Backup Assistance System

Driver assistance system





Described product BAS

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Manufacturer SICK AG

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1 About this document

This Backup Assistance System (BAS) document:

- Contains information that is required during the life cycle of the system.
- Must be available to all those who work with the system.
- Should be read through carefully, and the contents fully understood before working with the system.

1.1 Limitation of liability

Applicable standards and regulations, the latest technological developments, and our many years of knowledge and experience have all been taken into account when assembling the data and information contained in this document.

The manufacturer accepts no liability for damage caused by:

- · Failure to observe this document.
- · Non-compliance with notes and regulations.
- · Unauthorized mounting and installation.
- · Unauthorized technical and other changes.
- Use of unauthorized spare parts, wear and tear parts, and accessories.
- Unauthorized changes, adjustments, and/or manipulations of software.
- Failure to perform and document regular maintenance work.

The actual scope of delivery may differ from the features and illustrations shown here in the case of the use of special system version, use of additional ordering options, or as a result of the latest technical changes.

1.2 Purpose of this document

This operating instructions are designed to give **technical personnel** instructions on the safe mounting, parameterization, electrical installation, commissioning, operation, and maintenance of the BAS driver assistance system.

These operating instructions do **not** provide information on operating the customer system into which the Backup Assistance System has been or is going to be integrated. Additional information can be found in the customer documentation.

1.3 Target groups

This document is intended for persons integrating the driver assistance system into a manned forklift truck or another industrial truck and performing initial commissioning and operation.

It is also intended for the planners, developers and operating entities of manned forklift trucks or other industrial trucks.

1.4 Abbreviations used

BAS Backup Assistance System

SOPAS SICK Engineering Tool = software for 2D LiDAR sensor configuration and diagnostics

1.5 Further information

Special local conditions

▶ The local laws, regulations, technical rules and internal company operating instructions at the operation site must be observed.

Storage of documents

This document and other relevant technical documentation/information:

- Must be kept available for reference.
- Must be handed over to new system operators/new specialist personnel.

1.6 Other relevant technical documentation/information

· Technical system documentation

Technical data Connection diagram Terminal diagram

• Documentation of the following system components:

Component	Manufacturer
TiM3xx Detecting Laser Scanner Operating Instructions	SICK
QUICKSTART BAS 2.0 Signal Light Bar	SICK

1.7 Document conventions

The warnings used in this manual have the following meanings:

DANGER

Identifies an imminent danger, which will lead to death or serious injuries if not prevented.

WARNING

Identifies a situation presenting danger, which will lead to death or serious injuries if not prevented.

△ CAUTION

Identifies a possibly hazardous situation which may lead to minor or moderate bodily injuries or material damage if not prevented.

Note

Important information and useful notes.

► Instructions

2 Safety information

2.1 Intended use

When reversing with activated reverse gear, the BAS (**B**ackup **A**ssistance **S**ystem) warns the driver of the vehicle via optical and acoustic signals when the vehicle is too close to a stationary or moving object. The steering system of the vehicle is not overridden.

The driver assistance system is designed for **installation** in manned forklift trucks or other industrial trucks with electric motors (UL-583) or combustion engines (UL-558).

By using the retrofittable stand-alone solution, accidents and damage can be reduced while drivers can concentrate on their current tasks.

NOTE! Intended use also includes observance of this system description, in particular the safety notes as well as the repair and maintenance requirements.

⚠ WARNING!

- The driver assistance system is not suitable for the protection of persons according
 to the applicable safety standards for machines. The system therefore does not
 comply with safety standards.
- At all times the driver bears the full responsibility for safe operation, in particular for people who are in the hazardous zones of the vehicle.

2.2 General safety notes

- ▶ Please read this document through carefully and observe all the safety notes and information before doing any work on the driver assistance system.
- ▶ Only qualified persons from the relevant departments are permitted to work on the driver assistance system.
- ► Follow operating processes.
- ► Follow local regulations.
- ► Follow all local regulations relating to working with electrical components.
- ▶ Only authorized persons are permitted to use the driver assistance system.
- ▶ After commissioning, the driver assistance system must be checked regularly by the customer, specifically by the person responsible for the vehicle, to ensure that it is functioning correctly. The procedure is described in chapter 7.1.1 Function test.

System damage/transport damage

Damage to the individual components can lead to malfunctions of the system as a whole.

- ▶ Do not ignore any damage caused to system components during transport.
- ► In case of damage, contact SICK Service.

2.3 Requirements for the qualification of personnel

Only qualified persons with the relevant technical expertise are permitted to work on the driver assistance system.

- Qualified persons have the specialist training, skills, and experience, as well as knowledge of the relevant regulations and standards, to be able to perform work assigned to them and to identify and avoid any potential dangers independently.
- Electricians have the professional training, skills and experience, and knowledge of the relevant standards and provisions to work on electrical systems and to detect and avoid any potential dangers independently.

2.4 Warranty

No warranty claims will be accepted if:

- ▶ The safety notes and measures in this document are not observed.
- ▶ Parts or components of the driver assistance system have been installed, mounted or modified without authorization.
- ▶ The driver assistance system has been altered or modified.
- ▶ The software has been modified, customized, and/or tampered with without authorization.

2.5 **RoHS Directive**

This product has been designed for specific applications in large industrial systems according to Article 2 (4) e, RoHS 2011/65 / EU, and must therefore only be used in such systems.

The product is neither suitable nor approved for use outside of these systems. SICK therefore cannot provide any warranty or accept any liability whatsoever for such use.

2.6 Sources of danger

The driver assistance system is designed in a way that allows for safe operation. Protective devices reduce potential risks to the maximum possible extent.

WARNING!

RISK OF INJURY FROM LASER RADIATION

The TiM351 2D LiDAR sensor used in the driver assistance system conforms to laser class 1 (eye-safe) in accordance with EN 60825-1:2014.

The radiation emitted in normal operation is harmless to human skin and eyes if the following points are observed:

- ▶ Do not open the housing.
- Current national regulations regarding laser protection must be observed.

WARNING!

RISK OF INJURY DUE TO ELECTRICAL CURRENT

The driver assistance system is connected to the battery of the industrial truck.

Touching live devices, which may still be energized, can lead to death, burns or electrical shock.

- ▶ Only qualified specialist personnel are permitted to perform electrical work on the driver assistance system.
- ▶ Before working on electrical components, observe the five safety rules:
 - ▶ Disconnect.
 - Secure against being switched back on.
 - ► Ensure that there is no voltage.
 - Ground and short-circuit.
 - Cover or enclose live parts in the vicinity.

WARNING!

RISK OF INJURY DUE TO EQUIPOTENTIAL BONDING CURRENTS

Due to equipotential bonding currents, incorrect earthing can lead to the following dangers and faults: Voltage is applied to the metal housing, cable fires due to cable shields heating up, the product and other devices become damaged.

- ▶ Generate the same ground potential at all grounding points.
- Ground the equipotential bonding via the functional ground connection with a low impedance.

▲ WARNING!

RISK OF INJURY DUE TO SOUND PRESSURE

The signal light bar features a buzzer that can generate sound pressure of 75, 85 and 98 dB(A) at a distance of 1 meter.

- ► Wear hearing protection when the noise level is above LEX, 8 h=80 dB(A) (EU regulation) to reduce noise exposure and risk of hearing loss.
- Current national regulations regarding laser protection must be observed.

▲ WARNING!

RISK RESULTING FROM IMPROPER OPERATION

Improper installation and commissioning, damaged components, and unsuitable ambient conditions such as excessively cold or warm temperatures and high levels of dust, fog or spray, may cause faults and faulty alarms and may result in a complete system crash.

2.7 Warning symbols on the system components

Warning labels must not be removed or covered up. If labels are missing, these must be affixed. Damaged labels must be replaced.

Symbol	Meaning
^	Hazardous point warning
4	Hazardous electrical voltage warning
*	Laser beam warning

2.8 Mandatory symbols

Symbol	Meaning
(3)	Read document
	Use head protection
	Use foot protection
	Disconnect before maintenance or repairs

3 System description

The BAS (**B**ackup **A**ssistance **S**ystem) is a driver assistance system that monitors the blind spot behind a manned forklift truck or other industrial truck when reversing with reverse gear activated using one or two 2D LiDAR sensors, thus minimizing collisions.

Only objects which are visible in the measurement plane for the 2D LiDAR sensor are detected. Therefore, the 2D LiDAR sensor must have a free view of the area to be monitored.

3.1 Scope of delivery

The BAS driver assistance system distinguishes between two system variants with one or two TiM351 2D LiDAR sensors for each vehicle type (vehicles with electric motors or combustion engines).

The driver assistance system is designed for indoor and outdoor use.



