.2 Parameter - data processing

##### Data output format of the measured values

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

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

In order to output remission values in the telegram, select the RSSI checkbox.

To display the remission values in the scan as well, select the RSSI... checkbox under "Monitor" > "scan view pro".

##### Output range of the measured values

The device scans an angular range of 270° (-45° to 225°) and outputs one measured value per angular increment (0.33° or 1° depending on the device type).

The angle range for which measured values can be output can be set using the Output range input field (resolution corresponds to the angular resolution of the device).

### 7.3.3 Telegram

If the device receives one of the two following commands by telegram over the Ethernet or USB interface, it will start the output of measured values in real time over these data interfaces.

The detailed construction of the output telegram as well as the flow of requests and outputs is described in the Telegram Listing publication (no. 8014631).

#### One-off output of measured values:

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

Example:

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

#### Continuous output of measured values:

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	Starting/stopping the output of measured values	Enum8	1	0: Stop 1: Start

Example:

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

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

1. Start the terminal emulator with the button.
  2. Select the Connect... command in the Connections menu in the dialog window and establish communication with the TiM over the Ethernet or USB interface.
  3. Enter one of the two telegrams in the "Send telegram" input line as they appear (automatically framed by STX and ETX when sending in the default setting). Pay attention to blank characters in the string.
  4. Use the button to transmit the telegram to the device.
- ✓ The device responds by providing the data as a one-off or continuously in the

display area of the terminal emulator.

### 7.4 ROS driver

Suitable drivers for integrating the device into the ROS (Robot Operating System) are available for download on the product page:

[www.sick.com/TiM7xx](http://www.sick.com/TiM7xx)

## 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 11: Maintenance plan*

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

### 8.2 Cleaning



#### NOTICE

##### Equipment damage due to improper cleaning.

Improper cleaning may result in equipment damage.

- Only use recommended cleaning agents and tools.
- Never use sharp objects for cleaning.
  
- ▶ Clean the optics cover at regular intervals and in the event of contamination with a lint-free lens cloth (part number 4003353) and plastic cleaning agent (part number 5600006). Rinse off coarse dirt first with water. The cleaning interval essentially depends on the ambient conditions.

# 9 Troubleshooting

## 9.1 Detecting and displaying errors

### Error memory

The device has an error memory where its internal error states are recorded. The content of the error memory is retained when the device is switched off and when the “Restore Factory Settings” function is used.

The SOPAS ET software can be used to create a diagnostics report containing error information (**Complete view**, **Configuration tab**, **Start Diagnosis button**).

## 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/TiM7xx](http://www.sick.com/TiM7xx)

Please note: This documentation may contain further technical data.

### 10.1 Features

<b>Variant</b>	<b>TiM781</b>
<b>Measurement principle</b>	HDDM+
<b>Application</b>	Outdoor
<b>Light source</b>	Infrared (wavelength 850 nm, max. pulse power 880 mW, max. pulse width 5 ns, pulse frequency 1,500 kHz)
<b>Laser class</b>	1 (IEC 60825-1:2014, EN 60825-1:2014) Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed.3., as described in Laser Notice No. 56 dated 8 May 2019.
<b>Aperture angle</b>	270° (horizontal)
<b>Scan field flatness</b>	Typ. ± 1.5°
<b>Scanning frequency</b>	15 Hz
<b>Angular resolution</b>	0.33°
<b>Working range</b>	0.05 m ... 25 m
<b>Scanning range for 5% remission</b>	5 m (typical)
<b>Sensing range for 10% remission</b>	8 m (typical) <sup>1)</sup>
<b>Distance resolution</b>	1 mm
<b>Spot size</b>	Spot size on the optics cover: 7 mm Divergence: 8.6 mrad (0.49°)
<b>Number of echoes evaluated</b>	1
<b>Scan/frame rate</b>	12195 measurement point(s)

<sup>1)</sup> at ambient temperature < -15 °C: typ. 7.5 m

### Working range diagram

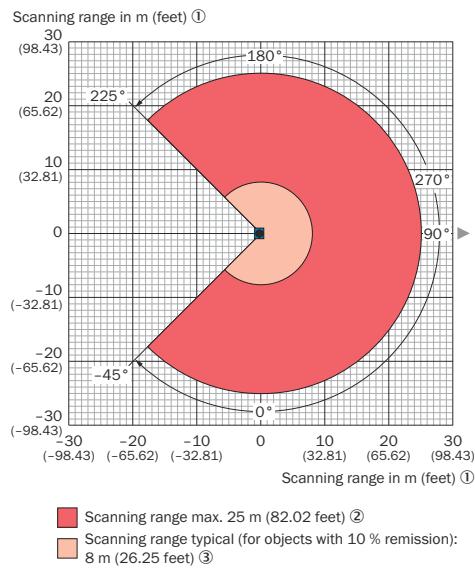


Figure 27: TiMx1x / TiMx2x working range diagram

- ① Sensing range in meters (feet)
- ② Maximum sensing range: 25 m (82.02 feet)
- ③ Typical sensing range for objects with 10% remission: 8 m (26.25 feet)

## 10.2 Performance

Variant	TiM781
Response time	Typ. 1 scan: 67 ms Max. 2 scans: 134 ms <sup>1)</sup>
Power-up delay	Typ. 20 s
Detectable object shape	Almost any
Measurement error	Statistical (1 σ): < 20 mm <sup>2)</sup> Systematic: ± 60 mm <sup>2)</sup> Temperature drift: 0.5 mm/K
Integrated application	Field evaluation with flexible fields Measurement data output (radial distance, RSSI signal level, device and status information, time stamp)
Number of field sets	16 triple fields, (of 1 triple (3 fields) can be configured directly at the scanner)
Simultaneous evaluation cases	1 (3 fields) 2 (2 fields for detection and 1 field for contour as reference)
Filter	Edge filter Particle filter Median filter Average filter

1) Corresponds to max. 134 ms between +45° and +225° of the working range, max. 150 ms between -45° and +45° of the working range (see "Working range diagram", page 50).

