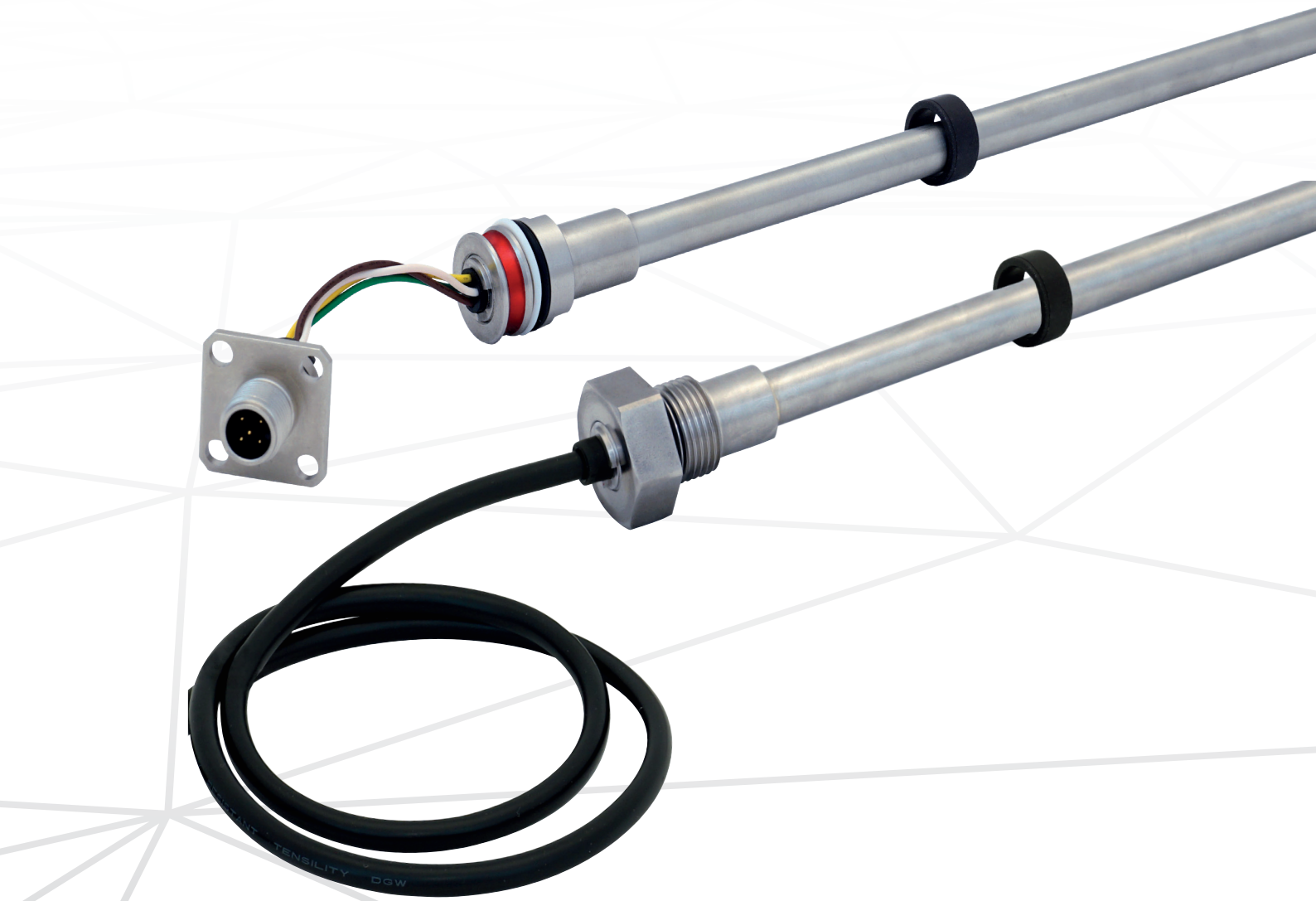
Temposonics
AN AMPHENOL COMPANY

Installation Manual

MH-Series SLIM

Magnetostrictive Linear Position Sensors



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1. Introduction

1.1 Purpose and use of this manual

Before starting the operation of Temposonics® position sensors, read this documentation thoroughly and follow the safety information. Keep the manual for future reference!

The content of this technical documentation and of its annex is intended to provide information on mounting, installation and commissioning by qualified automation personnel [1] or instructed service technicians who are familiar with the project planning and dealing with Temposonics® sensors.

1.2 Used symbols and warnings

Warnings are intended for your personal safety and for avoidance of damage to the described product or connected devices. In this documentation, safety information and warnings to avoid danger that might affect the life and health of operating or service personnel or cause material damage are highlighted by the preceding pictogram which is defined below.

Symbol	Meaning
NOTICE	This symbol is used to point to situations that may lead to material damage, but not to personal injury.

2. Safety instructions

2.1 Intended use

This product may be used only for the applications defined under item 1 and only in conjunction with the third-party devices and components recommended or approved by Temposonics. As a prerequsite of proper and safe operation: the product requires correct transport, storage, mounting and commissioning and must be operated with utmost care.

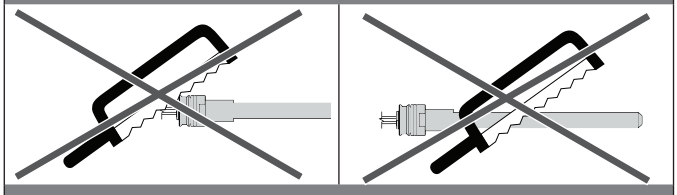
1. The MH-Series sensor systems are intended exclusively for measurement tasks on mobile hydraulic equipment. The sensors are considered as system accessories and must be connected to suitable evaluation electronics, e.g. a PLC, IPC, indicator or other electronic control unit.

1/ The term qualified technical personnel characterizes persons who:
- are familiar with the safety concepts of automation technology applicable to the particular project,
- are competent in the field of electromagnetic compatibility (EMC),
- have received adequate training for commissioning and service operations
- are familiar with the operation of the device and know the information required for correct operation provided in the product documentation.

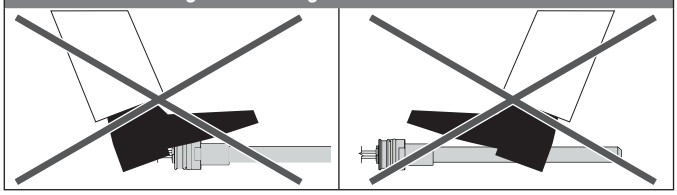
2.2 Forseeable misuse

Foreseeable misuse	Consequence
Wrong sensor connection	The sensor will not work properly or will be destroyed
Operate the sensor out of the operating temperature range	No signal output /The sensor can be damaged
Power supply is out of the defined range	Signal output is wrong / no signal output / the sensor will be damaged
Position measurement is influenced by an external magnetic field	Signal output is wrong
Cylinder bore hole too small	Component damage due to excessive installation force required.
Cylinder bore hole after welding too small	Component damage due to excessive installation force required.
Sharp Edges	Damage to cables and conductors
Rough senor handling	Destruction of internal components
Welding after installation	High energy voltage peaks or currents are fed to the sensor, damaging housing or electronic components.
Cables are damaged	Short circuit – the sensor can be destroyed / sensor does not respond
Loose connectors	Liquid can penetrate into the sensor housing through cables or strands and cause short circuit or corrosion of electronics components
Spacer(s) are missing or installed in wrong order	Error in position measurement
Wrong connection of ground/ shield	Signal output is disturbed / The electronics can be damaged

Do not reprocess the sensor afterwards.
➔ The sensor might be damaged.



Do not step on the sensor.
➔ The sensor might be damaged.



2.3 Installation, commissioning and operation

The position sensors must be used only in technically safe conditions. To maintain this condition and to ensure safe operation, installation, connection and service, work may be performed only by qualified technical personnel.
If danger of injury to persons or of damage to operating equipment is caused by sensor failure or malfunction, additional safety measures such as plausibility checks, limit switches, EMERGENCY STOP systems, protective devices etc. are required. In the event of trouble, shut down the sensor and protect it against accidental operation.

Safety instructions for commissioning
To maintain the sensor operability, it is mandatory to follow the instructions given below.

1. Protect the sensor against mechanical damage during installation and operation.
2. Connect the sensor very carefully and pay attention to the polarity of connections and power supply.
3. Use only approved power supplies.
4. Ensure that the specified permissible limit values of the sensor for operating voltage, environmental conditions, etc. are met.
5. Check the function of the sensor regularly and provide documentation of the checks.
6. Before applying power, ensure that nobody's safety is jeopardized by starting machines.

2.4 Safety instructions for use in explosion-hazardous areas

The sensor is not suitable for operation in explosion-hazardous areas.

2.5 Warranty

Temposonics grants a warranty period for the Temposonics® position sensors and supplied accessories relating to material defects and faults that occur despite correct use in accordance with the intended application [2]. The Temposonics obligation is limited to repair or replacement of any defective part of the unit. No warranty can be provided for defects that are due to improper use or above average stress of the product, as well as for wear parts. Under no circumstances will Temposonics accept liability in the event of offense against the warranty rules, no matter if these have been assured or expected, even in case of fault or negligence of the company. Temposonics explicitly excludes any further warranties. Neither the company's representatives, agents, dealers nor employees are authorized to increase or change the scope of warranty.

2.6 Return

For diagnostic purposes, the sensor can be returned to Temposonics. Any shipment cost is the responsibility of the sender [2].
For a corresponding form, see chapter "9. Appendix - Safety declaration" on page 35.

2/ See also applicable Temposonics sales and delivery on www.temposonics.com

3. Identification

3.1 Order code of Analog

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

a	Sensor model
S M	MH-Series SLIM

b	Design
D	Pressure fit flange (20 mm)
B	Threaded flange ¾"-16 UNF-3A
E	Threaded flange M18×1.5-6g

c	Stroke length				
X	X	X	X	M	0100…0600 mm (in 5 mm steps)

d	Electrical wiring	
for pressure fit flange »D«		
DT connector system (VDC – GND – SIG)		
A	E	60…240 mm wire length (in 20 mm steps) *Example wire length A06E = 60 mm* Connector wiring E: 2-3-4
A	G	60…240 mm wire length (in 20 mm steps) *Example wire length A06G = 60 mm* Connector wiring G: 1-3-4
A	H	60…240 mm wire length (in 20 mm steps) *Example wire length A06H = 60 mm* Connector wiring H: 1-3-2
Interconnect without DT connector		
W	E	60…240 mm wire length (in 20 mm steps) *Example wire length W06E = 60 mm* Connector wiring E: 2-3-4
W	G	60…240 mm wire length (in 20 mm steps) *Example wire length W06G = 60 mm* Connector wiring G: 1-3-4
W	H	60…240 mm wire length (in 20 mm steps) *Example wire length W06H = 60 mm* Connector wiring H: 1-3-2
M12 connector system without flange (VDC – GND – SIG)		
K	E	60…240 mm wire length (in 20 mm steps) *Example wire length K06E = 60 mm* Connector wiring E: 2-3-4
K	G	60…240 mm wire length (in 20 mm steps) *Example wire length K06G = 60 mm* Connector wiring G: 1-3-4
K	H	60…240 mm wire length (in 20 mm steps) *Example wire length K06H = 60 mm* Connector wiring H: 1-3-2

d	Electrical wiring	
M12 connector system (VDC – GND – SIG) with flange		
N	E	60…240 mm wire length (in 20 mm steps) *Example wire length N06E = 60 mm* Connector wiring E: 2-3-4
N	G	60…240 mm wire length (in 20 mm steps) *Example wire length N06G = 60 mm* Connector wiring G: 1-3-4
N	H	60…240 mm wire length (in 20 mm steps) *Example wire length N06H = 60 mm* Connector wiring H: 1-3-2
Single wires		
S	A	60…240 mm wire length (in 20 mm steps) *Example wire length N20A = 200 mm*
for threaded flange »B«/»E«		
Cable outlet with DT04-4P		
F	E	100…1000 mm (in 100 mm steps) *Example wire length F06E = 600 mm* Connector wiring E: 2-3-4
F	G	100…1000 mm (in 100 mm steps) *Example wire length F06G = 600 mm* Connector wiring G: 1-3-4
F	H	100…1000 mm (in 100 mm steps) *Example wire length F06H = 600 mm* Connector wiring H: 1-3-2
Cable with M12 termination		
Q	E	100…1000 mm (in 100 mm steps) *Example wire length Q06E = 600 mm* Connector wiring E: 2-3-4
Q	G	100…1000 mm (in 100 mm steps) *Example wire length Q06G = 600 mm* Connector wiring G: 1-3-4
Q	H	100…1000 mm (in 100 mm steps) *Example wire length Q06H = 600 mm* Connector wiring H: 1-3-2
Cable outlet		
T	A	100…1000 mm cable length (in 100 mm steps) *Example wire length T10A = 1000 mm*

