Original operating instructions
Fail-safe inductive sensor
efector100
GG851S
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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 Directive. 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.

1.1 Explanation of symbols

▷ Instructions
→ Cross-reference
⚠ Important note
Non-compliance can result in malfunction or interference.
ℹ Information
Supplementary note.

● LED on
○ LED off
❖ LED flashes (2 Hz)
☀ LED flashes quickly (5 Hz)
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 (→ 9 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.

Observe the following requirements:

► Take appropriate measures for a permanent and safe fixing (→ 6 Installation).

► In case of lateral damping in the area of the safe switch-off distance of < 5 mm, the target must stay there until the safe state of the complete system is achieved. Note the response time for safety-related faults of the sensor!
► The safe fixing must be regularly maintained at suitable intervals (cyclical inspection). Document maintenance actions (time, persons etc.).

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

► Adhere to the specified operating conditions (→ 9 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 GG851S with 2 lock washers and 2 M18 fixing nuts,
1 original operating instructions GG851S, ident no. 80005307.
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 GG851S detects metal without contact.
Safety function SF: the safe state (output stage switched off; logic "0") is achieved when damping smaller than the safe switch-off distance (→ 9 Technical data). Also observe the notes on installation of the sensor (→ 6 Installation).

The fail-safe sensor conforms to Performance Level d according to EN ISO 13849-1 as well as to the requirements SIL 2 to IEC 61508 and meets SILcl 2 to IEC 62061.

The unit corresponds to the classification I1A18SP2 to IEC 60947-5-2 for flush installation (→ 6 Installation).

The fail-safe inductive sensor has been certified by TÜVNord.
5 Function

1: fail-safe sensor
2: safe switch-off distance
3: inadmissible zone
4: enable zone
5: target

Yellow signal LED: switching status
Green power LED: operating voltage

5.1 Enable zone

The outputs (OSSDs) are only enabled when undamping in the enable zone > 10 mm. The change of switching states of the OSSDs is carried out in the inadmissible zone (3). Below the safe switch-off distance the sensor is damped and the outputs (OSSDs) are switched off.

► Take measures to ensure that the damping element does not remain in the inadmissible zone.

If damped with a reference target of 24 x 24 x 1 mm made of FE360 and flush installation to IEC 60947-5-2, the safe switch-off distance is < 5 mm.

⚠ The safe switch-off distance is different if damping elements which deviate from the reference target in terms of material, form and size are used.

Recommendation: Set the demand upon the safety function to half the safe switch-off distance.
6 Installation

The sensor can be mounted flush according to IEC 60947-5-2, type I1A18SP2.

**Ensure the unit cannot work loose by using the supplied lock washers:**

- Use the supplied lock washers and tighten the fixing nut with 15...25 Nm.

**Do not use the supplied lock washers and nuts for softer materials (e.g. aluminium, plastics, wood).**

Secure fixing is only assured with a carrier material hardness of 230...350 HV (table ISO 18265, Vickers hardness ISO 898-1).

**Verify the safe fixing:**

1. Loosen the fixing nut.
   - The lock washer must not rotate simultaneously.
   - The torque for opening the connection must be greater than the tightening torque.
   - Lock washer marks must be clearly visible in the carrier material.
2. Tighten the fixing nut with 15...25 Nm.

**No mechanical forces may be exerted. Forces required for safe fixing are exempt from this.**

**Adhere to the installation conditions in accordance with the figures 1 to 3:**

- 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).
7 Electrical connection

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

⚠ The sensor can be damaged if energized during connection.

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

ℹ 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 a maximum of 40 V DC. (This requires the safe separation between power supply and transformer.)

7.1 Operation as 4-wire unit

![Diagram of 4-wire unit]

1: safety-related logic unit

7.2 Operation as 3-wire unit

![Diagram of 3-wire unit]

1: safety-related logic unit

* When there is no current flow on the output stage, back feeding > 3.5 V will lead to malfunction.
In case of operation as 3-wire unit only A2 must be used as output (OSSD). Otherwise the safety function of the sensor will be impaired or prevented.

► Connect output A1 to supply voltage.

Make absolutely sure to exclude cross faults and short circuits between the supply voltage and output A2 by means of appropriate installation.

The indicated values regarding the safety function (→ 9 Technical data) remain unchanged.

8 Operation

8.1 Switching state of the outputs

8.1.1 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.

8.1.2 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").

8.1.3 Output characteristics

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

| Logic "1" | ≥ 15 V | ≥ 11 V | 2...15 mA | 15...30 mA |
| Logic "0" | ≤ 5 V  |       |           |            |

leakage current 0.2 mA

8.1.4 Cross fault / short circuit

• 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 or a voltage reset has been carried out.

