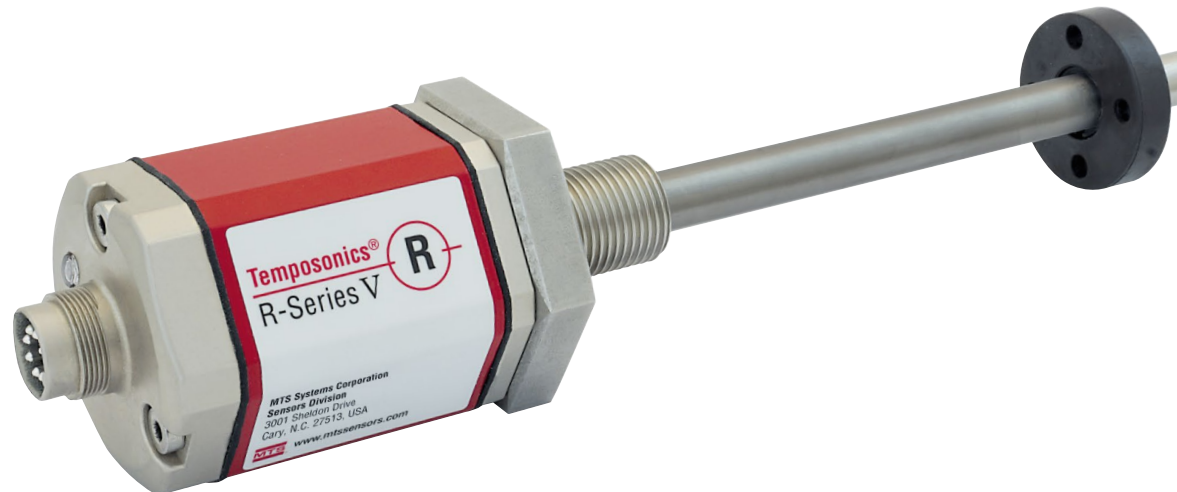


# Temposonics®

Magnetostrictive Linear Position Sensors

## R-Series V RH5 SSI Data Sheet

- Position measurement with a resolution up to 0.1  $\mu\text{m}$
- Update rate up to 10 kHz
- Field adjustments and diagnostics using the new TempoLink smart assistant



**V**  
THE NEW GENERATION

## MEASURING TECHNOLOGY

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 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.

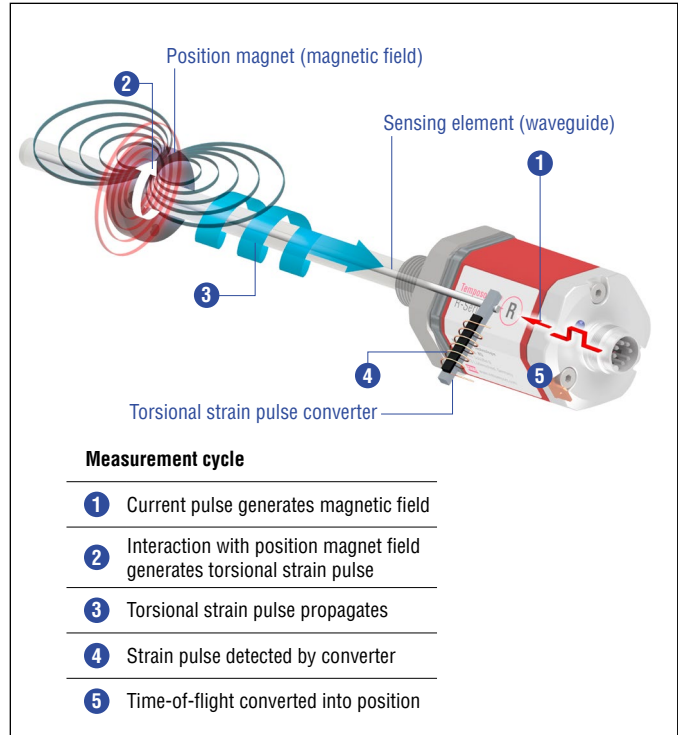


Fig. 1: Time-of-flight based magnetostrictive position sensing principle

## R-SERIES V SSI

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 with SSI output (Synchronous Serial Interface) is characterized by a very stable position signal with a minimum resolution of 0.1 µm. The sensor offers one asynchronous mode as well as three different synchronous modes for measurement. The synchronous modes also support linear extrapolation. This allows a cycle time of 100 µs or the readout of the data with up to 10 kHz for any stroke length of the sensor. Temposonics® R-Series V sensors are available with internal linearization which offers improved linearity for overall higher accuracy of the position measurement value.