Order code continued on next page

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

f	Output		
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

3.2 Order code of CANbus

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
S	M						M					3							
a		b	c					d				e	f			g	h		i

a	Sensor model
S	M	MH-Series SLIM

b	Design
D	Pressure fit flange (20 mm)
B	Threaded flange ¾"-16 UNF-3A
E	Threaded flange M18×1.5-6g

c	Stroke length
X	X	X	X	M	0100…0600 mm (in 5 mm steps)

d	Electrical wiring
for pressure fit flange	
DT connector system (VDC – GND – HI – LO)	
A			S	60…240 mm wire length (in 20 mm steps) *Example wire length A06S = 60 mm* Connector wiring S: 1-3-4-2
Interconnect without DT connector	
W			S	60…240 mm wire length (in 20 mm steps) *Example wire length W06S = 60 mm* Connector wiring S: 1-3-4-2
M12 connector without flange (VDC – GND – HI – LO)	
K			F	60…240 mm wire length (in 20 mm steps) *Example wire length K06F = 60 mm* Connector wiring: F: 2-3-4-5
M12 connector with flange (VDC – GND – HI – LO)	
N			F	60…240 mm wire length (in 20 mm steps) *Example wire length N06F = 60 mm* Connector wiring: F: 2-3-4-5
Single wires	
S			A	60…240 mm wire length (in 20 mm steps) *Example wire length N20A = 200 mm*
for threaded flanges	
Cable outlet with DT04-4P	
F			S	100…1000 mm (in 100 mm steps) *Example wire length F06S = 600 mm* Connector wiring S: 1-3-4-2
Cable outlet with M12 connector	
Q			F	100…1000 mm (in 100 mm steps) *Example wire length Q06F = 600 mm* Connector wiring: F: 2-3-4-5
Cable outlet	
T			A	100…1000 mm cable length (in 100 mm steps) *Example wire length T10A = 1000 mm*

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

f	Output
C	0	1	CANopen
J	0	1	SAE J1939

g	Baud rate
CANopen (C01)	
0	1000 kbit/s
1	800 kbit/s
2	500 kbit/s
3	250 kbit/s (default)
4	125 kbit/s
6	50 kbit/s
7	20 kbit/s
8	10 kbit/s
SAE J1939 (J01)	
2	500 kbit/s
3	250 kbit/s (default)

h	Node ID (CANopen)/Source address (SAE J1939)
CANopen (C01)	
		Hex 01…7F (default: 7F)
SAE J1939 (J01)	
		Hex 01…FD (default: FD)

i	Cycle time
C	10 msec
D	20 msec (default CANopen & J1939)
E	25 msec
F	30 msec
G	40 msec
H	50 msec

3.3 Nameplate

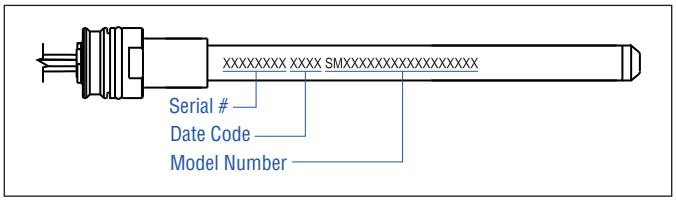


Fig. 1: Example of nameplate

3.4 Scope of delivery

- Position sensor
- O-ring
- Backup-ring (only for embedded mount)
- M12 connector system with M12 flange (when option selected)
- DT connector system with connector assembly and retainer (when option selected)

4. Product description and commissioning

4.1 Functionality and system design

Product designation
- Position sensor Temposonics® SLIM

Sensor model
- Temposonics® SLIM (embedded mount)
- Temposonics® SLIM (threaded mount)

Stroke length
- 100…600 mm

Output signal
- Digital (CANopen/J1939)
- Analog (Voltage/Current)

Application
The Temposonics SLIM sensor is ideal for usage in hydraulic actuator cylinders where it remains protected from corrosion, vibration, and electrical interference.
- Absolute measurement - no calibration necessary
- Non-Contacting measurement, free of mechanical wear.

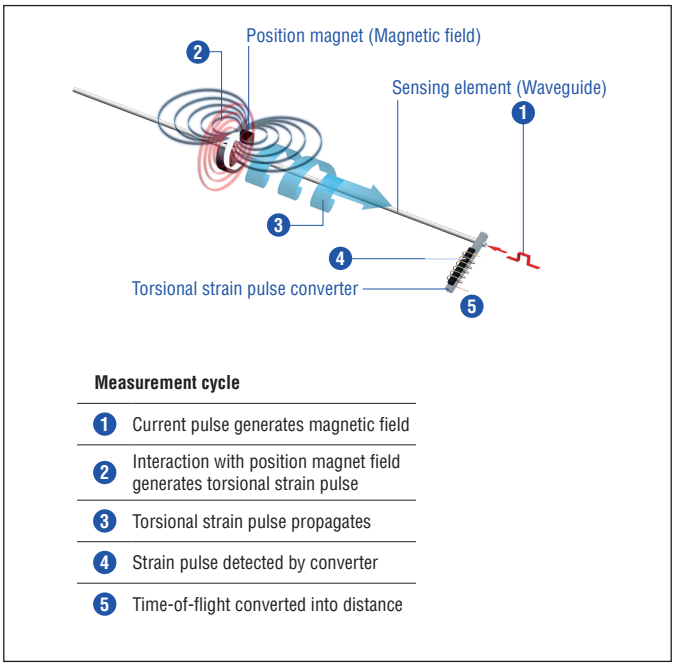
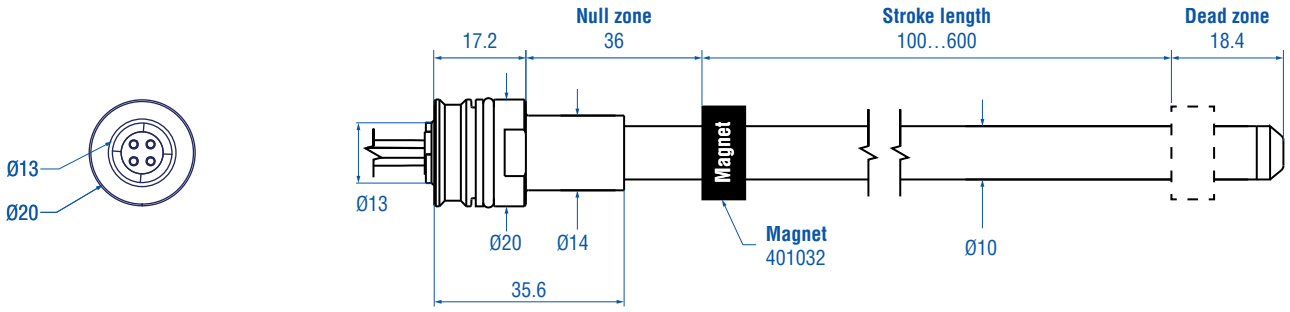


Fig. 2: Principle of operation: Time-based magnetostrictive position sensing principle

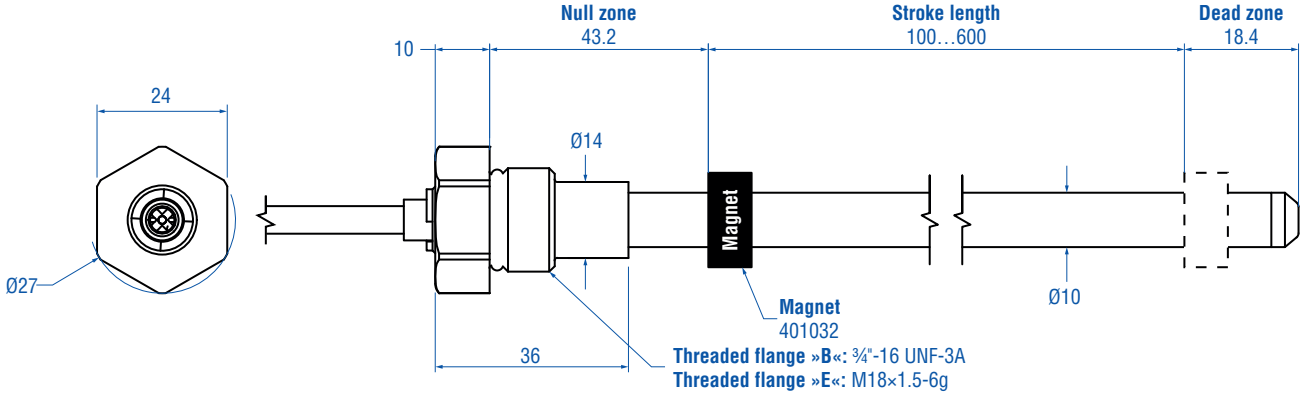
Principle of operation and system construction
The absolute, linear position sensors provided by Temposonics rely on the company's proprietary Temposonics® magnetostrictive technology, which can determine position with a high level of precision and robustness. Each Temposonics® position sensor consists 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 end 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.

4.2 Styles and installation of MH-Series SLIM

SM-D – Pressure fit flange



SM-B/E – Threaded flange

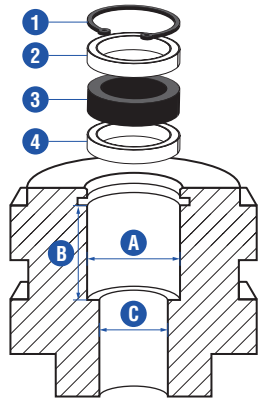


Controlling design dimensions are in millimeters

Fig. 3: Temposonics® MH-Series SLIM Sensor

4.3 SLIM Installation – Magnet Mounting (all flange styles)

Magnet installation



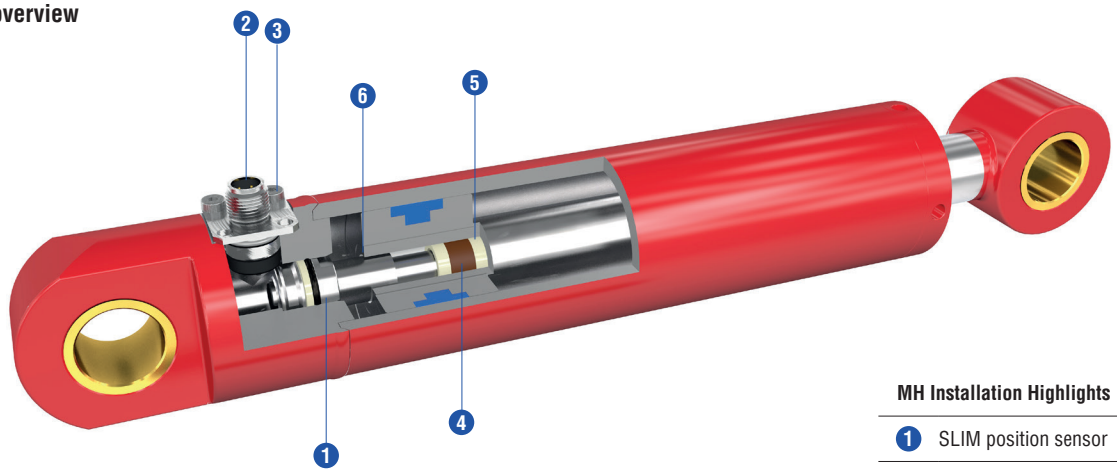
1	Circlip				
2	Non-magnetic spacer (≥ 5 mm)				
3	Position magnet				
4	Non-magnetic spacer (≥ 5 mm)				
	201 542-2	**400 533**	**401 032**	**402 316**	**403 974**
A	$32.9^{+0.1}$	$25.5^{+0.1}$	$17.5^{+0.1}$	$30.6^{+0.1}$	$32.1^{+0.1}$
B	≥ 17.9	≥ 17.9	≥ 17.9	≥ 17.6	≥ 22
C	**Sensor rod**		**Piston rod drilling**		
	Ø 10 mm		Ø 12 mm		

Fig. 4: Temposonics® MH-Series SLIM Magnet Mounting

- Magnet and spacers are typically fastened into piston using a circlip/ retaining ring 1
- Note - Use a LOW PROFILE Internal retaining ring to prevent wear against the sensor pipe during cylinder operation.
- A non-magnetic spacer 4 is required to offset the ring magnet from a magnetic piston face.
- A second non-magnetic spacer 2 is optional.
- The retaining ring and spacers are not supplied by Temposonics and typically specified by the cylinder manufacturer.

