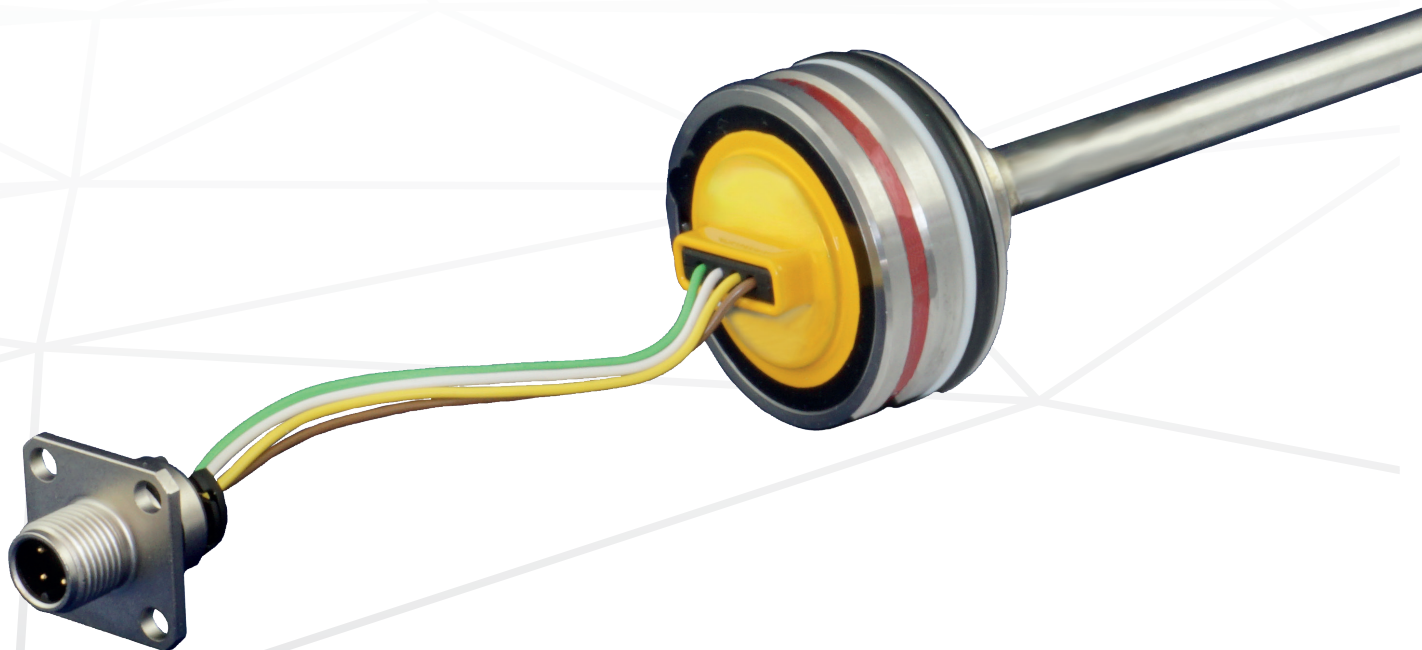


## Data Sheet

### **MH-Series SAFETY Analog** Magnetostrictive Linear Position Sensors

- Stroke length up to 2500 mm
- Linearity < 0.04 % F.S./Resolution 0.1 mm
- High reliability due to EMC, shock & vibration resistance
- Suitable for Safety Integrity Level 2 (SIL-2) applications



## MEASURING TECHNOLOGY

The absolute, linear position sensors provided by Temposonics rely on the company's proprietary magnetostrictive technology, which can determine position with a high level of precision and robustness. Each Temposonics® position sensor consists of a ferromagnetic waveguide, a position magnet, a strain pulse converter and supporting electronics. The magnet, connected to the object in motion in the application, generates a magnetic field at its location on the waveguide. A short current pulse is applied to the waveguide. This creates a momentary radial magnetic field and torsional strain on the waveguide. The momentary interaction of the magnetic fields releases a torsional strain pulse that propagates the length of the waveguide. When the ultrasonic wave reaches the beginning of the waveguide it is converted into an electrical signal. Since the speed of the ultrasonic wave in the waveguide is precisely known, the time required to receive the return signal can be converted into a linear position measurement with both high accuracy and repeatability.