Fig. 1: BAS scope of delivery for vehicles with electric motor and combustion engine

BAS for vehicles with electric motor

Quantity Part no.		Description		
	1117895	BAS3501-E11111		
1	1067299	TiM351 2D LiDAR sensor		
1	1115792	Control unit for connection to vehicles with electric motor		
1	1114219	Operable signal light bar with buzzer		
1	6045234	2D LiDAR sensor M12 connection cable, 12-pin, 5 m		
1	2096106	Signal light bar M12 connection cable, 8-pin, 5 m		
1	2086761	TiM351 2D LiDAR sensor mounting kit		
1	2122092	Mounting kit with screws and 2 RAM brackets		
OR				
	1117896	BAS3502-E11221		
2	1067299	TiM351 2D LiDAR sensor		
1	1115792	Control unit for connection to vehicles with electric motor		
2	1114219	Operable signal light bar with buzzer		
2	6045234	2D LiDAR sensor M12 connection cable, 12-pin, 5 m		
2	2096106	Signal light bar M12 connection cable, 8-pin, 5 m		
2	2086761	TiM351 2D LiDAR sensor mounting kit		
2	2122092	Mounting kit with screws and 2 RAM brackets		

BAS for vehicles with combustion engine

Quantity	Part no.	Description	
	1117897	BAS3501-C11111	
1	1067299	TiM351 2D LiDAR sensor	
1	1115791	Control unit for connection to vehicles with combustion engine	
1	1114219	Operable signal light bar with buzzer	
1	6045234	2D LiDAR sensor M12 connection cable, 12-pin, 5 m	
1	2096106	Signal light bar M12 connection cable, 8-pin, 5 m	
1	2086761	TiM351 2D LiDAR sensor mounting kit	
1	2122092	Mounting kit with screws and 2 RAM brackets	
OR			
	1117898	BAS3502-C11221	
2	1067299	TiM351 2D LiDAR sensor	
1	1115791	Control unit for connection to vehicles with combustion engine	
2	1114219	Operable signal light bar with buzzer	
2	6045234	2D LiDAR sensor M12 connection cable, 12-pin, 5 m	
2	2096106	Signal light bar M12 connection cable, 8-pin, 5 m	
2	2086761	TiM351 2D LiDAR sensor mounting kit	
2	2122092	Mounting kit with screws and 2 RAM brackets	

3.2 System components

3.2.1 TiM351 2D LiDAR sensor



Fig. 2: Scan plane of the TiM351

Features

- One or two 2D LiDAR sensors detect their surroundings by scanning them twodimensionally using the time-of-flight method.
- To do so, a laser beam is emitted, and a moving mirror is used to guide it in the required direction.
- The laser beam is emitted through the front screen. The scan plane position is indicated by a housing marking next to the front screen.
- When the laser pulse hits an object, it is reflected and sent back to the receiver of the 2D LiDAR sensor.
- By calculating the time difference between sending and receiving and the signal strength, the position of the object is detected with millimeter precision and forwarded to the internal field evaluation unit of the 2D LiDAR sensor.

Function

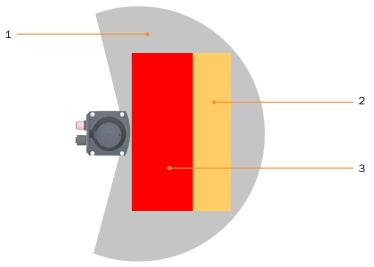


Fig. 3: Monitored area of the 2D LiDAR sensor and monitoring fields

Legend

- 1 Monitored area of the 2D LiDAR sensor
- 2 Monitoring field of the "Warning field" type
- 3 Monitoring field of the "Stopping field" type
- The environment is monitored in a radius of up to 8 m (at 10% remission), starting from the 2D LiDAR sensor. This is the area the 2D LiDAR sensor "sees".
- This monitored area is divided into so-called monitoring fields.
- A distinction is made between monitoring fields of type Warning field 1 and Warning field 2 (=stopping field).
- The size and geometry of the monitoring fields can vary and must be parameterized onsite.
- Each monitoring field is linked to an evaluation case, which is assigned to a switching output of the 2D LiDAR sensor.
- If an object is detected within a monitoring field, the assigned switching output is triggered.
- The output signal is transferred to the control unit of the driver assistance system and processed there accordingly.

NOTES

- If an object is detected in **warning field 2** (=**stopping field**), the system does not stop the vehicle.
- The driver only receives an acoustic and visual signal to initiate braking of the vehicle.

3.2.2 Signal light bar with buzzer



Fig. 4: Signal light bar with buzzer

Legend

- 1 Light fields
- 2 Beeper

Features

- Signal light bar with bright light fields and integrated buzzer.
- Each 2D LiDAR sensor is connected to its own signal light bar via the control unit.

Function

- Optical and acoustic signaling in the event of object detection within the monitoring fields.
- If an object is detected within **warning field 1** (**=warning**), the yellow LED lights up and a warning tone is audible.
- If an object is detected within **warning field 2** (=**stopping field**), the red LED lights up and a continuous tone is audible.

3.2.3 Control unit



Fig. 5: Control unit with power supply unit and printed circuit board assembly

Legend

- 1 Housing with mounting plate
- 2 Cables leading out of the housing for connecting the control unit to the industrial truck
- 3 M12 round connector for connecting the system components

Features

- Control unit with printed circuit board assembly and integrated power supply unit.
- · Installed near the seat of the vehicle.

TRANSLATION OF AN ORIGINAL OPERATING INSTRUCTIONS | Backup Assistance System

- Connection to the voltage supply and the reverse signal of the industrial truck.
- Connection of the individual system components.

Function

- Main control unit of the driver assistance system.
- Provides the voltage supply for all connected system components.

NOTE! Different power supply units are available for vehicles with different electrical systems.

- Processes the incoming signals of the connected 2D LiDAR sensors and outputs the processing result to the associated signal light bar via I/O signal.
- Also evaluates the vehicle signal for reverse when reverse gear is activated.

NOTE! Result processing is only forwarded when the reverse gear of the industrial truck is activated.

3.3 Operating principle



Fig. 6: Monitoring principle

Monitoring principle

- One or two 2D LiDAR sensors mounted on the industrial truck continuously monitor the area behind the vehicle when the reverse gear is activated.
- Depending on the mounting position, monitoring of the side area is also possible.
- With the factory setting, the monitored area scanned by the 2D LiDAR sensor is divided into the two **Warning** and **Stop** monitoring fields.
- The size and geometry of the monitoring fields can vary and must be parameterized correspondingly during commissioning.
- Each monitoring field is assigned to a switching output of the 2D LiDAR sensor.
- When an object is detected in a monitoring field, the switching signal is passed on to the control unit.
- The control unit processes the incoming signals from the 2D LiDAR sensor and signals
 corresponding results such as "object detection within the warning field" or "object
 detection within the stopping field" to the optical and acoustic signaling devices.

NOTE!

- To avoid false alarms, the signals from the 2D LiDAR sensor are only taken into account when the vehicle is **reversing** (with **reverse gear activated**).
- If an object is detected in **warning field 2** (=stopping field), the system does not stop the vehicle.
- The driver only receives an acoustic and visual signal to initiate braking of the vehicle.

Signaling - reverse

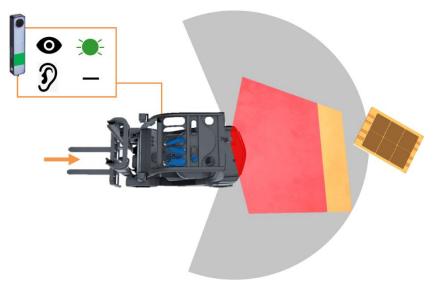


Fig. 7: Signaling of reverse movement

- When reverse gear is activated, signaling is active.
- In the figure above, the object is detected by the 2D LiDAR sensor, but there is no object detection within the defined monitored areas.
- The signal light is green, there is no acoustic signal.

Signaling - "object detection in warning field"

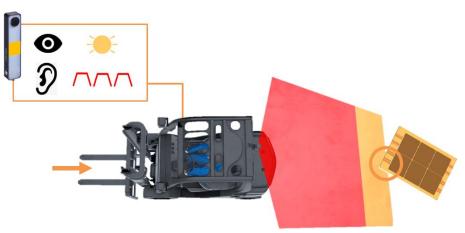


Fig. 8: Signaling of "object detection in warning field"

- If an object is detected in the warning field, the signal light bar lights up yellow.
- In addition, a pulsing warning tone is active.

Signaling -"object detection in stopping field"

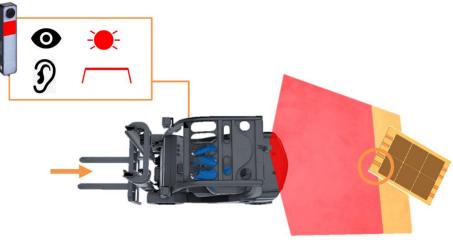


Fig. 9: Signaling of "object detection in stopping field"

- If an object is detected in the **stopping field**, the signal light bar lights up **red**.
- In addition, a **constant warning tone** is activated.

Monitoring with 2 sensors

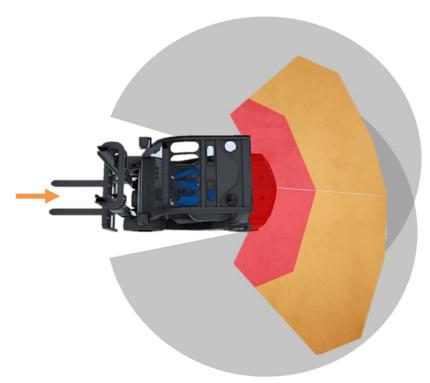


Fig. 10: Monitoring with two 2D LiDAR sensors

- Each 2D LiDAR sensor has its monitored area with the warning and stopping fields configured in it.
- The monitoring fields may overlap.

• Object detection in a monitoring field is signaled by the signal light bar associated with the 2D LiDAR sensor.

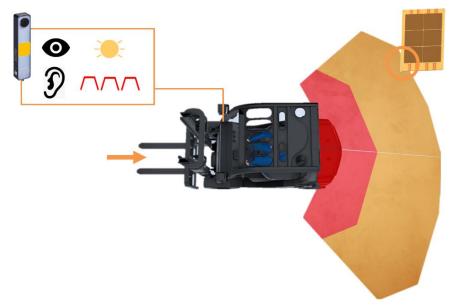


Fig. 11: Signaling of "object detection in one of the two warning fields"

• If the object is detected in an overlapping area of both 2D LiDAR sensors, signaling is performed by both signal light bars.

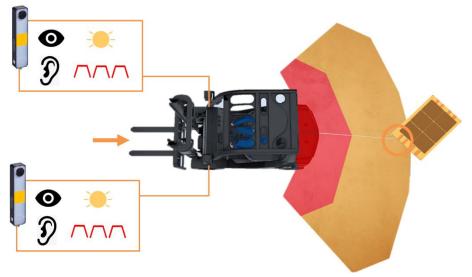


Fig. 12: Signaling "of" object detection in both warning fields"

NOTE! When reversing, both signal light bars light up green.

3.4 **Status indicators**

The BAS driver assistance system uses two LEDs of the 2D LiDAR sensor to signal the operational status.