2) Typical value at room temperature and up to a sensing range of 10 m at 90% remission, real value depends on ambient conditions, temperature drift: 0.5 mm/K

## 10.3 Interfaces

Variant	TiM781
<b>Ethernet</b>	TCP/IP Max. data transmission rate: 10 Mbit and 100 Mbit Length of cable: max. 100 m
<b>USB</b>	Type: Micro-USB Function: AUX, configuration
<b>Digital inputs</b>	4 (PNP, for field switching)
<b>Digital outputs</b>	3 (PNP, additional 1x "device ready")
<b>Delay time</b>	67 ms ... 30,000 ms (can be configured)
<b>Holding time</b>	67 ms ... 10,000 ms (can be configured)
<b>Optical indicators</b>	2 LEDs (on, "device ready")
<b>Control elements</b>	Pushbutton (teach-in)

## 10.4 Mechanics/electronics

Variant	TiM781
<b>Electrical connection</b>	1 x Ethernet connection, 4-pin M12 female connector 1 x voltage supply connection, 12-pin M12 male connector 1 x micro USB female connector, type B
<b>Supply voltage</b>	9 V DC ... 28 V DC SELV and PELV acc. to IEC 60364-4-41
<b>Power consumption</b>	4 W (typical), with unloaded digital outputs, incl. start-up current Max. 16 W with 4 loaded digital outputs
<b>Input voltage</b>	Low: $V_{in} \leq 2$ V; $I_{in} \leq 0.3$ mA High: $8 \leq V_{in} \leq 32$ V; $0.7 \leq I_{in} \leq 5$ mA
<b>Output voltage</b>	Low: $0 \leq V_{out} \leq 2$ V High: $(V_S - 2) \leq V_{out} \leq V_S$ ; $I_{out} \leq 100$ mA
<b>Housing</b>	Base part: Aluminum die cast Optics cover: Polycarbonate with scratch-resistant coating
<b>Housing color</b>	Gray (RAL 7032)
<b>Electrical safety</b>	According to IEC 61010-1 (ed.3)
<b>Enclosure rating</b>	IP67 (IEC 60529:1989+AMD1:1999+AMD2:2013), only valid with closed "Aux interface" plastic cover
<b>Protection class</b>	III (IEC 61140:2016-1)
<b>Weight</b>	250 g, without connecting cables
<b>Dimensions (L x W x H)</b>	60 mm x 60 mm x 86 mm

## 10.5 Ambient data

Variant	TiM781
<b>Object remission</b>	4% ... 1,000% (reflectors)
<b>Electromagnetic compatibility (EMC)</b>	IEC 61000-6-3:2006+AMD1:2010, IEC 61000-6-2:2005

Variant	TiM781
<b>Vibration resistance</b>	<b>Sine resonance scan:</b> 10 Hz ...1,000 Hz (IEC 60068-2-6:2007) <b>Sine test:</b> 10 Hz ... 500 Hz; 5 g; 10 frequency cycles (IEC 60068-2-6:2007) <b>Noise test:</b> 10 ... 250 Hz; 4.24 grms, 5 h (IEC 60068-2-64:2008)
<b>Shock resistance</b>	50 g; 11 ms; 6 shocks/axis 25 g; 6 ms; 2,000 shocks/axis 50 g; 3 ms; 10,000 shocks/axis (IEC 60068-2-27:2008)
<b>Ambient temperature</b>	Commissioning/switching on: -10 °C ... +50 °C Operation: -25 °C ... +50 °C Storage: -40 °C ... +75 °C
<b>Ambient humidity</b>	Operation: ≤ 80%, non-condensing ≤ 95%, non-condensing (EN 60068-2-30:2005)
<b>Ambient light immunity</b>	80,000 lx (indirect exposure)
<b>Altitude</b>	< 5,000 m above sea level
<b>Ambient conditions</b>	Contamination level 3 outside the housing (EN 61010-1:2011-07)
<b>Damp heat</b>	+25 °C ... +55 °C, 95% r.h., 6 cycles (EN 60068-2-30:2005)
<b>Temperature change</b>	-25 °C... +50 °C, 10 cycles (EN 60068-2-14: 2009)

## 11 Accessories



### NOTE

Accessories and, if applicable, mounting information can be found online at:

- [www.sick.com/TiM7xx](http://www.sick.com/TiM7xx)

## **12** Annex

### **12.1** Declarations of conformity and certificates

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

- [www.sick.com/TiM7xx](http://www.sick.com/TiM7xx)

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



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