

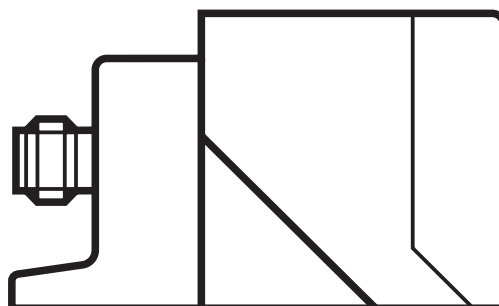


Original operating instructions
Fail-safe inductive sensor

GM701S

UK

11491861 / 00 11 / 2022



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1 Preliminary note

The instructions are part of the unit. They are intended for authorised persons according to the EMC, Low Voltage and Machinery Directives and safety regulations. The instructions contain information about the correct handling of the product. Read the instructions before use to familiarise yourself with operating conditions, installation and operation.
Follow the safety instructions.

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1.1 Symbols used

- ▶ Instructions
- Cross-reference
-  Important note
Non-compliance can result in malfunction or interference.
-  Information
Supplementary note.
 - LED on
 - LED off
 - ✕ LED flashes (2 Hz)
 - ⚡ LED flashes quickly (5 Hz)

1.2 Warning signs used

 **WARNING**

Warning of serious personal injury.
Death or serious irreversible injuries may result.

2 Safety instructions

- Follow the operating instructions.
- Improper use may result in malfunctions of the unit. This can lead to personal injury and/or damage to property during operation of the machine. For this reason note all remarks on installation and handling given in this document. Also adhere to the safety instructions for the operation of the whole installation.
- In case of non-observance of notes or standards, especially when tampering with and/or modifying the unit, any liability and warranty is excluded.
- If the sensor is damaged, the safety function cannot be guaranteed.
- Errors caused by damage cannot be detected by the sensor.
- The unit must be installed, connected and put into operation by a qualified electrician trained in safety technology.
- The applicable technical standards for the corresponding application must be complied with.
- For installation the requirements according to EN 60204 must be observed.
- In case of malfunction of the unit please contact the manufacturer. Tampering with the unit is not allowed.
- Disconnect the unit externally before handling it. Also disconnect any independently supplied relay load circuits.
- After installation, maintenance or repair of the system perform a complete function check.
- Use the unit only in specified environmental conditions (→ 10 Technical data). In case of special operating conditions please contact the manufacturer.
- Use only as described below (→ 4).

2.1 Safety-related requirements regarding the application

It must be ensured that the safety requirements of the respective application correspond to the requirements stated in these instructions.

WARNING

Failure of the safety function

When used outside of the defined environmental conditions, the safety-related function of the sensor cannot be guaranteed.

- Use only in accordance with the defined environmental conditions (→ 10 Technical data).

Use of the sensor in the vicinity of chemical and biological media (solid, liquid, gaseous) as well as ionising radiation is not permitted.

Observe the following requirements:

- Take measures to avoid metallic objects being placed on the sensing face unintentionally.
- Adhere to EN 14119 for interlocking devices associated with guards.
- Adhere to the principle of normally closed operation for all external safety circuits connected to the system.
- In case of faults within the fail-safe sensor which result in the defined safe state: take measures to maintain the safe state when the complete control system continues to be operated.
- Replace damaged units.

3 Items supplied

1 fail-safe sensor GM701S with premounted angle bracket,
1 Allen key for fixing the fail-safe sensor onto the angle bracket
1 original operating instructions GM701S, ident no. 11491861.

If one of the above-mentioned components is missing or damaged, please contact one of the ifm branch offices.

4 Functions and features

The fail-safe inductive sensor GM701S detects metal without contact.

Safety function SF: the safe state (output stage switched off; logic "0") is achieved when undamping greater than or equal to the safe switch-off distance s_{ar} (→ 10 Technical data).

Also observe the notes on installation of the sensor (→ 6 Installation).

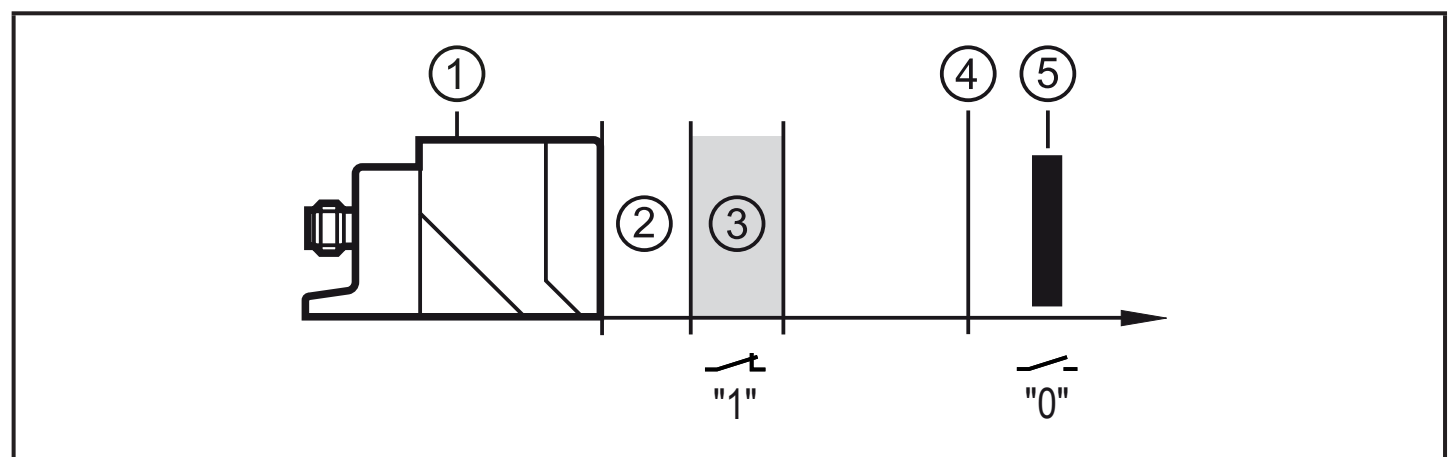
The fail-safe inductive sensor is a proximity device with defined behaviour under fault conditions (PDDb) to IEC 60947-5-3.

