Temposonics
AN AMPHENOL COMPANY

Data Sheet

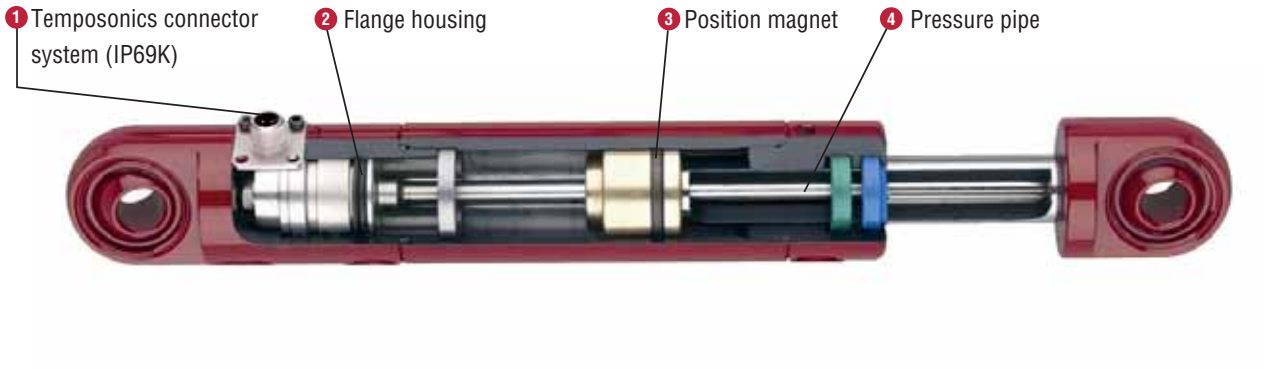
MH-Series MS Analog/Digital

Magnetostrictive Linear Position Sensors

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

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 qua-lity 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.



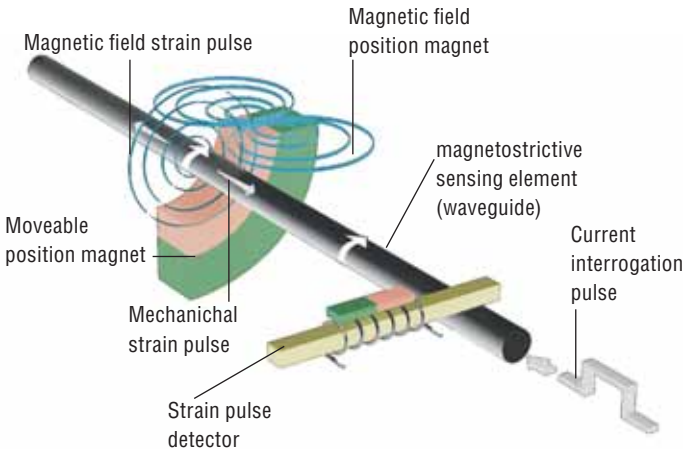
Simple Mechanics
The extremely robust sensor consists of the following main parts:

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.

- 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

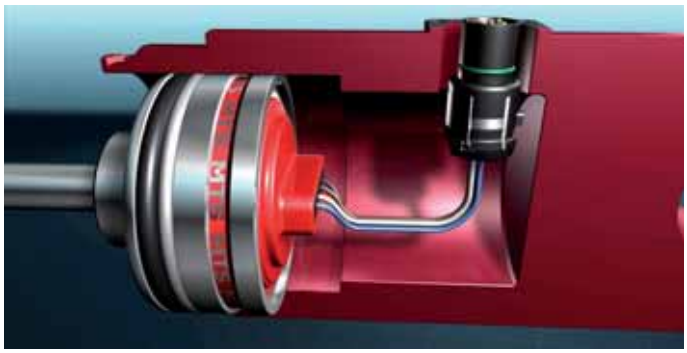
Magnetostriction
Temposonics linear sensors are based on the magnetostrictive technology. By measuring the actual position with a non-contact position magnet the sensor operates 100% wear-free. The absolute operating principle enables reliable readings without any reference point or recalibration. A 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



2. Temposonics connector system M12

Temposonics presents the innovative connector system for Temposonics® MH-Series
The 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.