4.4 SLIM Installation – Embedded Mount

Installation overview



MH Installation Highlights

1	SLIM position sensor
2	M12 Electrical connector
3	Hex screw M4 flat head
4	Magnet
5	Magnet spacer
6	Gundrill bore

NOTICE

Installation dimensions may vary depending on the type of cylinder and the desired mounting of the sensor connector.

4.5 Embedded Sensor Installation Dimension and Tolerances

This section describes common embedded sensor installation options. Please contact Temposonics Application Engineering for assistance. Additional details for mounting the M12 or DT connector systems can be found in their respective sections.

SLIM Embedded Install with M12 Flange - Right Angle Exit

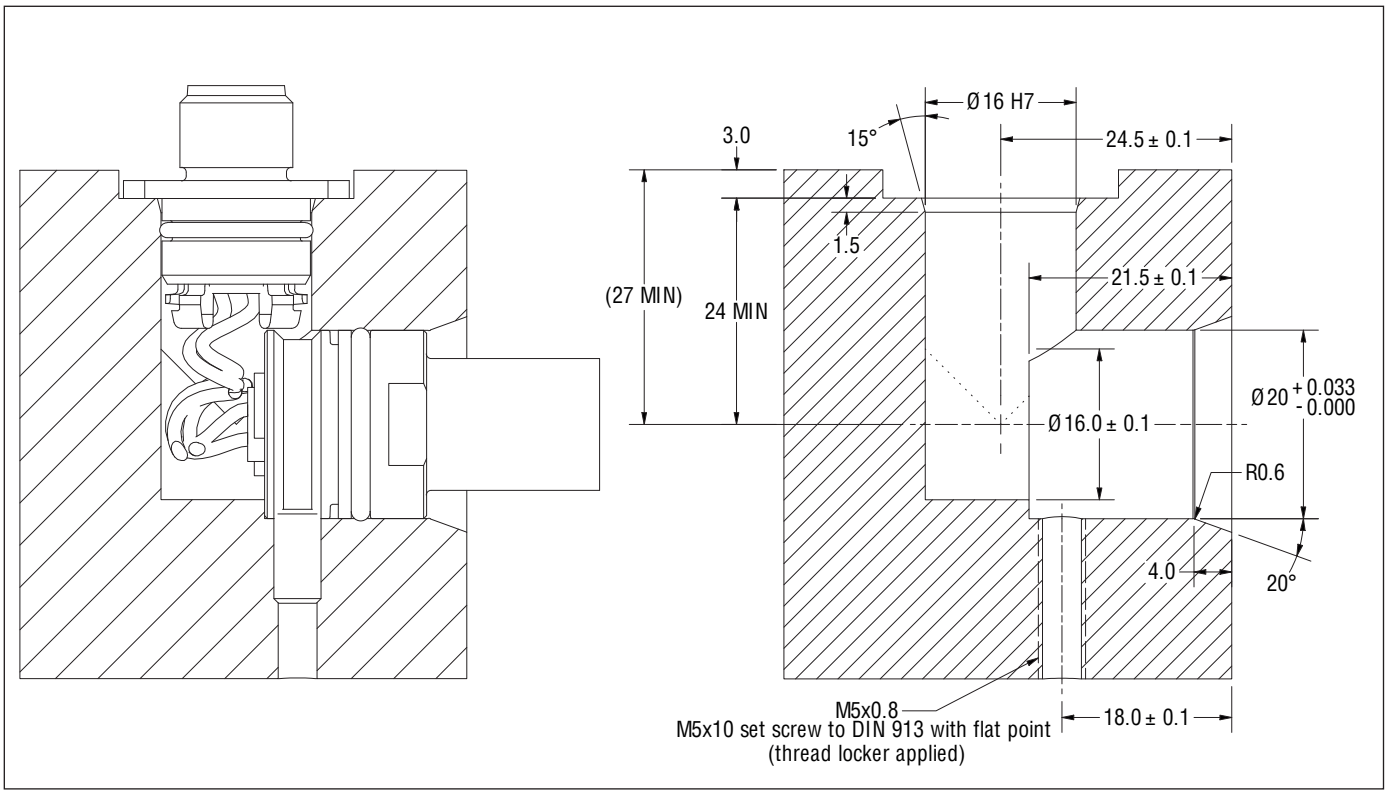


Fig. 5: Temposonics® MH-Series SLIM M12 - rigth angle exit

SLIM Embedded Install with M12 Flange - Straight Exit

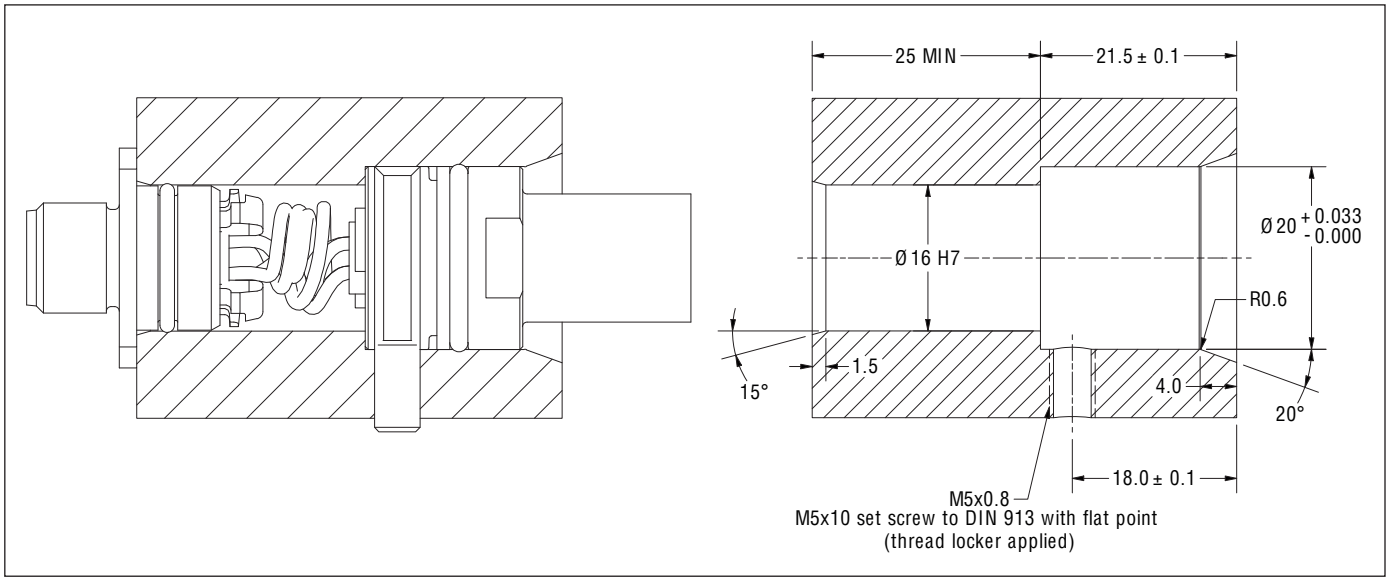


Fig. 6: Temposonics® MH-Series SLIM M12 straight exit

SLIM Embedded Install with pigtails or cable/cable gland

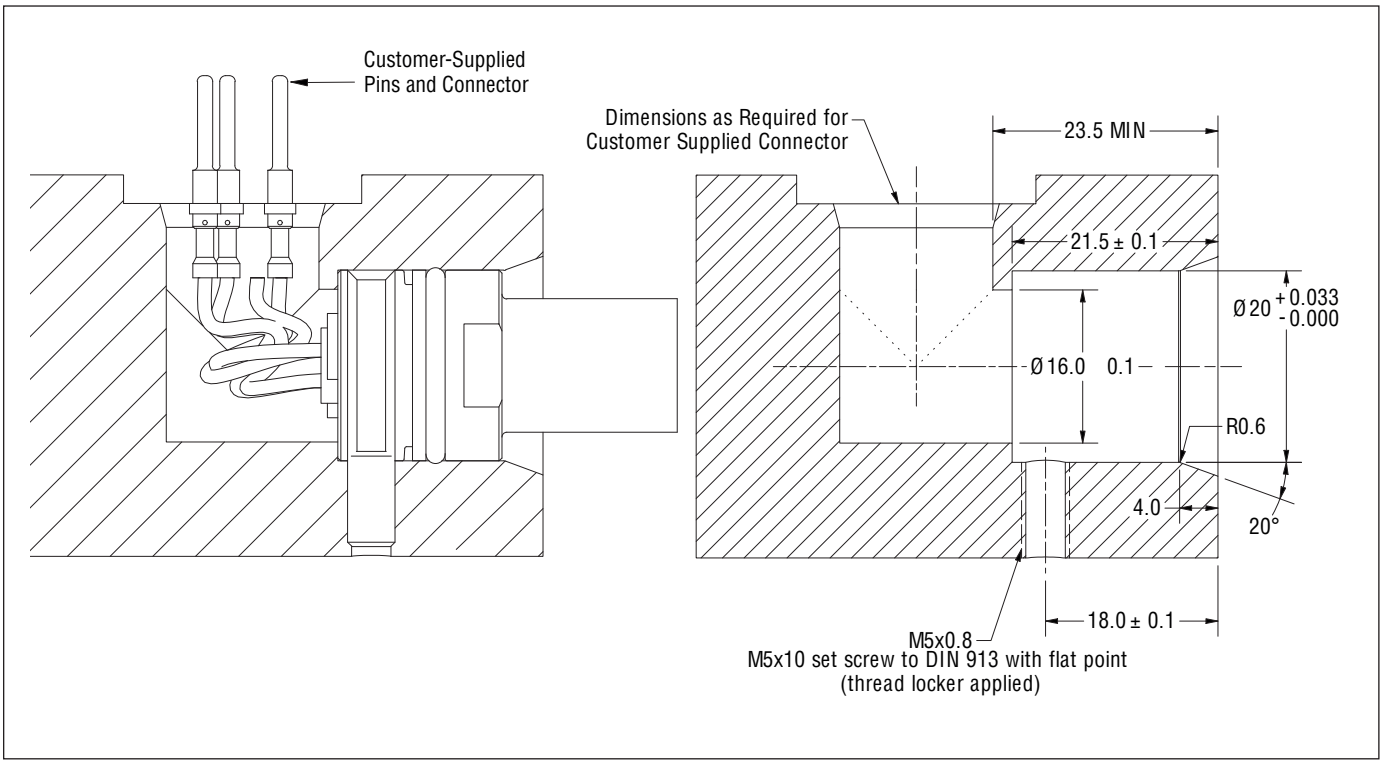


Fig. 7: Temposonics® MH-Series SLIM pigtails or cable/cable gland

Required feed-in chamfer

• For correct and easy sensor mounting in the cylinder, a chamfered edge as shown in the drawings above is required. To avoid damaging the O-ring during installation, the radius at the transition from bore hole to chamfered edge must be R0.6 - R1. Without this radius, there would be a sharp edge, which could damage the O-ring.
• A 20 degree lead in angle long enough to capture the O-ring is recommended.

