Special Features
• Touchless hall technology
• Electrical range 360°
• 2-part, mechanically decoupled
• High protection class IP67, IP68, IP69
• Resolution 14 bit
• Wear-free
• Temperature range -40 °C to +105 °C
• One and multi-channel versions
• Optimized for use in mobile applications with highest EMC requirements such as ISO pulses and high interferences to ISO 11452, exceeds E1 requirements
• Other configurations see separate data sheets

Applications
• Mobile working machines (industrial trucks, construction machinery, agricultural and forestry machinery)
• Marine applications

The two-part design consisting of sensor and magnetic position marker offers great flexibility when mounting. The absence of shaft and bearing makes the assembly much less sensitive to axial and radial application tolerances - separate couplings are obsolete. Measurements can be made transmissively through any non-ferromagnetic material.

The sensor is perfectly suitable for use in harsh environmental conditions through the completely encapsulated electronics.

<table>
<thead>
<tr>
<th>Description</th>
<th>Material</th>
<th>Housing: high grade, temperature resistant plastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting</td>
<td>With 2 lens flange head screws M4x20 (included in delivery)</td>
<td></td>
</tr>
<tr>
<td>Fastening torque of mounting</td>
<td>250 Nm</td>
<td></td>
</tr>
<tr>
<td>Electrical connection</td>
<td>Cable 2x 2x 0.34 mm² (AWG 22), TPE, shielded / Connector M12x1, A-coded with cable L = 0.15 m / Cable 4x 2x 0.25 mm² (AWG 24), TPE, shielded</td>
<td></td>
</tr>
</tbody>
</table>

| Mechanical Data | Dimensions | See dimension drawing |
### Ordering Specifications

**Preferred types printed in bold**
- Delivery time up to 25 pcs. within 10 working days EXW
- Best low-volume pricing

### Interface

**J: CAN SAE J1939**

<table>
<thead>
<tr>
<th>Interface parameters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1: 1x position, 1x speed, 1x revolution counter</td>
<td></td>
</tr>
<tr>
<td>2: 2x position, 2x speed</td>
<td></td>
</tr>
<tr>
<td>3: 2x position, 1x revolution counter</td>
<td></td>
</tr>
<tr>
<td>5: 1x position, 1x speed, 1x revolution counter with bus termination 120Ω</td>
<td></td>
</tr>
<tr>
<td>6: 2x position, 2x speed with bus termination 120Ω</td>
<td></td>
</tr>
<tr>
<td>7: 2x position, 1x revolution counter with bus termination 120Ω</td>
<td></td>
</tr>
</tbody>
</table>

**Baud rate**
- 3: 500 kBit/s
- 4: 250 kBit/s

**Electrical connection**
- 231: Cable, 4-pole, shielded, L = 0.5 m
- 232: Cable, 4-pole, shielded, L = 1 m
- 236: Cable, 4-pole, shielded, L = 3 m
- 240: Cable, 4-pole, shielded, L = 5 m
- 432: Cable, 8-pole, shielded, L = 1 m (CAN in/out)
- 511: Connector M12x1, 5-pin, with cable, shielded, L = 0.15 m

Cable versions and assembled connectors on request

### Resolution

14: 14 bits

### Interface

2: Digital Interface

### Series

<table>
<thead>
<tr>
<th>Mechanical version</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4851: Elongated hole mounting</td>
<td></td>
</tr>
<tr>
<td>4852: Round hole mounting</td>
<td></td>
</tr>
</tbody>
</table>
When the marking of the position marker is pointing towards the cable, the sensor output is near the electrical center position.
**Type**
- RFC-48...-214-J...

**Measured variables**
- Position, speed, revolution counter

**Measuring range**
- 360°

**Measuring range speed**
- 0 ... 750 rpm

**Number of channels**
- 1 / 2

**Output signal / Protocol**
- CAN SAE J1939

**Programmable parameters**
- Offset position, counting direction, averaging, baud rate, transmit mode, transmit cycle, source address, resolution position, resolution speed

