Temposonics
AN AMPHENOL COMPANY

Temposonics®

Magnetostrictive Linear Position Sensors

MH-Series Flexible MH

Installation Manual

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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

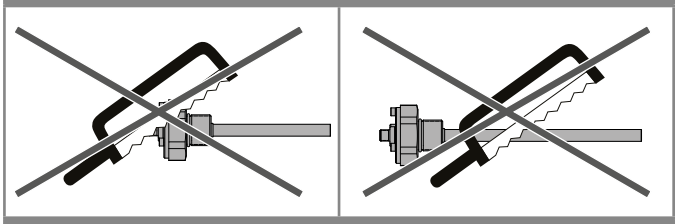
This product may be used only for the applications defined under item 1 and only in conjunction with the third-party devices and components recommended or approved by MTS Sensors. As a prerequsite of proper and safe operation: the product requires correct transport, storage, mounting and commissioning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

1. The sensor systems of all Temposonics® series are intended exclusively for measurement tasks encountered in industrial, commercial and laboratory applications. 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.

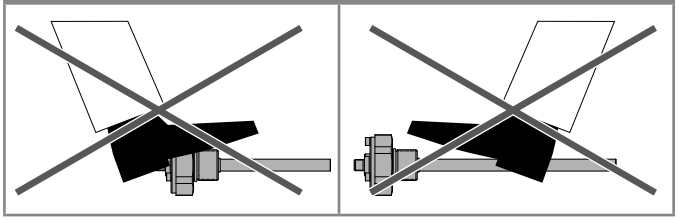
2.2 Forseeable misuse

Foreseeable misuse	Consequence
Wrong sensor connection	The sensor will not work properly or can be damaged
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
Cables are damaged	Short circuit – the sensor can be destroyed / sensor does not respond
Spacers are missing / installed in a wrong order	Error in position measurement
Wrong connection of ground / shield	Signal output is disturbed The electronics can be damaged
Use of a magnet that is not specified by MTS Sensors	Error in position measurement

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



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



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.

2.3 Installation, commissioning and operation

The position sensors must be used only in technically safe condition. 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. Do not open or dismantle the sensor.
3. Connect the sensor very carefully and pay attention to the polarity of connections and power supply.
4. Use only approved power supplies.
5. It is indispensable to ensure that the specified permissible limit values of the sensor for operating voltage, environmental conditions, etc. are met.
6. Check the function of the sensor regularly and provide documentation of the checks.
7. 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

MTS Sensors 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 MTS Sensors 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 MTS Sensors 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.
MTS Sensors 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 MTS Sensors. Any shipment cost is the responsibility of the sender [2].
For a corresponding form, see chapter "6. Appendix" on page 18.

2/ See also applicable MTS Sensors sales and delivery on www.mtssensors.com

3. Identification

3.1 Order code of Flexible MH analog

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

a	Sensor model
F M H	Flexible MH

b	Design
A	M33 thread flange, flat end plug
B	M33 thread flange, M4 female plug
Z	Base unit (for replacement)

c	Stroke length
X X X X M	0500…5000 mm (20 mm increments)

d	Pin assignment
M12 connector (VDC - GND - SIG)	
E	M12 connector (E: 2-3-4)
G	M12 connector (G: 1-3-4)
H	M12 connector (H: 1-3-2)

e	Operating voltage
3	+12/24 VDC (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
A 0 1	4…20 mA
A 0 4	20…4 mA

3.2 Order code of Flexible MH CANbus

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
F	**M**	**H**						**M**	**F**	**3**		**0**	**1**			
a			**b**	**c**					**d**	**e**	**f**			**g**	**h**	

a	Sensor model
F **M** **H**	Flexible MH

b	Design
A	M33 thread flange, flat end plug
B	M33 thread flange, M4 female plug
Z	Base unit (for replacement)

c	Stroke length
X **X** **X** **X** **M**	0500…5000 mm (20 mm increments)

d	Pin assignment
M12 connector (VDC - GND - CAN_HI - CAN_LO)	
F	M12 connector (F: 2-3-4-5)

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

f	Output
C **0** **1**	CANopen
J **0** **1**	SAE J1939

g	Baud rate setting
CANopen	
0	1000 kbit/s
1	800 kbit/s
2	500 kbit/s
3	250 kbit/s (default)
4	125 kbit/s
SAE J1939	
3	250 kbit/s (fix setting)

h	Node ID
CANopen	
7 **F**	Node ID (hex): 01…7F (default: 7F)
SAE J1939	
F **D**	Node ID (hex): 01…FD (default: FD)

