

# Temposonics® and Hall Effect

Magnetostrictive Linear Position Sensors

## SENSOR SELECTOR GUIDE

Mobile Hydraulics



be certain.





## **MEETING THE CHALLENGES OF MOBILE APPLICATIONS**

Agricultural • Construction • Forestry • Mining • Handling & Logistics •  
Municipal Vehicle • Railway Vehicle • Maritim Applications

**MTS Sensors also offers solutions for Industrial and Liquid Level applications.**





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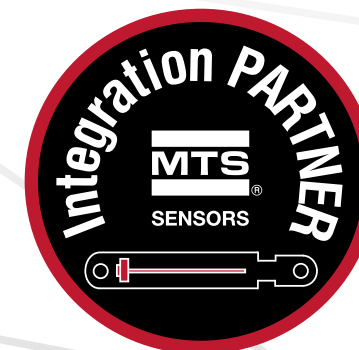
## COMPANY

MTS Sensors is recognized as an industry leader in sensing technologies and solutions. These sensors permit high-precision and dynamic position and/or speed measurement in state-of-the-art automation and safety-relevant applications.

With a versatile and ever increasing product portfolio, MTS Sensors cooperates closely with customers, to optimize performance and reduce downtimes. Outstanding quality associated with practical know-how ensures that customers achieve utmost productivity and success. Continuous research, development and production of sensor systems constantly enable new solutions for measuring tasks in the industrial, mobile hydraulics as well as process technology fields to be created.

MTS Sensors is a division of MTS Systems Corporation (NASDAQ:MTSC). In July 2016, MTS Systems Corporation (Eden Prairie, USA) purchased PCB Piezotronics Inc. (Depew, USA). The acquisition will continue MTS' and PCB's long history of growth. Our customers benefit from an extended, complementary product portfolio, while relying on the unwavering competence and diligence of our support team. MTS Sensors has 1600 employees worldwide who serve our global customers with a focus on superior regional support.

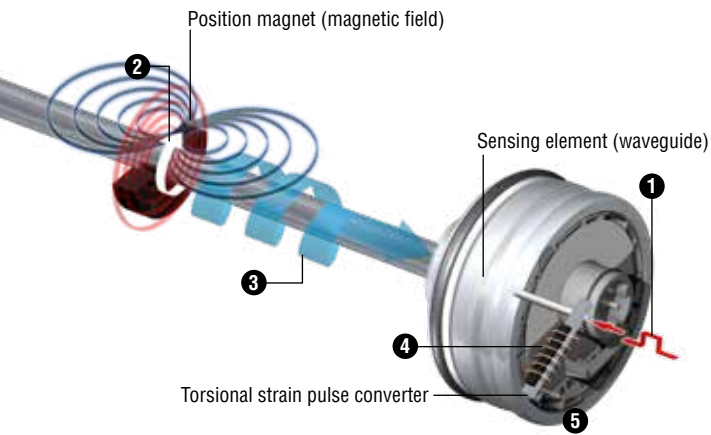
be certain.



The MTS Integration partner program brings together the position-sensing technology and expertise of MTS Sensors with hydraulic cylinder manufacturers, and system integrator partners to develop complete system solutions that meet OEM needs.

Strong Partnership. Complete system solutions.

## MEASURING TECHNOLOGIES



### Measurement Cycle

- 1 Current pulse generates magnetic field
- 2 Interaction with position magnet field generates torsional strain pulse
- 3 Torsional strain pulse propagates
- 4 Strain pulse detected by converter
- 5 Time-of-flight converted into position

## Magnetostriction

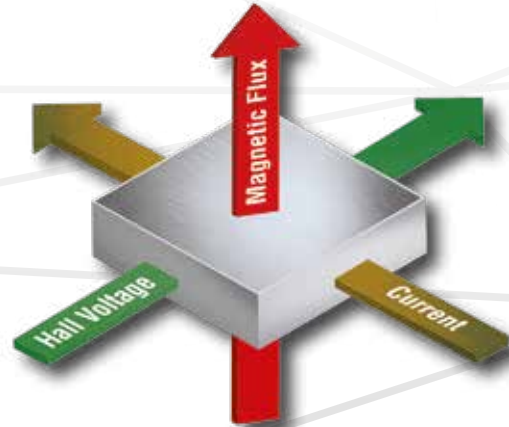
The absolute, linear position sensors provided by MTS Sensors rely on the company's proprietary Temposonics® magnetostrictive technology, which can determine position with a high level of precision and robustness.