**Diagnosis**
- activated (in case of error output signal is outside of the plausible signal range)

**Source Address**
- 128 ... 247 (dynamic address claiming)

**Baud rate**
- 250, 500 kBaud (default 250 kBaud)

**Update rate**
- 1 kHz

**Resolution position (across 360°)**
- 14 bits

**Resolution speed (LSB)**
- 0.055°/s ... 2.2°/s

**Independent linearity**
- ±0.5 %FS

**Repeatability**
- ±0.3°

**Hysteresis**
- ±0.2 °/FS

**Temperature error**
- ±0.2 %FS

**Supply voltage Ub**
- 12/24 VDC (8 ... 34 VDC)

**Current consumption w/o load**
- ≤ 100 mA

**Overvoltage protection**
- 45 VDC (permanent)

**Polarity protection**
- yes (supply lines)

**Short circuit protection**
- yes (all outputs vs. GND and supply voltage up to 40 VDC)

**Insulation resistance (500 VDC)**
- ≥ 10 MΩ

**Bus termination internal**
- 120 Ω (optionally)

**Environmental Data**

**Max. operational speed**
- Mechanically unlimited

**Vibration IEC 60068-2-6**
- 20 g, 5 ... 2000 Hz, Amax = 0.75 mm

**Shock IEC 60068-2-27**
- 50 g, 6 ms

**Protection class DIN EN 60529**
- IP67 / IP68 / IP69, IP67 (connector M12)

**Operating temperature**
- -40 ... +105°C, -25 ... +85°C (connector M12)

**Functional safety**
- If you need assistance in using our products in safety-related systems, please contact us

**MTTF (IEC 60050)**
- 413 years (one-channel) or 303 years (two-channel, per channel)

**Traceability**
- Serial number on type labeling; production batch of the sensor assembly and relevant sensor components

**EMC Compatibility**

**ISO 10605 ESD (Handling/Component)**
- 8 kV

**ISO 11452-2 Radiated HF-fields**
- 100 V/m

**ISO 11452-4 BCI (Bulk current injection)**
- 200 mA

**ENSPR 25 Radiated emission**
- Level 3

**ISO 7637-2 Pulses on supply lines**
- [1, 2a, 2b, 3a, 3b, 4, 5] Level 4

**ISO 7637-2 Radiated Emissions**
- Level 4

**ISO 7637-3 Pulses on output lines**
- [3a, 3b] Fast Level 2, Slow Level 4

**Connection Assignment**

<table>
<thead>
<tr>
<th>Signal</th>
<th>Cable code 2_ _</th>
<th>Connector code 5_ _</th>
<th>Cable code 4_ _</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage Ub</td>
<td>WH</td>
<td>Pin 2</td>
<td>WH, RD</td>
</tr>
<tr>
<td>GND</td>
<td>RN</td>
<td>Pin 3</td>
<td>BN, BU</td>
</tr>
<tr>
<td>CAN_H</td>
<td>YE</td>
<td>Pin 4</td>
<td>YE, PK</td>
</tr>
<tr>
<td>CAN_L</td>
<td>GN</td>
<td>Pin 5</td>
<td>GN, GY</td>
</tr>
<tr>
<td>CAN_SHLD</td>
<td>Shield</td>
<td>Pin 1</td>
<td>Shield</td>
</tr>
</tbody>
</table>

Connect cable shielding to GND
Position Markers

Z-RFC-P02
Position marker for frontal fixation with 2 cylinder head screws M4x20 (with microencapsulation) or with locking pin (both included in delivery).
Material: PF
Max. permitted radial offset: ± 3 mm

<table>
<thead>
<tr>
<th>P/N</th>
<th>Pack. unit [pcs]</th>
</tr>
</thead>
<tbody>
<tr>
<td>400056661</td>
<td>1</td>
</tr>
<tr>
<td>400056080</td>
<td>25</td>
</tr>
</tbody>
</table>

Z-RFC-P08
Position marker for fixation with threaded pin M5 (included in delivery).
Material: PF
Max. permitted radial offset: ± 3 mm

<table>
<thead>
<tr>
<th>P/N</th>
<th>Pack. unit [pcs]</th>
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</thead>
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<tr>
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<tr>
<td>400056084</td>
<td>25</td>
</tr>
</tbody>
</table>

Z-RFC-P41
Position marker for frontal fixation with 2 cylinder head screws M4x20 (with microencapsulation) or with locking pin (both included in delivery).
Material: PF
Max. permitted radial offset: ± 3 mm