3.3 Nameplate

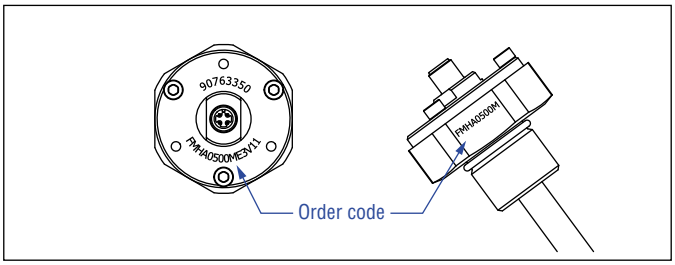


Fig. 1: Example of nameplate

3.4 Scope of delivery

Flexible MH analog/digital:
- Sensor
- O-ring

Flexible MH Sensor Element:
- Sensor element
- Lid
- M5×12 screws (3×)
- M2.5×12 screws (2×)
- Sensor element bracket
- Gasket

4. Product description and commissioning

4.1 Functionality and system design

Product designation
- Position sensor Temposonics® MH-Series

Sensor model
- Temposonics® Flexible MH (rod sensor)

Stroke length
- 500…5000 mm

Output signal
- Analog
- CANopen
- SAE J1939

Principle of operation and system construction
The absolute, linear position sensors provided by MTS Sensors 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.

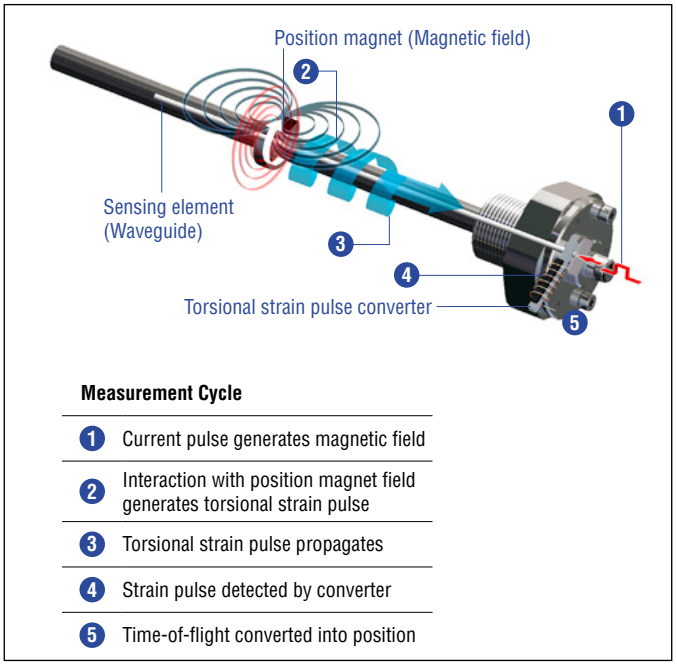
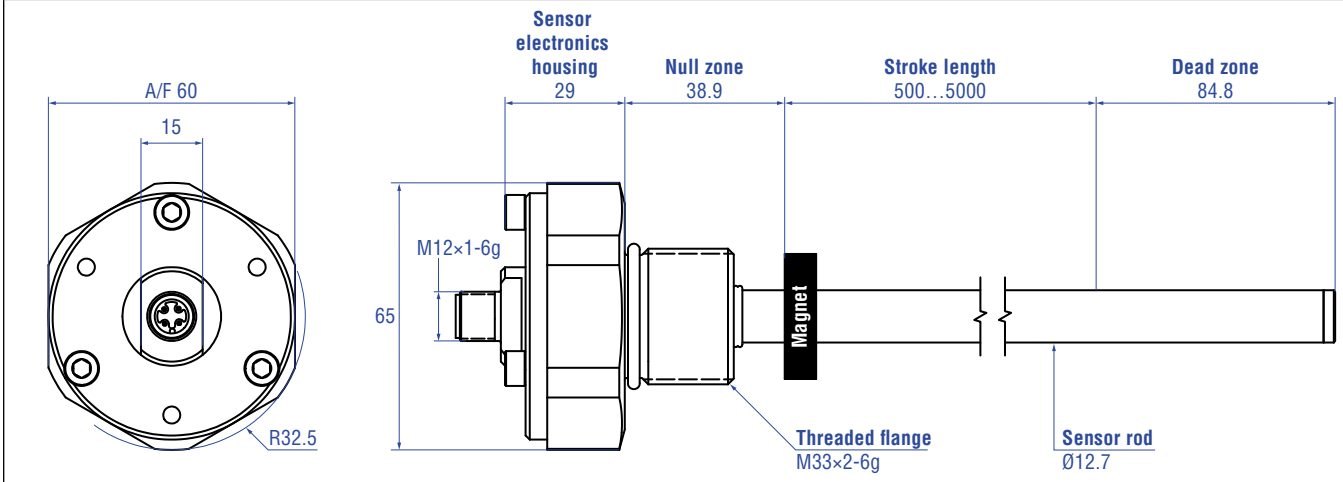


