OPERATING INSTRUCTIONS

TR4 Direct Rectangular

Safety switches

SICK
Sensor Intelligence.

Described product

TR4 Direct Rectangular

Manufacturer

SICK AG
Erwin-Sick-Str. 1
79183 Waldkirch
Germany

Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Purpose of this document

These operating instructions provide technical personnel of the machine manufacturer or the machine operator with instructions regarding the safe mounting, electrical installation, commissioning, operation and maintenance of the safety switch.

These operating instructions do not provide information on operating the machine in which a safety switch is integrated. For information about this, refer to the operating instructions of the specific machine.

1.2 Target group

These operating instructions are intended for planning engineers, developers, and operating entities of plants and systems that are to be protected by one or more safety switches. They are also intended for people who integrate the safety switch into a machine, initialize its use, or who are in charge of maintenance.

1.3 Information depth

These operating instructions contain information on the following topics:

- Mounting
- Electrical installation
- Commissioning
- Fault diagnosis and troubleshooting
- Part numbers
- Conformity

Please note that technical skills not covered by this document are also required when planning and using protective devices.

The official and legal regulations for operating must always be complied with.

General information on the topic of safety technology can be found in the “Guide for Safe Machinery” brochure, which can be ordered under part number 8008007.

NOTE
You can find more information at: www.sick.com.

1.4 Scope

These operating instructions are original operating instructions.

NOTE
These operating instructions only apply to safety switches with the following type label entry in the Operating instructions field:
8023284

1.5 Abbreviations used

OSSD	Output signal switching device = signal output that is responsible for controlling the safety circuit

2 On safety

2.1 Qualified safety personnel

The safety switch must only be installed, commissioned, and serviced by qualified safety personnel. A person is authorized if he/she...

- Has sufficient skills in the field of the power-driven machinery to be inspected based on his/her technical training and experience

and

- has been instructed by the machine operator in machine operation and the applicable safety guidelines

and

- Is familiar with all relevant state occupational safety regulations, work safety regulations, guidelines, and generally accepted technical rules and standards (e.g., DIN standards, VDE regulations, technical rules of other power-driven machinery) to such an extent that he/she is able to evaluate the safe condition of the power-driven machinery

and

- Has access to and has read the operating instructions.

These are usually qualified safety personnel of the manufacturer of the protective device or those persons who were sufficiently trained by the manufacturer of the protective device and who are mainly tasked with testing protective devices and have been commissioned by the operating entity of the protective device.

2.2 Intended use

The safety switch is a transponder safety switch which is activated by a non-contact actuator and is suitable for the following applications:

- Movable physical guards
- Safe position monitoring

The product may be used in safety functions.

The safety switch must only be used within the limits of the prescribed and specified technical data and operating conditions at all times.

Incorrect use, improper modification or manipulation of the safety switch will invalidate any warranty from SICK; in addition, any responsibility and liability of SICK for damage and secondary damage caused by this is excluded.

Before using the safety switch, a risk assessment must be run on the machine.

The safety switch is **not** suitable for the ambient conditions such as, but not limited, to the following:

- Radioactivity (exception: natural radioactivity)
- Vacuum or high pressure
- High UV load
- In the vicinity of low-frequency RFID devices
- In the vicinity of magnetic fields

The following may impair the function of the safety switch:

- Metal subsurface or metal in direct proximity (see "Mounting", page 10)
- Passing metal chips

2.3 General safety notes and protective measures

The national and international legal specifications as well as the work safety regulations/safety rules apply to the installation and use of the safety switch, to the commissioning of said device, and to recurring technical inspections.

Safety switches fulfill personal protection functions. Improper installation or manipulation can lead to serious personal injuries.

Safety switches must not be circumvented, turned away, removed, or rendered ineffective in any other way. Observe the measures for reducing the possibilities for circumvention of an interlocking device in accordance with EN ISO 14119.

Liability is excluded in the following cases:

- Non-intended use
- Non-compliance with safety notes
- Attachment and electrical connection by non-authorized personnel
- Third-party interference

WARNING

Validate the entire system!

You are responsible for ensuring that the device is safely incorporated into a safe overall system. This involves validating the entire system according to specifications such as those defined in EN ISO 13849-2.

3 Product description

This chapter provides information on the special features of the TR4 safety switch. It describes the design and operating principle of the device.

▶ Always read this chapter before you mount, install, and commission the device.

3.1 Description of operation

Structure and function

The safety switch consists of two components:

- A sensor
- A coded actuator (transponder)

The sensor is mounted on the fixed part of the protective device, the actuator on the moving part.

When the protective device is closed, the actuator is moved towards the sensor. If the switch-on distance is reached, the actuator code is read out and evaluated by the sensor. If a valid actuator is located in the response range of the sensor, then the sensor sets safety outputs OSSD 1 and OSSD 2 (semiconductor outputs) to High and the Aux application diagnostic output to Low.

If the protective device is opened and the actuator is removed from the response range of the sensor, then it sets safety outputs OSSD 1 and OSSD 2 to Low and the Aux application diagnostic output to High.

Coding

There are two different types of coding:

- Universal coding
  Universally coded sensors accept all universally coded TR4 actuators.
- Unique coding (products are labeled with “CODED”)
  A “coded” actuator must be taught-in during commissioning. It is possible to teach in up to 8 actuators in succession. Only the most recently taught-in actuator is valid. Previously taught-in actuators can no longer be used.
  see "Teach-in (uniquely coded variants)", page 17

Both the sensors and the actuator are coded. Universally coded sensors can only be operated with universally coded actuators. Uniquely coded sensors can only be operated with uniquely coded actuators.

Fault detection

Any faults that occur, including internal device faults, are detected at the latest with the next request to close the safety contacts (e. g. during machine start). The safety switch then switches to safe state. If a fault is detected, the safety circuit is switched off and the Status/Diag LED shows an error (see table 5, page 20).

Safe series connection

The number of safety switches in a safe series connection is nearly limitless. This has an influence the response times, however. Ideally, the number of safety switches in a safe series connection is set to a maximum of 30 devices.

In a safe series connection, only safety switches with inputs In 1 and In 2 can be used, i. e. safety switch with cable or an 8-pin M12 connector.

Safety switches with a 5-pin M12 connector can only be used individually.

Boundary area indication

Some variants of the safety switch are equipped with a boundary area indication. The boundary area indication displays when the actuator is situated in the boundary area of the response range when the sensor is active (weak signal). The Status/Diag LED then lights up ● **yellow**. The outputs are closed (High).