Fig. 13: Status indicators of the TiM351

Status indicators

LED A	LED ► (green)	Status	Used in BAS
	•	Device ready/monitoring mode	Yes
•	•	Object detection field / fields	Yes
	***	Teach-in - start	No
•	•	Teach-in - end of pre-warning phase 60 second teach-in phase	No
	***	Teach-in - completion of teach-in phase	No
`		Error	Yes
		Device without supply voltage	Yes

Status displays Tab. 1:

Teach-in display

LED A	LED ► (green)	Status	Used in BAS
	*	Field contour teach-in – start LED flashes slowly (0.5 Hz)	No
		Field contour teach-in - pre-warning phase LED flashes increasingly rapidly within 15 s	
•	•	Field contour teach-in - teach-in phase 60 seconds	No
	```	Field contour teach-in - completion of teach-in phase LED flashes increasingly rapidly within 15 s	No
	•	Automated return to monitoring mode All fields free	Yes
•	•	Monitoring mode If an object is detected	Yes

Progress of teach-in of the field contour

Field set factory settings - switching inputs

Field	Switching inputs				Field shape, default size of
set	IN 1	IN 2	IN 3	IN 4	field 1
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

L = length, W = width

For the BAS driver assistance system, using field set 9 is mandatory (see chapter <u>6.3.1 Opening field set with monitoring fields</u>).

Tab. 3: Field set factory settings - switching inputs

 $[\]ensuremath{^{\star}}$ Default setting, starting shape can be modified as required

4 Mounting

All transport, assembly, mounting, and electrical installation work must only be carried out by qualified persons.

Qualified persons have the specialist training, skills, experience and knowledge of the relevant regulations and standards needed to be able to perform work assigned to them and to identify and avoid any potential dangers independently.

4.1 Function test before mounting

- ▶ Before mounting the system components on the industrial truck, check the functional readiness of the devices.
- ▶ To do this, place components on a table
- ► Connect components according to the wiring overview in chapter <u>5 Electrical</u> <u>installation</u>.
- ► Establish the supply voltage and check the general operational readiness of the components (see chapter 6.1 System start-up).

NOTE! Before mounting, check the required lengths of cable and adjust them if necessary. Cables may only be shortened, not extended!

4.2 Mounting the 2D LiDAR sensor

4.2.1 General notes for mounting

Reliable and problem-free operation of the system depends primarily on the proper mounting and alignment of the 2D LiDAR sensor.

Tips on mounting position

- ► Select the mounting position so that the 2D LiDAR sensor is protected from dirt, mechanical damage and direct sunlight (risk of overheating) or other light sources.
- ► Ensure that the field of view of the entire front screen is not restricted. The 2D LiDAR sensor must always have a clear view of the scanning area.
- ▶ Avoid exposing the 2D LiDAR sensor to excessive shock and vibration.
- ► For systems that vibrate heavily, use shock absorbers to prevent the possibility of fixing screws unintentionally coming loose.
- ▶ Select the mounting position so that the connectors can be attached and removed.

NOTE! If the BAS is used in outdoor areas, protecting the 2D LiDAR sensor against direct sunlight and other environmental influences with a weather protection housing is recommended.

Laying cables before installation

- Depending on the installation situation of the 2D LiDAR sensor, it is possible that the connections are not accessible or are hardly accessible after the final installation.
- In this case, we recommend laying and connecting the cables before installation of the 2D LiDAR sensor.

Recommended mounting positions

All mounting positions are located on the rear of the industrial truck.

- Top mounting position (1 sensor solution)
- Mounting position on top and bottom for additional blind spot coverage (2 sensor solution)
- Mounting position on right and left for side cover (2 sensor solution)

NOTE The illustrations shown below are examples of mounting. The driver assistance system also allows for other very flexible mounting positions.

4.2.2 Top mounting position



Fig. 14: Mounting position of the 2D LiDAR sensor - top

Mounting position

- If only one 2D LiDAR sensor is used, it must be mounted as centrally as possible on the vehicle so that the monitoring fields cover the area behind the vehicle on both sides.
- The laser output is towards the back when viewed from the vehicle cab.

Mounting height and tilt angle



Fig. 15: Correctly setting the tilt angle of the top-mounted 2D LiDAR sensor

Legend

- 1 Laser beam (monitored area)
- 2 Monitoring field
- 3 Distance between monitoring field and ground
- The tilt angle must be adjusted depending on the mounting height and scanning range of the 2D LiDAR sensor.
- The field of vision of the 2D LiDAR sensor must not be restricted by components on the vehicle (e.g. the counterweight of the manned forklift truck).
- As the monitoring fields are tilted downwards, care must be taken to ensure that the field boundaries do not impact on the ground in advance due to vehicle movements and causing false alarms.
- ► The 2D LiDAR sensor must be aligned so that the measurement plane hits the ground at a sufficient distance.
- ► The distance between the end of the monitoring field and the ground should be observed.

Tilt angle too steep



Fig. 16: Tilt angle of the 2D LiDAR sensor too steep

- ▶ Do not select a tilt angle that is too steep.
- Otherwise the distance from the vehicle is too small and the driver will not have sufficient time to react appropriately if objects are detected.

Inclination angle too flat



Fig. 17: Tilt angle of the 2D LiDAR sensor too flat

- ▶ Do not select a tilt angle that is too flat.
- If the laser beam does not strike the ground, as shown in the figure above, smaller objects located behind the vehicle may not be detected when reversing.

Notes on correct adjustment

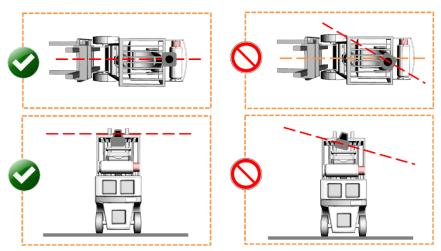


Fig. 18: Correct alignment of the 2D-LiDAR sensor in the top mounting position

- ▶ Make sure that the 2D LiDAR sensor is not mounted in a tilted position.
- The 2D LiDAR sensor is correctly aligned when the measurement plane of the 2D LiDAR sensor is **parallel to the vehicle axis** and **parallel to the ground**.

4.2.3 Top and bottom mounting position



Fig. 19: Additional mounting position of a second 2D LiDAR sensor - bottom

Mounting positions

- The 2D LiDAR sensor mounted centrally at the top can be supplemented by another 2D LiDAR sensor.
- The mounting position of this 2D LiDAR sensor is ideally at the bottom on the counterweight of the industrial truck.
- Recesses in the counterweight of the industrial truck can be used for mounting. This
 mounting position provides additional protection of the 2D LiDAR sensor from damage.
- The beam exit of the lower 2D LiDAR sensor is horizontal to the rear.

Advantage



Fig. 20: Elimination of blind spot by second 2D LiDAR sensor

- The monitored area can be expanded by a second 2D LiDAR sensor. This provides blind spot coverage compared to a single sensor solution.
- In addition, objects protruding into the monitored area, such as tables or overhangs, are detected by the lower 2D LiDAR sensor.

4.2.4 Right and left mounting position

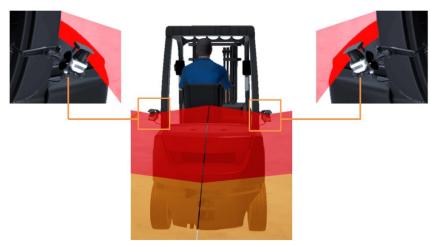


Fig. 21: Mounting of two 2D LiDAR sensors on the side struts of the driver's cage

Mounting positions

- The mounting position on the two sides of the driver's cage is an alternative to the top and bottom mounting positions.
- Just like with the top mounting position, the tilt angle should not be too flat and not too steep.

Advantage



Fig. 22: Monitoring the rear area as well as the side areas

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- Due to a slightly lateral alignment of the 2D LiDAR sensors, monitoring of the lateral areas is performed in addition to monitoring of the rear area.
- This is advantageous when maneuvering the vehicle in tight and low-visibility spaces.

4.2.5 Using SICK mounting kit



Fig. 23: SICK mounting kit with weather protection housing

Legend

- 1 Adapter plate
- 2 Mounting bracket
- The TiM351 2D LiDAR sensor is supplied with a mounting kit to match the device type.
- This U-shaped mounting kit acts as a bracket with impact protection.
- It comprises a mounting bracket and a mounting plate for mounting and fine adjustment of the 2D LiDAR sensor.

Mounting TiM351 on adapter plate

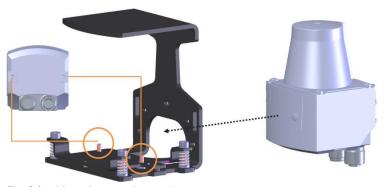


Fig. 24: Mounting on adapter plate

- ► Fasten the 2D LiDAR sensor to the adapter plate using the two M3 x 8 screws.
- ► Insert the screws from below through the hole in the mounting bracket and the hole in the adapter plate.