Fig. 2: Principle of operation: Time-based magnetostrictive position sensing principle

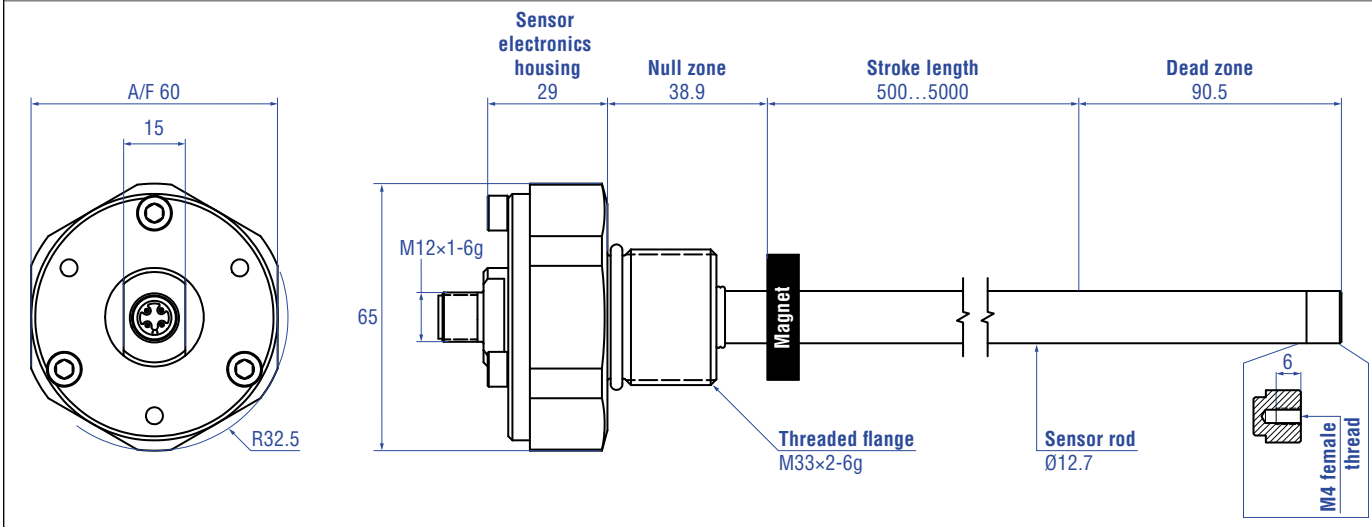
Modular mechanical and electronic construction
- The sensor rod protects the inner sensor element.
- The sensor electronics housing, a rugged stainless steel construction, contains the complete electronic interface with active signal conditioning.
- The external position magnet is a permanent magnet. It travels along the sensor rod and triggers the measurement through the sensor rod wall.
- The sensor can be connected directly to a control system. Its electronics generates a strictly position-proportional signal output between zero and end position.

4.2 Styles and installation of Flexible MH

FMH with flat end plug



FMH with M4 female thread plug



All dimensions in millimeters

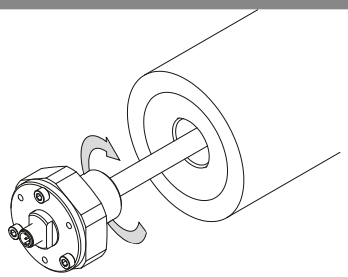
Fig. 3: Temposonics® FMH with ring magnet

Installation of a rod-style sensor in a fluid cylinder

The rod-style version has been developed for direct stroke measurement in a fluid cylinder. Mount the sensor via threaded flange. Use non-magnetic material for mounting support.