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 generated by the sensor element and 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.

The Temposonics® technology, based on magnetostriction, does not rely on moving parts and is not exposed to mechanical stress. Therefore, the sensors exhibit considerably longer lifespans and much higher reliability when compared to other technologies, even in harsh working conditions. Furthermore, since the output from sensors with Temposonics® technology corresponds to an absolute position, rather than a relative value, it is not required to recalibrate sensors.

## Hall Effect

MTS Sensors' linear position sensors utilizing Hall Effect technology are able to determine position with a high level of repeatability and robustness. The sensor consists of sensing elements and supporting electronics in a robust sensor rod. The non-contacting position magnet is attached to the object in motion for the given application. The magnetic field, of the position magnet, perpendicular to the sensing elements creates a measurable (Hall) voltage which is proportional to the strength of the magnetic field. The Hall voltage is then converted into a linear position measurement. Since the output of the sensor corresponds to an absolute position, rather than a relative value, recalibration is not required.

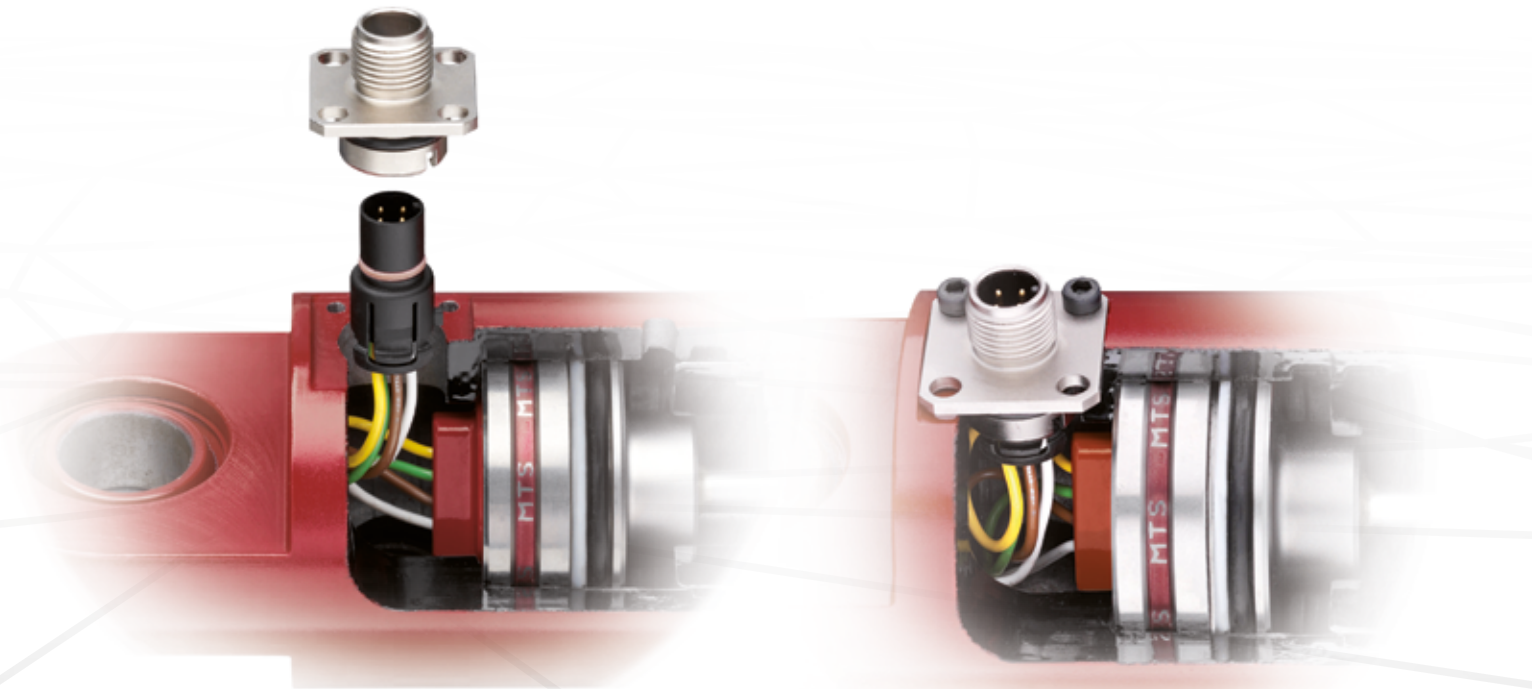


## M12 Connector System

The MTS Connector System M12 meets the highest protection requirements according to DIN EN 60529 - important for a harsh environment in mobile hydraulic applications. With protection type IP69K, the robust metal housing is not only absolutely dustproof, but penetration of water inside the cylinder is also prevented. It is able to withstand even extremely hard cleaning conditions using high-pressure equipment.

Click-on mounting without the need of any tools saves valuable mounting time and increases the safety of the sensor installation. The sensor is installed in the hydraulic cylinder and connected electrically within seconds. Time-consuming connection of the cable conductors, polarity errors or "dry" solder joints are a matter of the past!

