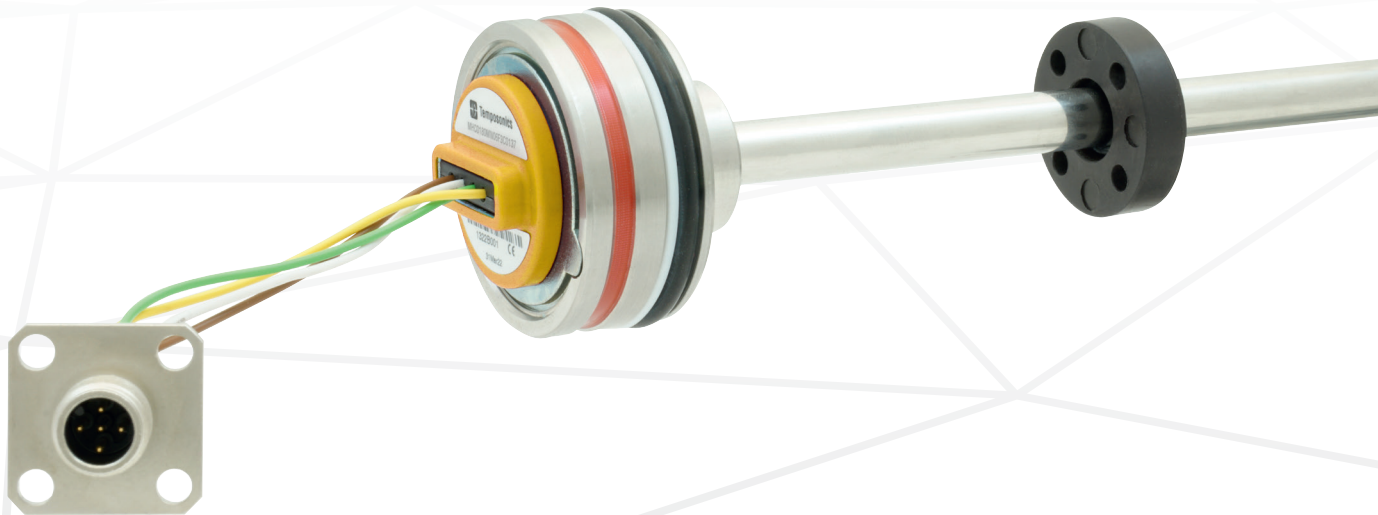


Data Sheet

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 Tempsonics rely on the company's proprietary magnetostrictive technology, which can determine position with a high level of precision and robustness. Each Tempsonics® 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.

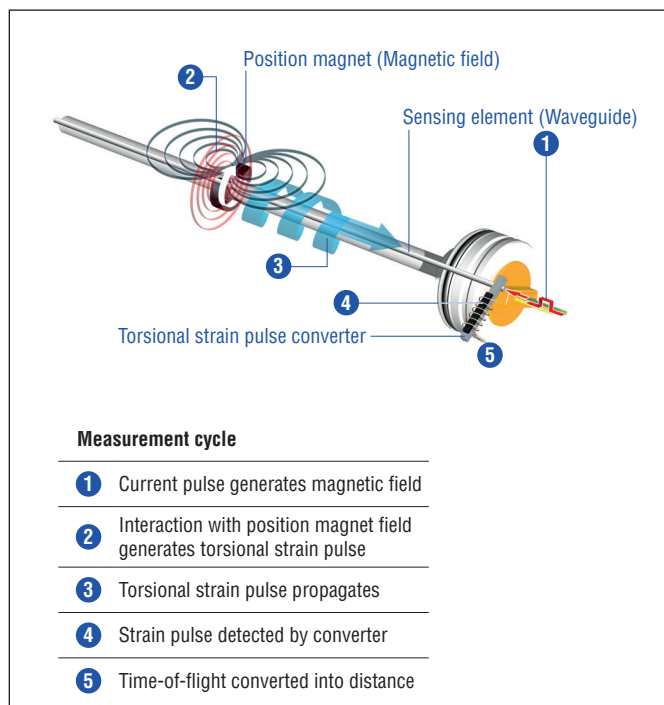


Fig. 1: Time-of-flight based magnetostrictive position sensing principle

MH SAFETY SENSOR

The Tempsonics® 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

Tempsonics® 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 Tempsonics® 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. Tempsonics® 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.