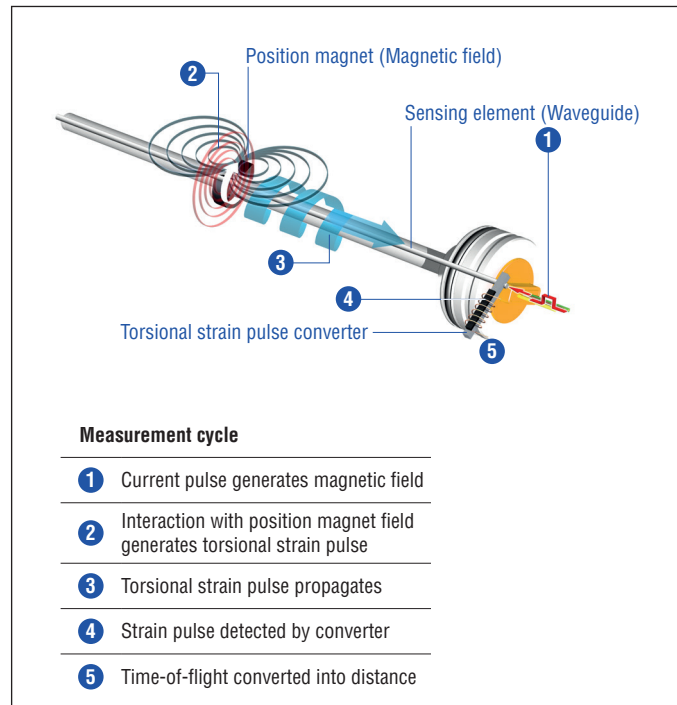


Fig. 1: Time-of-flight based magnetostrictive position sensing principle

## MH SAFETY SENSOR

The Temposonics® MH SAFETY sensors are specifically designed for direct stroke measurement in hydraulic cylinders. The MH-Series sensors can be fully sealed and embedded in a cylinder which provides excellent protection against the environment and EMI and ensures a long operating life. The MH-Series sensors can be installed from the head side or the rod side of the cylinder depending on the cylinder design. The sensor is certified according to IEC 61508:2010 and ISO 13849-1:2006 and 13849-2:2003.

## MH SENSOR

Temposonics® sensors can be used in versatile mobile machines without any restriction and replace contact-based linear sensors like potentiometers. Highly dynamic systems are controlled safely by means of Temposonics® sensors, thus enhancing the productivity, availability and quality of the working process of the machine. Insensitive to vibration, shock, dust and weathering influence and electro-magnetic disturbances. Temposonics® MH sensors are successfully used in front axle and articulated frame steering cylinders, hydraulic jacks and in steering systems for hydraulic units on agricultural and construction machinery.



Fig. 2: Typical applications

## TECHNICAL DATA

Output			
Signal characteristic	Continuously analog output restricted by noise or A/D converter of control unit		
Voltage	0.5...4.5 VDC with failure signal	< 0.5 VDC LO	> 4.5 VDC HI
Current	4...20 mA with failure signal	< 4.0 mA LO	> 20 mA HI
Measured value	Position		
Measurement parameters			
Stroke length	50...2500 mm		
Resolution	Typ. 0.1 mm		
Boot up Time	Typ. 250 ms		
Linearity	0050...0250 mm	0255...2000 mm	2005...2500 mm
	≤ ±0.1 mm	±0.04 % (F.S.)	≤ ±0.8 mm
Hysteresis	±0.1 mm		
Internal sample rate	2 ms		
Setpoint tolerance	≤ 1 mm		
Operating conditions			
Operating temperature electronics	-40...+100 °C		
Humidity	90 % relative humidity, no condensation, EN 60068-2-30		
Ingress protection - Connector	M12 connector system: IP67/IP69K (connectors correctly fitted), EN 60529 DT connector system: IP69K, EN 60529		
Ingress protection – Sensor housing	IP67, EN 60529		
Shock test	100 g (6 ms) single shock per axis, IEC 60068-2-27 50 g (11 ms) at 1000 shocks per axis, IEC 60068-2-27		
Vibration	Operational sine vibration test IEC 60068-2-6: 25 g (5...2000 Hz) Survival random vibration test IEC 60068-2-64: 15 g RMS (20...2000 Hz) 12 h per axis		
EMC	Compliant with: ISO 13766-1:2006 Earth-moving and building construction machinery ISO 14982:1998 Agricultural and forest machines The MH sensors fulfill the requirements of the EMC directives 2014/30/EU, UKSI 2016 No. 1091 and TR CU 020/2011		
EMI	100 V/m (200...2000 MHz), ISO 11452-2: 2019 200 mA (20...400 MHz), ISO 11452-4: 2011		
Operating pressure ratings		Pressure (according to DIN EN ISO 19879)*	
PN (nominal operating)	350 bar		
Pmax (max. overload)	450 bar		
Pstatic (proof pressure)	625 bar		
Design/Material			
Sensor electronics housing	Stainless steel 1.4305 (AISI 303)		
Sealing	O-ring: H-NBR 70		
Sensor rod	Stainless steel 1.4306 (AISI 304L)		
RoHS compliance	The used materials are compliant with the requirements of EU Directive 2011/65/EU and EU Regulation 2015/863 as well as UKSI 2022 No. 622 with amendments.		
Electrical installation			
Connection type	M12 male connector or DT connector system		
Operating voltage	12 VDC (8...32 VDC)		24 VDC (16...32 VDC)
Current consumption	Typ. ≤ 100 mA		Typ. ≤ 50 mA
Load (output VDC)	R <sub>L</sub> > 10 kΩ		R <sub>L</sub> > 10 kΩ
Load current (output VDC)	Typ. 0.5 mA		Typ. 0.5 mA
Load (output mA)	R <sub>L</sub> < 250 Ω		R <sub>L</sub> < 500 Ω
Inrush current	Max. 2.5 A/2 ms		Max. 4.5 A / 2 ms
Supply voltage ripple	< 1 % <sub>PP</sub>		
Power drain	< 1 W		
Over voltage protection (GND - VDC)	Up to +36 VDC		
Polarity protection (GND - VDC)	Up to -36 VDC		
Insulation Resistance	R ≥ 10 MΩ @ 60 sec		
Electric strength	500 VDC (DC GND to chassis GND)		

