BALLUFF

BES M12EN-PFC40F-S04G-D11
BES M18EN-PFC80F-S04G-D11
BES M18MN-PFC50B-S04G-D11
BES M30EN-PFC15F-S04G-D11
BES M30MN-PFC10B-S04G-D11
Inductive Safety Sensors

User's Manual

english

www.balluff.com

Original user's guide

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1 About This User's Guide

This user's guide contains all the information you need for operating the following inductive safety sensors:

– BES0574
– BES0575
– BES0576
– BES0578
– BES0579

For questions that go beyond the scope of this user's guide, our Technical Customer Service is available for any function-related information.

1. Read this user's guide completely and follow the instructions contained in it.
2. In particular, follow the safety and warning instructions.
3. Retain this user's guide and ensure that it is always available directly at the location of the use.
4. Make this user's guide available to third parties as necessary.

Note
In the interest of continual product improvements the technical data for this product and the contents of this user's guide are subject to change without notice. The latest status of this user's guide is available on Balluff website **www.balluff.com.**

1.1 Typographical Convention

Actions

Individual action instructions are indicated by a preceding triangle:

- ▶ Action instruction 1
  ⇒ Result of action
- ▶ Action instruction 2

Action sequences are numbered in order:

1. Step 1
2. Step 2
3. Step 3

Symbols

Note
The symbol and the word Note indicate information which is helpful or important for use of the product.

1.2 Abbreviations

CCF Common Cause Failure
Failure as a consequence of as common cause

DC Diagnostic Coverage
Diagnostic Coverage

$MTTF_D$ Mean Time To Dangerous Failure
Mean Time To Dangerous Failure

OSSD Output Signal Switch Device
Output Signal Switching Device

PFH (PFH_D) Probability of (dangerous) Failure per Hour
Probability of (dangerous) Failure per Hour

PL Performance Level
PL according to EN ISO 13849-1

SIL Safety Integrity Level
Safety Integrity Level SIL 1-4 according to IEC 61508. The higher the SIL, the less the probability for failure of a safety function.

SILcl Safety Integrity Level claim limit
Safety Integrity Level Suitability (according to IEC 62061)

T_M Mission time
Life expectancy (=max. time of use)

1.3 Warnings

Warning notes are especially safety-relevant and are used for accident avoidance. This information must be read thoroughly and followed exactly. The warning notes are constructed as follows:

SIGNAL WORD
Type and source of the hazard **Consequences of non-observance** ► Measures for hazard avoidance

The signal words used have the following meaning:

NOTICE
The warning word NOTICE indicates a risk which can result in **damage to or destruction of the product.**

⚠ CAUTION
The general warning symbol combined with the signal word CAUTION indicates a risk which can result in **slight or moderate injuries.**

⚠ WARNING
The general warning symbol combined with the signal word WARNING indicates a risk which can result in **serious injury or death.**

⚠ DANGER
The general warning symbol combined with the signal word DANGER indicates a risk which can result **directly in serious injury or death.**

2 About This Product

2.1 Scope of delivery

The inductive safety sensor version BES0574, BES0575, BES0576, BES0578 and BES0579 detects metal without contact.

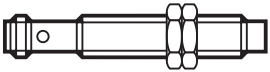
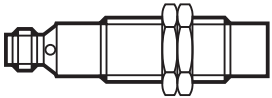
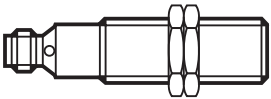
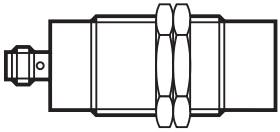
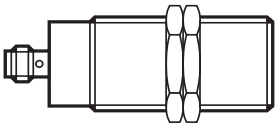
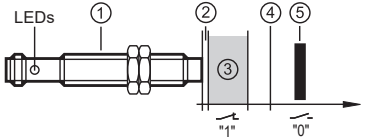
Typ	Scope of delivery	Order code
BES M12EN-PFC40F-S04G-D11: 	1 Safety sensor 2 Mounting nuts M12 1 Original user's guide	BES0574
BES M18EN-PFC80F-S04G-D11: 	1 Safety sensor 2 Mounting nuts M18 1 Original user's guide	BES0575
BES M18MN-PFC50B-S04G-D11: 	1 Safety sensor 2 Mounting nuts M18 1 Original user's guide	BES0576
BES M30EN-PFC15F-S04G-D11: 	1 Safety sensor 2 Mounting nuts M30 1 Original user's guide	BES0578
BES M30MN-PFC10B-S04G-D11: 	1 Safety sensor 2 Mounting nuts M30 1 Original user's guide	BES0579