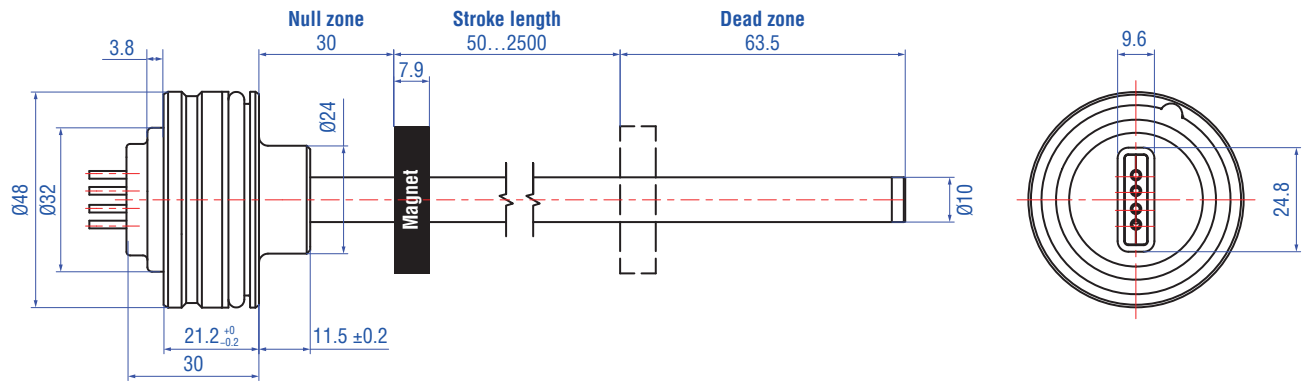
Fig. 2: Typical applications

TECHNICAL DATA

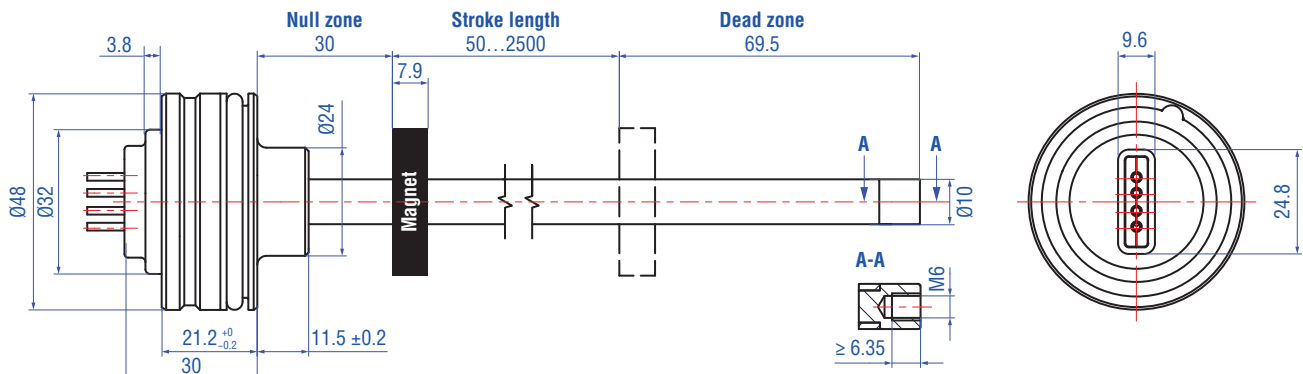
Output			
Signal characteristic	Continuously analog output restricted by noise or A/D converter of control unit		
Voltage	0.5...4.5 VDC with failure signal	< 0.5 VDC LO	> 4.5 VDC HI
Current	4...20 mA with failure signal	< 4.0 mA LO	> 20 mA HI
Measured value	Position		
Measurement parameters			
Stroke 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:		
EMC	25 g RMS (20...2000 Hz) 12 h per axis		
	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 _L > 10 kΩ		R _L > 10 kΩ
Load current (output VDC)	Typ. 0.5 mA		Typ. 0.5 mA
Load (output mA)	R _L < 250 Ω		R _L < 500 Ω
Inrush current	Max. 2.5 A / 2 ms		Max. 4.5 A / 2 ms
Supply voltage ripple	< 1 % _{pp}		
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 ⁶ pressure cycles	350 bar		
Static pressure: < 2 × 10 ⁴ pressure cycles	450 bar		
Proof pressure: Maximum 5 minutes testing time for cylinder pressure test	625 bar		