The fail-safe sensor conforms to Performance Level e according to EN ISO 13849-1 as well as to the requirements SIL 3 to IEC 61508 and meets SIL_{cl} 3 to IEC 62061.

Depending on the type of installation the unit corresponds to the classification I1C40SP2 to IEC 60947-5-2 for flush installation as well as I2C40SP2 to IEC 60947-5-2 for non-flush installation (→ 6 Installation).

The fail-safe inductive sensor has been certified by TÜV Nord.

5 Function



- 1: dual LED: signal (yellow); power (green)
- 2: close zone
- 3: enable zone
- 4: safe switch-off distance s_{ar}
- 5: target

5.1 Enable zone

The outputs (OSSD) are only enabled when a damping target is present in the enable zone. Outside this enable zone the outputs remain switched off.

The safe switch-off distance s_{ar} is > 30 mm.



The enable zone is different if damping elements which deviate from the standard target plate in terms of material, form and size are used.

Enable zone for selected materials*:

Material	Enable zone
FE360 (= mild steel)	10...15 mm

Material	Enable zone
Stainless steel	7.5...13.2 mm
AlMg3G22	2.0...5.8 mm
Al 99 %	1.4...5.0 mm
CuZn37	2.3...6.2 mm
Copper	0.8...4.3 mm

* Typical values for damping with a reference target of 45 x 45 x 1 mm and non-flush installation to IEC 60947-5-2 at an ambient temperature of 20 °C.



Depending on the characteristics of the damping element there may be no close zone.

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5.2 Protection against simple defeating

The fail-safe sensor reacts to metal objects, e.g. the frame of a safety door. Other metal objects that are not intended to enable the sensor must not be allowed to enable the fail-safe sensor unintentionally.



- Take measures to prevent metal objects, except the designated target, from being placed on the sensing face or in the enable zone unintentionally.

In addition, the sensor has the following switching characteristics to make simple defeating of its safety function more difficult:

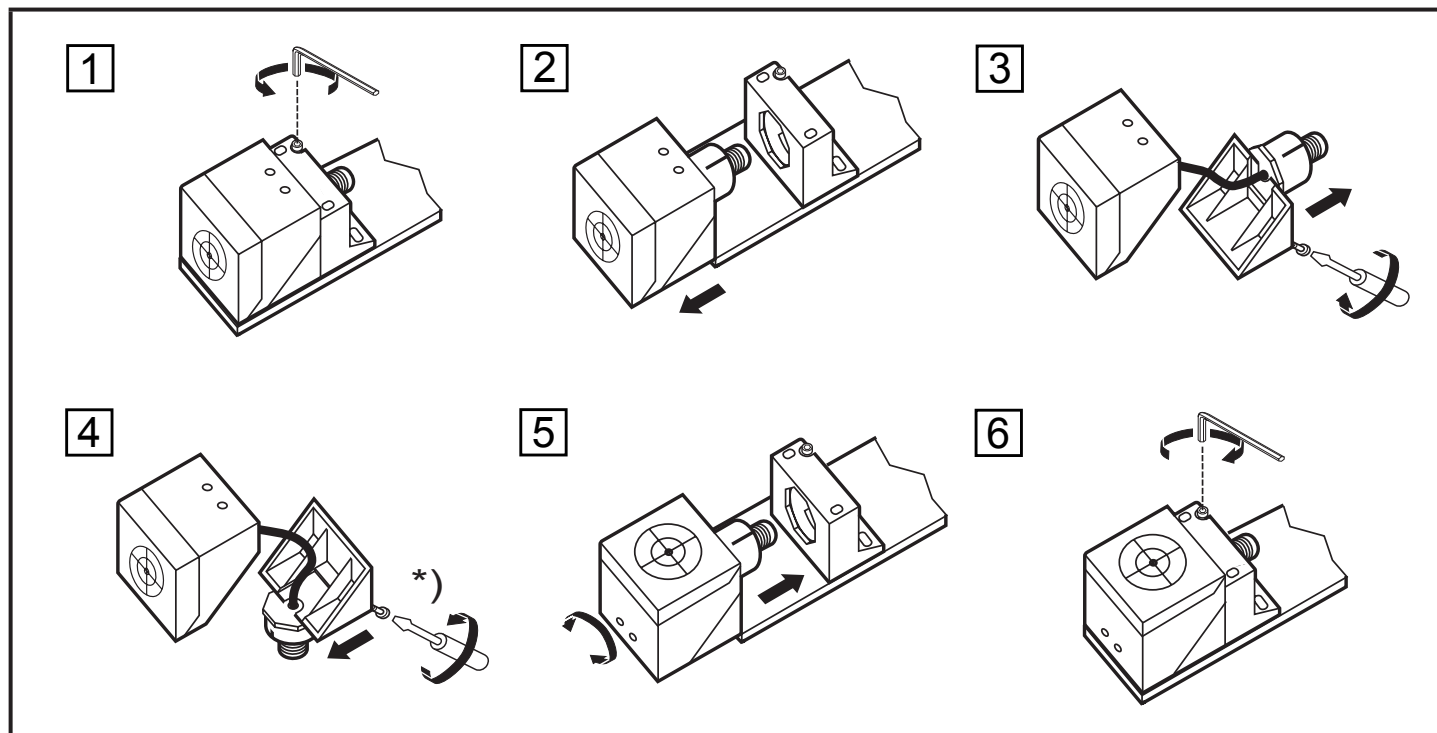
1. By slowly introducing a metallic object into the enable zone, the outputs are immediately switched, but displayed by the LED with a delay of approx. 3 s (→ 9.2.1 Delayed switching of the LED). By doing so, the object is generally in the close range before the LED indication is lit. The technical instructions concerning the restart of the installation must be observed.
2. If the object remains in the close zone for over approx. 2 s, the outputs are completely disabled and no longer enabled in case of damping in the enable zone. If the object stays in the close range for longer than approx. 5 s, the setting aid is activated (→ 8.1).

Release of the enable zone can be carried out

- either by undamping (> 30 mm) for a time of more than 2 s
- or by a voltage interruption (→ 8.3 Deactivate setting aid).

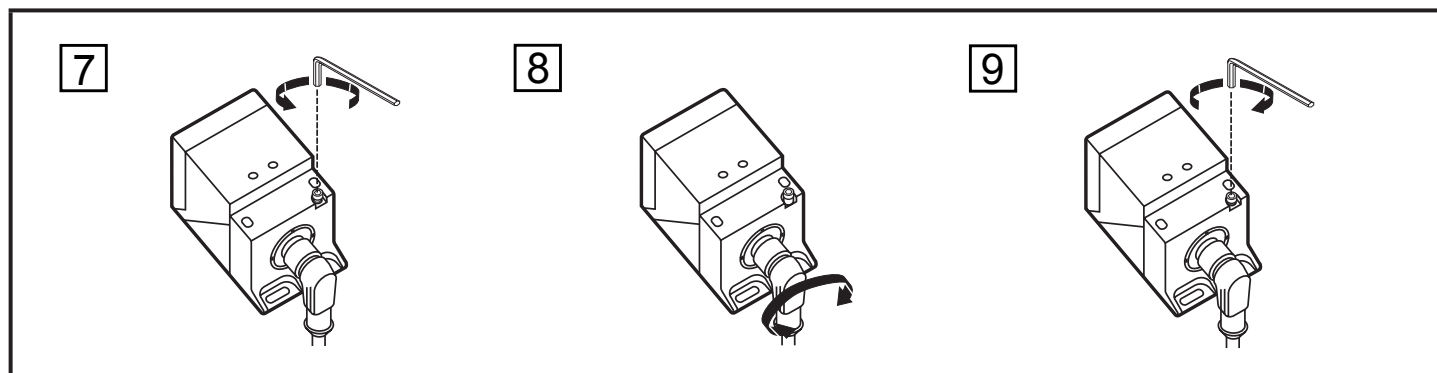
6 Installation

6.1 Alignment of the sensing face



*) max. 1 Nm

The socket is rotatable:

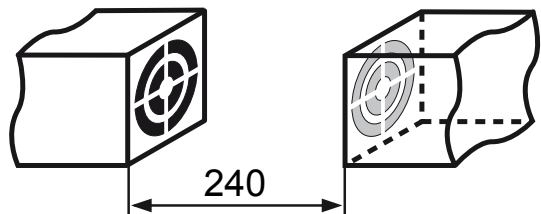
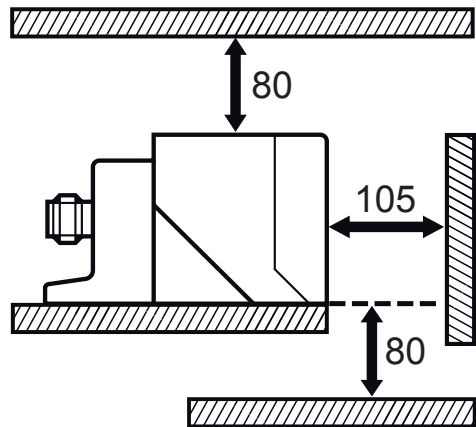
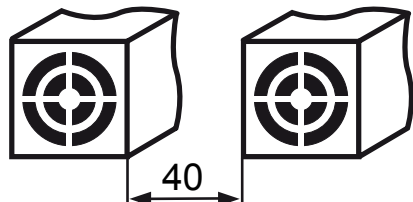
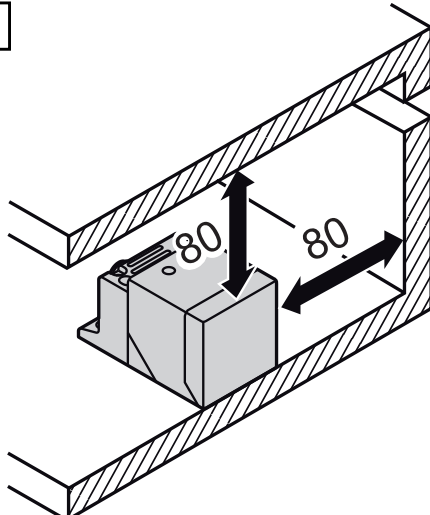
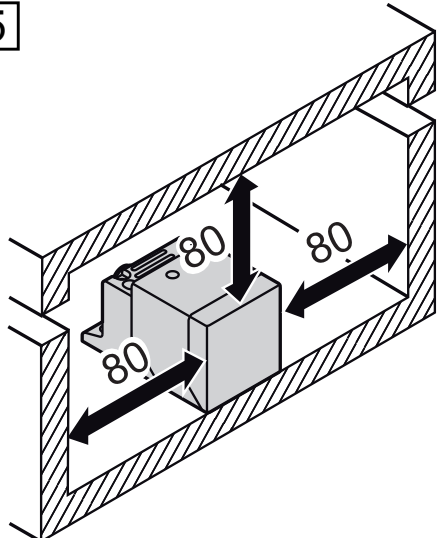


- Tighten the socket according to the manufacturer's indications. Observe the tightening torque for the ifm socket (e.g. EVxxxx: 0.6...1.5 Nm).

6.2 Installation conditions

- The unit is non flush mountable in steel in accordance with IEC 60947-5-2, type I2C40SP2. In addition one side of the unit can be mounted flush with steel.
- The unit can be mounted flush with copper, aluminium and brass according to IEC 60947-5-2, type I1C40SP2.

- Ensure the unit cannot work loose.
- Limit the use of oblong holes to the initial setting.
- Adhere to the installation conditions in accordance with the figures 1 to 5:

1 	3 
2 	
Angle mounting 4 	Channel mounting 5 

7 Electrical connection

Wiring diagram → 10 Technical data

► Disconnect power. Also disconnect any independently supplied relay load circuits.

► Supply voltage: connect L+ to pin 1 and L- to pin 3 of the connector.

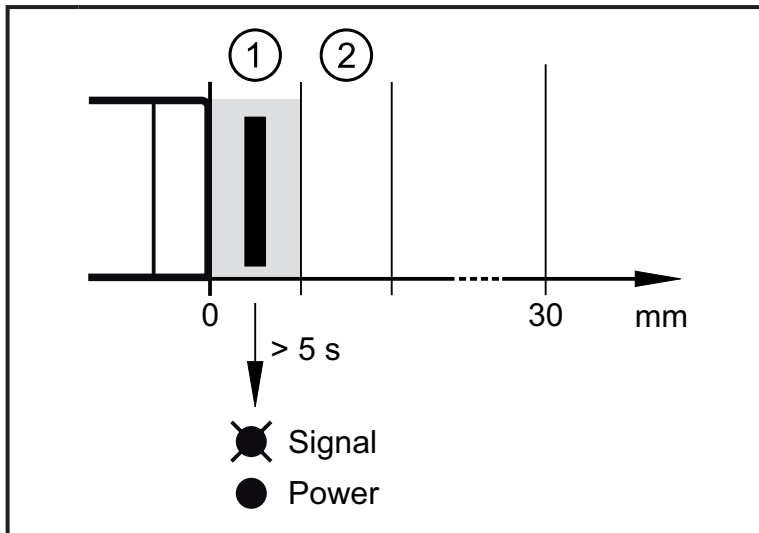
 The nominal voltage is 24 V DC. This voltage may vary between 19.2 V and 30 V incl. 5 % residual ripple to EN 61131-2.

 In case of one fault the supply voltage must not exceed 60 V DC for more than 0.2 s up to a max. value of 120 V DC. (This requires the safe separation between power supply and transformer.)

8 Set-up

8.1 Setting aid

For easy and reliable installation the sensor features an optical setting aid to visualise the enable zone.



The setting aid is activated by placing a metal object in front of the fail-safe sensor (close range).

After approx. 5 s the yellow LED starts to flash: the setting aid is active.

