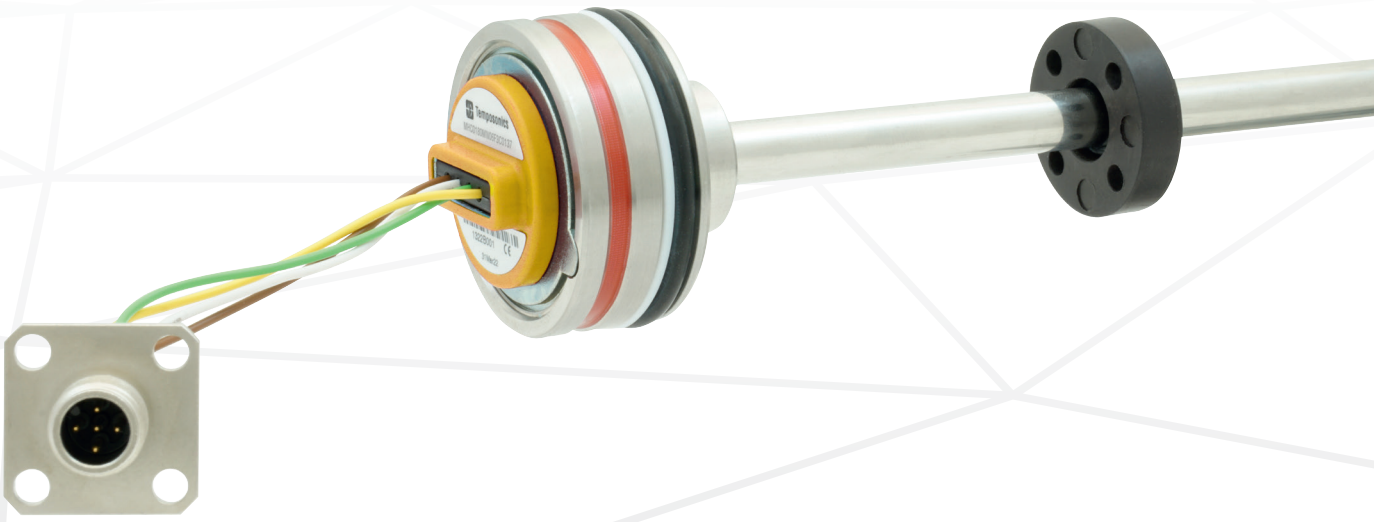
Temposonics
AN AMPHENOL COMPANY

Data Sheet

MH-Series SAFETY CANBus

Magnetostrictive Linear Position Sensors

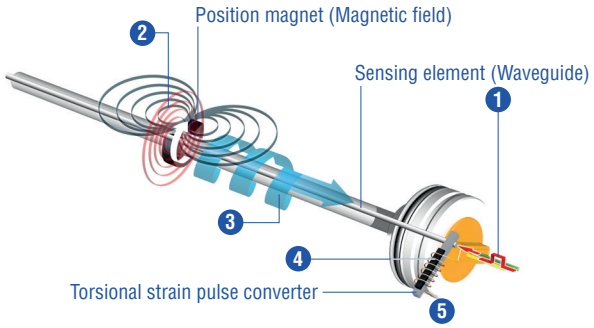
- Stroke length up to 5000 mm
- Linearity < 0.04 % F.S. / Resolution 0.1 mm
- High reliability due to EMC, shock & vibration resistance
- Suitable for Safety Integrity Level 2 (SIL-2) applications



EMEA & India

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.



Measurement cycle	
1	Current pulse generates magnetic field
2	Interaction with position magnet field generates torsional strain pulse
3	Torsional strain pulse propagates
4	Strain pulse detected by converter
5	Time-of-flight converted into distance

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

MH SAFETY SENSOR

The Temposonics® MH SAFETY sensors are designed for safety functions requiring direct stroke measurement in hydraulic cylinders. Suitable for functional safety applications in off-highway machinery, the MH SAFETY sensor is engineered to withstand vibration, shock, dust, weathering, and electromagnetic interference. Available with CANopen Safety and J1939-76 outputs, the MH SAFETY sensor is ideal for critical automation and control on aerial work platforms, emergency vehicles, man-lifts, machine stabilizers, and more.