TECHNICAL DRAWING

MH-C – Rod: Ø 10 mm / Dead zone: 63.5 mm/Stroke length: 50...2500 mm



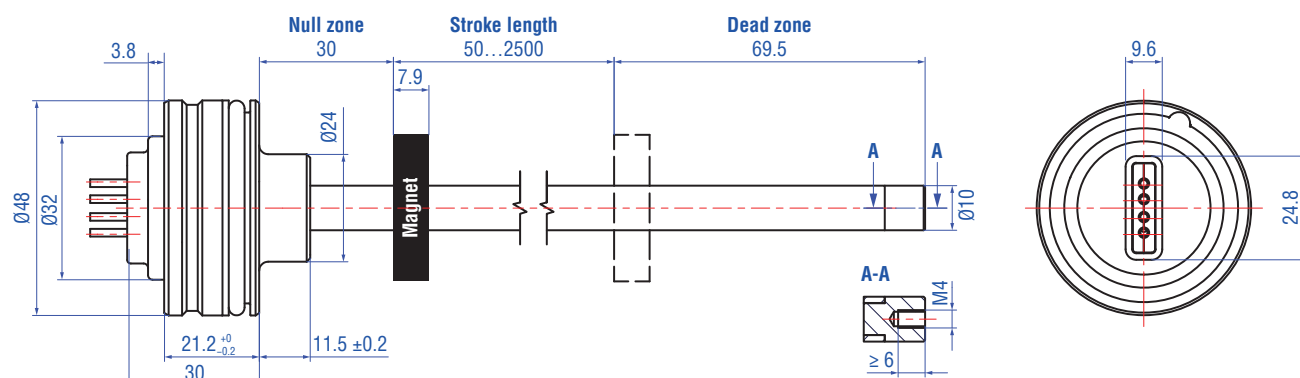
MH-L – Rod: Ø 10 mm + end plug with female M6 thread/Dead zone: 69.5 mm / Stroke length: 50...2500 mm



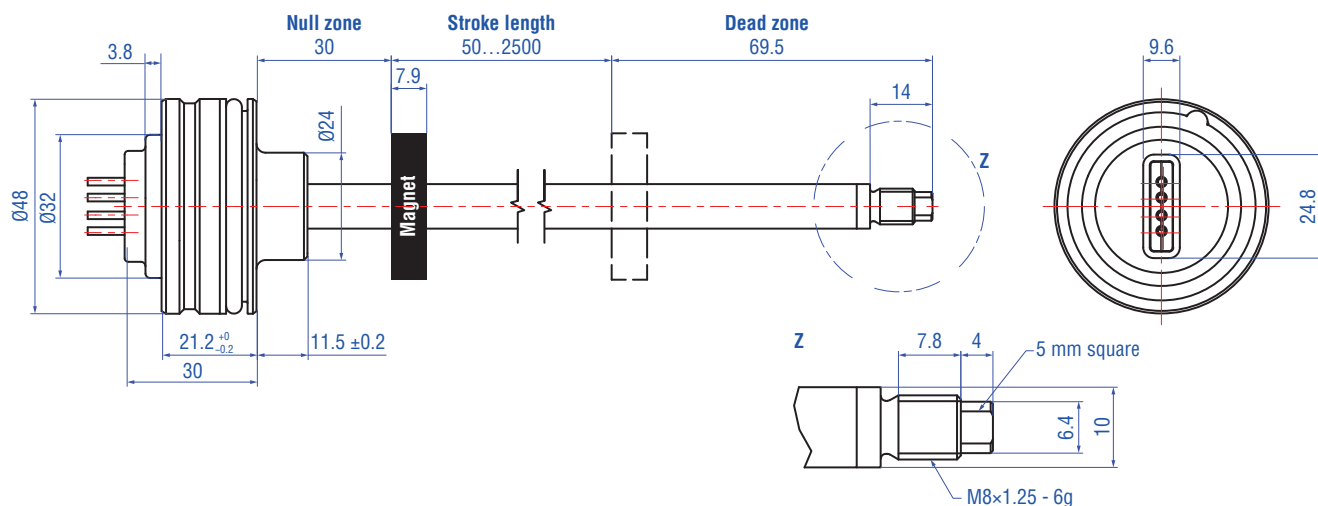
Controlling design dimensions are in millimeters