NOTE! With its rotatable connector unit, the TiM351 offers greater flexibility and space for installation.

WARNING!

RISK OF DAMAGE TO THE CONNECTOR

► Turn the swivel connector unit with the electrical connections max 180° from end position to end position.

Aligning sensor



Fig. 25: Aligning 2D LiDAR sensor

- ▶ Align the scan plane by means of the three cheese-head screws.
- ► After adjustment, lock the adapter plate against the mounting bracket by means of the two studs.

Mounting the mounting bracket on the attachment mechanism of the industrial truck

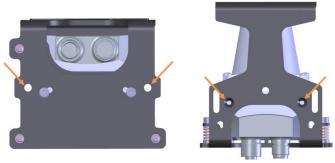


Fig. 26: Mounting the mounting bracket on the attachment mechanism of the industrial truck

- ► Fasten the mounting bracket horizontally or vertically to the attachment mechanism of the industrial truck.
- The mounting bracket has two holes with a diameter of 4.3 mm on the bottom and rear sides

NOTE! The attachment mechanism of the industrial truck must ensure the required tilt angle of the 2D LiDAR sensor.

Mounting kit



Fig. 27: Mounting kit

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- ▶ Use the supplied mounting kit to screw on the mounting bracket.
- The kit consists of screws, nuts and washers as well as the two RAM MOUNT brackets and a RAM MOUNT socket arm (see the following chapter <u>4.2.6 Installation with RAM MOUNT universal mounts</u>).

4.2.6 Installation with RAM MOUNT universal mounts

As an alternative or supplement to the mounting kits of the 2D LiDAR sensor, universal mounting kits such as the RAM MOUNT can also be used for installation.

RAM MOUNT

- RAM MOUNT is a universal and solid mounting system for special brackets.
- It uses ball joints in various sizes that are joined together with fasteners to form a complete retainer system that can be very flexibly adjusted.
- The joints can be moved and easily adjusted when the fixing screw is loosened.
- The bracket is fixed in its set position as soon as the fixing screw is tightened.

Combination of RAM MOUNT/
SICK mounting kit



Fig. 28: Example of mounting with RAM MOUNT universal brackets

Legend

- 1 2D LiDAR sensor mounting plate
- 2 RAM MOUNT bracket
- 3 RAM MOUNT socket arm
- 4 RAM MOUNT clamp base
- 5 Mounting position on the industrial truck
- ► First mount the 2D LiDAR sensor on the SICK mounting kit (see above).
- ▶ Mount RAM MOUNT bracket RAM-B-238 to the back of the TiM mounting kit.
- ▶ Mount RAM MOUNT bracket to a RAM MOUNT socket arm.
- ► Clamp socket arm to a suitable RAM MOUNT clamp base.
- ▶ Then fasten the clamp base to the side strut of the driver's cage, for example.

The following RAM MOUNT fasteners can be purchased from SICK.

Image	Part no.	Туре	Description			
Mounting b	rackets and plat	es	·			
2	5333533 *	RAM-B-238U Mount for sensor (1" ball)	Mount for connection with the TiM mounting bracket at the socket arm.			
	* Included wi	th delivery				
P 9	5333546	RAP-S-KNOB3U Security knob	Security knob for socket arms			
Clamp and	alignment brack	ets	'			
	5333534	RAM-B-201U-A 2.38" socket arm (1" ball)	2.38" socket arm (1" ball)			
A	5333535	RAM-B-201U 3.69" socket arm (1" ball)	3.69" socket arm (1" ball)			
	5333536 *	RAM-B-201U-C 6" socket arm (1" ball)	6" socket arm (1" ball)			
40	* Included wi	ncluded with delivery				
0 6	5333537	RAM-B-230 Short 1" ball adapter	Short 1" ball adapter for lengthening the socket arm			
Universal c	lamping systems					
	5333542	RAM-B-247U-2 2" clamp base, 3" studs (1" ball)	2" clamp base, 3" studs (1" ball) for connecting socket arm and protective roof			
	5333541	RAM-B-247U-25 2.5" clamp base, 3" studs (1" ball)	2.5" clamp base, 3" studs (1" ball) for connecting socket arm and protective roof			
	5333540	RAM-B-247U-3 3" clamp base, 3" studs (1" ball)	3" clamp base, 3" studs (1" ball) for connecting socket arm and protective roof			
	5333539	RAM-B-247U-4 4" clamp base, 3" studs (1" ball)	4" clamp base, 3" studs (1" ball) for connecting socket arm and protective roof			
00	5333545	RAM-B-108BU Ring-shaped e 1/2" to 2" clamp base	Ring-shaped 1/2" to 2" clamp base for connecting socket arm and protective roof			

Tab. 4: RAM MOUNT universal mounts for BAS

4.3 Mounting the control unit

4.3.1 Important notes for mounting

Maximum ambient temperature

- The maximum ambient temperature for the control unit is +65 °C (149 °F) for systems with two sensors and +70 °C (158 °F) for systems with one sensor.
- ▶ **NOTE** Ensure that all system components (especially sensor, control unit, cable) do not touch hot surfaces during installation and operation.

Cable	Permitted cable temperature
Voltage supply / Reverse signal	-25 °C +90 °C

Fuse

• The power for the BAS control unit must be connected at the fuse panel of the manned forklift truck with a fuse rated at 4 amperes.

Permitted lengths of cable

Cable	Permitted lengths of cable
Voltage supply	max. 3 m
Reverse signal	max. 3 m
Sensor and signal light bar	max. 5 m each

4.3.2 Mounting



Fig. 29: Mounting the control unit on the driver's seat

- ► Securely fasten the control unit to the frame of the manned forklift truck or to another solid surface.
- ▶ Use four M5 or #10 screws or bolts (not supplied) for this purpose.
- ▶ Use outer toothed washer on the screw or bolt to break through the painted surface of the mounting plate and make a metal connection to the metal frame.
- ▶ Mount the control unit on the vehicle with all cables protected from external damage.

NOTE Ensure that the connections on the control unit are easily accessible after mounting.

4.4 Mounting signal light bar

4.4.1 Notes on mounting



Fig. 30: Mounting the signal light bar(s) in the driver field of vision

General

- ► In general, install signal light bar(s) with buzzer within the driver field of vision in the driver's cab.
- ► Ensure that the connection on the signal light bar can be easily reached after mounting. Otherwise, connect the signal light bar <u>before</u> mounting (see <u>5.3 Connecting signal light bar</u>).

Fastening methods

- · Screw on.
- · Fasten with adhesive tape.
- Fasten with metal strip.

4.4.2 Screwing on signal light bar

The signal light bar has four M5 holes on the back.



Fig. 31: Tightening the signal light bar

- ► Mount the lamp with suitable screws.
- ► Select the tightening torque according to the screws used. The housing of the rail is made of aluminum alloy.

4.4.3 Adhering signal light bar

The scope of delivery includes VHB industrial adhesive tape.

- ► Clean the surface of the back of the housing and dry it well.
- ► Position the adhesive tape and stick the first side of the tape to the surface of the housing.

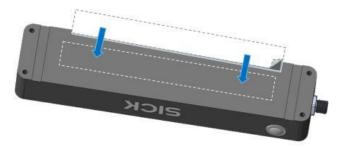


Fig. 32: Sticking adhesive tape to signal light bar

► Now peel off the second side of the tape and stick it firmly to the desired mounting surface.



Fig. 33: Sticking adhesive tape to mounting surface

4.4.4 Fastening signal light bar with metal strip

The scope of delivery includes a self-securing strap with metal strip holder.

- ▶ Position the metal strip holder behind the device.
- ► Screw on the metal strip holder clockwise using the 4x M5 screws included with delivery. Use a 3 mm Allen key for this purpose.

NOTE The recommended applied tightening torque is 3.5 Nm.



Fig. 34: Screwing down metal strip holder

Position rubber pad to protect the metal strip holder.

Feed the self-securing strap through the metal strip holder and secure it with sufficient force (minimum 100 N, maximum 450 N).

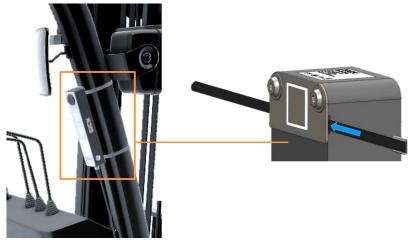


Fig. 35: Passing the self-securing strap through the metal strip holder and securing it

▶ **NOTE** If necessary, shorten the length of the self-securing strap (2 x 520 mm) by cutting off the protruding end.

5 Electrical installation

All electrical work may only be performed by qualified persons.

- Qualified persons have the specialist training, skills, experience and knowledge of the relevant regulations and standards needed to be able to perform work assigned to them and to identify and avoid any potential dangers independently.
- Electricians have the professional training, skills, experience and knowledge of the relevant standards and provisions needed to work on electrical systems and to detect and avoid any potential dangers independently.

A DANGER!

RISK OF INJURY DUE TO ELECTRICAL CURRENT

Injury or death from electrical voltage

- ▶ Work on electrical systems must only be performed by qualified electricians.
- ► The power supply must be disconnected when attaching and detaching electrical connections.
- ► Only connect to a voltage source which meet the requirements in the operating instructions.
- ► Safety requirements relating to work on electrical systems must be observed and complied with.