\*/ According to calculations under use of the FKM guideline

Cycles	Ø 10 mm sensor rod
Dynamic pressure: < 2 × 10 <sup>6</sup> pressure cycles	350 bar
Static pressure: < 2 × 10 <sup>4</sup> pressure cycles	450 bar
Proof pressure: Maximum 5 minutes testing time for cylinder pressure test	625 bar

TECHNICAL DRAWING

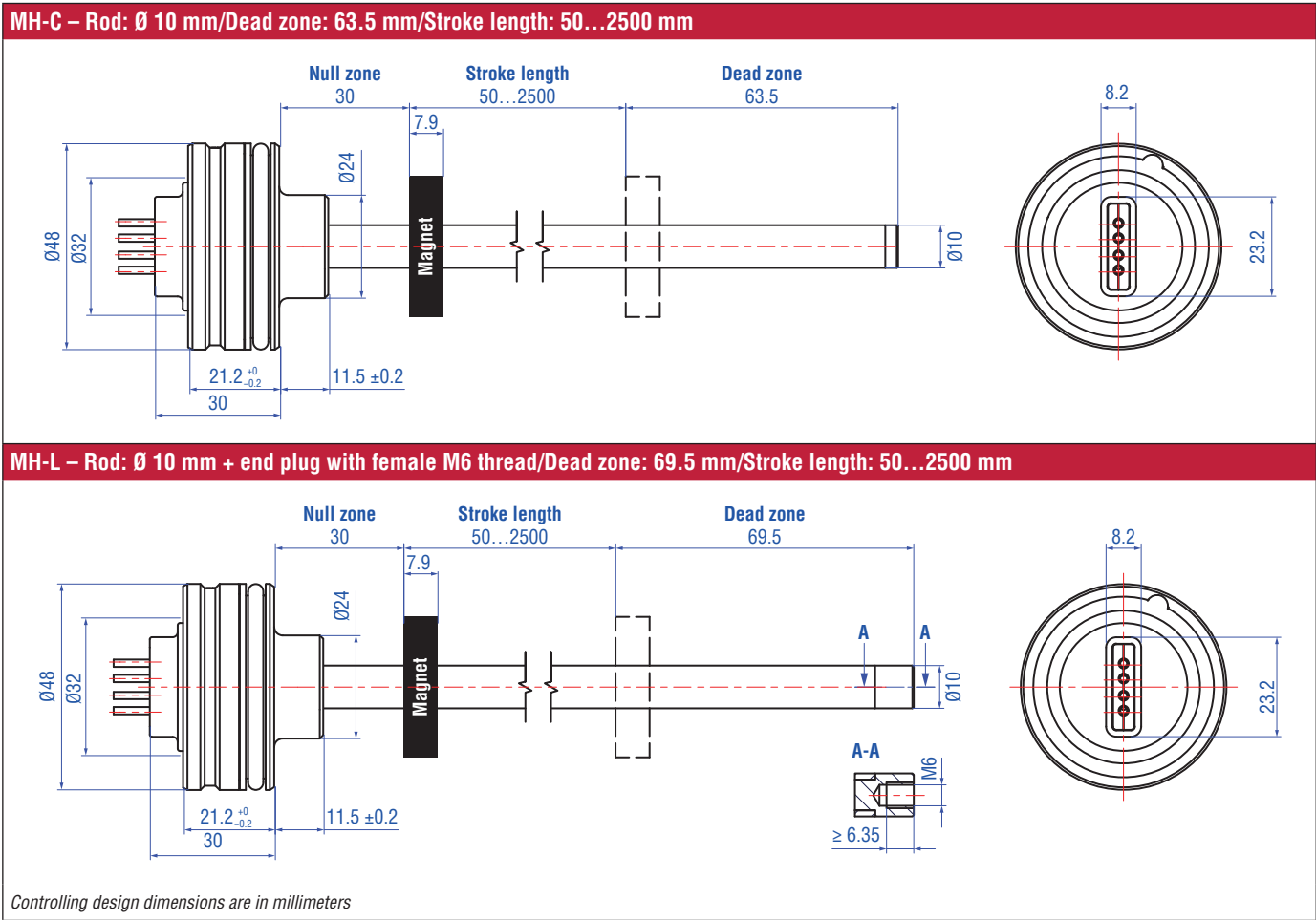
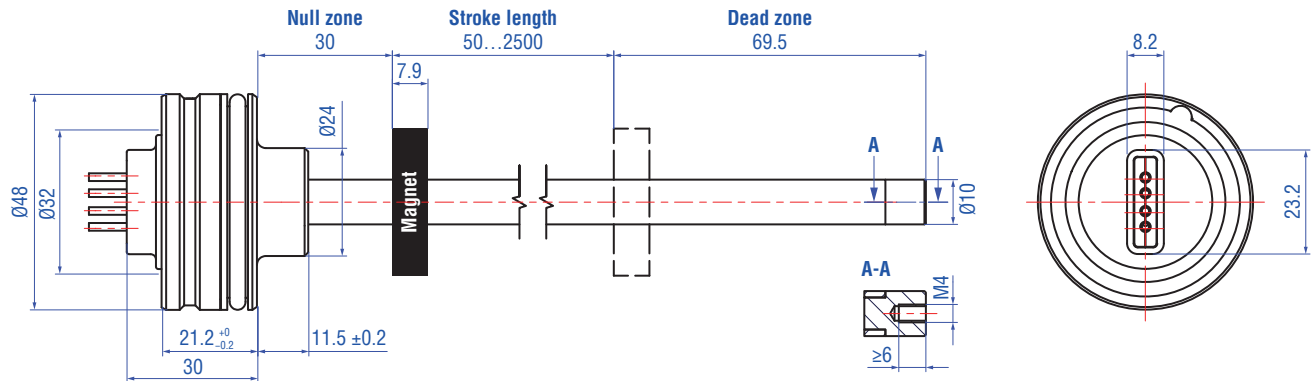
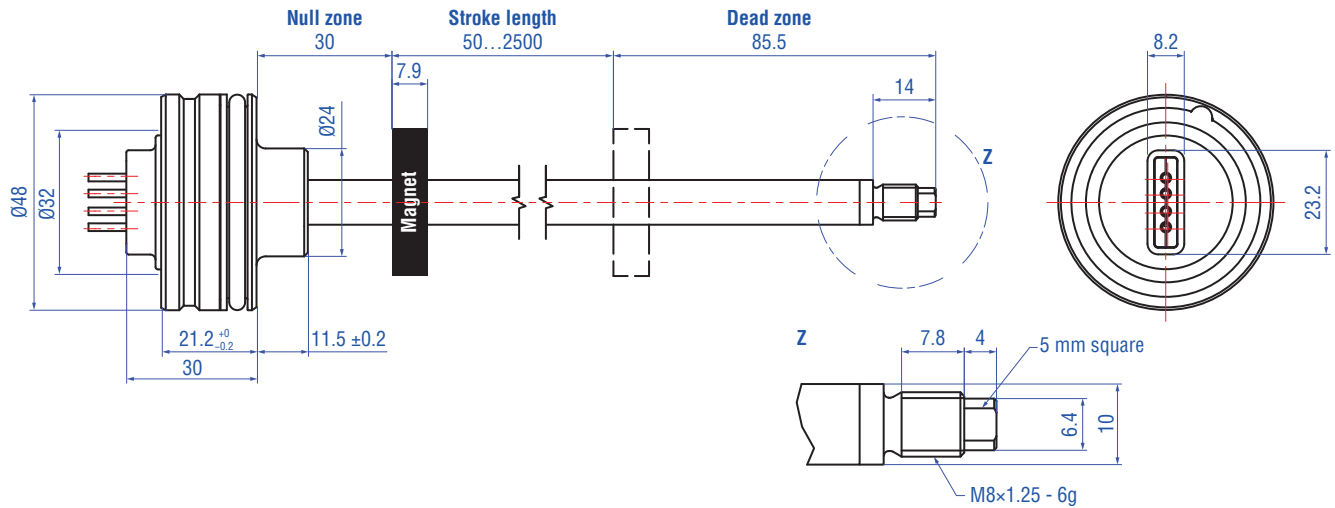