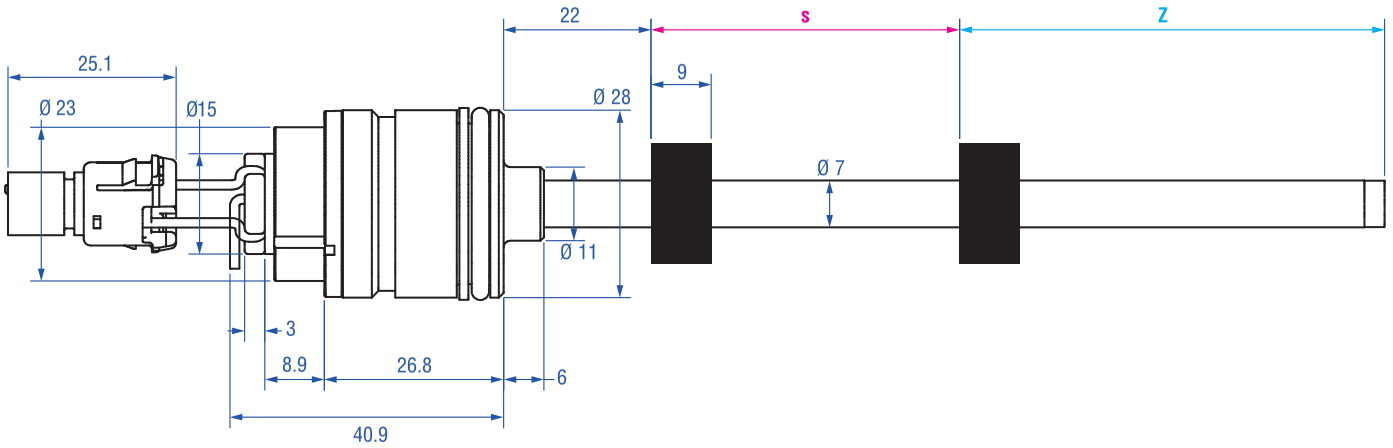
1 The MH sensor is delivered by Temposonics together with the new connector system:
The connector insert carrier is already connected to the sensor conductors, i.e. no soldering, any colour or connection mistake.

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.



Mechanical configurations

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

Electrical configurations

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

Model no. **MS D - 1 5 0 0 M -N 1 2 G -3 - V12 ☐ ☐**

e.g.: s = 1500 mm

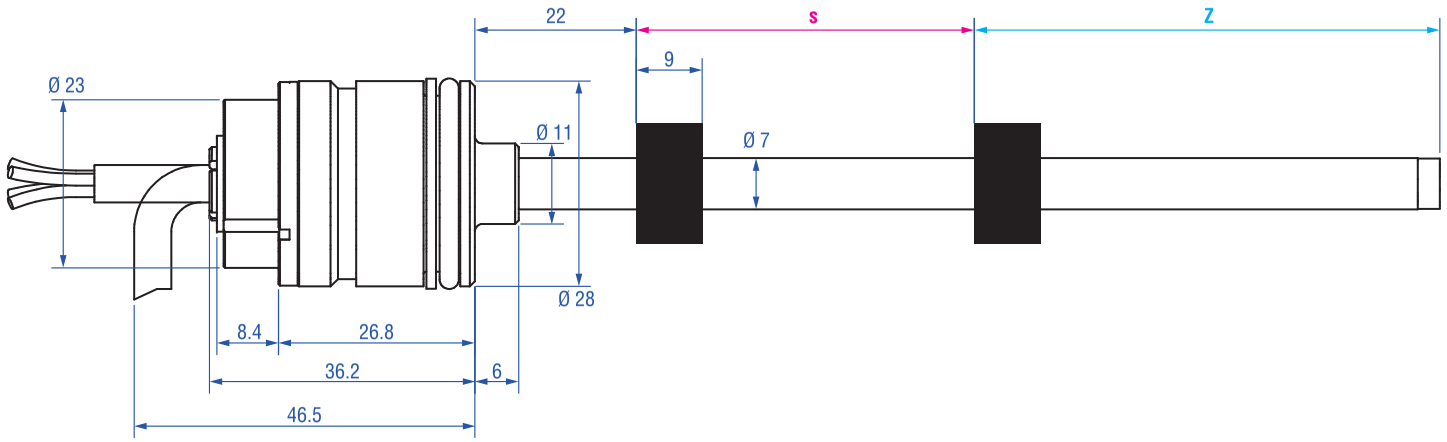
e.g.: w = 120 mm

D	**G**	**V11**		
F	**H**	**A01**		
	F	**C01**	**4**	**7F**
		J01	**3**	**FD**

All dimensions in mm

Please see detailed model configuration on page 11 and 13.