SAFETY OUTPUT OPTIONS

The CANopen Safety and J1939-76 outputs can be used in applications up to SIL2 and Performance Level d for the safety function "Measurement of position & velocity". The MH SAFETY CANBus has been certified according to IEC 61508:2010 and ISO 13849-1:2015. For further details around the safety function of this product please consult the safety manual (552177).

NOTICE

For further details, please consult the Safety Manual (document part no. 552177)

Fig. 2: Typical applications

TECHNICAL DATA

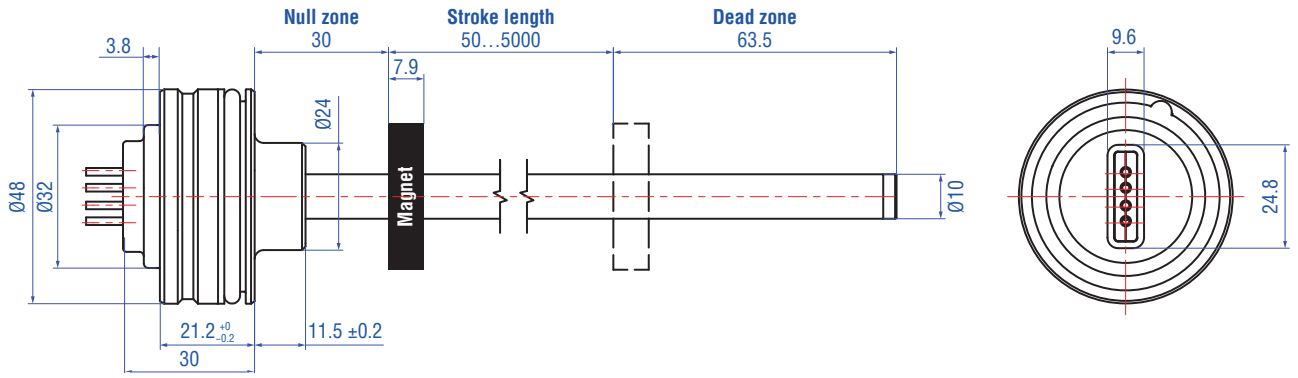
Output			
Bus-protocol	J1939-76 and CANopen Protocol DS-301, DS-304 CANopen Safety protocol, device profile DS-406		
Measured value	Position and velocity		
Measurement parameters			
Stroke length	50…5000 mm		
Resolution (position)	0.1 mm		
Resolution (velocity)	1 mm/s		
Boot up Time	400 ms (typical)		
Cycle Time	Programmable (CANopen Safety: 25 ms default; J1939-76: 20 ms default)		
Linearity	0050…0250 mm	0255…2000 mm	2005…5000 mm
	≤ ±0.1 mm	±0.04 % (F.S.)	≤ ±0.8 mm
Internal sample rate	2 ms		
Setpoint tolerance	±1 mm or ±0.04 % F.S. (whatever is greater)		
Operating conditions			
Operating temperature electronics	–40…+105 °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: 2018 Earth-moving and building construction machinery ISO 13766-2: 2018 Part 2: Additional EMC requirements for functional safety ISO 16750-2:2012 Road vehicles 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 connector or DT connector system		
Operating voltage	12/24 VDC nominal (8…32 VDC)		
Max Inrush current	1.5 A/2 ms (1.0 A/2 ms if supply < 13 V)		
Supply voltage ripple	< 10 V_{PP}		
Power drain	< 1.5 W		
Bus termination (HI-LO)	120 Ω		
Over voltage protection (GND-VDC)	Up to +200 VDC		
Polarity protection (GND-VDC)	Up to –600 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**

