

# Temposonics®

Magnetostrictive Linear Position Sensors

## MH-Series MS Analog/Digital Data Sheet

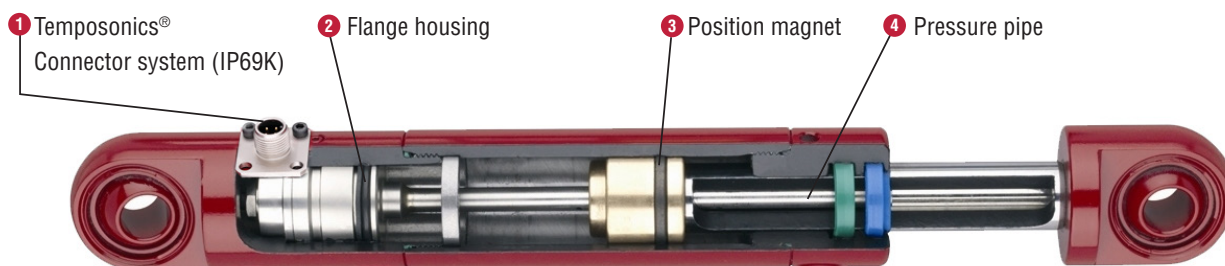
- Smallest magnetostrictive Sensor for Mobile Hydraulics
- Analog output up to 2,500 mm
- Digital output up to 1,500 mm

**NOW WITH  
DIGITAL OUTPUT  
AVAILABLE!**



## 1. Product description and technology

Temposonics® sensors can be used in versatile mobile machines without any restriction and replace contact-based linear sensors like potentiometers. Highly dynamic systems are controlled safely by means of Temposonics® sensors, thus enhancing the productivity, availability and quality of the working process of the machine. Insensitive to vibration, shocks, dust and weathering influence and electro-magnetic disturbances. Temposonics® MH Series sensors are successfully used in front axle and articulated frame steering cylinders, hydraulic jacks and in steering systems for hydraulic units on agricultural and construction machinery.



### Simple Mechanics

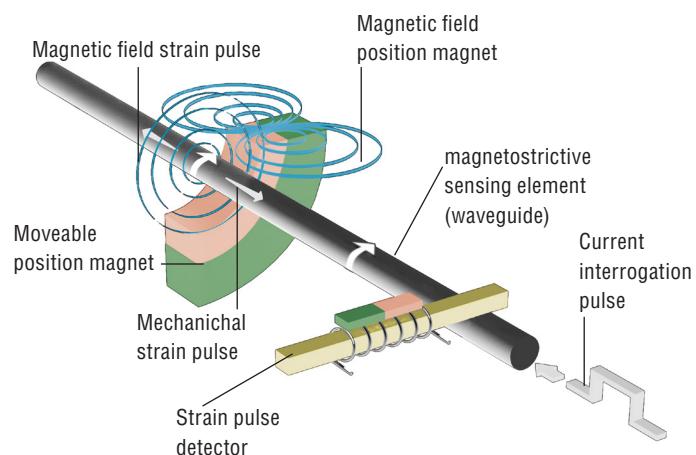
The extremely robust sensor consists of the following main parts:

- 1 The innovative connector system which is easy to install in a few seconds, any soldering or crimping needless, dust-and waterproof up to IP69K.
- 2 The flange housing with built-in electronics and signal converter.
- 3 The position magnet as only moving part, which is assembled into the piston bottom. This permanent magnet travels wear-free and contactless along the pressure pipe and measures the actual position.
- 4 The pressure pipe placed within the drilled piston rod contains the protected magnetostrictive sensing element.

### Magnetostriction

Temposonics® linear sensors are based on the magnetostrictive technology. By measuring the actual position with a non-contact position magnet the sensor operates 100% wear-free. The absolute operating principle enables reliable readings without any reference point or recalibration. A mechanical strain pulse is triggered by the travelling position magnet. The runtime of this ultrasonic wave is measured precisely and compiled into standard electronic output signals.

### Measurement principle

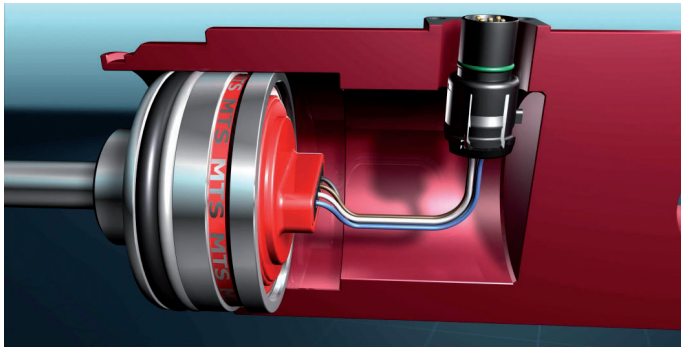


- Due to small dimensions MH sensors require only little space
- Suitable for operating pressures up to 350 bar
- Unaffected by surrounding media such as ageing or foaming oil
- Insensitive to shock and vibration
- Designed for all current supply voltages (12/24 VDC)
- Temposonics® sensors offer all common used output signals:
  - Analog: VDC/mA
  - Bus protocols: CANopen, SAE J1939

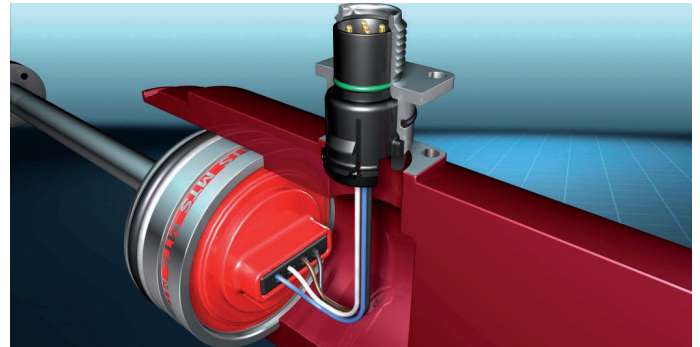
## 2. Temposonics® connector system M12

### MTS presents the innovative connector system for Temposonics® MH-Series

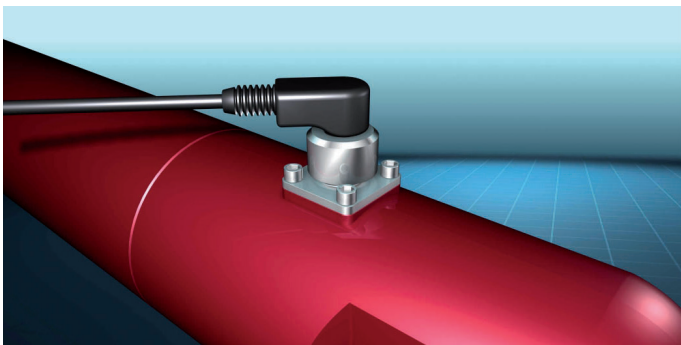
The Temposonics® Connector System meets the highest protection requirements important for a harsh environment in mobile hydraulic applications. Protection type IP69K performs water and dust proof. In addition it is even resistive against high pressure water cleaning.



