Preliminary Data sheet

Special Features
• Compact design for tight spaces
• Touchless magnetostrictive measurement technology
• Operating pressure up to 350 bar, peaks up to 450 bar
• Non-contacting position detection with ring-shaped position marker
• Unlimited mechanical life
• No velocity limit for position marker
• Absolute output
• Outstanding accuracy performance up to 0.04 %
• Wide range of supply voltage
• Optimized for use in industrial applications
• Other configurations see separate data sheets

Applications
• Manufacturing Engineering
• Level measurement
• Actuators

The absolute linear transducer TM1 enables a compact and cost-effective position measurement. It consists of a stainless steel flange welded to a pressure-resistant rod and can therefore be used under harsh environmental conditions. The magnetostrictive measuring technology offers excellent accuracy for measuring lengths up to 2000 mm. The passive ring-shaped position marker allows a mechanically decoupled measurement.

Description

| Material | Range: stainless steel 1.4307 / AISI 304L |
|          | Range cover: AlSiMgBi |
|          | Rod: stainless steel 1.4571 / AISI 316Ti |
|          | Sealing: O-ring FKM 80, Supporting ring: PTFE |

Mounting
Plugged and secured in position with set screw M5 ISO 4026

Electrical connection
Connector M12x1, A-coded / Connector system M12x1, A-coded with lead wires

Mechanical Data

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

**Preferred types printed in bold**

<table>
<thead>
<tr>
<th>T</th>
<th>M 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>05</td>
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<td>8</td>
<td>21</td>
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<tr>
<td>1</td>
<td>04</td>
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**Supply voltage Ub**
- U_B = 24 VDC

**Output signal**
- 2: 4 ... 20 mA

**Output characteristic**
1: Rising output characteristic, seen from flange
2: Falling output characteristic, seen from flange

**Electrical connection**
- 104: Connector M12x1, 4-pin
- 438: Plug system M12x1, 4-pin, with lead wires 80 mm*
- 442: Plug system M12x1, 4-pin, with lead wires 120 mm*
- 446: Plug system M12x1, 4-pin, with lead wires 165 mm*
- 450: Plug system M12x1, 4-pin, with lead wires 200 mm*
- 454: Plug system M12x1, 4-pin, with lead wires 240 mm*
- * Only for installation in a cylinder

**Series**
- Mechanical version
  - 305: Plug-in flange Ø 46 mm
  - 307: Plug-in flange Ø 48 mm with internal thread M4x6 at rod end, additional length 7.5 mm

**Electrical measuring range**
- Standard lengths 0000 up to 2000 mm in 25 mm-steps
- Other lengths on request
**Technical Data**

**Type**  
TM1-__-305-82-__-

**Output signal**  
4 ... 20 mA

**Load / burden**  
@Ub 24 V: ≤ 500 Ω, @Ub 12 V: ≤ 250 Ω

**Sampling rate / Update rate**  
0.5 kHz

**Electrical measuring range (dim. L)**  
0 ... 50 mm up to 0 ... 2000 mm

**Absolute linearity**  
≤ ±0.04 %FS (min. 300 µm)

**Tolerance of electr. zero point**  
±1 mm

**Resolution**  
0.1 mm

**Repeatability**  
≤ ±0.1 mm

**Hysteresis**  
≤ ±0.1 mm

**Temperature error**  
typ. 50 ppm/K (min. 0.01 mm/K)

**Supply voltage Ub**  
12/24 VDC (8 ... 32 VDC)

**Supply voltage ripple**  
≤ 10% Ub

**Power drain w/o load**  
< 1 W

**Overvoltage protection**  
36 VDC (permanent)

**Polarity protection**  
yes (± 36 VDC)

**Short circuit protection**  
yes (output vs GND and supply voltage up to 36 VDC)

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

**Environmental Data**

**Max. operational speed**  
Mechanically unlimited

**Vibration IEC 60068-2-6**  
20 g, 10 ... 2000 Hz, Amax = 0.75 mm

**Shock IEC 60068-2-27**  
100 g, 11 ms (single hit)

**Protection class DIN EN 60529**  
IP67 (Connector system M12, fastened, when correctly fitted in cylinder: IP69)

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

**Operating humidity**  
0 ... 95 % R.H. (no condensation)

**Working pressure**  
≤ 350 bar

**Pressure peaks**  
≤ 450 bar

**Burst pressure**  
> 700 bar

**Life**  
Mechanically unlimited

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

**MTTF (IEC 60050)**  
> 20 years

**EMC Compatibility**

**EN 61000-4-2 ESD (contact/air discharge)**  
4 kV, 8 kV

**EN 61000-4-3 Electromagnetic fields (RFI)**  
10 V/m

**EN 61000-4-4 Fast transients (burst)**  
1 kV

**EN 61000-4-6 Cond. disturbances (HF fields)**  
10 V eff.

**EN 55016-2-3 Radiated disturbances**  
Industrial and residential area

Only for connector system M12: Data applies only inside a cylinder.

The EMC measurements are conducted in a reference cylinder. The EMC properties can deviate when using different cylinders.