Figure 1 Scope of delivery by type

Note
Should one of the components listed be missing or damaged, please contact one of the Balluff subsidiaries.

2.2 Function

BES0574:

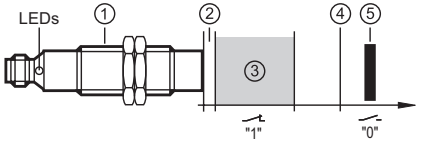


① Safety sensor
② Close zone
③ Release zone
④ Assured turn-off distance s_{ar}
⑤ Damping element

Yellow signal LED: Switching state

Green power LED: Operating voltage

BES0575:

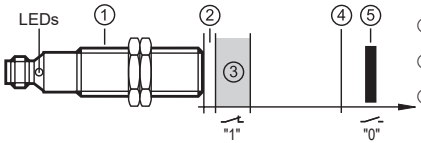


① Safety sensor
② Close zone
③ Release zone
④ Assured turn-off distance s_{ar}
⑤ Damping element

Yellow signal LED: Switching state

Green power LED: Operating voltage

BES0576:

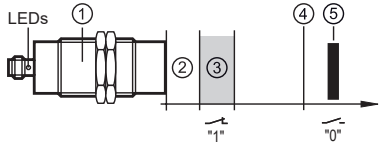


① Safety sensor
② Close zone
③ Release zone
④ Assured turn-off distance s_{ar}
⑤ Damping element

Yellow signal LED: Switching state

Green power LED: Operating voltage

BES0578:

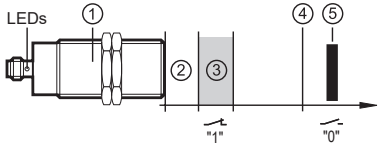


① Safety sensor
② Close zone
③ Release zone
④ Assured turn-off distance s_{ar}
⑤ Damping element

Yellow signal LED: Switching state

Green power LED: Operating voltage

BES0579:



① Safety sensor
② Close zone
③ Release zone
④ Assured turn-off distance s_{ar}
⑤ Damping element

Yellow signal LED: Switching state

Green power LED: Operating voltage

Figure 2 Function overview

2.3 Release zone

The outputs (OSSDs) are only released when damping occurs in the release zone. Outside this release zone the outputs remain off.

NOTICE

Improper damping elements

Changes or deviations in the release zone may occur.

- ► Use only standardized targets which correspond to the standardized target in shape and size.

Please refer to the following table for the assured turn-off distance s_{ar} for the various sensors:

Order code	Turn-off distance
BES0574	> 6 mm
BES0575	> 12 mm
BES0576	> 7 mm
BES0578	> 22 mm
BES0579	> 15 mm

Release zone for selected materials

Material	Release zone[1)]				
	BES0574	BES0575	BES0576	BES0578	BES0579
FE360 (=ST37K)	0.5…4 mm	1…8 mm	1…5 mm	1…15 mm	1…10 mm
Stainless steel 1.4301 (V2A)	0…3.1 mm	0…5.6 mm	0…3.5 mm	0…11.4 mm	0…7.4 mm
AlMg3G22	0…1.8 mm	0…3.2 mm	0…2 mm	0…6.8 mm	0…4.3 mm
CuZn37	0…2 mm	0…3.2 mm	0…2 mm	0…7.2 mm	0…4.6 mm
Cu	0…1.2 mm	0…2.4 mm	0…1.5 mm	0…5.5 mm	0…3.3 mm