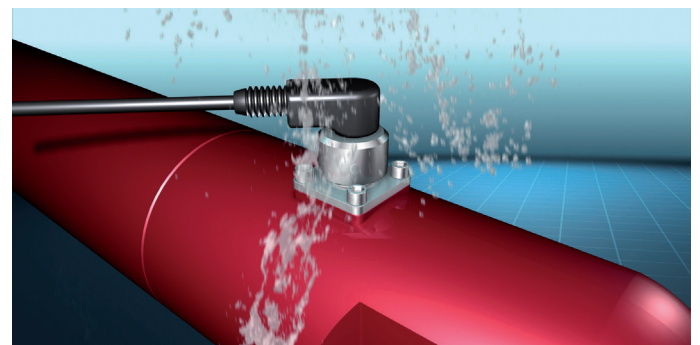
- 1 The MH sensor is delivered by MTS together with the new connector system:  
The connector insert carrier is already connected to the sensor conductors, i.e. no soldering, any colour or connection mistake.



- 2 The connector insert is taken out of the cylinder through a bore hole. The flange can easily be clicked in position from outside.



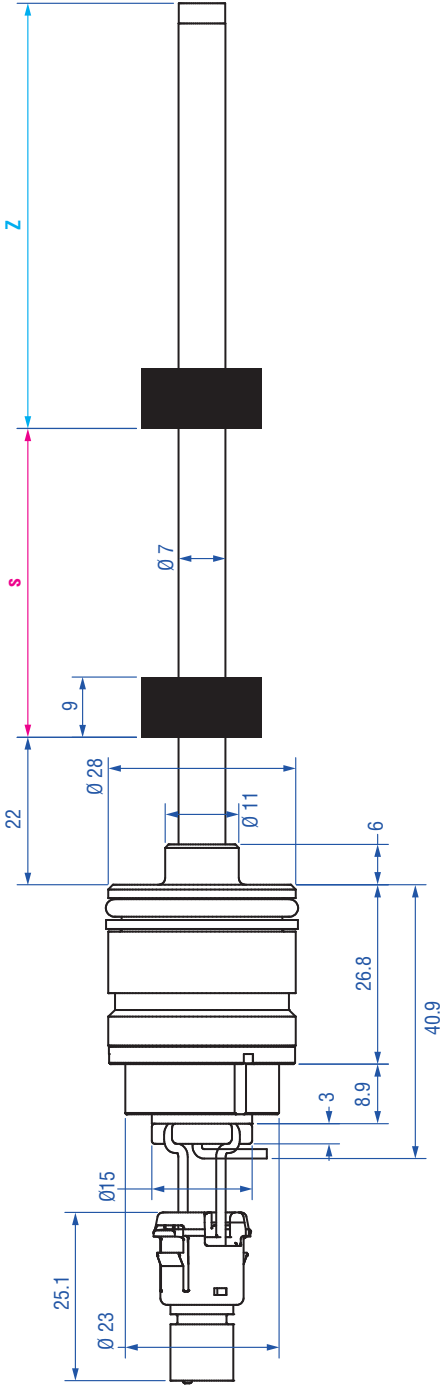
- 3 Four standard screws must be tightened to mount the connector system on the cylinder. In case of using angled type connectors the connector insert can be rotated inside the flange in 45° steps.



- 4 With a corresponding mating plug the connector system fulfills an IP rating of IP69K.

- Absolutely easy and safe installation.
- No brazing or crimping of connecting leads is required.

### 3. Dimensions MS-Sensor with M12 connector



**Mechanical configurations**

<b>Form factor</b>	<b>D</b> Z = 63.5 mm (s ≤ 2500 mm*), Ø 7 mm pressure pipe
	<b>F</b> Z = 36.5 mm (s ≤ 1200 mm), Ø 7 mm pressure pipe
<b>Stroke range</b>	<b>s</b> 0050...2500 mm (in 5 mm steps)*
<b>Wire length</b>	<b>w</b> 60...240 mm (in 20 mm steps)

**Model no.** MS **D** - **1** **5** **0** **0** **M** - **N** **1** **2** **G** - **3** - **V12** V11  
A01  
C01 4 7F  
J01 3 FD

**F** H F

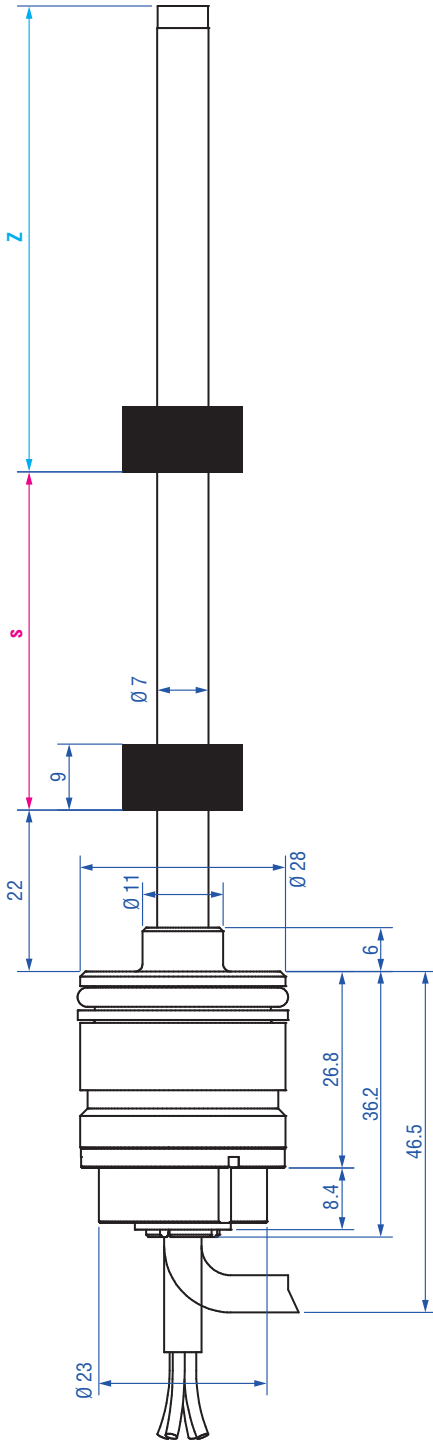
e.g.: s = 1500 mm  
e.g.: w = 120 mm

**Electrical configurations**

<b>MH Analog</b>	<b>G</b> 1 = VDC 3 = GND 4 = Sig 2 = n.c.
	<b>H</b> 1 = VDC 2 = Sig 3 = GND 4 = n.c.
<b>MH Digital</b>	<b>F</b> 2 = VDC 3 = GND 4 = CAN HI 5 = CAN LO 1 = n.c.
	<b>A01</b> 4...20 mA
<b>MH Analog</b>	<b>V12</b> 0.5...4.5 VDC
<b>MH Digital</b>	<b>C01</b> CANopen
	<b>J01</b> SAE J1939
<b>Baudrate</b>	<b>3</b> 250 kbit/sec
	<b>4</b> 125 kbit/sec
<b>Node ID</b>	<b>7F</b> hex
	<b>FD</b> hex