- ▶ National and regional regulations must be complied with.

WARNING!

▶ Disconnect the system from the power supply before carrying out installation or maintenance work.

5.1 Connection overview

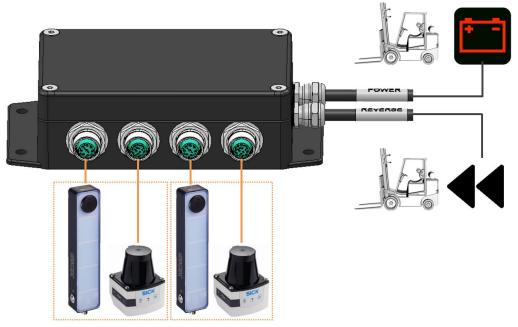


Fig. 36: Connection overview

Connections to be made

Make connections in the following order:

- ► Connect the 2D-LiDAR sensor(s) to the control unit using the 5 m cable included with delivery.
- ► Connect the signal light bar(s) to the control unit using the 5 m cable included with delivery.
- ► Connect the control unit to the fuse panel or to the control cabinet of the vehicle.

 The connection is made via the two 3 m-long cables leading out of the control unit housing.

Notes on routing the cables

The components are always connected starting from the control unit:

▶ Then pull the cables to the component to be connected.

5.2 Connecting the 2D LiDAR sensor

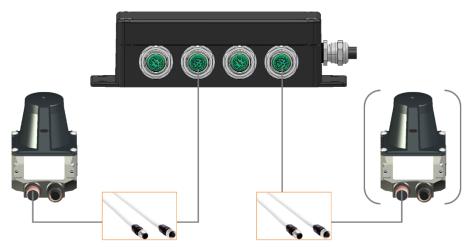


Fig. 37: Connecting 2D LiDAR sensor(s) to control unit

Connection notes

- The 2D LiDAR sensor(s) is/are connected to the control unit via a 12-pin connecting cable with two M12 round connectors.
- The cable is used for supplying voltage and for signal transmission of the digital inputs and outputs.

Creating a connection

- ▶ Screw the M12 round connector of the connecting cable to the control unit as shown.
- ▶ Run the connecting cable from the control unit to the 2D LiDAR sensor.
- Screw the M12 round connector on the TiM351 2D LiDAR sensor onto the Power/ I/O female connector.

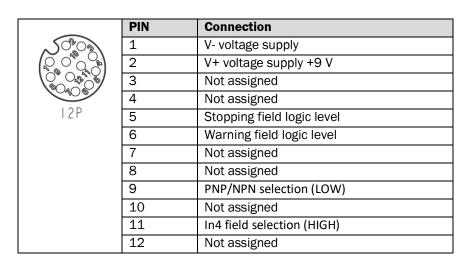
NOTE! With this rotatable connector unit, the TiM351 offers greater flexibility and space for installation.

AWARNING!

RISK OF DAMAGE TO THE CONNECTOR

► Turn the swivel connector unit with the electrical connections max 180° from end position to end position.

Pin assignment



5.3 Connecting signal light bar

5.3.1 Creating a connection

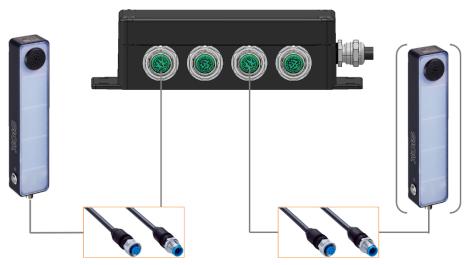


Fig. 38: Connecting signal light bar(s) to the control unit

Connection notes

- The signal light bar(s) is/are connected to the control unit via an 8-pin connecting cable with two M12 round connectors.
- The cable is used for supplying the voltage and for signal transmission.

Creating a connection

- ▶ Screw the M12 round connector of the connecting cable to the control unit as shown.
- ► Run the connecting cable from the control unit to the signal light bar.
- ► Screw M12 round connector onto signal light bar.

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Pin assignment

	PIN	Connection
	1	Buzzer
	2	Not assigned
	3	Green
706	4	GND
8P	5	+24 V DC
	6	Yellow
	7	Not assigned
	8	Red

5.3.2 Adjusting volume and brightness



Fig. 39: Adjusting volume and brightness

Volume button

- The signal light bar has sequential sound level adjustment.
- The sound level after initial switch-on is 75 dB (at a distance of one meter). It can be increased to 85 and 98 dB in steps.
- As soon as the volume button is pressed, the buzzer sounds for approx. 1 second (and indicates the selected volume level).

NOTE When changing the volume, acoustic feedback is given for 1 second. In the operational status (acoustic signal ON), there is no such acoustic feedback.

Brightness button

- The signal light bar has the two brightness levels, **High** and **Low.**
- By default, the highest brightness level is activated.
- As soon as the brightness button is pressed, all light fields are switched on for approx.
 1 second (and indicates the selected brightness level).
- The optical display cannot be switched off.
- The difference between the lowest and the highest brightness level is about 55%.

5.4 Connecting control unit to industrial truck

A DANGER!

RISK OF INJURY DUE TO ELECTRICAL CURRENT

Injury or death from electrical voltage

- ▶ Work on electrical systems must only be performed by qualified electricians.
- ► The power supply must be disconnected when attaching and detaching electrical connections.
- ▶ Only connect to a voltage source which meet the requirements in the operating instructions.
- ► Safety requirements relating to work on electrical systems must be observed and complied with.
- ▶ National and regional regulations must be complied with.

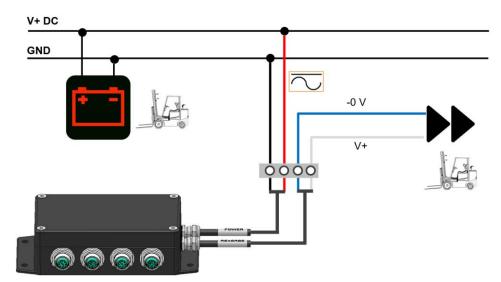


Fig. 40: Connecting control unit to industrial truck

NOTE The complete voltage range depends on the respective system variant (for vehicles with electric motor: 24 V - 72 V; for vehicles with combustion engine: 12 V - 24 V).

POWER cable

► Route the POWER cable to the fuse panel.

NOTE The system requires a 4 A fuse.

► Connect the wire ends as follows.

Wire color	Connection
Red	+ V DC
Black	- V DC

REVERSE cable

▶ Route the REVERSE cable to the vehicle control cabinet.

NOTE The system requires a minimum voltage of 9 V as a reverse signal.

► Connect the wire ends as follows.

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Wire color	Connection	
White	+ signal for reverse	
Blue	- signal for reverse	

6 Commissioning

Commissioning may only be performed by qualified persons.

- Qualified persons have the specialist training, skills, experience and knowledge of the
 relevant regulations and standards needed to be able to perform work assigned to
 them and to identify and avoid any potential dangers independently.
- Electricians have the professional training, skills, experience and knowledge of the relevant standards and provisions needed to work on electrical systems and to detect and avoid any potential dangers independently.

6.1 System start-up

All system components are automatically launched when starting the vehicle. The system is ready for operation after approximately 30 seconds.

Operational readiness of 2D LiDAR sensor



Fig. 41: Reading the operational readiness on the 2D LiDAR sensor

- After the supply voltage is switched on, the TiM351 initializes and the green LED lights up to indicate its operational readiness.
- The 2D LiDAR sensor begins its readiness to measure automatically.

6.2 Preparing configuration

6.2.1 Installing SOPAS on the configuration PC

Commissioning is performed using the SOPAS ET configuration software, which is installed on a connected PC.

- ► Download the latest version of SOPAS at <u>www.sick.com</u> and save it on the configuration PC
- ▶ Start installation by double-clicking the exe file.
- ► Click **OK** to select a user language for the wizard. The setup wizard opens.
- ► Follow the setup wizard.



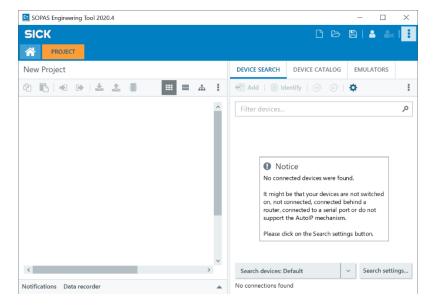
✓ Perform the installation.

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6.2.2 Launching SOPAS

► Start SOPAS using the desktop icon or the Windows Start menu.

A new **project** is automatically created in SOPAS. One or more devices are combined and edited in a single project.



6.2.3 Connecting 2D LiDAR sensor to configuration PC

The 2D LiDAR sensor(s) are connected to the configuration PC via a USB cable.



Fig. 42: Connecting 2D LiDAR sensors to configuration PC (USB)

▶ Open the black plastic cover with the screwdriver included with delivery. The micro USB female connector of the TiM351 is now accessible.

NOTE! Protect the TiM351 from moisture and dust when the USB female connector is open. The black plastic cover must be screwed flush in order to comply with enclosure rating IP 67 in operation.

Connect the 2D LiDAR sensor to a free USB female connector on the configuration PC using a suitable shielded high-speed USB cable. The USB device will be automatically detected by the PC.

NOTE! When the sensor is connected to the configuration PC for the firsts time, the USB drivers used by the sensor will be installed on the PC.

The Install device driver message appears in the status bar of the screen window.

► Successful installation of the device driver software is confirmed with a corresponding note in the status bar.

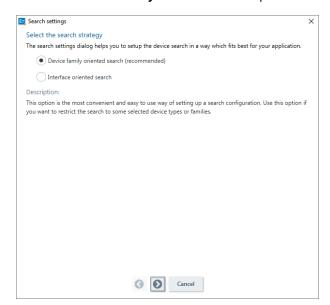
Establishing USB connection before SOPAS installation

If the USB connection is established <u>before</u> SOPAS is started, the SOPAS configuration software is started automatically. Connection to the 2D LiDAR sensor is automated.

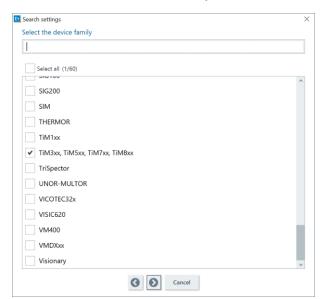
▶ In this case, skip the following chapter and proceed directly to chapter <u>6.2.5 Loading</u> <u>device drivers into the SOPAS project</u>.

6.2.4 Starting the device search

- ► Click the **Search settings** button. The connection wizard helps you establish a connection to a connected device.
- ▶ Select the **Device family oriented search** option and confirm with **Next**.

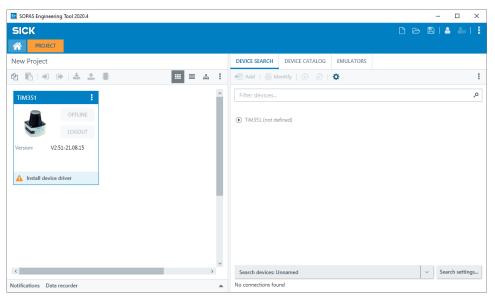


▶ Restrict list to TiMxxx device family and confirm with Next.



► Confirm the configuration of the search settings with **Next** and complete with **Finish**.