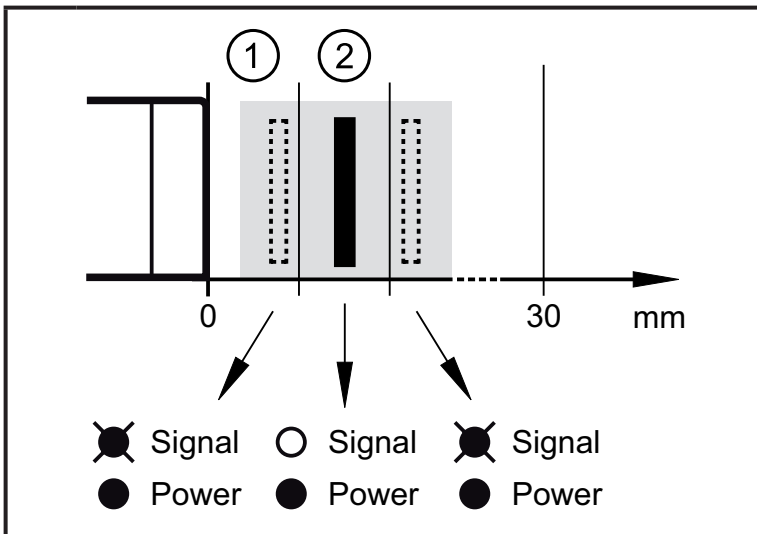
While this mode is active, the output remains in the safe state ("0").

1: close zone

2: enable zone

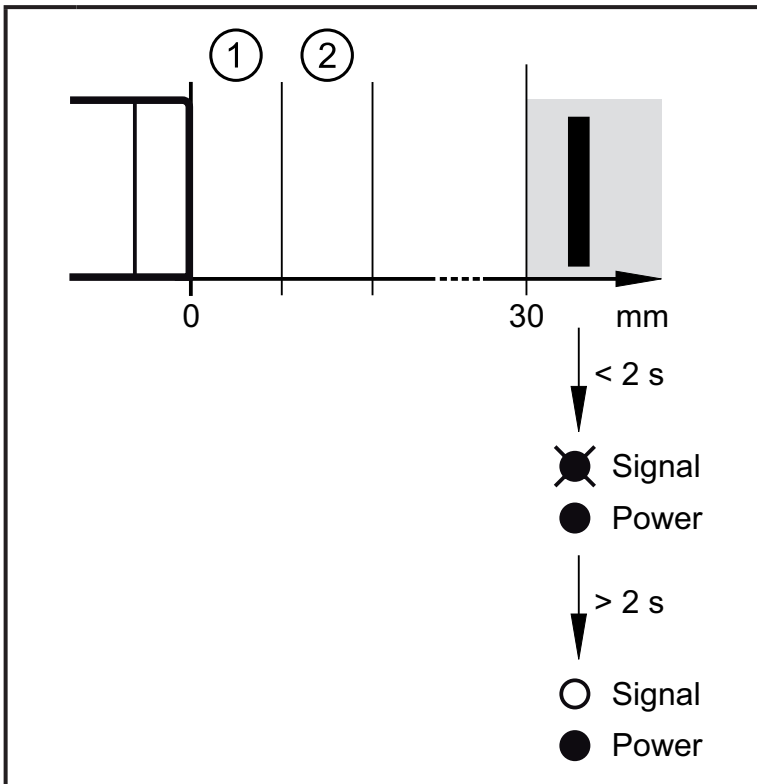
8.2 Determine the enable zone

When the setting aid is active, the enable zone can be determined by moving the target (or the sensor if the target is fixed).



- 1: close zone
2: enable zone

8.3 Deactivate setting aid



- 1: close zone
2: enable zone

As soon as the target enters the enable zone, the yellow LED goes out. If the target is just outside the enable zone in either direction the LED starts to flash again.

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If the sensor is undamped for more than 2 s (> 30 mm), the setting aid is switched off and the yellow LED goes out.

This can also be achieved by power off.

9 Operation

9.1 Switching state of the outputs

9.1.1 The safe state

The safe state is when at least one of the outputs A1 or A2 (OSSDs) is switched off (zero-current state: logic "0").

If one of the outputs A1 or A2 is switched off, the subsequent safety-related logic unit must bring the complete system into the state defined as safe.

9.1.2 The switched state

If the damping element is in the enable zone and if there is no sensor error, both outputs A1 and A2 (OSSDs) are enabled (logic "1").

9.1.3 Output characteristics

The output characteristics are compatible with the input characteristics to EN 61131-2 type 1 or 2:

Logic "1"	$\geq 15 \text{ V}$	2...15 mA
	$\geq 11 \text{ V}$	15...30 mA
Logic "0"	$\leq 5 \text{ V}$	leakage current 0.2 mA *)

*) pull-down current typ. 30 mA

The interface corresponds to interface type C class 0 according to the ZVEI position paper "Klassifizierung binärer 24-V-Schnittstellen mit Testung im Bereich der Funktionalen Sicherheit" (Classification of binary 24V interfaces tested with regard to functional safety).