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: 69.5 mm / Stroke length: 50...2500 mm



Controlling design dimensions are in millimeters

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

CONNECTOR WIRING

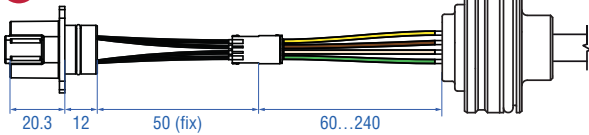
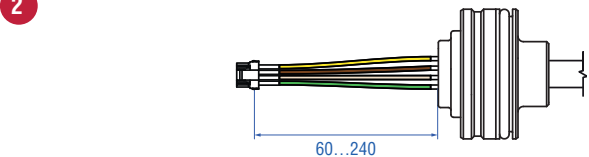
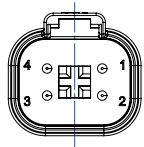
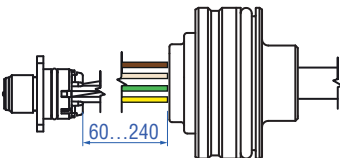

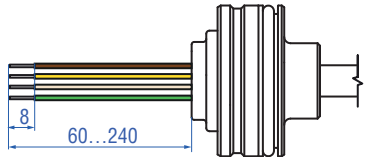

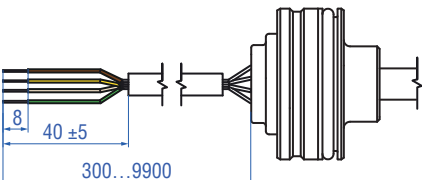
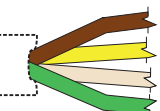
(1) DT connector system (A...E/A...G/A...H) & (2) Interconnect without DT connector system (W...E/W...G/W...H)													
<div>1</div> 				<ul style="list-style-type: none">• Single lead wires 0.22 mm²• 4 pin DT style connector• Toolless Assembly• Sealing IP69K (with or without mating connector)									
<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.	
M12 connector system with flange(N...E/N...G/N...H)													
				<ul style="list-style-type: none">• Single lead wires 0.22 mm²• Attached A-coded M12 connector• Toolless Assembly• Sealing IP67, up to IP69K with mating connector									
 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">• Single lead wires 0.5 mm²• Insulation PVC									
				Connector wiring		Color		Function					
						YE		n.c.					
						BN		VDC					
						WH		GND					
						GN		SIG					
Pigtail cable (T...A)													
				<ul style="list-style-type: none">• PUR cable• Ø 5 mm, non-shielded, 3 × 0.5 mm²• Flexible, oil resistance									
				Connector wiring		Color		Function					
						YE		n.c.					
						BN		VDC					
						WH		GND					
						GN		SIG					