The connector system is prefabricated and delivered in conjunction with the position sensor, i.e. its contact carrier is already connected to the sensor conductors. When mounting, the contact carrier is taken out of the cylinder through a bore hole, and the flanged housing can be clicked in position easily from outside. During installation of the cylinder unit into the mobile machine, the sensor can be connected at 8 different angles using a universal M12 connector. The minimized installation height of the connector system ensures successful cylinder mounting even under limited space conditions.







## SERIES QUICK GUIDE

	<b>MH</b> Standard (In-Cylinder & external mount)	<b>FMH</b> Easy in-field serviceability	<b>MHRM</b> For railway applications	<b>MT</b> Redundant	<b>MS</b> For smaller bore cylinders	<b>MXR</b> External mount	<b>C</b> Compact	<b>HE</b> Hall effect sensor
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<b>TECHNOLOGY</b>								
Magnetostrictive Technology	•	•	•	•	•	•	•	
Hall Effect Technology								•

<b>OUTPUT</b>								
Analog	•	•	•	•	•	•	•	•
CANbus	•	•			•	•		

<b>FEATURES</b>								
Position Measurement	•	•	•	•	•	•	•	•
Velocity Measurement	•	•			•	•		
M12 Connector (IP69K)	•	•	•	•	•	•	•	•
Embedded Installation	•		•	•	•			•
Threaded Version	•	•	•				•	•
External Mounting						•		
Ø 7 mm Pressure Pipe	•		•		•			
Ø 8 mm Pressure Pipe							•	
Ø 10 mm Pressure Pipe	•		•	•				•
Ø 12.7 mm Pressure Pipe		•						
SIL 2	•							
Redundancy				•				
5 VDC Operating Voltage						•	•	•
12 VDC Operating Voltage	•	•	•	•	•	•	•	•
24 VDC Operating Voltage	•	•	•	•	•	•		•

<b>STROKE LENGTH</b>								
100...500 mm						•	*	•
50...2500 mm	•	•	•	•	•			
2520...5000 mm	•	•						

MTS Sensors offers full application support – from design to production and logistics excellence. Contact us for free support.

\* specific stroke lengths, see page 20



# SAVE YOUR TIME FOR THE THINGS YOU LOVE.

...trust the experts!

Have you ever thought about how much time you're wasting waiting for adequate support or your order?

Our commitment at MTS Sensors is to consistently deliver quality products on time to meet your schedules and provide first-class service. Trust in our continuous product development of high-performance position sensors and rely on our highly qualified personnel. At MTS Sensors, we live by the promise of unparalleled service that enables us to take all available means to exceed your expectations. Our goal is to support you optimizing your productivity and we love the idea to make you save your valuable time.