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



Mechanical configurations

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

Electrical configurations

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

Model no. MS D - 1 5 0 0 M -T 1 0 A -3 - V12 [ ] [ ]

F
V11
A01
C01 2 7F
J01 4 FD

e.g.: s = 1500 mm
e.g.: w = 1000 mm

All dimensions in mm

Please see detailed model configuration on page 11 and 13.

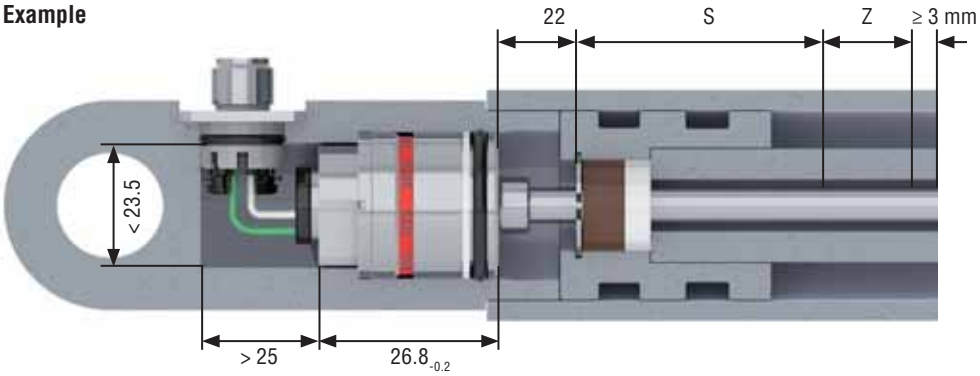
*Note: Digital output only up to 1500 mm stroke range

4. In Cylinder assembly

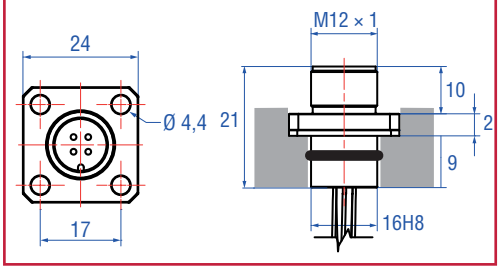
Mechanical installation

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

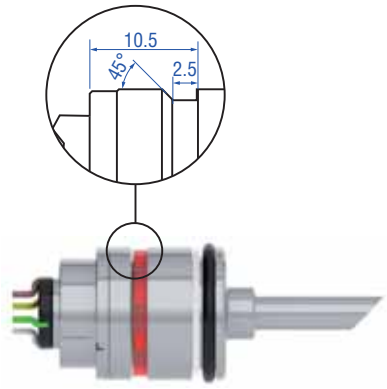


M12 connector system

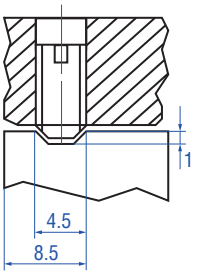


Sensor installation

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



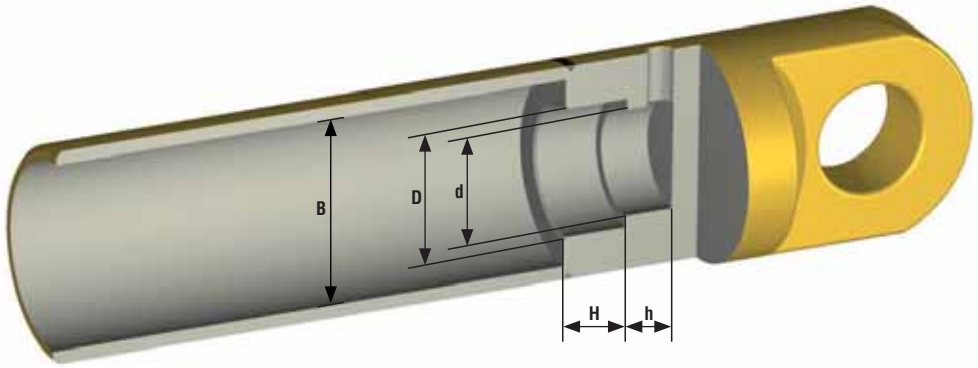
e.g. retaining with set screw
DIN 913 M5 × 10 (with flat point!)
max. torque 0.5 Nm