<table>
<thead>
<tr>
<th>P/N</th>
<th>Pack. unit [pcs]</th>
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</thead>
<tbody>
<tr>
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<td>1</td>
</tr>
<tr>
<td>400105038</td>
<td>25</td>
</tr>
</tbody>
</table>

Z-RFC-P47
Position marker for frontal fixation with 2 cylinder head screws M4x20 (with microencapsulation) or with threaded pin M5 (both included in delivery).
Material: PF
Max. permitted radial offset: ± 3 mm

<table>
<thead>
<tr>
<th>P/N</th>
<th>Pack. unit [pcs]</th>
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</thead>
<tbody>
<tr>
<td>400105039</td>
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</tr>
<tr>
<td>400105040</td>
<td>25</td>
</tr>
</tbody>
</table>
Position Markers

Z-RFC-P23
Position marker for fixation with threaded pin M4 (included in delivery)
Material: PA6-GF
Max. permitted radial offset: ± 3 mm

<table>
<thead>
<tr>
<th>P/N</th>
<th>Pack. unit [pcs]</th>
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</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>400056085</td>
<td>25</td>
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</tbody>
</table>

Z-RFC-P43
Position marker for fixation with threaded pin M4 (included in delivery)
Material: PA6-GF
Max. permitted radial offset: ± 3 mm

<table>
<thead>
<tr>
<th>P/N</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>400105042</td>
<td>25</td>
</tr>
</tbody>
</table>

Z-RFC-P30
Position marker for frontal fixation with 2 cylinder screws M3x8 (included in delivery)
Material: PBT-GF
Max. permitted radial offset: ± 1.5 mm

<table>
<thead>
<tr>
<th>P/N</th>
<th>Pack. unit [pcs]</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>400056067</td>
<td>25</td>
</tr>
</tbody>
</table>

Z-RFC-P31
Position marker for frontal fixation with 2 cylinder screws M3x8 (included in delivery)
Material: PBT-GF
Max. permitted radial offset: ± 3 mm

<table>
<thead>
<tr>
<th>P/N</th>
<th>Pack. unit [pcs]</th>
</tr>
</thead>
<tbody>
<tr>
<td>400056088</td>
<td>1</td>
</tr>
<tr>
<td>400056089</td>
<td>25</td>
</tr>
</tbody>
</table>
Position Markers

Z-RFC-P22
Position marker for frontal fixation with 2 cylinder head screws M4x20 (with microencapsulation, included in delivery).
Attention: Closed side of position marker faces the active side of sensor.
Material: Aluminium, anodized
Max. permitted radial offset: ± 4 mm
Operating temp.: -40 ... +125°C
P/N | Pack. unit (pcs)
---|---
400106736 | 1
400106736 | 25

Z-RFC-P18
Screw position marker M10 x 25 mm, similar DIN 933, magnet potted
Material: Aluminium, anodized
Max. permitted radial offset: ± 3 mm
P/N | Pack. unit (pcs)
---|---
400104756 | 1
400104757 | 25

Z-RFC-P19
Screw position marker M8 x 25 mm, similar DIN 933/ISO 4017, magnet potted
Material: Aluminium, anodized
Max. permitted radial offset: ± 1.5 mm
P/N | Pack. unit (pcs)
---|---
400104754 | 1
400104755 | 25

Z-RFC-P20
Screw position marker M10 x 25 mm, similar DIN 933
Material: Aluminium, anodized
Max. permitted radial offset: ± 3 mm
P/N | Pack. unit (pcs)
---|---
400104758 | 1
400104759 | 25
Z-RFC-P03
Magnet for direct application onto customer's shaft (see user manual).
We recommend mounting on non-magnetizable materials; otherwise the specified working distances will vary (e.g. reduction of approx. 20% with axial mounting on a magnetizable shaft).
Max. permitted radial offset ± 1.5 mm

<table>
<thead>
<tr>
<th>P/N</th>
<th>Pack. unit [pcs]</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>400056081</td>
<td>50</td>
</tr>
</tbody>
</table>

Z-RFC-P04
Magnet for direct application onto customer's shaft (see user manual).
We recommend mounting on non-magnetizable materials; otherwise the specified working distances will vary (e.g. reduction of approx. 20% with axial mounting on a magnetizable shaft).
Max. permitted radial offset ± 3 mm