The connected 2D LiDAR sensor(s) are detected and added to the SOPAS project. The added sensor is shown in the left area of the window as a device tile.



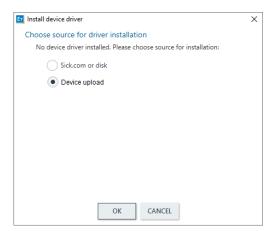
NOTE! Where applicable, a message window will appear indicating that the device driver for the 2D LiDAR sensor is not yet known in the SOPAS project.

6.2.5 Loading device drivers into the SOPAS project

- ► Confirm the message with **OK**.
- ► Click Install device driver in the tile.



▶ Install device drivers depending on the connection variant.



• Default: Select Sick.com or disk option.

When connected to the device via a USB cable, the latest drivers are loaded and installed directly from <u>sick.com</u>. For this to happen, the configuration PC must have an Internet connection.

- **Optional**: When connected to the device via an Ethernet cable, the drivers can also be loaded directly from the device.
- ► Click **OK** to confirm. The device drivers are installed. The 2D LiDAR sensor will now be detected by the configuration PC.
- ▶ It is not yet connected to the system, however, i.e. still **offline**.



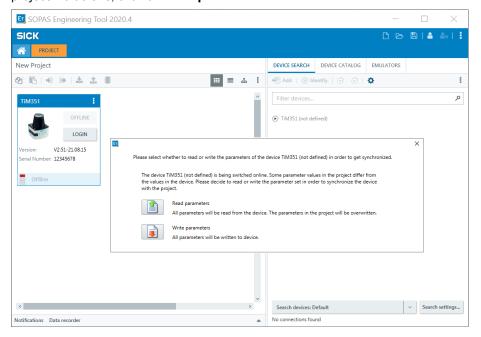
6.2.6 Setting 2D LiDAR sensor online

By connecting the SOPAS project and the 2D LiDAR sensor, parameters and configuration data of the 2D LiDAR sensor can be read into the SOPAS project or written from SOPAS to the 2D LiDAR sensor.

During the initial commissioning, the standard parameters saved on the 2D LiDAR sensor at the factory are transferred to the SOPAS project and then adapted to the requirements of the relevant application there.

Setting 2D LiDAR sensor online

- ► Click **Offline** in the tile.
- ► Synchronize the 2D LiDAR sensor's device data with the device data of the SOPAS project. To do this, click on **Read parameters**.



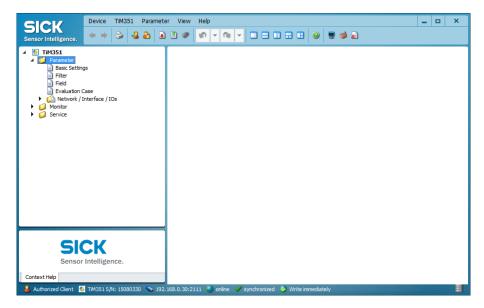
- ► The standard parameters are transmitted from the 2D LiDAR sensor into the SOPAS project. These parameters are then adapted to the customer requirements in SOPAS.
- ▶ Online appears in the tile. The LED lights up green.



6.2.7 Opening configuration interface

- ► Double-click on the device tile.

 All configurable parameters of the device are compiled together in a corresponding device description for the SOPAS configuration software.
- ► Use the tree structure to open the functional areas of the configuration. Click on the plus sign to expand the tree.



NOTE! Depending on the SOPAS version, individual contents of the dialog window and their position could deviate. The general operation of the device parameters is the same, however.

6.2.8 Logging into the 2D LiDAR sensor



▶ In the SOPAS toolbar, click on the icon with the three dots and select **Device** → **Login**.



- ▶ Select **Authorized client** user level and enter the default password **client**.
- ✓ Confirm with login.

The parameters that were previously grayed out on the tabs are now accessible.

6.3 Adapting the geometry of the monitoring fields

6.3.1 Opening field set with monitoring fields

The BAS driver assistance system is delivered with all required monitoring fields. The monitoring fields are already created on the 2D LiDAR sensor. Each field has a fixed assignment to a switching output.

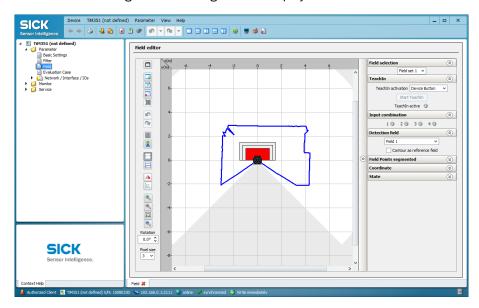
Only the geometries and positions of these fields have to be adapted to the conditions on site. This adaptation can be carried out using the SOPAS configuration software.

NOTE! When connecting two 2D LiDAR sensors, the geometry of the monitoring fields must be configured separately for each sensor.

► Click on the following entry in the SOPAS project tree:

TiM351 \rightarrow Parameters \rightarrow Evaluation fields.

The editor for editing the monitoring fields is displayed.

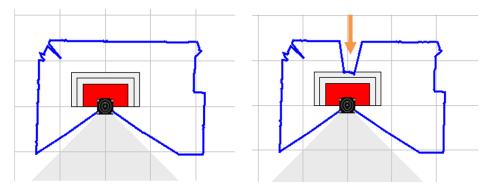


- The 2D LiDAR sensor and the scan lines of the surrounding contour scanned by the sensor are visible in the center area.
- The gray area depicts the area that is not scanned by the sensor. Scanning by the TiM351 takes place in a sector of 270°.
- On the right side, the field set with the contained monitoring fields is selected for editing. When the window is opened for the first time, the monitoring fields of field set 1 are displayed.
- There is a toolbar on the left that allows you to adjust the display area and edit the monitoring fields.

Displaying scan lines

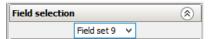


- Click on the **Display scan line** icon in the toolbar if the scan lines of the 2D LiDAR sensor are not displayed.
- The scan lines of the surrounding contour scanned by the 2D LiDAR sensor are now displayed. The scan lines are determined by the individual measuring points of the 2D LiDAR sensor. Measuring points are generated wherever a laser beam hits an object.
- Using the scan lines, you can adapt the size of the monitoring fields so that they correspond better to the scanning range of the 2D LiDAR sensor.



- ▶ Check representation. Do this by placing an object in the measuring range and then checking the result on the screen.
- ► Check that the scan line moves with the object and correctly reflects the changed surrounding contour (arrow).

Selecting field set



- ▶ In the **Field selection** area, select field set 9. This field set is relevant for the BAS driver assistance system.
- The predefined fields for the driver assistance system are now visible in the scan range. The stopping (field 1) is located on the very inside. It is activated after selection of the field set and is shown in red.
- The stopping field is surrounded by the larger warning field. The external third field is not used by the driver assistance system.

ATTENTION!

FIELD SET 9 MUST BE SELECTED.

▶ The selection of field set 9 is absolutely necessary for proper functioning of the driver assistance system.

6.3.2 Adjusting the display view

► Adjust the spatial situation on the screen so that the scan lines and the geometry of the monitoring fields can be easily recognized.

NOTE! The view of the scanned area is not saved. You must repeat the setting whenever SOPAS is restarted. The same applies if you switch to a different window.

Zooming in/zooming out the display area



- ► Enlarge or reduce the display area with zoom functions. To do this, click on one of the two icons. The mouse cursor is now a magnifying glass icon.
- Click in the display area. Every click of the mouse causes the display to zoom in or zoom out.

NOTE! Zooming in/zooming out always originates at the position of the mouse cursor.

Click on the magnifying glass symbol again to switch off the zoom function.
 NOTE! The scale of the coordinate system automatically adapts to the current zoom level.

Additional settings



- Click on the **Display all active points** icon to zoom in or zoom out on the view of all
 active points of the monitoring field.
- The **Display maximum sight range of the sensor** icon shows the 2D LiDAR sensor with all scan lines and the monitoring fields in the display area.

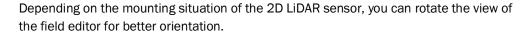


- The right area with the display of outputs and evaluation cases can be hidden to make more space for the display of the 2D LiDAR sensor and the scanned surrounding contour.
- ▶ To do this, click on the double arrow on the right edge of the monitor window.
- Click on the double arrow again. The area is displayed again.



- The **Full-screen presentation** icon displays the monitor window over the entire screen.
- The Close full-screen presentation icon returns to the previous display.

Rotating the display area

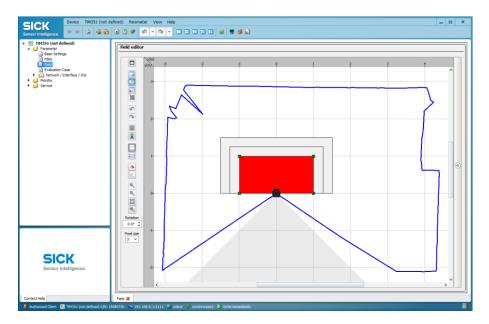






- ► Enter the rotation angle of the view.
- Change the rotation angle of the view step-by-step using the arrow keys to the right of the field.
- ▶ NOTE! If necessary, click the Show all active points icon again.

6.3.3 Editing fields



Editing field points



- The geometry of the monitoring field is determined by means of so-called field points.
- These are visualized as green marker squares in the graphic as soon as one of the Set field points, Move field points or Delete field points icons has been activated in the vertical toolbar.
- In the default setting, the rectangular monitoring fields have four field points at the corners.
- The geometry of the monitoring fields is adapted to the conditions on site by moving, adding or deleting field points.

Getting started

► On the right side of the window, in the **Monitoring field** area, select a monitoring field to edit.

The selected monitoring field is shown red in the graphic.

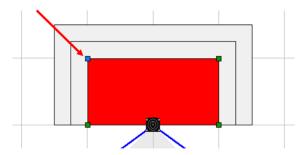
NOTE! The stopping field is automatically selected for editing after selection of the field set.

Moving field point