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

## 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	SSI (Synchronous Serial Interface) – differential signal in SSI standard (RS-485/RS-422)						
Data format	Binary or gray						
Data length	8...32 bit						
Data transmission rate	70 kBaud <sup>1</sup> ...1 MBaud, depending on cable length:						
	Cable length	< 3 m	< 50 m	< 100 m	< 200 m	< 400 m	
	Baud rate	1 MBd	< 400 kBd	< 300 kBd	< 200 kBd	< 100 kBd	
Measured value	Position						
Measurement parameters							
Resolution: Position	0.1...100 µm (0.0001...0.1 mm)						
Resolution: Velocity	0.001 mm/s (determined over 10 measured values)						
Update rate <sup>2</sup>	Stroke length	25 mm	300 mm	750 mm	1000 mm	2000 mm	7620 mm
	Update rate	10 kHz	3.4 kHz	2.7 kHz	2.1 kHz	1.2 kHz	0.3 kHz
Linearity deviation <sup>3</sup>	Stroke length	≤ 400 mm	> 400 mm				
	Linearity deviation	≤ ±40 µm	< ±0.01 % F.S.				
	Optional internal linearization: Linearity tolerance (applies for the first magnet for differential 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) typical						
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)/IP68 for cable output						
Shock test	150 g/11 ms, IEC standard 60068-2-27						
Vibration test	30 g/10...2000 Hz, IEC standard 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 EC 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 (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 5</a> and the operation manual (document number: <a href="#">552011</a> )						

Technical data “Electrical connection” on [page 4](#)

1/ With standard one shot of 16 µs

2/ Sensor with standard settings. Further information can be found in the operation manual R-Series V SSI (document number: [552011](#))