Your MTS Sensors Team





## MH-SERIES MH Standard (In-Cylinder & External Mount)

The Temposonics® MH-Series sensors are specifically designed for direct stroke measurement in hydraulic cylinders. MH-Series sensors can be fully sealed and embedded in a cylinder while providing excellent protection against the environment and EMI and ensures a long operating life. The MH-Series sensors can be installed from the head side or the rod side of the cylinder depending on the cylinder design. The MH sensor is also available as an external threaded installation. A Temposonics® M12 connector system ensures protection to IP69K. Various signal outputs (Analog, CANbus) are available.

### Output (resolution)

Analog	Voltage / Current (50...2500 mm: typical $\pm 0.1$ mm 2520...3500 mm: $\leq 0.5$ mm 3520...5000 mm: $\leq 1.0$ mm)
CANbus	CANopen & SAE J1939 (Position: 0.1 mm; Velocity: 1 mm/s)

### Operating conditions

Temperature	-40...+105 °C (-40...+221 °F)
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 25 g (sinusoidal) $\varnothing$ 10 mm pressure pipe (10...2000 Hz) 15 g (sinusoidal) $\varnothing$ 7 mm pressure pipe (10...2000 Hz) – excluding resonant frequencies

### EMC\*

### Design

Stroke length	50...5000 mm
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### Electrical connection

Operating voltage	+12 / 24 VDC (8...32 VDC)
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\* More information available at:  
[www.mtssensors.com](http://www.mtssensors.com)



## MH-SERIES FMH (Flexible MH) Easy In-Field Serviceability

Designed for use with hydraulic cylinders in mobile applications, the externally threaded Temposonics® FMH sensor features an innovative two-part design. This design allows users to separate flexibly the sensing element and electronics from the housing without opening the hydraulic system.

While it is manageable to install and remove hydraulic cylinder sensors at a manufacturing facility, it can be extremely challenging in the field. Trained service technicians can remove and replace the internal components with just 200 mm of clearance – regardless of stroke length and without breaking the hydraulic seal. This serviceability means decreased downtime and disruption, providing increased productivity. Replacement units shipped as coiled rings to ease handling and reduce shipping costs.

### Output (resolution)

Analog	Voltage / Current ( $\pm 0.2$ mm)
CANbus	CANopen / SAE J1939 ( $\pm 0.2$ mm)

### Operating conditions

Temperature	-40...+105 °C (-40...+221 °F)
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\*

### Design

Stroke length	500...5000 mm
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### Electrical connection

Operating voltage	+12 / 24 VDC (8...32 VDC)
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\* More information available at:  
[www.mtssensors.com](http://www.mtssensors.com)

## MH-SERIES MHRM For Railway Applications

The MHRM sensor was developed especially for railway applications and extends the portfolio of the Temposonics® MH-Series sensors. It is compliant with EN 50121-3-2 and meets the special requirements for shock according to EN 61373 Cat2 (Bogie) and Cat3 (Axle), vibration according to IEC 60068-2-64 Fn Cat3 (Axle) and EMC according to DIN EN 50155.

Because of its two mounting styles, the sensor is applicable i.a. for inclination controls, in damping units or in rail processing vehicles. All MHRM sensors use the M12 connector system which meets the protection requirements to IP69K.

### Output (resolution)

Analog	Voltage / Current (typical $\pm 0.1$ mm)
Linearity	50...250 mm: $\leq 0.1$ mm 255...2000 mm: $\pm 0.04$ % (F.S.) 2005...2500 mm: $\leq 0.8$ mm
Hysteresis	$\leq 0.2$ mm

### Operating conditions

Temperature	MHRM: $-40 \dots +105$ °C ( $-40 \dots +221$ °F) MHRM Threaded: $-40 \dots +85$ °C ( $-40 \dots +185$ °F)
Shock test	EN 61373 Cat2 (Bogie) and Cat3 (Axle)
Vibration test	IEC 60068-2-64 Fn Cat3 (Axle)

