ifm electronic

CE

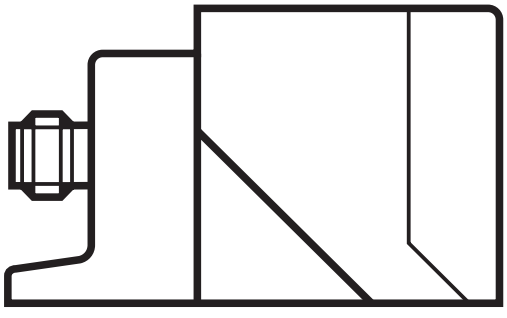
Original operating instructions
Fail-safe inductive sensor

efector100®

GM701S

UK

701976 / 05 10 / 2011



Contents

1 Preliminary note

The instructions are part of the unit. They are intended for authorised persons according to the EMC and Low Voltage Directive 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.
Adhere to the safety instructions.

1.1 Explanation of symbols

▶ Request for action

● LED on

○ LED off

✱ LED flashes

✹ LED flashes quickly

ⓘ Important note

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 these instructions. Also adhere to the safety instructions for the operation of the whole installation.
- In case of non-observance of notes or standards, specially when tampering with and/or modifying the unit, any liability and warranty is excluded.
- 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 setup the system has to be subjected to a complete function check.
- Use the unit only in specified environmental conditions (→ 11 Technical data). In case of special operating conditions please contact the manufacturer.
- Use only as described below (→ 4 Functions and features).

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.

Observe the following requirements:

▶ Take measures to avoid metallic objects being placed on the sensing face intentionally or unintentionally.

▶ Adhere to EN 1088 for interlocking devices associated with guards.

▶ Adhere to the specified operating conditions (→ 11 Technical data). Use of the sensor in the vicinity of chemical and biological media as well as ionising radiation is not permitted.

- ▶ 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 operating instructions GM701S, ident number 701976.

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} (→ 11 Technical data).
Also observe the notes on installation of the sensor (→ 6 Installation).

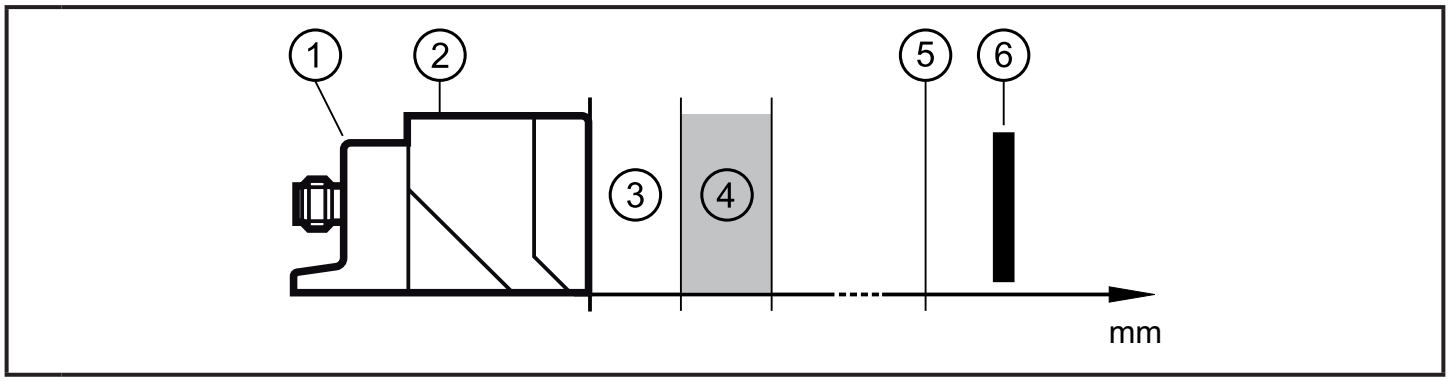
The fail-safe sensor conforms to the category 4 according to EN 954-1 (valid until 31 December 2011), Performance Level e according to EN ISO 13849-1:2008 as well as to the requirements SIL 3 to IEC 61508 and meets SILcl 3 to IEC 62061.

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 TÜVNord.

The unit is suited for applications up to 5 Hz.

5 Function



① fail-safe sensor
② 2 x LED: Signal (yellow); Power (green)
③ close range
④ enable zone
⑤ safe switch-off distance s_{ar}
⑥ 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.

