Temposonics
AN AMPHENOL COMPANY

Data Sheet

Improved flexible sensor rod

R-Series V RF5 EtherNet/IP™

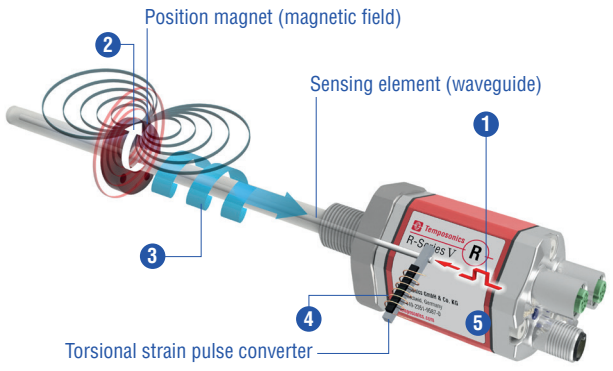
Magnetostrictive Linear Position Sensors

- Flexible sensor rod with improved features
- Stroke length up to 20 m
- Field adjustments and diagnostics using the TempoLink® and TempoGate® smart assistants

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 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.



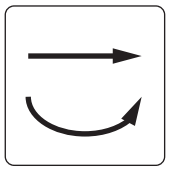
Measurement cycle

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

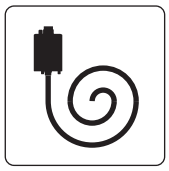
Fig. 1: Time-of-flight based magnetostrictive position sensing principle

R-SERIES V RF5 EtherNet/IP™

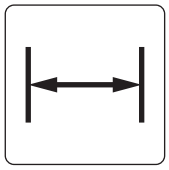
The Temposonics® R-Series V brings very powerful sensor performance to meet the many demands of your application. The RF5 sensor is the R-Series V with improved flexible sensor rod. The main advantages of the flexible sensor rod are:



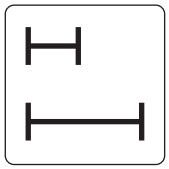
Straight and curved line
The flexible sensor rod enables position measurement on straight and also curved line.



Compact for transport and storage
For transport and storage, the RF5 sensor can be coiled up. This saves costs and space.



Installation with little space
Due to the bendable rod, the RF5 sensor can be installed even if only little space is available.



Large stroke length range
The sensor is available with stroke lengths from 150 mm to 20,000 mm and thus can be used in both short and long distance applications.

In addition the R-Series V EtherNet/IP™ scores with the following features:

20 positions simultaneously
The R-Series V EtherNet/IP™ can detect and report the position and velocity of up to 20 magnets simultaneously.

R-Series V EtherNet/IP™
The sensor supports DLR. The DLR capability provides a fault-tolerant network so that the sensor can be used in ring connection topologies when reliable continuous system operation is required.

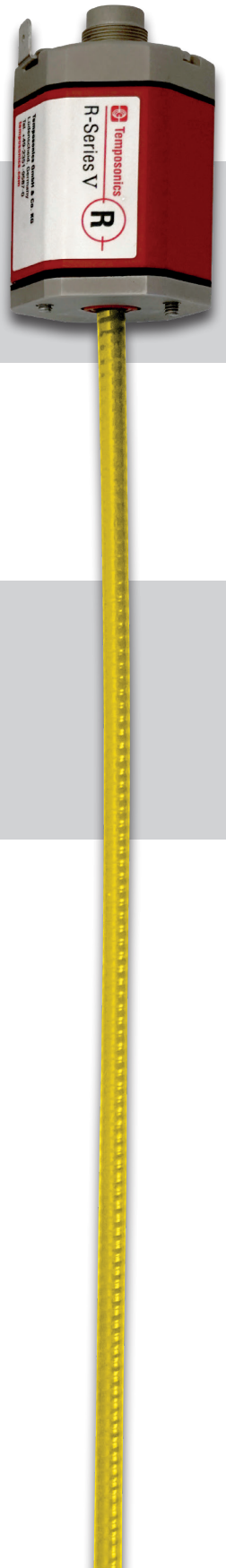
All settings under control with the smart assistants for the R-Series V
The TempoLink® and the TempoGate® smart assistants support you in setup and diagnostics of the R-Series V. For more information of these assistants please see the data sheets:

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

ADVANTAGES OF THE R-SERIES V RF5 COMPARED TO THE R-SERIES V RFV

R-Series V RFV
(previous design)

R-Series V RF5
(improved design)



The first magnetostrictive sensor with a flexible sensor rod was developed and introduced to the market by Temposonics over 25 years ago. With this experience, we have further developed the sensor to improve handling in your application. The R-Series V RF5 offers you the following advantages:

Shortened non-flexible area

- Compared to the previous design, the non-flexible area of the RF5 has been reduced by more than 70 % from 107 mm to 30 mm.

➢ *This makes it easier to install the sensor, especially in confined spaces.*

Smooth transition

- The transition between the non-flexible and flexible areas is designed to be smooth.

➢ *This makes it easier to install the sensor in your application.*

Reduced outer diameter and bending radius

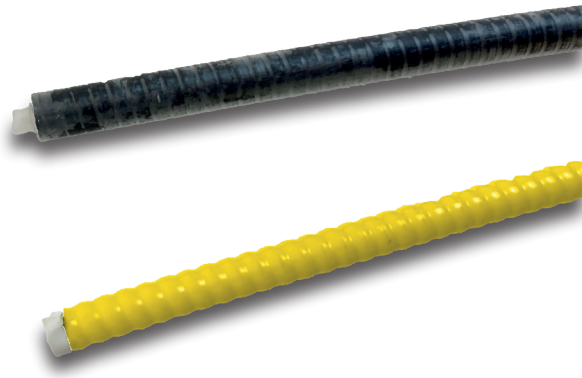
- The outer diameter of the flexible sensor rod has been reduced to 6.4 mm
- This now allows a minimum bending radius of the flexible sensor rod of 100 mm.

➢ *This makes it easier to install the sensor, especially in confined spaces.*

Increased ingress protection

- The RF5-B base unit meets the ingress protection IP68 (3 d/3 m) (connectors and flange correctly fitted).
- Therefore, the internal waveguide is protected against the ingress of water.