Magnetic holding force

Some variants of the safety switch are equipped with magnets. These magnets draw the actuator to the sensor with their holding force so that the protective device (e. g. a protective door) is held with a certain force. This makes unintended opening of the protective device more difficult in the event of disturbances such as shock and vibration, thereby increasing machine availability.

3.2 Protective functions

The safety switch features the following internal protective functions:

- Short-circuit protection at all outputs
- Overload protection at all outputs
- Reverse polarity protection of the supply voltage

3.3 LED indicators

Table 1: LED indicators

Status/Diag LED	Meaning
○ **Off**	No supply voltage
3 × ☼ **green** 1 × ☼ **red**	Power up sequence
● **Green**	Actuator in response range Safety outputs active Aux application diagnostic output deactivated
● **Red**	Actuator outside of response range Safety outputs deactivated Aux application diagnostic output active
☼ **Yellow**	Sensor approaches the maximum response range (boundary area indication, only with certain variants)
☼ **Red** or ☼ **green**	Error. see table 5, page 20

Further topics

- see table 4, page 18
- see table 5, page 20

4 Mounting

DANGER

Mounting must only be done by authorized and qualified personnel!

Mounting must be done by qualified safety personnel in compliance with the following notes and specifications.

Follow the following mounting instructions. Otherwise the guarantee becomes invalid.

NOTE

This device is part of a protective device for safeguarding a machine. A risk analysis should be done before mounting to determine if the specifications of this device are suitable for all foreseeable operating and environmental parameters of the machine in which is installed.

Ambient conditions

Mount the sensor and actuator on a non-ferrous surface and at a distance from metal parts if possible in order to avoid influencing the sensing range. If this is not possible, the influence on assured switch-on distance Sao and assured switch-off distance SAR must be checked.

Steps for mounting the device

1. Select the mounting position for the safety switch so that the sensor and actuator for are easily accessible monitoring and exchange work and are protected from damage.
2. Make sure that dangerous states are excluded when the protective device is opened, even if the actuator has not yet reached the assured switch-off distance.
3. Observe ISO 14119 when mounting the safety switch and actuator.
4. Observe EN ISO 14119 for reducing the possibilities for circumvention of an interlocking device.
5. Mount the actuator on the movable part of the protective device.
6. Mount the sensor on the fixed part of the protective device.
7. Align the sensor and actuator so that their front sides face each other at a switch-off distance of 15 mm or closer when the protective device is closed (see figure 1, page 10).

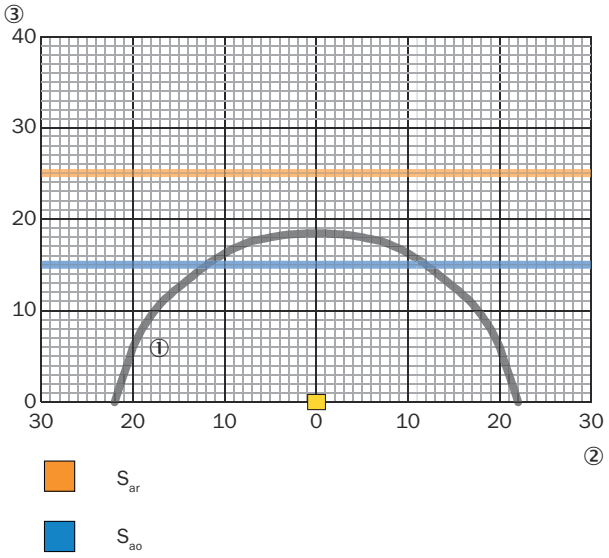


Figure 1: Response range

① Sensing range

② Side deviation in mm

③ Distance to sensor surface in mm

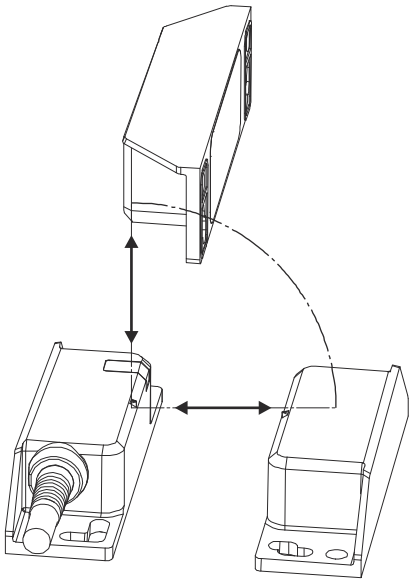


Figure 2: Approach directions

- If necessary, attach an additional protective stop for the moving part of the protective device.
- Observe the maximum tightening torque of 2.2 Nm for mounting the sensor and actuator.

DANGER

Observe the following safety notes:

- The sensor and actuator must not be used as a mechanical stop.
- Prevent manipulation such as adjustment, disassembly or circumvention of the device which prevents proper functioning in any way. Otherwise serious injuries or even death could be the result.
- The integrity of the safety system can be endangered if there are available replacement actuators (risk of manipulation). This can lead to injuries or death, property damage or economic loss. Arrange for appropriate monitoring, work processes or alternative protective measures to regulate the use and availability of these replacement actuators.

Mounting of several safety switches

- When several safety switches are mounted, observe the prescribed minimum distance of 50 mm between the individual systems in order to avoid mutual interference.

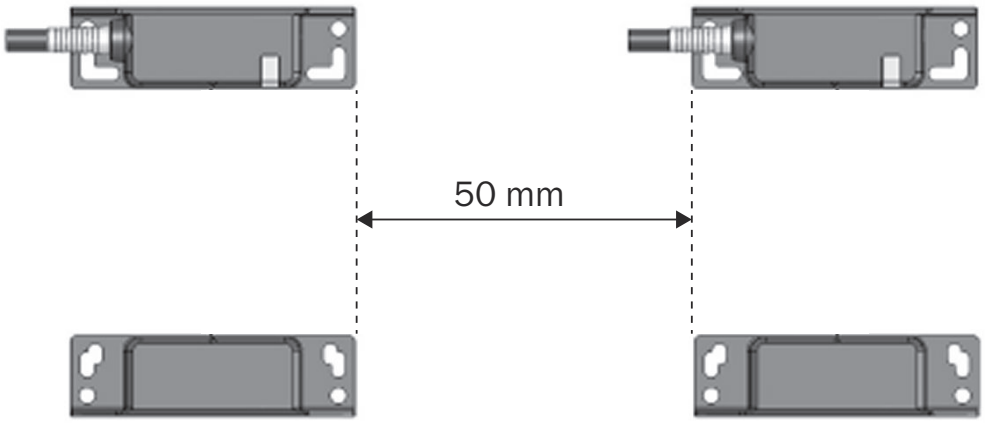


Figure 3: Minimum distance when mounting several safety switches

5 Electrical installation

5.1 Notes on cULus

For use according to the requirements of UL 508, the following conditions must also be met:

- The voltage supply must correspond to class 2 in accordance with UL 508.
- The ambient temperature must not exceed 40 °C.