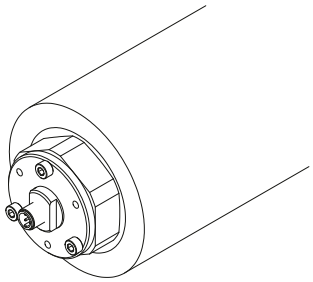
- Mounted on the face of the piston, the position magnet travels over the rod without touching it and indicates the exact position through the rod wall – independent of the hydraulic fluid.
- The pressure resistant sensor rod is installed into a bore in the piston rod.

Step 1



1. Insert sensor into cylinder
   Be careful not to drop or cause impact to the sensor
2. Screw the sensor into the cylinder by hand (< 10 Nm)
3. Stop rotation when sensor is flush with the cylinder
   (do not use much force in step 2. It should screw in smoothly)

Step 2



Tighten sensor to a torque of 310 Nm

Fig. 5: Sensor in fluid cylinder

Hydraulics sealing

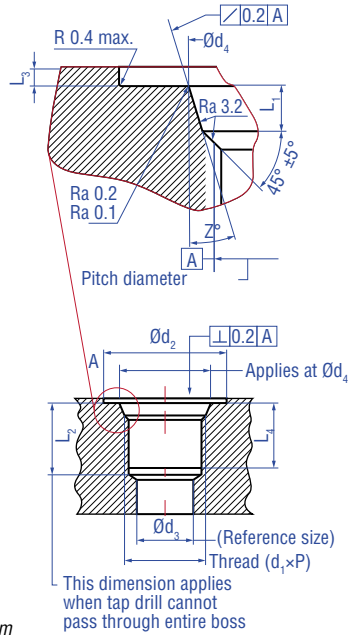
To seal the flange contact surface:
A sealing via an O-ring in the undercut via O-ring 29.6 × 2.9 mm (part no. 561 968)
In the case of threaded flange M33×2-6h, provide a screw hole based on ISO 6149-1. See ISO 6149-1 for further information.

- Note the fastening torque of 310 Nm.
- Seat the flange contact surface completely on the cylinder mounting surface.
- The cylinder manufacturer determines the pressure-resistant gasket (copper gasket, O-ring, etc.).
- The position magnet should not rub on the sensor rod.
- The piston rod drilling
  (Ø 12.7 mm rod: ≥ Ø 16 mm)
  depends on the pressure and piston speed.
- Adhere to the information relating to operating pressure.
- Protect the sensor rod against wear.

Cavity Dimensions

Notice for metric threaded flanges

Thread (d_1×P)	d_2	d_3	d_4 +0.1 0	L_1 +0.4 0	L_2	L_3	L_4	Z° ±1°
M33×2-6g	72	33	35.4	3.1	30	2.5	27	15°



All dimensions in mm

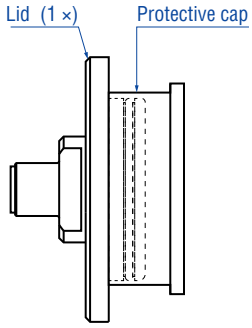
Fig. 4: Cavity dimensions for metric threaded flange M33×2-6h

4.3 Replacement of sensor

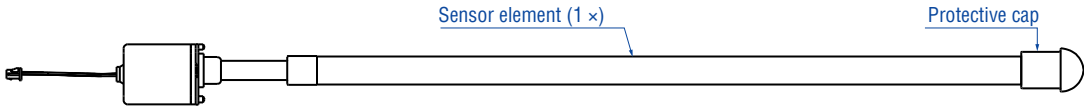
The sensor element of the sensor is replaceable. The sensor can be replaced without interrupting the hydraulic circuit.

