Temposonics
AN AMPHENOL COMPANY

Data Sheet

R-Series V RM5 SSI

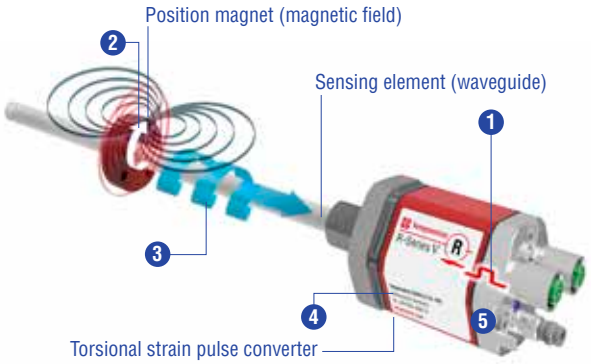
Magnetostrictive Linear Position Sensors

- Super shield housing with IP68/IP69 against ingress of dust and water
- Position measurement with a resolution up to 0.1 µm
- Update rate up to 10 kHz

THE NEW V 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 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.



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

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

R-SERIES V RM5 SSI

The Temposonics® 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 SSI scores with the following features:

Differential measurement between 2 positions
The R-Series V SSI can measure and output the distance between 2 position magnets.

R-Series V SSI
The interface of the R-Series V SSI corresponds to the SSI industry standard for absolute encoders. You can select the configuration of the SSI signal that fits best to your application and also adjust it on site with the sensor assistants.

All settings under control with the sensor 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	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 [1]…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 or velocity, position and temperature in the sensor electronics housing
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 [2]

Stroke length	25 mm	300 mm	750 mm	1000 mm	2000 mm	7615 mm
Update rate	10 kHz	3.4 kHz	2.7 kHz	2.1 kHz	1.2 kHz	0.3 kHz

Linearity deviation [3]

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	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.)

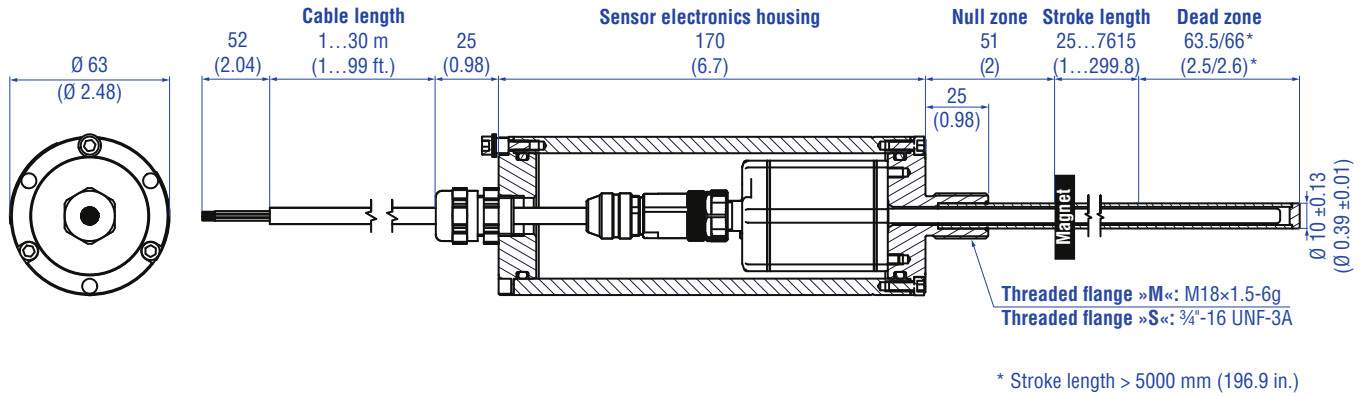
Technical data “Mechanical mounting” and “Electrical connection” on page 4

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 part number: 552011)
3/ With position magnet # 251 416-2

Mechanical mounting	
Mounting position	Any
Mounting instruction	Please consult the technical drawings and the operation manual (document number: 552011)
Electrical connection	
Connection type	Cable outlet
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

RM5-M/-S – RM5 with threaded flange M18×1.5 or ¾"-16 UNF-3A, example: Connection type HXX/PXX/RXX/TXX (cable outlet)



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

Fig. 2: Temposonics® RM5 with ring magnet

STRUCTURE

The RM5 SSI consists of (Fig. 3)

1. Super shield housing
2. R-Series V sensor with connector outlet (connection type D84)
3. Cable for direct connection to the controller (connection type HXX/PXX/RXX/TXX)