Safety Screw

An M5×10 set screw to DIN 913 with flat point should be used. This safety screw is only required for blocking the sensor housing in axial direction and needs to butt only against the groove, i.e. the screw may be tightened only with a torque of 0.5 Nm to prevent damaging the sensor. The set screw should be inserted with a resolvable safety adhesive, e.g. Loctite blue.

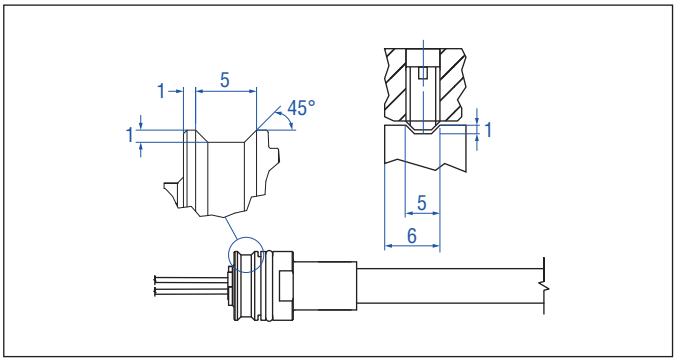


Fig. 8: Temposonics® MH-Series SLIM safety screw

Position of O-ring and backup ring

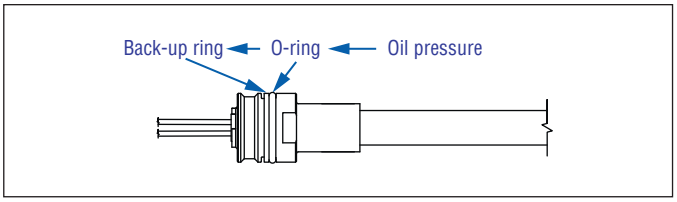


Fig. 9: Temposonics® MH-Series SLIM O-ring and backup ring position

4.6 Mounting Embedded Sensor with M12 Connector System

This section describes the mounting of SLIM Sensor with M12 connector, SLIM threaded version, and SLIM with cable gland into cylinder. Please contact Temposonics Application Engineering for assistance.

M12 connector system dimensions

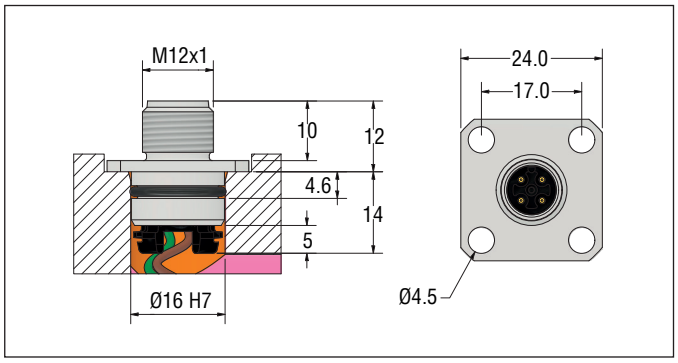
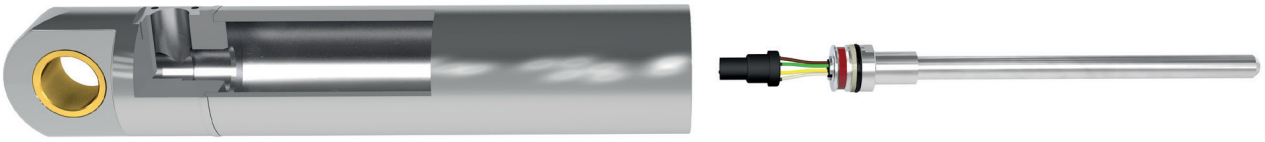


Fig. 10: Temposonics® MH-Series SLIM

Step1: Lubricate sensor O-ring and backup ring before mounting



NOTICE

Confirm the M12 mounting flange is removed from the connector. Feed the black plastic contact carrier through the cylinder wall carefully. (note: rigid wire and a short piece of flexible tubing may be used as a guide). Make sure to keep the conductors away from sharp or pointed edges.

Step 2: Pull the contact carrier through the cavity and out the port. Carefully engage the sensor o-ring and seat the sensor fully into the cavity backstop.

NOTICE

Never use a steel hammer. Do not hit the sensor during installation.Shock may cause damage.

Step3: Lubricate M12 connector O-rings and insert the contact carrier into the flange plate and click it in position. Note the nose of the contact carrier and one of the two apertures of the flange connector, as the contact carrier can be inserted into one of two positions offset by 45°.

Fig. 11: Temposonics® MH-Series SLIM M12 mounting

Step 4: Press the flange plate into the borehole in the cylinder wall. Fasten the flange plate using M4 screws (see list of recommended M4 screws below).

Step 5: Finished installation

NOTICE

The dimensions of screws for mounting the flange plate should be selected so that they don‘t collide with the lock nuts of the connected mating plugs.

Fig. 12: Temposonics® MH-Series SLIM M12 mounitng

Recommended M4 cylinder head screws with pan head, max. Ø 7 mm:

- Button head screw (according to ISO 7380)
- Hexagon socket head cap screw (according to DIN 912)
- Hexalobular socket cylinder head screw (according to ISO 14580)
- Slotted screw (according to DIN 84)
- Comparable cross-head screw
- Comparable thread-forming screws

Screws should be inserted using resolvable safety adhesive. Alternatively, mounting can be done using a round head rivet (according to DIN 660).

Not Recommended:

- Hexagon head screws
- Countersunk/flat head screws
- Self-tapping screws

4.7 Mounting Embedded Sensor With DT Connector System

DT connector system: Connector/flange assembly

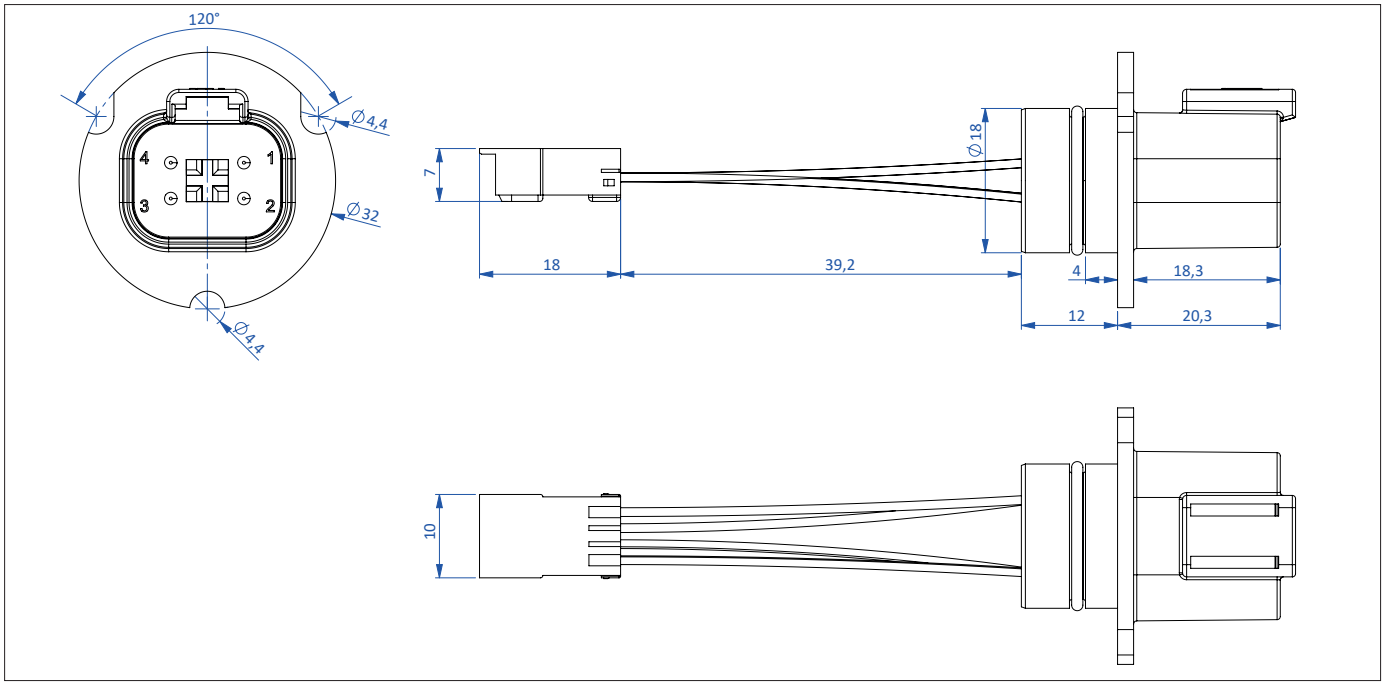


Fig. 13: Temposonics® MH-Series SLIM

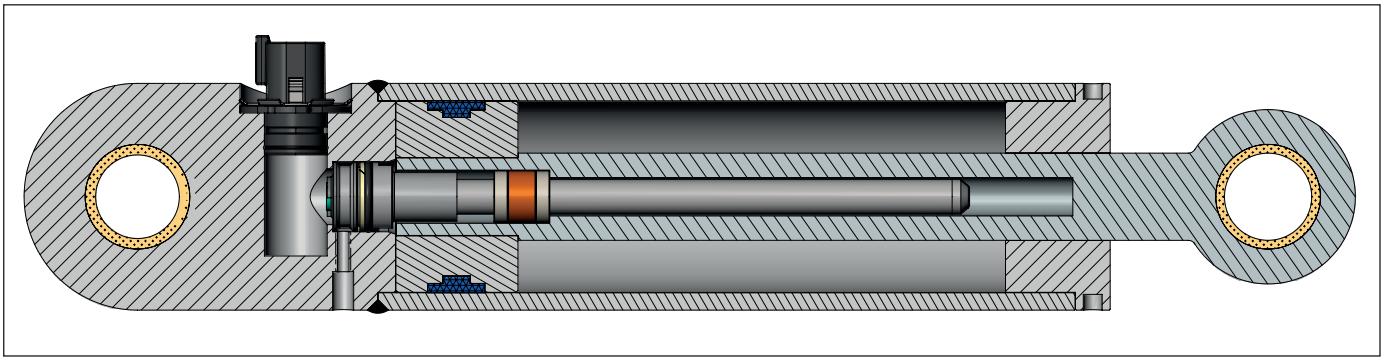


Fig. 14: Overview of MH SLIM install with DT Connector System

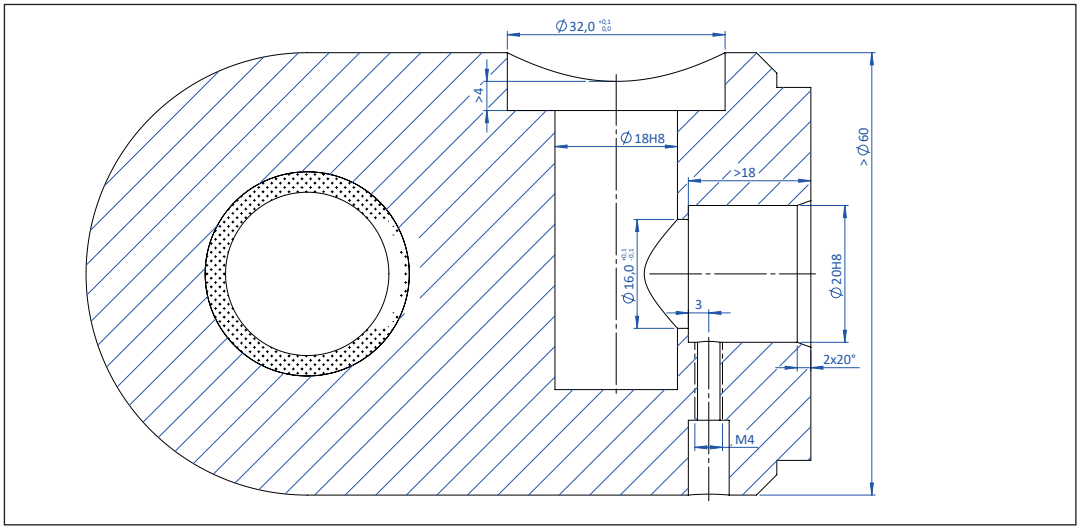
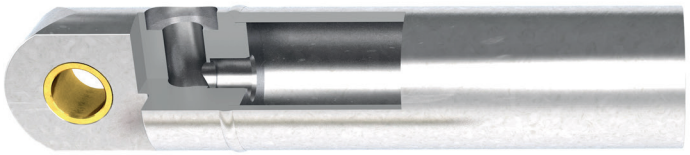