**Connection Assignment**

<table>
<thead>
<tr>
<th>Signal</th>
<th>Connector code</th>
<th>Plug system code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage Ub</td>
<td>Pin 1</td>
<td>Pin 1</td>
</tr>
<tr>
<td>GND</td>
<td>Pin 3</td>
<td>Pin 3</td>
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<tr>
<td>Signal output</td>
<td>Pin 2</td>
<td>Pin 2</td>
</tr>
<tr>
<td>Do not connect</td>
<td>Pin 4</td>
<td></td>
</tr>
</tbody>
</table>

Connect cable shielding to protection earth
Technical Data
Output Characteristics
Position Markers

Z-TH1-P18
Ring position marker for fixation with screws M3
Material: PA6-GF
Weight: approx. 12 g
Operating temp.: -40 ... +100°C
Surface pressure: max. 40 N/mm²
Fastening torque of mounting: max. 100 Ncm
P/N: 400005697
Pack. unit [pcs]: 1

Z-TH1-P19
Ring position marker for fixation with screws M4
Material: PA6-GF
Weight: approx. 14 g
Operating temp.: -40 ... +100°C
Surface pressure: max. 40 N/mm²
Fastening torque of mounting: max. 100 Ncm
P/N: 400005698
Pack. unit [pcs]: 1

Z-TIM-P20
Ring position marker for mounting via lock washer and retaining ring
Material: PA-Neonbond Compound
Weight: approx. 5 g
Operating temp.: -40 ... +100°C
Surface pressure: max. 10 N/mm²
P/N: 400005699
Pack. unit [pcs]: 1

Z-TH1-P25
U-shaped position marker for fixation with M4 screws
Caution: for dimension of electrical zero point please follow the user manual!
Material: PA6-GF
Operating temp.: -40 ... +105°C
Surface pressure: max. 40 N/mm²
Fastening torque of mounting: max. 100 Ncm
P/N: 400105076
Pack. unit [pcs]: 1
Position Markers

Z-TH1-P22
Ball-type floating position marker
Material  Stainless steel 1.4571
Weight  approx. 42 g
Operating temp.  -40 ... +100°C
Compression strength  ≤ 60 bar
Density  720 kg/m³
Immersion depth in water  36.7 mm
P/N  400056045
Pack. unit [pcs]  1

Z-TH1-P21
Cylinder floating position marker
Material  Stainless steel 1.4404
Weight  approx. 20 g
Operating temp.  -40 ... +100°C
Compression strength  ≤ 8 bar
Density  740 kg/m³
Immersion depth in water  approx. 26.6 mm
P/N  400056044
Pack. unit [pcs]  1

When using floating position markers, we recommend to secure the marker against loss with a washer at the rod end.
For this purpose, a sensor version with inner thread at the rod end is required (s. ordering code).
Connector System
M12

M12x1 Mating female connector, 4-pin, straight, A-coded, with molded cable, shielded, IP67, open ended
Plug housing: PA
Cable sheath: PUR, Ø = max. 6 mm,
-25 ... +80°C (moved)
-50 ... +80°C (fixed)
Lead wires: PP , 0.34 mm²

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
<th>Length</th>
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<tbody>
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<td>400005609</td>
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<td>5 m</td>
</tr>
<tr>
<td>400005650</td>
<td>EEM-33-97</td>
<td>10 m</td>
</tr>
</tbody>
</table>

M12x1 Mating female connector, 4-pin, angled, A-coded, with molded cable, shielded, IP67, open ended
Plug housing: PA
Cable sheath: PUR, Ø = max. 6 mm,
-25 ... +80°C (moved)
-50 ... +80°C (fixed)
Lead wires: PP , 0.34 mm²

<table>
<thead>
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<th>P/N</th>
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<td>400005610</td>
<td>EEM-33-63</td>
<td>5 m</td>
</tr>
<tr>
<td>400005696</td>
<td>EEM-33-99</td>
<td>10 m</td>
</tr>
</tbody>
</table>

Very good Electromagnetic Compatibility (EMC) and shield systems
Very good resistance to oils, coolants and lubricants
Suitable for applications in explosive gases
UL - approved
CAN-Bus
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.
Preliminary Data sheet

Special Features
- Compact design for tight spaces
- Touchless magnetostrictive measurement technology
- Operating pressure up to 350 bar, peaks up to 450 bar
- Non-contacting position detection with ring-shaped position marker
- Unlimited mechanical life
- No velocity limit for position marker
- Absolute output
- Outstanding accuracy performance up to 0.04 %
- Wide range of supply voltage
- Optimized for use in industrial applications
- Other configurations see separate data sheets

Applications
- Manufacturing Engineering
- Level measurement
- Actuators

The absolute linear transducer TM1 enables a compact and cost-effective position measurement. It consists of a stainless steel flange welded to a pressure-resistant rod and can therefore be used under harsh environmental conditions. The magnetostrictive measuring technology offers excellent accuracy for measuring lengths up to 2000 mm. The passive ring-shaped position marker allows a mechanically decoupled measurement.