5.2 Safety notes for the electrical connection

DANGER
Both safety outputs OSSD 1 and OSSD 2 (semiconductor outputs) must be evaluated without fail in order to guarantee safety.

An incorrect connection may cause the device to malfunction or become damaged. Please note the following:

- ▶ Do not use a control with clocking or switch off the clocking function of your control system.
- ▶ The device generates its own clock on output powers OSSD 1/OSSD 2. A downstream controller must tolerate these test pulses, which can have a length of up to 1 ms.
- ▶ The inputs of a connected evaluation device must be positive-switching (PNP) inputs because the two outputs of the safety switch supply a level of the supply voltage in the switched-on state.
- ▶ All electrical connections must be isolated from the supply network either through safety transformers in accordance with IEC/EN 61558-2-6 with output voltage limitation or through equivalent isolation measures.
- ▶ For use according to the requirements of cULus, a secondary class 2 transformer according to UL 5085-3 or a class 2 voltage supply according to UL 1310 must be used. This requirement also applies for inputs In 1 and In 2 as well as outputs OSSD 1 and OSSD 2 of the safety switch.
- ▶ All electrical outputs must have an adequate suppressor for inductive loads. For this purpose, the outputs must be protected with a suitable suppressor (e.g. freewheeling diodes, varistors, RC elements).

NOTE
The response time increases depending on the selected suppressor!

- ▶ Power devices (e.g. motors) that represent a strong source of interference must be locally isolated from the input and output current circuits for signal processing. The cable routing of the safety circuits should be separated from the cables of the power circuits by the greatest possible distance.

5.3 Failsafety

- If the device does not respond when the supply voltage is connected (e.g. Status/Diag LED does not flash), the safety switch must be replaced.
- The supply voltage is reverse polarity protected. The 1 / In 2 and OSSD 1 / OSSD 2 contacts are short-circuit protected.
- A cross-circuit between OSSD 1 and OSSD 2 is detected by the safety switch. A cross-circuit in the cable can be ruled out by protected cable routing.
- A short-circuit between OSSD 1 and OSSD 2 to 24 V DC is detected. A short-circuit between OSSD 1 and OSSD 2 simultaneously to 24 V DC must be ruled out by protected cable routing without fail.

5.4 Connection

DANGER
De-energize the system!
The plant could inadvertently start while you are connecting the devices.

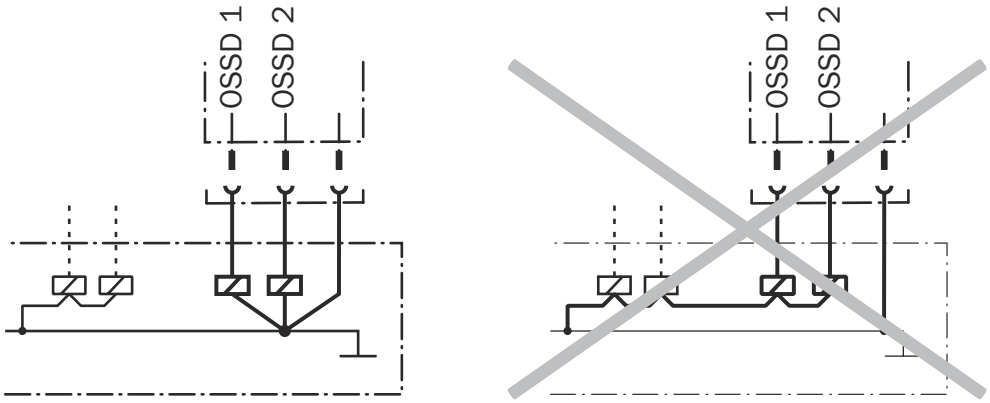
- Make sure that the entire plant is disconnected from the voltage supply during all electrical installation work.

Only use a suitable voltage supply!

The sensor must be connected to a voltage supply of protection class 2 SELV/PELV 24 V DC, +10 %/–15 %.

Prevent the formation of a potential difference between the load and the protective device!

- If you connect the loads to the OSSDs or safety outputs that do not have reverse polarity protection, you must connect the 0 V connections of these loads and those of the corresponding protective device separately and directly to the same 0 V terminal strip. In the event of a fault, this is the only way to ensure that there can be no potential difference between the 0 V connections of the loads and those of the corresponding protective device.



NOTE

- The safety switch complies with the regulations for electromagnetic compatibility (EMC) for the industrial sector (Radio Safety Class A). Radio interference cannot be ruled out when used in residential areas.
- In order to minimize network influences on the device behavior, the external voltage supply of the devices (SELV/PELV) must be able to bypass events, including a power outage of 20 ms. Power supply units according to EN 60204-1 fulfill this prerequisite. Suitable power supply units are available as accessories from SICK.

5.4.1 Device connection (M12, 8-pin or cable variant)

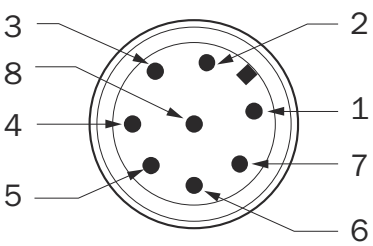


Figure 4: Device connection (M12, 8-pin)

Table 2: Pin assignment (M12, 8-pin) and cable assignment (cable variant)

Pin	Wire color [1]	Designation	Description
1	White	Aux	Application diagnostic output (not safe)
2	Brown	24 V DC	Voltage supply 24 V DC
3	Green	n. a.	Not connected
4	Yellow	In 2	Enable input for OSSD 2[2]
5	Gray	OSSD 1	OSSD 1 output
6	Pink	OSSD 2	Output OSSD 2
7	Blue	0 V	Voltage supply 0 V DC
8	Red	In 1	Enable input for OSSD 1 [2]

1) Applies to the connecting cables recommended as accessories.
2) When using an individual safety switch or in a series connection with T-connector, apply 24 V DC on the first safety switch.