Fig. 15: Dimensions for DT Connector System Installation

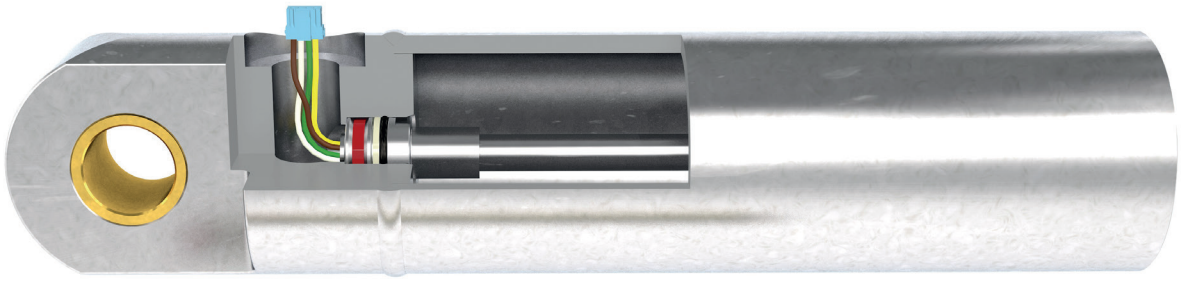
Step 1: Lubricate sensor O-ring and backup ring before mounting



NOTICE

Confirm the mounting flange is removed from the white interconnection. Feed the white plastic interconnection through the cylinder wall carefully. (note: rigid wire and a short piece of flexible tubing may be used as a guide). Make sure to keep the conductors away from sharp or pointed edges.

Step 2: Pull the white interconnection through the cavity and out the port. Carefully engage the sensor o-ring and seat the sensor fully into the cavity backstop.



Step 3: Lubricate the DT Connector flange assembly o-ring. Then insert the plastic interconnect into the mating connector with the DT Connector/flange assembly. Take care to NOT damage the wires.

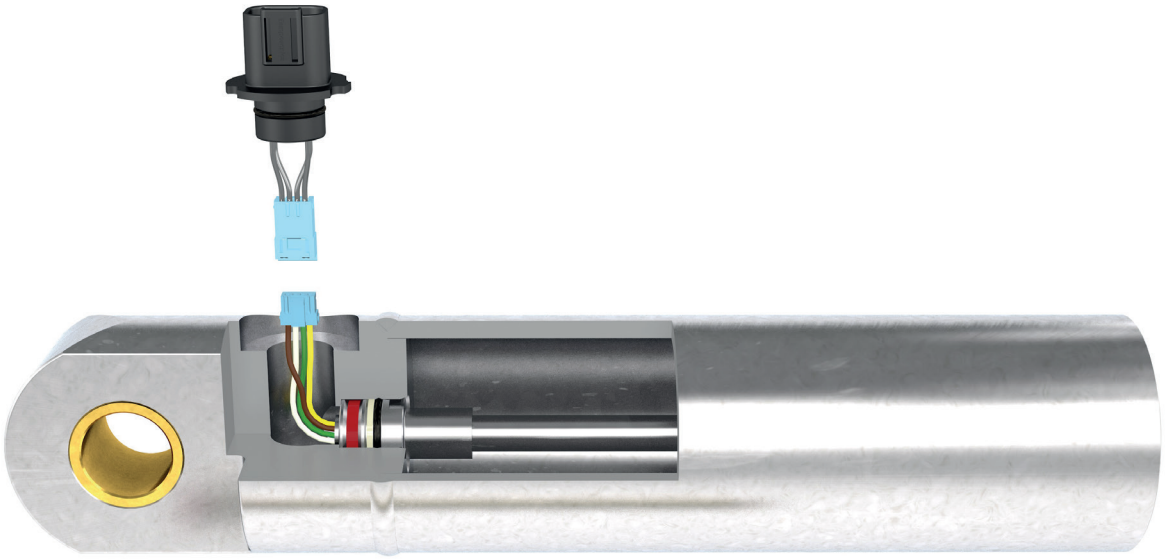
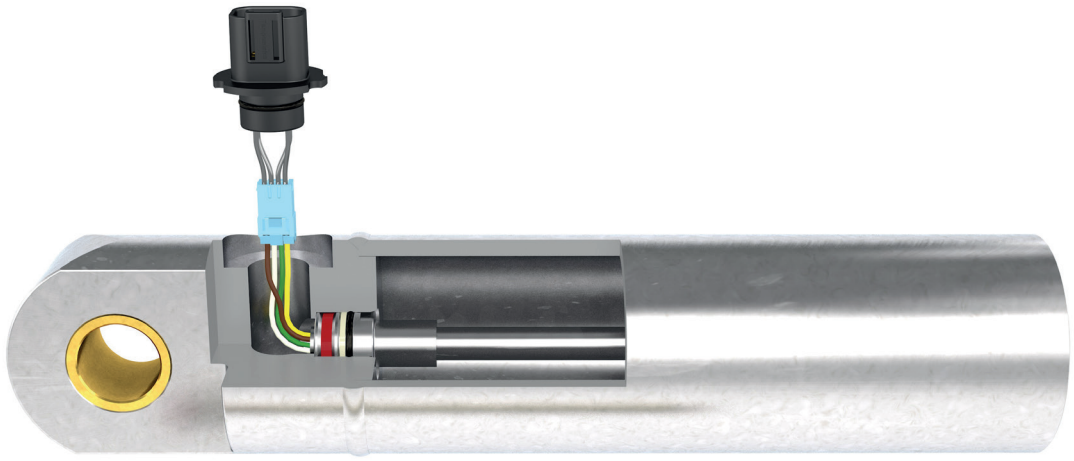


Fig. 16: Temposonics® MH-Series SLIM DT connector mounting

Step 4: Insert the connected DT Connector/flange assembly to the cylinder and rotate to the desired angle.



Step 5a: The DT Connector/flange assembly may be secured with screws or the optional retainer ring.

Apply 3 screw metric M4 and add a bolt adhesive against loosing. Tighten the screws according to the recommended torque (~ 2.5…3 Nm).

Step 5b: Retainer Ring Mounting - if not using screws, place the retainer ring onto flange.

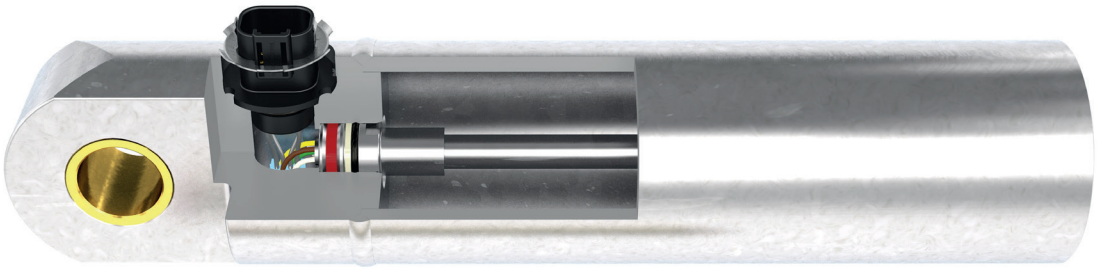


Fig. 17: Temposonics® MH-Series SLIM DT connector mounting

Recommended M4 cylinder head screws with pan head, max. Ø 7 mm:
- Button head screw (according to ISO 7380)
- Hexagon socket head cap screw (according to DIN 912)
- Hexalobular socket cylinder head screw (according to ISO 14580)
- Slotted screw (according to DIN 84)
- Comparable cross-head screw
- Comparable thread-forming screws

Screws should be inserted using resolvable safety adhesive. Alternatively, mounting can be done using a round head rivet (according to DIN 660).

Non-recommended screws:
- Hexagon head screws
- Countersunk/flat head screws
- Self-tapping screws

Step 5b: Retainer Ring Mounting (continued).

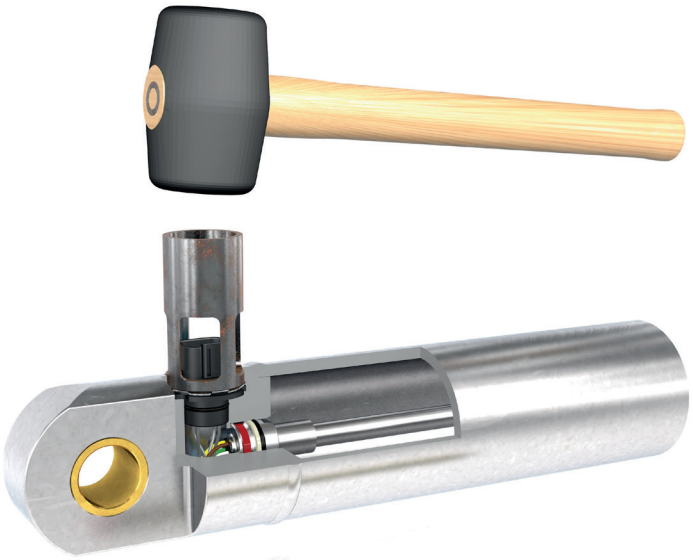
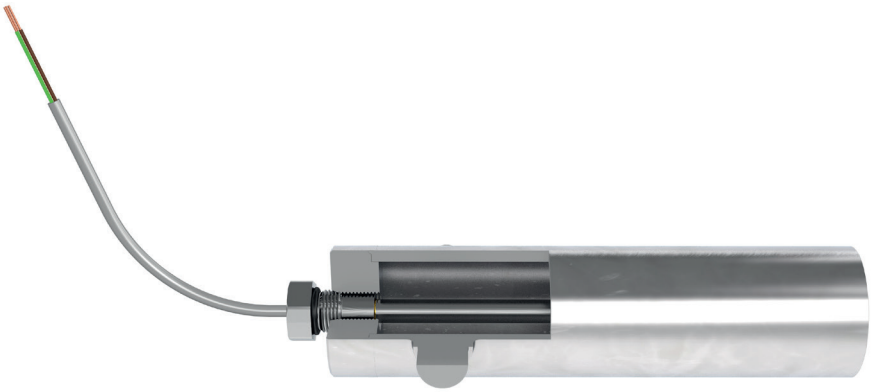


Fig. 18: Temposonics® MH-Series SLIM DT connector mounting

4.8 Mounting threaded sensor

Step1: Lubricate sensor O-ring before mounting

Step 2: Fasten sensor to recommended torque (50 Nm unless noted otherwise)



NOTICE

Sensor should be installed with the cables free to rotate with the sensor. Twisting the cable relative to the sensor could cause damage.