Description

Material
- Flange: stainless steel 1.4307 / AISI 304L
- Flange cover: AlSiMgBi
- Rod: stainless steel 1.4571 / AISI 316Ti
- Sealing: O-ring FKM 80, Supporting ring: PTFE

Mounting
- Plugged and secured in position with set screw M5 ISO 4026

Electrical connection
- Connector M12x1, A-coded / Connector system M12x1, A-coded with lead wires

Mechanical Data

Dimensions
- See dimension drawing

See dimension drawing
## Ordering Specifications

Preferred types printed in bold

### Supply voltage Ub

8: Ub = 24 VDC

### Output signal

1: 0.1 ... 10 VDC  
4: 0.5 ... 4.5 VDC  
5: 0.25 ... 4.75 VDC

### Output characteristic

1: Rising output characteristic, seen from flange  
2: Falling output characteristic, seen from flange

### Electrical connection

- **104**: Connector M12x1, 4-pin  
- **438**: Plug system M12x1, 4-pin, with lead wires 80 mm*  
- **440**: Plug system M12x1, 4-pin, with lead wires 120 mm*  
- **446**: Plug system M12x1, 4-pin, with lead wires 160 mm*  
- **450**: Plug system M12x1, 4-pin, with lead wires 200 mm*  
- **454**: Plug system M12x1, 4-pin, with lead wires 240 mm*  
  * Only for installation in a cylinder

### Mechanical version

- **305**: Plug-in flange Ø 48 mm  
- **307**: Plug-in flange Ø 48 mm with internal thread M4x6 at rod end, additional length 7.5 mm

### Series

- **T M 1 - 0 5 0 0 - 3 0 5 - 8 1 1 - 1 0 4**

### Electrical measuring range

- Standard lengths 0000 up to 2000 mm in 25 mm-steps
- Other lengths on request
CAD data see www.novotechnik.de/en/download/cad-data/
### Technical Data

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<th>TM1_ _ _ <em>-305-81</em> _ _</th>
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<td>0.25 ... 4.75 V</td>
<td>0.1 ... 10 V</td>
<td>0.5 ... 4.0 V</td>
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<tr>
<td>Load / burden</td>
<td>≥ 10 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampling rate / Update rate</td>
<td>0.5 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical measuring range (dim. L)</td>
<td>0 ... 50 mm up to 0 ... 2000 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute linearity</td>
<td>≤ ±0.04 %FS (min. 300 µm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tolerance of electr. zero point</td>
<td>≤ 1 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeatability</td>
<td>≤ ±0.1 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hysteresis</td>
<td>≤ ±0.1 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature error</td>
<td>typ. 50 ppm/K (min. 0.01 mm/K)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply voltage Ub</td>
<td>12/24 VDC (16 ... 32 VDC)</td>
<td>24 VDC (16 ... 34 VDC)</td>
<td></td>
</tr>
<tr>
<td>Supply voltage ripple</td>
<td>≤ 10% Ub</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power drain w/o load</td>
<td>≤ 3 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overvoltage protection</td>
<td>36 VDC (permanent)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polarity protection</td>
<td>yes (-36 VDC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short circuit protection</td>
<td>yes (output vs GND and supply voltage up to 36 VDC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation resistance (500 VDC)</td>
<td>≥ 10 MΩ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Environmental Data

Max. operational speed: Mechanically unlimited
Vibration IEC 60068-2-6: 20 g, 10 ... 2000 Hz, Amax = 0.75 mm
Shock IEC 60068-2-27: 100 g, 11 ms (single hit)
Protection class DIN EN 60529: IP67 (Connector system M12, fastened, when correctly fitted in cylinder: IP69)
Operating temperature: -40 ... +105°C, -40 ... +85°C (connector system M12)
Operating humidity: 0 ... 95 % R.H. (no condensation)
Working pressure: ≤ 350 bar
Pressure peaks: ≤ 450 bar
Burst pressure: > 700 bar
Life: Mechanically unlimited
Functional safety: If you need assistance in using our products in safety-related systems, please contact us
MTTF (IEC 60056): > 20 years

### EMC Compatibility

EN 61000-4-2 ESD (contact/air discharge): 4 kV, 8 kV
EN 61000-4-3 Electromagnetic fields (RFI): 10 V/m
EN 61000-4-4 Fast transients (burst): 1 kV
EN 61000-4-6 Cond. disturbances (HF fields): 10 V eff.
EN 55016-2-3 Radiated disturbances Industrial and residential area

Only for connector system M12: Data applies only inside a cylinder.
The EMC measurements are conducted in a reference cylinder. The EMC properties can deviate when using different cylinders.

### Connection Assignment

<table>
<thead>
<tr>
<th>Signal</th>
<th>Connector code 1_ _</th>
<th>Plug system code 4_ _</th>
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</thead>
<tbody>
<tr>
<td>Supply voltage Ub</td>
<td>Pin 1</td>
<td>Pin 1</td>
</tr>
<tr>
<td>M82</td>
<td>Pin 3</td>
<td>Pin 3</td>
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<tr>
<td>Signal output</td>
<td>Pin 2</td>
<td>Pin 2</td>
</tr>
<tr>
<td>Do not connect</td>
<td>Pin 4</td>
<td>Pin 4</td>
</tr>
</tbody>
</table>

Connect cable shielding to protection earth
Position Markers

Z-TH1-P18
Ring position marker for fixation with screws M3
Material: PA6-GF
Weight: approx. 12 g
Operating temp.: -40 ... +100°C
Surface pressure: max. 40 N/mm²
Fastening torque of mounting: max. 100 Ncm
P/N: 400005697
Pack. unit [pcs]: 1