4.3.1 FMH replacement parts

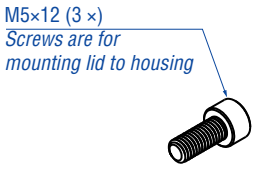
Lid



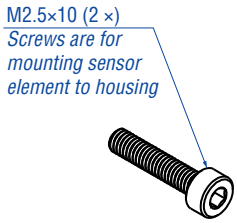
Sensor element



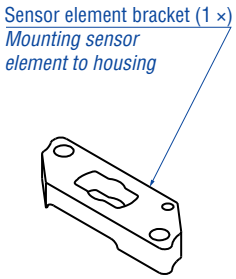
M5×12 screw



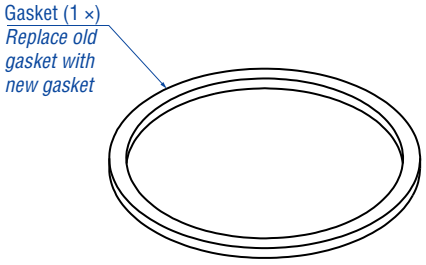
M2×12 screw



Bracket



Gasket



Loctite 242

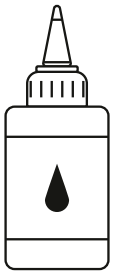
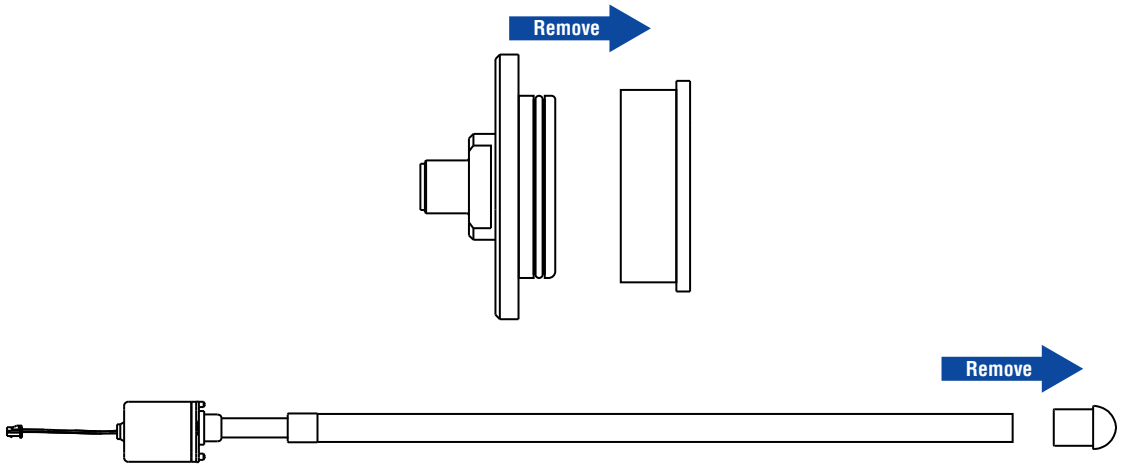


Fig. 6: FMH replacement parts

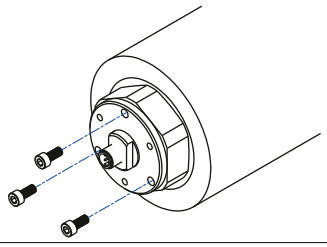
4.3.2 FMH replacement steps

Step 1: Remove endcaps

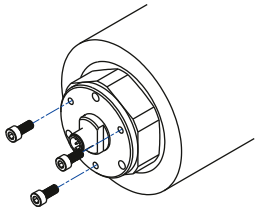


Step 2: Remove lid

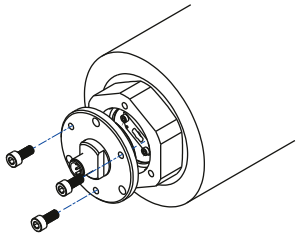
Step 2 A
- Remove three screws (M5×12 mm) with 4 mm hex key



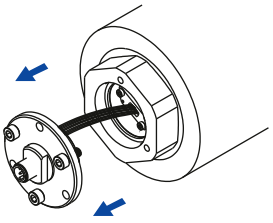
Step 2 B
- Insert screws into threaded holes in lid to aid lid removal



Step 2 C
- Spin screw one in (clockwise) with two rotations
- Spin screw two (any other screw) in (clockwise) with two rotations
- Spin screw three (last, remaining screw) in (clockwise) with two rotations
- Repeat the above steps until all 3 screws are fully inserted



Step 2 D
- Pull lid out from behind flange



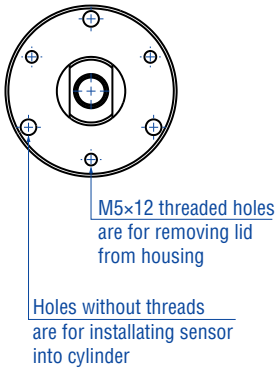
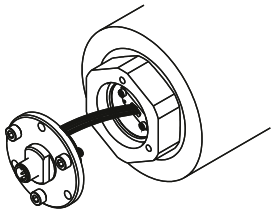


Fig. 7: FMH replacement steps

Step 3: Remove old sensor element

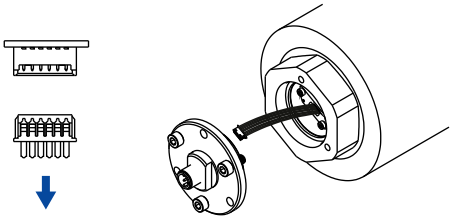
Step 3 A

- Slowly remove lid entirely
- Be careful not to damage PCB or wires



Step 3 B

- Unplug sensor element from PCB in lid
- Pull straight out
- Grip the connector. Do not pull on wires.



