



# Temposonics

AN AMPHENOL COMPANY

## Data Sheet

### R-Series V RH5 EtherCAT®

#### Magnetostrictive Linear Position Sensors

- Minimum resolution of 0.5 µm with down to 100 µs cycle time
- Position, velocity and acceleration measurements for up to 30 magnets
- Field adjustments and diagnostics using the new TempoLink® smart assistant



**V**  
THE NEW 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 supporting electronics. The magnet, connected to the object in motion in the application, generates a magnetic field at its location on the waveguide. A short current pulse is applied to the waveguide. This creates a momentary radial magnetic field and torsional strain on the waveguide. The momentary interaction of the magnetic fields releases a torsional strain pulse that propagates the length of the waveguide. When the ultrasonic wave reaches the end of the waveguide it is converted into an electrical signal. Since the speed of the ultrasonic wave in the waveguide is precisely known, the time required to receive the return signal can be converted into a linear position measurement with both high accuracy and repeatability.

## R-SERIES V EtherCAT®

Tempsonics® R-Series V brings very powerful sensor performance to meet the many demands of your application. The R-Series V is the long term solution for harsh environments that have high levels of shock and vibration. The sensor supports the EtherCAT® specifications including distributed clock. The mechanism of distributed clocks enables a synchronized communication with a minimum cycle time as fast as 100 µs. For time-critical applications R-Series V with extrapolation allows synchronized controller communication for any stroke length of the sensor. In addition to position and velocity, the acceleration for up to 30 magnets can also be reported. Tempsonics® R-Series V sensors are available with internal linearization which offers improved linearity for overall higher accuracy of the position measurement values. In addition to the measured position value via the EtherCAT® protocol further data about the current sensor status, such like the total distance travelled, the internal temperature and the total operating hours, can be utilized for diagnostic purposes.

With many outstanding features the R-Series V sensors are fit for a very broad range of applications.

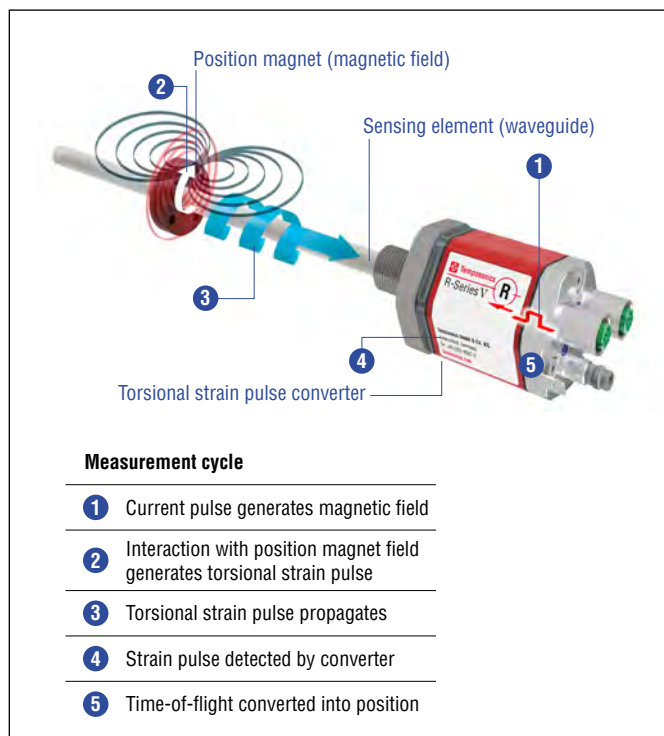


Fig. 1: Time-of-flight based magnetostrictive position sensing principle

## TempoLink YOUR SMART ASSISTANT

The TempoLink smart assistant is an accessory for the R-Series V family of sensors that supports setup and diagnostics. Depending on the sensor protocol it enables the adjustment of parameters like measurement direction, resolution and filter settings. For diagnostics and analysis of operational data the R-Series V sensors continuously track values such as total distance traveled by the position magnet, internal temperature of the sensor and the quality of the position signal. This additional information can be read out via TempoLink smart assistant even while the sensor remains operational in the application.