<table>
<thead>
<tr>
<th>P/N</th>
<th>Pack. unit [pcs]</th>
</tr>
</thead>
<tbody>
<tr>
<td>400005659</td>
<td>1</td>
</tr>
<tr>
<td>400056082</td>
<td>50</td>
</tr>
</tbody>
</table>

Z-RFC-S01/S02/S03
Shaft adapter for fixation at position marker Z-RFC-P02/P41 with locking pin
Material SS 1.4305 / AISI 303

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type ØB / A [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>400056206</td>
<td>Z-RFC-S01 6 / 4.5</td>
</tr>
<tr>
<td>400056207</td>
<td>Z-RFC-S02 8 / 6.5</td>
</tr>
<tr>
<td>400056208</td>
<td>Z-RFC-S03 10 / 8.5</td>
</tr>
</tbody>
</table>
Position Markers

Working Distances Position Markers [mm] - One-channel Versions

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3 ... 5</td>
<td>0.7 ... 2.2</td>
<td>2.3 ... 5</td>
<td>0 ... 2.2</td>
<td>2.3 ... 5</td>
<td>4.4 ... 9.2</td>
<td>2.3 ... 5</td>
<td>0.7 ... 2.2</td>
<td>2.3 ... 5</td>
<td>0 ... 2.7</td>
<td>0 ... 2.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Working Distances Position Markers [mm] - Redundant Versions

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9 ... 4.5</td>
<td>0.3 ... 1.8</td>
<td>1.9 ... 4.5</td>
<td>0 ... 4</td>
<td>0 ... 1.7</td>
<td>1.9 ... 4.5</td>
<td>4 ... 8.8</td>
<td>1.9 ... 4.5</td>
<td>0.3 ... 1.8</td>
<td>1.9 ... 4.5</td>
<td>0 ... 2.3</td>
<td>0 ... 2.3</td>
<td></td>
</tr>
</tbody>
</table>

Lateral Magnet Offset

Lateral magnet offset will cause additional linearity error. The angle error, which is caused by radial displacement of sensor and position marker depends on the used position marker or magnet.

Additional Linearity Error at Radial Displacement - One-channel Versions

<table>
<thead>
<tr>
<th>Z-RFC-P02 / P04 / P08</th>
<th>Z-RFC-P41 / P43 / P47</th>
<th>Z-RFC-P03 / P06</th>
<th>Z-RFC-P18</th>
<th>Z-RFC-P19</th>
<th>Z-RFC-P22</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 mm: ±0.7°</td>
<td>0.5 mm: ±1.4°</td>
<td>0.5 mm: ±0.4°</td>
<td>0.5 mm: ±0.7°</td>
<td>0.5 mm: ±1.3°</td>
<td>1.0 mm: ±0.8°</td>
</tr>
<tr>
<td>1.0 mm: ±1.1°</td>
<td>1.0 mm: ±1.1°</td>
<td>1.0 mm: ±3.7°</td>
<td>1.0 mm: ±1.3°</td>
<td>1.0 mm: ±2.6°</td>
<td>2.0 mm: ±1.8°</td>
</tr>
<tr>
<td>2.0 mm: ±3.5°</td>
<td>2.0 mm: ±3.5°</td>
<td>2.0 mm: ±3.5°</td>
<td>2.0 mm: ±3.3°</td>
<td>2.0 mm: ±3.3°</td>
<td>4.0 mm: ±5.4°</td>
</tr>
</tbody>
</table>

Additional Linearity Error at Radial Displacement - Redundant Versions

<table>
<thead>
<tr>
<th>Z-RFC-P02 / P04 / P08</th>
<th>Z-RFC-P41 / P43 / P47</th>
<th>Z-RFC-P03 / P06</th>
<th>Z-RFC-P18</th>
<th>Z-RFC-P19</th>
<th>Z-RFC-P22</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 mm: ±0.7°</td>
<td>0.5 mm: ±1.4°</td>
<td>0.5 mm: ±0.7°</td>
<td>0.5 mm: ±1.3°</td>
<td>0.5 mm: ±2.2°</td>
<td>1.0 mm: ±1.1°</td>
</tr>
<tr>
<td>1.0 mm: ±1.1°</td>
<td>1.0 mm: ±1.8°</td>
<td>1.0 mm: ±6.4°</td>
<td>1.0 mm: ±2°</td>
<td>1.0 mm: ±4.5°</td>
<td>2.0 mm: ±2.4°</td>
</tr>
<tr>
<td>2.0 mm: ±5.2°</td>
<td>2.0 mm: ±5.2°</td>
<td>2.0 mm: ±2.2°</td>
<td>2.0 mm: ±4.6°</td>
<td>2.0 mm: ±4.6°</td>
<td>4.0 mm: ±6.7°</td>
</tr>
</tbody>
</table>
## Connector System M12

