Temposonics
AN AMPHENOL COMPANY

Data Sheet

R-Series V RP5 SSI

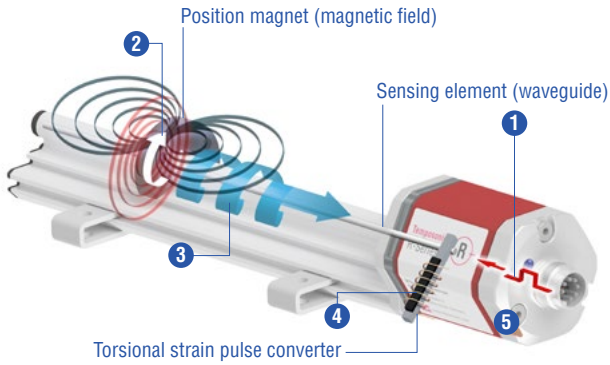
Magnetostrictive Linear Position Sensors

- Position measurement with a resolution up to 0.1 µm
- Update rate up to 10 kHz
- Field adjustments and diagnostics using the new TempoLink smart assistant

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

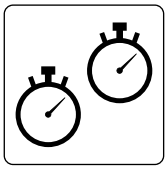
Fig. 1: Time-of-flight based magnetostrictive position sensing principle

R-SERIES V RP5 SSI

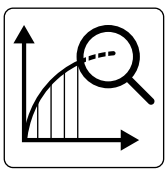
The Temposonics® R-Series V brings very powerful sensor performance to meet the many demands of your application. The main advantages of the profile version RP5 with SSI output (Synchronous Serial Interface) are:

High shock and vibration resistance
The R-Series V is the long term solution for harsh environments that have high levels of shock and vibration.

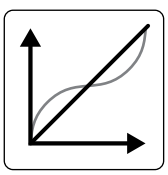
Minimum resolution 0.1 µm
The sensor is characterized by a very stable position signal with a minimum resolution of 0.1 µm.



Synchronous measurement
The sensor offers one asynchronous mode as well as three different synchronous modes to match the measurement to the data request cycle of the controller.

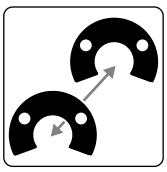


Extrapolation
The sensor supports linear extrapolation. This allows a cycle time of 100 µs or the readout of the data with up to 10 kHz for any stroke length of the sensor.



Internal linearization
The sensor is available with internal linearization which offers improved linearity for overall higher accuracy of the position measurement value.

In addition the R-Serie V SSI scores with the following features:



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

R-Serie 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 assistents.

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	6350 mm
Update rate	10 kHz	3.4 kHz	2.7 kHz	2.1 kHz	1.2 kHz	0.4 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)

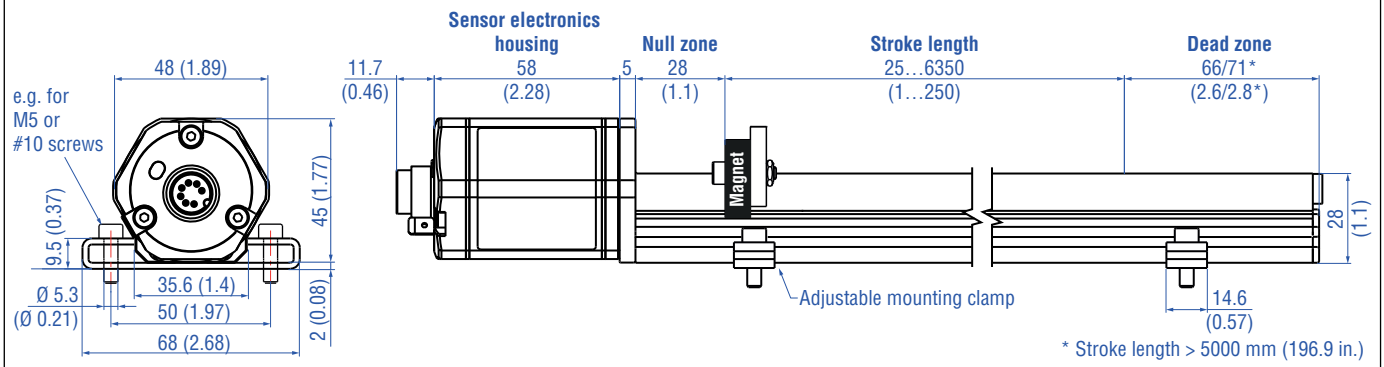
Stroke length	25…300 mm	300…600 mm	600…1200 mm	1200…3000 mm	3000…5000 mm	5000…6350 mm
typical	± 15 µm	± 20 µm	± 25 µm	± 45 µm	± 85 µm	± 95 µm
maximum	± 25 µm	± 30 µm	± 50 µm	± 90 µm	± 150 µm	± 190 µm