5.4.2 Device connection (M12, 5-pin)

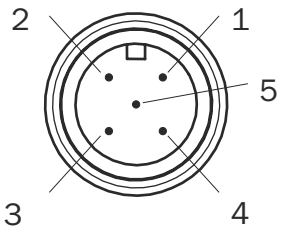


Figure 5: Device connection pin assignment (M12, 5-pin)

Table 3: Device connection pin assignment (M12, 5-pin)

Pin	Wire color [1]	Designation	Description
1	Brown	24 V DC	Voltage supply 24 V DC
2	White	OSSD 1	OSSD 1 output
3	Blue	0 V	Voltage supply 0 V DC
4	Black	OSSD 2	Output OSSD 2
5	Gray	Aux	Application diagnostic output (not safe)

1) Applies to the connecting cables recommended as accessories.

5.4.3 Connecting an individual safety switch

DANGER
Use external device monitoring!

The safety switch does not feature external device monitoring. To reach SIL3/PL e, you must therefore implement external device monitoring with the help of a suitable higher-level safety evaluation.

The actually achieved performance level or safety integrity level depends on the external wiring, the wiring version, the selection of control switches and their arrangement on the machine.

Evaluate both safety outputs!

Both safety outputs (OSSD 1 and OSSD 2) must be evaluated without fail in order to guarantee safety.

5.4.4 Series connection of several safety switches

Several safety switches with cable or an 8-pin M12 connector can be safely connected in series. The number of safety switches in a safe series connection is nearly limitless. This has an influence the response times of the system, however. We therefore recommend using no more than 30 safety switches in a safe series connection.

DANGER

Use external device monitoring!

The safety switch does not feature external device monitoring. To reach SIL3/PL e, you must therefore implement external device monitoring with the help of a suitable higher-level safety evaluation.

The actually achieved performance level or safety integrity level depends on the external wiring, the wiring version, the selection of control switches and their arrangement on the machine.

Evaluate both safety outputs!

Both safety outputs (OSSD 1 and OSSD 2) must be evaluated without fail in order to guarantee safety.

Prevent manipulation!

If using T-connectors, you must mount the connecting cables so that simple bridging of the safety switch is not possible.

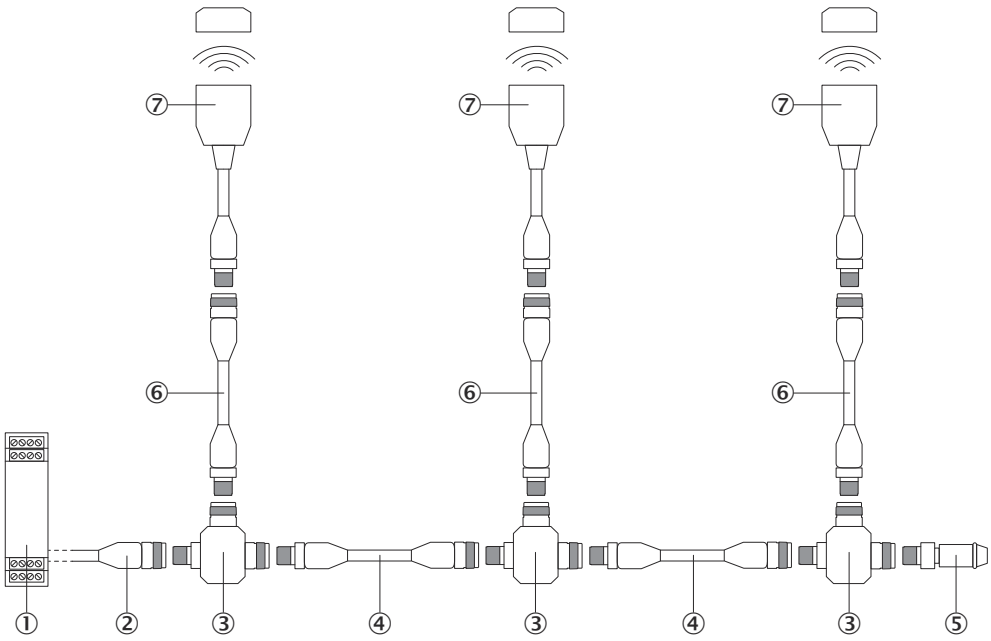


Figure 6: Safe series connection of several safety switches

① Safe evaluation unit

② Connecting cable with female connector, M12, 4-pin and flying leads (e.g. YF2A14-xxxVB3XLEAX)

③ T-connector STR-XXA

④ Connection cable with male connector, M12, 4-pin and female connector, M12, 4-pin (e.g. YF2A14-xxxVB3M2A14)

⑤ End connector MLP1-XXT

⑥ Connection cable with male connector, M12, 8-pin, and female connector, M12, 8-pin (e.g. YF2A18- xxxUA5M2A18)

⑦ TR4 Direct safety switch

6 Commissioning

DANGER
Do not commission without a thorough check by qualified safety personnel!

- Before you operate a plant protected by the safety switch for the first time, make sure that it is first checked and released by qualified safety personnel. (see "On safety", page 6)

DANGER
Make sure that the time for the safety requirement (closing the protective device again) is longer than the risk time. (see "Data sheet", page 23)

6.1 Indication when switching on

The device performs a self-test after switching on. During this time, the Status/Diag LED flashes **green** (see table 5, page 20).

6.2 Teach-in (uniquely coded variants)

An actuator must be taught in before initial commissioning of the uniquely coded safety switch. Only if a taught-in actuator is situated in the response range of the sensor does it enables its outputs. Only the most recently taught-in actuator is valid.

The teach-in process can either be performed so that a new actuator can be taught in or so the sensor is locked for additional teach-in processes.

6.2.1 Teaching in an actuator

Up to eight actuators can be taught in on uniquely coded safety switches. The number of actuators which can still be taught in is displayed by repeated flashing of the Status/Diag LED when switching on the device. see table 4, page 18).

How to teach in an actuator

1. Switch on the voltage supply for the sensor.
2. Bring the actuator into the response range of the sensor. The sensor then automatically begins teaching in.

NOTE
The actuator must not be removed from the response range during the teach-in process for at least 2 minutes. Otherwise the ability of the sensor to teach in other actuators will be deactivated.

Teach-in sequence

- Actuator in response range: The Status/Diag LED flashes **green** (2 Hz).
- Verifying actuator: The Status/Diag LED flashes **green**/**red** for 15 seconds (1 Hz).
- Programming sensor: The Status/Diag LED flashes **green**/**red** for 15 seconds (2 Hz).
- Programming complete: The Status/Diag LED flashes **green** (2 Hz) and shows the number of possible remaining teach-in processes, followed by a break. This signal is repeated for 15 seconds.
- Teach-in complete, sensor ready: The Status/Diag LED lights up **green**.