➢ *This improves the longevity of the sensor in your application.*



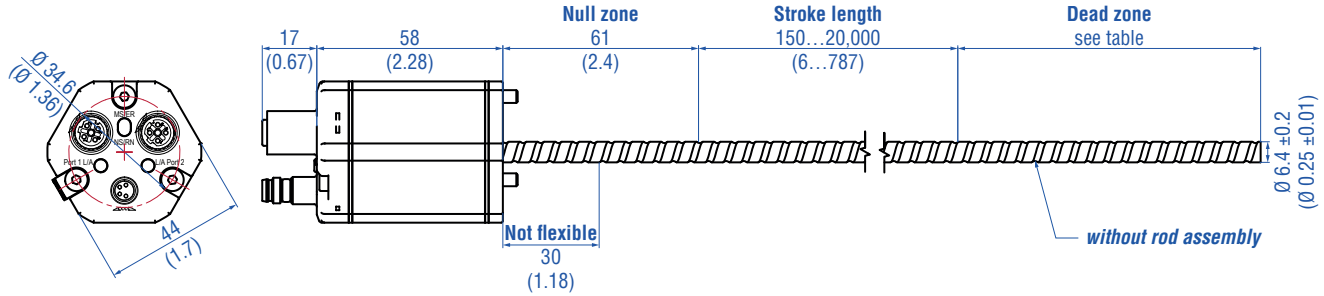
TECHNICAL DATA

Output						
Interface	EtherNet/IP™					
Data protocol	Encoder CIP device profile with CIP Sync™ and DLR capabilities					
Data transmission rate	100 MBit/s (maximum)					
Measured value	Position, velocity/option: Simultaneous multi-position and multi-velocity measurements up to 20 magnets					
Measurement parameters						
Resolution: Position	1…500 µm (selectable)					
Cycle time[1]	Stroke length	≤ 715 mm	≤ 2000 mm	≤ 4675 mm	≤ 10,000 mm	≤ 20,000 mm
	Cycle time	500 µs	1000 µs	2000 µs	4000 µs	8000 µs
Linearity deviation[2]	< ±0.02 % F.S. (minimum ±100 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	IP68 (3 d/3 m) (connectors and flange correctly fitted)					
Shock test	100 g/6 ms, IEC standard 60068-2-27 (when guided in a support pipe, e.g. sensor rod HD/HL/HP)					
Vibration test	5 g/10…2000 Hz, IEC standard 60068-2-6 (excluding resonant frequencies) (when guided in a support pipe, e.g. sensor rod HD/HL/HP)					
EMC test	Electromagnetic emission according to EN 61000-6-3 Electromagnetic immunity according to EN 61000-6-2 With EMC-compliant installation, the RF5 sensors fulfill the requirements of EMC directives 2014/30/EU and UKSI 2016 No. 1091.[3]					
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 conduct with PU coating					
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 with amendments					
Stroke length	150…20,000 mm (6…787 in.)					
Mechanical mounting						
Mounting position	Any					
Mounting instruction	Please consult the technical drawings on page 5 and the operation manual (document number: 551971)					
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); the RF5 sensors must be power supplied via an external Class 2 power source in accordance with the UL approval					
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/ These values refer to a single position measurement
2/ With position magnet # 251 416-2
3/ The flexible sensor element must be mounted in an appropriately shielded environment.

TECHNICAL DRAWING

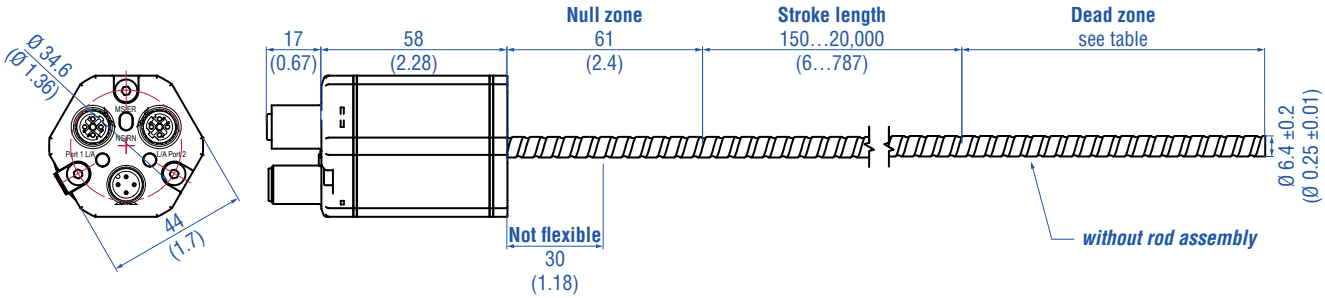
RF5-B – RF5 base unit (without flange & rod assembly), example: Connection type D56 (connector outlet)



Stroke length	Tolerance of total length	Dead zone
Up to 7620 mm (300.00 in.)	±5 mm (0.20 in.)	94 mm (3.70 in.)
Up to 10,000 mm (393.70 in.)	±10 mm (0.39 in.)	100 mm (3.94 in.)
Up to 15,000 mm (590.55 in.)	±15 mm (0.59 in.)	120 mm (4.72 in.)
Up to 20,000 mm (787.00 in.)	±20 mm (0.79 in.)	140 mm (5.51 in.)

Note: Tolerance of total length has no influence on the stroke length.

RF5-B – RF5 base unit (without flange & rod assembly), example: Connection type D58 (connector outlet)



Stroke length	Tolerance of total length	Dead zone
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Up to 15,000 mm (590.55 in.)	±15 mm (0.59 in.)	120 mm (4.72 in.)
Up to 20,000 mm (787.00 in.)	±20 mm (0.79 in.)	140 mm (5.51 in.)