Step 3

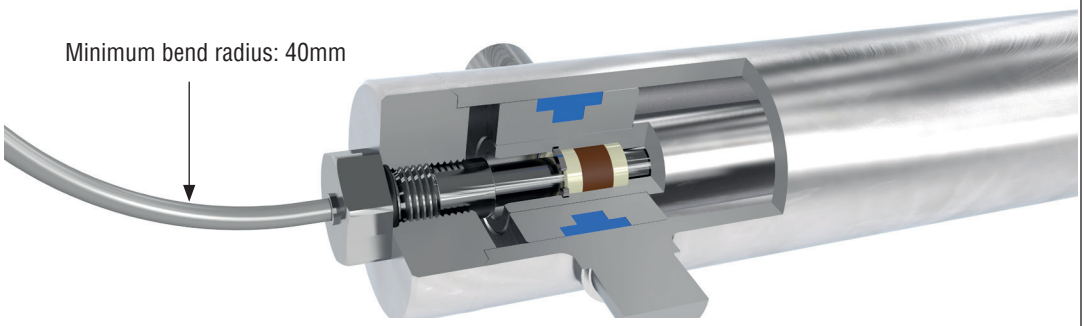


Fig. 19: Temposonics® MH-Series SLIM threaded mounitng

4.9 Mounting sensors with single conductor and third-party connector

When mounting third-party connectors on sensors with single conductors, the following information should be taken into account:

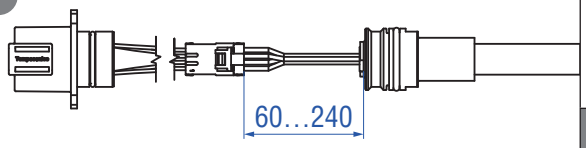
- The connector protection type should be at least IP68. Make sure O-rings are fitted correctly.
- The connector housing should be completely made of metal. Plastic connectors can be damaged easily, thus tightness is not ensured.
- Make sure that the polarity is correct.
- For connectors with screw terminals, cable end sleeves should be used, in order to prevent short circuiting and contact corrosion.
- End sleeves should be pressed onto the conductors in a way that all strands are clamped into the sleeve. Protruding strands can cause short circuiting!
- If connectors are provided with solder contacts, ensure that the contacts are soldered correctly and that no strands proud.
- Crimp contacts should be gas-tight and pressed only using special crimp tools. This is the pre-requisite to preclude corrosion of contacts.
- Most commercially available connectors are not or not sufficiently protected against the ingress of water running along the cable. For this reason, suitable caps should be fitted to close them after mounting.
- When mounting connectors, make sure protection against ESD is provided, i.e. workplaces and personnel must be protected against electrostatic charging.

4.10 Electrical connections

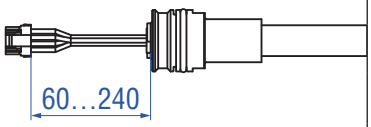
Connector wiring Analog

(1) DT connector system (A…E/A…G/A…H) & (2) Interconnect without DT connector system (W…E/W…G/W…H)

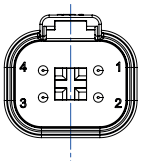
1



2



- Single lead wires 0.22 mm²
- 4 pin DT style connector
- Toolless Assembly
- Sealing IP67, up to IP69K with mating connector

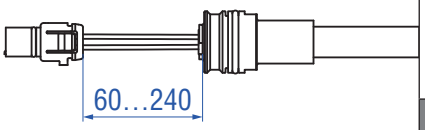


View on connector

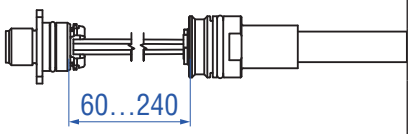
Connector wiring	E		G		H	
Pin	Wire	Function	Wire	Function	Wire	Function
1	YE	n.c.	BN	VDC	BN	VDC
2	BN	VDC	YE	n.c.	GN	SIG
3	WH	GND	WH	GND	WH	GND
4	GN	SIG	GN	SIG	YE	n.c.

(1) M12 connector system without flange(K…E/K…G/K…H) & (2) with flange (N…E/N…G/N…H)

1



2

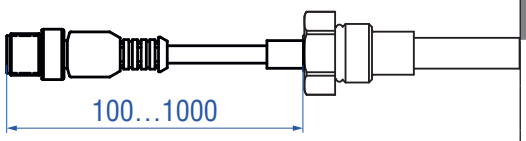


- Single lead wires 0.22 mm²
- Attached A-coded M12 connector
- Toolless Assembly
- Sealing IP67, up to IP69K with mating connector

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.

Cable with M12 connector (Q…E/Q…G/Q…H)

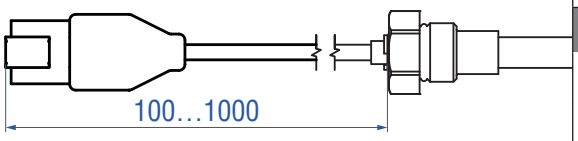


- Cable output Ø 5 mm
- Attached A-coded M12 connector
- Toolless Assembly
- Sealing IP67, up to IP69K with mating connector

View on connector

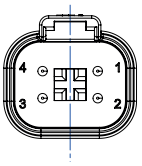
Connector wiring	E		G		H	
Pin	Wire	Function	Wire	Function	Wire	Function
1	YE	n.c.	BN	VDC	BN	VDC
2	BN	VDC	YE	n.c.	GN	SIG
3	WH	GND	WH	GND	WH	GND
4	GN	SIG	GN	SIG	YE	n.c.

Cable outlet with DT04-4P style connector (F…E/F…G/F…H)



- Cable output Ø 5 mm
- Attached DT04-4P style connector
- Toolless Assembly
- Sealing IP67, up to IP69K with mating connector

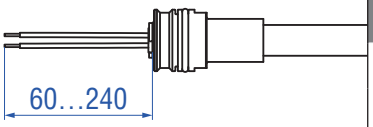
Connector wiring



View on connector

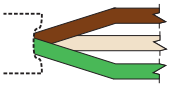
Pin	E		G		H	
	Wire	Function	Wire	Function	Wire	Function
1	YE	n.c.	BN	VDC	BN	VDC
2	BN	VDC	YE	n.c.	GN	SIG
3	WH	GND	WH	GND	WH	GND
4	GN	SIG	GN	SIG	YE	n.c.

Single wires (S…A)



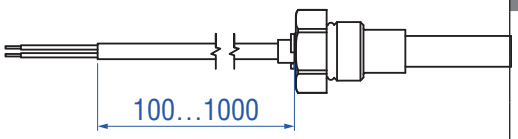
- Single lead wires, 3 × 0.5 mm²
- Insulated PVC

Connector wiring



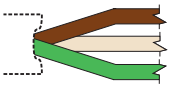
Color	Function
BN	VDC
WH	GND
GN	SIG

Cable outlet (T…A)



- Cable output Ø 5 mm
- Toolless Assembly

Connector wiring

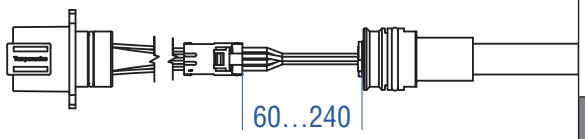


Color	Function
BN	VDC
WH	GND
GN	SIG

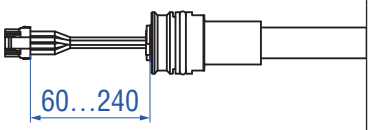
Connector wiring CANbus

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

1

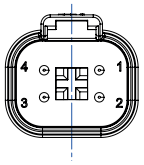


2



- Single lead wires 0.22 mm²
- 4 pin DT style connector
- Toolless Assembly
- Sealing IP67, up to IP69K with mating connector

Connector wiring

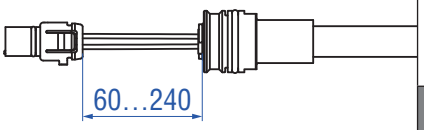


View on connector

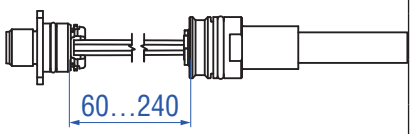
Pin	Function
1	VDC
2	CAN_L
3	GND
4	CAN_H

(1) M12 connector system without flange(K …F) & (2) with flange (N…F)

1



2



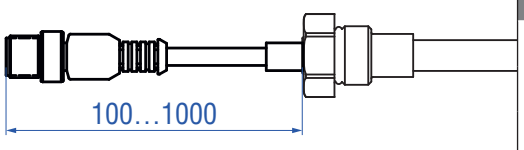
- Single lead wires 0.22 mm²
- Attached A-coded M12 connector
- Toolless Assembly
- Sealing IP67, up to IP69K with mating connector

Connector wiring

View on connector

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

Cable with M12 connector outlet (Q…F)



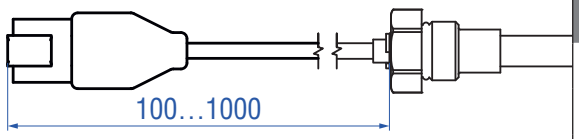
- Cable output Ø 5 mm
- Attached A-coded M12 connector
- Toolless Assembly
- Sealing IP67, up to IP69K with mating connector

Connector wiring

View on connector

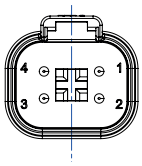
Pin	Wire	Function
1	–	–
2	BN	VDC
3	WH	GND
4	YE	CAN_H
5	GN	CAN_L

Cable outlet with DT04-4P style connector (F…S)



- Cable output Ø 5 mm
- Attached DT04-4P style connector
- Toolless Assembly
- Sealing IP67, up to IP68 with mating connector

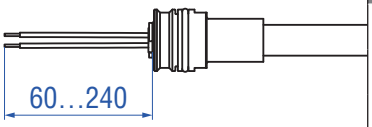
Connector wiring



View on connector

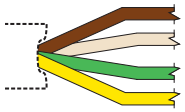
Pin	Function
1	VDC
2	CAN_L
3	GND
4	CAN_H

Single wires (S…A)



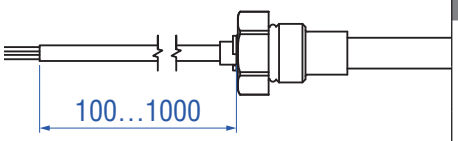
- Single lead wires 0.5 mm²
- Insulation PVC

Connector wiring



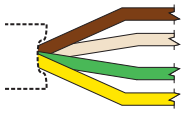
Wire	Function
BN	VDC
WH	GND
GN	CAN_L
YE	CAN_H

Cable outlet (T…A)



- Cable output Ø 5 mm
- Toolless Assembly

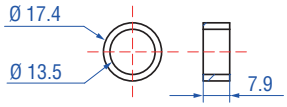
Connector wiring



Color	Function
BN	VDC
WH	GND
GN	CAN_L
YE	CAN_H

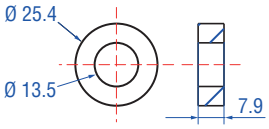
4.11 Frequently ordered accessories

Position magnets



Ring magnet OD17.4
Part no. 401 032

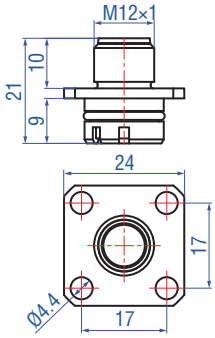
Material: PA neobond
Weight: Approx. 5 g
Surface pressure: Max. 20 N/mm²
Operating temperature:
–40…+105 °C (–40…+221 °F)



Ring magnet OD25.4
Part no. 400 533

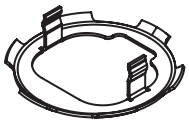
Material: PA ferrite
Weight: Approx. 10 g
Surface pressure: Max. 40 N/mm²
Operating temperature:
–40…+105 °C (–40…+221 °F)

Connector accessories



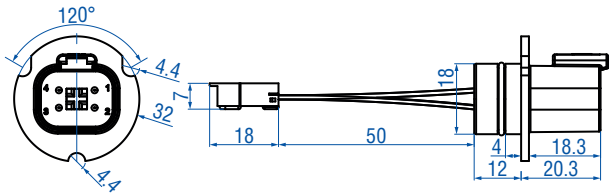
M12 flange
Part no. 253 769

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

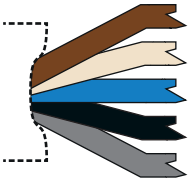
Material: PA66
Weight: Approx. 6 g
Operating temperature:
–40…+105 °C (–40…+221 °F)

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)

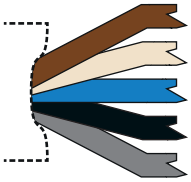
Wiring

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	

4.12 DT Connector Mounting Tool

To press in the DT Connector Retainer correctly it is necessary to use a tool with dimensions as shown below. Only with this geometry it is guaranteed that the locking ring gets fixed properly.