EMC\*

### Design

Stroke length	50...2500 mm
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### Electrical connection

Operating voltage	+12 / 24 VDC (8...32 VDC)
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**MHRM embeddable sensor**  
for In-cylinder integration

**InterConnection Plug**  
M12 system plug or cable

**MHRM Threaded**  
for external  
threaded installation

**DEVELOPED  
FOR  
RAILWAY APPLICATIONS**



## MH-SERIES MH SAFETY SIL 2

The Temposonics® MH SAFETY sensors are specifically designed for direct stroke measurement in hydraulic cylinders. The MH-Series sensors can be fully sealed and embedded in a cylinder which provides excellent protection against the environment and EMI and ensures a long operating life. The MH-Series sensors can be installed from the head side or the rod side of the cylinder depending on the cylinder design. A MTS M12 connector system ensures protection to IP69K. The MH Safety models are designed according to the design principles of the IEC 61508-2 (Safety Integrity Level 2). They have a Performance Level (PL) in line with ISO 13849-1 and meet the EN 954-1 standard.

### Output (resolution)

Analog	Voltage / Current (typical ±0.1 mm)
CANbus	CANopen Safety protocol according EN 50325-5 (Position: 0.1 mm; Velocity: 1 mm/s)

### Operating conditions

Temperature	-40...+100 °C (-40...+212 °F)
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 25 g (sinusoidal) (10...2000 Hz)

EMC\*

### Design

Stroke length	50...2500 mm
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### Electrical connection

Operating voltage	+12 / 24 VDC (8...32 VDC)
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### Safety Classification

IEC 61508-2	SIL 2 (Device type B)
ISO 13849-1	PLd – Category 2

### Approvals

E1 type-approved

**SIL 2**  
Safety Integrity Level  
IEC 61508

**MH SAFETY Sensor**  
with Analog or CANbus output

**MT Sensor**  
with redundant output

## MH-SERIES MT Redundant

MTS Sensors has developed the redundant position sensor Temposonics® MT to maximize safety and availability of mobile machines. The MT sensor is a redundant sensor with two discrete sensing elements, electronic boards and output connections. Both sensing elements are enclosed in a single pressure-resistant stainless steel rod for direct stroke measurement in the hydraulic cylinder, which provides excellent protection against the environment and EMI and ensures a long operating life. Dual MTS Sensors M12 connector systems ensure protection to IP69K.

### Output (resolution)

Analog	Voltage / Current (typical 0.1 mm)
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### Operating conditions

Temperature	-40...+105 °C (-40...+221 °F)
Shock test	IEC-60068-2-27 100 g (6 ms) single shock 50 g (11 ms) at 1000 Shocks per axis
Vibration test	IEC 60068-2-6 15 g (sinusoidal) (10...2000 Hz)

EMC\*

### Design

Stroke length	50...2500 mm
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### Electrical connection

Operating voltage	+12 / 24 VDC (8...32 VDC)
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## MH-SERIES MS For Smaller Bore Cylinders

The Temposonics® MS sensors are specifically designed for direct stroke measurement in hydraulic cylinders with bore diameters of 28 mm or larger. MS-Series sensors can be fully sealed and embedded in a cylinder which provides excellent protection against the environment and EMI and ensures a long operating life. The MS-Series sensors can be installed from the head side or the rod side of the cylinder depending on the cylinder design. A Temposonics® M12 connector system ensures protection to IP69K. Various signal outputs (Analog, CANbus) are available.