Please pay attention:

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

Pressure Pipe	Ø 7
Drilling	Ø 10

- Do not exceed operating pressure.

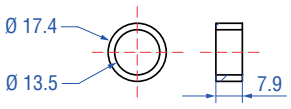
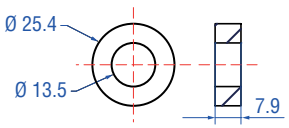
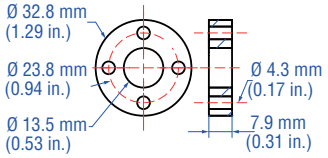


Type	B - Ø Cylinder	D - Ø min.	H - Depth	d - Ø min.	h - Depth
MS	≥ 32	28H7 screwed 28G7 welded	26.8 +0.2	23.5	< 25

Please pay attention to installation manual!

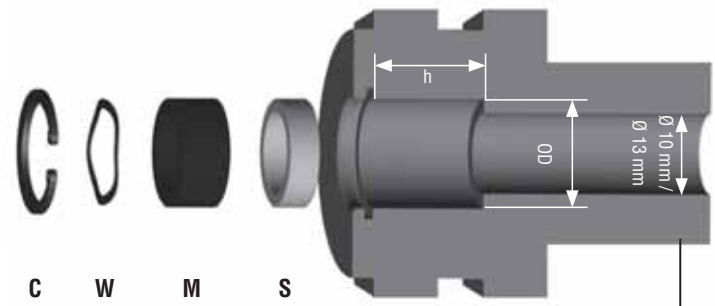
All dimensions in mm

4.1. Position magnets

Position magnets (please order separately)			
			
Part no.	**401 032**	**400 533**	**201 542-2**
Dimensions			
OD_M	17.4 mm	25.4 mm	32.8 mm
ID_M	13.5 mm	13.5 mm	13.5 mm
Height	7.9 mm	7.9 mm	7.9 mm
Characteristics			
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/mm²	max. 40 N/mm²	max. 40 N/mm²
Fastening torque for M4 screws	–	–	max. 1 Nm

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

4.2. Magnet assembly in piston



$S = OD_M \times 5 \times ID_M$

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

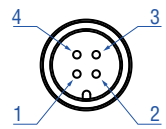
Magnet (M)	**401 032**	**400 533**	**201 542-2**
OD	17.5 $mm^{+0,2}$	25.5 $mm^{+0,2}$	32.9 $mm^{+0,2}$
h - Depth	13.5 mm	13.5 mm	13.5 mm

Please pay attention to installation manual!

All dimensions in mm

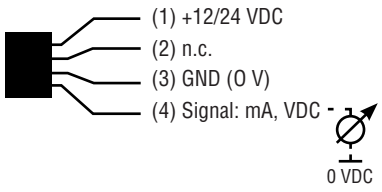
5. Electrical installation

MS Analog
PIN assignment M12 (4 pin)

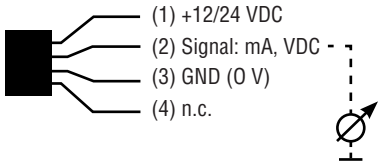


Pin	G	H
1	VDC	VDC
2	n.c.	Signal
3	GND	GND
4	Signal	n.c.