1) Typical values for damping with a reference target
(according to EN 60947-5-2 at an ambient temperature of 20 °C):
– BES0574: 12 x 12 x 1 mm and non-flush installation
– BES0575: 24 x 24 x 1 mm and non-flush installation
– BES0576: 18 x 18 x 1 mm and flush installation
– BES0578: 45 x 45 x 1 mm and non-flush installation
– BES0579: 30 x 30 x 1 mm and non-flush installation

Note
Depending on the composition of the damping element the close zone may be absent.

2.4 Relevant standards

The following directives and standards were applied:

– **2006/42/EC**
European Machine Directive
– **2014/30/EU**
EMC Directive
– **EN ISO 13849-1:2015**
Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
– **IEC 60947-5-2:2007 + A1:2012**
Low-voltage switching devices: Control devices and switching elements – Proximity switches
– **IEC 61508:2010**
Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems
– **EN : 62061/: 2013**
Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
– **UL 508**
– **IEC 60947-5-3:2013**

3 General Safety Notes

3.1 Approved Use

Safety function SF: The safe condition (final stage turned off, logical "0") is achieved when there is undamping greater than or equal to the safe turn-off condition s_{ar} (see Section 7 Technical Data on page 26). Also observe the instructions for installing the sensor (see Section 4 Installation on page 17).

The safety sensor meets Performance Level d per EN ISO 13849-1 as well as the requirements for SIL 2 per IEC 61508 and meets SILcl 2 per IEC 62061.

The device corresponds to the classification:

– I2A12SP2, I2A18SP2 and I2A30SP2 per IEC 60947-5-2 **for non-flush** mounting (BES0574, BES0575 and BES0578).
– I1A18SP2 and I1A30SP2 per IEC 60947-5-2 **for flush** mounting (only BES0576 and BES0579).

For more information refer to see Section 4 Installation on page 17.

The inductive safety sensor has been certified by TÜV NORD.

Note
The EU Declaration of Conformity as well as the certificates for EN/IEC 61508 and EN/ISO 13849-1 from TÜV NORD can be found at **www.balluff.com**.

3.2 Non-approved Use

Warranty and liability claims against the manufacturer are rendered void by:

- Unauthorized tampering
- Improper use
- Use, installation or handling contrary to the instructions provided in this User's Guide.
- The sensor is not permitted to be used as a mechanical stop.
- Measures must be taken against the foreseeable defeating of the interlocking device (see DIN EN ISO 14119).

3.3 Personnel Requirements

Installation and startup are to be performed only by skilled professionals. The specifications contained in this user's guide as well as the prevailing standards and directives must be followed. Skilled professionals are persons who are familiar with the work such as installation and the operation of the product and have the necessary qualifications for these tasks.

3.4 Obligations of the Operating Company

Follow the instructions in the user's guide.

- Improper use may result in malfunction of the device. Equipment damage and/or personal injury during operation may then result. Therefore observe all instructions for installation and handling of the device as described in this document. Observe the safety instructions for operation of the overall system.
- Non-observance of instructions and standards, especially for manipulation and/or changes to the device will result in loss of liability and warranty.
- If the sensor is damaged the safety function can no longer be guaranteed.
- Errors caused by damage cannot be detected by the sensor.

- The device may be installed, connected and put into service only by a person trained in safety technology and electronics.
- The relevant technical standards must be considered as part of the respective application.
- Observe the requirements of EN 60204 when installing.
- If the device malfunctions, contact the manufacturer. Opening of and tampering with the device are not permitted.
- Disconnect the device from power before working on it. If appropriate also turn off independently powered relay circuits.
- Perform a complete function test after installation, maintenance or repair.
- Use the device only in specified ambient conditions (see Section 8 Maintenance, Care, and Disposal on page 30). Contact the manufacturer for any special ambient conditions.
- Use only within the specified application description.
- Safety requirements for the application
- The safety requirements for the respective application must agree with the requirements laid out here.