Fig. 3: Temposonics® MH SAFETY with ring magnet, part 1

**MH-R – Rod: Ø 10 mm + end plug with female M4 thread/Dead zone: 69.5 mm/Stroke length: 50...2500 mm**



**MH-Q – Rod: Ø 10 mm + end plug with male M8 thread/Dead zone: 85.5 mm/Stroke length: 50...2500 mm**



Controlling design dimensions are in millimeters

Fig. 4: Temposonics® MH Safety with ring magnet, part 2

CONNECTOR WIRING

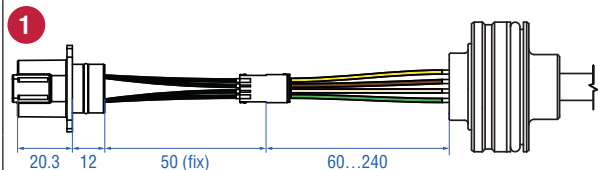
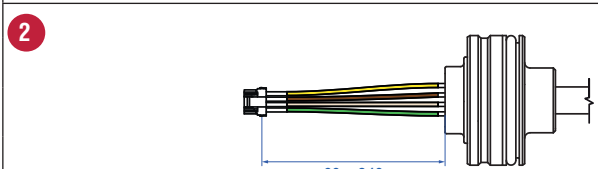
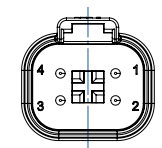
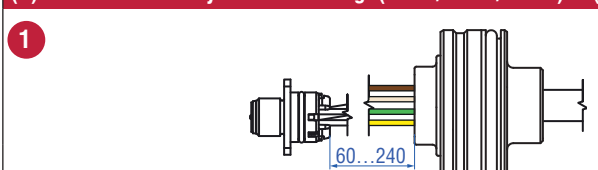
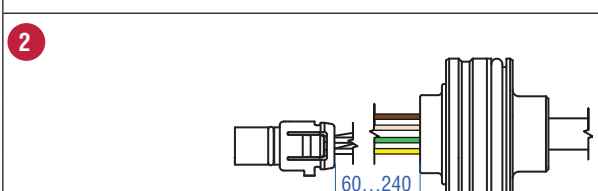