9.1.4 Cross faults

- A cross fault between both outputs (A1 and A2) is detected by the fail-safe sensor and results in the outputs (OSSD) being switched off at the next safety request. The outputs A1 and A2 remain switched off until the error has been removed.
- A cross fault between one of the two outputs (A1 or A2) and the supply voltage leads to switching off the other output (A2 or A1) in case of a safety request.

9.2 Operating mode

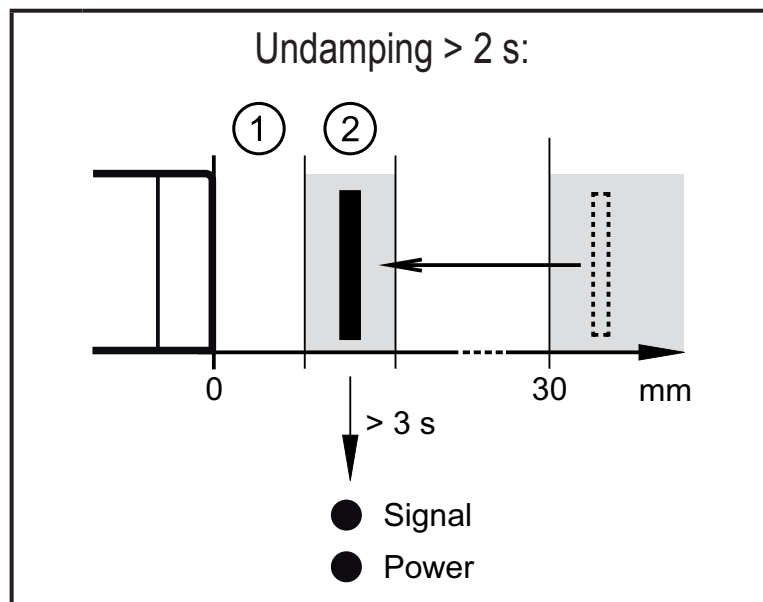
The length of the preceding undamping determines whether the yellow LED comes on with a delay (→ 9.2.1) or without delay (→ 9.2.2) when a target moves into the enable zone. In any case, the outputs switch on without delay.

In case of undamping the outputs switch off and the yellow LED goes out without delay.

In case of damping in the close range the outputs switch off immediately whereas the yellow LED goes out with a delay of approx. 2 s. When the LED goes out the outputs are maintained in the safe state ("0"). Thus, switching on again in the enable zone is not possible. Enabling is done by undamping (> 30 mm) of more than 2 s or by interrupting the voltage (→ 5.2 Protection against simple defeating).

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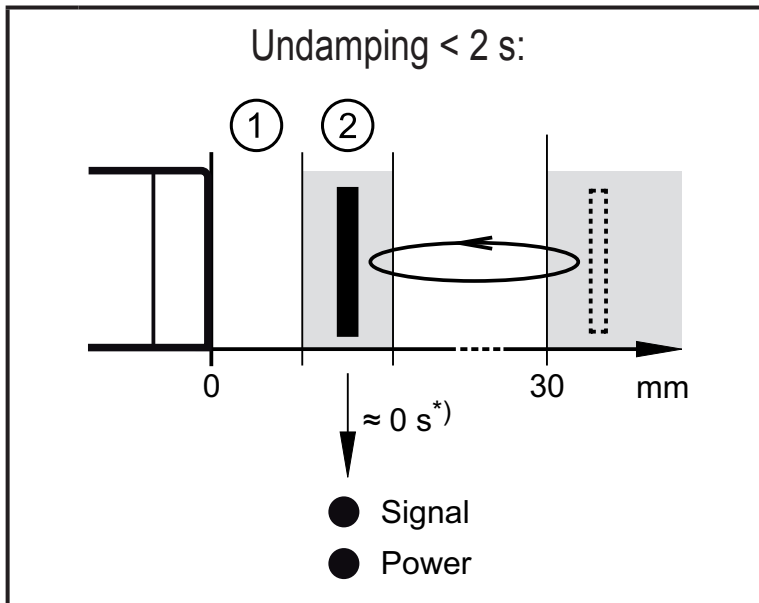
9.2.1 Delayed switching of the LED



If the target was away from the sensor for more than approx. 2 s (> 30 mm), the yellow LED goes on with a delay of approx. 3 s in case of damping in the enable zone.

This is also the case if the target is in the enable zone when the voltage is switched on.