All dimensions in mm  
\*Note: Digital output only up to 1500 mm stroke range  
Please see detailed model configuration on page 11 and 13.

### 3.1 Dimensions MS-Sensor with cable



#### Mechanical configurations

<b>Form factor</b>	<b>D</b> Z = 63.5 mm (s ≤ 2500 mm), Ø 7 mm pressure pipe
	<b>F</b> Z = 36.5 mm (s ≤ 1200 mm), Ø 7 mm pressure pipe
<b>Stroke range</b>	<b>s</b> 0050...2500 mm (in 5 mm steps)*
<b>Wire length</b>	<b>w</b> 300...9000 mm (in 100 mm steps)

**Model no.** MS **D** - **1** **5** **0** **0** **M** - **T** **1** **0** **A** - **3** - **V12** **V11**  
**F** **A01**  
**C01** **2** **7F**  
**J01** **4** **FD**  
 e.g.: s = 1500 mm  
 e.g.: w = 1000 mm

#### Electrical configurations

<b>MS Analog</b>	<b>BN</b> = VDC <b>WH</b> = GND <b>GN</b> = Sig
<b>MS Digital</b>	<b>A</b> <b>BN</b> = VDC <b>WH</b> = GND <b>GN</b> = CAN LO <b>YE</b> = CAN HI
<b>MS Analog</b>	<b>A01</b> 4...20 mA
	<b>V12</b> 0.5...4.5 VDC
<b>MS Digital</b>	<b>C01</b> CANopen
	<b>J01</b> SAE J1939
<b>Baudrate</b>	<b>2</b> 500 kbit/sec
	<b>4</b> 125 kbit/sec
<b>Node ID</b>	<b>7F</b> hex
	<b>FD</b> hex

All dimensions in mm

Please see detailed model configuration on page 11 and 13.

\*Note: Digital output only up to 1500 mm stroke range

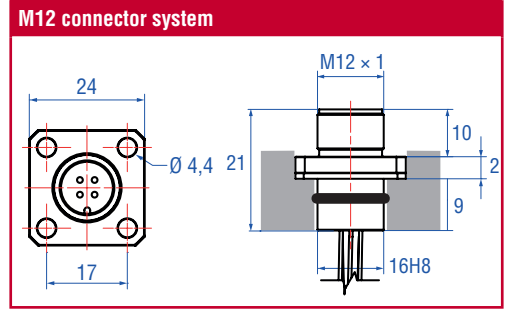
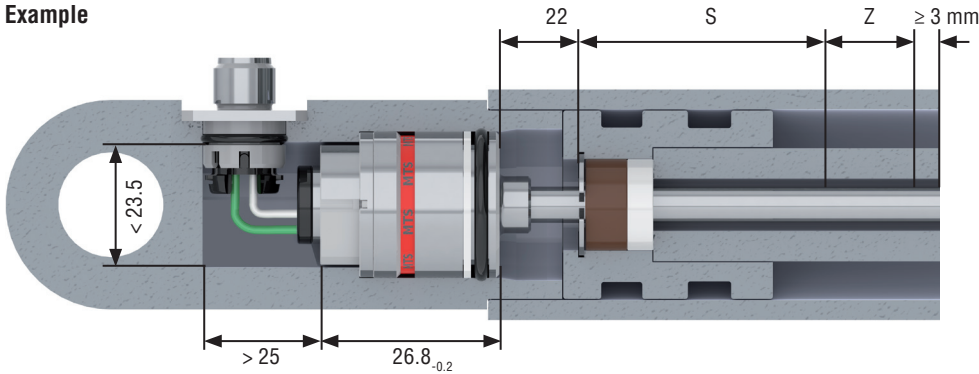
## 4. In Cylinder assembly

### Mechanical installation

The robust Temposonics® model MH sensor is designed for direct stroke measurement in hydraulic cylinders.

The Temposonics® MH sensor can be installed from the head side or the rod side of the cylinder depending on the cylinder design.

### Example

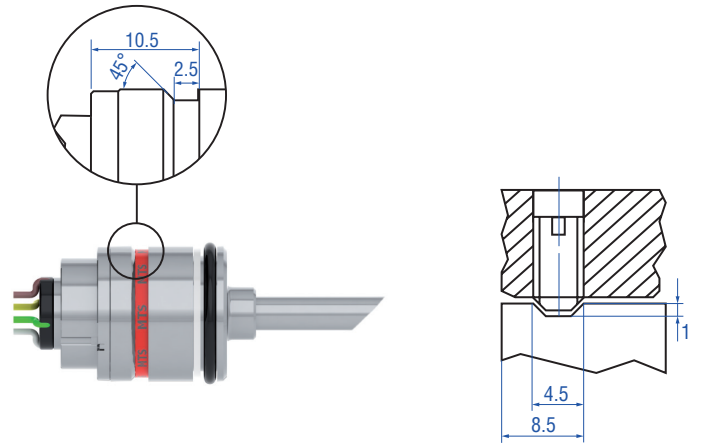


### Sensor installation

The method of installation is entirely dependent on the cylinder design.

While the most common method of installation is from the rod side of the cylinder, an installation from the head side of the cylinder is also possible.

In both installation methods, the hermetic sealing of the cylinder is given by an O-ring with additional back up ring.