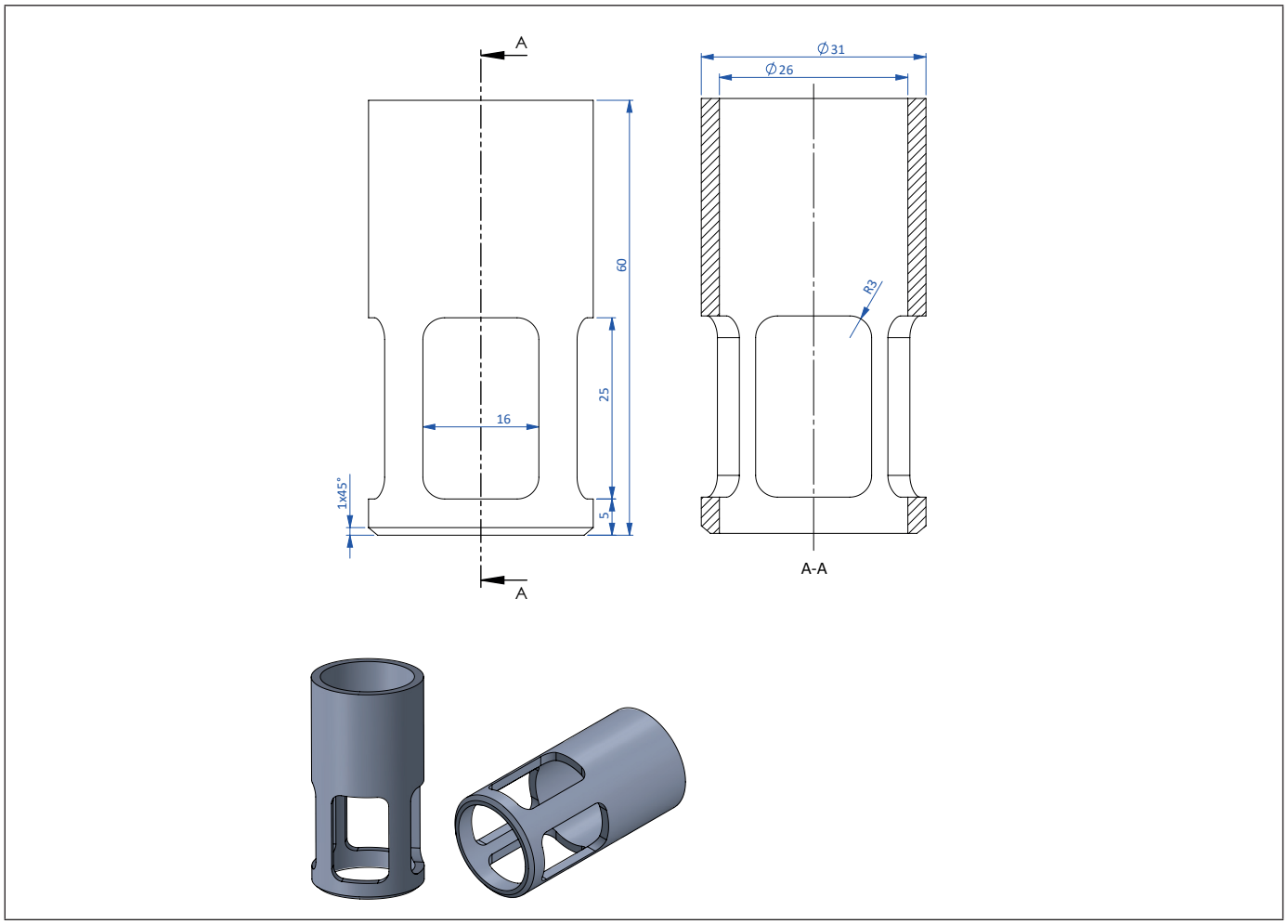


Fig. 21: DT Mounting Tool

5. Cylinder handling after sensor installation

5.1 Washing and drying cylinders with installed sensors

Frequently, hydraulic cylinders are washed or degreased before painting. For this purpose, various chemical and/or thermal methods are used, whereby cleaning agents are sprayed onto the components under high pressure up to 50 bar. During this procedure, the following measures relating to polyurethane (PUR) connecting cables and plug-in connections must be taken.

5.2 Sensors with M12 connector system

- When washing at low pressures up to approximately 5 bar, the plastic cap supplied with sensor and connector system is sufficient to protect the M12 connector system (part no. 403287).
- When washing at higher pressures, an M12×1 metal protective device should be used to protect the connector system against the effect of chemicals.
- The actual Temposonics connector system won't be damaged due to its high protection class, however, mating plugs which are connected subsequently might corrode due to the effect of chemicals.
- If temperatures higher than +85 °C are used for drying after washing, the connector systems should not be exposed to this temperature for more than about 5 minutes.

5.3 Sensors with connecting cable

- Protect the connecting cables using suitable enclosures (e.g. bags) against the effect of moisture, high pressures and temperatures.
- Normally, cable entry glands meet the requirements of IP67, however, they are not pressure-tight. For this reason, they must be protected against moisture as well, in order to prevent moisture from accumulating in the connecting compartment of the cylinder.
- Temposonics connecting cables are made of PUR and relatively resistant against a large variety of chemicals and oils. However, exceptions are e.g. carbon tetrachloride, trichloroethylene, perchloroethylene, which can be ingredients of fat solvents and cleaning agents.
- Therefore, make sure that cables are protected adequately, if cleaning agents that can attack PUR are used.
- If temperatures higher than +85 °C are used for drying after washing, the connecting cables shouldn`t be exposed to this temperature for more than 5 minutes.

5.4 Sensors provided with third-party connectors

- If third-party connectors are used, a sealed screw cap must be fitted when washing, since third-party connectors normally have only protection class IP67.
- Moreover, check if the housing of the third-party connector is sufficiently tight to resist high pressures when washing. If necessary, measures for protection of the housing should be taken.
- These connectors must be protected against the ingress of moisture as well to prevent moisture from accumulating in the connecting compartment of the cylinder.
- If temperatures higher than +85 °C are used for drying after washing, third-party connectors shouldn‘t be exposed to this temperature during more than 5 minutes either.

5.5 Painting cylinders

5.6 Electrostatic painting

Various dry and wet methods of applying paint to the component surface use electrostatic charge to paint cylinders. These methods employ very high voltages up to 100 kV, which can damage the electronics of position measuring systems. To prevent this damage, it is mandatory to take the following measures during electrostatic painting.

- Attach the cylinder to the painting frame by the barrel side of the cylinder rather than by the piston rod. The reason is that the integrated sealing and slide rings can cause electric isolation between the piston rod and the cylinder/sensor housing, i.e. low-impedance connection between the painting equipment ground and the sensor housing is not ensured.
- Clean the suspension points at the painting system and all connections used for short-circuiting conductors and connection to the painting system ground regularly and remove paint as well as other residues, in order to ensure low-impedance connection.

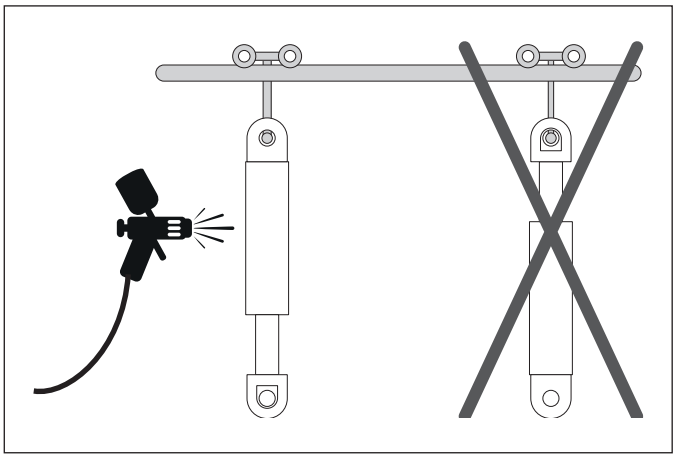


Fig. 1: Electrostatic painting

NOTICE

- Cut or disconnect all sensor connections during welding.
- Never fasten the grounding point at the piston rod or at the cylinder pipe.
- Never perform welding work on a part of the cylinder, if a sensor has been installed.
- Never perform welding work near a cylinder, if a sensor has been installed.
- Due to isolating bearings, plastic slide bearings or grease in the contact points, electric potentials/voltages can build up at every bearing point of machines. Accordingly, similar effects as on hydraulic cylinders can be produced.

5.7 Electrostatic effects

Electrostatic charge is caused due to friction and separation of charge. This phenomenon is widely known and can be produced e.g. by carpets or car seats. Mostly, the charge is noticed only in the event of discharge, when the associated „shock“ occurs. The voltages due to electrostatic discharge can have very high values, for example:

- Walking over carpet floors up to 30,000 V
- Walking over synthetic floors up to 12,000 V
- Moving at the workplace up to 6,000 V

Not only the high voltages, but especially the sudden discharge and related currents (up to 50 Ampere!) can cause destruction of electrical components. The effects are similar to those occurring due to electrostatic discharge during dry painting.

To avoid electrostatic discharge, workplaces and persons working with or on electronic components must be grounded. This also applies to sensor installation into the hydraulic cylinder as well mounting procedure the cylinder to the machine.

Current flow curve during electrostatic discharge of a human body

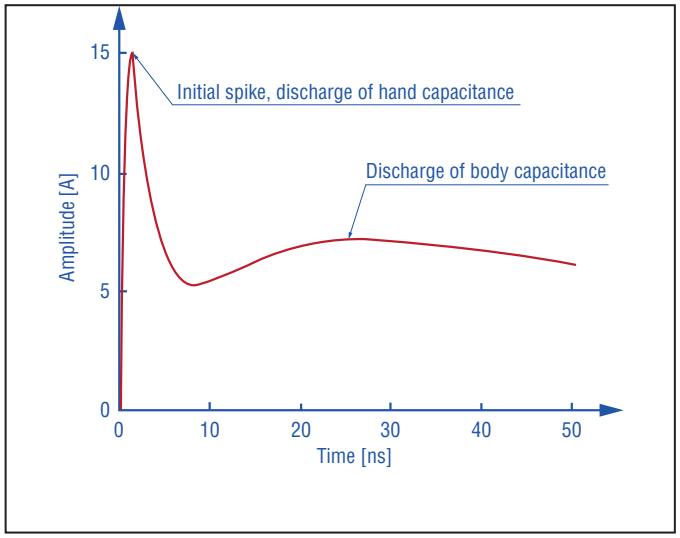


Fig. 2: Current flow curve during electrostatic discharge of a human body

Suitable protective measures are:

- Persons wear ribbons connected to the grounding point by means of spiral cable around their wrist. Please, contact us, if you need information on suppliers for suitable protective equipment.
- Work is only performed on diverting material, i.e. charges can be diverted gently (e.g. work plate of wood, rubber, ESD foam material).
- Avoid hard discharge. Do not deposit components on metal plates or metal film.
- Do not remove electrostatically sensitive components from the packaging without grounding.
- Caution when cutting adhesive tapes, do not tear to open.

