

## Data Sheet

### **R-Series V RP5 EtherCAT®** Magnetostrictive Linear Position Sensors

- Minimum resolution of 0.5  $\mu\text{m}$  with down to 100  $\mu\text{s}$  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 Temposonics rely on the company's proprietary 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 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®

Temposonics® 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. Temposonics® 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.

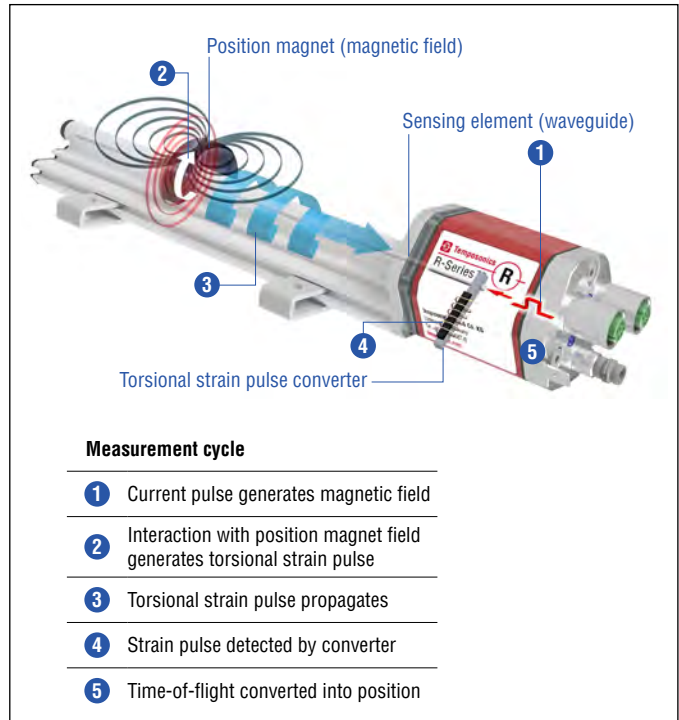


Fig. 1: Time-of-flight based magnetostrictive position sensing principle

## 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	≤ 6350 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	1200...3000 mm	3000...5000 mm	5000...6350 mm
	typical	±15 µm	±20 µm	±25 µm	±45 µm	±85 µm	±95 µm
	maximum	±25 µm	±30 µm	±50 µm	±90 µm	±150 µm	±190 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)						
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>						
Magnet movement velocity	Magnet slider: Max. 10 m/s; U-magnet: Any; block magnet: Any						
Design/Material							
Sensor electronics housing	Aluminum (painted), zinc die cast						
Sensor profile	Aluminum						
Stroke length	25...6350 mm (1...250 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