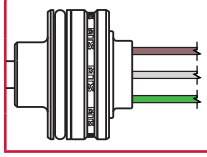
Pin assignment "G"



Pin assignment "H"

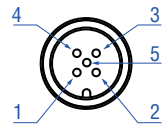


MS Analog
wire assignment



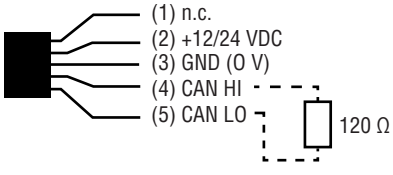
Color	Signal
BN	VDC
WH	GND
GN	Signal

MS Digital
PIN assignment M12 (5 pin)

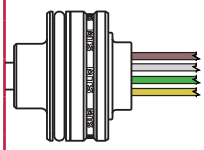


Pin	F
1	n.c.
2	VDC
3	GND
4	CAN HI
5	CAN LO

Pin assignment "F"



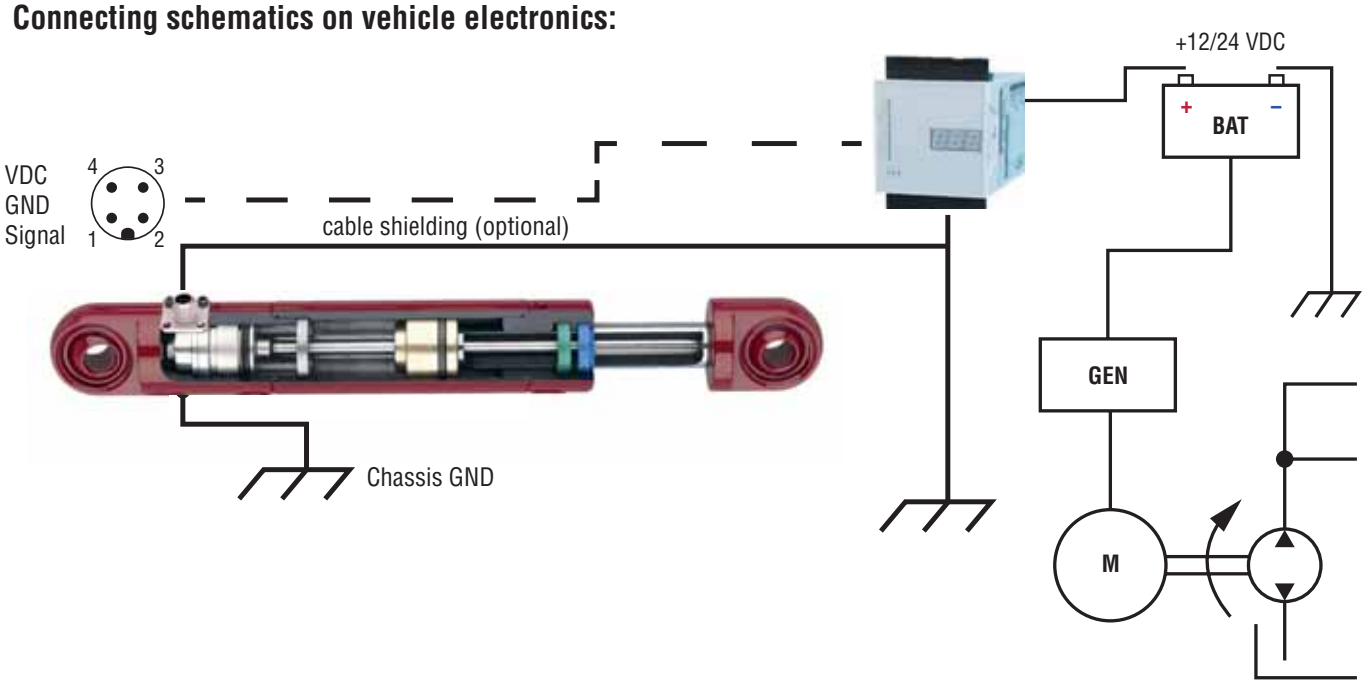
MS Digital
wire assignment



Color	Signal
BN	VDC
WH	GND
GN	CAN LO
YE	CAN HI

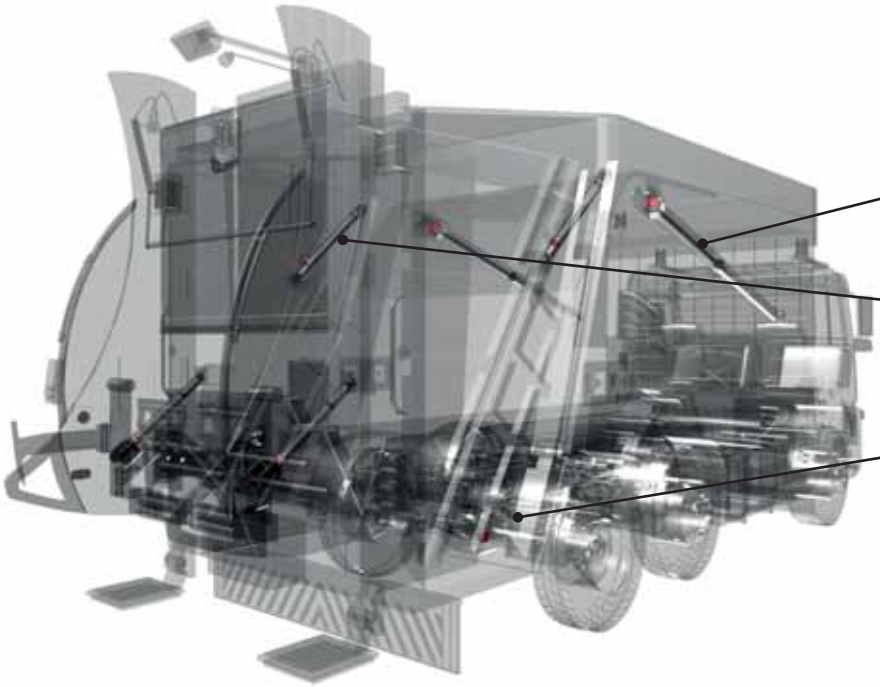
Please pay attention to installation manual!

Connecting schematics on vehicle electronics:



All dimensions in mm

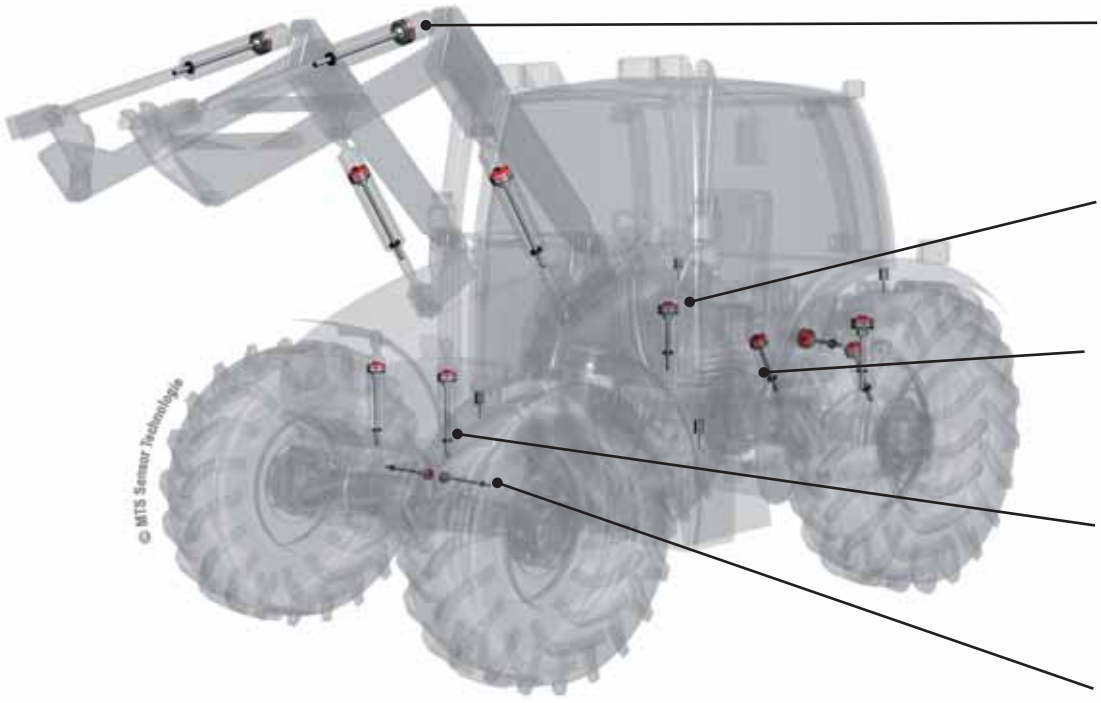
Typical Applications for Linear Motion Control in hydraulic cylinders