Observe the following conditions:

- Take measures which prevent metallic objects from unknowingly contacting the active surface.
- For interlocking devices together with guards observe DIN EN ISO 14119.
- Maintain specified application conditions (see Section 7 Technical Data on page 26).
- Use of the sensor in the vicinity of chemical and biological media as well as ionizing radiation is not permitted.
- Maintain the rest current principle for all safety circuits connected externally to the system.
- For faults within the safety sensor which result in a change to the condition defined as safe: Take measures which maintain the safe condition for continued operation of the host controller.
- Replace damaged devices.

Functional impairments

In the event of defects and device malfunctions that cannot be rectified, the device must be immediately taken out of operation and protected against unauthorized use.

Intended use is ensured only when the housing is fully installed.

4 Installation

Depending on the model the sensor may be installed flush (per IEC 60947-5-2) or non-flush (per IEC 60947-5-2).

⚠ WARNING

Failure of the safety function

The safety function of the sensor cannot be assured when using outside of the defined ambient conditions.

- ► Use only in accordance with the defined ambient conditions (see Section 8 Maintenance, Care, and Disposal on page 30).
- ► Use of the sensor in the vicinity of chemical and biological media as well as ionizing radiation is not permitted.

NOTICE

Improper installation

Flush mounting of the safety sensor BES0574, BES0575 and BES0578 can result in an increase of the switching distance before the outputs (OSSDs) are released.

- ► Install the safety sensor according to the specifications described in this section.

NOTICE

Intended or unintended circumventing of the safety function.

Metallic objects which directly contact the active surface or are in the release zone of the sensor can result in an unintended activation of the machine function.

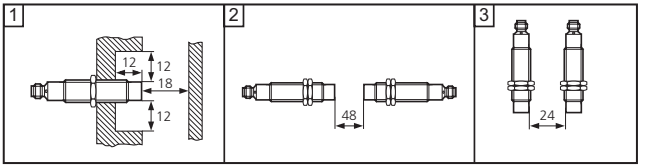
- ► Prevent intentional circumventing of the safety functions by means such as covered installation.
- ► Protect the active surface of the sensor against falling metallic objects (e.g. by having the active surface pointing down).
- ► Otherwise use the sensor only after strict evaluation of the accident risk and documented risk assessment.

► Secure the device against coming loose (observe tightening torque in the table).

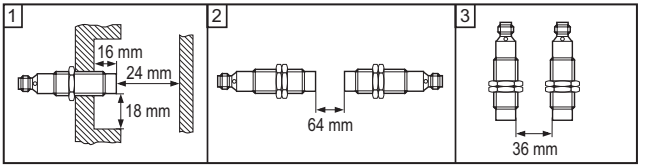
Order code	Installation	Tightening torque
BES0574	Non-flush mount	≤ 7 Nm
BES0575	Non-flush mount	≤ 25 Nm
BES0576	Flush-mounted	≤ 25 Nm
BES0578	Non-flush mount	≤ 50 Nm
BES0579	Flush-mounted	≤ 50 Nm

► Observe the installation conditions depending on the model according to the associated illustrations 1 to 3:

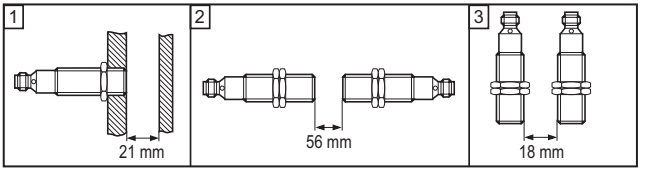
BES0574:



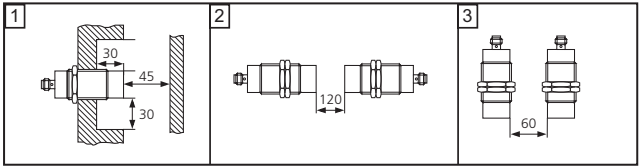
BES0575:



BES0576:



BES0578:



BES0579:

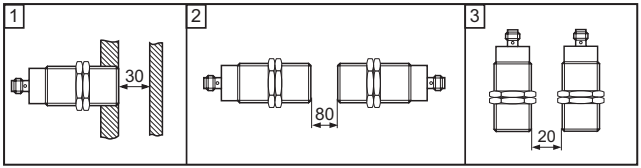


Figure 3 Installation dimensions by type

5 Electrical Connection

NOTICE
Exceeding maximum voltage **In case of a single fault, exceeding the maximum supply voltage of 40 V DC can result in destruction of the device and loss of the safety functionality.** ► Ensure separation of the supply voltage and transformer.

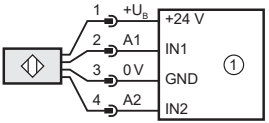
Connecting the safety sensor:

1. Disconnect the equipment from power.
2. If appropriate also turn off independently powered relay circuits.
3. Connect the supply voltage: $+U_B$ to terminal 1 and 0 V to terminal 3 of the plug.

Note
The nominal voltage is 24 V DC. This voltage may fluctuate according to EN 61131-2 between 19.2 V and 30 V incl. 5 % ripple.

5.1 Operation as 4-conductor

⚠ DANGER
High electrical voltage **Contact with current carrying components will result in severe injury or death.** ► Turn off power to the device before working on it.



① Safety logic unit
For an unpowered final stage a feedback of > 3.5 V will result in malfunction.

Figure 4 Electrical connection when operating as a 4-conductor

Cross-connection / short circuit

- Crossing both the outputs (A1 and A2) is detected by the sensor and results in turning off the outputs (OSSDs) at the next safety request. The outputs A1 and A2 remain turned off until the fault is eliminated and a voltage reset has been performed.
- A cross-connection (short-circuit) between output A2 and the supply voltage results in turning off of the other output A1 when there is a safety request. A short-circuit of A1 and U_B results in operation as a 3-conductor (5.2).
- For an unpowered final stage a feedback of > 3.5 V will result in malfunction.
- The device performs self-tests for turn-off capability on A2.

5.2 Operation as 3-conductor

NOTICE
Loss of the safety functionality **When using an output other than A2 the safety functionality is completely lost.** ► When operating in 3-conductor mode use only A2 as the output (OSSD).

NOTICE

Function fault from cross-connections and short-circuits

Inappropriate installation can cause cross-connections and short-circuits between the supply voltage and output A2.

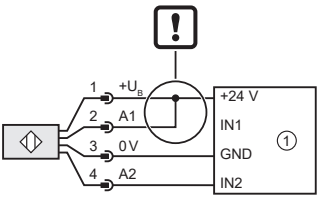
► Install the devices only in suitable configurations according to this user's guide.

Connections for 3-conductor operation:

► Connect output A1 to the supply voltage.

Electrical conductors must be permanently routed and protected against external damage (protected wiring).

The specified values with respect to the safety functionality remain intact (see Section 7 Technical Data on page 26).



① Safety logic unit
For an unpowered final stage a feedback of > 3.5 V will result in malfunction.

Figure 5 Electrical connection when operating as a 3-conductor

In this type of use a fault exclusion must be able to be performed for the possible error "Short circuit between any two conductors" as per EN ISO 13849-2:2015 Table D.4.

This fault can be excluded between conductors which are permanently (fixed) routed and protected against external damage. This can be done for example using protected wiring (cable duct / armored tube) according to ISO 13849-2: Table D4. In addition the requirements per IEC 60204-1 (Electrical equipment of machines).