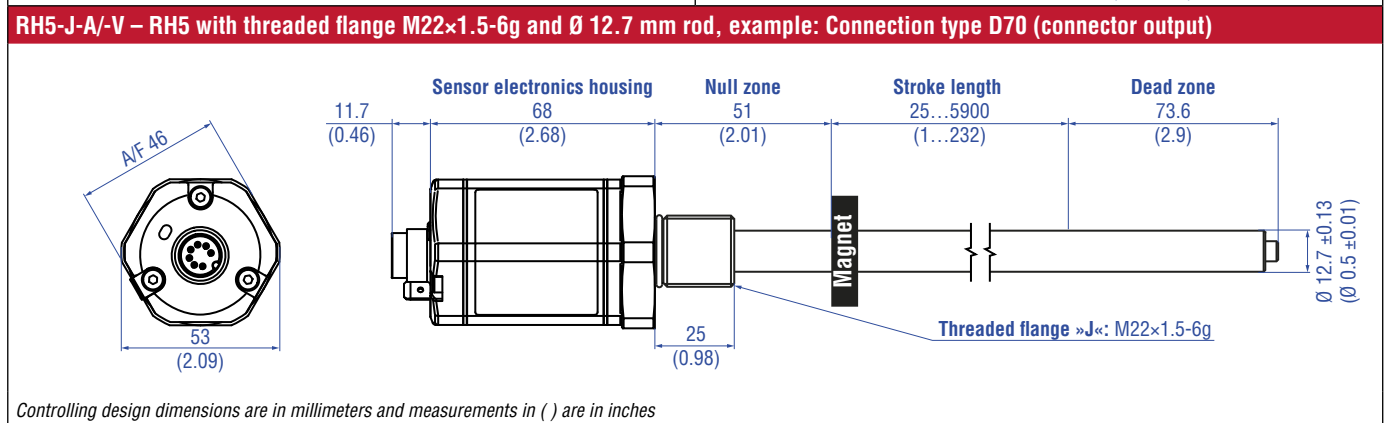
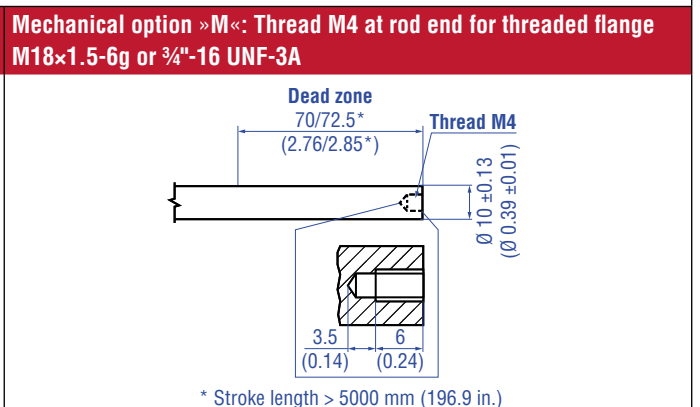
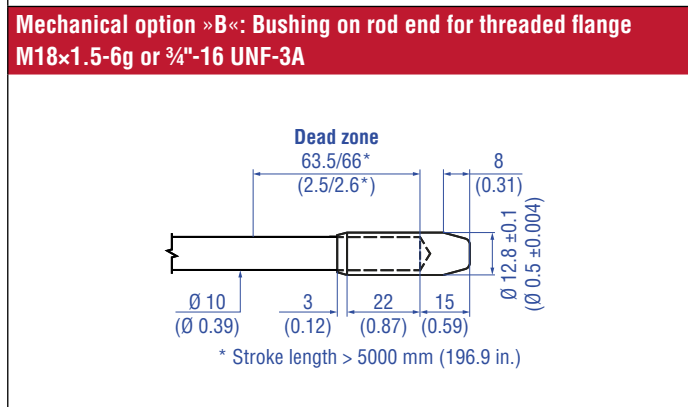
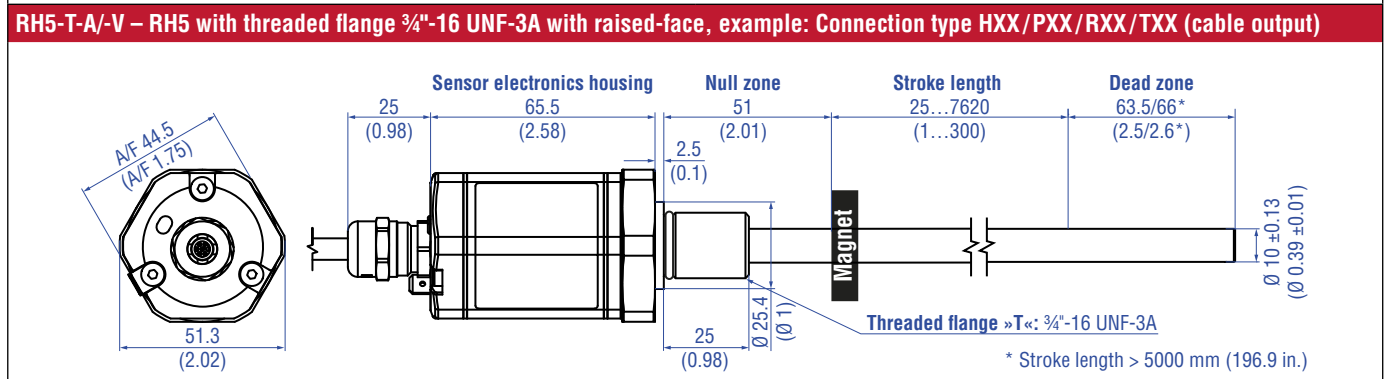
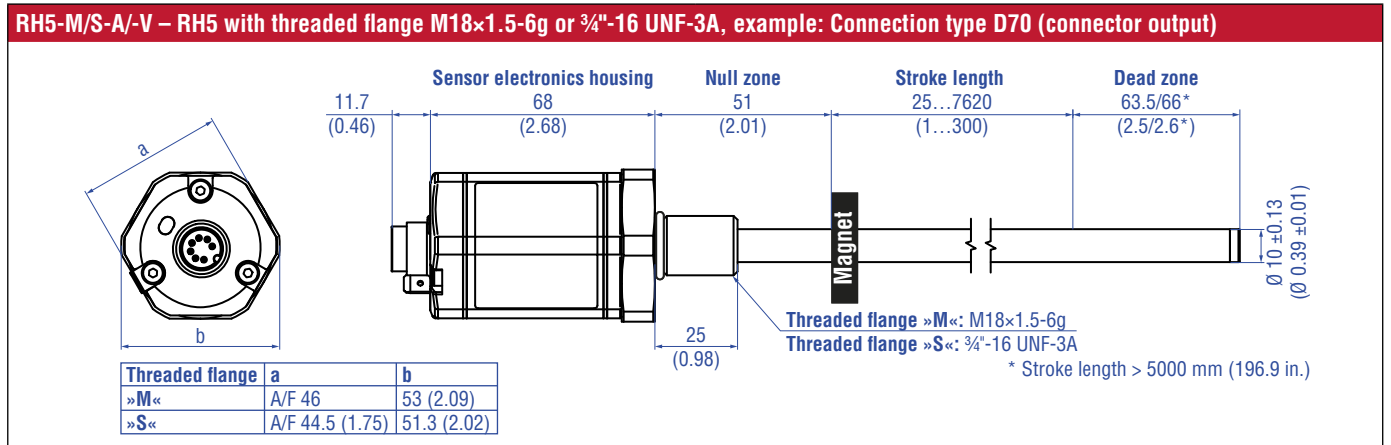
3/ With position magnet # 251 416-2