Fig. 5: Cable wiring of cable outlet

Connection schematics

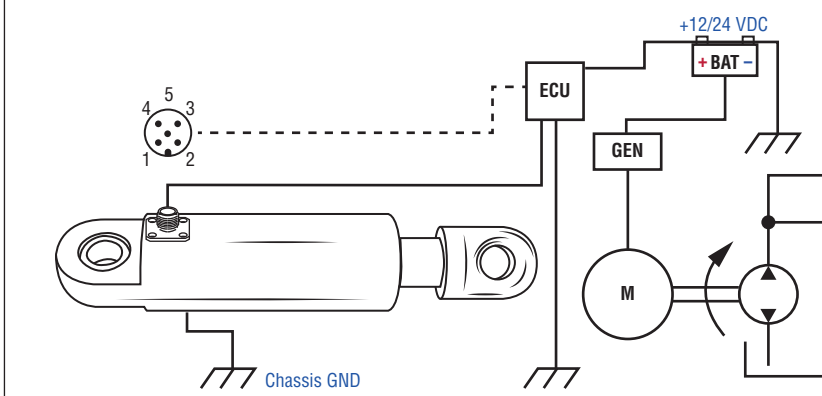


Fig. 9: Connection schematics

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.

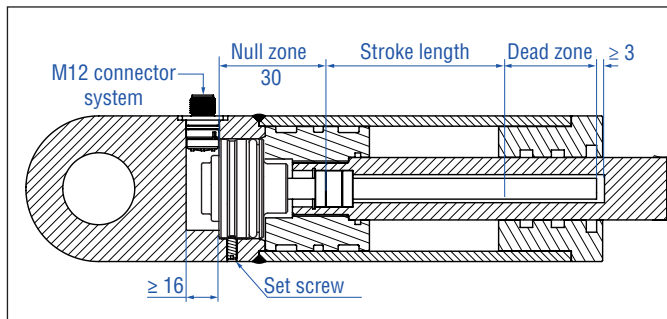


Fig. 6: Example of In-Cylinder assembly with M12 connector system

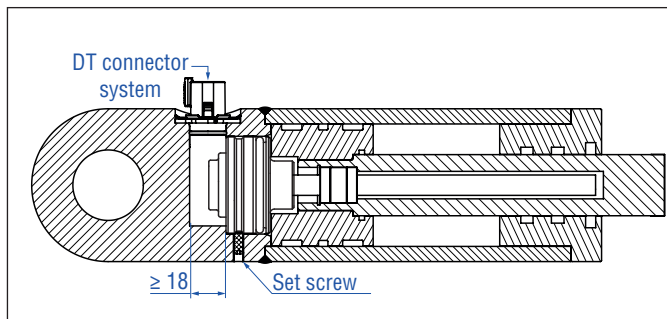


Fig. 7: Example of In-Cylinder assembly with DT connector system

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: $\geq \varnothing 13$ mm

Space requirements

M12 connector system / cable outlet

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

DT connector system

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

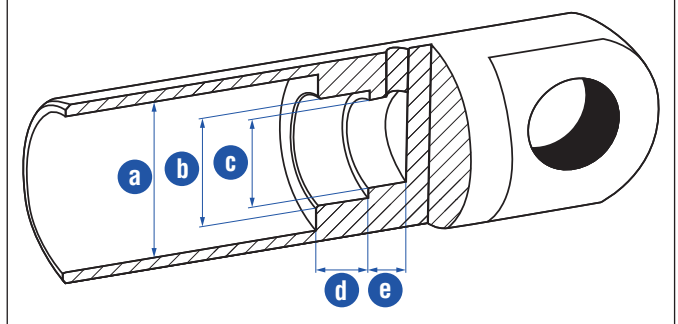


Fig. 8: Space requirements for cylinder

Controlling design dimensions are in millimeters

Set screw

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

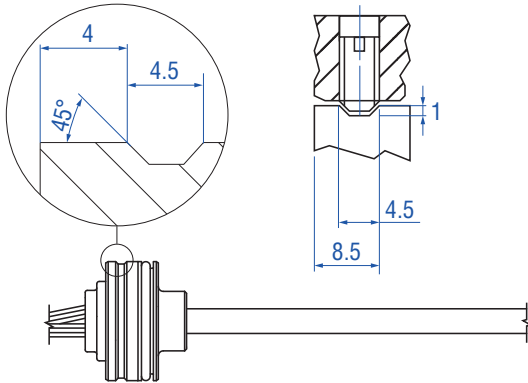


Fig. 10: Set screw

NOTICE

Avoid sensor damage:

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

Lock set screw:

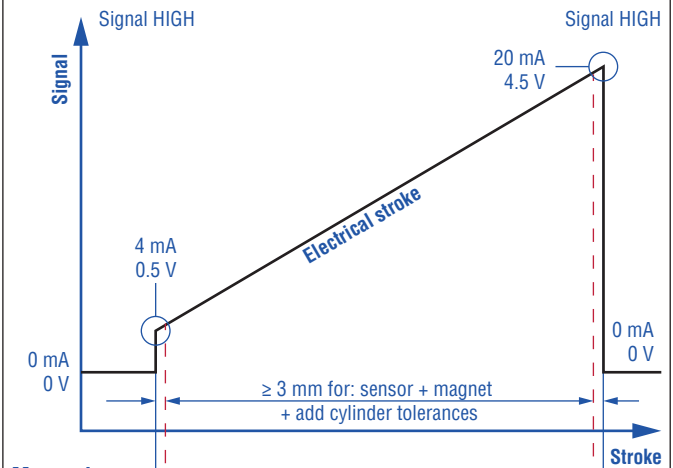
- Lock the set screw against falling out.
- Make sure that the threads are free of oil, grease and dirt.

Sealing:

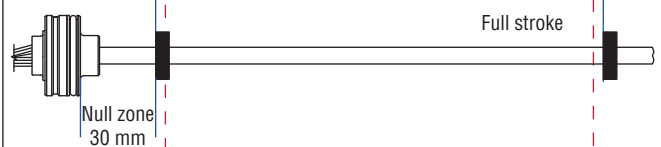
- Consider a seal against water ingress (capillary effect).