If damped with a standard target plate of 45 x 45 x 1 mm made of FE360 (= mild steel) and non-flush installation to IEC 60947-5-2, the enable zone is in the range of ≤ 10 ... ≥ 15 mm.

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 other materials*:

Material	Enable zone
stainless steel (304/1.4301)	7.5...13.2 mm
AlMg3G22	2.0...5.8 mm
Al 99 %	1.4...5.0 mm
CuZn37	2.3...6.2 mm
Cu	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.

5.2 Protection against simple defeating

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

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

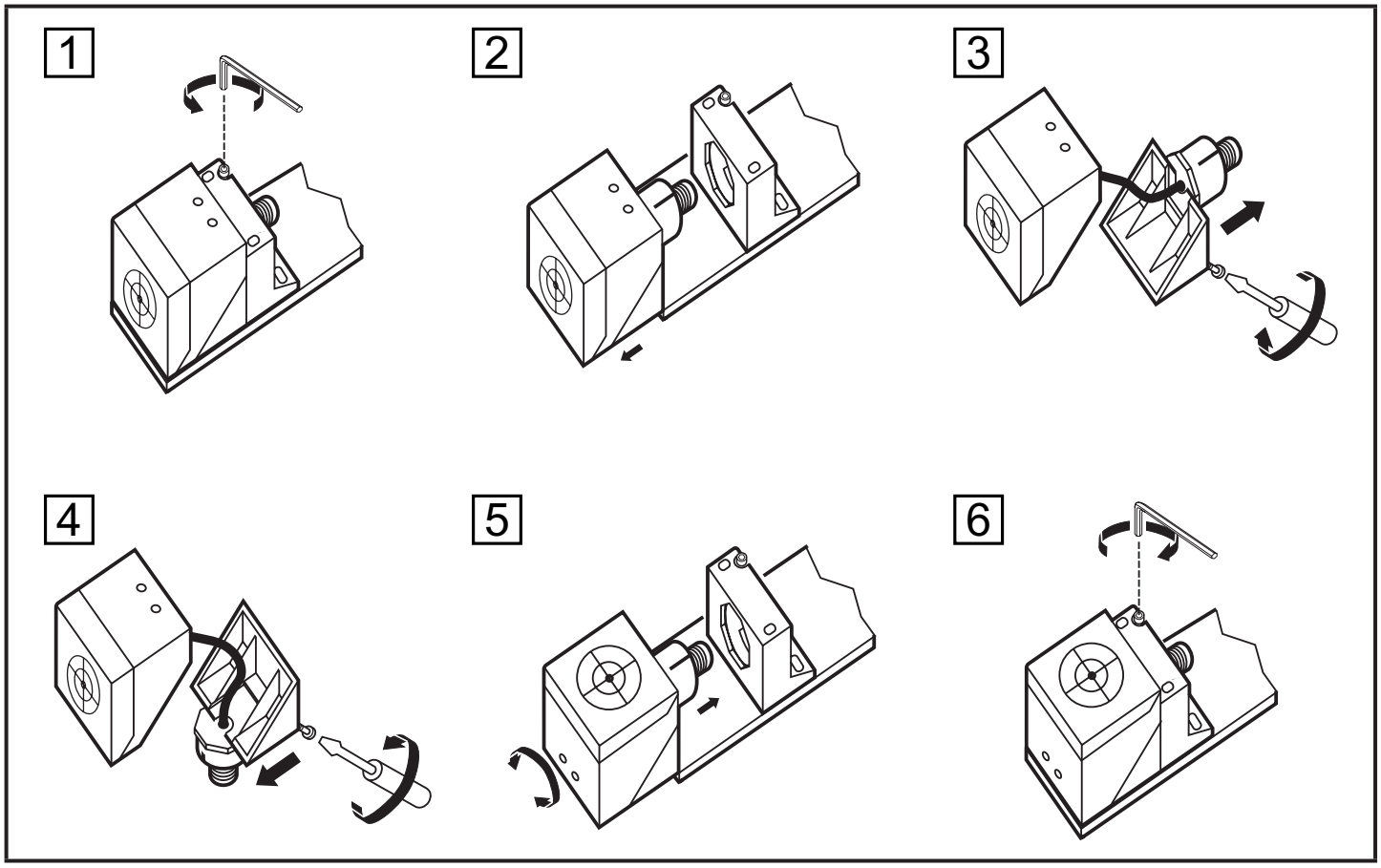
In addition, the sensor has the following switching characteristics to make simple defeating of its safety function more difficult:

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 metal 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 adjustment mode is activated (→ 8.1 Activate adjustment mode).