Flange housing with O-ring and back-up ring

e.g. retaining with set screw  
DIN 913 M5 x 10 (with flat point!)  
max. torque 0.5 Nm

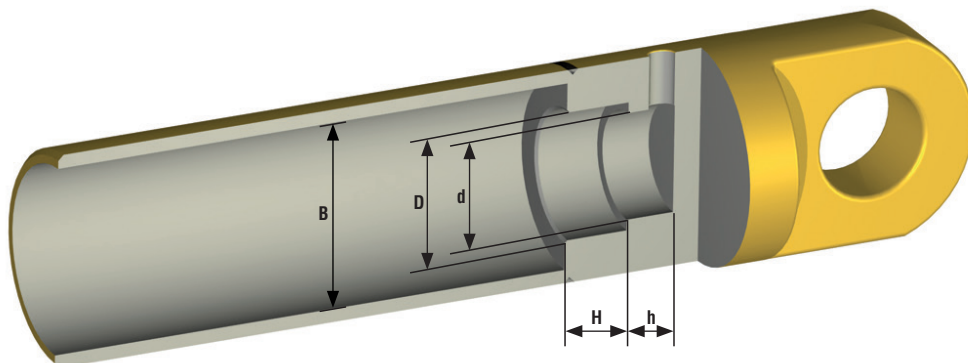
### Please pay attention:

- The position magnet shall not touch the pressure pipe.
- Piston rod drilling:  
Depth:  $S + Z + 3$  mm  
Diameter:

**Pressure Pipe**  $\varnothing 7$

**Drilling**  $\varnothing 10$

- Do not exceed operating pressure.



Type	B - $\varnothing$ Cylinder	D - $\varnothing$ min.	H - Depth	d - $\varnothing$ min.	h - Depth
MS	$\geq 32$	28H7 screwed 28G7 welded	$26.8^{+0.2}$	23.5	$< 25$

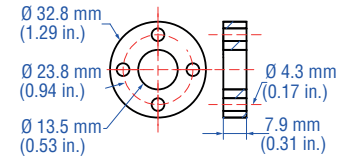
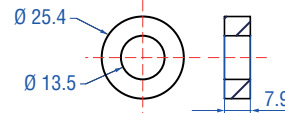
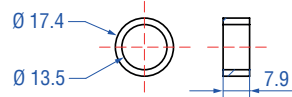


Please pay attention to installation manual!

All dimensions in mm

## 4.1. Position magnets

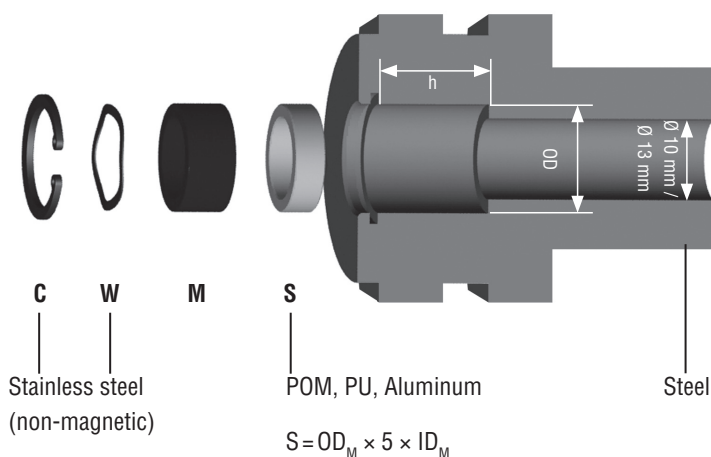
Position magnets (please order separately)



Part no.	401 032	400 533	201 542-2
<b>Dimensions</b>			
OD <sub>M</sub>	17.4 mm	25.4 mm	32.8 mm
ID <sub>M</sub>	13.5 mm	13.5 mm	13.5 mm
Height	7.9 mm	7.9 mm	7.9 mm
<b>Characteristics</b>			
Material	PA neobond	PA ferrite	PA ferrite
Weight	ca. 5 g	ca. 10 g	ca. 14 g
Operating temperature	-40...+100 °C	-40...+100 °C	-40...+100 °C
Surface pressure*	max. 20 N/mm <sup>2</sup>	max. 40 N/mm <sup>2</sup>	max. 40 N/mm <sup>2</sup>
Fastening torque for M4 screws	-	-	max. 1 Nm

\*max. mechanical burden, e.g. by circlip, lock washers etc.

## 4.2. Magnet assembly in piston



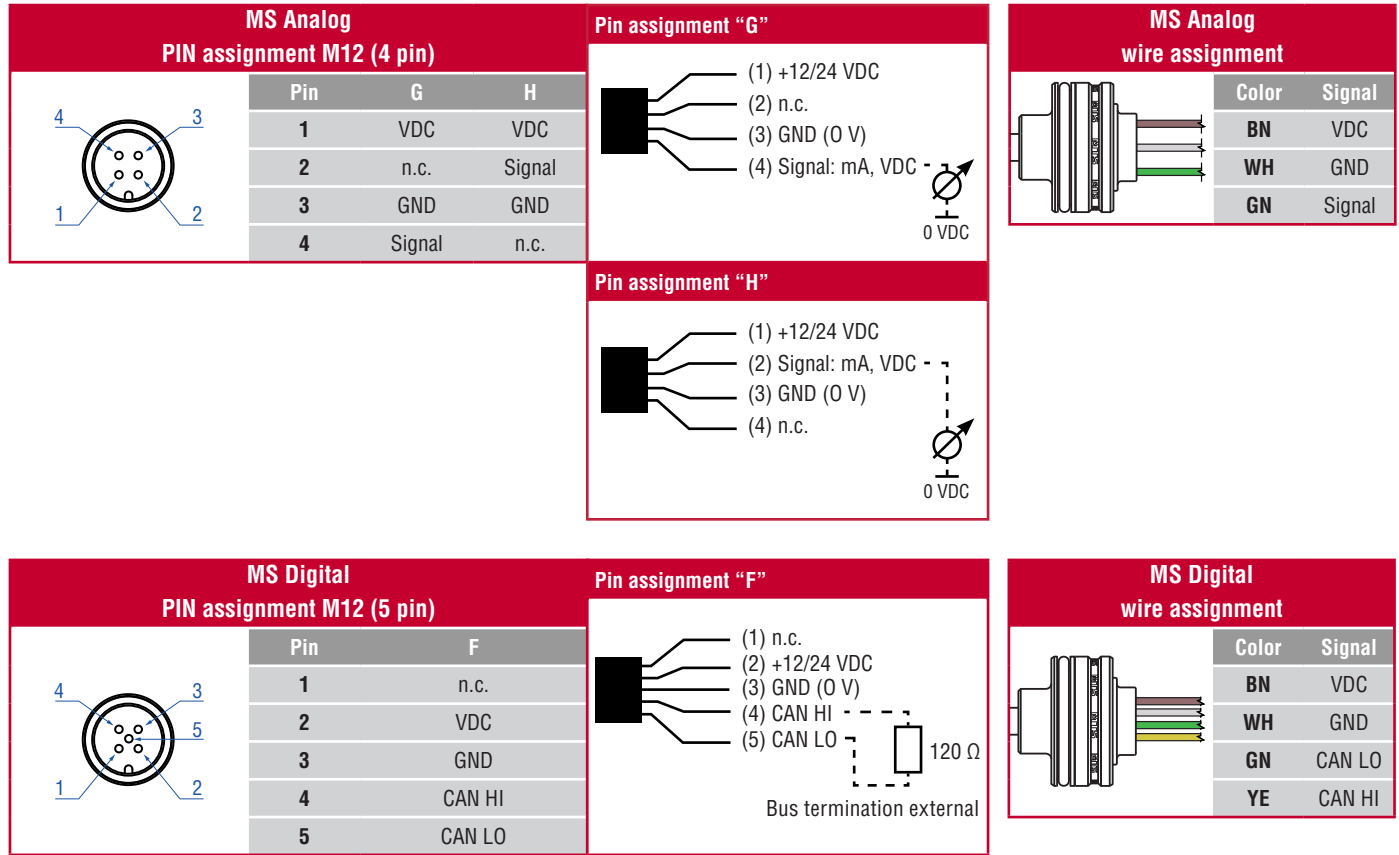
Pressure pipe	Ø 7
Piston rod drilling (min.)	Ø 10