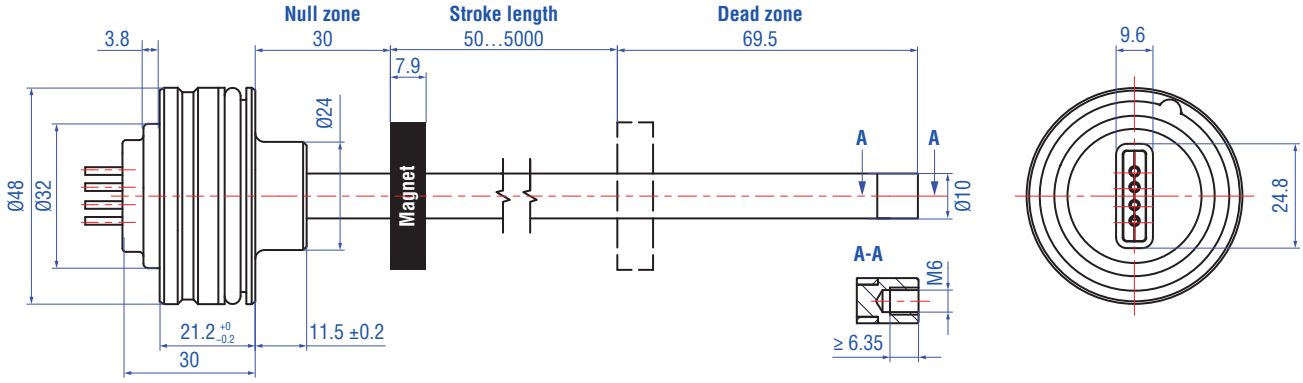
Cycles	**Ø 10 mm sensor rod**
Dynamic pressure: < 2 × 10^6 pressure cycles	350 bar
Static pressure: < 2 × 10^4 pressure cycles	450 bar
Proof pressure: Maximum 5 minutes testing time for cylinder pressure test	625 bar

TECHNICAL DRAWING

MH-C – Rod: Ø 10 mm / Dead zone: 63.5 mm/Stroke length: 50…5000 mm



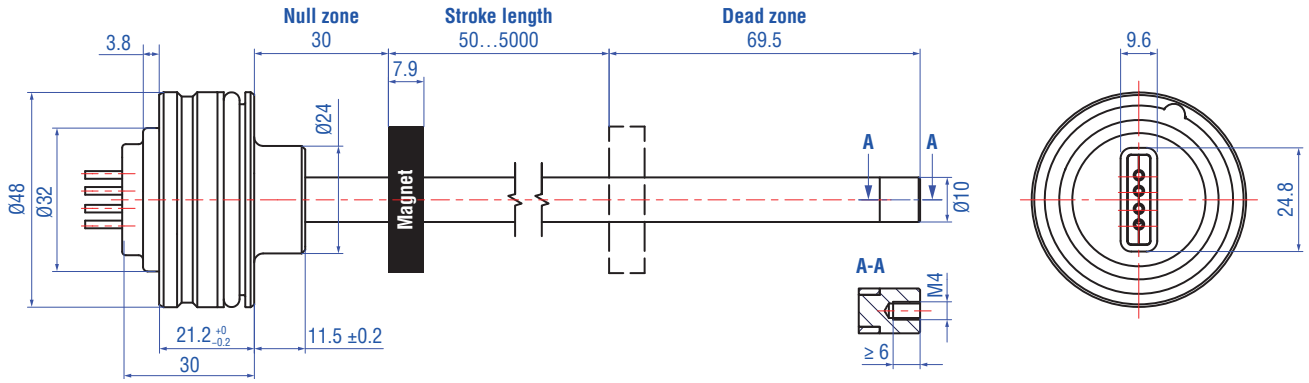
MH-L – Rod: Ø 10 mm + end plug with female M6 thread/Dead zone: 69.5 mm / Stroke length: 50…5000 mm