TempoLink smart assistant is connected to the sensor via the power connection, which now adds bidirectional communication for setup and diagnostics. The TempoLink smart assistant is operated using a graphical user-interface that will be displayed on your smartphone, tablet, laptop or PC. Just connect your Wi-Fi-enabled device to TempoLink Wi-Fi access point and go to the website URL for the user-interface.



Fig. 2: R-Series V sensor with TempoLink Smart Assistant

## TECHNICAL DATA

Output						
Interface	EtherCAT® Ethernet Control Automation Technology					
Data protocol	EtherCAT® 100 Base-Tx, Fast Ethernet					
Data transmission rate	100 MBit/s max.					
Measured value	Simultaneous position, velocity and acceleration for 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	≤ 7620 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	90 % relative humidity, no condensation					
Ingress protection	IP67 (connectors correctly fitted)					
Shock test	150 g/11 ms, IEC standard 60068-2-27					
Vibration test	30 g/10...2000 Hz, IEC 60068-2-6 (excluding resonant frequencies)/ RH5-J: 15 g / 10...2000 Hz, IEC standard 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 sensor meets the requirements of the EU directives and is marked with <b>CE</b>					
Operating pressure	350 bar (5,076 psi)/700 bar (10,153 psi) peak (at 10 × 1 min) for sensor rod/RH5-J: 800 bar (11,603 psi)					
Magnet movement velocity	Any					
Design/Material						
Sensor electronics housing	Aluminum (painted), zinc die cast					
Sensor flange	Stainless steel 1.4305 (AISI 303)					
Sensor rod	Stainless steel 1.4306/1.4307 (AISI 304L)/RH5-J: Stainless steel 1.4301 (AISI 304)					
Stroke length	25...7620 mm (1...300 in.)/RH5-J: 25...5900 mm (1...232 in.)					
Mechanical mounting						
Mounting position	Any					
Mounting instruction	Please consult the technical drawings on <a href="#">page 4</a>					
Electrical connection						
Connection type	2 × M12 female connectors (5 pin), 1 × M8 male connector (4 pin) or 2 × M12 female connectors (5 pin), 1 × M12 male connector (4 pin)					
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					