6 Operation

6.1 Switching state of the outputs

Safe condition

The safe condition is a turned-off condition (unpowered condition: Logic "0") of at least one of the outputs A1 or A2 (OSSDs).

If one of the outputs A1 or A2 is turned off, the downstream safety logic unit must bring the entire system into the condition defined as safe.

Switched condition

If the damping element is in the release zone and there is no sensor error, both outputs A1 and A2 (OSSDs) are released (Logic "1").

Output specifications

The output specifications are based on the specifications for the input per EN 61131-2 Type 1 or Type 2:

Logic "1"	≥ 15 V	2…15 mA
	≥ 11 V	15…30 mA
Logic "0"	≤ 5 V	Residual current 0.2 mA

6.2 Response times

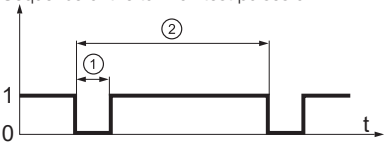
Description	Type	
	BES0574 BES0575 BES0576	BES0578 BES0579
Response time to a safety request (removing from the release zone)	≤ 1 ms	≤ 10 ms
Response time when approaching the release zone (release time)	≤ 1 ms	
Risk time / error response time for safety-relevant errors	≤ 20 ms	≤ 30 ms
Simultaneity of switching on and off of the outputs in case of a safety request	≤ 1 ms	
Test pulse duration t_{i_max} on A2 (1)	≤ 1 ms	
Sequence of the turn-off test pulses on A2  ① Test pulse duration ② Test pulse interval T	$T_{typ.}$ 180 ms $T_{max.}$ 300 ms $T_{min.}$ 100 ms	

Figure 6 Response times

6.3 LED display

LED	Operating status	Outputs	A1 (OSSD)	A2 (OSSD)
○ Signal ○ Power	No supply voltage	Both outputs turned off	0	0
○ Signal ✱ Power	Undervoltage (BES0574, BES0575, BES0576)		1 0	0 0
○ Signal[1)] ● Signal[2)] ✱ Power	Undervoltage (BES0578, BES0579)		0 1	0 0
○ Signal ✱ Power	Overvoltage	Both outputs turned off	0	0
	Sensor error (see Section 8.1 Troubleshooting, page 20)	One output or both outputs turned off	0 1 0	1 0 0
● Signal ● Power	Damping element within the release zone	Both outputs released	1	1
	Damping element within the close zone	Output A2 is turned off	1	0

1) Sensor undamped
2) Sensor damped

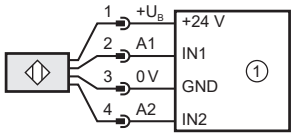
● LED on ○ LED off ✱ LED flashing (2 Hz) ✱ LED flashing rapidly (5 Hz)

7 Technical Data

	BES0574	BES0575	BES0576	BES0578	BES0579
Product Features					
Plug connection	M12				
Metal threads	M12 × 1	M18 × 1	M18 × 1	M30 ×1.5	M30 ×1.5
Release zone	0.5…4 mm	1…8 mm	1…5 mm	1…15 mm	1…10 mm
	Non-flush mount	Non-flush mount	Flush-mounted	Non-flush mount	Flush-mounted
Meets the requirements	EN ISO 13849-1: 2015, Category 2 PL d IEC 61508, SIL 2 IEC 62061, SILcl 2				
Area of use					
Operating mode	Continuous operation (maintenance-free)				
Electrical data					
Electrical version	DC PNP				
Operating voltage	24 V DC (19.2…30 V DC)				
Rated isolation voltage	30 V				
Current consumption	< 20 mA	< 30 mA	< 30 mA	< 30 mA	< 30 mA
Protection class	III				
Polarity reversal protection	Yes				
Ready delay	1 s				