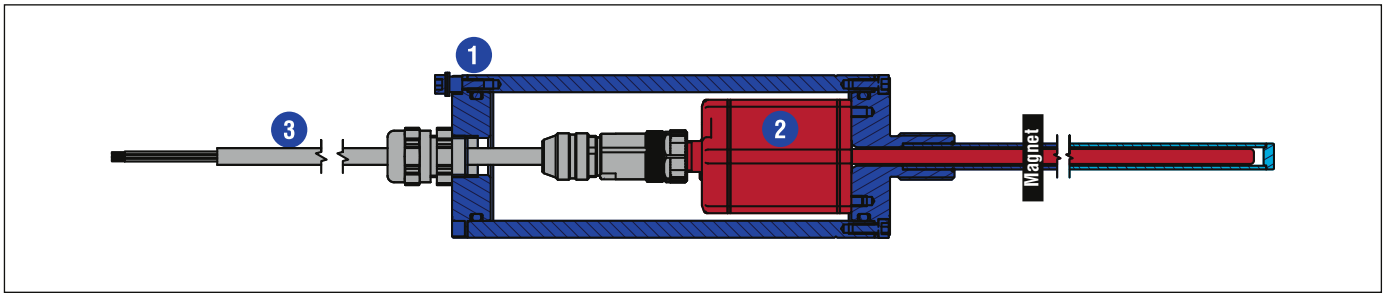


Fig. 3: Structure of RM5 SSI

CONNECTOR WIRING

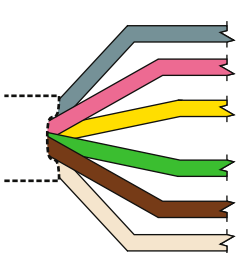
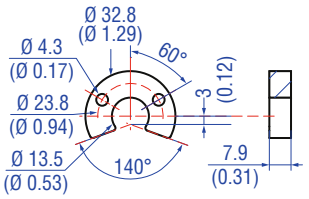
HXX/PXX/RXX/TXX		
Signal + power supply		
Cable	**Color**	**Function**
	GY	Data (–)
	PK	Data (+)
	YE	Clock (+)
	GN	Clock (–)
	BN	+12…30 VDC (±20 %)
	WH	DC Ground (0 V)
For cable type TXX, the extra red & blue wires are not used.		

Fig. 4: Connector wiring HXX/PXX/RXX/TXX

FREQUENTLY ORDERED ACCESSORIES – Additional options available in our Accessories Catalog 551444

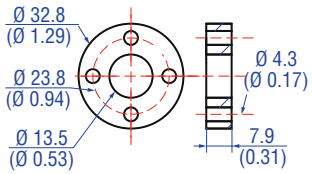
Position magnets



U-magnet OD33
Part no. 251 416-2

Material: PA ferrite GF20
Weight: Approx. 11 g
Surface pressure: Max. 40 N/mm²
Fastening torque for M4 screws: 1 Nm
Operating temperature:
–40…+105 °C (–40…+221 °F)

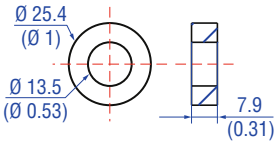
Marked version for sensors with internal linearization: Part no. 254 226



Ring magnet OD33
Part no. 201 542-2

Material: PA ferrite GF20
Weight: Approx. 14 g
Surface pressure: Max. 40 N/mm²
Fastening torque for M4 screws: 1 Nm
Operating temperature:
–40…+105 °C (–40…+221 °F)

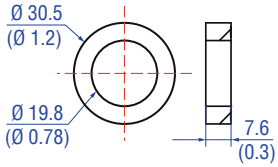
Marked version for sensors with internal linearization: Part no. 253 620



Ring magnet OD25.4
Part no. 400 533

Material: PA ferrite
Weight: Approx. 10 g
Surface pressure: Max. 40 N/mm²
Operating temperature:
–40…+105 °C (–40…+221 °F)

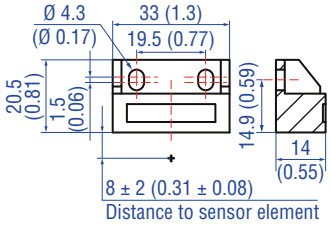
Marked version for sensors with internal linearization: Part no. 253 621



Ring magnet
Part no. 402 316

Material: PA ferrite coated
Weight: Approx. 13 g
Surface pressure: Max. 20 N/mm²
Operating temperature:
–40…+100 °C (–40…+212 °F)

Position magnet

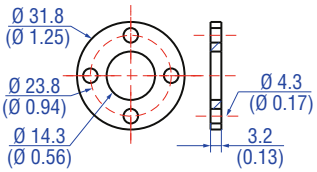


Block magnet L
Part no. 403 448

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.