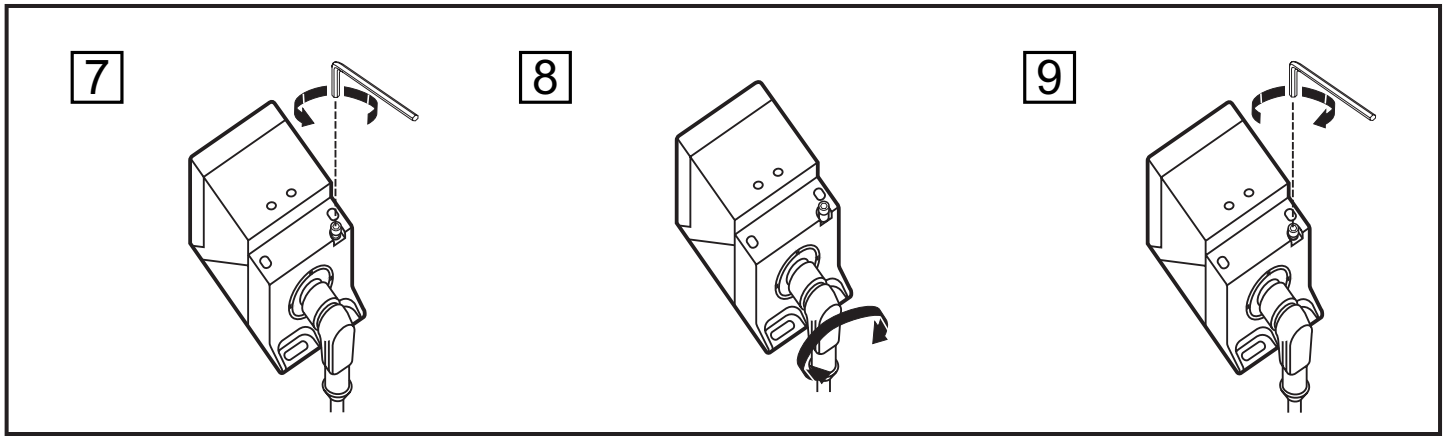
   Release of the enable zone can be carried out
   • by undamping (> 30 mm) for over 2 s
   • or by power off
   (→ 8.3 End adjustment mode).

6 Installation

6.1 Alignment of the sensing face



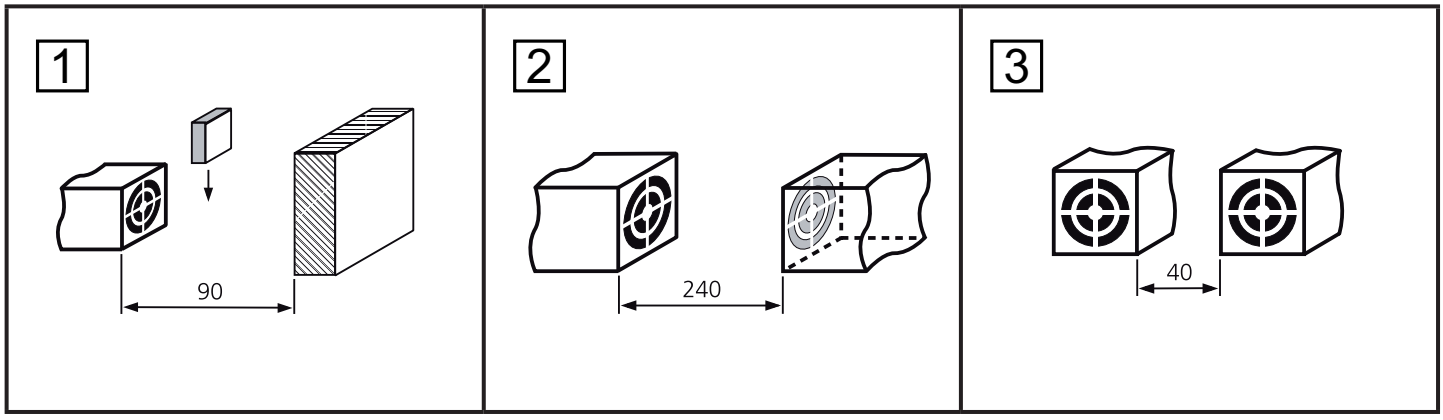
The socket is rotatable:



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.
- ▶ Tighten captive screws with 1 Nm.
- ▶ Limit the use of oblong holes to the initial setting.
- ▶ Adhere to the installation conditions in accordance with the figures 1 to 3:



7 Electrical connection

Wiring diagram → 11 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.

