



**Temposonics**

AN AMPHENOL COMPANY

## Data Sheet

### R-Series V RM5 EtherCAT®

#### Magnetostrictive Linear Position Sensors

- Super shield housing with IP68/IP69 against ingress of dust and water
- Minimum position resolution 0.5 µm with down to 100 µs cycle time
- Position, velocity and acceleration measurements for up to 30 magnets



**THE NEW V GENERATION**

## MEASURING TECHNOLOGY

The absolute, linear position sensors provided by Tempsonics rely on the company's proprietary magnetostrictive technology, which can determine position with a high level of precision and robustness. Each Tempsonics® position sensor consists of a ferromagnetic waveguide, a position magnet, a strain pulse converter and a 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 beginning 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.

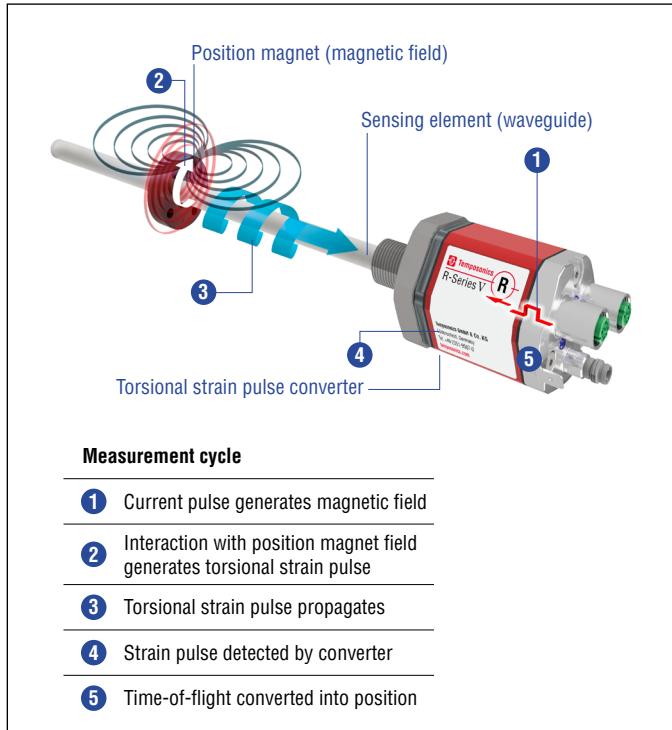


Fig. 1: Time-of-flight based magnetostrictive position sensing principle

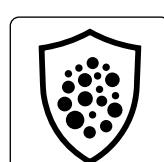
## R-SERIES V RM5 EtherCAT®

The Tempsonics® R-Series V brings very powerful sensor performance to meet the many demands of your application. The RM5 sensor is the version of the RH5 rod sensor in a protective housing (super shield housing). The main advantages of the RM5 are:



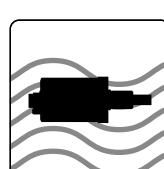
### Protection against corrosion

The housing made of high-quality stainless steel offers very good corrosion resistance. Thus, you can use the R-Series V also in aggressive environments.



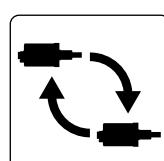
### Protection against ingress of dust

The housing protects the internal sensor against penetration of dust. This maintains the sensor's performance even in heavy dust.



### Protection against ingress of water

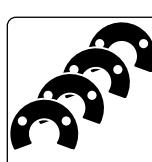
The housing protects the internal sensor when submerged. This allows you to use the R-Series V even under water.



### Easy and fast replacement

If necessary, the sensor inside the housing can be replaced easily and fast. This saves time and downtime costs.

### In addition the R-Series V EtherCAT® scores with the following features:



### 30 positions simultaneously

The R-Series V EtherCAT® can detect and report the position, velocity and acceleration of up to 30 magnets simultaneously.



### R-Series V EtherCAT®

In addition to the measured position value via the EtherCAT® protocol further data about the current sensor status, such as the total distance travelled, the internal temperature and the total operating hours, can be displayed for diagnostic purposes.