## Temposonics® R-Series V RH5 SSI

### Data Sheet

Electrical connection	
Connection type	1 × M16 male connector (7 pin) or cable output
Operating voltage	+12...30 VDC ±20 % (9.6...36 VDC)
Power consumption	1.2 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



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

Fig. 3: Temposonics® RH5 with ring magnet

## CONNECTOR WIRING


D70		
Signal + power supply		
M16 male connector	Pin	Function
 <p>View on sensor</p>	1	Data (-)
	2	Data (+)
	3	Clock (+)
	4	Clock (-)
	5	+12...30 VDC (±20 %)
	6	DC Ground (0 V)
	7	Not connected

Fig. 4: Connector wiring D70

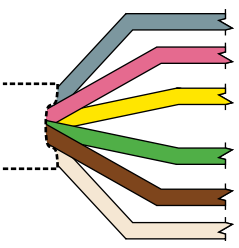
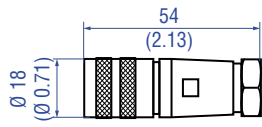
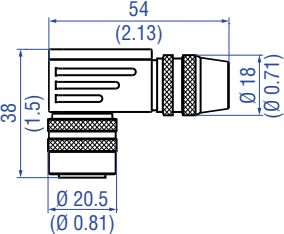

HXX / PXX / RXX / TXX		
Signal + power supply		
Cable	Color	Function
	GY	Data (-)
	PK	Data (+)
	YE	Clock (+)
	GN	Clock (-)
	BN	+12...30 VDC (±20 %)
	WH	DC Ground (0 V)
	For cable type TXX, the extra red & blue wires are not used.	