Note: Tolerance of total length has no influence on the stroke length.

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

Fig. 2: Temposonics® RF5

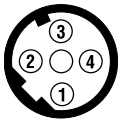
CONNECTOR WIRING

D58

Port 1 – Signal

M12 female connector (D-coded)	Pin	Function
View on sensor	1	Tx (+)
	2	Rx (+)
	3	Tx (–)
	4	Rx (–)

Port 2 – Signal

M12 female connector (D-coded)	Pin	Function
 View on sensor	1	Tx (+)
	2	Rx (+)
	3	Tx (–)
	4	Rx (–)

Power supply

M12 male connector (A-coded)	Pin	Function
View on sensor	1	+12…30 VDC (±20 %)
	2	Not connected
	3	DC Ground (0 V)
	4	Not connected

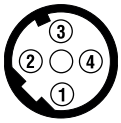
Fig. 3: Connector wiring D58

D56

Port 1 – Signal

M12 female connector (D-coded)	Pin	Function
View on sensor	1	Tx (+)
	2	Rx (+)
	3	Tx (–)
	4	Rx (–)

Port 2 – Signal

M12 female connector (D-coded)	Pin	Function
 View on sensor	1	Tx (+)
	2	Rx (+)
	3	Tx (–)
	4	Rx (–)

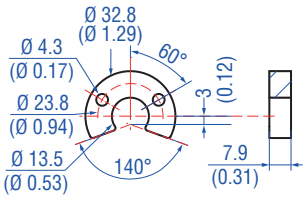
Power supply

M8 male connector	Pin	Function
View on sensor	1	+12…30 VDC (±20 %)
	2	Not connected
	3	DC Ground (0 V)
	4	Not connected

Fig. 4: Connector wiring D56

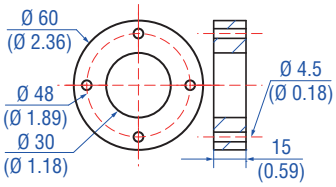
FREQUENTLY ORDERED ACCESSORIES – Additional options available in our Accessories Catalog 551444

Position magnets



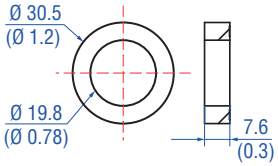
U-magnet OD33
Part no. 251 416-2

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)



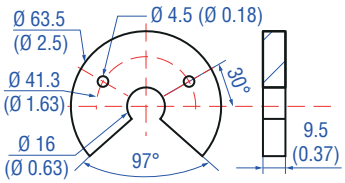
Ring magnet OD60
Part no. MT0162

Material: AlCuMgPb,
magnets compound-filled
Weight: Approx. 90 g
Surface pressure: Max. 20 N/mm²
Fastening torque for M4 screws: 1 Nm
Operating temperature:
–40…+75 °C (–40…+167 °F)



Ring magnet
Part no. 402 316

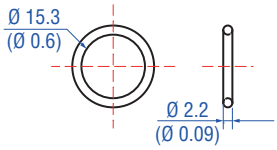
Material: PA ferrite coated
Weight: Approx. 13 g
Surface pressure: Max. 20 N/mm²
Operating temperature:
–40…+100 °C (–40…+212 °F)



U-magnet OD63.5
Part no. 201 553

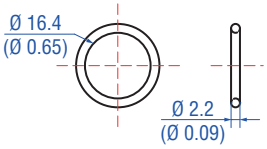
Material: PA 66-GF30,
magnets compound-filled
Weight: Approx. 26 g
Surface pressure: 20 N/mm²
Fastening torque for M4 screws: 1 Nm
Operating temperature:
–40…+75 °C (–40…+167 °F)