Magnet (M)	401 032	400 533	201 542-2
OD	17.5 mm <sup>+0.2</sup>	25.5 mm <sup>+0.2</sup>	32.9 mm <sup>+0.2</sup>
h - Depth	13.5 mm	13.5 mm	13.5 mm



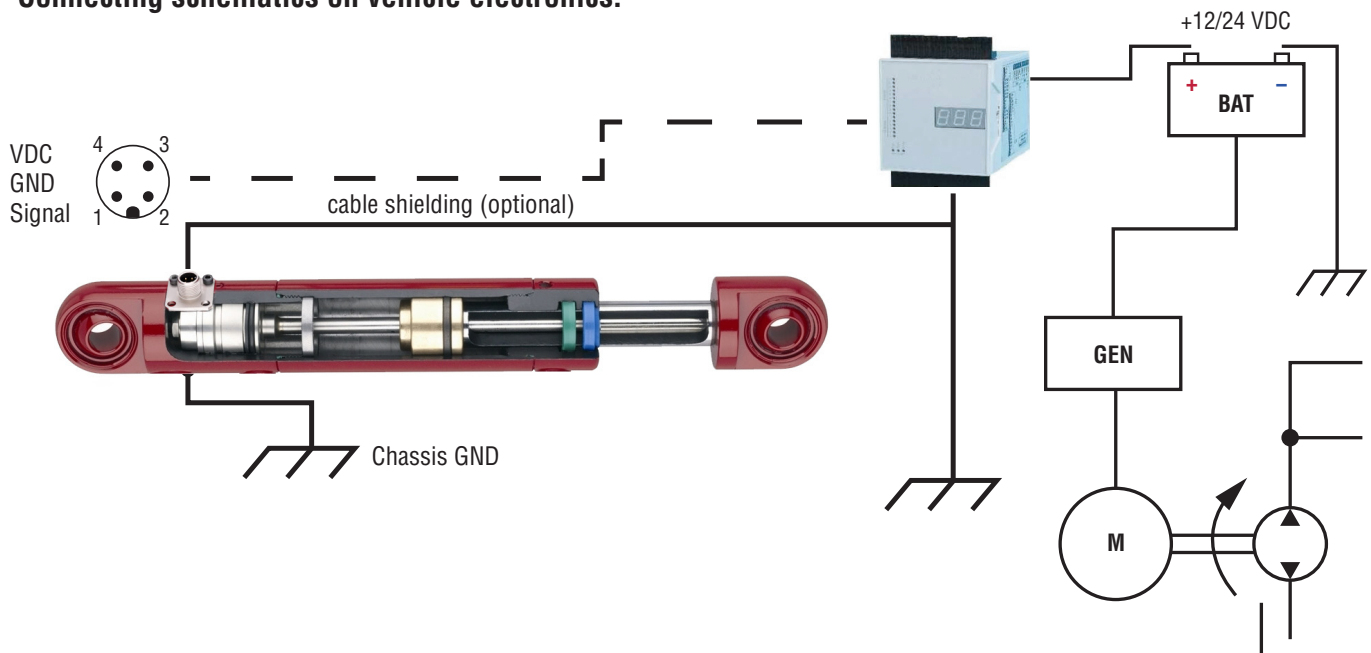
Please pay attention to installation manual!

## 5. Electrical installation



Please pay attention to installation manual!