Z-TH1-P19
Ring position marker for fixation with screws M4
Material: PA6-GF
Weight: approx. 14 g
Operating temp.: -40 ... +100°C
Surface pressure: max. 40 N/mm²
Fastening torque of mounting: max. 100 Ncm
P/N: 400005698
Pack. unit [pcs]: 1

Z-TIM-P20
Ring position marker for mounting via lock washer and retaining ring
Material: PA-Neonbond Compound
Weight: approx. 5 g
Operating temp.: -40 ... +100°C
Surface pressure: max. 10 N/mm²
P/N: 400005699
Pack. unit [pcs]: 1

Z-TH1-P25
U-shaped position marker for fixation with M4 screws
Caution: for dimension of electrical zero point please follow the user manual!
Material: PA6-GF
Operating temp.: -40 ... +105°C
Surface pressure: max. 40 N/mm²
Fastening torque of mounting: max. 100 Ncm
P/N: 400105076
Pack. unit [pcs]: 1
Position Markers

Z-TH1-P22
Ball-type floating position marker
Material: Stainless steel 1.4571
Weight: approx. 42 g
Operating temp.: -40 ... +100°C
Compression strength: ≤ 60 bar
Density: 720 kg/m³
Immersion depth in water: 36.7 mm
P/N: 400056045
Pack. unit [pcs]: 1

Z-TH1-P21
Cylinder floating position marker
Material: Stainless steel 1.4404
Weight: approx. 20 g
Operating temp.: -40 ... +100°C
Compression strength: ≤ 8 bar
Density: 740 kg/m³
Immersion depth in water: approx. 26.6 mm
P/N: 400056044
Pack. unit [pcs]: 1

When using floating position markers, we recommend to secure the marker against loss with a washer at the rod end. For this purpose, a sensor version with inner thread at the rod end is required (s. ordering code).
**Connector System M12**

**M12x1 Mating female connector, 4-pin, straight, A-coded, with molded cable, shielded, IP67, open ended**

- **Plug housing**: PA
- **Cable sheath**: PUR, Ø = max. 6 mm, -25°C ... +80°C (moved), -50°C ... +80°C (fixed)
- **Lead wires**: PP, 0.34 mm²

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
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<td>400005650</td>
<td>EEM-33-97</td>
<td>10 m</td>
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</tbody>
</table>

**M12x1 Mating female connector, 4-pin, angled, A-coded, with molded cable, shielded, IP67, open ended**

- **Plug housing**: PA
- **Cable sheath**: PUR, Ø = max. 6 mm, -25°C ... +80°C (moved), -50°C ... +80°C (fixed)
- **Lead wires**: PP, 0.34 mm²

<table>
<thead>
<tr>
<th>P/N</th>
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<td>400005661</td>
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<td>5 m</td>
</tr>
<tr>
<td>400005696</td>
<td>EEM-33-99</td>
<td>10 m</td>
</tr>
</tbody>
</table>

**Protection class IP67 DIN EN 60529**

**Very good Electromagnetic Compatibility (EMC) and shield systems**

**Very good resistance to oils, coolants and lubricants**

**Suitable for applications in excessively dusty environments**

**UL - approved**

**CAN-Bus**
Preliminary Data sheet

Special Features
- For integration in pneumatic and hydraulic cylinders
- Touchless magnetostrictive measurement technology
- Operating pressure up to 350 bar, peaks up to 450 bar
- Ring-shaped position marker does not contact sensor
- Unlimited mechanical life
- No velocity limit for position marker
- Absolute output
- Outstanding accuracy performance up to 0.04 %
- Wide range of supply voltage
- 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
Hydraulic or pneumatic cylinders in
- Agricultural and forestry machinery
- Construction machines
- Vehicles with loading and unloading devices
- Vehicles with extension arms

The absolute position transducer can be used directly in-cylinder and thus enables a compact and cost-effective position measurement. The sensor consists of a stainless steel flange welded to a pressure tight rod and can therefore be used in harsh environments.

The magnetostrictive measuring technology offers excellent accuracy for measuring lengths up to 2000 mm. The passive ring-shaped position marker allows a mechanically decoupled measurement.

Description
| Material | Flange: stainless steel 1.4307 / AISI 304L |
|          | Flange cover: AlSiMgBi |
|          | Rod: stainless steel 1.4571 / AISI 316Ti |
|          | Sealing: O-ring FKM 80, Supporting ring: PTFE |

Mounting
Plugged into cylinders, secured in position with set screw M5 ISO 4026

Electrical connection
Connector M12x1, A-coded / Cable 3x 0.5 mm² (AWG 20), PUR, unshielded / Connector system M12x1, A-coded with lead wires

Mechanical Data
Dimensions
See dimension drawing
## Ordering Specifications

Prefered types printed in bold

<table>
<thead>
<tr>
<th>Supply voltage $U_{b}$</th>
<th>8: $U_{b} = 12/24$ VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output signal</strong></td>
<td>2: 4 ... 20 mA</td>
</tr>
</tbody>
</table>

**Output characteristic:**
1: Rising output characteristic, seen from flange
2: Falling output characteristic, seen from flange