O-rings



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

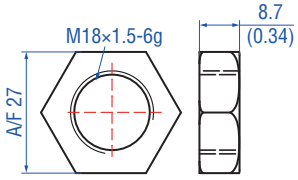
Material: Fluoroelastomer
Durometer: 75 ±5 Shore A
Operating temperature:
–40…+204 °C (–40…+400 °F)



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

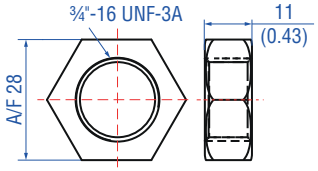
Material: Fluoroelastomer
Durometer: 75 ±5 Shore A
Operating temperature:
–40…+204 °C (–40…+400 °F)

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

Mounting accessories

Threaded flange M18×1.5-6g
Part no. 404 874

Material: Stainless steel 1.4305
(AISI 303)
Order O-rings separately:
O-ring 15×2: Part no. 560 853
O-ring 15.3×2.2: Part no. 401 133

Threaded flange ¾"-16 UNF-3A
Part no. 404 875

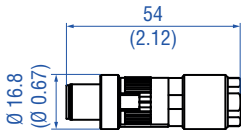
Material: Stainless steel 1.4305
(AISI 303)
Order O-rings separately:
O-ring 15×2: Part no. 560 853
O-ring 16.4×2.2: Part no. 560 315

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

Mounting accessories

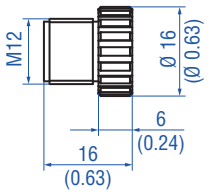
Sensor rod with threaded flange with flat-face (M18×1.5-6g) and O-ring **HD [length mm: XXXX] M** **HD [length in.: XXX.X] U**	**Sensor rod with threaded flange with flat-face (¾"-16 UNF-3A) and O-ring** **HL [length mm: XXXX] M** **HL [length in.: XXX.X] U**	**Sensor rod with threaded flange with raised-face (¾"-16 UNF-3A) and O-ring** **HP [length mm: XXXX] M** **HP [length in.: XXX.X] U**	**Profile with flange** **HFP [length mm: XXXXX] M** **HFP [length in.: XXXX.X] U**
Pressure rod Ø: 12.7 mm (0.5 in.) Length: 100…7500 mm (4…295 in.) Operating pressure: 350 bar (5076 psi) Material flange: Stainless steel 1.4305 (AISI 303) Material rod: Stainless steel 1.4301 (AISI 304)	Pressure rod Ø: 12.7 mm (0.5 in.) Length: 100…7500 mm (4…295 in.) Operating pressure: 350 bar (5076 psi) Material flange: Stainless steel 1.4305 (AISI 303) Material rod: Stainless steel 1.4301 (AISI 304)	Pressure rod Ø: 12.7 mm (0.5 in.) Length: 100…7500 mm (4…295 in.) Operating pressure: 350 bar (5076 psi) Material flange: Stainless steel 1.4305 (AISI 303) Material rod: Stainless steel 1.4301 (AISI 304)	Length: Max. 20,000 mm (max. 787 in.) Ingress protection: IP30 Material: Aluminum

Cable connectors* – Signal



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

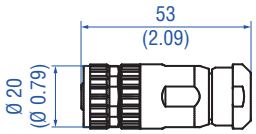
Material: Zinc nickel-plated
Termination: Insulation-displacement
Cable Ø: 6…7.2 mm (0.2…0.28 in.)
Wire: 24 AWG – 22 AWG
Operating temperature:
–25…+85 °C (–13…+185 °F)
Ingress protection: IP65 / IP67 (correctly fitted)
Fastening torque: 0.6 Nm



M12 connector end cap
Part no. 370 537

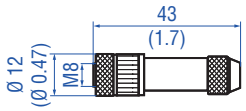
Female connectors M12 should be covered by this protective cap
Material: Brass nickel-plated
Ingress protection: IP67 (correctly fitted)
Fastening torque: 0.39…0.49 Nm