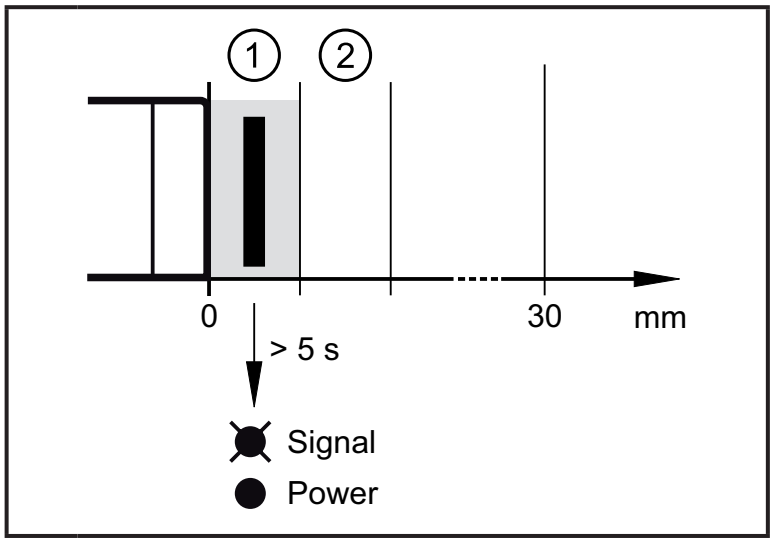
In case of a single fault the supply voltage must not exceed 60 V DC for over 0.2 s up to a max. value of 120 V DC. (This requires the safe separation between power supply and transformer.)

For unit with cULus approval and the scope of validity cULus:
The device shall be supplied from an isolating transformer having a secondary listed fuse rated either
a) max. 5 amps for voltages 0~20 Vrms (0~28.3 Vp) or
b) 100/Vp for voltages of 20~30 Vrms (28.3~42.4 Vp).

8 Set-up

8.1 Activate adjustment mode

For easy and reliable installation the sensor can be put in the adjustment mode.



① close range
② enable zone

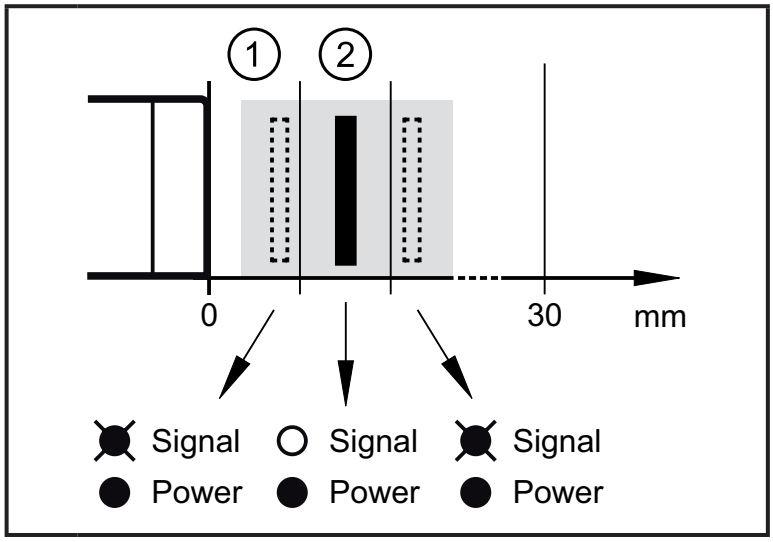
This is done by placing a metallic object directly in front of the sensing face of the fail-safe sensor (close range).

After approx. 5 s the yellow LED starts to flash: The adjustment mode is active.

As long as this mode is active the output stages remain in the safe state.

8.2 Determine the enable zone

If the sensor is in the adjustment mode, the enable zone of the sensor can be determined by moving the damping element.

