Temposonics
AN AMPHENOL COMPANY

Data Sheet

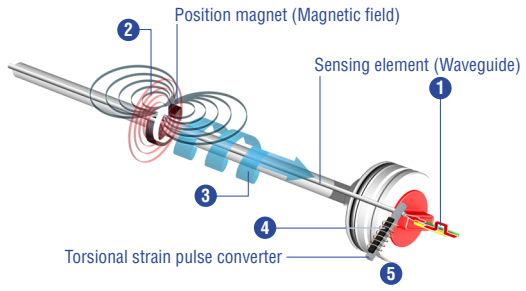
MH-Series MH Analog

Magnetostrictive Linear Position Sensors

- Stroke length up to 2500 mm
- Linearity < 0.04 % F.S. / Resolution typ. 0.1 mm
- High reliability due to EMC, shock & vibration resistance

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 a 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 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.

DESIGNED FOR THE MOBILE WORLD

MH sensors are designed for mobile machines and intended for IN cylinder use. They are validated in the field by worldwide OEM's and replace linear potentiometers and inductive sensors.

Fig. 2: Typical applications

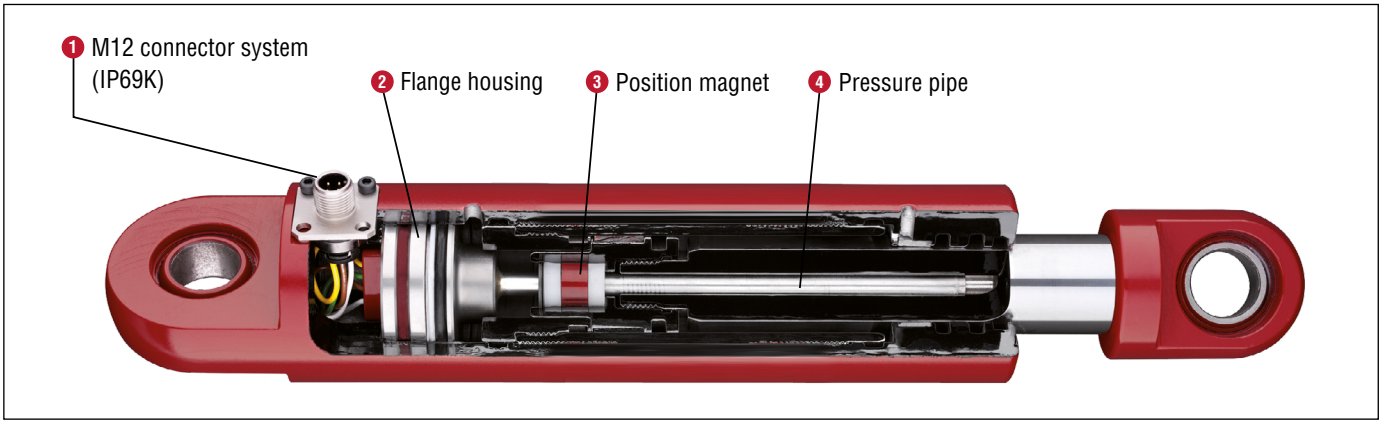


Fig. 3: IN cylinder installation

TECHNICAL DATA

Output	
Voltage	0.25…4.75 VDC / 0.5…4.5 VDC / 0.5…9.5 VDC / 4.75…0.25 VDC / 4.5…0.5 VDC
Current	4…20 mA / 20…4 mA
Measured value	Position
Measurement parameters	
Stroke length	50…2500 mm
Resolution	Better than 0.1 mm
Power up time	250 ms (typical)
Linearity	0050…0250 mm ≤ ±0.1 mm 0255…2000 mm ±0.04 % (F.S.) 2005…2500 mm ≤ ±0.8 mm
Internal sample rate	2 ms
Setpoint tolerance	≤ 1 mm
Repeatability	±0.1 mm
Operating conditions	
Operating temperature electronics	–40…+105 °C
Humidity	90 % relative humidity, no condensation, EN60068-2-30
Ingress protection - Connector	M12 connector: IP67/IP69K (connectors correctly fitted), EN60529 DT connector system: IP67/IP69K (connectors correctly fitted), EN60529
Ingress protection – Sensor housing	IP67, EN60529
Shock	100 g (11 ms) single shock per axis, IEC 60068-2-27 50 g (11 ms) at 1000 shocks per axis, IEC 60068-2-29