NOTE

- To teach in another actuator, bring it into the response range of the sensor. The teach-in sequence is the same as for the first teach-in process.
- Any actuators which were taught in earlier are now no longer accepted and cannot be taught in again.
- Universally coded actuators cannot be taught in.
- A maximum of eight actuators can be taught in on uniquely coded sensors. The device is then automatically locked for additional teach-in processes. The interlocking cannot be removed.

6.2.2 Teaching in and locking a uniquely coded sensor

How to teach in an actuator and lock the sensor for additional teach-in processes

1. Switch on the voltage supply for the sensor.
2. Bring the actuator into the response range of the sensor. The sensor then automatically begins teaching in.
3. Remove the actuator from the response range during step 4 of the teach-in sequence (“Programming complete”) until the Status/Diag LED lights up ● **red**.
4. Bring the actuator back to the response area. The Status/Diag LED flashes ☼ **green** again (1 Hz). The sensor is now locked and no other teach-in processes are possible. With its flashing signal, the Status/Diag LED shows the number of teach-in processes that would be possible for 15 seconds.

Teach-in sequence

- Actuator in response range: The Status/Diag LED flashes ☼ **green** for 15 seconds (2 Hz).
- Verifying actuator: The Status/Diag LED flashes ☼ **green**/**red** for 15 seconds (1 Hz).
- Programming sensor: The Status/Diag LED flashes ☼ **green**/**red** for 15 seconds (2 Hz).
- Programming complete: The Status/Diag LED flashes ☼ **green** (2 Hz) and shows the number of possible remaining teach-in processes, followed by a break. This signal is repeated for 15 seconds. If you remove the actuator from the response range during these 15 seconds and then bring it back into the response range, the sensor is locked for additional teach-in processes.
- Teach-in complete, sensor ready: The Status/Diag LED flashes ● **green**.

NOTE

- The interlocking processes (removal and return of the actuator) must be completed within the 15 seconds of step 4.
- The interlocking cannot be removed.

6.2.3 Fault indicators during teach-in

Table 4: Fault indicators during teach-in

Display of the Status/Diag LED (4 Hz)	Meaning
☼ **Green**	OSSD inputs invalid or not available
8 × ☼ **green**	No actuator taught-in (delivery state)
☼ 3 × **red**, 1 × **green**	A universally coded actuator should be taught in. This is not possible.
☼ 3 × **red**, 2 × **green**	An actuator which was already taught in on this sensor should be taught in again. This is not possible.

Display of the Status/Diag LED (4 Hz)	Meaning
3 × **red**, 3 × **green**	The actuator was moved out of sensing range (RFID signal interrupted).
3 × **red**, 4 × **green**	Eight actuators have been taught in. No other teach-in process is possible.
3 × **red**, 5 × **green**	The device has been interlocked. No other teach-in process is possible.

NOTE
The fault indicators are repeated until the device is reset.

- To reset the device, interrupt the voltage supply to the device for at least 3 seconds.

6.3 Inspection instructions

6.3.1 Checks before initial commissioning

Check the protective device as described below and in accordance with the applicable standards and regulations.

NOTE
The tests before initial commissioning described in the following are used to detect the influence on the protection system by unusual ambient influences.
These checks must therefore always be performed.

- Check the effectiveness of the protective device of the machine in all operating modes in which the machine can be set.
- Ensure that all operators have been instructed by the qualified safety personnel before they start working on a machine protected by a safety switch. Instruction is the responsibility of the machine user.

The tests must be documented accordingly.

6.3.2 Regular inspection of the protective device by qualified safety personnel

- Check the plant following the inspection intervals specified in the national rules and regulations. If any changes are made to the machine or someone tampers with the protective device after initial commissioning, this will ensure that any such issues are detected.
- If substantial alterations have been made to the machine or protective device, or if safety switches have been changed or repaired, check the plant again.

6.3.3 Regular testing of the effectiveness of the protective device

Check if the safety switch is functioning correctly at regular intervals and after each error. You can find possible time intervals in ISO 14119.

How to check the effectiveness of the mounted safety switch

- Check whether the machine always switches off when a protective door is opened.
- Check that the switch cables are operating properly.
- Check the protective device for signs of misuse or manipulation.
- Check the switch housing for damage.

7 Fault diagnosis

This chapter describes how to identify and remedy faults in the safety switch.

7.1 Response to errors

DANGER
Cease operation if the cause of the malfunction has not been clearly identified!

- Immediately put the machine out of operation if you cannot clearly identify the fault and if you cannot safely remedy the problem.
- Do not try to repair the safety switch.
- Replace defective devices before recommissioning the machine.

DANGER
Behavior if errors cannot be remedied

- If errors occur which cannot be remedied (LED **red (0.5 Hz)**, see table 5, page 20), check outputs OSSD 1 and OSSD 2 for short-circuit to 0 V, 24 V DC or between one another and remedy this error immediately.
- Check the cabling for damage, i.e. whether dual-channel functionality is still working.

7.2 SICK Support

If you cannot remedy the fault with the help of the information provided in this chapter, please contact your respective SICK subsidiary.

7.3 Fault indicators of the Status/Diag LED

This section explains what the fault indicators for the Status/Diag LED mean and how to respond to them.

Description of the fault indicators during teach-in operation: see "Fault indicators during teach-in", page 18

Table 5: Fault indicators of the Status/Diag LED

Display	Possible cause	Remedy
Green	Switch-on test or Signal to OSSD inputs In 1 and In 2 invalid or not available	▶ Wait until the device has completed the switch-on test. ▶ Check the voltage supply (24 V DC) and OSSD inputs In 1 and In 2 (red and yellow wires). ▶ With cascaded safety switches, check whether all actuators are located in the response range of the respective sensor.
Red	Actuator outside of response range	▶ Move the actuator into the response range.
Red (0.5 Hz)	Remediable error	▶ Check the OSSDs for short-circuit to 0 V, 24 V DC or between one another. ▶ Interrupt the voltage supply to the device for at least 3 seconds to reset the device.
Red (2 Hz)	Non-remediable error	▶ Replace the device.

Display	Possible cause	Remedy
Yellow (1 Hz)	Actuator in the limit range of the switch-off distance; safe state, OSSD 1 and OSSD 2 active	▶ Realign the sensor and actuator to one another.

7.4 Troubleshooting in safe series connection

If an error occurs in a device in a safe series connection, the affected device displays the error and switches off the OSSDs (Status/Diag LED flashes red). All downstream devices switch off their OSSDs (Status/Diag LED flashes green).