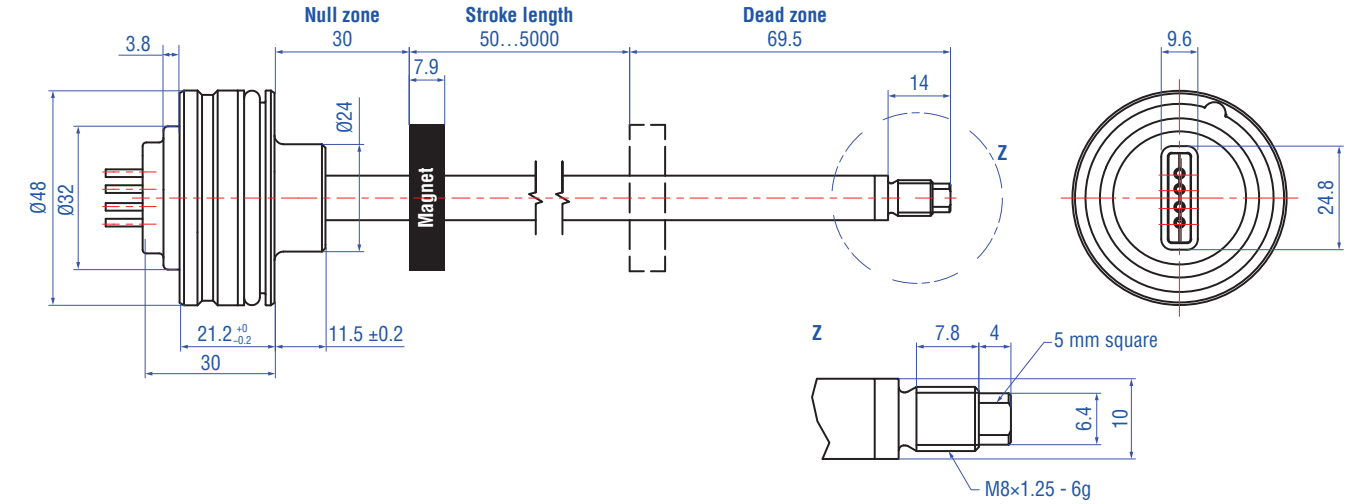
Controlling design dimensions are in millimeters

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…5000 mm



MH-Q – Rod: Ø 10 mm + end plug with male M8 thread/Dead zone: 69.5 mm / Stroke length: 50…5000 mm



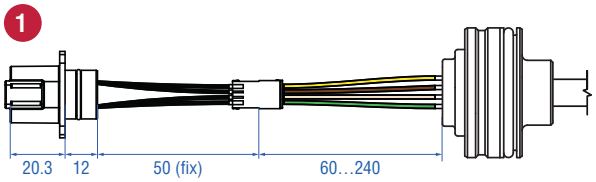
Controlling design dimensions are in millimeters

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

CONNECTOR WIRING

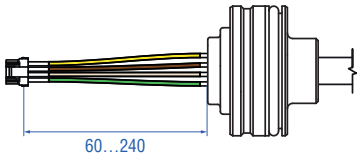
(1) DT connector system (A…S) & (2) Interconnect without DT connector system (W…S)

1

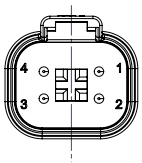


- Single lead wires 0.22 mm²
- 4 pin DT style connector
- Toolless Assembly
- Sealing IP69K (with or without mating connector)

2



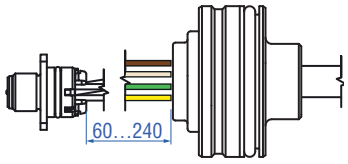
Connector wiring



View on connector

Pin	Wire	Function
1	BN	VDC
2	GN	CAN_L
3	WH	GND
4	YE	CAN_H

M12 connector system with flange (N…F)



- Single lead wires 0.22 mm²
- Attached A-coded M12 connector
- Toolless Assembly
- Sealing IP67, up to IP69K with mating connector