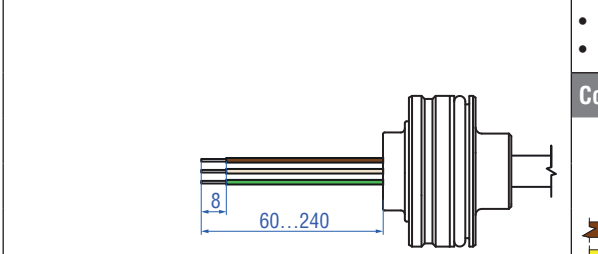
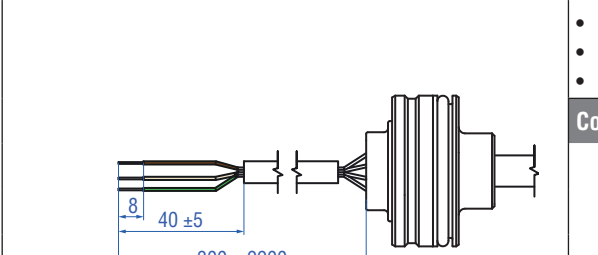
(1) DT connector system (A...E/A...G/A...H) & (2) Interconnect without DT connector system (W...E/W...G/W...H)											
<div>1</div> 				<ul style="list-style-type: none"><li>• Single lead wires 0.22 mm<sup>2</sup></li><li>• 4 pin DT style connector</li><li>• Toolless Assembly</li><li>• Sealing IP69K (with or without mating connector)</li></ul>							
<div>2</div>    View on connector				Connector wiring		E		G		H	
				Pin	Wire	Function	Wire	Function	Wire	Function	
				1	YE	n.c.	BN	VDC	BN	VDC	
				2	BN	VDC	YE	n.c.	GN	SIG	
				3	WH	GND	WH	GND	WH	GND	
				4	GN	SIG	GN	SIG	YE	n.c.	
(1) M12 connector system with flange(N...E/N...G/N...H) & (2) without flange (K...E/K...G/K...H)											
<div>1</div> 				<ul style="list-style-type: none"><li>• Single lead wires 0.22 mm<sup>2</sup></li><li>• Attached A-coded M12 connector</li><li>• Toolless Assembly</li><li>• Sealing IP67, up to IP69K with mating connector</li></ul>							
<div>2</div>    View on connector				Connector wiring		E		G		H	
				Pin	Wire	Function	Wire	Function	Wire	Function	
				1	YE	n.c.	BN	VDC	BN	VDC	
				2	BN	VDC	YE	n.c.	GN	SIG	
				3	WH	GND	WH	GND	WH	GND	
				4	GN	SIG	GN	SIG	YE	n.c.	
Single wires pigtail (N...A)											
				<ul style="list-style-type: none"><li>• Single lead wires 0.5 mm<sup>2</sup></li><li>• Insulation PVC</li></ul>							
				Connector wiring							
				Color		Function					
				YE		n.c.					
				BN		VDC					
				WH		GND					
				GN		SIG					
Pigtail cable (T...A)											
				<ul style="list-style-type: none"><li>• PUR cable</li><li>• Ø 5 mm, non-shielded, 3 × 0.5 mm<sup>2</sup></li><li>• Flexible, oil resistance</li></ul>							
				Connector wiring							
				Color		Function					
				YE		n.c.					
				BN		VDC					
				WH		GND					
				GN		SIG					

Fig. 5: Connector wiring

## Connection schematics

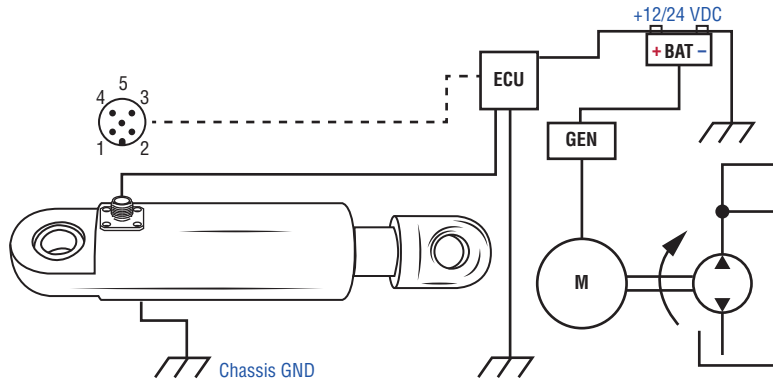


Fig. 9: Connection schematics

### NOTICE

To ensure proper operation of the sensor, the hydraulic cylinder must be connected to the machine ground. Grounding is often ensured by the mechanical contact between the cylinder and other machine elements. If the cylinder is connected with the machine separately, separate grounding, for example via a grounding strap directly on the cylinder must be ensured.

## MECHANICAL INSTALLATION

### Installation in a hydraulic cylinder

The robust Temposonics® MH sensor is designed for direct stroke measurement in hydraulic cylinders.

The Temposonics® MH sensor can be installed from the head side or the rod side of the cylinder depending on the cylinder design.

In both installation methods, the sensor seals the cylinder by using an O-ring and backup ring which is installed on the sensor housing.