### All settings under control with the smart assistants for the R-Series V

The TempoLink® and the TempoGate® smart assistants support you in setup and diagnostics of the R-Series V. For more information of these assistants please see the data sheets:

- TempoLink® smart assistant  
(Document part number: [552070](#))
- TempoGate® smart assistant  
(Document part number: [552110](#))



## TECHNICAL DATA

Output						
Interface	EtherCAT® Ethernet Control Automation Technology					
Data protocol	EtherCAT® 100 Base-Tx, Fast Ethernet					
Data transmission rate	100 MBit/s (maximum)					
Measured value	Position, velocity and acceleration/option: Simultaneous multi-position, multi-velocity and multi-acceleration measurements up to 30 magnets					
Measurement parameters						
Resolution: Position	0.5...1000 µm (selectable)					
Native cycle time	Stroke length	≤ 50 mm	≤ 715 mm	≤ 2000 mm	≤ 4675 mm	≤ 7615 mm
	Cycle time	250 µs	500 µs	1000 µs	2000 µs	4000 µs
Extrapolation cycle time	Number of magnets	≤ 10 magnets	11...30 magnets			
	Cycle time	100 µs	250 µs			
Linearity deviation <sup>1</sup>	Stroke length	≤ 500 mm	> 500 mm			
	Linearity deviation	≤ ±50 µm	< 0.01 % F.S.			
	Optional internal linearity: Linearity tolerance (Applies for the first magnet for multi-position measurement)					
	Stroke length	25...300 mm	300...600 mm	600...1200 mm		
	typical	±15 µm	±20 µm	±25 µm		
	maximum	±25 µm	±30 µm	±50 µm		
Repeatability	< ±0.001 % F.S. (minimum ±2.5 µm)					
Hysteresis	< 4 µm typical					
Temperature coefficient	< 15 ppm/K typical					
Operating conditions						
Operating temperature	-40...+85 °C (-40...+185 °F)					
Humidity	100 % relative humidity, no condensation					
Ingress protection	IP68 (3 m/180 d)/IP69					
Shock test	100 g/6 ms, IEC standard 60068-2-27					
Vibration test	10 g/10...2000 Hz, IEC 60068-2-6 (excluding resonant frequencies)					
EMC test	Electromagnetic emission according to EN 61000-6-3 Electromagnetic immunity according to EN 61000-6-2 The RM5 sensors fulfill the requirements of the EMC directives 2014/30/EU, UKSI 2016 No. 1091 and TR CU 020/2011					
Operating pressure	350 bar (5076 psi)/700 bar (10,153 psi) peak (at 10 × 1 min) for sensor rod					
Magnet movement velocity	Any					
Design/Material						
Sensor electronics housing	Stainless steel 1.4404 (AISI 316L)					
Sensor flange	Stainless steel 1.4404 (AISI 316L)					
Sensor rod	Stainless steel 1.4404 (AISI 316L)					
RoHS compliance	The used materials are compliant with the requirements of EU directive 2011/65/EU and EU regulation 2015/863 as well as UKSI 2022 No. 622					
Stroke length	25...7615 mm (1...299.8 in.)					
Mechanical mounting						
Mounting position	Any					
Mounting instruction	Please consult the technical drawings and the operation manual (document number: <a href="#">552059</a> )					
Electrical connection						
Connection type	2 × cable with M12 female connector (D-coded), 1 × cable					
Operating voltage	+12...30 VDC ±20 % (9.6...36 VDC)					
Power consumption	Less than 4 W typical					
Dielectric strength	500 VDC (DC ground to machine ground)					
Polarity protection	Up to -36 VDC					
Overvoltage protection	Up to 36 VDC					