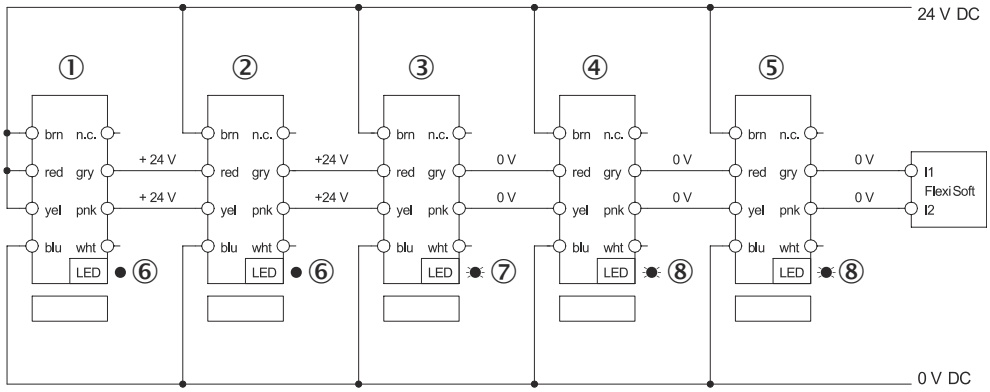


Figure 7: Trouble shooting for cascaded safety switches

①➜⑤ Safe series connection with 5 safety switches. Safety switch 3 is in the error state.

⑥ LED lights up green

⑦ LED flashes red

⑧ LED flashes green

8 Decommissioning

8.1 Disposal

Approach

- Always dispose of unusable devices in accordance with national waste disposal regulations.

Complementary information

SICK will be glad to help you dispose of these devices on request.

9 Technical data

9.1 Data sheet

Table 6: Safety-related characteristic data

Performance level	PL e (ISO 13849–1)
Category	4 (ISO 13849)
Safety integrity level	SIL 3 (EN 61508)
PFH_D (mean probability of a dangerous failure per hour)	6.03×10^{-10}
Electrical service life	10×10^6 switching operations
T_M (mission time)	20 years (ISO 13849)
Type	Type 4 (ISO 14119)
Universally coded	Actuator with low code level
Uniquely coded	Actuator with high code level
Safe status when a fault occurs	At least one safety-related semiconductor output (OSSD) is in the OFF state.

Table 7: Operating data

Assured switch-on distance S_{ao}	15 mm
Assured switch-off distance S_{ar}	25 mm
Output current (all outputs)	
ON state	≤ 200 mA
OFF state	≤ 0.5 mA
Current consumption (without load)	< 50 mA
Supply voltage V_S	24 V DC (20,4 V DC ... 26,4 V DC) Class 2 SELV PELV (according to IEC 60204-1)
Actuating frequency	≤ 0.25 Hz
Response time (removal from enable zone)	
Individual safety switch	45 ms
Safety switch in safe series connection	45 ms + (5 ms × number of safety switches between addressed safety switch and evaluation unit)
Response time when approaching the enable zone (enable time)	
Individual safety switch	360 ms
Safety switch in safe series connection	342 ms + (18 ms × number of safety switches in safe series connection)
Response time in the event of internal errors [1]	≤ 45 ms
Risk time [2]	≤ 100 ms
Time delay before availability [3]	3 s
Length of cable [4]	≤ 200 m
Max. number of cascaded safety switches	Unlimited, but a maximum of 30 is recommended.
Material	

Sensor Actuator	Polycarbonate Polycarbonate

1) At least one of the two OSSD outputs is safely switched off during the response time.
2) The risk time is the time needed to detect external faults. External errors affect the OSSD safety outputs (short-circuit to an OSSD safety output and cross-circuit between the two safety outputs). At least one of the two OSSD outputs is safely switched off during the risk time. Note that the time for the safety requirement (closing the protective device again) must be longer than the risk time.
3) After the supply voltage has been switched on, the OSSD outputs and the application diagnostic output are at Low potential during the time delay before availability. The time specified applies to one sensor; in a cascade, 0.1 s must be added per sensor.
4) Length of cable and cable cross-section change the voltage drop depending on the output current (R_{max} = 14.5 Ω).
Application-related high input loads and long cable lengths may result in functional limitations of the device.

Table 8: Outputs

2 OSSDs	2 × PNP, 0.2 A max., protected against short-circuits and overloads
Application diagnostic output	1 × PNP, 0.2 A max., protected against short-circuits and overloads
Switching voltage	
ON state	20.4 V DC ... 26.4 V DC
OFF state	0 ... 2 V DC
Voltage drop compared to supply voltage V_S	< 1.5 V DC

Table 9: Ambient environment

Ambient operating temperature	–25 °C ... +70 °C
Relative humidity	5% ... 95%
Enclosure rating	IP67, IP69K
Vibration resistance	3.5 mm / 10 ... 55 Hz (EN 60 068-2-6)
Shock resistance	30 g, 11 ms (EN 60068-2-27)
EMC	In accordance with IEC 61000, IEC 61326-1, IEC 6100-6-7, IEC 60497-1

Magnetic holding force

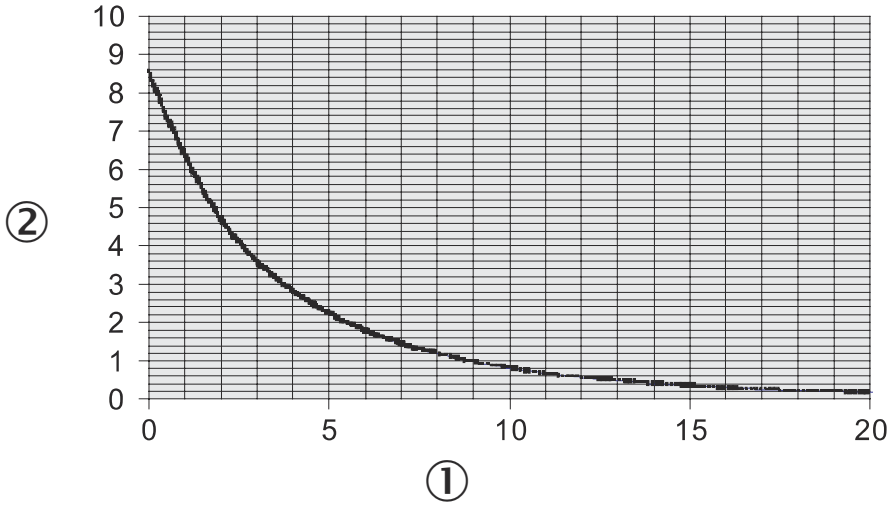


Figure 8: Magnetic holding force diagram (TR4-SFxxxx only)

① Distance [mm]
② Force (N)

NOTE

The magnetic holding force is measured from the front side of the actuator to the front side of the sensor. see figure 9).