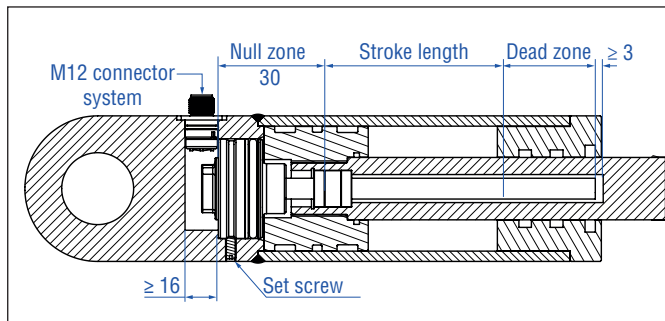


Fig. 6: Example of In-Cylinder assembly with M12 connector system

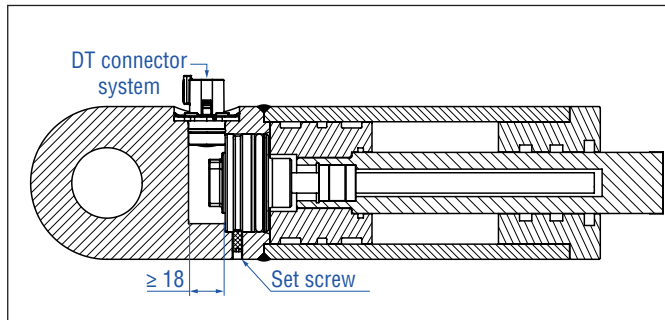


Fig. 7: Example of In-Cylinder assembly with DT connector system

### NOTICE

Installation Manual for MH sensors ([document part no. 551289](#))  
Installation Manual for DT connector system  
([document part no. 552093](#))

### NOTICE

#### Sealing:

- Take action against water ingress by sealing the cavity on the cover side.
- Cable glands should have IP69K rating.

#### Pressure:

- Do not exceed the operating pressure.

#### Avoid part collision:

- The bore depth in piston:  
Null zone + stroke length + dead zone + > 3 mm
- The position magnet shall not touch the pressure pipe.
- Note piston rod borehole diameter:  $\geq \varnothing 13 \text{ mm}$

## Space requirements

### M12 connector system / cable outlet

a	b	c	d	e
52 mm	48H8	21.2 mm	> 32.5 mm < 40 mm	> 16 mm

### DT connector system

a	b	c	d	e
52 mm	48H8	21.2 mm	> 32.5 mm < 40 mm	> 18 mm

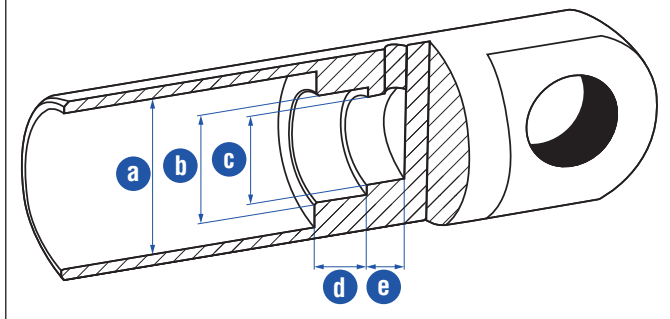


Fig. 8: Space requirements for cylinder

### Set screw

e.g. retaining with set screw (with flat point) ISO 4026 M5×10 (DIN 913).  
Fastening torque:  $\leq 0.5 \text{ Nm}$

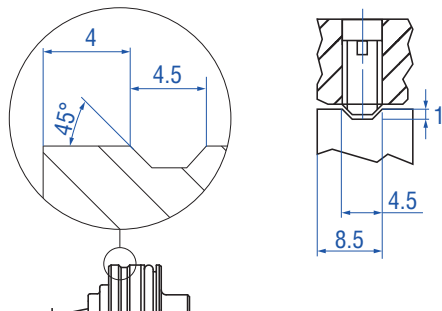


Fig. 10: Set screw

### NOTICE

#### Avoid sensor damage:

- The screw may touch the sensor housing.
- Tightening torque:  $\leq 0.5 \text{ Nm}$ .

#### Lock set screw:

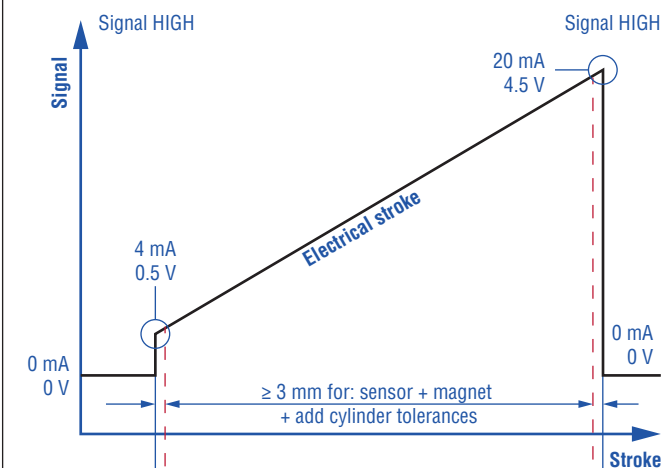
- Lock the set screw against falling out.
- Make sure that the threads are free of oil, grease and dirt.