### Output (resolution)

Analog	Voltage / Current (Position: Typical 0.1 mm)
CANbus	CANopen & SAE J1939 (Position: 0.1 mm; Velocity: 1 mm/s)

### Operating conditions

Temperature	-40...+105 °C (-40...+221 °F)
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 15 g (sinusoidal) (10...2000 Hz)

EMC\*

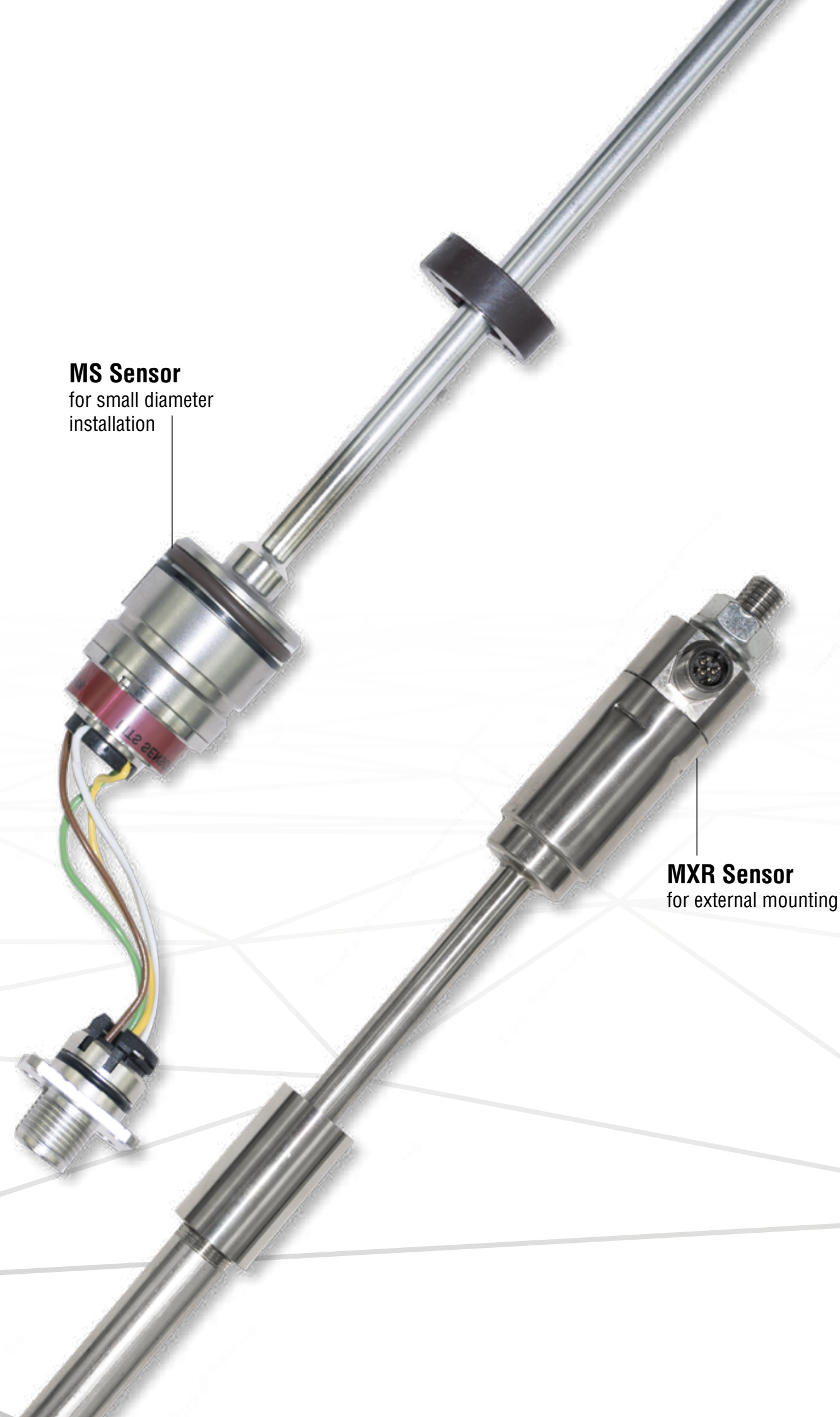
### Design

Stroke length	Analog:	50...2500 mm
	CANbus:	50...1500 mm

### Electrical connection

Operating voltage	+12 / 24 VDC (8...32 VDC)
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\* More information available at:  
[www.mtssensors.com](http://www.mtssensors.com)