Step 3 C

- Remove the M2.5×10 mm screws with 1.5 mm hex key or #1 Phillips (cross)
- Remove sensor element
- Take care not to bend sensor element (< 200 mm)

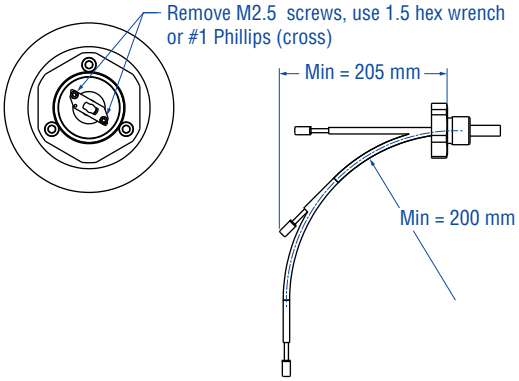
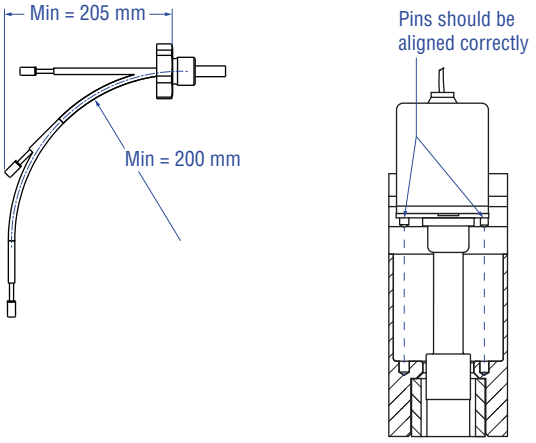


Fig. 8: FMH replacement steps

Step 4: Install new sensor element

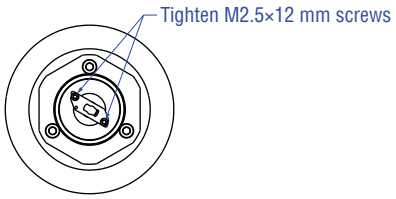
Step 4 A

- Insert new sensor element into sensor cavity
- be careful not to bend the sensor element more than 200 mm radius



Step 4 B

- Apply one drop of Loctite 242 to each screw thread
- Tighten sensor screws (M2.5×10 mm) to 0.27 Nm (±0.06 Nm) with 1.5 mm hex key or #1 Phillips (cross)



Step 4 C

- Plug wires from sensor element into PCB

Step 4 D

- Unscrew all three M5×12 mm screws, with 4 mm hex key from lid save screws for step 5 B

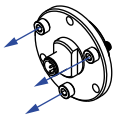
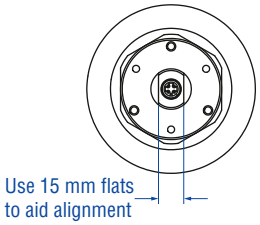


Fig. 9: FMH replacement steps

Step 5: Install lid

Step 5 A

- Insert lid into sensor cavity
- Align the lid through holes with the sensor cavity threaded holes



Step 5 B

- Apply Loctite 242 to each screw
- Insert M5×12 mm screws into lid through holes
- Screw all three screws to housing's threads torque M5 screws to 5.9 Nm (±0.3 Nm) with 4 mm hex key

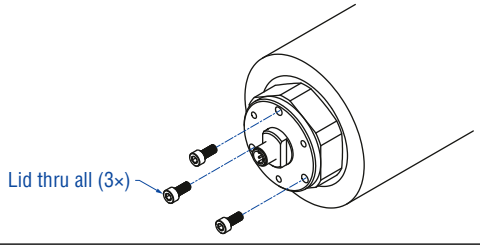


Fig. 10: FMH replacement steps

4.4 Electrical connections

Placement of installation and cabling have decisive influence on the sensor's electromagnetic compatibility (EMC). Hence correct installation of this active electronic system and the EMC of the entire system must be ensured by using suitable metal connectors, shielded cables and grounding. Overvoltages or faulty connections can damage its electronics despite protection against wrong polarity.