Repeatability	< ±0.001 % F.S. (minimum ±2.5 µm) 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 (3 m/3 d) for cable outlets
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)
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 CE.
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 page 4 and the operation manual (document number: 552011)
Electrical connection	
Connection type	1 × M16 male connector (7 pin), 1 × M12 male connector (8 pin) or 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

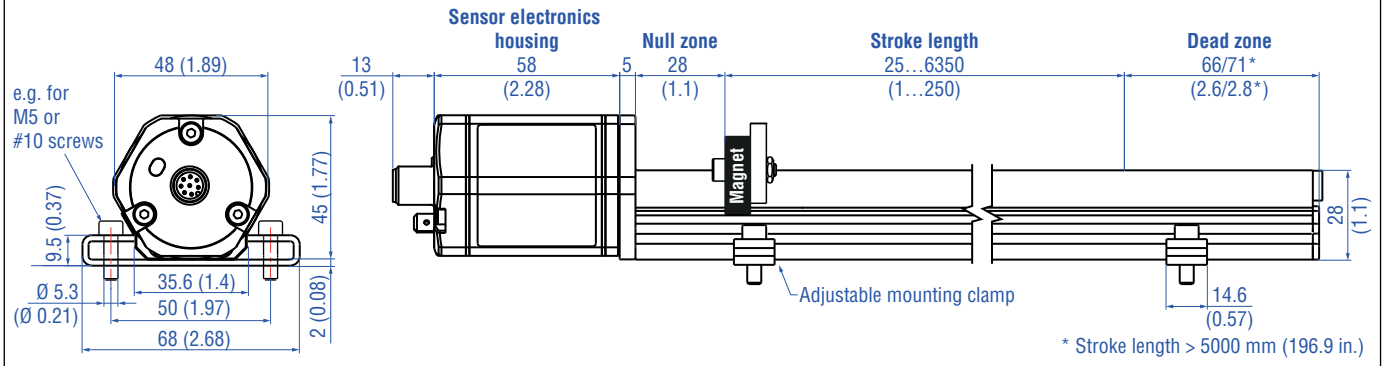
1/ With standard one shot of 16 µs
2/ Sensor with standard settings. Further information can be found in the operation manual R-Series V SSI (document number: 552011)
3/ With position magnet # 252 182

TECHNICAL DRAWING

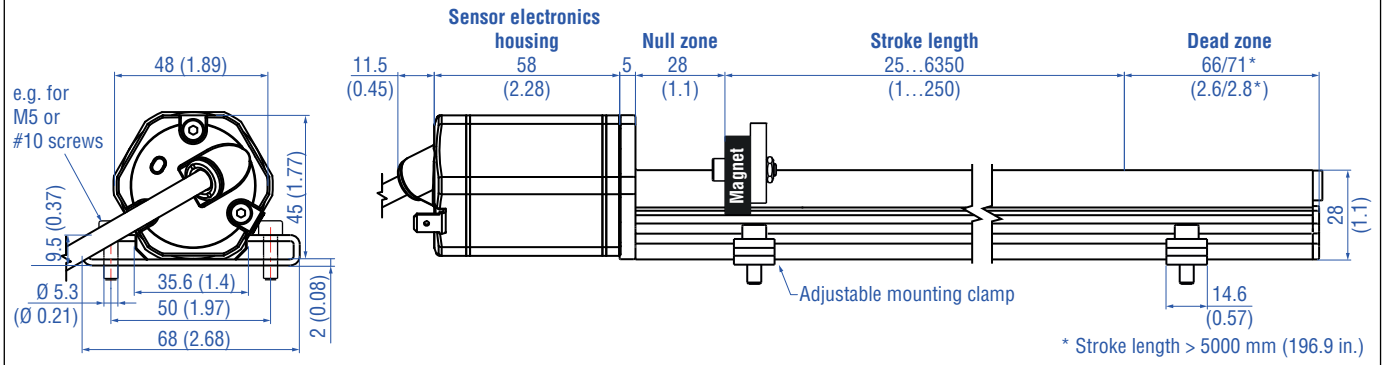
RP5-M-A/-V, example: Connection type D70 (connector outlet)