**Electrical connection**
- Connector M12x1, 4-pin
- Cable, 3-pole, unshielded, 1 m
- Cable, 3-pole, unshielded, 3 m
- Cable, 3-pole, unshielded, 5 m
- Plug system M12x1, 4-pin, with lead wires 80 mm
- Plug system M12x1, 4-pin, with lead wires 120 mm
- Plug system M12x1, 4-pin, with lead wires 160 mm
- Plug system M12x1, 4-pin, with lead wires 200 mm
- Plug system M12x1, 4-pin, with lead wires 240 mm

### Mechanical version
- 305: Plug-in flange ø 48 mm
- 307: Plug-in flange ø 48 mm with internal thread M4x6 at rod end, additional length 7.5 mm

### Electrical measuring range
- Standard lengths 0000 up to 2000 mm in 25 mm-steps
- Other lengths on request

| T | M | 1 | - | 0 | 5 | 0 | 0 | - | 3 | 0 | 5 | - | 8 | 2 | 1 | - | 4 | 4 | 2 |

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Page 2
### Technical Data

<table>
<thead>
<tr>
<th>Type</th>
<th>TM1-...-&lt;305-82&gt;...</th>
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<tbody>
<tr>
<td>Output signal</td>
<td>4 ... 20 mA</td>
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<tr>
<td>Load / burden</td>
<td>48 kΩ ±500 Ω, 48 kΩ ±500 Ω</td>
</tr>
<tr>
<td>Sampling rate / Update rate</td>
<td>0.5 kHz</td>
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<tr>
<td>Electrical measuring range (dim. L)</td>
<td>0 ... 50 mm up to 0 ... 2000 mm</td>
</tr>
<tr>
<td>Absolute linearity</td>
<td>≤ ±0.04 %FS (min. 300 µm)</td>
</tr>
<tr>
<td>Tolerance of elec. zero point</td>
<td>±1 mm</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 mm</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.1 mm</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>± ±0.1 mm</td>
</tr>
<tr>
<td>Temperature error</td>
<td>typ. 50 ppm/K (max. 0.01 mm/K)</td>
</tr>
<tr>
<td>Supply voltage Ub</td>
<td>12/24 VDC (8 ... 32 VDC)</td>
</tr>
<tr>
<td>Supply voltage ripple</td>
<td>≤ 10% Ub</td>
</tr>
<tr>
<td>Power drain w/o load</td>
<td>&lt; 1 W</td>
</tr>
<tr>
<td>Overvoltage protection</td>
<td>36 VDC (permanent)</td>
</tr>
<tr>
<td>Polarity protection</td>
<td>yes (36 VDC)</td>
</tr>
<tr>
<td>Short circuit protection</td>
<td>yes (output vs GND and supply voltage up to 36 VDC)</td>
</tr>
<tr>
<td>Insulation resistance (500 VDC)</td>
<td>≥ 10 MΩ</td>
</tr>
</tbody>
</table>

### Environmental Data

| Max. operational speed | Mechanically unlimited |
| Shock IEC 60068-2-27 | 100 g, 11 ms (single hit) |
| Protection class DIN EN 60529 | IP67 (Connector system M12, fastened, when correctly fitted in cylinder: IP69) |
| Operating humidity | 0 ... 95 % R.H. (no condensation) |
| Working pressure | ≤ 250 bar |
| Burst pressure | > 700 bar |
| Life | Mechanically unlimited |

### Functional safety

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

MTTF (IEC 60050) > 20 years

### EMC Compatibility

ISO 10605 ESD (Handling/Component) 8 kV / 15 kV

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

ISO 11452-3 Radiated HF-fields, stripline 200 V/m

EN 61000-6-2 Transient emissions Level 4

EN 61000-6-4 Transient emissions Level 4

EN 61000-6-6 Transient emissions Level 4

EN 13309 Construction machinery

The EMC measurements are conducted in a reference cylinder. The EMC properties can deviate when using different cylinders.

### Connection Assignment

<table>
<thead>
<tr>
<th>Signal</th>
<th>Connector code 1_ _</th>
<th>Cable code 2_ _</th>
<th>Plug system code 4_ _</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage Ub</td>
<td>Pin 1</td>
<td>Pin 1</td>
<td></td>
</tr>
<tr>
<td>SND</td>
<td>Pin 3</td>
<td>WH</td>
<td>Pin 3</td>
</tr>
<tr>
<td>Signal output</td>
<td>Pin 2</td>
<td>GN</td>
<td>Pin 2</td>
</tr>
<tr>
<td>Do not connect</td>
<td>Pin 4</td>
<td>-</td>
<td>Pin 4</td>
</tr>
</tbody>
</table>

*Pin assignment M12*
Position Markers

Z-TH1-P18
Ring position marker for fixation with screws M3
Material: PA6-GF
Weight: approx. 12 g
Operating temp.: -40 ... +100°C
Surface pressure: max. 40 N/mm²
Fastening torque: max. 100 Ncm
P/N: 400005697
Pack. unit [pcs]: 1

Z-TH1-P19
Ring position marker for fixation with screws M4
Material: PA6-GF
Weight: approx. 14 g
Operating temp.: -40 ... +100°C
Surface pressure: max. 40 N/mm²
Fastening torque: max. 100 Ncm
P/N: 400005698
Pack. unit [pcs]: 1