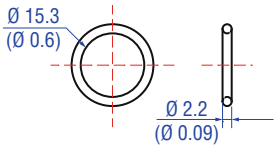
Magnet spacer



Magnet spacer
Part no. 400 633

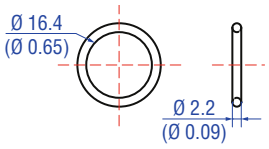
Material: Aluminum
Weight: Approx. 5 g
Surface pressure: Max. 20 N/mm²
Fastening torque for M4 screws: 1 Nm

O-rings



O-ring for threaded flange
M18×1.5-6g
Part no. 401 133

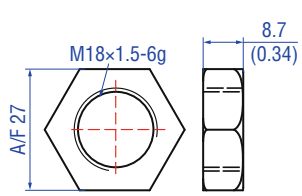
Material: Fluoroelastomer
Durometer: 75 ± 5 Shore A
Operating temperature:
–40…+204 °C (–40…+400 °F)



O-ring for threaded flange
¾"-16 UNF-3A
Part no. 560 315

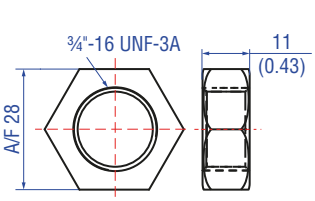
Material: Fluoroelastomer
Durometer: 75 ± 5 Shore A
Operating temperature:
–40…+204 °C (–40…+400 °F)

Mounting accessories



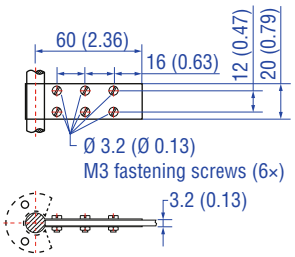
Hex jam nut M18×1.5-6g
Part no. 500 018

Material: Steel, zinc plated



Hex jam nut ¾"-16 UNF-3A
Part no. 500 015

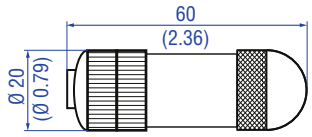
Material: Steel, zinc plated



Fixing clip
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 connector*



M12 A-coded female connector (8 pin), straight
Part no. 370 694

Housing: GD-ZnAL
Termination: Screw
Contact insert: CuZn
Cable Ø: 4…9 mm (0.16…0.35 in.)
Wire: 0.75 mm²
Operating temperature:
–25…+90 °C (–13…+194 °F)
Ingress protection: IP67 (correctly fitted)
Fastening torque: 0.6 Nm

Cables

PVC cable
Part no. 530 032

Material: PVC jacket; gray
Features: Twisted pair, shielded, flexible
Cable Ø: 6 mm (0.23 in.)
Cross section: 3 × 2 × 0.14 mm²
Bending radius: 10 × D
(fixed installation)
Operating temperature:
–40…+105 °C (–40…+221 °F)

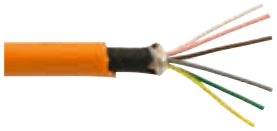
PUR cable
Part no. 530 052

Material: PUR jacket; orange
Features: Twisted pair, shielded, highly flexible, halogen free, suitable for drag chains, mostly oil & flame resistant
Cable Ø: 6.4 mm (0.25 in.)
Cross section: 3 × 2 × 0.25 mm²
Bending radius: 5 × D
(fixed installation)
Operating temperature:
–30…+80 °C (–22…+176 °F)

FEP cable
Part no. 530 112

Material: FEP jacket; black
Features: Twisted pair, shielded, flexible, high thermal resistance, mostly oil & acid resistant
Cable Ø: 7.6 mm (0.3 in.)
Cross section: 4 × 2 × 0.25 mm²
Bending radius: 8 – 10 × D
(fixed installation)
Operating temperature:
–100…+180 °C (–148…+356 °F)

Cables



PUR cable
Part no. 530 175

Material: PUR jacket; orange
Features: Flexible, additional EMC protection
Cable Ø: 6.5 mm (0.26 in.)
Cross section: 6 × 0.14 mm²
Bending radius: 10 × D
(fixed installation)
Operating temperature:
–30…+90 °C (–22…+194 °F)

Cable sets

Cable with M12 A-coded female connector (8 pin), straight – pigtail
Part no. 370 674

Material: PUR jacket; black
Features: Shielded
Cable length: 5 m (16.4 ft)
Ingress protection: IP67/IP69K (correctly fitted)
Operating temperature:
–25…+80 °C (–13…+176 °F)

Programming tools

TempoLink® kit for Temposonics® R-Series V
Part no. TL-1-0-SD70 (for D70)
Part no. TL-1-0-SD84 (for D84)
Part no. TL-1-0-AS00 (for cable outlet)