Vibration	Operational sine vibration test IEC 60068-2-6: Ø 7 mm sensor rod: 15 g (5…2000 Hz)* Ø 10 mm sensor rod: 20 g (5…2000 Hz)* Survival random vibration test IEC 60068-2-64: 20 g RMS (20…2000 Hz) 12 h per axis*
EMC	Compliant with: ISO 13766-1:2018 Earth-moving and building construction machinery EN ISO 14982:2009 Agricultural and Forestry Machinery EN 13309:2010 Construction machinery ISO 16750-2:2012 Road vehicles
EMI	200 V/m (ISO 11452-2:2019 200…2000 MHz) 200 mA (ISO 11452-4:2011 20…200 MHz)
Operating pressure ratings	**Pressure (according to DIN EN ISO 19879)****
PN (nominal operating)	Ø 7 mm sensor rod: 300 bar Ø 10 mm sensor rod: 350 bar
Pmax (max. overload)	Ø 7 mm sensor rod: 400 bar Ø 10 mm sensor rod: 450 bar
Pstatic (proof pressure)	Ø 7 mm sensor rod: 525 bar Ø 10 mm sensor rod: 625 bar
Design / Material	
Sensor electronics housing	Stainless steel 1.4305 (AISI 303)
Sealing	O-ring: HNBR 70, back-up ring: PTFE
Sensor rod	Ø 7 mm sensor rod: Stainless steel 1.4301 (AISI 304) Ø 10 mm sensor rod: Stainless steel 1.4306 (AISI 304L)

*/ Resonance frequencies excluded
**/ According to calculations under use of the FKM guideline

Cycles	**Ø 7 mm sensor rod**	**Ø 10 mm sensor rod**
Dynamic pressure: < 2×10^6 pressure cycles	300 bar	350 bar
Static pressure: < 2×10^4 pressure cycles	400 bar	450 bar
Proof pressure: Maximum 5 minutes testing time for cylinder pressure test	525 bar	625 bar

Electrical connection	
Connection type	M12 connector or DT connector system or single wires or cable output
Operating voltage	12/24 VDC nominal (8…32 VDC)
Min Load resistance (output VDC)	10 kΩ
Max Load resistance (output mA)	250 Ω (500 Ω if supply > 13 V)
Max Inrush current	4.5 A/2 ms (2.5 A/2 ms if supply < 13 V)
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)