Z-TIM-P20
Ring position marker for mounting via lock washer and retaining ring
Material: PA-Neonbond Compound
Weight: approx. 5 g
Operating temp.: -40 ... +100°C
Surface pressure: max. 10 N/mm²
P/N: 400005699
Pack. unit [pcs]: 1

Z-TH1-P25
U-shaped position marker for fixation with M4 screws
Caution: for dimension of electrical zero point please follow the user manual!
Material: PA6-GF
Operating temp.: -40 ... +105°C
Surface pressure: max. 40 N/mm²
Fastening torque: max. 100 Ncm
P/N: 400105076
Pack. unit [pcs]: 1
## Position Markers

### Z-TH1-P22
- **Ball-type floating position marker**
- **Material**: Stainless steel 1.4571
- **Weight**: approx. 42 g
- **Operating temp.**: -40 ... +100°C
- **Compression strength**: ≤ 60 bar
- **Density**: 720 kg/m³
- **Immersion depth in water**: 36.7 mm
- **P/N**: 400056045
- **Pack. unit [pcs]**: 1

### Z-TH1-P21
- **Cylinder floating position marker**
- **Material**: Stainless steel 1.4404
- **Weight**: approx. 20 g
- **Operating temp.**: -40 ... +100°C
- **Compression strength**: ≤ 8 bar
- **Density**: 740 kg/m³
- **Immersion depth in water**: approx. 26.6 mm
- **P/N**: 400056044
- **Pack. unit [pcs]**: 1

When using floating position markers, we recommend to secure the marker against loss with a washer at the rod end. For this purpose, a sensor version with inner thread at the rod end is required (s. ordering codes).
**Connector System M12**

**EEM-33-35/36/37**
M12x1 Mating female connector, 4-pin, straight, A-coded, with molded cable, not shielded, IP67, open ended

- **Plug housing**: PA
- **Cable sheath**: PUR, Ø = max. 6 mm, -40 ... +85°C (fixed)
- **Lead wires**: PP, 0.34 mm²

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>400056135</td>
<td>EEM-33-35</td>
<td>2 m</td>
</tr>
<tr>
<td>400056136</td>
<td>EEM-33-36</td>
<td>5 m</td>
</tr>
<tr>
<td>400056137</td>
<td>EEM-33-37</td>
<td>10 m</td>
</tr>
</tbody>
</table>

**EEM-33-38/39/40**
M12x1 Mating female connector, 4-pin, angled, A-coded, with molded cable, not shielded, IP67, open ended

- **Plug housing**: PA
- **Cable sheath**: PUR, Ø = max. 6 mm, -40 ... +85°C (fixed)
- **Lead wires**: PP, 0.34 mm²

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>400056138</td>
<td>EEM-33-38</td>
<td>2 m</td>
</tr>
<tr>
<td>400056139</td>
<td>EEM-33-39</td>
<td>5 m</td>
</tr>
<tr>
<td>400056140</td>
<td>EEM-33-40</td>
<td>10 m</td>
</tr>
</tbody>
</table>

**EEM-33-89**
M12x1 Mating female connector, 4-pin, angled, A-coded, with coupling nut, screw termination, IP67, not shieldable

- **Operating temp.**: -25 ... +90°C
- **Plug housing**: PBT
- **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>40005604</td>
<td>EEM-33-89</td>
</tr>
</tbody>
</table>
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.
Preliminary Data sheet

Special Features
- For integration in pneumatic and hydraulic cylinders
- Touchless magnetostrictive measurement technology
- Operating pressure up to 350 bar, peaks up to 450 bar
- Ring-shaped position marker does not contact sensor
- Unlimited mechanical life
- No velocity limit for position marker
- Absolute output
- Outstanding accuracy performance up to 0.04 %
- Wide range of supply voltage
- 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
Hydraulic or pneumatic cylinders in
- Agricultural and forestry machinery
- Construction machines
- Vehicles with loading and unloading devices
- Vehicles with extension arms

The absolute position transducer can be used directly in-cylinder and thus enables a compact and cost-effective position measurement. The sensor consists of a stainless steel flange welded to a pressure tight rod and can therefore be used in harsh environments.

The magnetostrictive measuring technology offers excellent accuracy for measuring lengths up to 2000 mm. The passive ring-shaped position marker allows a mechanically decoupled measurement.

<table>
<thead>
<tr>
<th>Description</th>
<th>Flange: stainless steel 1.4307 / AISI 304L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Flange cover: AlSiMg Bi</td>
</tr>
<tr>
<td></td>
<td>Rod: stainless steel 1.4571 / AISI 316Ti</td>
</tr>
<tr>
<td></td>
<td>Sealing: O-ring FKM 80, Supporting ring: PTFE</td>
</tr>
<tr>
<td>Mounting</td>
<td>Plugged into cylinders, secured in position with set screw M5 ISO 4026</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>Connector system M12x1, A-coded with lead wires / Cable 3x 0.5 mm² (AWG 20), PUR, unshielded / Connector M12x1, A-coded</td>
</tr>
<tr>
<td>Mechanical Data</td>
<td>Dimensions: See dimension drawing</td>
</tr>
</tbody>
</table>
Ordering Specifications