- Connect wirelessly via Wi-Fi enabled device or via USB with the diagnostic tool
- Simple connectivity to the sensor via 24 VDC power line (permissible cable length: 30 m)
- User friendly interface for mobile devices and desktop computers
- See data sheet “TempoLink® smart assistant” (document part no.: 552070) for further information

TempoGate® smart assistant for Temposonics® R-Series V
Part no. TG-C-0-D*xx*
(*xx* indicates the number of R-Series V sensors that can be connected (even numbers only))

- OPC UA server for diagnostics of the R-Series V
- For installation in the control cabinet
- Connection via LAN and Wi-Fi
- See data sheet “TempoGate® smart assistant” document part no.: 552110) for further information

*/ 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. Colors of the cores 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	21	22	23	24	25	26	27
R	M	5		A											1	S										
a			b	c	d					e		f			g	h	i	j	k	l	m	n	o			

optional

a Sensor model

R	M	5	Super shield housing

b Design

M	Threaded flange M18×1.5-6g (standard)
S	Threaded flange ¾"-16 UNF-3A (standard)

c Mechanical options

A	Standard

d Stroke length

X	X	X	X	M	0025…7615 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…7615 mm	250 mm

X	X	X	X	U	001.0…299.8 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…299.8 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

H	X	X	XX m/ft. PUR cable (part no. 530 052) H01…H30 (1…30 m/3…99 ft.) (Note the temperature range of the cable!) See “Frequently ordered accessories” for cable specifications
P	X	X	XX m/ft. PUR cable (part no. 530 175) P01…P30 (1…30 m/3…99 ft.) (Note the temperature range of the cable!) See “Frequently ordered accessories” for cable specifications
R	X	X	XX m/ft. 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/ft. PTFE 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; ***NOTICE*** In this case, only option 2 “24 bit” can be selected under I “Data length”.

j Options

0	Standard
1	Internal linearization

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 8), 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.
- If the option for internal linearization in **j** “Options” 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

*/ The stroke length of the sensor influences the choice of resolution and data width. See glossary under “Resolution and data width depending on stroke length”

GLOSSARY

A

Alarm
The alarm bit is set by the sensor if the sensor detects more magnets (extra magnet) or less magnets (magnet status error) than configured.

Asynchronous mode
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)

D

Differential measurement
For differential measurement, the distance between the two position magnets is output as a value.

E

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.

F

FIR filter
The FIR filter (**F**inite **I**mpulse **R**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)

I

IIR filter
The IIR filter (**I**nfinite **I**mpulse **R**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)

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

Measuring direction
When moving the position magnet, the position and velocity values increase in the measuring direction.
- Forward: Values increasing from sensor electronics housing to rod end/profile end
- Reverse: Values decreasing from sensor electronics housing to rod end/profile end

P

Parity
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.

R

Resolution and data width depending on stroke length
The stroke length of the sensor influences the choice of resolution and data width. The resolution (step size) and data width (number of steps) must be selected so that the stroke length is covered. For example, with a data width of 24 bit and a resolution of 0.5 µm for an RH5 sensor the maximum stroke length of 7620 mm can be represented. You can adjust the resolution and the data width of the R-Series V SSI via the TempoLink® and TempoGate® smart assistants.

S

Synchronous Serial Interface
SSI (**S**ynchronous **S**erial **I**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).

Synchronous mode
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)
- **Synchronous mode 1**
  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.
- **Synchronous mode 2**
  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.
- **Synchronous mode 3**
  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.

T

Temperature in the sensor electronics housing
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. The temperature value is coded in the same format as the position value.

Temposonics
AN AMPHENOL COMPANY

UNITED STATES
Temposonics, LLC
Americas & APAC Region
3001 Sheldon Drive
Cary, N.C. 27513
Phone: +1 919 677-0100
E-mail: info.us@temposonics.com

GERMANY
Temposonics
GmbH & Co. KG
EMEA Region & India
Auf dem Schüffel 9
58513 Lüdenscheid
Phone: +49 2351 9587-0
E-mail: info.de@temposonics.com

ITALY
Branch Office
Phone: +39 030 988 3819
E-mail: info.it@temposonics.com

FRANCE
Branch Office
Phone: +33 6 14 060 728
E-mail: info.fr@temposonics.com

UK
Branch Office
Phone: +44 79 21 83 05 86
E-mail: info.uk@temposonics.com

SCANDINAVIA
Branch Office
Phone: +46 70 29 91 281
E-mail: info.sca@temposonics.com

CHINA
Branch Office
Phone: +86 21 3405 7850
E-mail: info.cn@temposonics.com

JAPAN
Branch Office
Phone: +81 3 6416 1063
E-mail: info.jp@temposonics.com

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