TECHNICAL DRAWING

MH-Series MH

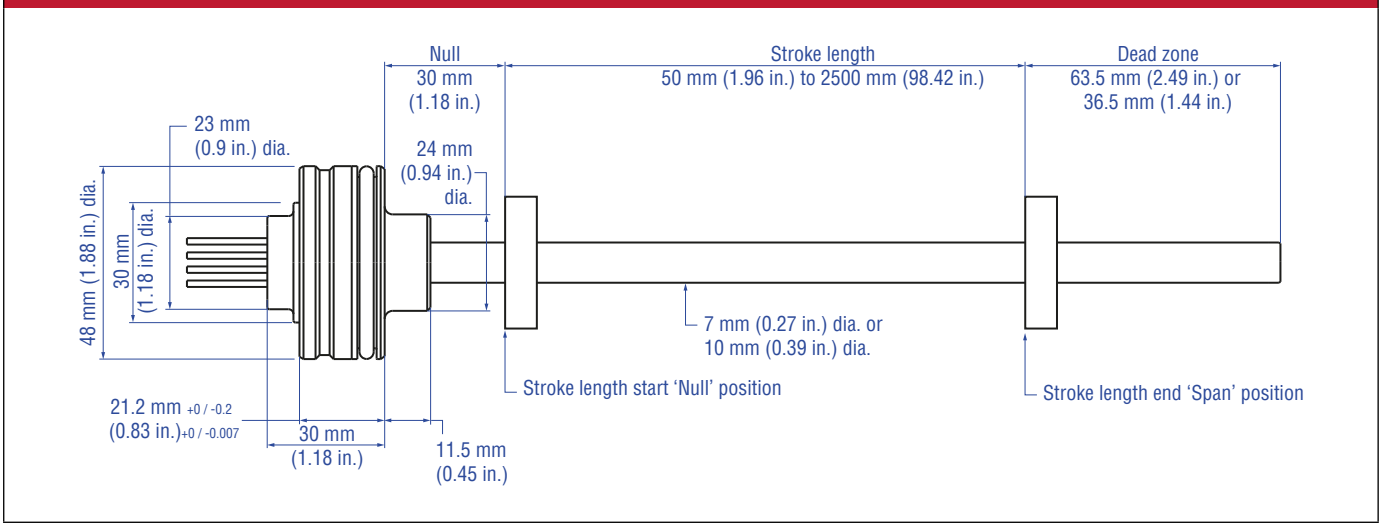
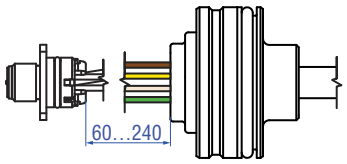


Fig. 4: Temposonics® MH-Series MH sensor

CONNECTOR WIRING

M12 connector system (N…E)



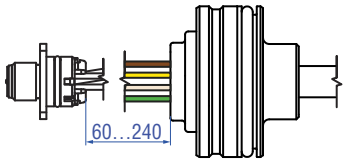
- Single lead wires 0.22 mm²
- Attached A-coded M12 connector attached
- Toolless assembly
- Sealing IP67, up to IP69K with plugged mating connector

Connector wiring

View on connector

Pin	Wire	Function
1	YE	not connected
2	BN	VDC
3	WH	GND
4	GN	SIG

M12 connector system (N…G)



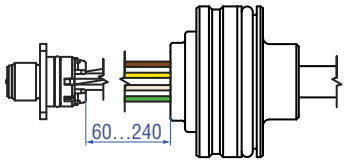
- Single lead wires 0.22 mm²
- Attached A-coded M12 connector attached
- Toolless assembly
- Sealing IP67, up to IP69K with plugged mating connector

Connector wiring

View on connector

Pin	Wire	Function
1	BN	VDC
2	YE	not connected
3	WH	GND
4	GN	SIG

M12 connector system (N…H)



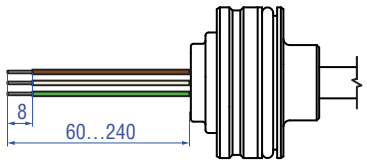
- Single lead wires 0.22 mm²
- Attached A-coded M12 connector attached
- Toolless assembly
- Sealing IP67, up to IP69K with plugged mating connector

Connector wiring

View on connector

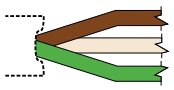
Pin	Wire	Function
1	BN	VDC
2	GN	SIG
3	WH	GND
4	YE	not connected

Single wires pigtail (N…A)



- Single lead wires 0.5 mm²
- Insulation PVC

Connector wiring

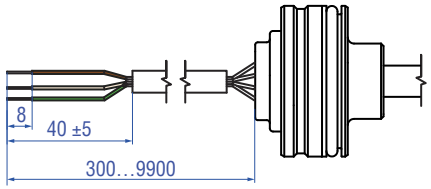


Color	Function
BN	VDC
WH	GND
GN	SIG

Fig. 5: Connector wiring

Controlling design dimensions are in millimeters

Pigtail cable (T…A)