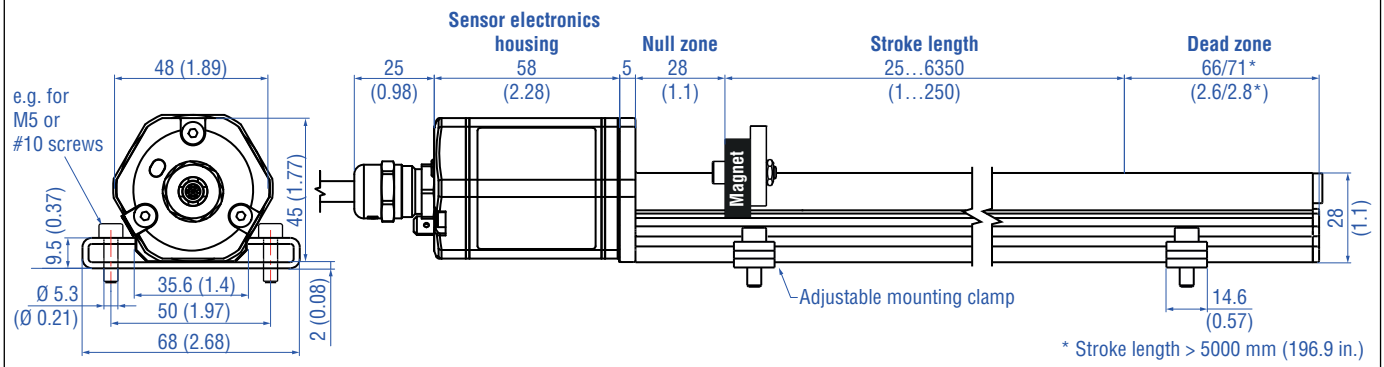
RP5-M-A/-V, example: Connection type D84 (connector outlet)



RP5-M-A/-V, example: Connection type LXX/BXX/EXX/GXX/UXX (angled cable outlet)



RP5-M-A/-V, example: Connection type HXX/PXX/RXX/TXX (straight cable outlet)



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

Fig. 2: Temposonics® RP5 with U-magnet

CONNECTOR WIRING

D70

Signal + power supply

M16 male connector	Pin	Function
 View on sensor	1	Data (–)
	2	Data (+)
	3	Clock (+)
	4	Clock (–)
	5	+12…30 VDC (±20 %)
	6	DC Ground (0 V)
	7	Not connected

Fig. 3: Connector wiring D70

D84

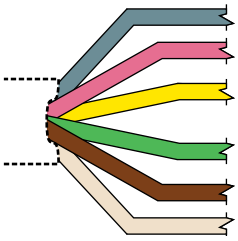
Signal + power supply

M12 male connector (A-coded)	Pin	Function
 View on sensor	1	Clock (+)
	2	Clock (–)
	3	Data (+)
	4	Data (–)
	5	Not connected
	6	Not connected
	7	+12…30 VDC (±20 %)
	8	DC Ground (0 V)

Fig. 5: Connector wiring D84

LXX / BXX / EXX / GXX / UXX / HXX / PXX / RXX / TXX

Signal + power supply

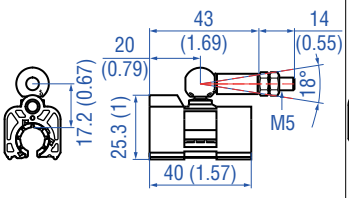
Cable	Color	Function
	GY	Data (–)
	PK	Data (+)
	YE	Clock (+)
	GN	Clock (–)
	BN	+12…30 VDC (±20 %)
	WH	DC Ground (0 V)

For cable type TXX, the extra red & blue wires are not used.