#### Sealing:

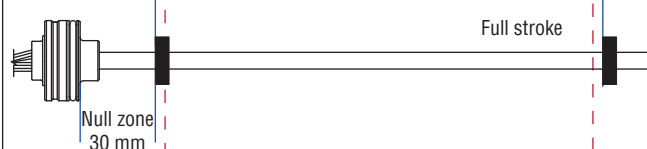
- Consider a seal against water ingress (capillary effect).

### Electrical installation for analog output

#### Signal



#### Measuring range



#### Mechanical stroke

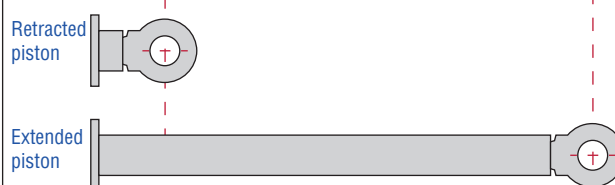
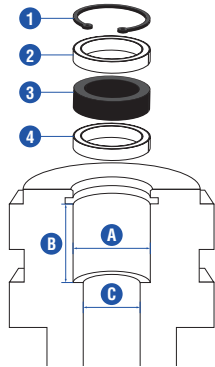


Fig. 11: Electrical installation



## MECHANICAL INSTALLATION – POSITION MAGNET

### Magnet installation



- 1 Circlip
- 2 Non-magnetic spacer
- 3 Position magnet
- 4 Non-magnetic spacer ( $\geq 5$  mm)

#### Position magnet (Part no.)

	401 032	400 533	201 542-2
A	17.4 mm	25.4 mm	32.8 mm
B	$\geq 18$ mm	$\geq 18$ mm	$\geq 18$ mm
Rod $\varnothing$ 10 mm → Piston rod drilling $\geq \varnothing$ 13 mm			

Fig. 12: Dimensions for magnet mounting

## ORDER CODE (CURRENT)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
M	H	C					M					3	A	9	9			
a		b	c					d				e	f			g		

a	Sensor model
M H	Pressure fit flange

b	Design
C	Rod: Ø 10 mm + flat end plug / Dead zone: 63.5 mm / Stroke length: 50...2500 mm
L	Rod: Ø 10 mm + end plug with female M6 thread / Dead zone: 69.5 mm / Stroke length: 50...2500 mm
R	Rod: Ø 10 mm + end plug with female M4 thread / Dead zone: 69.5 mm / Stroke length: 50...2500 mm
Q	Rod: Ø 10 mm + end plug with male M8 thread / Dead zone: 85.5 mm / Stroke length: 50...2500 mm

c	Stroke length
X X X X M	0050...2500 mm (in 5 mm steps)

d	Electrical wiring
<b>DT connector system (VDC – GND – SIG)</b>	
A	60...240 mm wire length (in 20 mm steps) Connector wiring E: 2-3-4 Example wire length A06E = 60 mm
A	60...240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4 Example wire length A06G = 60 mm
A	60...240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2 Example wire length A06H = 60 mm
<b>Interconnect without DT connector (VDC – GND – SIG)</b>	
W	60...240 mm wire length (in 20 mm steps) Connector wiring E: 2-3-4 Example wire length W06E = 60 mm
W	60...240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4 Example wire length W06G = 60 mm
W	60...240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2 Example wire length W06H = 60 mm
<b>M12 connector system (VDC – GND – SIG) incl. flange</b>	
N	60...240 mm wire length (in 20 mm steps) Connector wiring E: 2-3-4 Example wire length N06E = 60 mm
N	60...240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4 Example wire length N06G = 60 mm
N	60...240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2 Example wire length N06H = 60 mm

d	Electrical wiring
<b>M12 connector system (VDC – GND – SIG) without flange</b>	
K	60...240 mm wire length (in 20 mm steps) Connector wiring E: 2-3-4 Example wire length K06E = 60 mm
K	60...240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4 Example wire length K06G = 60 mm
K	60...240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2 Example wire length K06H = 60 mm
<b>Single wires</b>	
N	60...240 mm cable length (in 20 mm steps) Examples wire length N06A = 60 mm
<b>Cable outlet</b>	
T	300...9900 mm cable length (in 100 mm steps) Examples wire length T10A = 1000 mm

e	Supply voltage
3	+12/24 VDC (8...32 VDC)

f	Output
A 9 9	4...20 mA

g	Load resistance
	10...500 Ω

## DELIVERY



- Position sensor
- O-ring
- Backup-ring
- M12 connector system incl. M12 flange (when option selected)
- DT connector system incl. connector assembly and re-tainer (when option selected)

Accessories (e.g. position magnets) have to be ordered separately

Manuals, Software & 3D models available at:  
[www.temposonics.com](http://www.temposonics.com)