Preferred types printed in bold

Ordering Specifications

Supply voltage $U_b$
8: $U_b = 12/24$ VDC, 34VDC

Output signal
1: 0.1 ... 10 VDC
4: 0.5 ... 4.5 VDC
5: 0.25 ... 4.75 VDC

Output characteristic
1: Rising output characteristic, seen from flange
2: Falling output characteristic, seen from flange

Electrical connection
104: Connector M12x1, 4-pin
251: Cable, 3-pole, unshielded, 1 m
253: Cable, 3-pole, unshielded, 3 m
255: Cable, 3-pole, unshielded, 5 m
458: Plug system M12x1, 4-pin, with lead wires 80 mm
442: Plug system M12x1, 4-pin, with lead wires 120 mm
446: Plug system M12x1, 4-pin, with lead wires 180 mm
450: Plug system M12x1, 4-pin, with lead wires 200 mm
454: Plug system M12x1, 4-pin, with lead wires 240 mm

<table>
<thead>
<tr>
<th>T</th>
<th>M</th>
<th>1</th>
<th>0</th>
<th>5</th>
<th>0</th>
<th>0</th>
<th>3</th>
<th>0</th>
<th>5</th>
<th>8</th>
<th>5</th>
<th>1</th>
<th>4</th>
<th>4</th>
<th>2</th>
</tr>
</thead>
</table>

Mechanical version
305: Plug-in flange Ø 48 mm
307: Plug-in flange Ø 48 mm with internal thread M4x6 at rod end, additional length 7.5 mm

Electrical measuring range
Standard lengths 0000 up to 2000 mm in 25 mm-steps
Other lengths on request.
## Technical Data

**Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>TM1-<strong>-305-81-</strong>-__</th>
<th>TM1-<strong>-305-84-</strong>-__</th>
<th>TM1-<strong>-305-85-</strong>-__</th>
</tr>
</thead>
</table>

- **Output signal**
  - 0.1 ... 10 V
  - 0.25 ... 4.75 V
  - 0.5 ... 4.5 V

- **Load / burden**
  - ≥ 10 kΩ

- **Update rate**
  - 0.5 kHz

- **Measuring range**
  - 0 ... 50 mm up to 0 ... 2000 mm

- **Linearity**
  - ± 0.04 %FS (min. 300 µm)

- **Tolerance of electr. zero point**
  - ± 1 mm

- **Resolution**
  - 0.1 mm

- **Repeatability**
  - ± 0.1 mm

- **Hysteresis**
  - ± 0.1 mm

- **Temperature error**
  - Typ. 50 ppm/K (min. 0.01 mm/K)

- **Supply voltage Ub**
  - 24 VDC (16 ... 34 VDC)
  - 12/24 VDC (8 ... 32 VDC)

- **Supply voltage ripple**
  - ≤ 10% Ub

- **Power drain w/o load**
  - ≤ 1 W

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

- **Polarity protection**
  - Yes (-36 VDC)

- **Short circuit protection**
  - Yes (output vs GND and supply voltage up to 36 VDC)

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

**Environmental Data**

- **Max. operational speed**
  - Mechanically unlimited

- **Vibration IEC 60068-2-6**
  - 20 g, 10 ... 2000 Hz, Amax = 0.75 mm

- **Shock IEC 60068-2-27**
  - 100 g, 11 ms (single hit)

- **Protection class DIN EN 60529**
  - IP67 (Connector system M12, fastened, when correctly fitted in cylinder: IP69)

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

- **Operating humidity**
  - 0 ... 95 % R.H. (no condensation)

- **Working pressure**
  - ≤ 350 bar

- **Pressure peaks**
  - ≤ 700 bar

- **Burst pressure**
  - > 700 bar

- **Life**
  - Mechanically unlimited

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

- **MTTF (IEC 60056)**
  - > 20 years

**EMC Compatibility**

- **ISO 10605 ESD (Handling/Component)**
  - 8 kV / 15 kV

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

- **ISO 11452-5 Radiated HF-Fields, stripline**
  - 200 V/m

- **USPR 25 Radiated emission**
  - Level 5

- **ISO 7037-2 Pulses on supply lines**
  - (1, 2a, 2b, 3a, 3b) Level 4

- **ISO 16750 Pulses on supply lines**
  - (4, 5) Level 4

- **ISO 16750-2 Transient emissions**
  - Level 4

- **ISO 16750-3 Pulses on output lines**
  - Level 4

- **EN 13309 Construction machinery**

- **ISO 11892 Agriculture/forestry machines**

The EMC measurements are conducted in a reference cylinder. The EMC properties can deviate when using different cylinders.