• A cross fault (short circuit) between output A2 and the supply voltage results in the other output A1 being switched off in case of a safety request. A short circuit of A1 and L+ leads to operation as 3-wire unit (→ 7.2).
• The subsequent safety-related logic unit (e.g. safe PLC or safety relay) must be able to detect faults via dual-channel evaluation (e.g. "stuck-at faults"). The monitored hazardous area may only be enabled if both inputs of the safety-related logic unit were previously switched off at the same time (logic "0").
• When there is no current flow on the output stage, back feeding > 3.5 V will lead to malfunction.

8.2 Response times

<table>
<thead>
<tr>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response time on safety request (removal from the enable zone)</td>
<td>≤ 5 ms</td>
</tr>
<tr>
<td>Response time when approaching the enable zone (enable time)</td>
<td>≤ 5 ms</td>
</tr>
<tr>
<td>Risk time / response time for safety-related faults</td>
<td>≤ 45 ms</td>
</tr>
<tr>
<td>Simultaneity of switching on and off of the outputs in case of a safety request</td>
<td>≤ 1 ms</td>
</tr>
<tr>
<td>Duration of switch-off test pulses on output A2</td>
<td>≤ 1 ms</td>
</tr>
</tbody>
</table>
### 8.3 LED display

<table>
<thead>
<tr>
<th>LED</th>
<th>Operating status</th>
<th>Outputs</th>
<th>A1 (OSSD)</th>
<th>A2 (OSSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>Signal Power</td>
<td>No voltage supply</td>
<td>Both outputs switched off</td>
<td>0 0</td>
</tr>
<tr>
<td>○</td>
<td>Signal Power</td>
<td>Undervoltage</td>
<td></td>
<td>1 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>○</td>
<td>Signal Power</td>
<td>Overvoltage</td>
<td>Both outputs switched off</td>
<td>0 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensor fault (→ 10 Troubleshooting)</td>
<td>One output or both outputs switched off</td>
<td>0 1 1 0</td>
</tr>
<tr>
<td>○</td>
<td>Signal Power</td>
<td>damping element is at safe switch-off distance from the sensor (&lt; 5 mm)</td>
<td>Both outputs switched off</td>
<td>0 0</td>
</tr>
<tr>
<td>●</td>
<td>Signal Power</td>
<td>damping element is in the enable zone (&gt; 10 mm)</td>
<td>Both outputs enabled</td>
<td>1 1</td>
</tr>
</tbody>
</table>
# 9 Technical data

## Made in Germany

### Product characteristics

- Fail-safe inductive sensor
- Metal thread
- M12 connector
- Enable zone > 10 mm; [f] flush mountable

Complies with the requirements:
- EN ISO 13849-1: 2008 category 2 PL d
- IEC 61508: SIL 2
- IEC 62061: SILcl 2

### Application

- Type of operation: continuous operation (maintenance-free)

### Electrical data

<table>
<thead>
<tr>
<th>Electrical design</th>
<th>DC PNP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage [V]</td>
<td>24 DC (10...30 DC)</td>
</tr>
<tr>
<td>Rated insulation voltage [V]</td>
<td>30</td>
</tr>
<tr>
<td>Current consumption [mA]</td>
<td>&lt; 30</td>
</tr>
<tr>
<td>Protection class</td>
<td>III</td>
</tr>
<tr>
<td>Reverse polarity protection</td>
<td>yes</td>
</tr>
<tr>
<td>Power-on delay time [s]</td>
<td>1</td>
</tr>
</tbody>
</table>

### Outputs

- Output function: 2 x OSSD (A1 and A2)
- Output voltage at 24 V: compatible with EN 61131-2 inputs type 1, 2
  - Voltage drop [V]: < 2.5; (30 mA)
  - Minimum load current [mA]: 2
  - Current rating [mA]: 50
  - Short-circuit protection: yes

### Range

- Enable zone [mm]: > 10
- Safe switching off distance s(ar) [mm]: < 5

### Reaction times

- Response time to safety request [ms]: ≤ 5
- Response time when approaching the enable zone (enable time) [ms]: ≤ 5
- Risk time (response time for safety-related faults) [ms]: ≤ 45
### Environment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Class C to EN 60654-1 weatherproof application</td>
</tr>
<tr>
<td>Ambient temperature [°C]</td>
<td>-25...70, for service life ≤ 87600 h</td>
</tr>
<tr>
<td></td>
<td>10...40, for service life ≤ 175200 h</td>
</tr>
<tr>
<td>Rate of temperature change [K/min]</td>
<td>0.5</td>
</tr>
<tr>
<td>Max. relative air humidity [%]</td>
<td>5...95, briefly</td>
</tr>
<tr>
<td></td>
<td>5...70, permanently</td>
</tr>
<tr>
<td>Air pressure [kPa]</td>
<td>80...106</td>
</tr>
<tr>
<td>Height above sea level [m]</td>
<td>≤ 2000</td>
</tr>
<tr>
<td>Ionising radiation</td>
<td>not permissible</td>
</tr>
<tr>
<td>Salt spray</td>
<td>Tested to IEC 60068-2-11</td>
</tr>
<tr>
<td>Protection</td>
<td>IP 65 / IP 67</td>
</tr>
</tbody>
</table>