**MS Sensor**  
for small diameter  
installation

**MXR Sensor**  
for external mounting

## MH-SERIES MXR External Mount

The MH-Series Model MXR sensor is ideal for retrofitting older equipment or for external mounting. The magnetostrictive sensor includes a stainless steel housing and can be mounted externally alongside a hydraulic cylinder. The MH-Series Model MXR sensor is available in two versions: the MXRC and the MXRS. Although the two versions are similar in both appearance and performance, there are unique features distinguishing the two sensors from one another. The MXRC is available in four discrete stroke lengths up to 250 mm, while the MXRS is available in stroke lengths from 100 to 500 mm (50 mm ordering increments). The MXRC works with a 5 VDC operating voltage, and provides a voltage output that is ratiometric to the operating voltage. The MXRS can work with an operating voltage of either 12 or 24 VDC, and has multiple analog and digital output options available.

### Output (resolution)

Analog	Voltage / Current (Position: Typical 0.1 mm)
CANbus	CANopen & SAE J1939 (Position: 0.1 mm; Velocity: 1 mm/s)

### Operating conditions

Temperature	-40...+105 °C (-40...+221 °F)
Shock test*	IEC 60068-2-27 MXRS: 100 g single shock MXRC: 5 g single shock
Vibration test*	IEC 60068-2-6 MXRS: 15 g (10...2000 Hz) MXRC: 1 g (10...150 Hz)

EMC\*\*

### Design

Stroke length	MXRS:	100...500 mm
	MXRC:	100...250 mm

### Electrical connection

Operating voltage	+12 / 24 VDC (8...32 VDC)
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\* The shock and vibration rating is stated for a fully retracted sensor. The rating for full or partially extended sensor depends on the application  
\*\* More information available at:  
[www.mtssensors.com](http://www.mtssensors.com)



## C-SERIES

### Compact

The Temposonics® C-Series is the smallest sensor series on the market that offers all the advantages of magnetostrictive measurement technology. This makes the C-Series ideal for integration in small applications. The low weight allows installation in small portable OEM products. Due to the contact-free measuring principle, the sensor is completely wear-free and does not have to be readjusted again. In addition, the C-Series is cost-effective and has low energy requirements with an operating supply from 5 VDC or 12 VDC.

#### Output (resolution)

Analog Voltage  
(infinite)

PWM Controller dependent

#### Operating conditions

Temperature -40...+75 °C (-40...+167 °F)

Shock test IEC-68-2-27  
10 g (11ms) single hit  
10 g (11ms) 1000 shocks per axis

Vibration test IEC 68-2-6 (10...2000 Hz)  
10 g (sinusoidal) excluding resonant frequencies

EMC\*

#### Design

Stroke length 72, 109, 128, 148, 162, 186, 194, 217, 250 mm

#### Electrical connection

Operating voltage CS: 5 VDC (tolerance range 4.75...5.5 VDC),  
CM: 12 VDC (tolerance range 9...15 VDC)

**C Sensor**  
OEM sensor



**HE Sensor**  
with Hall effect technology

## HE-SERIES

### With Hall effect technology

The HE-Series utilizing Hall effect technology is specifically designed for direct stroke measurement in hydraulic cylinders with bore diameters of 25 mm or larger. With virtually no dead zone, tight pin to pin measurements can be achieved. HE sensors can be fully sealed and embedded in a cylinder which provides excellent protection against the environment and EMI and ensures a long operating life. With six different mounting styles, the HE sensors can be installed externally from the head side or internally from the rod side of the cylinder depending on the cylinder design. A Temposonics® M12 connector system ensures protection to IP69K. Analog signal outputs are available.