Fig. 5: Connector wiring cable output

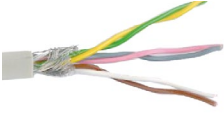
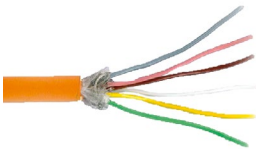

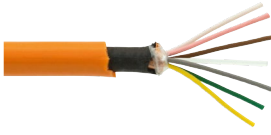
**FREQUENTLY ORDERED ACCESSORIES** – Additional options available in our [Accessories Guide](#) 551444

Position magnets			
<p><b>U-magnet OD33</b> Part no. 251 416-2</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><b>Ring magnet OD33</b> Part no. 201 542-2</p> <p>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)</p> <p>Marked version for sensors with internal linearization: Part no. 253 620</p>	<p><b>Ring magnet OD25.4</b> Part no. 400 533</p> <p>Material: PA ferrite Weight: Approx. 10 g Surface pressure: Max. 40 N/mm<sup>2</sup> Operating temperature: -40...+105 °C (-40...+221 °F)</p> <p>Marked version for sensors with internal linearization: Part no. 253 621</p>	<p><b>Ring magnet</b> Part no. 402 316</p> <p>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)</p>
Position magnet Magnet spacer O-rings			
<p><b>Block magnet L</b> Part no. 403 448</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)</p> <p>This magnet may influence the sensor performance specifications for some applications.</p>	<p><b>Magnet spacer</b> Part no. 400 633</p> <p>Material: Aluminum Weight: Approx. 5 g Surface pressure: Max. 20 N/mm<sup>2</sup> Fastening torque for M4 screws: 1 Nm</p>	<p><b>O-ring for threaded flange</b> M18×1.5-6g Part no. 401 133</p> <p>Material: Fluoroelastomer Durometer: 75 ± 5 Shore A Operating temperature: -40...+204 °C (-40...+400 °F)</p>	<p><b>O-ring for threaded flange</b> ¾"-16 UNF-3A Part no. 560 315</p> <p>Material: Fluoroelastomer Durometer: 75 ± 5 Shore A Operating temperature: -40...+204 °C (-40...+400 °F)</p>
O-ring		Mounting accessories	
<p><b>O-ring for threaded flange</b> M22×1.5-6g Part no. 561 337</p> <p>Material: FPM Durometer: 75 Shore A Operating temperature: -20...+200 °C (-6...+392 °F)</p>	<p><b>Hex jam nut M18×1.5-6g</b> Part no. 500 018</p> <p>Material: Steel, zinc plated</p>	<p><b>Hex jam nut ¾"-16 UNF-3A</b> Part no. 500 015</p> <p>Material: Steel, zinc plated</p>	<p><b>Fixing clip</b> Part no. 561 481</p> <p>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</p>

**Cable connectors\*** **Programming tool**

		
<p><b>M16 female connector (7 pin), straight</b> Part no. 370 624</p> <p>Material: Zinc nickel plated Termination: Solder Contact insert: Silver plated Cable clamp: PG9 Cable Ø: 6...8 mm (0.24...0.31 in.) Operating temperature: -40...+100 °C (-40...+212 °F) Ingress protection: IP65/IP67 (correctly fitted) Fastening torque: 0.7 Nm</p>	<p><b>M16 female connector (7 pin), angled</b> Part no. 560 779</p> <p>Material: Zinc nickel plated Termination: Solder Contact insert: Silver plated Cable clamp: PG9 Cable Ø: 6...8 mm (0.24...0.31 in.) Operating temperature: -40...+100 °C (-40...+212 °F) Ingress protection: IP65/IP67 (correctly fitted) Fastening torque: 0.7 Nm</p>	<p><b>TempoLink kit for Temposonics® R-Series V</b> Part no. TL-1-0-SD70 (for D70) Part no. TL-1-0-AS00 (for cable output)</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>