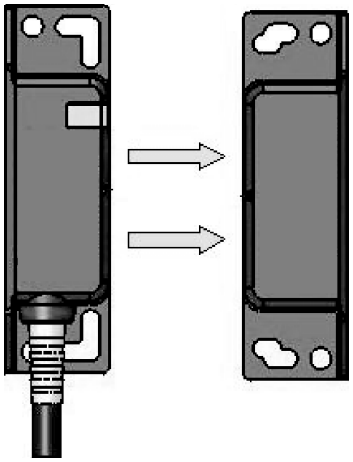


Figure 9: Area for measuring the magnetic holding force

9.2 Course of the OSSD test over time

The safety locking device tests the OSSDs for self-diagnosis at regular intervals. To do this, the safety locking device switches each OSSD briefly to the OFF state and checks whether this channel is voltage-free during this time.
Make sure that the machine's control does not react to these test pulses and the machine does not switch off.

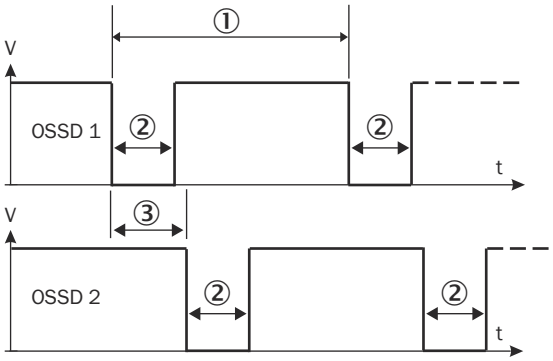


Figure 10: Course of the OSSD test over time

① Usually every 20 ms.

①	Test pulse interval	About every 45 ms
②	Test pulse width	450 µs
③	Test pulse deviation	

9.3 Dimensional drawings

9.3.1 Sensor dimensional drawing

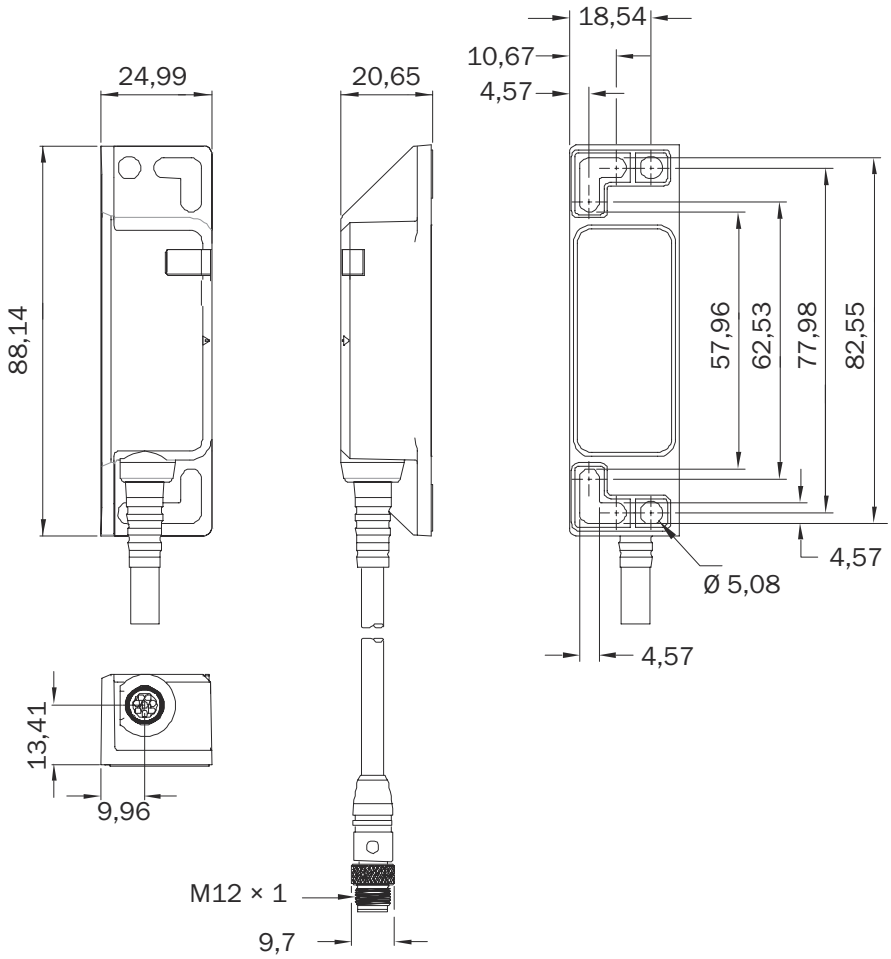


Figure 11: Sensor dimensional drawing (mm) (version with male connector)

9.3.2 Actuator dimensional drawing

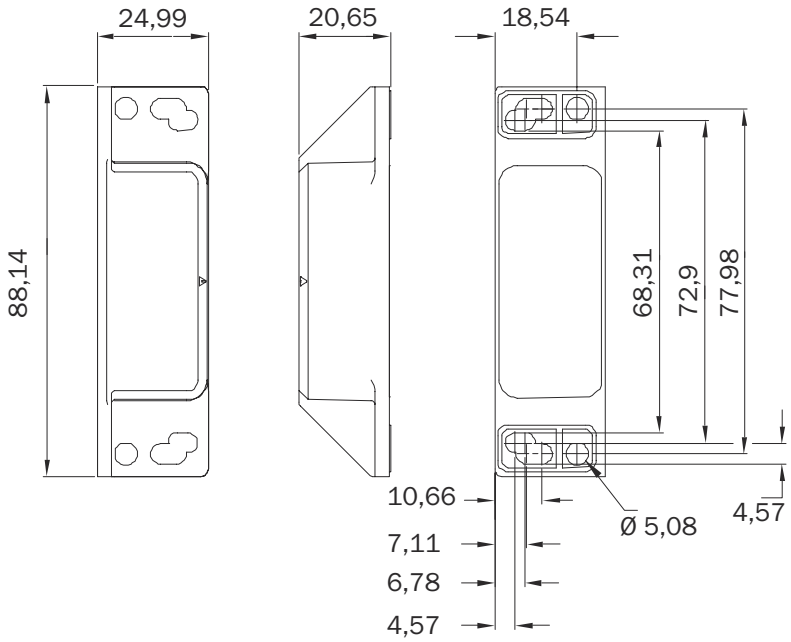


Figure 12: Actuator dimensional drawing (mm)