1/ With position magnet # 251 416-2

TECHNICAL DRAWING

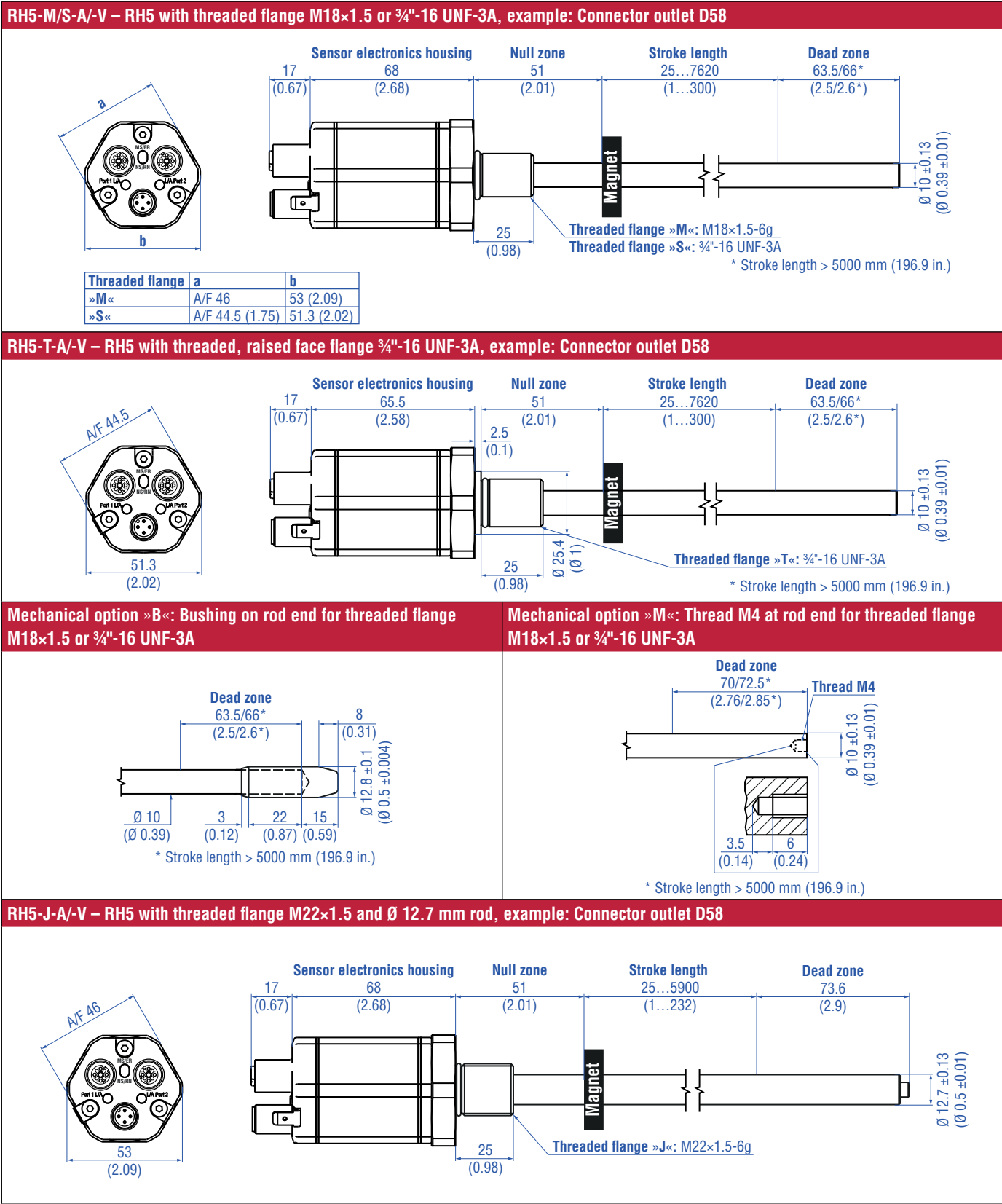


Fig. 3: Temposonics® RH5 with ring magnet

CONNECTOR WIRING

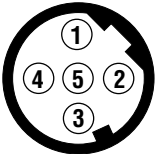
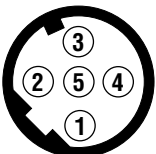

D56		
Port 1 – Signal		
M12 female connector (D-coded)	Pin	Function
	1	Tx (+)
	2	Rx (+)
	3	Tx (-)
	4	Rx (-)
	5	Not connected
Port 2 – Signal		
M12 female connector (D-coded)	Pin	Function
	1	Tx (+)
	2	Rx (+)
	3	Tx (-)
	4	Rx (-)
	5	Not connected
Power supply		
M8 male connector	Pin	Function
	1	+12...30 VDC (±20 %)
	2	Not connected
	3	DC Ground (0 V)
	4	Not connected

Fig. 4: Connector wiring D56



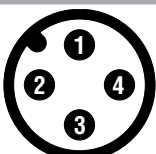
D58		
Port 1 – Signal		
M12 female connector (D-coded)	Pin	Function
	1	Tx (+)
	2	Rx (+)
	3	Tx (-)
	4	Rx (-)
	5	Not connected
Port 2 – Signal		
M12 female connector (D-coded)	Pin	Function
	1	Tx (+)
	2	Rx (+)
	3	Tx (-)
	4	Rx (-)
	5	Not connected
Power supply		
M12 male connector (A-coded)	Pin	Function
	1	+12...30 VDC (±20 %)
	2	Not connected
	3	DC Ground (0 V)
	4	Not connected