**Connection Assignment**

- **Signal**
  - **Plug system**
    - code 4_ _
  - **Cable**
    - code 2_ _
  - **Connector**
    - code 1_ _

- **Supply voltage Ub**
  - Pin 1
  - BN
  - Pin 1

- **GND**
  - Pin 3
  - WH
  - Pin 3

- **Signal output**
  - Pin 2
  - GN
  - Pin 2

- **Do not connect**
  - Pin 4
  - -
  - Pin 4

---

**Environmental Data**

- **Max. operational speed**
  - Mechanically unlimited

- **Vibration IEC 60068-2-6**
  - 20 g, 10 ... 2000 Hz, Amax = 0.75 mm

- **Shock IEC 60068-2-27**
  - 100 g, 11 ms (single hit)

- **Protection class DIN EN 60529**
  - IP67 (Connector system M12, fastened, when correctly fitted in cylinder: IP69)

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

- **Operating humidity**
  - 0 ... 95 % R.H. (no condensation)

- **Working pressure**
  - ≤ 350 bar

- **Pressure peaks**
  - ≤ 450 bar

- **Burst pressure**
  - > 700 bar

- **Life**
  - Mechanically unlimited

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

- **MTTF (IEC 60056)**
  - > 20 years

**EMC Compatibility**

- **ISO 10605 ESD (Handling/Component)**
  - 8 kV / 15 kV

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

- **ISO 11452-5 Radiated HF-Fields, stripline**
  - 200 V/m

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  - Level 4

- **EN 13309 Construction machinery**

- **ISO 11892 Agriculture/forestry machines**

The EMC measurements are conducted in a reference cylinder. The EMC properties can deviate when using different cylinders.
### Position Markers

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Material</th>
<th>Weight</th>
<th>Operating Temp.</th>
<th>Surface Pressure</th>
<th>Fastening Torque</th>
<th>P/N</th>
<th>Pack. unit (pcs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z-TH1-P18</td>
<td>Ring position marker for fixation with screws M3</td>
<td>PA6-GF</td>
<td>approx. 12 g</td>
<td>-40 ... +100°C</td>
<td>max. 40 N/mm²</td>
<td>max. 100 Ncm</td>
<td>400005697</td>
<td>1</td>
</tr>
<tr>
<td>Z-TH1-P19</td>
<td>Ring position marker for fixation with screws M4</td>
<td>PA6-GF</td>
<td>approx. 14 g</td>
<td>-40 ... +100°C</td>
<td>max. 40 N/mm²</td>
<td>max. 100 Ncm</td>
<td>400005698</td>
<td>1</td>
</tr>
<tr>
<td>Z-TIM-P20</td>
<td>Ring position marker for mounting via lock washer and retaining ring</td>
<td>PA-Neonbond Compound</td>
<td>approx. 5 g</td>
<td>-40 ... +100°C</td>
<td>max. 10 N/mm²</td>
<td></td>
<td>400005699</td>
<td>1</td>
</tr>
<tr>
<td>Z-TH1-P25</td>
<td>U-shaped position marker for fixation with M4 screws</td>
<td>PA6-GF</td>
<td></td>
<td>-40 ... +105°C</td>
<td>max. 40 N/mm²</td>
<td>max. 100 Ncm</td>
<td>400105076</td>
<td>1</td>
</tr>
</tbody>
</table>
Position Markers

Z-TH1-P22
Ball-type floating position marker
Material: Stainless steel 1.4571
Weight: approx. 42 g
Operating temp.: -40...+100°C
Compression strength: ≤ 60 bar
Density: 720 kg/m³
Immersion depth in water: 36.7 mm
P/N: 400056045
Pack. unit [pcs]: 1

Z-TH1-P21
Cylinder floating position marker
Material: Stainless steel 1.4404
Weight: approx. 20 g
Operating temp.: -40...+100°C
Compression strength: ≤ 8 bar
Density: 740 kg/m³
Immersion depth in water: approx. 26.6 mm
P/N: 400056044
Pack. unit [pcs]: 1

When using floating position markers, we recommend to secure the marker against loss with a washer at the rod end.
For this purpose, a sensor version with inner thread at the rod end is required (s. ordering codes).
Connector System

M12

**EEM-33-35/36/37**
M12x1 Mating female connector, 4-pin, straight, A-coded, with molded cable, not shielded, IP67, open ended

- Plug housing: PA
- Cable sheath: PUR, Ø = max. 6 mm, -40 ... +85°C (fixed)
- Lead wires: PP, 0.34 mm²

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>400056135</td>
<td>EEM-33-35</td>
<td>2 m</td>
</tr>
<tr>
<td>400056136</td>
<td>EEM-33-36</td>
<td>5 m</td>
</tr>
<tr>
<td>400056137</td>
<td>EEM-33-37</td>
<td>10 m</td>
</tr>
</tbody>
</table>

**EEM-33-38/39/40**
M12x1 Mating female connector, 4-pin, angled, A-coded, with molded cable, not shielded, IP67, open ended

- Plug housing: PA
- Cable sheath: PUR, Ø = max. 6 mm, -40 ... +85°C (fixed)
- Lead wires: PP, 0.34 mm²

<table>
<thead>
<tr>
<th>P/N</th>
<th>Type</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>400056138</td>
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<td>2 m</td>
</tr>
<tr>
<td>400056139</td>
<td>EEM-33-39</td>
<td>5 m</td>
</tr>
<tr>
<td>400056140</td>
<td>EEM-33-40</td>
<td>10 m</td>
</tr>
</tbody>
</table>

**EEM-33-89**
M12x1 Mating female connector, 4-pin, angled, A-coded, with coupling nut, screw termination, IP67, not shieldable

- Operating temp.: -25 ... +90°C
- Plug housing: PBT
- 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>400005634</td>
<td>EEM-33-89</td>
</tr>
</tbody>
</table>
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