NOTICE

1. Do not mount the sensors in the area of strong magnetic or electric noise fields.
2. Never connect / disconnect the sensor when voltage is applied.

Instructions for connection

- Use low-resistant twisted pair and shielded cables. Connect the shield to ground externally via the controller equipment.
- Keep control and signal leads separate from power cables and sufficiently far away from motor cables, frequency inverters, valve lines, relays, etc..
- Use only connectors with metal housing and connect the shielding to the connector housing.
- Keep the connection surface at both shielding ends as large as possible. Connect the cable clamps to function as a ground.
- Keep all non-shielded leads as short as possible.
- Keep the earth connection as short as possible with a large cross section. Avoid ground loops.
- With potential differences between machine and electronics earth connections, no compensating currents are allowed to flow across the cable shielding.
  Recommendation:
  Install potential compensating leads with large cross section, or use cables with separate double shielding, and connect only one end of the shield.
- Use only stabilized power supplies in compliance with the specified connecting values.

Analog output

M12 connector

View on connector

Pin	E	G	H
1	do not connected	VDC	VDC
2	VDC	do not connected	SIG
3	GND	GND	GND
4	SIG	SIG	do not connected

Fig. 11: Connector wiring analog

CANbus output

M12 connector

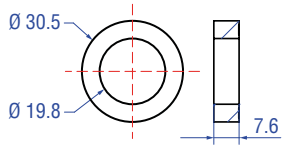
View on connector

Pin	F
1	not connected
2	VDC
3	GND
4	CAN_H
5	CAN_L

Fig. 12: Connector wiring digital

4.5 Frequently ordered accessories

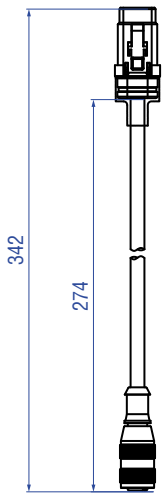
Position magnets



Ring magnet
Part no. 402 316

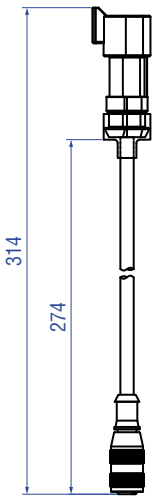
Material: PA ferrite coated
Weight: ca. 13 g
Operating temperature: -40…+100 °C
Surface pressure: 20 N/mm²

Cord sets and adapter cables



4 pin M12 to DTM06 connector
Part no. 254 597

M12 connector: Brass/Nickel
DT connector: DTM06 3 pin
Material: PVC Jacket
Cable length: 275 mm
Cable Ø: 5 mm
Operating temperature:
–40…+105 °C



4 pin M12 to DT04 connector
Part no. 254 600

M12 connector: Brass/Nickel
DT connector: DT04 3 pin
Material: PVC Jacket
Cable length: 275 mm
Cable Ø: 5 mm
Operating temperature:
–40…+105 °C

Test kits

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

MH test kit (digital) for US
Part no. 253 879

- USB CAN-Modul Kit:
  - USB CAN-Modul
  - USB CAN-Modul Utility CD (driver & manual)
- USB cable
  cable with MTS M12 connector and RS232 connector
- cable with RS232 connector
- carrying case
- 12 VDC power supply

MH test kit (digital) for EU / Asia
Part no. 254 267

- USB CAN-Modul Kit:
  - USB CAN-Modul
  - USB CAN-Modul Utility CD (driver & manual)
- USB cable
  cable with MTS M12 connector and RS232 connector
- cable with RS232 connector
- carrying case
- 12 VDC power supply