Connector wiring

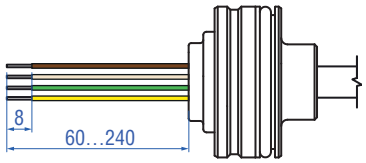
View on connector

Pin	Wire	Function
1	–	–
2	BN	VDC
3	WH	GND
4	YE	CAN_H
5	GN	CAN_L

Fig. 5: Connector wiring

Controlling design dimensions are in millimeters

Single wires pigtail (N…A)

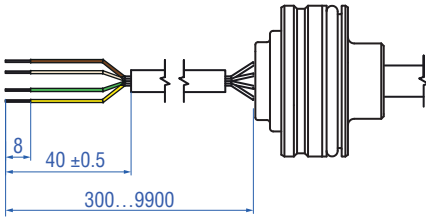


- Single lead wires 0.5 mm²
- Insulation PVC

Connector wiring

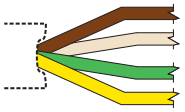
Wire	Function
BN	VDC
WH	GND
GN	CAN_L
YE	CAN_H

Pigtail cable (T…A)



- PUR cable, black
- Ø 5 mm, non-shielded, 4 × 0.5 mm²
- Flexible, oil resistance

Connector wiring

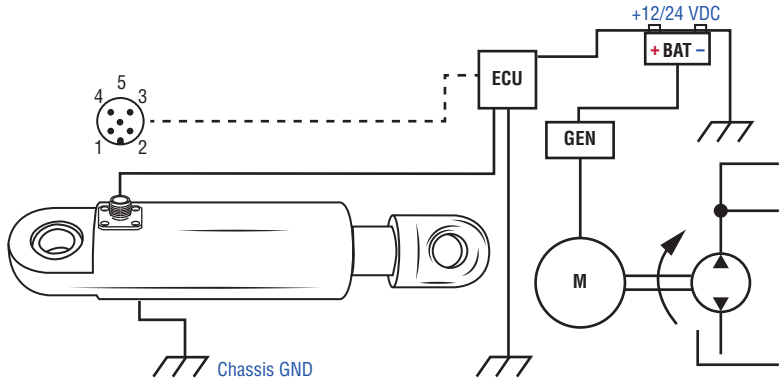


Wire	Function
BN	VDC
WH	GND
GN	CAN_L
YE	CAN_H

Fig. 6: Connector wiring

Controlling design dimensions are in millimeters

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 machanical 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.

Fig. 7: Connection schematics

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.

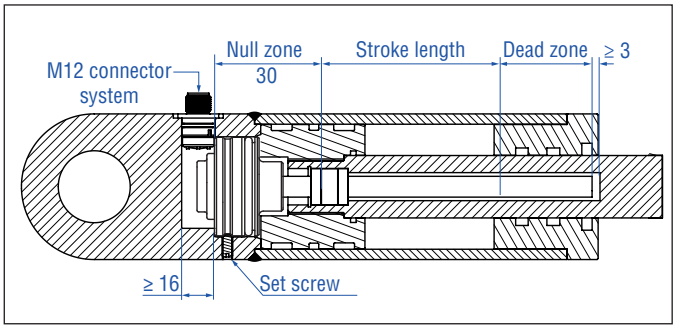


Fig. 8: Example of In-Cylinder assembly with M12 connector system

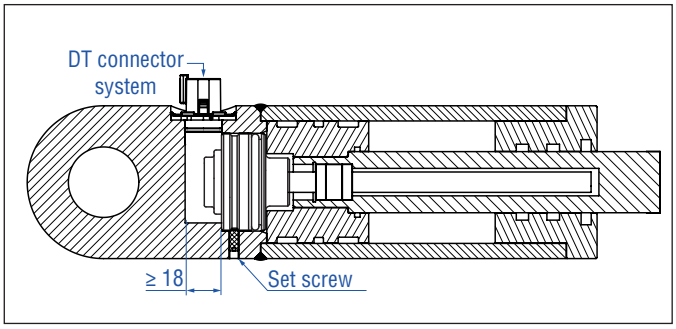


Fig. 9: Example of In-Cylinder assembly with DT connector system

NOTICE

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

Controlling design dimensions are in millimeters

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: ≥ Ø 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