Fig. 4: Connector wiring cable outlet

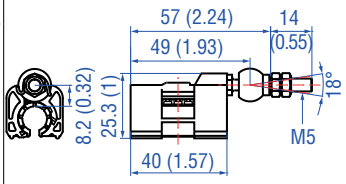
FREQUENTLY ORDERED ACCESSORIES – Additional options available in our Accessories Guide 551444

Position magnets



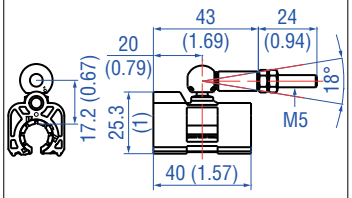
Magnet slider S, joint at top
Part no. 252 182

Material: GRP, magnet hard ferrite
Weight: Approx. 35 g
Operating temperature:
–40…+85 °C (–40…+185 °F)



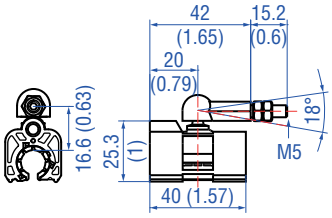
Magnet slider V, joint at front
Part no. 252 184

Material: GRP, magnet hard ferrite
Weight: Approx. 35 g
Operating temperature:
–40…+85 °C (–40…+185 °F)



Magnet slider N
longer ball-joint arm
Part no. 252 183

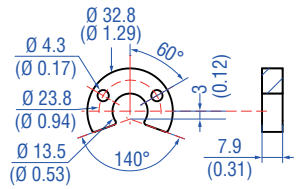
Material: GRP, magnet hard ferrite
Weight: Approx. 35 g
Operating temperature:
–40…+85 °C (–40…+185 °F)



Magnet slider G, backlash free
Part no. 253 421

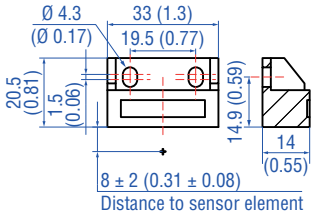
Material: GRP, magnet hard ferrite
Weight: Approx. 25 g
Operating temperature:
–40…+85 °C (–40…+185 °F)

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)

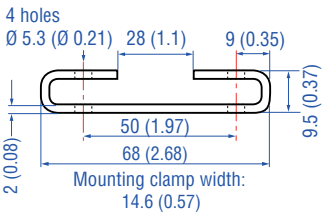


Block magnet L
Part no. 403 448

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)

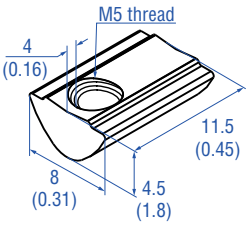
This magnet may influence the sensor performance specifications for some applications.

Mounting accessories



Mounting clamp
Part no. 400 802

Material: Stainless steel (AISI 304)

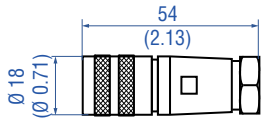


T-nut
Part no. 401 602

Fastening torque for M5 screw: 4.5 Nm

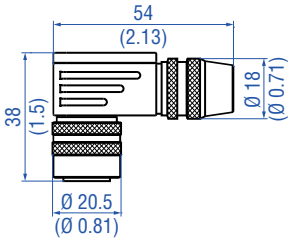
Controlling design dimensions are in millimeters and measurements in ( ) are in inches

Cable connectors*



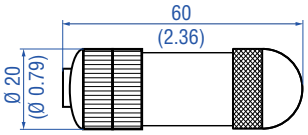
M16 female connector (7 pin), straight
Part no. 370 624

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



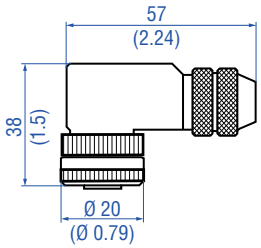
M16 female connector (7 pin), angled
Part no. 560 779

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



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



M12 A-coded female connector (8 pin), angled
Part no. 370 699

Housing: GD-ZnAL
Termination: Screw
Contact insert: CuZn
Cable Ø: 6…8 mm (0.24…0.31 in.)
Wire: 0.5 mm²
Operating temperature:
–25…+85 °C (–13…+185 °F)
Ingress protection: IP67 (correctly fitted)
Fastening torque: 0.6 Nm

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)

Cable with M12 A-coded female connector (8 pin), angled – pigtail
Part no. 370 676

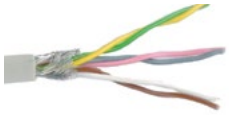
Cable: Shielded
Cable length: 5 m (16.4 ft)
Ingress protection: IP67 (correctly fitted)