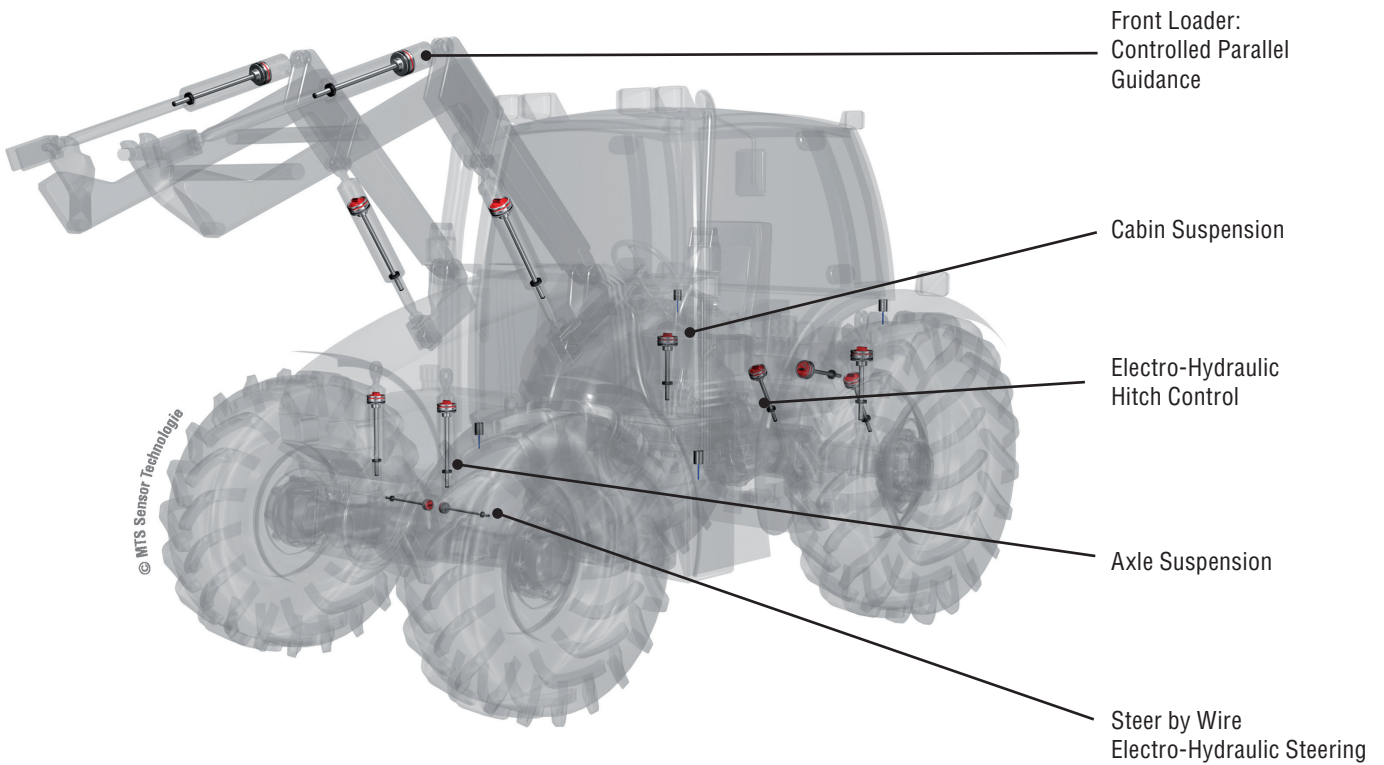
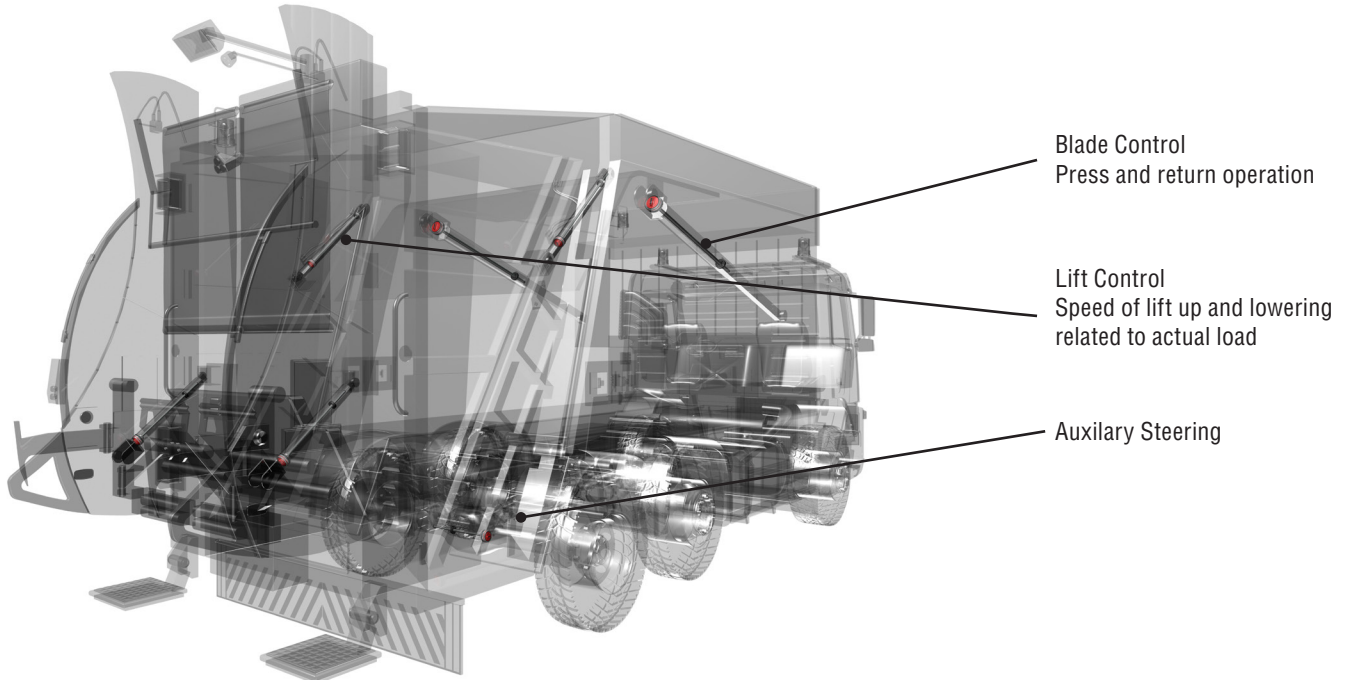
### Connecting schematics on vehicle electronics:



All dimensions in mm



## Typical Applications for Linear Motion Control in hydraulic cylinders



## 6.1 MS Analog: Technical data

Input		
Measured value	Position	
Stroke range	50...2500 mm (in 5 mm steps)	
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	
Resolution	Typ. 0.1 mm	
Power up time	Typ. 250 ms	
Mounting zone	22 mm	
Damping	36.5 / 63.5 mm	
Accuracy		
Linearity	0050...0250 mm $\leq \pm 0.1$ mm, 0255...2000 mm $\pm 0.04$ % (F.S.), 2005...2500 mm $\leq \pm 0.8$ mm	
Repeatability	$\pm 0.1$ mm	
Internal sample rate	2 ms	
Setpoint tolerance	$\leq 1$ mm	
Operating conditions		
Mounting position	Any	
Operating temperature electronics	-40...+105 °C	
Storage temperature	-25...+ 65 °C	
Fluid temperature	-30...+ 85 °C	
Dew point, humidity	EN60068-2-30, 90 % rel. humidity, no condensation	
Pressure		
Operating pressure ratings	Pressure impulse test according DIN EN ISO 19879	
Pressure Pipe	Ø 7 mm	
Nominal operating pressure (P <sub>N</sub> )	300 bar	
Max. overload pressure in cylinder (P <sub>MAX</sub> )	400 bar	
Max. static proof pressure in cylinder (P <sub>PROOF</sub> )	525 bar	
IP rating		
M12 connector	EN60529 (IP69K) when plugged	
Sensor housing	EN60529 (IP67)	
Environmental testing		
Shock test	IEC 60068-2-27, 100 g (11 ms) single shock, 50 g (11 ms) at 1000 shocks per axis	
Vibration test	IEC 60068-2-64, 15 g (r.m.s.) Ø 7 mm pressure pipe (10...2000 Hz) – resonance frequencies excluded	
EMC test & evaluation	ISO 14982 Agricultural and forest machines EN 13309 Construction machines Immunity: ISO 11452-2 (200 V/m Antenna), ISO 11452-4 (200 mA BCI) Emissions: CISPR 16 Transiente Impulses: ISO 7637-2 E.S.D.: ISO/TR 10605	
Materials and dimensions		
Pressure pipe	Stainless steel 1.4306 / AISI 304L	
Housing	Stainless steel 1.4305 / AISI 303	
Sealing	O-ring 23.47 x 2.62 mm NBR; Backup Ring 28 x 2 x 1.4 mm, Parker Parbaks 8-119 N1444-90 or 8-119 N0300-90	
M12 connector insert	Material: polyamide reinforces; O-ring 7 x 1.35 mm NBR 70; pins: brass with gold plated pins	
M12 flange	Brass nickel-plated with O-ring 13 x 1.6 NBR 70	
Electrical installation		
Connector	M12 male plug or cable assembly	
Supply voltage	<b>12 VDC (8...32 VDC)</b>	<b>24 VDC (8...32 VDC)</b>
Current consumption	Typ. $\leq 100$ mA	Typ. $\leq 50$ mA
Load (output VDC)	$R_L \geq 10$ kΩ	$R_L \geq 10$ kΩ
Load current (output VDC)	Typ. 0.5 mA	Typ. 0.5 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	$< 1$ % p-p	
Power drain	$< 1$ W	
Over voltage protection (GND-VDC)	Up to +36 VDC	
Polarity protection (GND-VDC)	Up to -36 VDC	
Insulation Resistance	$R \geq 10$ MΩ @ 60 sec	
Electric strength	500 VDC (DC GND to chassis GND)	