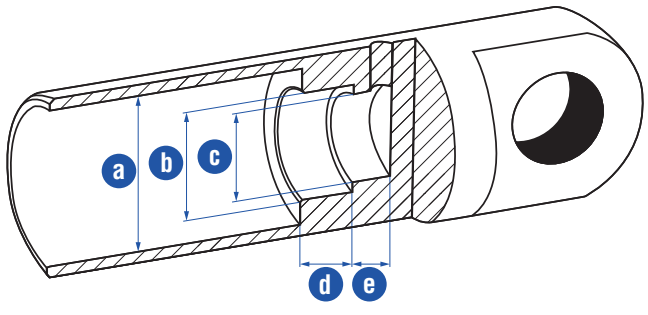


Fig. 10: Space requirements for cylinder

Set screw

e.g. retaining with set screw (with flat point) ISO 4026 M5×10 (DIN 913).
Fastening torque: ≤ 0.5 Nm

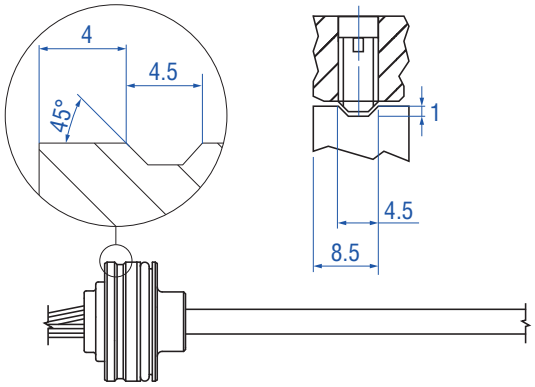


Fig. 11: Set screw

NOTICE

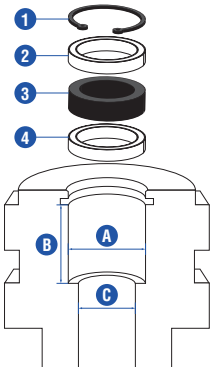
Avoid sensor damage:
- The screw may touch the sensor housing.
- Tightening torque: ≤ 0.5 Nm.

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).

MECHANICAL INSTALLATION – POSITION MAGNET

Magnet installation



1	Circlip		
2	Non-magnetic spacer		
3	Position magnet		
4	Non-magnetic spacer (≥ 5 mm)		
	Position magnet (Part no.)		
	401 032	**400 533**	**201 542-2**
A	17.4 mm	25.4 mm	32.8 mm
B	≥ 18 mm	≥ 18 mm	≥ 18 mm
C	Rod Ø 10 mm ➔	Piston rod drilling ≥ Ø 13 mm	

Fig. 12: Dimensions for magnet mounting

Controlling design dimensions are in millimeters

ORDER CODE

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		b	c					d				e	f			g	h	

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…5000 mm
L	Rod: Ø 10 mm + end plug with female M6 thread / Dead zone: 69.5 mm / Stroke length: 50…5000 mm
R	Rod: Ø 10 mm + end plug with female M4 thread / Dead zone: 69.5 mm / Stroke length: 50…5000 mm
Q	Rod: Ø 10 mm + end plug with male M8 thread / Dead zone: 69.5 mm / Stroke length: 50…5000 mm

c	Stroke length
X X X X M	0050…5000 mm (in 5 mm steps)

d	Electrical wiring
DT connector system (VDC – GND – HI – LO)	
A _ _ S	60…240 mm wire length (in 20 mm steps) Connector wiring S: 1-3-4-2 *Example wire length A06S = 60 mm*
W _ _ S	60…240 mm wire length (in 20 mm steps) Connector wiring S: 1-3-4-2 *Example wire length W06S = 60 mm*
M12 connector (VDC – GND – HI – LO) incl. flange	
N _ _ F	60…240 mm wire length (in 20 mm steps) Connector wiring: F: 2-3-4-5 *Example wire length N06F = 60 mm*
Single wires	
N _ _ A	60…240 mm wire length (in 20 mm steps) *Examples wire length N20A = 200 mm*
Cable outlet	
T _ _ A	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
S 0 2	CANopen Safety (default cycle time: 25 ms)
J 9 1	J1939 (default cycle time: 20 ms)