### Tests / Approvals

<table>
<thead>
<tr>
<th>Test / Approval</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC</td>
<td>IEC 60947-5-2</td>
</tr>
<tr>
<td>Shock resistance</td>
<td>IEC 60947-5-2</td>
</tr>
<tr>
<td>Vibration resistance</td>
<td>IEC 60947-5-2</td>
</tr>
</tbody>
</table>

### Safety Classification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission time TM [h]</td>
<td>≤ 175200, (20 years)</td>
</tr>
<tr>
<td>Safety-related reliability PFHd [1/h]</td>
<td>&lt; 1.0E-07</td>
</tr>
<tr>
<td>MTTFd [Years]</td>
<td>900</td>
</tr>
<tr>
<td>DC/CCF/Cat.</td>
<td>85 % / 65 % / 2</td>
</tr>
</tbody>
</table>

### Mechanical Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting</td>
<td>flush mountable</td>
</tr>
<tr>
<td>Housing materials</td>
<td>Brass white bronze coated; PBT</td>
</tr>
<tr>
<td>Weight [kg]</td>
<td>0.15</td>
</tr>
</tbody>
</table>

### Displays / Operating Elements

| Display                          | LED yellow (signal), LED green (power)                                |

### Electrical Connection

| Connection                      | M12 connector; Gold-plated contacts                                  |

### Wiring

1: Safety-related logic unit

### Accessories

| Accessories                     | 2 lock nuts                                                          |

### Remarks

| Remarks                          | Unless stated otherwise, all data refer to the 24x24x1 mm reference target plate to IEC 60947-5-2 (FE360 = mild steel) over the whole temperature range. |

| Pack quantity [piece]            | 1                                                                    |

ifm electronic gmbh • Friedrichstraße 1 • 45128 Essen — GB — GG851S-03 — 21.08.2013
## 10 Troubleshooting

**LED display → 8.3**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible cause</th>
<th>Troubleshooting</th>
</tr>
</thead>
<tbody>
<tr>
<td>No LED display</td>
<td>No voltage supply</td>
<td>Apply voltage</td>
</tr>
<tr>
<td>Power LED flashes and sensor does not switch</td>
<td>• Undervoltage</td>
<td>Correct the voltage (→ 9 Technical data)</td>
</tr>
<tr>
<td></td>
<td>• Overvoltage</td>
<td></td>
</tr>
<tr>
<td>Sensor does not switch, not even after undamping and redamping</td>
<td>Sensor was brought into the safe state (logic &quot;0&quot;). Cause:</td>
<td>• Remove the cross fault</td>
</tr>
<tr>
<td></td>
<td>• cross fault between both outputs A1 and A2</td>
<td>• Replace the unit</td>
</tr>
<tr>
<td></td>
<td>• cross fault between one output (A1 or A2) and the supply voltage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• error in the sensor detected</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 3-wire operation: A1 and A2 reversed</td>
<td>• Remove L+ from A2 and connect to A1</td>
</tr>
</tbody>
</table>

## 11 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.
12 Approvals / standards
The following standards and directives have been applied:

- 2006/42/EC European Machinery Directive
- 2004/108/EC EMC Directive
- IEC 61508 (2010)
- IEC 62061 (2005)
- UL 508

13 Terms and abbreviations

<table>
<thead>
<tr>
<th>CCF</th>
<th>Common Cause Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>Diagnostic Coverage</td>
</tr>
<tr>
<td>MTTF D</td>
<td>Mean Time To Dangerous Failure</td>
</tr>
<tr>
<td>OSSD</td>
<td>Output Signal Switch Device</td>
</tr>
<tr>
<td>PFH (PFH D)</td>
<td>Probability of (dangerous) Failure per Hour</td>
</tr>
<tr>
<td>PL</td>
<td>Performance Level</td>
</tr>
<tr>
<td>SIL</td>
<td>Safety Integrity Level</td>
</tr>
<tr>
<td>SIL cl</td>
<td>Safety Integrity Level claim limit</td>
</tr>
<tr>
<td>T M</td>
<td>Mission time</td>
</tr>
</tbody>
</table>

- PL to EN ISO 13849-1
- SIL 1-4 to IEC 61508. The higher the SIL, the lower the probability that a safety function will fail.
- According to IEC 62061
- Lifetime (= max. service life)