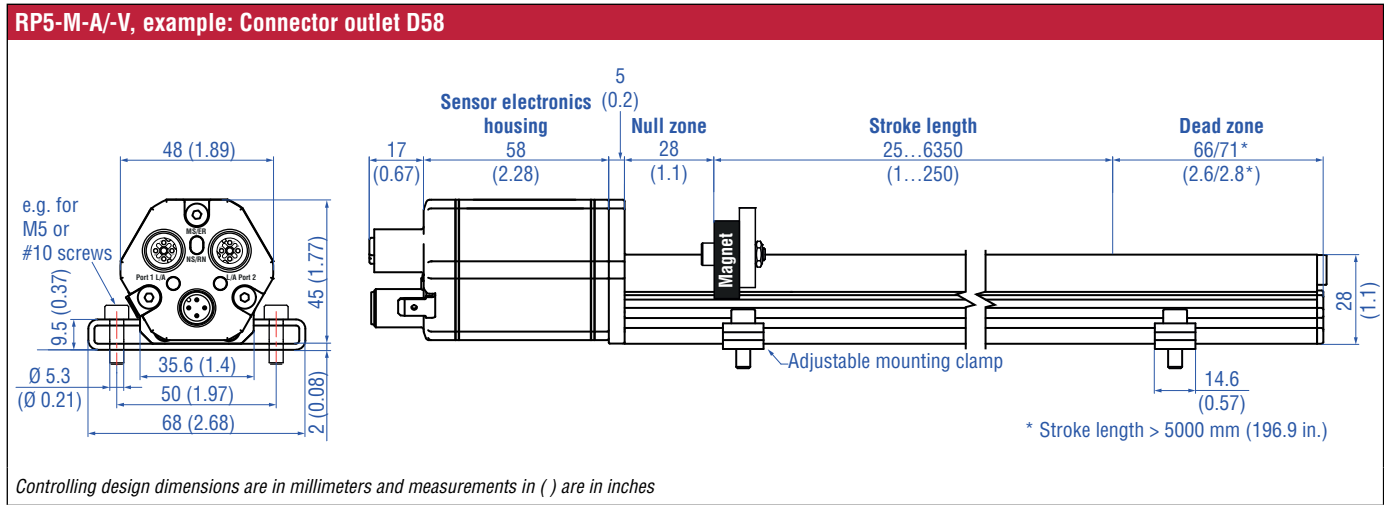


Fig. 3: Temposonics® RP5 with U-magnet


## CONNECTOR WIRING

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

Fig. 4: Connector wiring D56

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

Fig. 5: Connector wiring D58

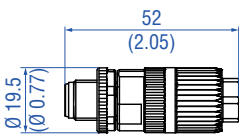
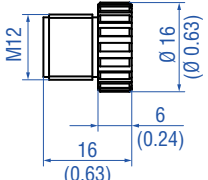
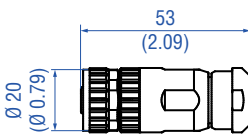
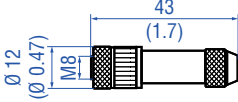
**FREQUENTLY ORDERED ACCESSORIES** – Additional options available in our [Accessories Guide](#)  551444

Position magnets			
<p><b>Magnet slider S, joint at top</b> Part no. 252 182</p>	<p><b>Magnet slider V, joint at front</b> Part no. 252 184</p>	<p><b>Magnet slider N longer ball-joint arm</b> Part no. 252 183</p>	<p><b>Magnet slider G, backlash free</b> Part no. 253 421</p>
<p>Material: GRP, magnet hard ferrite Weight: Approx. 35 g Operating temperature: -40...+85 °C (-40...+185 °F)</p>	<p>Material: GRP, magnet hard ferrite Weight: Approx. 35 g Operating temperature: -40...+85 °C (-40...+185 °F)</p>	<p>Material: GRP, magnet hard ferrite Weight: Approx. 35 g Operating temperature: -40...+85 °C (-40...+185 °F)</p>	<p>Material: GRP, magnet hard ferrite Weight: Approx. 25 g Operating temperature: -40...+85 °C (-40...+185 °F)</p>

Position magnets	Mounting accessories		
<p><b>U-magnet OD33</b> Part no. 251 416-2</p>	<p><b>Block magnet L</b> Part no. 403 448</p>	<p><b>Mounting clamp</b> Part no. 400 802</p>	<p><b>T-nut</b> Part no. 401 602</p>
<p>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)</p> <p>Marked version for sensors with internal linearization: Part no. 254 226</p>	<p>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.</p>	<p>Material: Stainless steel (AISI 304)</p>	<p>Fastening torque for M5 screw: 4.5 Nm</p>





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

**Cable connectors\***

			
<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 mm<sup>2</sup> 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 mm<sup>2</sup> 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 mm<sup>2</sup> (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



**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 × 0.34 mm<sup>2</sup>  
Bending radius: 10 × D  
Operating temperature:  
-30...+80 °C (-22...+176 °F)



**Power cable with M8 female connector**  
**(4 pin), straight – pigtail**  
**Part no. 530 066 (5 m (16.4 ft.))**  
**Part no. 530 096 (10 m (32.8 ft.))**  
**Part no. 530 093 (15 m (49.2 ft.))**

Material: PUR jacket; gray  
Features: Shielded  
Cable Ø: 8 mm (0.3 in.)  
Operating temperature:  
-40...+90 °C (-40...+194 °F)

## ORDER CODE

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

<b>a</b>	<b>Sensor model</b>		
R	P	5	Profile

<b>b</b>	<b>Design</b>
G	Magnet slider backlash free (part no. 253 421), suitable for internal linearization
L	Block magnet L (part no. 403 448)
M	U-magnet OD33 (part no. 251 416-2), suitable for internal linearization
N	Magnet slider longer ball-jointed arm (part no. 252 183), suitable for internal linearization
O	No position magnet
S	Magnet slider joint at top (part no. 252 182), suitable for internal linearization
V	Magnet slider joint at front (part no. 252 184), suitable for internal linearization

<b>c</b>	<b>Mechanical options</b>
A	Standard
V	Fluorelastomer seals for the sensor electronics housing

<b>d</b>	<b>Stroke length</b>				
X	X	X	X	M	0025...6350 mm
<b>Standard stroke length (mm)</b>		<b>Ordering steps</b>			
25... 500 mm		25 mm			
500...2500 mm		50 mm			
2500...5000 mm		100 mm			
5000...6350 mm		250 mm			

X	X	X	X	U	001.0...250.0 in.
<b>Standard stroke length (in.)</b>		<b>Ordering steps</b>			
1... 20 in.		1.0 in.			
20...100 in.		2.0 in.			
100...200 in.		4.0 in.			
200...250 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>	
X	X	01...30 Position(s) (1...30 magnet(s))

<b>f</b>	<b>Connection type</b>		
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)

<b>g</b>	<b>System</b>
1	Standard

<b>h</b>	<b>Output</b>			
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

- For the RP5, the magnet selected in **b** "Design" is included in the scope of delivery. For multi-position measurements with more than 1 magnet, order the other 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, 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



- Sensor
  - Position magnet (not valid for RP5 with design »O«)
  - 2 mounting clamps up to 1250 mm (50 in.) stroke length  
+ 1 mounting clamp for each 500 mm (20 in.) additional stroke length
- 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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