**Cables**

			
<p><b>PVC cable</b> Part no. 530 032</p> <p>Material: PVC jacket; gray Features: Twisted pair, shielded, flexible Cable Ø: 6 mm (0.23 in.) Cross section: 3 × 2 × 0.14 mm<sup>2</sup> Bending radius: 10 × D (fixed installation) Operating temperature: -40...+105 °C (-40...+221 °F)</p>	<p><b>PUR cable</b> Part no. 530 052</p> <p>Material: PUR jacket; orange Features: Twisted pair, shielded, highly flexible, halogen free, energy chain capable, mostly oil &amp; flame resistant Cable Ø: 6.4 mm (0.25 in.) Cross section: 3 × 2 × 0.25 mm<sup>2</sup> Bending radius: 5 × D (fixed installation) Operating temperature: -30...+80 °C (-22...+176 °F)</p>	<p><b>Teflon® cable</b> Part no. 530 112</p> <p>Material: Teflon® jacket; black Features: Twisted pair, shielded, flexible, high thermal resistance, mostly oil &amp; acid resistant Cable Ø: 7.6 mm (0.3 in.) Cross section: 4 × 2 × 0.25 mm<sup>2</sup> Bending radius: 8 – 10 × D (fixed installation) Operating temperature: -100...+180 °C (-148...+356 °F)</p>	<p><b>PUR cable</b> Part no. 530 175</p> <p>Material: PUR jacket; orange Features: Flexible, additional EMC protection Cable Ø: 6.5 mm (0.26 in.) Cross section: 6 × 0.14 mm<sup>2</sup> Bending radius: 10 × D (fixed installation) Operating temperature: -30...+90 °C (-22...+194 °F)</p>

\*/ Follow the manufacturer's mounting instructions

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



## ORDER CODE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27							
R	H	5													1	S																	
a			b		c		d				e		f			g	h		i		j		k		l		m		n		o		

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)	Ordering steps
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 in.
Standard stroke length (in.)	Ordering steps
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...02 position(s) (1...2 magnet(s))

f	Connection type
D 7 0	M16 male connector (7 pin)
H X X	XX m PUR cable (part no. 530 052) H01...H30 (1...30 m/3...99 ft.) See "Frequently ordered accessories" for cable specifications
P X X	XX m PUR cable (part no. 530 175) P01...P30 (1...30 m/3...99 ft.) See "Frequently ordered accessories" for cable specifications
R X X	XX m PVC cable (part no. 530 032) R01...R30 (1...30 m/3...99 ft.) See "Frequently ordered accessories" for cable specifications
T X X	XX m Teflon® cable (part no. 530 112) T01...T30 (1...30 m/3...99 ft.) See "Frequently ordered accessories" for cable specifications
Encode in meters if using metric stroke length. Encode in feet if using US customary stroke length.	

g	System
1	Standard

h	Output
S	SSI

i	Function
1	Position
2	Differential measurement (2 magnets and 1 output)
3	Velocity
4	Position and temperature in the sensor electronics housing; <b>NOTICE</b> In this case, only option <b>2</b> "24 bit" can be selected under <b>1</b> "Data length".

j	Options
0	Standard
1	Internal linearization

## Temposonics® R-Series V RH5 SSI

### Data Sheet

k	Mode
1	Measuring direction forward, asynchronous mode
2	Measuring direction forward, synchronous mode 1
3	Measuring direction forward, synchronous mode 2
4	Measuring direction forward, synchronous mode 3
5	Measuring direction reverse, asynchronous mode
6	Measuring direction reverse, synchronous mode 1
7	Measuring direction reverse, synchronous mode 2
8	Measuring direction reverse, synchronous mode 3

l	Data length
1	25 bit
2	24 bit
3	26 bit
A	24 bit + alarm bit + parity bit

m	Format
B	Binary
G	Gray

n	Resolution
1	5 µm
2	10 µm
3	50 µm
4	100 µm
5	20 µm
6	2 µm
7	0.1 µm
8	1 µm
9	0.5 µm

o	Additional options (optional)
S 0 0 2	FIR filter (2 measurements)
S 0 0 4	FIR filter (4 measurements)
S 0 0 8	FIR filter (8 measurements)
S 0 0 A	No filter, error counter (4 cycles)
S 0 0 C	No filter, error counter (8 cycles)
S 0 0 D	No filter, error counter (10 cycles)
S 0 0 G	FIR filter (8 measurements), error counter (10 cycles)
S 0 0 J	IIR filter (filter grade 4)
S 0 0 K	IIR filter (filter grade 8)
S 0 0 N	IIR filter (filter grade 4), error counter (10 cycles)

### NOTICE

- Specify the 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 differential measurement, e.g. 2 × U-magnet (part no. 251 416-2).
- If the option for internal linearization in **j** "Options" 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.mtssensors.com](http://www.mtssensors.com)