	BES0574	BES0575	BES0576	BES0578	BES0579
Outputs					
Output function	2 x OSSD (A1 und A2)				
Voltage drop	2.5 V; (30 mA)				
Current load capacity	100 mA				
Short circuit protection	Yes				
Detection range					
Release zone	0.5…4 mm	1…8 mm	1…5 mm	1…15 mm	1…10 mm
Assured turn-off distance s_{ar}	6 mm	12 mm	7 mm	22 mm	15 mm
Response time					
Response time to a safety request (removing from the release zone)	≤ 1 ms	≤ 1 ms	≤ 1 ms	≤ 10 ms	≤ 10 ms
Response time when approaching the release zone (release time)	≤ 1 ms				
Risk time (fault response time)	≤ 20 ms	≤ 20 ms	≤ 20 ms	≤ 30 ms	≤ 30 ms

	BES0574	BES0575	BES0576	BES0578	BES0579
Environmental conditions					
Operating conditions	Class C per EN 60654-1 Weather-protected				
Ambient temperature	–25…70 °C, for service life ≤ 87,600 h 10…40 °C, for service life ≤ 175,200 h				
Temperature change rate	0.5 K/min				
Max. permissible relative humidity	5…95 %, short-time 5…70 %, continuous				
Air pressure	80…106 kPa				
Height above sea level	≤ 2000 m				
Isolating radiation	not permitted				
Salt mist	No				
Protection Class	IP65/IP67				
Approvals/Tests					
EMC	IEC 60947-5-2				
Shock resistance	IEC 60947-5-2				
Vibration resistance	IEC 60947-5-2				
Safety values					
Mission Time	≤ 175,200 h (20 years)				
Safety-related reliability PFH_D	1.0E-07 h				

	BES0574	BES0575	BES0576	BES0578	BES0579
Mechanical data					
Installation type	Non-flush mount	Non-flush mount	Flush-mounted	Non-flush mount	Flush-mounted
Housing material	V4A (1.4571); PBT	V4A (1.4571); PBT	Brass, white-bronze plating; PTB	V4A (1.4571); PBT	Brass, white-bronze plating; PTB
Weight	0.116 kg	0.105 kg	0.11 kg	0.19 kg	0.22 kg
Displays/operating elements					
Display	LED yellow (Signal) LED green (Power)				
Electrical Connection					
Connection	M12 plug connection; gold plated contacts				
Pin assignments  	 ① Safety-relevant logic unit				
Packaging unit	1 pc.				
Accessories					
Accessories (included)	2 mounting nuts				
Remarks	Unless otherwise indicated, all data in the entire temperature range are based on a reference target per IEC 60947-5-2 (FE360 = ST37K)				
	12 x 12 x 1 mm	24 x 24 x 1 mm	18 x 18 x 1 mm	45 x 45 x 1 mm	30 x 30 x 1 mm

8 Maintenance, Care, and Disposal

No special measures for maintenance and upkeep are necessary when operated properly.

The device may be repaired only by the manufacturer.

Dispose of the device in accordance with the prevailing national regulations for environmentally safe disposal.

8.1 Troubleshooting

Problem	Possible Cause	Troubleshooting
No LED display	No supply voltage	Turn voltage on
Power LED flashes and sensor does not switch	– Undervoltage – Overvoltage	Correct voltage (see Section 7 Technical Data on page 26)
Sensor does not switch even after undamping and damping	Sensor was placed in the safe condition (logical "0"). Cause: – Short-circuit between outputs A1 and A2 – Short-circuit between output A2 and the supply voltage – Error detected within the sensor	– Eliminate short-circuit – Replace the device
	– 3-conductor operation: A1 and A2 crossed	– Terminal +U_B from A2 to A1
No close zone	Damping element shifts the release zone directly up to the sensor face due to its composition (material, shape, size).	If possible change the material, shape or size of the damping element (see Section 3.1 Approved Use on page 13).

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929652 EN K16; Subject to changes.