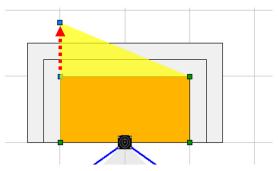
- ► Click on the **Move field points** icon in the toolbar.
- ► In the graphical representation, select the field point to be edited.

 To do this, click on the green marker square of the field point. The color of the marker square changes to blue.

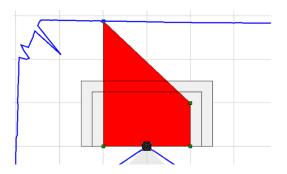


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► Click on the square again and drag the field point to the desired position while pressing the mouse button.



► Release the mouse button.



Moving other field points

The Move function remains active so that the next point can be moved directly afterwards.

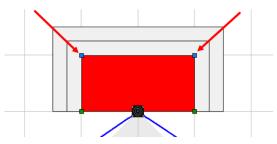
- ▶ Click on the point. The marker square is shown in blue.
- ▶ Move point with mouse button pressed.

Moving multiple points in one operation

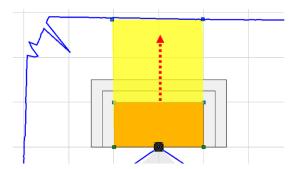


► Hold down the Ctrl button to select the field points to be moved or draw a frame around the points to be edited.

The marker squares of the selected field points are shown in blue.



► Click on one of the marked points and change the geometry of the monitoring field by moving the point.





NOTE! The **Undo** and **Redo** icons can be used to correct an action that was performed by mistake.

Inserting additional field points



- ► Click on the **Set field points** icon.
- ► Click on the border of the outer field at the desired position. SOPAS inserts a new, green marker square.
- Now click on the Move field points icon and move the newly added field point as described.

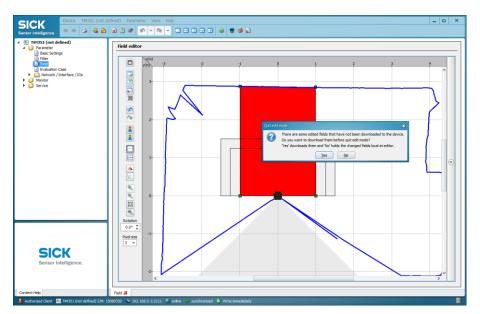
Deleting field points



- ► Click on the **Delete field points** icon.
- ► Click on the green marker square of the field point you want to delete. The color of the marker square changes to red.
- ► Click again on the field point to be deleted. SOPAS removes the marker square and instead connects the two nearest marker squares with a new line.

Ending editing mode

► Click on the icon of the active editing function again to finish editing the monitoring field.



► Answer the query of whether the modified geometry should be transmitted to the 2D LiDAR sensor with **Yes.**

The modified geometry is transmitted to the 2D sensor. The grip points of the monitoring field are now no longer visible in the scan range.

• With **No,** the modified geometries are still available in SOPAS. They can then be transmitted to the device at a later point in time (see following chapter).

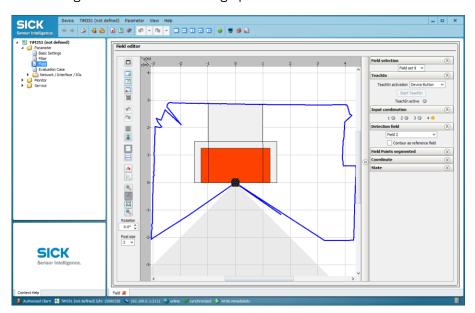
NOTE! The message is not displayed if you change to a different editing function. The grip points remain visible and can be edited as described.

Editing warning field

The geometry of the warning field is processed analogously to the stopping field and adapted to the spatial conditions.

► On the right side of the window, in the **Monitoring field** area, select **Field 2** (warning field) for editing.

The warning field is shown red in the graphic.



▶ Adjust the field geometry of the warning field as described.

6.4 Completing configuration

6.4.1 Transmitting parameters to the 2D LiDAR sensor

All geometries modified in SOPAS are transmitted to the connected 2D LiDAR sensor and executed. However, the data is only stored **temporarily** in the sensor.

Saving the configuration in the non-volatile memory

To retain the changes after the 2D LiDAR sensor is restarted, the configuration must be permanently saved in the sensor.

▶ Click on **Permanently save parameters** in the SOPAS toolbar.

The configuration is transferred to the 2D LiDAR sensor and saved there permanently. It is loaded each time the 2D LiDAR sensor is restarted.

6.4.2 Testing the configuration of the monitoring fields

Once the configuration has been verified and permanently saved in the 2D LiDAR sensor, the BAS driver assistance system will start with the loaded configuration.

Checking the correct stopping and warning behavior of the system in regular cycles is recommended, but at the latest each time the vehicle is commissioned.

Checking object detection

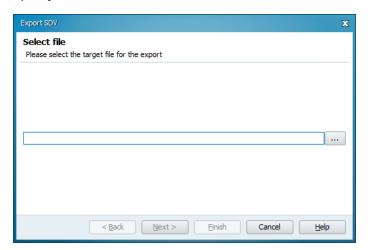
- ▶ Check monitoring fields along the outer boundaries for detection.
- ▶ To do this, walk along them or check the functionality with suitable aids.
- The system must trigger accordingly each time an object is detected (see chapter 3.3 Operating principle).

6.4.3 Exporting configuration to device file

► After a successful test, save the current parameters and settings as a **device file** in SVD format. The SVD device file is independent of the SOPAS version.

NOTE! This means that when the 2D LiDAR sensor is replaced, the device data can be transferred directly to the replacement device.

- ▶ In the **Device** menu, click **Export SVD file**.
- ► Specify file name and location.

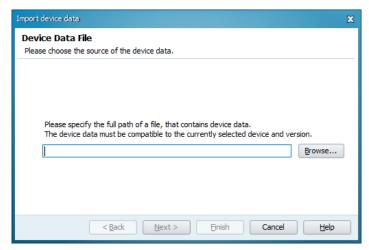


- ► Click on **Next**. The device file is saved.
- ► End export with Complete.

6.5 Importing configuration

A saved configuration can be quickly transmitted to other 2D LiDAR sensors. This is useful, for example, when commissioning multiple vehicles or replacing a 2D LiDAR sensor.

- ► Connect 2D-LiDAR sensor to configuration PC (see chapter <u>6.2.3 Connecting 2D LiDAR sensor to configuration PC</u>).
- ► Start SOPAS and perform device search if necessary (see chapter <u>6.2.4 Starting the</u> device search).
- ► Transfer device to project and open configuration interface by double-clicking on device tile (see chapter 6.2.7 Opening configuration interface).
- ▶ Adopt parameters from the SVD device file with **Device** → **Import SVD file**.



- ► Select saved configuration and start import. The new 2D LiDAR sensor scanner is displayed in the project tree with the saved configuration.
- ► Now open the configuration interface and check and, if necessary, adjust the geometry of the monitoring fields (see chapter <u>6.3 Adapting the geometry of the monitoring fields</u>).

7 Maintenance

▲ WARNING!

▶ Disconnect the system from the power supply before carrying out installation or maintenance work.

Maintenance and repair measures may only be carried out by qualified persons.

- Qualified persons have the specialist training, skills, experience and knowledge of the
 relevant regulations and standards needed to be able to perform work assigned to
 them and to identify and avoid any potential dangers independently.
- Electricians have the professional training, skills, experience and knowledge of the relevant standards and provisions needed to work on electrical systems and to detect and avoid any potential dangers independently.

Device	Maintenance task	Interval *	Туре
2D LiDAR sensor	Clean the front screen	Weekly or if dirty	Trained personnel
General	Visual inspection of the system components for mechanical stability of the mounting brackets	Weekly	Trained personnel
	Visual inspection of the electrical cabling and wiring for damage	1x/year	Trained personnel

^{*} The intervals depend on the ambient conditions and degree of contamination. In addition, the intervals must be defined according to how important they are for the customer process.

Tab. 5: Maintenance intervals

7.1 Monitoring and cleaning work

7.1.1 Function test

Function test by customer

- ► Fault-free functioning of the driver assistance system should be ensured by means of regular monitoring.
- ▶ The function test must be carried out by the customer.
- ▶ It is recommended that the customer designate a person responsible for the vehicle to carry out the function test.

Performing function test

- ▶ Place object in the detection zone and start reversing with reverse gear activated.
- ► The driver assistance system must trigger if an object is detected in one of the two monitoring fields.
- ► In case of unexpected error behavior, check the components of the driver assistance system for mechanical damage.
- ▶ In case of mechanical damage, contact SICK Service.

7.1.2 Visual control

Checking plug connectors

- Unscrew plug connectors and check male contacts for moisture and signs of corrosion.
- ▶ Immediately replace plug connectors damaged by corrosion.

NOTE! Corroded plug connectors can significantly impair the performance of the 2D LiDAR sensor.

Checking connecting cables

- ► Check the electrical installation regularly.
- ▶ Make sure that all cable connections are secure.
- ▶ Defects such as loose connections, scorched cables, or cables with damaged insulation must be corrected immediately.

Checking brackets

- ► Check the sturdiness of the brackets by looking for cracks and other signs of damage.
- ► Check the fittings once a year.

7.1.3 Cleaning the 2D LiDAR sensor

Contamination on the front screen of the 2D LiDAR sensor can impair the measuring behavior of the device.