g	Baud rate
CANopen (Safety (S02)	
0	1000 kbit/sec
1	800 kbit/sec
2	500 kbit/sec (default setting)
3	250 kbit/sec
4	125 kbit/sec
6	50 kbit/sec
7	20 kbit/sec
8	10 kbit/sec
J1939-76 (J91)	
2	500 kbit/sec (default setting)
3	250 kbit/sec

h	Node-ID
CANopen Safety (S02)	
_ _	Hex 01…40
J1939-76 (J91)	
_ _	Hex 01…FD

DELIVERY

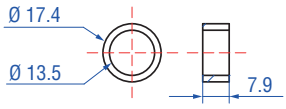
- Position sensor
- O-ring
- backup-ring
- M12 connector system incl. M12 flange (when option selected)
- DT connector system incl. connector assembly and retainer (when option selected)

Accessories have to be ordered separately

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

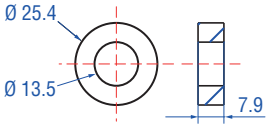
FREQUENTLY ORDERED ACCESSORIES

Position magnets



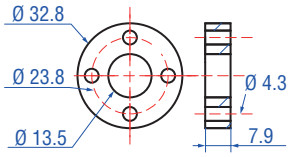
Ring magnet OD17.4
Part no. 401 032

Material: PA neobond
Weight: Approx. 5 g
Surface pressure: Max. 20 N/mm²
Operating temperature:
–40…+105 °C (–40…+221 °F)



Ring magnet OD25.4
Part no. 400 533

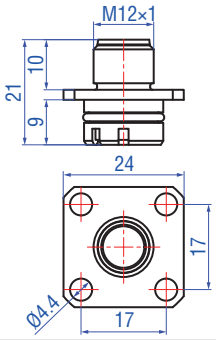
Material: PA ferrite
Weight: Approx. 10 g
Surface pressure: Max. 40 N/mm²
Operating temperature:
–40…+120 °C (–40…+248 °F)



Ring magnet OD33
Part no. 201 542-2

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)

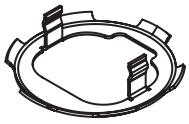
M12 flange



M12 flange
Part no. 253 769

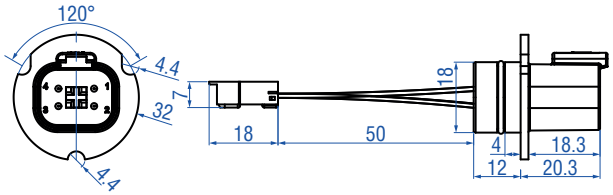
Material: Brass, nickel-plated
Weight: Approx. 5 g
Operating temperature:
–40…+105 °C (–40…+221 °F)

Connector accessories



DT connector system retainer
Part no. 520 101

Material: 1.4310
Weight: Ca. 1.7 g
Operating temperature:
–40…+105 °C (–40…+221 °F)



DT connector assembly
Part no. 255 098

Material: PA66
Weight: Approx. 6 g
Operating temperature:
–40…+105 °C (–40…+221 °F)

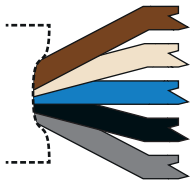
Controlling design dimensions are in millimeters

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



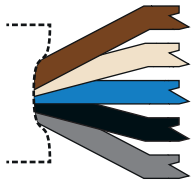
Wires	Color		Pin
	BN	↔	1
	WH	↔	2
	BU	↔	3
	BK	↔	4
	GY	↔	5

M12 A-coded female connector (5 pin)

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
	BN	↔	1
	WH	↔	2
	BU	↔	3
	BK	↔	4
	GY	↔	5

M12 A-coded female connector (5 pin)

Controlling design dimensions are in millimeters

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