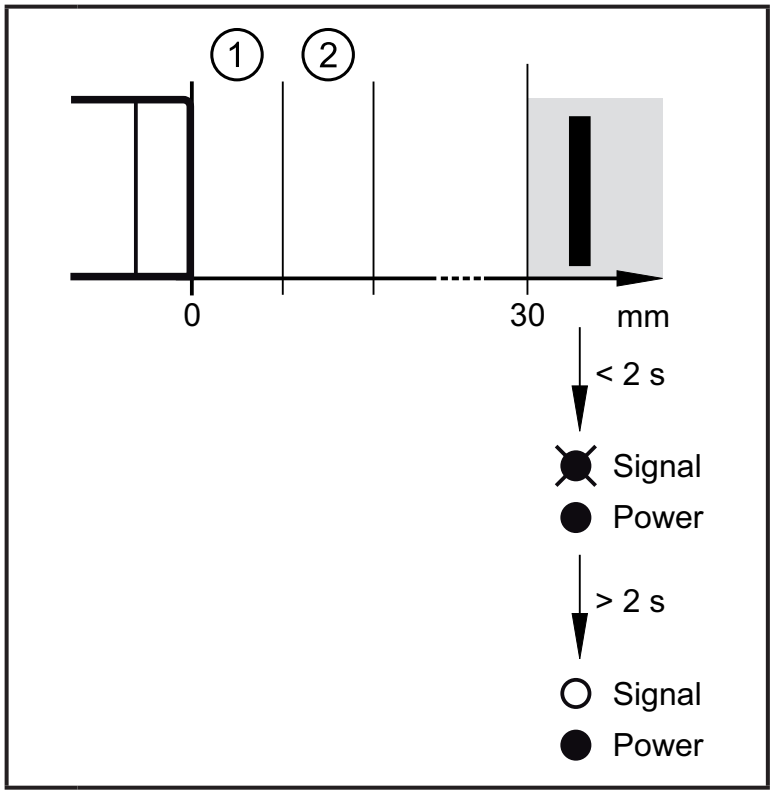


① close range
② enable zone

As soon as damping is carried out in the enable zone, the yellow LED goes out.

If the target is in the close range or in the immediate vicinity of the enable zone, the LED starts to flash again.

8.3 End adjustment mode



① close range
② enable zone

If the sensor is undamped for more than 2 s (> 30 mm), the adjustment mode 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 and A2 (OSSD) is switched off (zero-current state: logic "0").
If one of the outputs A1 and 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 (OSSD) 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"	≥ 15 V	2...15 mA
	≥ 11 V	15...30 mA
Logic "0"	≤ 5 V	leakage current 0.2 mA*)

*) pull-down current typ. 30 mA

9.1.4 Cross faults

- A cross fault between both outputs (A1 and A2) is detected by the fail-safe sensor and leads to switching off the outputs (OSSD) 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.

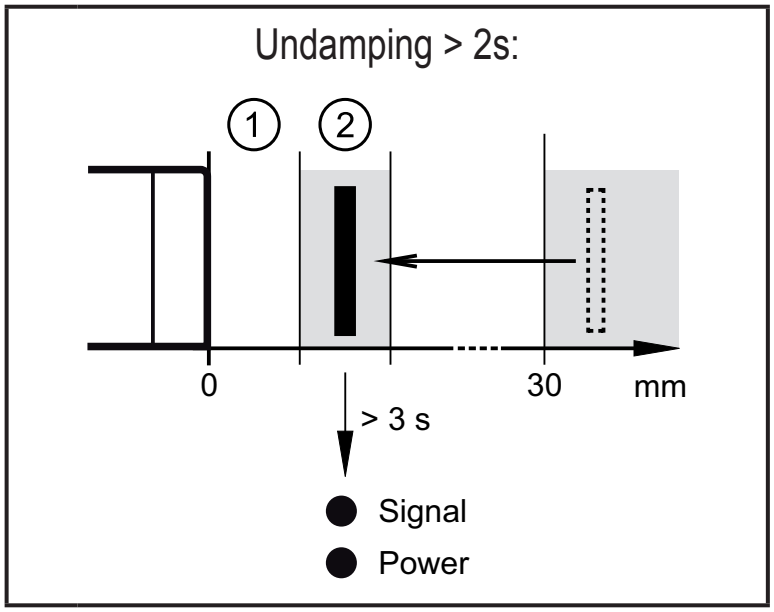
9.2 Operating mode

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. The outputs definitely 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. With the LED going 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).