## Temposonics® Model configurator

<b>M</b>	<b>S</b>							<b>3</b>		
<b>a</b>	<b>b</b>	<b>c</b>			<b>d</b>			<b>e</b>	<b>f</b>	
<b>a Sensor model</b>										
<b>M</b>	<b>S</b>	Flange housing Ø 28 mm								
<b>b Form factor</b>										
<b>D</b>	≤ 2500 mm, Pressure pipe Ø 7 mm, Damping: 63.5 mm									
<b>F</b>	≤ 1200 mm, Pressure pipe Ø 7 mm, Damping: 36.5 mm									
<b>c Stroke range (mm)</b>										
				0050...2500 mm (in 5 mm steps)						
<b>d Electrical wiring</b>										
<b>M12 connector (VDC – GND – SIG) incl. M12 flange</b>										
<b>N</b>			<b>G</b>	4 pin (1-3-4), 60...240 mm cable length (in 20 mm steps)			<i>Examples M12 connector</i>			
<b>N</b>			<b>H</b>	4 pin (1-3-2), 60...240 mm cable length (in 20 mm steps)			<i>N08G = 080 mm</i>			
<b>Cable assembly</b>										
<b>T</b>			<b>A</b>	300...9000 mm cable length (in 100 mm steps)			<i>Example cable length</i>			
<b>e Supply voltage</b>										
<b>3</b>	+12 / 24 VDC									
<b>f Output</b>										
<b>V</b>	<b>1</b>	<b>1</b>	0.25...4.75 VDC							
<b>V</b>	<b>1</b>	<b>2</b>	0.5...4.5 VDC							
<b>A</b>	<b>0</b>	<b>1</b>	4...20 mA							

**Scope of delivery:**  
Position sensor, O-ring, backup-ring, M12 connector system (optional)

**Please order position magnets separately!**

## 6.2 MS Digital: Technical data

Input		
Measured value	Position and velocity	
Stroke range	50...1500 mm (in 5 mm steps)	
Velocity range	0...1000 mm/s	
Output		
Signal characteristic	Bus-protocol: SAE J1939, CANopen protocol according to CiA DS-301 V4.1, device profile DS-406 V3.1	
Resolution (position)	0.1 mm	
Resolution (velocity)	1 mm/s	
Boot up time	Typ. 400 ms	
Cycle time	CANopen: 1 ms SAE J1939: 20 ms	
Mounting zone	22 mm	
Damping	36.5 / 63.5 mm	
Accuracy		
Linearity	0050...0250 mm $\leq \pm 0.1$ mm, 0255...1500 mm $\pm 0.04$ % (F.S.)	
Hysteresis	$\pm 0.1$ mm	
Internal sample rate	1 ms	
Setpoint tolerance	$\pm 0.2$ mm	
Operating conditions		
Mounting position	Any	
Operating temperature electronics	-40...+105 °C	
Storage temperature	-25...+ 65 °C	
Fluid temperature	-30...+ 85 °C	
Dew point, humidity	EN60068-2-30, 90 % rel. humidity, no condensation	
Pressure		
Operating pressure ratings	Pressure impulse test according to DIN EN ISO 19879	
Pressure Pipe	Ø 7 mm pressure pipe	
Nominal operating pressure (PN)	300 bar	
Max. overload pressure in cylinder (P <sub>MAX</sub> )	400 bar	
Max. static proof pressure in cylinder (P <sub>PROOF</sub> )	525 bar	
IP rating		
M12 connector	EN60529 (IP69K) when plugged	
Sensor housing	EN60529 (IP67)	
Environmental testing		
Shock test	IEC 60068-2-27, 100 g (11 ms) single shock, 50 g (11 ms) at 1000 shocks per axis	
Vibration test	15 g (r.m.s.) Ø 7 mm pressure pipe (10...2000 Hz) – resonance frequencies excluded	
EMC test & evaluation	ISO 14982 Agricultural and forest machines EN 13309 Construction machines Immunity: ISO 11452-2 (200 V/m Antenna), ISO 11452-4 (200 mA BCI) Emissions: CISPR 25 Transiente Impulses: ISO 7637-2 E.S.D.: ISO/TR 10605	
Materials and dimensions		
Pressure pipe (Ø 10 mm / Ø 7 mm)	Stainless steel 1.4306 / AISI 304L	
Housing	Stainless steel 1.4305 / AISI 303	
Sealing	O-ring 23.47 × 2.62 mm NBR; Backup Ring 28 × 2 × 1.4 mm, Parker Parbaks 8-119 N1444-90 or 8-119 N0300-90	
M12 connector insert	Material: polyamide reinforces; O-ring 7 × 1.35 mm NBR 70; pins: brass with gold plated pins	
M12 flange	Brass nickel-plated with O-ring 13 × 1.6 NBR 70	
Electrical installation		
Connector	M12 male plug or cable assembly	
Supply voltage	<b>12 VDC (8...32 VDC)</b>	<b>24 VDC (8...32 VDC)</b>
Current consumption	Typ. $\leq 100$ mA	Typ. $\leq 50$ 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 protection (GND-VDC)	Up to +36 VDC	
Polarity protection (GND-VDC)	Up to -36 VDC	
Insulation Resistance	$R \geq 10$ MΩ @ 60 sec.	
Electric strength	500 VDC (DC GND to chassis GND)	