Electrical installation for analog output

Signal



Measuring range



Mechanical stroke

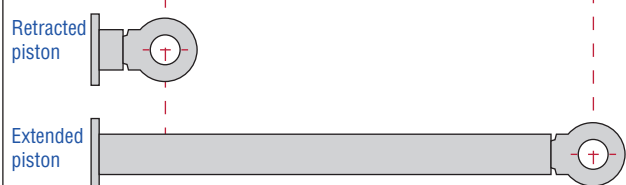


Fig. 11: Electrical installation

MECHANICAL INSTALLATION – POSITION MAGNET

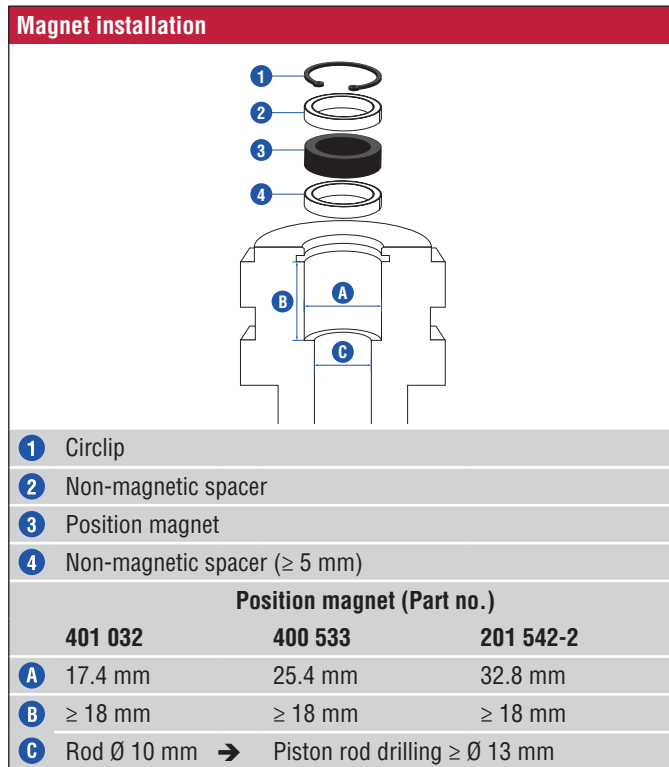


Fig. 12: Dimensions for magnet mounting

ORDER CODE – ANALOG CURRENT

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

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: 69.5 mm / Stroke length: 50...2500 mm											

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

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

14	15	16	17	18	19
A	9	9			
f			g		

d	Electrical wiring											
Single wires												
N				A	60...240 mm wire length (in 20 mm steps) <i>Examples wire length N06A = 60 mm</i>							
Cable outlet												
T				A	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											
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 retainer (when option selected)

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

Manuals, Software & 3D models available at:
www.temposonics.com

ORDER CODE – ANALOG 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: 69.5 mm / Stroke length: 50...2500 mm

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

d	Electrical wiring
DT connector system (VDC – GND – SIG)	
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>
Interconnect without DT connector system (VDC – GND – SIG)	
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>
M12 connector system (VDC – GND – SIG) incl. flange	
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
Single wires	
N	60...240 mm wire length (in 20 mm steps) <i>Examples wire length N06A = 60 mm</i>
Cable outlet	
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

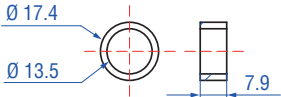
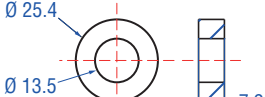
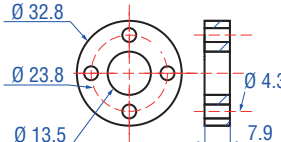
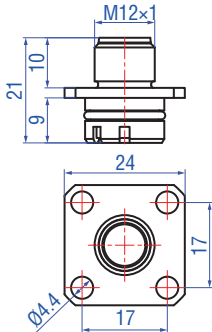
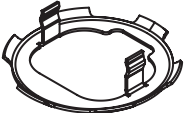
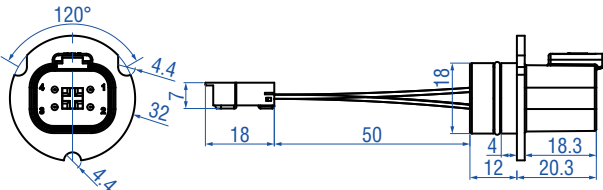



- Position sensor
- O-ring
- backup-ring
- M12 connector system incl. M12 flange (when option selected)
- DT connector system incl. connector assembly and retainer (when option selected)

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

Manuals, Software & 3D models available at:
www.temposonics.com

FREQUENTLY ORDERED ACCESSORIES

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

Cables



Cable with M12 A-coded female connector (5 pin), straight – pigtail
Part no. 370 673

Material: PUR jacket; black
Feature: Shielded
Cable length: 5 m (16.4 ft)
Ingress protection: IP67 (correctly fitted)
Operating temperature:
-25...+80 °C (-13...+176 °F)

Wiring

Wires	Color		Pin	M12 A-coded female connector (5 pin)
	BN	↔	1	
	WH	↔	2	
	BU	↔	3	
	BK	↔	4	
	GY	↔	5	



Cable with M12 A-coded female connector (5 pin), angled – pigtail
Part no. 370 675

Material: PUR jacket; black
Feature: Shielded
Cable length: 5 m (16.4 ft)
Ingress protection: IP67 (correctly fitted)
Operating temperature:
-25...+80 °C (-13...+176 °F)

Wiring

Wires	Color		Pin	M12 A-coded female connector (5 pin)
	BN	↔	1	
	WH	↔	2	
	BU	↔	3	
	BK	↔	4	
	GY	↔	5	



Temposonics

AN AMPHENOL COMPANY

UNITED STATES
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