9.2.1 Delayed switching of the LED

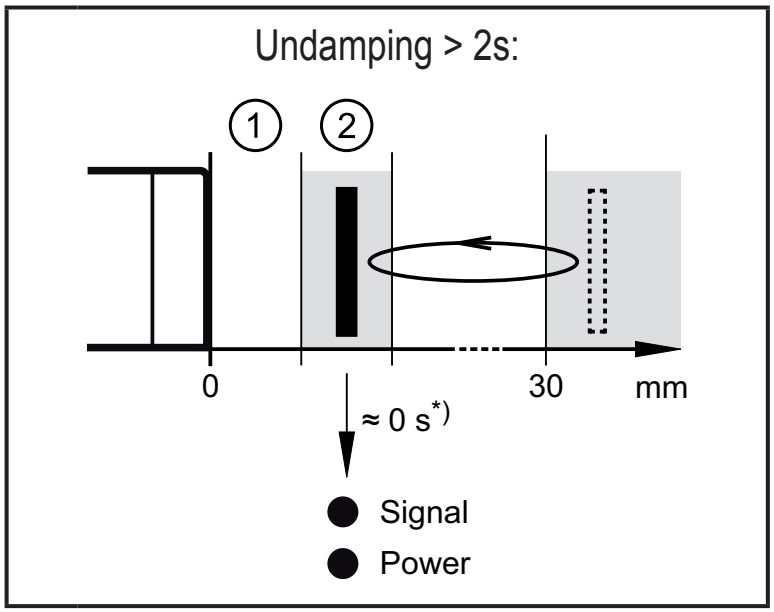


If the target was away from the sensor for more than approx. 2 s (> 30 mm), the yellow LED goes on with a delay of approx. 3 s in case of damping in the enable zone.

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

① close range
② enable zone

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 range
② Enable zone
*) except for the first start-up

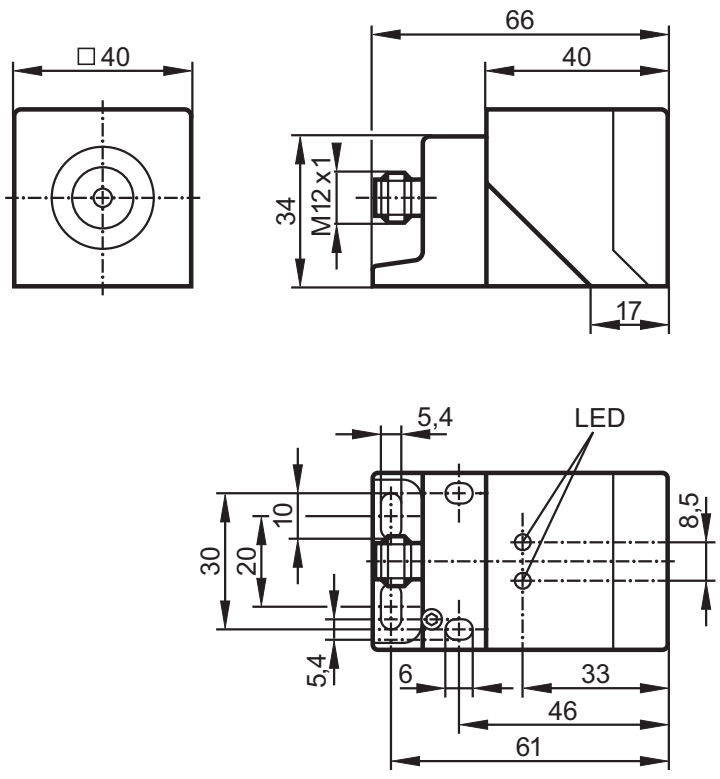
9.3 Response times

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 adjustment mode (→ 8.1 Activate adjustment mode)	approx. 5 s
Dwell time in the undamped condition (≥ 30 mm) to return to the operating mode (→ 8.3 End adjustment mode)	approx. 2 s
Simultaneity of switching on and off of the outputs in the case of a safety request	≤ 50 ms
Duration of switch-off test pulses	≤ 1 ms

9.4 LED display

LED status	Operating status	Outputs	A1 (OSSD)	A2 OSSD
○ Signal ○ Power	no voltage supply	both outputs switched off	0	0
○ Signal ✱ Power	undervoltage		0	0
○ Signal ☀ Power	overvoltage	both outputs switched off	0	0
○ Signal ● Power	target outside the enable zone (operating mode) or in the enable zone (adjustment mode)	both outputs switched off	0	0
● Signal ● Power	target in the enable zone (operating mode)	both outputs enabled	1	1
✱ Signal ● Power	target outside the enable zone (adjustment mode)	both outputs switched off	0	0
✱ Signal ○ Power	internal or external fault (→ 12 Troubleshooting)		0 0 1	0 1 0