10 Ordering information

10.1 TR4 Direct standard ordering information

Scope of delivery: Sensor, actuator, operating instructions

Table 10: Safety switch part numbers

Coding	Sensor connection type	Type code	Part number
Universally coded	Cable 3 m, PVC	TR4-SDM03PB	6070803
	Cable 10 m, PVC	TR4-SDM10PB	6070804
	Cable with male connector, M12, 8-pin	TR4-SDM01CB	6070805
	Cable with male connector, M12, 5-pin	TR4-SDM02CB	6070821
Uniquely coded	Cable 3 m, PVC	TR4-SDU03PB	6070806
	Cable 10 m, PVC	TR4-SDU10PB	6070807
	Cable with male connector, M12, 8-pin	TR4-SDU01CB	6070808
	Cable with male connector, M12, 5-pin	TR4-SDU02CB	6070822

10.2 TR4 Direct with boundary area indication ordering information

Scope of delivery: Sensor, actuator, operating instructions

Table 11: Safety switch part numbers

Coding	Sensor connection type	Type code	Part number
Universally coded	Cable 3 m, PVC	TR4-SEM03PB	6070809
	Cable 10 m, PVC	TR4-SEM10PB	6070810
	Cable with male connector, M12, 8-pin	TR4-SEM01CB	6070811
	Cable with male connector, M12, 5-pin	TR4-SEM02CB	6070823
Uniquely coded	Cable 3 m, PVC	TR4-SEU03PB	6070812
	Cable 10 m, PVC	TR4-SEU10PB	6070813
	Cable with male connector, M12, 8-pin	TR4-SEU01CB	6070814
	Cable with male connector, M12, 5-pin	TR4-SEU02CB	6070824

10.3 TR4 Direct ordering information with boundary area indication and magnetic holding force

Scope of delivery: Sensor, actuator, operating instructions

Table 12: Safety switch part numbers

Coding	Sensor connection type	Type code	Part number
Universally coded	Cable 3 m, PVC	TR4-SFM03PB	6070815
	Cable 10 m, PVC	TR4-SFM10PB	6070816
	Cable with male connector, M12, 8-pin	TR4-SFM01CB	6070817
	Cable with male connector, M12, 5-pin	TR4-SFM02CB	6070825
Uniquely coded	Cable 3 m, PVC	TR4-SFU03PB	6070818
	Cable 10 m, PVC	TR4-SFU10PB	6070819
	Cable with male connector, M12, 8-pin	TR4-SFU01CB	6070820
	Cable with male connector, M12, 5-pin	TR4-SFU02CB	6070826

11 Spare parts

11.1 Replacement actuator

Table 13: Replacement actuator part numbers

Replacement actuator	Coding	Type code	Part number
Actuator for TR4-SDxxxxB sensor	Universally coded	TR4-RDM00B	5339369
	Uniquely coded	TR4-RDU00B	5339370
Actuator for TR4-SExxxxB and TR4-SFxxxxB sensors	Universally coded	TR4-RFM00B	5339371
	Uniquely coded	TR4-RFU00B	5339372

12 Accessories

12.1 Connectivity

Table 14: Connecting and connection cables

Part	Type code	Part number
4-wire connecting cable With female connector, M12, 4-pin, straight/stripped		
2 m	YF2A14-020VB3XLEAX	2096234
5 m	YF2A14-050VB3XLEAX	2096235
10 m	YF2A14-100VB3XLEAX	2096236
8-wire connecting cable With female connector, M12, 8-pin, straight/stripped		
2 m	YF2A18-020UA5XLEAX	2095652
5 m	YF2A18-050UA5XLEAX	2095653
10 m	YF2A18-100UA5XLEAX	2095654
5-wire connecting cable With female connector, M12, 5-pin, straight/stripped		
2 m	YF2A15-020VB5XLEAX	2096239
5 m	YF2A15-050VB5XLEAX	2096240
10 m	YF2A15-100VB5XLEAX	2096241
4-wire connection cable With female connector, M12, 4-pin, straight/male connector, M12, 4-pin, straight		
2 m	YF2A14-020VB3M2A14	2096599
5 m	YF2A14-050VB3M2A14	2096600
10 m	YF2A14-100VB3M2A14	2096601
8-wire connection cable With female connector, M12, 8-pin, straight/male connector, M12, 8-pin, straight		
2 m	YF2A18-020UA5M2A18	2096033
5 m	YF2A18-050UA5M2A18	2096034
10 m	YF2A18-100UA5M2A18	2096035
5-wire connection cable With female connector, M12, 5-pin, straight/male connector, M12, 5-pin, straight		
2 m	YF2A15-020UB5M2A15	2096009
5 m	YF2A15-050UB5M2A15	2096010
10 m	YF2A15-100UB5M2A15	2096011

Table 15: T-connector and end connector

Part	Type code	Part number
T-connector for series connection of TR4 Direct	STR-XXA	5339609
End connector for series connection in connection with T-connector MLP1-XXT	MLP1-XXT	1078201

13 Annex

13.1 Conformities and certificates

You can obtain declarations of conformity, certificates, and the current operating instructions for the product at www.sick.com. To do so, enter the product part number in the search field (part number: see the entry in the “P/N” or “Ident. no.” field on the type label).

13.1.1 EU declaration of conformity

Excerpt

The undersigned, representing the manufacturer, herewith declares that the product is in conformity with the provisions of the following EU directive(s) (including all applicable amendments), and that the standards and/or technical specifications stated in the EU declaration of conformity have been used as a basis for this.

- ROHS DIRECTIVE 2011/65/EU
- MACHINERY DIRECTIVE 2006/42/EC
- RE DIRECTIVE 2014/53/EU

13.1.2 UK declaration of conformity

Excerpt

The undersigned, representing the following manufacturer herewith declares that this declaration of conformity is issued under the sole responsibility of the manufacturer. The product of this declaration is in conformity with the provisions of the following relevant UK Statutory Instruments (including all applicable amendments), and the respective standards and/or technical specifications have been used as a basis.

- Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
- Supply of Machinery (Safety) Regulations 2008
- Radio Equipment Regulations 2017

8023286/19UT/2022-10-24/en

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