Fig. 5: Connector wiring D58

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

### Position magnets

<b>U-magnet OD33</b> Part no. 251 416-2  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	<b>Ring magnet OD33</b> Part no. 201 542-2  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	<b>Ring magnet OD25.4</b> Part no. 400 533  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	<b>Ring magnet</b> Part no. 402 316  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

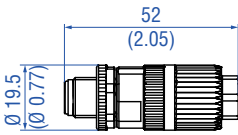
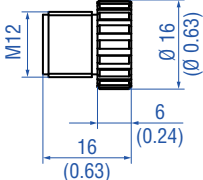
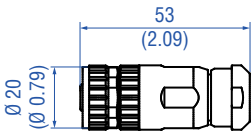
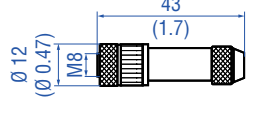
<b>Block magnet L</b> Part no. 403 448  Material: Plastic carrier with hard ferrite magnet Weight: Approx. 20 g Fastening torque for M4 screws: 1 Nm Operating temperature: -40...+75 °C (-40...+167 °F) This magnet may influence the sensor performance specifications for some applications.	<b>Magnet spacer</b> Part no. 400 633  Material: Aluminum Weight: Approx. 5 g Surface pressure: Max. 20 N/mm <sup>2</sup> Fastening torque for M4 screws: 1 Nm	<b>O-ring for threaded flange</b> M18x1.5-6g Part no. 401 133  Material: Fluoroelastomer Durometer: 75 ± 5 Shore A Operating temperature: -40...+204 °C (-40...+400 °F)	<b>O-ring for threaded flange</b> ¾"-16 UNF-3A Part no. 560 315  Material: Fluoroelastomer Durometer: 75 ± 5 Shore A Operating temperature: -40...+204 °C (-40...+400 °F)

### O-ring

### Mounting accessories





<b>O-ring for threaded flange</b> M22x1.5-6g Part no. 561 337  Material: FPM Durometer: 75 Shore A Operating temperature: -20...+200 °C (-6...+392 °F)	<b>Hex jam nut M18x1.5-6g</b> Part no. 500 018  Material: Steel, zinc plated	<b>Hex jam nut ¾"-16 UNF-3A</b> Part no. 500 015  Material: Zinc plated	<b>Fixing clip</b> Part no. 561 481  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\*

 <p>Dimensions: 52 (2.05) mm length, 19.5 (0.77) mm diameter, 16 (0.63) mm mounting hole offset.</p>	 <p>Dimensions: 16 (0.63) mm length, 6 (0.24) mm mounting hole offset, 16 (0.63) mm diameter.</p>	 <p>Dimensions: 53 (2.09) mm length, 20 (0.79) mm diameter.</p>	 <p>Dimensions: 43 (1.7) mm length, 12 (0.47) mm diameter, M8 thread.</p>
<p><b>Signal connector M12 D-coded male (4 pin), straight</b> Part no. 370 523</p> <p>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</p>	<p><b>Signal connector M12 end cap</b> Part no. 370 537</p> <p>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</p>	<p><b>Power connector M12 A-coded female (5 pin), straight</b> Part no. 370 677</p> <p>Material: GD-Zn, Ni Termination: Screw Contact insert: CuZn Cable Ø: 4...8 mm (0.16...0.31 in.) Wire: 1.5 mm² Operating temperature: –30...+85 °C (–22...+185 °F) Ingress protection: IP67 (correctly fitted) Fastening torque: 0.6 Nm</p>	<p><b>Power connector M8 female (4 pin), straight</b> Part no. 370 504</p> <p>Material: CuZn nickel plated Termination: Solder Cable Ø: 3.5...5 mm (0.14...0.28 in.) Wire: 0.25 mm² Operating temperature: –40...+85 °C (–40...+185 °F) Ingress protection: IP67 (correctly fitted) Fastening torque: 0.5 Nm</p>