## TECHNICAL DRAWING

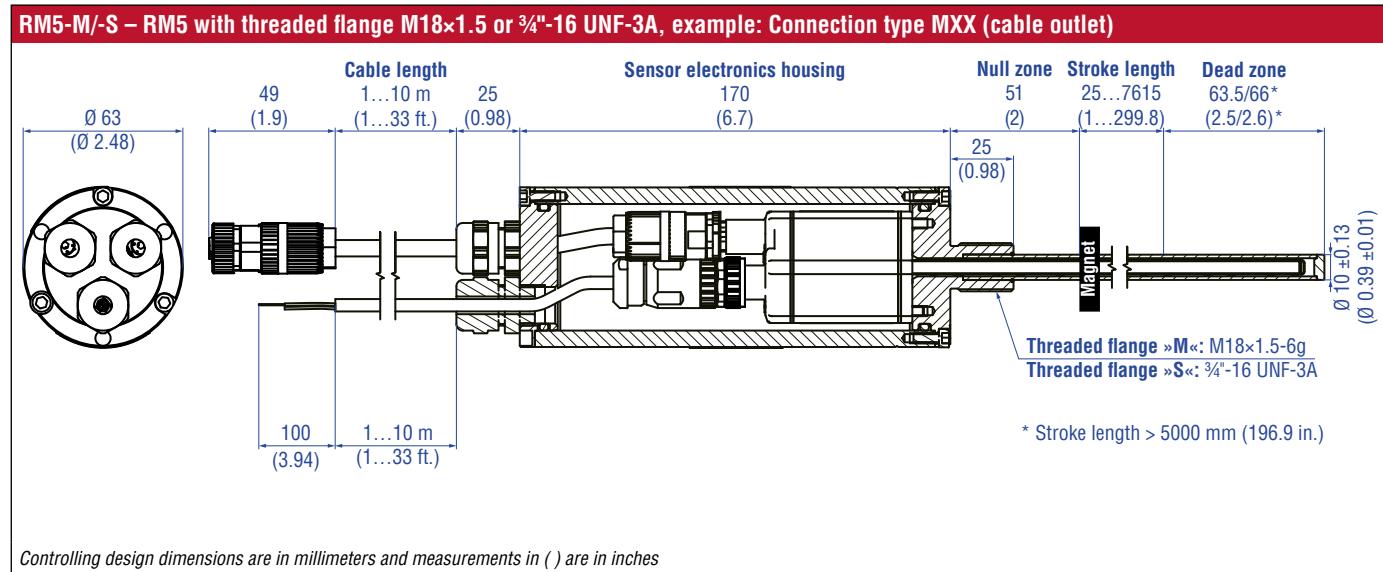


Fig. 2: Tempsonics® RM5 with ring magnet

## STRUCTURE

The RM5 EtherCAT® consists of (Fig. 3):

- 1 Super shield housing
- 2 R-Series V sensor with connector outlet (connection type D58)
- 3 Cable for direct connection to the controller (connection type MXX)