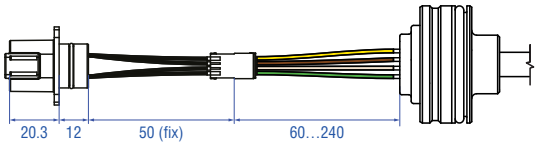


- PUR cable grey
- Ø 5 mm, non-shielded, 3 × 0.5 mm²
- Flexible, oil resistance

Connector wiring

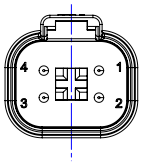
Color	Function
BN	VDC
WH	GND
GN	SIG

DT connector system E (A…E)



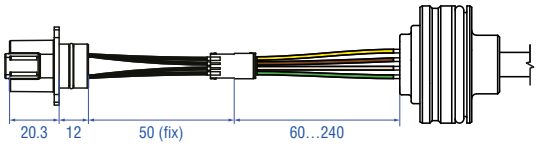
- Single lead wires 0.22 mm²
- Attached DT compatible connector
- Sealing IP69K (with or without mating connector)
- Wiring sequence controlled at sensor

Connector wiring



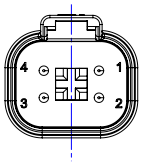
Wire	Pin	Function
YE	1	not connected
BN	2	VDC
WH	3	GND
GN	4	SIG

DT connector system G (A…G)



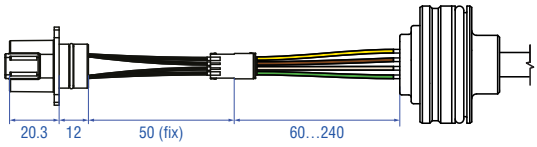
- Single lead wires 0.22 mm²
- Attached DT compatible connector
- Sealing IP69K (with or without mating connector)
- Wiring sequence controlled at sensor

Connector wiring



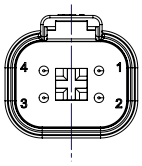
Wire	Pin	Function
BN	1	VDC
YE	2	not connected
WH	3	GND
GN	4	SIG

DT connector system H (A…H)



- Single lead wires 0.22 mm²
- Attached DT compatible connector
- Sealing IP69K (with or without mating connector)
- Wiring sequence controlled at sensor

Connector wiring



Wire	Pin	Function
BN	1	VDC
GN	2	SIG
WH	3	GND
YE	4	not connected

Fig. 6: Connector wiring

Controlling design dimensions are in millimeters

Connection schematic

To ensure proper operation of the sensor, the hydraulic cylinder must be connected to the machine ground. Grounding is oftern 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.

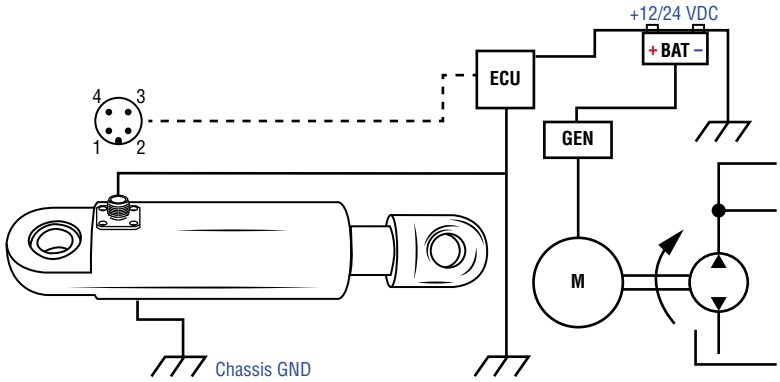


Fig. 7: Connection schematics

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.