## Programming kit

## Cables



			
<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 product brief “TempoLink smart assistant” (document part no.: <a href="#">551976</a>) for further information</li> </ul>	<p><b>PUR signal cable</b> Part no. 530 125</p> <p>Material: PUR jacket; green Features: Cat 5, highly flexible, halogen free, energy chain capable, mostly oil &amp; flame resistant Cable Ø: 6.5 mm (0.26 in.) Cross section: 2 × 2 × 0.35 mm² (22 AWG) Operating temperature: –20...+60 °C (–4...+140 °F)</p>	<p><b>Signal cable with M12 D-coded male connector (4 pin), straight – M12 D-coded, male connector (4 pin), straight</b> Part no. 530 064</p> <p>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)</p>	<p><b>Signal cable with M12 D-coded male connector (4 pin), straight – RJ45 male connector, straight</b> Part no. 530 065</p> <p>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)</p>

\*/ Follow the manufacturer's mounting instructions

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



Cables

	
<p> <b>PVC power cable</b>  <b>Part no. 530 108</b> </p>	<p> <b>Power cable with M8 female connector</b>  <b>(4 pin), straight – pigtail</b>  <b>Part no. 530 066 (5 m (16.4 ft.))</b>  <b>Part no. 530 096 (10 m (32.8 ft.))</b>  <b>Part no. 530 093 (15 m (49.2 ft.))</b> </p>
<p>                     Material: PVC jacket; gray                      Features: Shielded, flexible, mostly flame resistant                      Cable Ø: 4.9 mm (0.19 in.)                      Cross section: 3 × 0.34 mm<sup>2</sup>                      Bending radius: 10 × D                      Operating temperature:                      –30...+80 °C (–22...+176 °F)                 </p>	<p>                     Material: PUR jacket; gray                      Features: Shielded                      Cable Ø: 8 mm (0.3 in.)                      Operating temperature:                      –40...+90 °C (–40...+194 °F)                 </p>



## ORDER CODE

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

a	Sensor model
R H 5	Rod

b	Design
B	Base unit (only for replacement)
J	Threaded flange M22×1.5-6g (rod Ø 12.7 mm), stroke length: 25...5900 mm (1...232 in.)
M	Threaded flange M18×1.5-6g (standard)
S	Threaded flange ¾"-16 UNF-3A (standard)
T	Threaded flange ¾"-16 UNF-3A (with raised-face)

c	Mechanical options
A	Standard
B	Bushing on rod end (only for design »M«, »S« & »T«)
M	Thread M4 at rod end (only for design »M«, »S« & »T«)
V	Fluorelastomer seals for the sensor electronics housing

d	Stroke length
X X X X M	0025...7620 mm
Standard stroke length (mm)	
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...7620 mm	250 mm
X X X X U	001.0...300.0 mm
Standard stroke length (in.)	
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...300 in.	10.0 in.
Non-standard stroke lengths are available; must be encoded in 5 mm/0.1 in. increments.	

e	Number of magnets
X X	01...30 Position(s) (1...30 magnet(s))

f	Connection type
D 5 6	2 × M12 female connectors (5 pin), 1 × M8 male connector (4 pin)
D 5 8	2 × M12 female connectors (5 pin), 1 × M12 male connector (4 pin)

g	System
1	Standard

h	Output
U 1 0 1	EtherCAT®, position, velocity and acceleration (1...30 positions)
U 1 1 1	EtherCAT®, position, velocity and acceleration internal linearization (1...30 positions)

### NOTICE

- Specify number of magnets for your sensing application and order 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, e.g. 2 × U-magnet (part no. 251 416-2).
- If the option for internal linearization (U111) in **h** "Output" is chosen, select a suitable magnet.

## DELIVERY



### RH5-B:

- Base unit (without flange/rod assembly)
- 3 socket screws M4

### RH5-J/-M/-S/-T:

- 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 to synchronize the time on all local bus devices on the network. The EtherCAT® master selects the first 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.temposonics.com](http://www.temposonics.com).

#### **EtherCAT®**

EtherCAT® (**E**thernet for **C**ontrol **A**utomation **T**echnology) 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 certified 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.

### 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.



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**EtherCAT®**  
Conformance tested

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