5.8 Compatibility of seals with hydraulic oils

The sensors with a measuring rod are designed for installation in hydraulic cylinders. The seals used in the sensors come into contact with the hydraulic oil. Hydraulic oils that are moderately to not compatible with the material of the seals can damage the seal.

In general, sensors from Temposonics are equipped with seals made of NBR, FKM and PTFE. These seals can be used with hydraulic oil type HLP (according to DIN 51524-2).

Other oils, such as the so-called bio oils (e.g. HEES, HETG and HEPG), are, without prior testing, not approved for the seals used by Temposonics. Due to the large number of different oils and their different mixing ratios, not all seal materials can be tested with the corresponding oils. These tests are very time-consuming and therefore cost-intensive. It should also be noted that the composition and mixing ratios of oil types change continuously.

If hydraulic oil other than type HLP is to be used, we recommend testing the oil-seal combination in a test laboratory. Two tests are required per oil seal combination:

- Storage in oil for 1000 hours at an oil temperature of 80 °C
- Storage in oil for 168 hours at an oil temperature of 100 °C

During these tests, the components must be extensively tested for installation dimensions.

5.9 Painting and electrostatic charging

When using dry or powder painting methods for cylinders, powder is applied to the component surface by means of static charge. These methods employ very high voltages that can damage the electronics of Temposonics position measuring systems integrated in the cylinders. This can be prevented using the following metal protective caps.

The metal protective cap safeguards the contact pins and thus the electronics of the sensor against electrostatic effects (high voltage). It is important to note that:

- The material of the protective cap must be permanently electrically conductive.
- The cap must not be of aluminum (aluminum is subject to oxidation and can cause electric isolation).
- The metal protective cap must have an M12×1 thread.
- The cap must be screwed up to the connector flange plate.
- Make sure that no paint particles contaminate the thread or the contact pins.
- The thread of the protective cap must be clean and free from paint particles and other substances at all times.
- The metal protective cap must be tightened only so that it is hand-tight (max. 5 Nm).
- Paint particles on the cap outside are of no concern.
- Drawing examples for the protective cap are given in the attachment.

5.10 Cylinders with integrated sensors and connecting cables or third-party connectors

- Electrostatic painting cannot be used for sensors with connecting cables, since the cable cannot be protected safely against the high process voltage. Safe electrostatic painting is ensured only in conjunction with the M12 connector system and the brass caps.

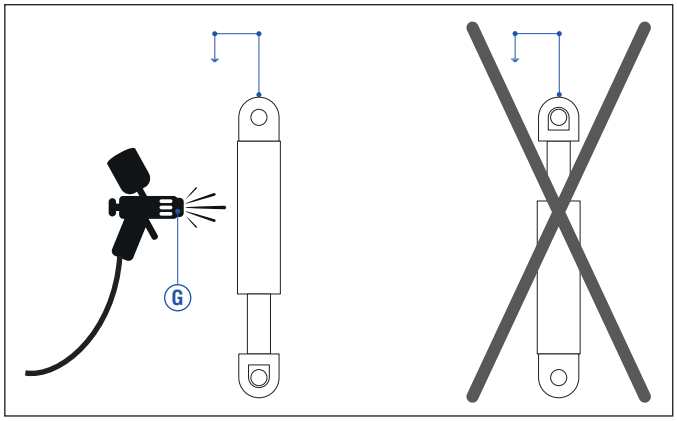


Fig. 3: Electrostatic painting of cylinders with integrated sensors

5.11 Mounting / dismounting cylinders on mobile hydraulics machines

As during transport, connectors, cables and cable ends should be protected sufficiently during mounting and dismounting. Cables and conductors must be neither subjected to load or tensile stress, nor bended. When connecting cables are installed, make sure that the insulation is not damaged by sharp edges.

NOTICE

Insulation tests
Part of the tests performed on mobile machines can be insulation tests. These tests are intended to determine the dielectric strength of the cables against the housing (insulation resistance) using high voltages. During these tests, all sensor cables must be disconnected, otherwise stray voltage over the sensor protective circuitry against ground can damage these components and cause sensor failure.

NOTICE

As a rule:
Don't perform welding work on the cylinder!

5.12 Welding

After installing the cylinder in machines, welding work on adjacent components can be necessary. If a grounding clamp is applied directly or too closely to the cylinder, welding currents can be transmitted to the sensor via the cylinder and cause burning of the sensor pipe or damage of internal sensor components. Cylinders mostly consist of two assemblies: the lower part with the cylinder pipe and the piston with the piston rod. These components are isolated electrically from each other by gaskets, bearings and slide rails. This means that, normally, no current flow is possible. With cylinders, however, the welding current may be transmitted from the piston to the cylinder pipe. In this case, an electrical connection causes the entire welding current to flow through the sensor pipe and the sensor head, thus damaging the electronics. Moreover, the cylinder and/or the gaskets are destroyed.

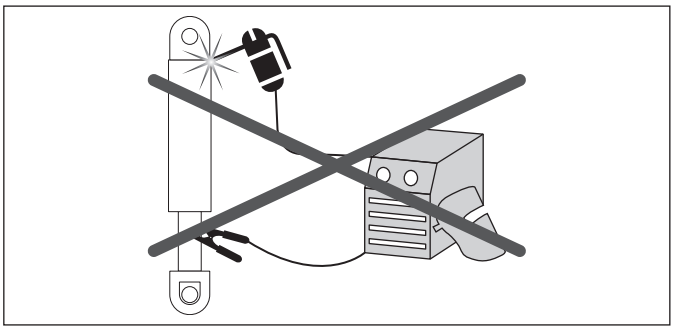


Fig. 4: Welding the cylinder with integrated sensor

Cylinder handling after sensor installation
When transporting the cylinders, make sure that the cables and connectors are not under tensile stress. When handling/storing carelessly, connectors and cables can be squeezed easily between stacked cylinders.
Moreover, it is necessary to encapsulate any exposed connections or cable ends using an antistatic bag. For this, the original TEMPOSONICS antistatic bags that shipped with the sensor can be re-used. Furthermore, it is important to re-fit the dust protective caps (TEMPOSONICS material number GZ0605) on the TEMPOSONICS M12 connector system (IP69K when mated) after installation of the connector. The cylinders storage conditions should be as dry as possible.

6. Technical Data

6.1 Technical data Analog

Output	
Voltage	0.25…4.75 VDC / 0.5…4.5 VDC / 4.75…0.25 VDC / 4.5…0.5 VDC
Measured value	Position
Measurement parameters	
Stroke length	100…600 mm
Resolution (position)	0.1 mm
Power up time	250 ms (typical)
Repeatability	±0.1 mm
Linearity	±0.4 mm
Internal sample rate	6 ms
Setpoint tolerance	≤ 1 mm
Operating conditions	
Operating temperature electronics	–40…+105 °C
Humidity	90 % relative humidity, no condensation, EN 60068-2-30
Ingress protection – Sensor housing	IP67, EN 60529
Shock	100 g (11 ms) single shock per axis, IEC 60068-2-27 50 g (6 ms) at 1000 shocks per axis, IEC 60068-2-29
Vibration	Operational sine vibration test IEC 60068-2-6 10 g (5…2000 Hz)* Survival random vibration test IEC 60068-2-64 15 g RMS (10…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 ISO 16750-2:2012 Road vehicles
EMI	200 V/m (ISO 11452-2:2004 200…2000 MHz) 200 mA (ISO 11452-4:2011 1…200 MHz)
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 housing	Stainless steel 1.4305 (AISI 303)
Sensor rod	Stainless steel 1.4306 (AISI 304L)
Sealing	O-ring: HNBR 70, back-up ring: PTFE
Electrical connection	
Operating voltage	12/24 VDC nominal (8…32VDC)
Min load resistance (output VDC)	10 kΩ
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 +200 VDC
Polarity protection (GND-VDC)	Up to –200 VDC
Insulation Resistance	R ≥ 10 MΩ @ 60 sec
Electric strength	500 VDC (DC GND to chassis GND)

***/** Resonance frequencies excluded
****/** 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

6.2 Technical data CANbus

Output	
Bus-protocol	SAE J1939, CANopen protocol according to CiA DS-301 V4.1, device profile DS-406 V3.1
Measured value	Position
Measurement parameters	
Stroke length	100…600 mm
Resolution (position)	0.1 mm
Boot up Time	400 ms (typical)
Cycle Time	Programmable (20 ms default)
Linearity	±0.4 mm
Internal sample rate	10 ms
Setpoint tolerance	≤ 1 mm
Operating conditions	
Operating temperature electronics	–40…+105 °C
Humidity	90 % relative humidity, no condensation, EN 60068-2-30
Ingress protection – Sensor housing	IP67, EN 60529
Shock	100 g (6 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 10 g (5…2000 Hz)* Survival random vibration test IEC 60068-2-64 15 g RMS (10…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 ISO 16750-2:2012 Road vehicles
EMI	200 V/m (ISO 11452-2:2004 200…2000 MHz) 200 mA (ISO 11452-4:2011 1…200 MHz)
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)
Sensor rod	Stainless steel 1.4306 (AISI 304L)
Sealing	O-ring: HNBR 70, back-up ring: PTFE
Electrical connection	
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	< 1 % $_{PP}$
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 –200 VDC
Insulation Resistance	R ≥ 10 MΩ @ 60 sec
Electric strength	500 VDC (DC GND to chassis GND)

*/ Resonance frequencies excluded
**/ 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

7. Maintenance and troubleshooting

7.1 Error conditions, troubleshooting

If the magnetic detection is lost, signal values rise to HIGH level

7.2 Maintenance

The sensor is maintenance-free.

7.3 Spare Parts

No spare parts are available for this sensor.

7.4 Transport and Storage

Storage of sensors and magnet assemblies
The sensors are supplied with an O-ring made of NBR-rubber, the material aging of which is in the characteristic of the material and can notbe avoided.

- Take appropriate storage precautions
- Protect the ferro magnetic magnet assy parts against rust

Storage of cylinders with integrated sensors
When transporting the cylinders, make sure that the cables and connectors are not under tensile stress. When handling/storing carelessly, connectors and cables can be squeezed easily between stacked cylinders. Moreover, it is necessary to encapsulate the connections or exposed cable ends using an antistatic bag. For this, the original bags can be re-used. Furthermore, it is important to re-fit the white dust protective caps (part no. 403287) on the M12 connector system after installation of the connector. The cylinders storage conditions should be as dry as possible.

8. Removal from service / dismantling

The product contains electronic components and must be disposed of in accordance with the local regulations.

Temposonics
AN AMPHENOL COMPANY

9. Appendix - Safety declaration

Dear Customer,
If you return one or several sensors for checking or repair, we need you to sign a safety declaration. The purpose of this declaration is to ensure that the returned items do not contain residues of harmful substances and/or that people handling these items will not be in danger.

Temposonics order code: _____ Sensor model(s): _____

Serial number(s): _____ Stroke length(s): _____

The sensor has been in contact with the following materials:

Do not specify chemical formulas.
Please include safety data sheets of the substances, if applicable.

In the event of suspected penetration of substances into the sensor, consult Temposonics to determine measures to be taken before shipment.

Short description of malfunction:

Corporate information

Company: _____

Address: _____

_____

Contact partner

Phone: _____

Fax: _____

Email: _____

We hereby certify that the measuring equipment has been cleaned and neutralized.
Equipment handling is safe. Personnel exposure to health risks during transport and repair is excluded.

Stamp

Signature _____

Date _____

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