Controlling design dimensions are in millimeters

5. Technical data

5.1 Technical data Flexible MH-Series analog

Output		
Signal characteristic	Analog output restricted by noise or A/D converter of control unit	
Voltage	0.25…4.75 VDC / 0.5…4.5 VDC	
Current	4…20 mA	
Sample rate	2 ms	
Measured value	Position	
Measurement parameters		
Resolution	±0.2 mm	
Linearity	±0.04 % (F.S.)	
Repeatability	±0.005 % (F.S.)	
Hysteresis	±0.2 mm	
Operating conditions		
Operating temperature	–40…+105 °C	
Humidity	90 % rel. humidity, no condensation	
Ingress protection	IP67 / IP69K (with appropriate mating connection)	
Shock test	IEC 60068-2-27, 100 g (6 ms) single shock, 50 g (11 ms) at 1000 shocks per axis	
Vibration test	IEC 60068-2-64, 2 g (5…2000 Hz)	
EMC test & evaluation	ISO16750-2:2010 ISO 14982:2009 - Agricultural and forestry machinery ISO 13766:2006 - Earth-moving machinery EN 13309:2010 - Construction machinery RF immunity to 200 V/m per ISO 11452-2/-4	
Mounting position	Any	
Pressure (according to DIN EN ISO 19879)*		
PN (nominal operating)	350 bar	
P_{MAX} (max. overload)	450 bar	
P_{STATIC} (proof pressure)	625 bar	
Design / Material		
Sensor electronics housing	Stainless steel 1.4305 (AISI 303)	
Sensor rod with flange	Stainless steel 1.4306 (AISI 304L)	
Stroke length	500…5000 mm	
Electrical installation		
Connection type	M12 male plug	
Operating voltage	**12 VDC (tolerance range 8…32 VDC)**	**24 VDC (tolerance range 8…32 VDC)**
Current consumption	Typ. ≤ 100 mA	Typ. ≤ 50 mA
Load (output VDC)	$R_L \geq 10$ kΩ	$R_L \geq 10$ kΩ
Load current (output VDC)	Typ. 1 mA	Typ. 1 mA
Loud (output mA)	$R_L \leq 250$ Ω	$R_L \leq 500$ Ω
Inrush current	Max. 2.5 A/2 ms	Max. 4.5 A/2 ms
Supply voltage ripple	< 1 % $_{PP}$	
Power drain	< 1 W	
Over voltage protection (GND-VDC)	Up to +36 VDC	
Polarity protection (GND-VDC)	Up to –36 VDC	
Insulation Resistance	R ≥ 10 MΩ @ 60 sec	
Electric strength	500 VDC (DC GND to chassis GND)	

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

Cycles	**Ø 12.7 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

5.2 Technical data Flexible MH-Series CANbus

Output		
Interface	CANopen / SAE J1939	
Sample rate	CANopen: 1 ms; SAE J1939: 20 ms	
Measured value	Position	
Measurement parameters		
Resolution	±0.2 mm	
Linearity	±0.04 % (F.S.)	
Repeatability	±0.005 % (F.S.)	
Hysteresis	±0.2 mm	
Operating conditions		
Operating temperature	–40…+105 °C	
Humidity	90 % rel. humidity, no condensation	
Ingress protection	IP67 / IP69K (with appropriate mating connection)	
Shock test	IEC 60068-2-27, 100 g (6 ms) single shock, 50 g (11 ms) at 1000 shocks per axis	
Vibration test	IEC 60068-2-64, 2 g (5…2000 Hz)	
EMC test	ISO16750-2:2010 ISO 14982:2009 - Agricultural and forestry machinery ISO 13766:2006 - Earth-moving machinery EN 13309:2010 - Construction machinery RF immunity to 200 V/m per ISO 11452-2/-4	
Mounting position	Any	
Pressure (according to DIN EN ISO 19879)*		
PN (nominal operating)	350 bar	
P_{MAX} (max. overload)	450 bar	
P_{STATIC} (proof pressure)	625 bar	
Design / Material		
Sensor electronics housing	Stainless steel 1.4305 (AISI 303)	
Sensor rod with flange	Stainless steel 1.4306 (AISI 304L)	
Stroke length	500…5000 mm	
Electrical installation		
Connection type	M12 male plug	
Operating voltage	**12 VDC (tolerance range 8…32 VDC)**	**24 VDC (tolerance range 8…32 VDC)**
Current consumption	Typ. ≤ 100 mA	Typ. ≤ 50 mA
Inrush current	Max. 1.0 A @ 2 ms	Max. 1.5 A @ 2 ms
Bus termination (HI-LO)	120 Ω	
Supply voltage ripple	< 1 % p-p	
Power drain	< 1.5 W	
Over voltage proctection (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)	
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 12.7 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. 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.

MTS Sensors order number: _____ Sensor type(s): _____

Serial number(s): _____ Sensor length: _____

The sensor has been in contact with the following materials:

Don't 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 MTS Sensors to determine measures to be taken before shipment.

Short description of malfunction:

Corporate information

Company: _____

Address: _____

_____

Contact partner

Name: _____

Phone: _____

E-Mail: _____

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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