Programming tool

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

- 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

Cables



PVC cable
Part no. 530 032

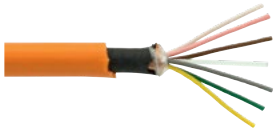
Material: PVC jacket; gray
Features: Twisted pair, shielded, flexible
Cable Ø: 6 mm (0.23 in.)
Cross section: 3 × 2 × 0.14 mm²
Bending radius: 10 × D
(fixed installation)
Operating temperature:
–40…+105 °C (–40…+221 °F)

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)

PTFE cable
Part no. 530 112

Material: PTFE 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)



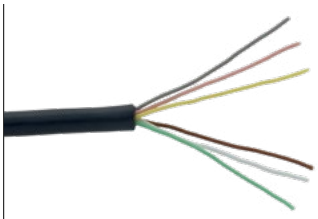
PUR cable
Part no. 530 175

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)

Cables

FEP cable
Part no. 530 157

Material: FEP jacket; black
Features: Twisted pair, shielded
Cable Ø: 6.7 mm (0.26 in.)
Cross section: 3 × 2 × 0.14 mm²
Operating temperature: –100…+180 °C
(–148…+356 °F)

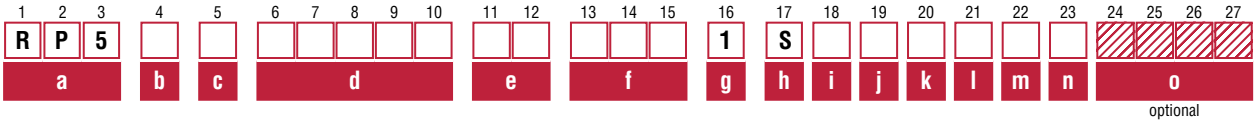


Silicone cable
Part no. 530 176

Material: Silicone jacket; black
Features: Twisted pair, shielded
Cable Ø: 6.3 mm (0.25 in.)
Cross section: 3 × 2 × 0.14 mm²
Bending radius: 7 × D
(fixed installation)
Operating temperature: –50…+150 °C
(–58…+302 °F)

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

ORDER CODE



a	Sensor model
R P 5	Profile

b	Design
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

c	Mechanical options
A	Standard
V	Fluorelastomer seals for the sensor electronics housing

d	Stroke length
X X X X M	0025…6350 mm

Standard stroke length (mm)	Ordering steps
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.

Standard stroke length (in.)	Ordering steps
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.

e	Number of magnets
X X	01…02 position(s) (1…2 magnet(s))

f	Connection type
Connector	
D 7 0	M16 male connector (7 pin)
D 8 4	M12 male connector (8 pin)
Angled cable outlet	
L X X	XX m/ft. PUR cable (part no. 530 052) L01…L30 (1…30 m/3…99 ft.) (Note the temperature range of the cable!) See “Frequently ordered accessories” for cable specifications
B X X	XX m/ft. PUR cable (part no. 530 175) B01…B30 (1…30 m/3…99 ft.) (Note the temperature range of the cable!) See “Frequently ordered accessories” for cable specifications
E X X	XX m/ft. PVC cable (part no. 530 032) E01…E30 (1…30 m/3…99 ft.) See “Frequently ordered accessories” for cable specifications
G X X	XX m/ft. FEP cable (part no. 530 157) G01…G30 (1…30 m/3…99 ft.) See “Frequently ordered accessories” for cable specifications
U X X	XX m/ft. Silicone cable (part no. 530 176) U01…U30 (1…30 m/3…99 ft.) See “Frequently ordered accessories” for cable specifications
Straight cable outlet	
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.) 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 l “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

*/ 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”

o	Additional options (optional)
S002	FIR filter (2 measurements)
S004	FIR filter (4 measurements)
S008	FIR filter (8 measurements)
S00A	No filter, error counter (4 cycles)
S00C	No filter, error counter (8 cycles)
S00D	No filter, error counter (10 cycles)
S00G	FIR filter (8 measurements), error counter (10 cycles)
S00J	IIR filter (filter grade 4)
S00K	IIR filter (filter grade 8)
S00N	IIR filter (filter grade 8), error counter (10 cycles)

NOTICE

- For the RP5, the magnet selected in b “Design” is included in the scope of delivery. Specify the number of magnets for your application. For differential measurements order the second magnet 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

- 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**

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 in 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 a stroke length of 7,620 mm can be represented. You can adjust the resolution and the data width of the R-Series V SSI via the Tempo-Link® smart assistant.

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

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