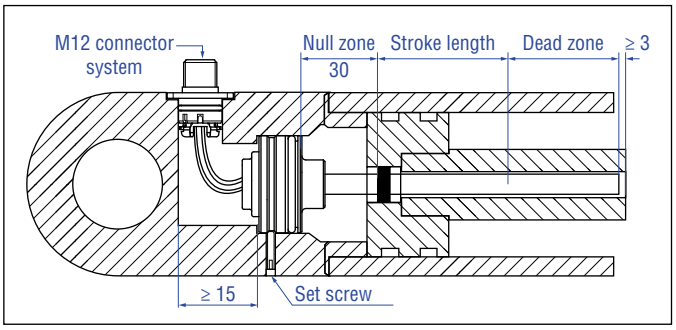


Fig. 8: Example of In-Cylinder assembly with M12 connector system

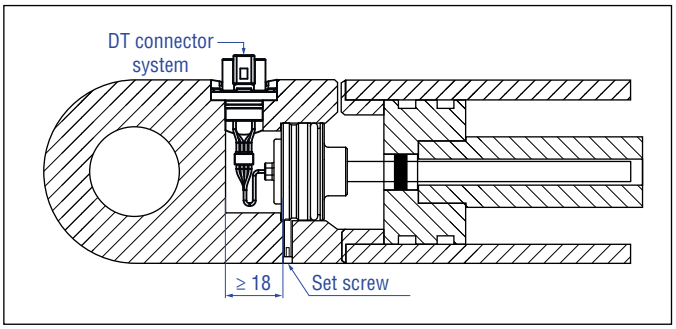


Fig. 9: Example of In-Cylinder assembly with DT connector system

NOTICE

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

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 the piston rod drilling:
  - Ø 7 mm rod: ≥ Ø 10 mm
  - Ø 10 mm rod: ≥ Ø 13 mm

Space requirements

M12 connector system / cable outlet				
B	D	d	H	h
52 mm	48H8	> 32.5 mm < 40 mm	21.2 mm	> 15 mm
DT connector system				
B	D	d	H	h
52 mm	48H8	> 32.5 mm < 40 mm	21.2 mm	> 18 mm

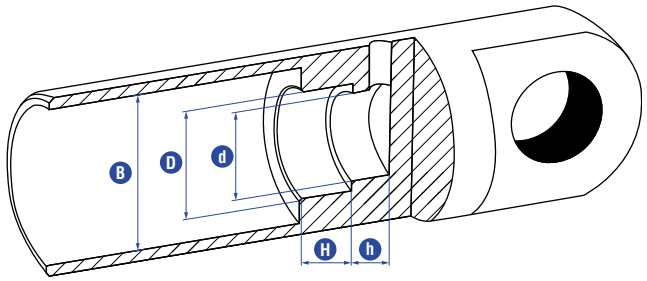


Fig. 10: Space requirements for cylinder

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: ≤ 0.5 Nm

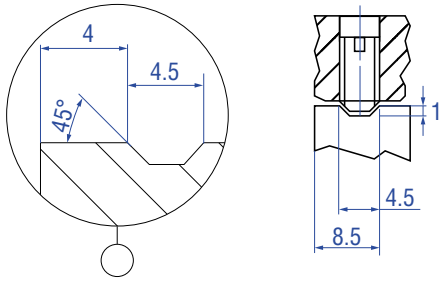


Fig. 11: Set screw

NOTICE

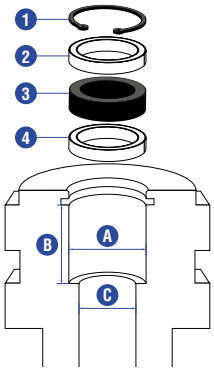
Avoid sensor damage:
- The screw may touch the sensor housing.
- Tightening torque: ≤ 0.5 Nm.

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 7 mm ➔	Piston rod drilling ≥ Ø 10 mm	
	Rod Ø 10 mm ➔	Piston rod drilling ≥ Ø 13 mm	

Fig. 12: Dimensions for magnet mounting

NOTICE

Spacers, circlip, pretension parts etc. are not part of Temposonics shipment!