## Temposonics® Model configurator

<input type="checkbox"/> M <input type="checkbox"/> S	<input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> M	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> 3	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>	<b>e</b>	<b>f</b>	<b>g</b>	<b>h</b>
<b>a Sensor model</b>							
<input type="checkbox"/> M <input type="checkbox"/> S	Flange housing Ø 28 mm						
<b>b Form factor</b>							
<input type="checkbox"/> D	≤ 1500 mm, Pressure pipe Ø 7 mm, Damping: 63.5 mm						
<input type="checkbox"/> F	≤ 1200 mm, Pressure pipe Ø 7 mm, Damping: 36.5 mm						
<b>c Stroke range (mm)</b>							
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	0050...1500 mm (in 5 mm steps)						
<b>d Electrical wiring</b>							
<b>M12 connector (VDC – GND – HI – LO) incl. M12 flange</b>				<i>Examples M12 connector</i>			
<input type="checkbox"/> N <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> F	5 pin (2-3-4-5), 60...240 mm cable length (in 20 mm steps)			<i>N08F = 080 mm</i>			
<b>Cable assembly</b>				<i>Example cable length</i>			
<input type="checkbox"/> T <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> A	300...9000 mm cable length (in 100 mm steps)			<i>T10A = 1000 mm</i>			
<b>e Supply voltage</b>							
<input type="checkbox"/> 3	+12/24 VDC						
<b>f Output</b>							
<input type="checkbox"/> C <input type="checkbox"/> 0 <input type="checkbox"/> 1	CANopen cycle time 1 ms (default setting)						
<input type="checkbox"/> J <input type="checkbox"/> 0 <input type="checkbox"/> 1	SAE J1939 cycle time 20 ms (default setting)						
<b>g Baud rate</b>							
<b>CANopen (C01)</b>							
<input type="checkbox"/> 0	1000 kbit/s						
<input type="checkbox"/> 1	800 kbit/s						
<input type="checkbox"/> 2	500 kbit/s						
<input type="checkbox"/> 3	250 kbit/s						
<input type="checkbox"/> 4	125 kbit/s						
<input type="checkbox"/> 6	50 kbit/s						
<b>SAE J1939 (J01)</b>							
<input type="checkbox"/> 3	250 kBit/s						
<b>h Node ID (CANopen) / Source adress (SAE J1939)</b>							
<b>CANopen (C01)</b>							
<input type="checkbox"/> <input type="checkbox"/>	hex 01...7F						
<b>SAE J1939 (J01)</b>							
<input type="checkbox"/> <input type="checkbox"/>	hex 01...FD						




**Scope of delivery:**

Position sensor, O-ring, backup-ring, M12 connector system




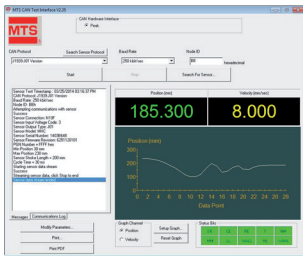
**Please order position magnets separately!**

## Accessories

### Position magnets

			
<b>OD17.4 Ring magnet</b> Part no. 401 032	<b>OD25.4 Ring magnet</b> Part no. 400 533	<b>OD33 Ring magnet</b> Part no. 201 542-2	
Material: PA-Neobind Weight: ca. 5 g Operating temperature: -40...+100 °C Surface pressure: max. 20 N/mm <sup>2</sup>	Material: PA-Ferrit Weight: ca. 10 g Operating temperature: -40...+100 °C Surface pressure: max. 40 N/mm <sup>2</sup>	Material: PA-Ferrit-GF20 Weight: ca. 14 g Operating temperature: -40...+100 °C Surface pressure: max. 40 N/mm <sup>2</sup> Fastening torque for M4 screw: max. 1 Nm	

### M12 Flange Testkits

			
<b>M12 Flange (spare part)</b> Part no. 253 769	<b>Testkit Analog</b> Part no. 280 618	<b>Testkit Digital</b> Part no. 254 267	<b>Testsoftware Digital</b> Part no. 625 129
	<ul style="list-style-type: none"> <li>MH-Serie analog / PWM Tester</li> <li>12 VDC battery charger with adapter (adapter main plug EU, adapter main plug UK)</li> <li>cable with M12 connector</li> <li>cable with pigtailed wires</li> <li>carrying case</li> </ul>	<ul style="list-style-type: none"> <li>USB CAN-Modul Kit: <ul style="list-style-type: none"> <li>USB CAN-Modul</li> <li>USB CAN-Modul Utility CD (driver &amp; manual)</li> </ul> </li> <li>USB cable</li> <li>cable with MTS M12 connector and RS232 connector</li> <li>cable with RS232 connector</li> <li>carrying case</li> <li>12 VDC power supply</li> </ul>	Software for MH Digital

**Order information:**  
For complete package please  
order both part numbers.

**Document Part Number:**  
551217 Revision E (EN) 06/2015

## LOCATIONS

**USA**  
**MTS Systems Corporation**  
**Sensors Division**  
3001 Sheldon Drive  
Cary, N.C. 27513, USA  
Tel. +1-919-677-0100  
Fax +1-919-677-0200  
info.us@mtssensors.com  
www.mtssensors.com

**JAPAN**  
**MTS Sensors Technology Corp.**  
737 Aihara-machi,  
Machida-shi,  
Tokyo 194-0211, Japan  
Tel. +81-42-775-3838  
Fax +81-42-775-5512  
info.jp@mtssensors.com  
www.mtssensors.com

**FRANCE**  
**MTS Systems SAS**  
Zone EUROPARC Bâtiment  
EXA 16  
16/18, rue Eugène Dupuis  
94046 Creteil, France  
Tel.: +33-1 58 43 90 28  
Fax: +33-1 58 43 90 03  
info.fr@mtssensors.com  
www.mtssensors.com

**GERMANY**  
**MTS Sensor Technologie**  
**GmbH & Co. KG**  
Auf dem Schüffel 9  
58513 Lüdenscheid, Germany  
Tel. +49-23 51-95 87 0  
Fax +49-23 51-5 64 91  
info.de@mtssensors.com  
www.mtssensors.com

**CHINA**  
**MTS Sensors**  
Room 504, Huajing Commercial Center,  
No. 188, North Qinzhou Road  
200233 Shanghai, China  
Tel: +86 -21 6485 5800  
Fax: +86 -21 6495 6329  
info.cn@mtssensors.com  
www.mtssensors.com

**ITALY**  
**MTS Systems Srl.Sensor Division**  
Via Camillo Golgi, 5/7  
25064 Gussago (BS), Italy  
Tel.: +39-030 988 38 19  
Fax: +39 - 030 982 33 59  
info.it@mtssensors.com  
www.mtssensors.com

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