#### Output (resolution)

Analog Voltage / Current  
(< 0.2 mm)

#### Operating conditions

Temperature -40...+85 °C (-40...+185 °F)

Shock test IEC 60068-2-27  
50 g / 10 ms up to 500 mm sensor length  
100 g / 6 ms up to 180 mm sensor length

Vibration test IEC 60068-2-6  
15 g (r.m.s.) (10...2000 Hz)

EMC\*

#### Design

Stroke length 100...500 mm

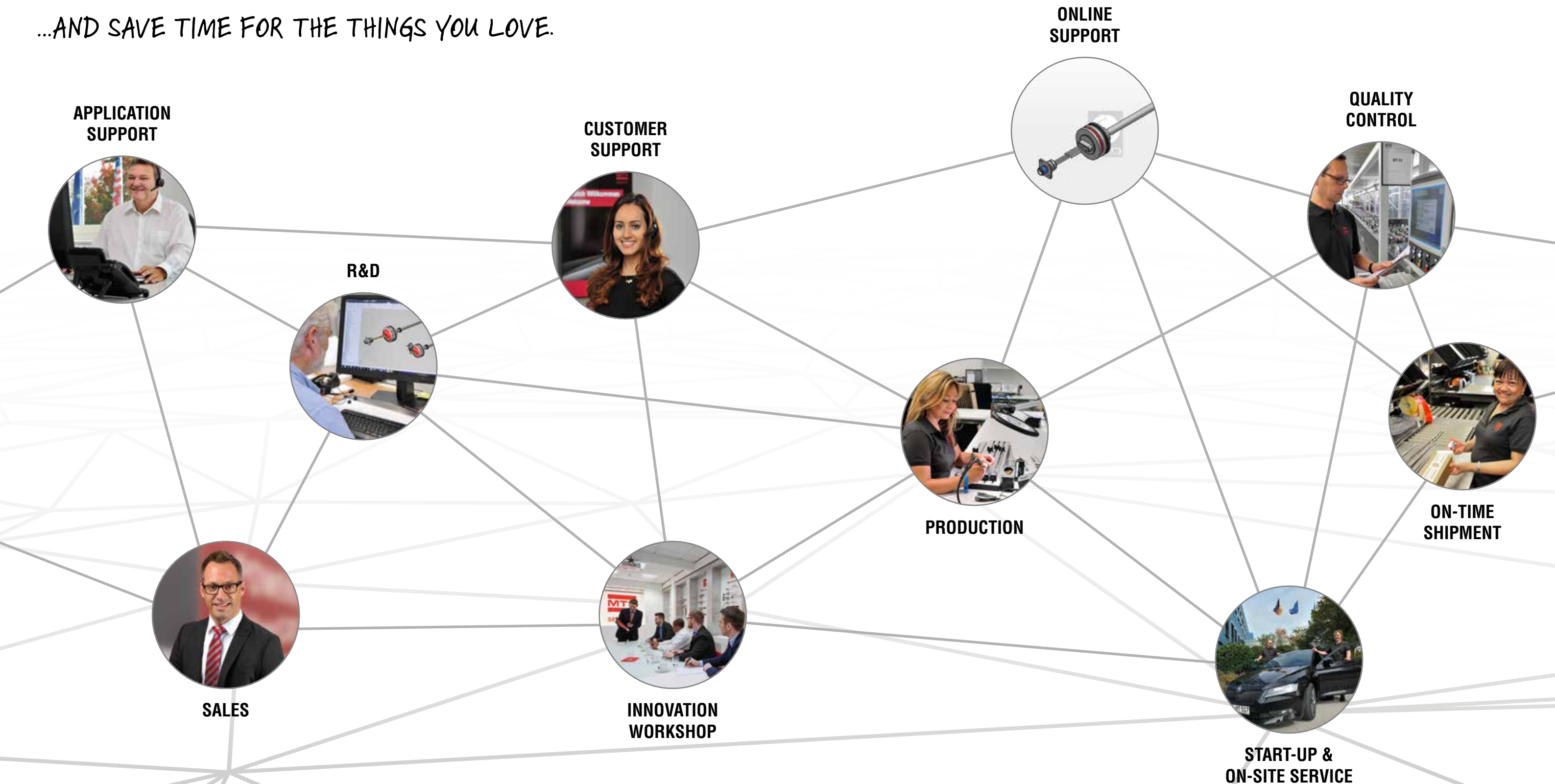
#### Electrical connection

Operating voltage +5, +12, +24 VDC (4.75...32 VDC)



# TRUST THE EXPERTS

...AND SAVE TIME FOR THE THINGS YOU LOVE.





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