ORDER CODE

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

a	Sensor model
M	H	Pressure fit flange

b	Design
Ø 10 mm rod	
C	Rod: Ø 10 mm + flat end plug / Dead zone: 63.5 mm / Stroke length: 50…2500 mm
E	Rod: Ø 10 mm + flat end plug / Dead zone: 36.5 mm / Stroke length: 50…1200 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
Ø 7 mm rod	
D	Rod: Ø 7 mm + flat end plug / Dead zone: 63.5 mm / Stroke length: 50…2500 mm
F	Rod: Ø 7 mm + flat end plug / Dead zone: 36.5 mm / Stroke length: 50…1200 mm

c	Stroke length
X X X X M	0050…2500 mm

d	Electrical wiring
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
N ___ G	60…240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4
N ___ H	60…240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2
Single wires	
N ___ A	60…240 mm wire length (in 20 mm steps)
Cable outlet	
T ___ A	300…9900 mm cable length (in 100 mm steps)
DT connector system (VDC – GND – SIG)	
A ___ E	60…240 mm wire length (in 20 mm steps) Connector wiring E: 2-3-4
A ___ G	60…240 mm wire length (in 20 mm steps) Connector wiring G: 1-3-4
A ___ H	60…240 mm wire length (in 20 mm steps) Connector wiring H: 1-3-2

e	Operating voltage
3	12/24 VDC nominal (8…32 VDC)

f	Output
V 0 2	0.5…9.5 VDC
V 1 1	0.25…4.75 VDC
V 1 2	0.5…4.5 VDC
V 1 3	4.75… 0.25 VDC
V 1 4	4.5… 0.5 VDC
A 0 1	4…20 mA
A 0 4	20…4 mA

DELIVERY

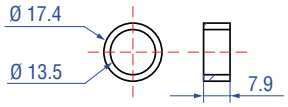
- Position sensor
- O-ring
- backup-ring
- M12 connector system incl. M12 flange (when option selected)
- DT connector system incl. connector assembly and retainer (when option selected)

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

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

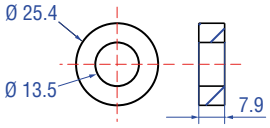
FREQUENTLY ORDERED ACCESSORIES

Position magnets



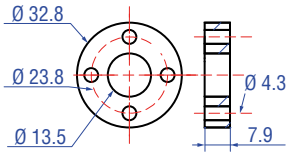
Ring magnet OD17.4
Part no. 401 032

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…+105 °C (–40…+221 °F)



Ring magnet OD33
Part no. 201 542-2

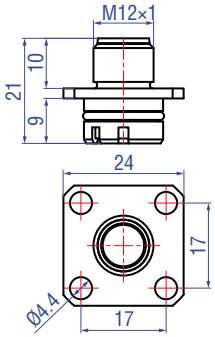
Material: PA ferrite GF20
Weight: Approx. 14 g
Surface pressure: Max. 40 N/mm²
Fastening torque for M4 screws: 1 Nm
Operating temperature:
–40…+105 °C (–40…+221 °F)

Test kit

MH test kit (analog)
Part no. 280 618

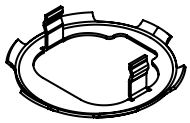
Kit includes:
- 12 VDC battery charger with adapter (EU & UK)
- Cable with M12 connector
- Cable with pigtailed wires
- Carrying case

Connector accessories



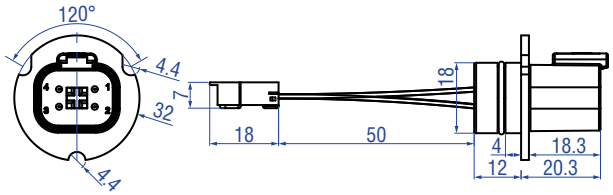
M12 Flange
Part no. 253 769

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



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)

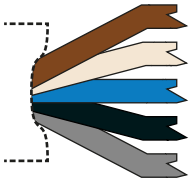
Controlling design dimensions are in millimeters

Cables

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

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

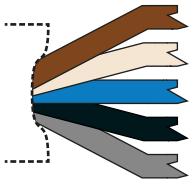
Wiring

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
Features: 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	

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