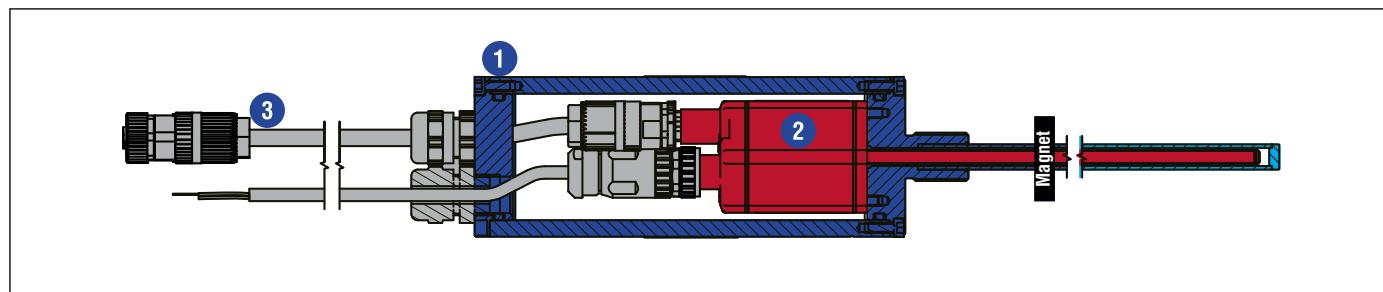


Fig. 3: Structure of RM5 EtherCAT®

## CONNECTOR WIRING

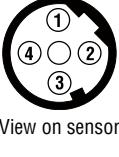
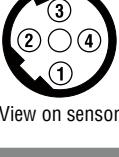
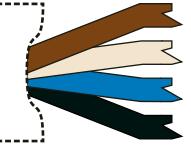
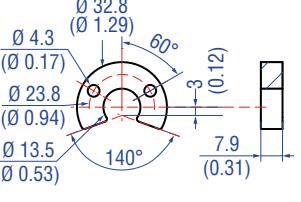
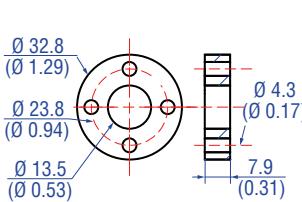
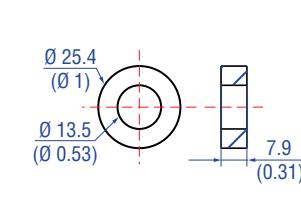
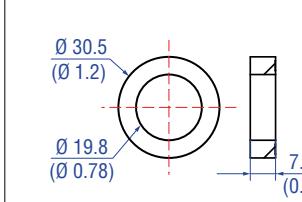
MXX		
<b>Port 1 – Signal</b>		
<b>M12 female connector (D-coded)</b>	<b>Pin</b>	<b>Function</b>
	1	Tx (+)
	2	Rx (+)
	3	Tx (-)
	4	Rx (-)
<b>Port 2 – Signal</b>		
<b>M12 female connector (D-coded)</b>	<b>Pin</b>	<b>Function</b>
	1	Tx (+)
	2	Rx (+)
	3	Tx (-)
	4	Rx (-)
<b>Power supply</b>		
<b>Cable</b>	<b>Color</b>	<b>Function</b>
	BN	+12...30 VDC ( $\pm 20\%$ )
	WH	Not connected
	BU	DC Ground (0 V)
	BK	Not connected

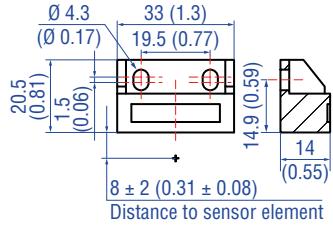
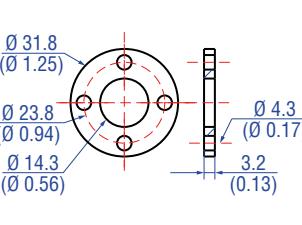
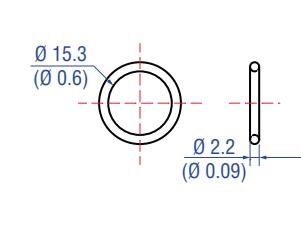
Fig. 4: Connector wiring MXX

## FREQUENTLY ORDERED ACCESSORIES

– Additional options available in our [Accessories Guide](#)  551444

### Position magnets

			
<b>U-magnet OD33</b> Part no. 251 416-2	<b>Ring magnet OD33</b> Part no. 201 542-2	<b>Ring magnet OD25.4</b> Part no. 400 533	<b>Ring magnet</b> Part no. 402 316
Material: PA ferrite GF20 Weight: Approx. 11 g Surface pressure: Max. 40 N/mm <sup>2</sup> Fastening torque for M4 screws: 1 Nm Operating temperature: -40...+105 °C (-40...+221 °F) Marked version for sensors with internal linearization: Part no. 254 226	Material: PA ferrite GF20 Weight: Approx. 14 g Surface pressure: Max. 40 N/mm <sup>2</sup> Fastening torque for M4 screws: 1 Nm Operating temperature: -40...+105 °C (-40...+221 °F) Marked version for sensors with internal linearization: Part no. 253 620	Material: PA ferrite Weight: Approx. 10 g Surface pressure: Max. 40 N/mm <sup>2</sup> Operating temperature: -40...+105 °C (-40...+221 °F) Marked version for sensors with internal linearization: Part no. 253 621	Material: PA ferrite coated Weight: Approx. 13 g Surface pressure: Max. 20 N/mm <sup>2</sup> Operating temperature: -40...+100 °C (-40...+212 °F)