## ORDER CODE (VOLTAGE)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
M	H	C					M					3	V	9	9
a		b	c					d				e	f		

a	Sensor model
M H	Pressure fit flange

b	Design
C	Rod: Ø 10 mm + flat end plug / Dead zone: 63.5 mm / Stroke length: 50...2500 mm
L	Rod: Ø 10 mm + end plug with female M6 thread / Dead zone: 69.5 mm / Stroke length: 50...2500 mm
R	Rod: Ø 10 mm + end plug with female M4 thread / Dead zone: 69.5 mm / Stroke length: 50...2500 mm
Q	Rod: Ø 10 mm + end plug with male M8 thread / Dead zone: 85.5 mm / Stroke length: 50...2500 mm

c	Stroke range
X X X X M	0050...2500 mm (in 5 mm steps)

d	Electrical wiring
<b>DT connector system (VDC – GND – SIG)</b>	
A	60...240 mm wire length (in 20 mm steps) Connector wiring E: 2-3-4 <i>Example wire length A06E = 60 mm</i>
A	60...240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4 <i>Example wire length A06G = 60 mm</i>
A	60...240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2 <i>Example wire length A06H = 60 mm</i>
<b>Interconnect without DT connector (VDC – GND – SIG)</b>	
W	60...240 mm wire length (in 20 mm steps) Connector wiring E: 2-3-4 <i>Example wire length W06E = 60 mm</i>
W	60...240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4 <i>Example wire length W06G = 60 mm</i>
W	60...240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2 <i>Example wire length W06H = 60 mm</i>
<b>M12 connector system (VDC – GND – SIG) incl. flange</b>	
N	60...240 mm wire length (in 20 mm steps) Connector wiring E: 2-3-4 <i>Example wire length N06E = 60 mm</i>
N	60...240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4 <i>Example wire length N06G = 60 mm</i>
N	60...240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2 <i>Example wire length N06H = 60 mm</i>

d	Electrical wiring
<b>M12 connector system (VDC – GND – SIG) without flange</b>	
K	60...240 mm wire length (in 20 mm steps) Connector wiring E: 2-3-4 <i>Example wire length K06E = 60 mm</i>
K	60...240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4 <i>Example wire length K06G = 60 mm</i>
K	60...240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2 <i>Example wire length K06H = 60 mm</i>
<b>Single wires</b>	
N	60...240 mm cable length (in 20 mm steps) <i>Examples wire length N06A = 60 mm</i>
<b>Cable outlet</b>	
T	300...9900 mm cable length (in 100 mm steps) <i>Examples wire length T10A = 1000 mm</i>

e	Supply voltage
3	+12/24 VDC (8...32 VDC)

f	Output
V 9 9	0.5...4.5 VDC

## DELIVERY

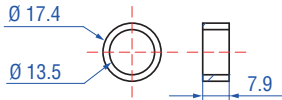
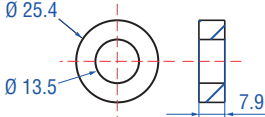
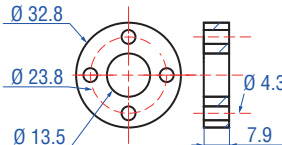

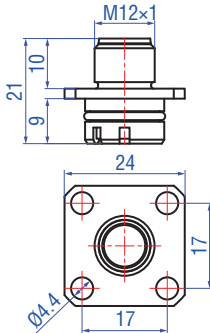
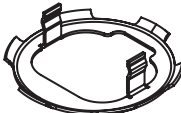
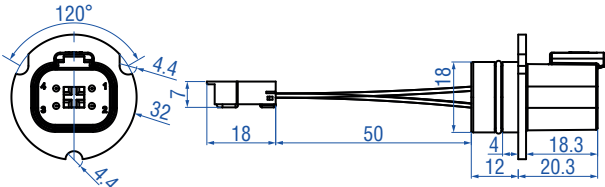


- Position sensor
- O-ring
- Backup-ring
- M12 connector system incl. M12 flange (when option selected)
- DT connector system incl. connector assembly and re-tainer (when option selected)

Accessories (e.g. position magnets) have to be ordered separately

Manuals, Software & 3D models available at:  
[www.temposonics.com](http://www.temposonics.com)

FREQUENTLY ORDERED ACCESSORIES

Position magnets			Test kit
			
<b>Ring magnet OD17.4</b> Part no. 401 032	<b>Ring magnet OD25.4</b> Part no. 400 533	<b>Ring magnet OD33</b> Part no. 201 542-2	<b>MH test kit (analog)</b> Part no. 280 618
Material: PA neobond Weight: Approx. 5 g Surface pressure: Max. 20 N/mm² Operating temperature: -40...+105 °C (-40...+221 °F)	Material: PA ferrite Weight: Approx. 10 g Surface pressure: Max. 40 N/mm² Operating temperature: -40...+120 °C (-40...+248 °F)	Material: PA ferrite GF20 Weight: Approx. 14 g Surface pressure: Max. 40 N/mm² Fastening torque for M4 screws: 1 Nm Operating temperature: -40...+120 °C (-40...+248 °F)	<b>Kit includes:</b> <ul style="list-style-type: none"><li>• 12 VDC battery charger with adapter (EU &amp; UK)</li><li>• Cable with M12 connector</li><li>• Cable with pigtailed wires</li><li>• Carrying case</li></ul>
M12 flange		Connector accessories	
			
<b>M12 flange</b> Part no. 253 769	<b>DT connector system retainer</b> Part no. 520 101	<b>DT connector assembly</b> Part no. 255 098	
Material: Brass, nickel-plated Weight: Approx. 5 g Operating temperature: -40...+105 °C (-40...+221 °F)	Material: 1.4310 Weight: Ca. 1.7 g Operating temperature: -40...+105 °C (-40...+221 °F)	Material: PA66 Weight: Approx. 6 g Operating temperature: -40...+105 °C (-40...+221 °F)	

Controlling design dimensions are in millimeters



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