10 Scale drawing



11 Technical data

GM701S

GIMC-4030-US/2OSSD

Fail-safe inductive sensor

Rectangular plastic

M12 connector

Enable zone: ≤ 10 ... ≥ ± 15 mm

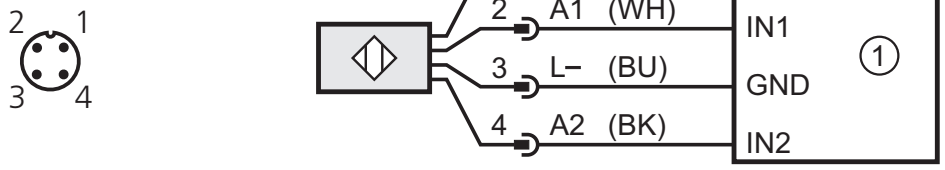
Meets the requirements of:
EN ISO 13849-1: 2008 category 4 PL e,
SIL 3 to IEC 61508: 2000, SILcl 3 to IEC 62061

Operating voltage	24 V DC (19.2...30 V)
Short-circuit protection	yes
Reverse polarity protection	yes
Voltage drop	< 2.5 V @ 100 mA
Current consumption	< 15 mA
Outputs A1, A2 (OSSD)	PNP

Rated insulation voltage	30 V
Output voltage at 24 V	compatible with EN 61131-2 inputs type 1, 2 and 3
Response time	response time on safety request (removal from the enable zone): ≤ 50 ms response time when approaching the enable zone (enable time): ≤ 200 ms
Risk time (response time for safety-related faults)	≤ 100 ms
Power-on delay time	5 s
Safe switch-off distance s_{ar}	30 mm
Operating mode	continuous operation (maintenance-free)
EMC / vibration, shock	according to IEC 60947-5-2
Application	class C to EN 60654-1 (weatherproof application)
Climate	
Air pressure	80...106 kPa
Salt spray	no
Height above sea level	max. 2000 m
Ionising radiation	not permissible
Rate of temperature change	0,5 K/min
Ambient temperature	-25..70 °C for service life ≤ 87 600 h 10...40 °C for service life ≤ 175 200 h
Relative air humidity	5...95 % for service life ≤ 87 600 h 5...70 % for service life ≤ 175 200 h
Mission time T_M (mission time)	≤ 87 600 h (10 years) at -25...70 °C and 5...95 % relative humidity ≤ 175 200 h (20 years) at 10...40 °C and 5...70 % relative humidity
Safety-related reliability (to IEC 61508)	PFH < 2.5 x 10^{-9}/ h
$MTTF_D$	1992 years
DC / CCF / Cat.	99 % / 100 % / 4
Protection	IP 65 / IP 67 (to EN 60529), III
Housing materials	PPE; diecast zinc

Display	LED yellow (Signal); LED green (Power)
Connection	M12 connector, gold-plated contacts

Wiring



① Evaluation unit or PLC

Core colours:
BK: black
BN: brown
BU: blue
WH: white

Comments:

Unless stated otherwise, all data refer to the 45 x 45 x 1 mm reference target plate to IEC 60947-5-2 (FE360 = mild steel) over the whole temperature range.

12 Troubleshooting

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 (→ 11 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

13 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.

14 Approvals / standards

The following standards and directives have been applied:

- 2006/42/EC European Machinery Directive
- 2004/108/EC EMC Directive
- EN ISO 13849-1 PL e (2008) Safety of machinery - Safety-related parts of control systems
- IEC 60947-5-2 (2007) Low-voltage switchgear and controlgear: Control circuit devices and switching elements - Proximity switches
- IEC 61508 (2000)
- IEC 62061 (2005)
- UL 508

15 Terms and abbreviations

CCF	Common Cause Failure	
DC	Diagnostic Coverage	
$MTTF_D$	Mean Time To Dangerous Failure	
OSSD	Output Signal Switching Device	
PFH	Probability of 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 $Level_{Claim\ Limit}$	to IEC 62061
T_M	Mission Time	Lifetime (= max. service life)