Position magnet	Magnet spacer	O-rings
		
<b>Block magnet L</b> Part no. 403 448	<b>Magnet spacer</b> Part no. 400 633	<b>O-ring for threaded flange</b> M18×1.5-6g Part no. 401 133

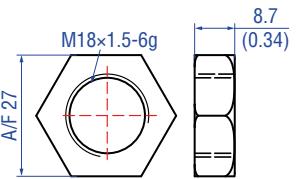
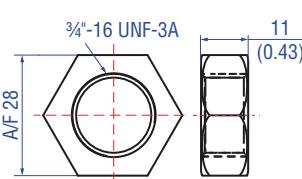
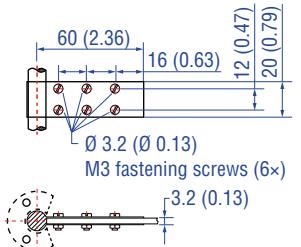
Material: Plastic carrier with hard ferrite magnet  
Weight: Approx. 20 g  
Fastening torque for M4 screws: 1 Nm  
Operating temperature:  
-40...+75 °C (-40...+167 °F)

This magnet may influence the sensor performance specifications for some applications.

Material: Aluminum  
Weight: Approx. 5 g  
Surface pressure: Max. 20 N/mm<sup>2</sup>  
Fastening torque for M4 screws: 1 Nm

Material: Fluoroelastomer  
Durometer: 75 ± 5 Shore A  
Operating temperature:  
-40...+204 °C (-40...+400 °F)

Material: Fluoroelastomer  
Durometer: 75 ± 5 Shore A  
Operating temperature:  
-40...+204 °C (-40...+400 °F)

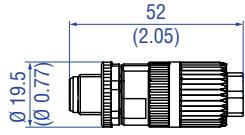
Mounting accessories		
		
<b>Hex jam nut M18x1.5-6g</b> Part no. 500 018	<b>Hex jam nut 3/4"-16 UNF-3A</b> Part no. 500 015	<b>Fixing clip</b> Part no. 561 481

Material: Steel, zinc plated

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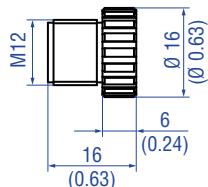
Application: Used to secure sensor rods (Ø 10 mm (Ø 0.39 in.)) when using an U-magnet or block magnet  
Material: Brass, non-magnetic

## Cable connectors\* – Signal



**M12 D-coded male connector (4 pin), straight**  
Part no. 370 523

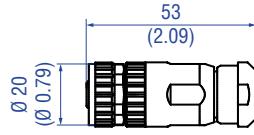
Material: Zinc nickel-plated  
Termination: Insulation-displacement  
Cable Ø: 5.5...7.2 mm (0.2...0.28 in.)  
Wire: 24 AWG – 22 AWG  
Operating temperature:  
-25...+85 °C (-13...+185 °F)  
Ingress protection: IP65 / IP67  
(correctly fitted)  
Fastening torque: 0.6 Nm



**M12 connector end cap**  
Part no. 370 537

Female connectors M12 should be covered by this protective cap  
Material: Brass nickel-plated  
Ingress protection: IP67 (correctly fitted)  
Fastening torque: 0.39...0.49 Nm

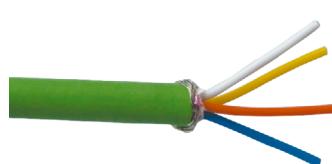
## Cable connectors\* – Power



**M12 A-coded female connector (4 pin/5 pin), straight**  
Part no. 370 677

Material: GD-Zn, Ni  
Termination: Screw  
Contact insert: CuZn  
Cable Ø: 4...8 mm (0.16...0.31 in.)  
Wire: 1.5 mm<sup>2</sup>  
Operating temperature:  
-30...+85 °C (-22...+185 °F)  
Ingress protection: IP67 (correctly fitted)  
Fastening torque: 0.6 Nm