9.2.2 Switching of the LED without delay



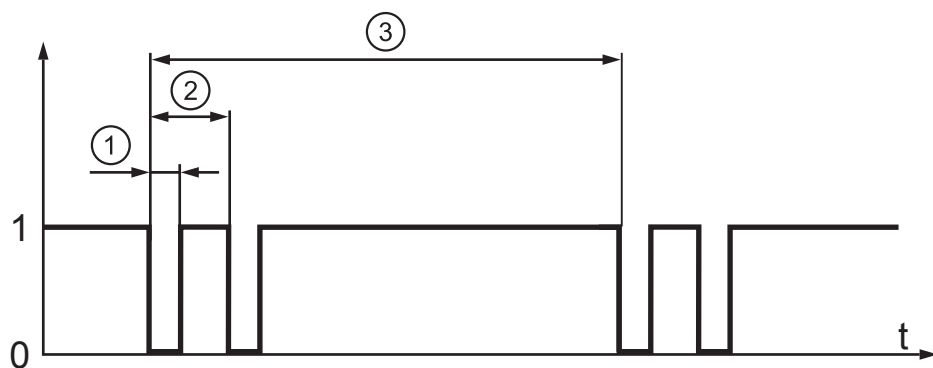
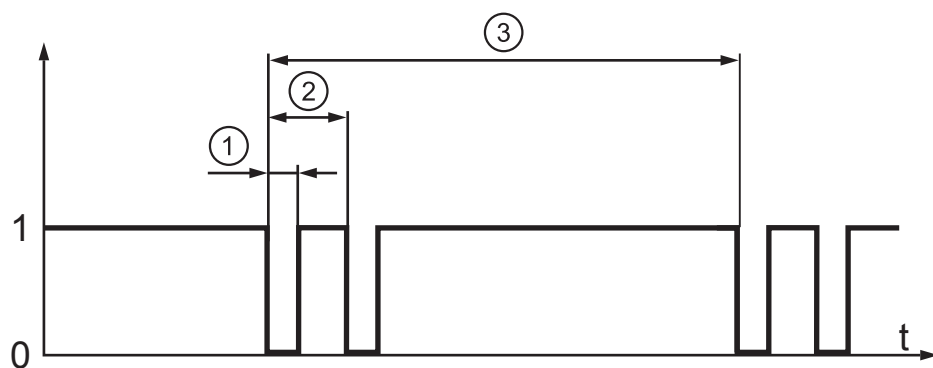
If the target was away from the sensor for less than 2 s (> 30 mm), the yellow LED comes on without delay in case of damping in the enable zone.

- 1: close zone
2: enable zone

*) except for the first start-up

9.3 Response times

Response time on safety request (removal from the enable zone)	≤ 50 ms
Response time when approaching the close range (non safety-related zone)	≤ 100 ms
Response time when approaching the enable zone (enable time)	typ. 100 ms ≤ 200 ms
Risk time / response time for safety-related faults	≤ 100 ms
Permissible dwell time in the close range	approx. 2 s
Delay time to activate the setting aid (→ 8.1)	approx. 5 s
Dwell time in the undamped condition (≥ 30 mm) to return into the operating mode (→ 8.3 Deactivate setting aid)	approx. 2 s
Simultaneity of switching on and off of the outputs in case of a safety request	≤ 50 ms
Test pulse duration t_{i_max} on A1/A2(1)	max. 1 ms
Test pulse interval T_p (2) [pulse package]	min. 2 ms max. 5 ms



- 1: Test pulse duration
- 2: Test pulse interval T_p (pulse package)
- 3: Test pulse interval T

Test pulse interval T (repetition pulse package)

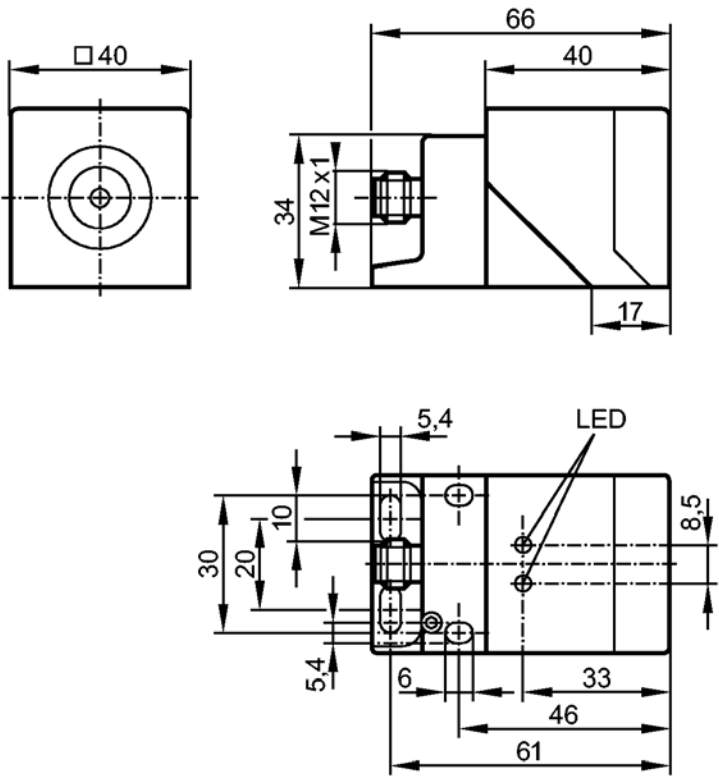
min. 30 ms

max. 50 ms

9.4 LED display

LED		Operating status	Outputs	A1 (OSSD)	A2 (OSSD)
○	Signal	No voltage supply	Both outputs switched off	0	0
○	Power				
○	Signal	Undervoltage		0	0
⊗	Power				
○	Signal	Overvoltage	Both outputs switched off	0	0
⊗	Power				
○	Signal	Target outside the enable zone (operating mode) or in the enable zone (setting aid)	Both outputs switched off	0	0
●	Power				
●	Signal	Target in the enable zone (operating mode)	Both outputs enabled	1	1
●	Power				
⊗	Signal	Target outside the enable zone (setting aid)	Both outputs switched off	0	0
●	Power				
⊗	Signal	Internal or external fault (→ 11 Troubleshooting)		0	0
⊗	Power			0	1
○	Power			1	0