## GLOSSARY

<b>A</b>	<b>P</b>
<p><b>Alarm</b> The alarm bit is set by the sensor if the sensor detects more magnets (extra magnet) or less magnets (magnet status error) than configured.</p> <p><b>Asynchronous mode</b> In asynchronous mode the position data is continuously updated inside the sensor as quickly as the sensor's measurement cycle will allow, independent of the controller. The controller's loop time will determine when the sensor's most recent data is clocked out over the SSI interface. (→ Synchronous mode)</p>	<p><b>Parity</b> The parity bit is a check bit that is added to a bit string to detect transmission errors. There are even parity and odd parity. With even parity, the parity bit is set so that the total number of 1-bits in the bit string including the parity bit is even. In case of odd parity, the total number of 1-bits in the bit sequence including the parity bit is odd. Even parity is implemented in the R-Series V SSI.</p>
<b>D</b>	<b>S</b>
<p><b>Differential measurement</b> For differential measurement, the distance between the two position magnets is output as a value.</p>	<p><b>Synchronous Serial Interface</b> SSI (<b>S</b>ynchronous <b>S</b>erial <b>I</b>nterface) is a digital interface where the data is transferred serially. The interface of R-Series V SSI corresponds to SSI industry standard for absolute encoders. Its displacement value is encoded in a 24/25/26 bit binary or gray format and transmitted as a differential signal in SSI standard (RS-485/RS-422).</p>
<b>E</b>	
<p><b>Extrapolation</b> 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.</p>	<p><b>Synchronous mode</b> In synchronous mode the measurement and output of the sensor is matched to the data request cycle of the controller. The synchronous mode minimizes the time delay between measurement and output. The synchronous mode is required for sophisticated motion control applications. (→ Asynchronous mode)</p> <ul style="list-style-type: none"> <li>• <b>Synchronous mode 1</b> Using synchronous mode 1, the sensor determines the controller's loop timing and when data is being requested. The sensor then determines when to start the next measurement cycle so that it will complete just in time to deliver the freshest data possible.</li> <li>• <b>Synchronous mode 2</b> If new position data is required faster than the sensor's measurement cycle time, synchronous mode 2 provides extrapolated data values, calculated on the fly. A measurement value will be calculated and output to the controller whenever the sensor has not yet completed the next measurement cycle.</li> <li>• <b>Synchronous mode 3</b> Synchronous mode 3 provides an additional enhancement to the high speed update feature of synchronous mode 2. For this mode all measurements values which are output are calculated to fully compensate for the inherent lag time due to the sensor's measurement cycle.</li> </ul>
<b>F</b>	
<p><b>FIR Filter</b> The FIR filter (<b>F</b>inite <b>I</b>mpulse <b>R</b>esponse) is used to smooth the measured position value before output. To determine the output value, only input values corresponding to the window (filter window size) are used for filter calculation. The output value is calculated from these input values in the form of a moving average value. (→ IIR Filter)</p>	
<b>I</b>	
<p><b>IIR Filter</b> The IIR filter (<b>I</b>nfinite <b>I</b>mpulse <b>R</b>esponse) is used to smooth the measured position value before output. To determine the output value, the input values corresponding to the filter grade (filter window size) are used for the filter calculation. The previous values are also taken into account when calculating the output value. (→ FIR Filter)</p>	
	<b>T</b>
<p><b>Internal Linearization</b> 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.</p>	<p><b>Temperature in the sensor electronics housing</b> The temperature in the sensor electronics housing is measured in °C. With this option, the transmitted data word has a length of 32 bits, with the highest 8 bits representing the temperature value, followed by 24 bits for the position value.</p>
<b>M</b>	
<p><b>Measuring direction</b> When moving the position magnet, the position and velocity values increase in the measuring direction.</p> <ul style="list-style-type: none"> <li>• Forward: Values increasing from sensor electronics housing to rod end/profile end</li> <li>• Reverse: Values decreasing from sensor electronics housing to rod end/profile end</li> </ul>	

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