### EEM-33-44
M12x1 mating female/male connector, 5-pin, straight, A-coded, with molded cable, IP68, CAN-Bus

- **Plug housing**: PUR
- **Cable sheath**: PUR, Ø = 7.2 mm, -25 ... +85°C (fixed)

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>400056144</td>
<td>EEM-33-44</td>
<td>5 m</td>
</tr>
</tbody>
</table>

### EEM-33-41/42/43
M12x1 mating female connector, 5-pin, straight, A-coded, with molded cable, IP67, shielded, open ended, CAN-Bus

- **Plug housing**: PUR
- **Cable sheath**: PUR, Ø = 7.2 mm, -25 ... +85°C (fixed)
- **Lead wires**: PP, 2x0.25 mm²+2x0.34 mm²

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>400056141</td>
<td>EEM-33-41</td>
<td>2 m</td>
</tr>
<tr>
<td>400056143</td>
<td>EEM-33-43</td>
<td>10 m</td>
</tr>
</tbody>
</table>

### EEM-33-73
M12x1 mating female connector, 5-pin, straight, A-coded, with coupling nut, screw termination, IP67, shieldable, CAN bus

- **Plug housing**: Metal, -40 ... +85°C
- **For wire gauge**: 6 ... 8 mm, max. 0.75 mm²

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>400005645</td>
<td>EEM-33-73</td>
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</tbody>
</table>

### EEM-33-75
M12x1 mating female connector, 5-pin, angled, A-coded, with coupling nut, screw termination, IP67, shieldable, CAN bus, turning and fixing of contact carrier in 90° positions possible.

- **Plug housing**: Metal, -40 ... +85°C
- **For wire gauge**: 6 ... 8 mm, max. 0.75 mm²

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>400005646</td>
<td>EEM-33-75</td>
</tr>
</tbody>
</table>
Connector System

**M12**

**EEM-33-45**
- M12x1 splitter / T-connector, 5-pin, A-coded, IP68; 1:1 connection, female - male - female, CAN-Bus
- Plug housing: PUR, -25 ... +85°C
- P/N: 400056145

**EEM-33-47**
- M12x1 terminating resistor, 5-pin, A-coded, IP67; 120 Ω resistance, CAN-Bus
- Plug housing: PUR, -25 ... +85°C
- P/N: 400056147

**IP67**
- Protection class IP67 DIN EN 60529
- Very good Electromagnetic Compatibility (EMC) and shield systems

**IP68**
- Protection class IP68 DIN EN 60529
- Very good resistance to oils, coolants and lubricants

**UL**
- UL - approved

**CAN-Bus**
Connecting Options

on request

- **M12 connector**
  - Customized lengths
  - 3-, 4-, 6- and 6-pole versions
  - Protection class IP68
  - Ordering codes of standard versions see ordering specifications

- **Tyco AMP Super Seal**
  - Pin- and bushing housing
  - Customized lengths
  - 3-, 4- and 6-pole versions
  - Protection class IP67
  - On request

- **Deutsch DTM 04**
  - Pin- and bushing housing
  - Customized lengths
  - 3-, 4- and 6-pole versions
  - Protection class IP67
  - On request

- **ITT Cannon Sure Seal connector**
  - Customized lengths
  - 3-, 4- and 6-pole versions
  - Protection class IP67
  - On request

- **Molex Mini Fit Jr.**
  - Customized length and lead wires
  - 3-, 4- and 6-pole versions
  - On request

- **Molex Mini Fit Jr.**
  - Customized length and lead wires
  - 3-, 4- and 6-pole versions
  - On request
The specifications contained in our datasheets are intended solely for informational purposes. The documented specification values are based on ideal operational and environmental conditions and can vary significantly depending on the actual customer application. Using our products at or close to one or more of the specified performance ranges can lead to limitations regarding other performance parameters. It is therefore necessary that the end user verifies relevant performance parameters in the intended application. We reserve the right to change product specifications without notice.