10 Technical data



Product characteristics

Fail-safe inductive sensor
Rectangular, plastics
M12 connector
Enable zone 10...15 mm; [nf] non-flush mountable
Complies with the requirements: EN ISO 13849-1: 2015 category 3 PL e IEC 61508: SIL 3 IEC 62061: SILcl 3

Application

Type of operation	continuous operation (maintenance-free)
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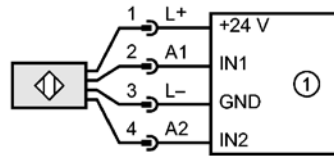
Electrical data

Electrical design	DC PNP
Operating voltage [V]	24 DC (19.2...30 DC)
Rated insulation voltage [V]	30
Current consumption [mA]	< 15
Protection class	III
Reverse polarity protection	yes

Outputs

Output function	2 x OSSD (A1 and A2)
Output data	Interface type C class 0
Output voltage at 24 V	compatible with EN 61131-2 inputs type 1, 2, 3
Voltage drop [V]	< 2.5; (100 mA)
Short-circuit protection	yes
Max. capacitive load CL_max [nF]	20

Range		
Enable zone	[mm]	10...15
Safe switching off distance s(ar)	[mm]	30
Reaction times		
Power-on delay time	[s]	5
Response time to safety request	[ms]	≤ 50
Response time when approaching the enable zone (enable time)	[ms]	≤ 200
Risk time (response time for safety -related faults)	[ms]	≤ 100
Environment		
Applications		Class C to EN 60654-1 weatherproof application
Ambient temperature	[°C]	-25...70, for service life ≤ 87600 h 10...40, for service life ≤ 175200 h
Rate of temperature change	[K/min]	0.5
Max. relative air humidity	[%]	5...95, briefly 5...70, permanently
Air pressure	[kPa]	80...106
Height above sea level	[m]	≤ 2000
Ionising radiation		not permissible
Salt spray		no
Protection		IP 65 / IP 67
Tests / approvals		
EMC	IEC 60947-5-2	
	IEC 60947-5-3	
	EN 60947-5-2	
	EN 61000-4-2 ESD:	6 kV CD / 8 kV AD
	EN 61000-4-3 HF radiated:	20 V/m
	EN 61000-4-4 Burst:	2 kV
	EN 61000-4-6 HF conducted:	10 V
	EN 61000-4-8:	30 A/m
	EN 55011:	class B
Shock resistance		IEC 60947-5-2
Vibration resistance		IEC 60947-5-2
Safety classification		
Mission time TM	[h]	≤ 175200, (20 years)
Safety-related reliability PFHd	[1/h]	1E-08
Mechanical data		
Mounting		non-flush mountable
Housing materials		PPE; diecast zinc
Weight	[kg]	0.305
Displays / operating elements		
Display		LED yellow (signal), LED green (power)
Electrical connection		
Connection		M12 connector; Gold-plated contacts



1: Safety-related logic unit

Remarks

Remarks

Unless stated otherwise, all data refer to the 45x45x1 mm reference target plate to IEC 60947-5-2 (FE360 = mild steel) over the whole temperature range.

Pack quantity

[piece]

1

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11 Troubleshooting

LED display → 9.4

Problem	Possible cause	Troubleshooting
No LED display	No voltage supply	Apply voltage
Power LED flashes and sensor does not switch	• Undervoltage • Overvoltage	Correct the voltage (→ 10 Technical data)
Sensor does not switch, not even after undamping and redamping	Sensor was brought into the safe state (logic "0"). Cause: • cross fault between both outputs A1 and A2 • cross fault between one output (A1 or A2) and the supply voltage • error in the sensor detected	• Switch the operating voltage off and on again • Check wiring and connections • Check external electronics (e.g. PLC) • Remove the cross fault • Replace the unit

12 Maintenance, repair and disposal

If used correctly, no maintenance and repair measures are necessary.

Only the manufacturer is allowed to repair the unit.

After use dispose of the unit in an environmentally friendly way in accordance with the applicable national regulations.

13 Terms and abbreviations

OSSD	Output Signal Switch Device	
PDDb	Proximity devices with defined behaviour under fault conditions	
PFH (PFH _D)	Probability of (dangerous) Failure per Hour	
PL	Performance Level	PL to EN ISO 13849-1
SIL	Safety Integrity Level	SIL 1-4 to IEC 61508. The higher the SIL, the lower the probability that a safety function will fail.
SIL _{cl}	Safety Integrity Level _{claim limit}	According to IEC 62061
T _M	Mission time	Lifetime to EN 60947-5-3 (= max. service life)