## Cables



**PUR signal cable**  
Part no. 530 125

Material: PUR jacket; green  
Features: Cat 5, highly flexible, halogen free, suitable for drag chains, mostly oil & flame resistant  
Cable Ø: 6.5 mm (0.26 in.)  
Cross section: 2 x 2 x 0.35 mm<sup>2</sup>  
(22 AWG)  
Bending radius: 5 x D (fixed installation)  
Operating temperature:  
-20...+60 °C (-4...+140 °F)



**PVC power cable**  
Part no. 530 108

Material: PVC jacket; gray  
Features: Shielded, flexible, mostly flame resistant  
Cable Ø: 4.9 mm (0.19 in.)  
Cross section: 3 x 0.34 mm<sup>2</sup>  
Bending radius: 5 x D (fixed installation)  
Operating temperature:  
-30...+80 °C (-22...+176 °F)

## Cable sets



**Signal cable with M12 D-coded male connector (4 pin), straight – M12 D-coded, male connector (4 pin), straight**  
Part no. 530 064

Material: PUR jacket; green  
Features: Cat 5e  
Cable length: 5 m (16.4 ft)  
Cable Ø: 6.5 mm (0.26 in.)  
Ingress protection: IP65, IP67, IP68 (correctly fitted)  
Operating temperature:  
-30...+70 °C (-22...+158 °F)



**Signal cable with M12 D-coded male connector (4 pin), straight – RJ45 male connector, straight**  
Part no. 530 065

Material: PUR jacket; green  
Features: Cat 5e  
Cable length: 5 m (16.4 ft)  
Cable Ø: 6.5 mm (0.26 in.)  
Ingress protection M12 connector:  
IP67 (correctly fitted)  
Ingress protection RJ45 connector:  
IP20 (correctly fitted)  
Operating temperature:  
-30...+70 °C (-22...+158 °F)

\*/ Follow the manufacturer's mounting instructions

Controlling design dimensions are in millimeters and measurements in ( ) are in inches

Color of connectors and cable jacket may change. Color codes for the individual wires and technical properties remain unchanged.

Cable sets	Programming tools	
 <p><b>Power cable with M12 A-coded female connector (5 pin), straight – pigtail</b> Part no. 370 673</p> <p>Material: PUR jacket; black Features: Shielded Cable length: 5 m (16.4 ft) Ingress protection: IP67 (correctly fitted) Operating temperature: -25...+80 °C (-13...+176 °F)</p>	 <p><b>TempoLink® kit for Temposonics® R-Series V</b> Part no. TL-1-0-EM08 (D56) Part no. TL-1-0-EM12 (D58)</p> <ul style="list-style-type: none"> <li>• Connect wirelessly via Wi-Fi enabled device or via USB with the diagnostic tool</li> <li>• Simple connectivity to the sensor via 24 VDC power line (permissible cable length: 30 m)</li> <li>• User friendly interface for mobile devices and desktop computers</li> <li>• See data sheet “TempoLink® smart assistant” (document part no.: <a href="#">552070</a>) for further information</li> </ul>	 <p><b>TempoGate® smart assistant for Temposonics® R-Series V</b> Part no. TG-C-0-Dxx (xx indicates the number of R-Series V sensors that can be connected (even numbers only))</p> <ul style="list-style-type: none"> <li>• OPC UA server for diagnostics of the R-Series V</li> <li>• For installation in the control cabinet</li> <li>• Connection via LAN and Wi-Fi</li> <li>• See data sheet “TempoGate® smart assistant” document part no.: <a href="#">552110</a> for further information</li> </ul>

Color of connectors and cable jacket may change. Color codes for the individual wires and technical properties remain unchanged.