NOTE! If the front screen is too dirty, the 2D LiDAR sensor signals a hardware error via the red LED.

Cleaning the front screen



Fig. 43: Cleaning the front screen of the 2D LiDAR sensor

- ► Switch off the device during cleaning.
- ▶ Remove dirt from the front screen.
- ▶ Then wipe the front screen with a lens cloth.
- ▶ NOTE SICK lens cloth with part no. 4003353 is recommended.

 Use a mild, anti-static lens cleaning fluid if necessary.

▲ CAUTION!

REDUCED READING PERFORMANCE DUE TO SCRATCHES OR STREAKS ON THE OPTICAL BOUNDARY SURFACE

The optical output is weakened by scratches and streaks on the optical boundary surface.

- ▶ Do not use aggressive cleaning agents.
- ▶ Do not use abrasive cleaning agents.

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▶ Avoid any movements that could cause scratches or abrasions on the front screen.

NOTE!

► Contact SICK Service if the red LED still reports a hardware error after cleaning.

7.2 Replacing components

7.2.1 Replacing the 2D LiDAR sensor

▲ WARNING!

➤ Disconnect the system from the power supply before carrying out installation or maintenance work.

If the device parameters have been stored on the configuration PC as a project or device file, the replacement device can be configured quickly and conveniently by importing the saved parameter set.

Replacement device

Part no.	Meaning
1067299	TiM351 2D LiDAR sensor

Replacing the device

- ► Loosen the M12 round connector on the 2D LiDAR sensor and remove the connecting cable from the 2D LiDAR sensor.
- ▶ Remove the defective 2D LiDAR sensor from the bracket.
- ► Mount the replacement device.
- ✓ Connect the cable to the new 2D LiDAR sensor and screw on the M12 plug connector.

Adopting configuration of the predecessor device

► Import saved configuration into replacement device (see chapter <u>6.5 Importing configuration</u>).

7.2.2 Replacing the control unit

△ WARNING!

- ▶ Disconnect the system from the power supply before carrying out installation or maintenance work.
- ▶ When ordering the control unit, make sure that it matches the vehicle type (see also chapter <u>3.1 Scope of delivery</u>).

Replacement devices

Part no.	Meaning
1115792	Control unit with power supply unit for connection to vehicle with electric motor
1115791	Control unit with power supply unit for connection to vehicle with combustion engine

Replacing the device

- ▶ Disconnect POWER cable and REVERSE cable from vehicle connection.
- ► Loosen all M12 round connectors on the control unit and disconnect the connecting cables from the control unit.
- ▶ Loosen and remove the retaining plate fixing screws.
- ▶ Remove the retaining plate with the control unit from the mounting position.
- ▶ Mount the replacement device in the same place.
- \checkmark Connect the cable to the new control unit according to the instructions in chapter <u>5.2</u>

7.2.3 Replacing signal light bar

▲ WARNING!

► Disconnect the system from the power supply before carrying out installation or maintenance work.

Replacement device

Part no.	Meaning
1114219	Signal light bar with buzzer

Replacing the device

- ► Loosen the M12 round connector on the signal light bar and disconnect the connecting cable.
- ▶ Remove the defective signal light bar from the mounting.
- ▶ Mount the replacement device.

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✓ Connect the cable to the new signal light bar and screw on the M12 plug connector.

Technical data 8

General notes

	BAS3501-C	BAS3501-E	BAS3502-C	BAS3502-E
Scope of	TiM351 2D LiDAR sensor		TiM351 2D LiDAR sensor (2 x)	
delivery	cables for current and reverse signal, 3 m Signal light bar with three-color visual and configurable audible alarm level up to 98 dB Mounting kit for sensor and signal		Control module with connection cables for current and reverse signal, 3 m	
			Signal light bar with three-color visual and configurable audible alarm level up to 98 dB (2 x)	
			Mounting kit for sensor and signal light bar (2 x)	
	Connection cable for sensor and signal light bar, 5 m		Connection cable for sensor and signal light bar, 5 m (2 x)	
Industry	Industrial vehicles, automotive and parts suppliers, food and beverage, retail and warehousing			

Features

	BAS3501-C	BAS3501-E	BAS3502-C	BAS3502-E
Areas of application	Indoor and outdo	or areas (8 m)		
Vehicles	Combustion manned forklift truck	Electric manned forklift truck	Combustion manned forklift truck	Electric manned forklift truck
Laser class	1 (IEC 60825-1:2014, EN 60825-1:2014)			

Performance

	BAS3501-C	BAS3501-E	BAS3502-C	BAS3502-E	
Functions	Visual and acoust	Visual and acoustic collision warning			
Number of laser	1		2		
scanners					
Monitored area	Rear of vehicle		Rear of vehicle		
			Blind spot or side cover		
Warning zones	2				
GPS	-				
Web interface	-				

Interfaces

USB		+, Micro USB
	Function	Parameterization
USB		+, for signal light bar
	Function	Human machine interface

Mechanics/Electronics

	BAS3501-C	BAS3501-E	BAS3502-C	BAS3502-E
Weight	1,530 g, without connecting cables		2,320 g, without connecting cables	
Power consumption	10 W (typical), 13	3 W (maximum)		
Reverse signal voltage of the machine	12 V, 24 V	24 V, 48 V, 60 V, 72 V	12 V, 24 V	24 V, 48 V, 60 V, 72 V
Operating voltage of the machine	12 V 24 V	24 V 48 V 60 V 72 V	12 V 24 V	24 V 48 V 60 V 72 V

Ambient data

Ambient temperature, operation	-20 °C +50 °C
Ambient temperature, storage	-25 °C +55 °C
Enclosure rating	IP65 / IP67

Tab. 6: Technical data of BAS351-xxxxx

9 Dimensional drawings

9.1 Dimensional drawings of TiM351 2D LiDAR sensor

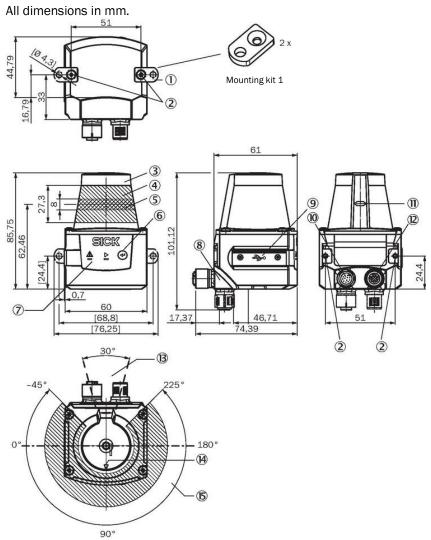


Fig. 44: Dimensional drawings of TiM351 2D-LiDAR sensor

- 2 x fastening clip with M3 x 4 mm screw (included in scope of delivery)
- 2 M3 threaded mounting hole, 2.8 mm deep (blind hole thread)
- 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
- 9 Micro USB female connector, type B
- 10 "Voltage supply" connection, 12-pin M12 male 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 (field of vision)

Mounting kit

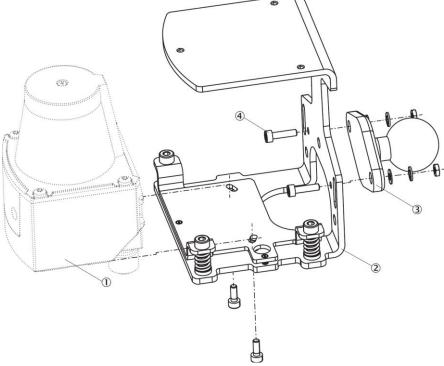


Fig. 45: Dimensional drawing of mounting kit (TiM351)

- 1 TiM3xx 2D LiDAR sensor (in scope of delivery)
- 2 TiM3xx mounting kit, part no. 2061776 (in scope of delivery)
- 3 RAM mount bracket, part no. 5333533 (in scope of delivery)
- 4 2x screws each, nuts, washers (in scope of delivery)

9.2 Dimensional drawings of control unit

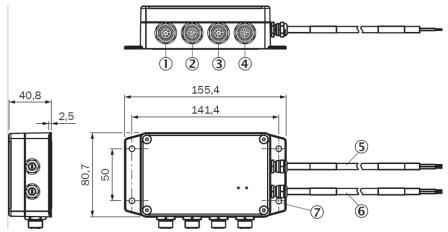


Fig. 46: Dimensional drawing of control unit

- 1 Signal light bar 1 connection, 8-pin, M12 male connector
- 2 Sensor 1 connection, 12-pin, M12 male connector
- 3 Signal light bar 2 connection, 8-pin, M12 male connector
- 4 Sensor 2 connection, 12-pin, M12 male connector
- 5 "Voltage supply" connection, 2-pin cable with open ends
- 6 "Reverse from vehicle" connection, 2-pin cable with open ends
- 7 Mounting plate with 4x holes, M5

9.3 Dimensional drawings of signal light bar

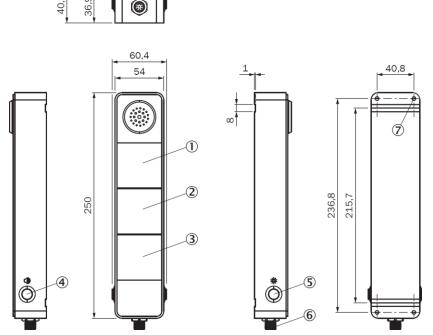


Fig. 47: Dimensional drawing of signal light bar

- 1 Red LED segment (visual signal display)
- 2 Yellow LED segment
- 3 Green LED segment
- 4 Function button for volume control
- 5 Function button for light intensity levels
- 6 "Power & I/O signal" connection, 8-pin, M12 male connector
- 7 4 x mounting holes, M5

10 **Disposal**

NOTE

The applicable local and statutory environmental regulations and guidelines for the disposal of industrial and electrical waste must be observed.

NOTE

Disposal of batteries, electrical and electronic devices.

- ▶ In accordance with international directives and regulations, batteries, accumulators, and electrical or electronic devices must not be disposed of with household waste.
- ▶ The owner is obligated to dispose of the devices at the end of their service life via the appropriate public disposal points.
- ▶ This icon on the product, packaging, or in this document indicates that a product is covered by these provisions.



The following assemblies may contain substances that need to be disposed of separately:

• Electronics:

Capacitors, accumulators, batteries.

• Displays:

Liquid in the LC displays.

Australia

Phone +61 (3) 9457 0600 1800 33 48 02 - tollfree

E-Mail sales@sick.com.au

Austria

Phone +43 (0) 2236 62288-0 E-Mail office@sick.at

Belgium/Luxembourg Phone +32 (0) 2 466 55 66

E-Mail info@sick.be

Brazil

Phone +55 11 3215-4900 E-Mail comercial@sick.com.br

Canada

Phone +1 905.771.1444 E-Mail cs.canada@sick.com

Czech Republic

Phone +420 2 57 91 18 50 E-Mail sick@sick.cz

Chile

Phone +56 (2) 2274 7430 E-Mail chile@sick.com

China

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Phone +358-9-25 15 800 E-Mail sick@sick.fi

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