Cable connectors* – Power



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

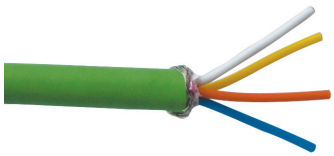
Material: GD-Zn, Ni
Termination: Screw
Contact insert: CuZn
Cable Ø: 4…8 mm (0.16…0.31 in.)
Wire: max. 1.5 mm² (16 AWG)
Operating temperature:
–30…+85 °C (–22…+185 °F)
Ingress protection: IP67 (correctly fitted)
Fastening torque: 0.6 Nm



M8 female connector (4 pin), straight
Part no. 370 504

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

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 × 2 × 0.35 mm² (22 AWG)
Bending radius: 6 × 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 × 0.34 mm²
Bending radius: 5 × 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
Feature: 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
Feature: 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	
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.))**	**Power cable with M12 A-coded female connector (5 pin), straight – pigtail** **Part no. 370 673**	**TempoLink® kit for Temposonics® R-Series V** **Part no. TL-1-0-EM08 (D56)** **Part no. TL-1-0-EM12 (D58)**	**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))
Material: PUR jacket; gray Feature: Shielded Cable Ø: 5 mm (0.2 in.) Operating temperature: –40…+90 °C (–40…+194 °F)	Material: PUR jacket; black Feature: Shielded Cable length: 5 m (16.4 ft) Ingress protection: IP67 (correctly fitted) Operating temperature: –25…+80 °C (–13…+176 °F)	• 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	• 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

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
R	F	5										D	5		1	U	2	0	1
a			b	d						e		f			g	h			

a	Sensor model
R F 5	Improved flexible rod

b	Design
B	Base unit (without flange & rod assembly)

Section **c** is intentionally omitted.

d	Stroke length
X X X X X M	00150…20000 mm

Stroke length (mm)	Ordering steps
150… 1000 mm	50 mm
1000… 5000 mm	100 mm
5000…10000 mm	250 mm
10000…15000 mm	500 mm
15000…20000 mm	1000 mm

X X X X . X U	0006.0…0787.0 in.

Stroke length (in.)	Ordering steps
6… 40 in.	2 in.
40…197 in.	4 in.
197…394 in.	10 in.
394…591 in.	20 in.
591…787 in.	40 in.

Non standard stroke lengths are available;
must be encoded in 5 mm/0.1 in. increments

e	Number of magnets
X X	01…20 position(s) (1…20 magnet(s))

f	Connection type
D 5 6	2 × M12 female connectors (D-coded), 1 × M8 male connector
D 5 8	2 × M12 female connectors (D-coded), 1 × M12 male connector (A-coded)

g	System
1	Standard

h	Output
U 2 0 1	EtherNet/IP™, position and velocity (1…20 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.
- The sensor is without rod assembly. Always insert the flexible sensor rod in a support pipe (e.g. sensor rod HD/HL/HP or HFP profile).

DELIVERY

RF5-B:
- Base unit (without flange & rod assembly)
- 3 × socket screws M4×59

Accessories have to be ordered separately.

Manuals, Software & 3D Models available at:
www.temposonics.com

GLOSSARY

C

CIP Sync™
Synchronization services in CIP (**C**ommon **I**ndustrial **P**rotcol) provide the increased control coordination to achieve real-time synchronization between distributed devices and systems.
CIP Sync™ is compliant with IEEE-1588™ standard and allows synchronization accuracy between two devices of fewer than 100 nanoseconds.

D

DLR
The **D**evice **L**evel **R**ing (DLR) protocol provides a means for detecting, managing and recovering from faults in a ring-based network.

E

EDS
The properties and functions of an EtherNet/IP™ device are described in an EDS file (**E**lectronic **D**ata **S**heet). The XML-based EDS 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 EDS file of the R-Series V EtherNet/IP™ is available on the homepage www.temposonics.com.

EtherNet/IP™
EtherNet/IP™ (**Ethernet I**ndustrial **P**rotocol) is an Industrial Ethernet interface and is managed by the **O**pen **D**eviceNet **V**endor **A**ssociation

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

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

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

temposonics.com

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