## ORDER CODE

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

<b>a</b>	<b>Sensor model</b>	<b>f</b>	<b>Connection type</b>							
R	M	5	Super shield housing							
<b>b</b>	<b>Design</b>	<b>M</b>	<b>X</b> <b>X</b> 2 × XX m/ft. PUR cable (part no. 530 125) for data lines with M12 female connector (part no. 370 830) and 1 × XX m/ft. PVC cable (part no. 530108) for power supply M01...M10 (1...10 m/1...33 ft.) See "Frequently ordered accessories" for cable & connector specifications							
M	Threaded flange M18×1.5-6g (standard)									
S	Threaded flange 3/4"-16 UNF-3A (standard)		Encode in meters if using metric stroke length Encode in feet if using US customary stroke length							
<b>c</b>	<b>Mechanical options</b>	<b>g</b>	<b>System</b>							
A	Standard	1	Standard							
<b>d</b>	<b>Stroke length</b>	<b>h</b>	<b>Output</b>							
X	X	X	X	M	0025...7615 mm	U	1	0	1	EtherCAT®, position, velocity and acceleration (1...30 magnet(s))
<b>Standard stroke length (mm)</b>		<b>Ordering steps</b>		U	1	1	1	EtherCAT®, position, velocity and acceleration internal linearization (1...30 magnet(s))		
25...	500 mm		5 mm							
500...	750 mm		10 mm							
750...	1000 mm		25 mm							
1000...	2500 mm		50 mm							
2500...	5000 mm		100 mm							
5000...	7615 mm		250 mm							
X	X	X	X	U	001.0...299.8 in.					
<b>Standard stroke length (in.)</b>		<b>Ordering steps</b>								
1...	20 in.		0.2 in.							
20...	30 in.		0.4 in.							
30...	40 in.		1.0 in.							
40...	100 in.		2.0 in.							
100...	200 in.		4.0 in.							
200...	299.8 in.		10.0 in.							
Non-standard stroke lengths are available; must be encoded in 5 mm/0.1 in. increments.										
<b>e</b>	<b>Number of magnets</b>	<b>• Sensor</b>	Accessories have to be ordered separately.							
X	X	01...30 position(s) (1...30 magnet(s))								

## NOTICE

- Specify number of magnets for your application and order the magnets separately.
- The number of magnets is limited by the stroke length. The minimum allowed distance between magnets (i.e. front face of one to the front face of the next one) is 75 mm (3 in.).
- Use magnets of the same type for multi-position measurement..
- If the option for internal linearization (U111) in **h** "Output" is chosen, select a suitable magnet.

## DELIVERY



- Sensor
- O-ring

Accessories have to be ordered separately.

Manuals, Software & 3D Models available at:  
[www.temposonics.com](http://www.temposonics.com)

## GLOSSARY

### D

#### **Distributed Clock**

EtherCAT® uses a logical network of **Distributed Clocks (DC)** to synchronize the time on all local bus devices on the network. The EtherCAT® master usually selects the first Distributed Clock capable slave device as a Reference Clock, and then maintains a precise mapping of frame delays for all other slave devices in order to adjust their time to match the system time.

### E

#### **ESI**

The properties and functions of an EtherCAT® device are described in an ESI file (**EtherCAT® Slave Information**). The XML-based ESI file contains all relevant data that are important for the implementation of the device in the controller as well as for data exchange during operation. The ESI file of the R-Series V EtherCAT® is available on the homepage [www.tempsonics.com](http://www.tempsonics.com).

#### **EtherCAT®**

EtherCAT® (**Ethernet for Control Automation Technology**) is an Industrial Ethernet interface and is managed by the **EtherCAT® Technology Group (ETG)**. The R-Series V EtherCAT® and its corresponding ESI file are certitifited by the ETG.

#### **Extrapolation**

The native measurement cycle time of a sensor increases with the stroke length. With extrapolation, the sensor is able to report data faster than the native cycle time, independent of the stroke length of the sensor. Without extrapolation, if data is requested faster than the native cycle time, the last measured value is repeated.

### I

#### **Internal Linearization**

The internal linearization offers an improved linearity for an overall higher accuracy of the position measurement. The internal linearization is set for the sensor during production.

### M

#### **Multi-position measurement**

During the measurement cycle, the positions of every magnet on the sensor are simultaneously reported. The velocity and acceleration are continuously calculated based on these changing position values as the magnets are moved.



# Temposonics

AN AMPHENOL COMPANY

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ISO 9001  
CERTIFIED



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