Blade Control
Press and return operation

Lift Control
Speed of lift up and lowering related to actual load

Auxilary Steering



Front Loader:
Controlled Parallel Guidance

Cabin Suspension

Electro-Hydraulic Hitch Control

Axle Suspension

Steer by Wire
Electro-Hydraulic Steering

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 ≤ ±0.1 mm, 0255…2000 mm ±0.04 % (F.S.), 2005…2500 mm ≤ ±0.8 mm	
Repeatability	± 0.1 mm	
Internal sample rate	2 ms	
Setpoint tolerance	≤ 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_N)	300 bar	
Max. overload pressure in cylinder (P_{MAX})	400 bar	
Max. static proof pressure in cylinder (P_{PROOF})	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 ×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	**12 VDC (8…32 VDC)**	**24 VDC (8…32 VDC)**
Current consumption	Typ. ≤ 100 mA	Typ. ≤ 50 mA
Load (output VDC)	R_L ≥ 10 kΩ	R_L ≥ 10 kΩ
Load current (output VDC)	Typ. 0.5 mA	Typ. 0.5 mA
Loud (output mA)	R_L ≤ 250 Ω	R_L ≤ 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 ≥ 10 MΩ @ 60 sec	
Electric strength	500 VDC (DC GND to chassis GND)	

Temposonics® Model configurator

a	Sensor model
M	S	Flange housing Ø 28 mm

b	Form factor
D	≤ 2500 mm, Pressure pipe Ø 7 mm, Damping: 63.5 mm
F	≤ 1200 mm, Pressure pipe Ø 7 mm, Damping: 36.5 mm

c	Stroke range (mm)
				0050…2500 mm (in 5 mm steps)

d	Electrical wiring	
				M12 connector (VDC – GND – SIG) incl. M12 flange	***Examples M12 connector***
N			G	4 pin (1-3-4), 60…240 mm cable length (in 20 mm steps)	*N08G = 080 mm*
N			H	4 pin (1-3-2), 60…240 mm cable length (in 20 mm steps)	*N10H = 100 mm*
				Cable assembly	***Example cable length***
T			A	300…9000 mm cable length (in 100 mm steps)	*T10A = 1000 mm*

e	Supply voltage
3	+12 / 24 VDC

f	Output	
V	1	1	0.25…4.75 VDC
V	1	2	0.5…4.5 VDC
A	0	1	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 ≤ ±0.1 mm, 0255…1500 mm ±0.04 % (F.S.)	
Hysteresis	±0.1 mm	
Internal sample rate	1 ms	
Setpoint tolerance	±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 (P_N)	300 bar	
Max. overload pressure in cylinder (P_{MAX})	400 bar	
Max. static proof pressure in cylinder (P_{PROOF})	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	**12 VDC (8…32 VDC)**	**24 VDC (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)	

Temposonics® Model configurator

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

Examples M12 connector
N08F = 080 mm
Example cable length
T10A = 1000 mm

Scope of delivery:
Position sensor, O-ring, backup-ring, M12 connector system

Please order position magnets separately!

Accessories

Position magnets

OD17.4 Ring magnet
Part no. 401 032

Material: PA-Neobind
Weight: ca. 5 g
Operating temperature: –40…+100 °C
Surface pressure: max. 20 N/mm²

OD25.4 Ring magnet
Part no. 400 533

Material: PA-Ferrit
Weight: ca. 10 g
Operating temperature: –40…+100 °C
Surface pressure: max. 40 N/mm²

OD33 Ring magnet
Part no. 201 542-2

Material: PA-Ferrit-GF20
Weight: ca. 14 g
Operating temperature: –40…+100 °C
Surface pressure: max. 40 N/mm²
Fastening torque for M4 screw: max. 1 Nm

M12 Flange

M12 Flange (spare part)
Part no. 253 769

Testkits

Testkit Analog
Part no. 280 618

- MH-Serie analog / PWM Tester
- 12 VDC battery charger with adapter (adapter main plug EU, adapter main plug UK)
- cable with M12 connector
- cable with pigtailed wires
- carrying case

Testkit Digital
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

Testsoftware Digital
Part no. 625 129

Software for MH Digital

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

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