Data Sheet

R-Series V RP5 EtherCAT®
Magnetostrictive Linear Position Sensors

- Minimum resolution of 0.5 μm with down to 100 μs cycle time
- Position, velocity and acceleration measurements for up to 30 magnets
- Field adjustments and diagnostics using the new TempoLink® smart assistant
MEASURING TECHNOLOGY

The absolute, linear position sensors provided by Temposonics rely on the company’s proprietary magnetostrictive technology, which can determine position with a high level of precision and robustness. Each Temposonics position sensor consists of a ferromagnetic waveguide, a position magnet, a strain pulse converter and supporting electronics. The magnet, connected to the object in motion in the application, generates a magnetic field at its location on the waveguide. A short current pulse is applied to the waveguide. This creates a momentary radial magnetic field and torsional strain on the waveguide. The momentary interaction of the magnetic fields releases a torsional strain pulse that propagates the length of the waveguide. When the ultrasonic wave reaches the end of the waveguide it is converted into an electrical signal. Since the speed of the ultrasonic wave in the waveguide is precisely known, the time required to receive the return signal can be converted into a linear position measurement with both high accuracy and repeatability.

R-SERIES V EtherCAT®

Temposonics® R-Series V brings very powerful sensor performance to meet the many demands of your application. The R-Series V is the long term solution for harsh environments that have high levels of shock and vibration. The sensor supports the EtherCAT® specifications including distributed clock. The mechanism of distributed clocks enables a synchronized communication with a minimum cycle time as fast as 100 µs. For time-critical applications R-Series V with extrapolation allows synchronized controller communication for any stroke length of the sensor. In addition to position and velocity, the acceleration for up to 30 magnets can also be reported. Temposonics® R-Series V sensors are available with internal linearization which offers improved linearity for overall higher accuracy of the position measurement values. In addition to the measured position value via the EtherCAT® protocol further data about the current sensor status, such like the total distance travelled, the internal temperature and the total operating hours, can be utilized for diagnostic purposes.

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

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.
TECHNICAL DATA

Output

Interface EtherCAT® Ethernet Control Automation Technology
Data protocol EtherCAT® 100 Base-Tx, Fast Ethernet
Data transmission rate 100 MBit/s max.
Measured value Simultaneous position, velocity and acceleration for up to 30 magnets

Measurement parameters

Resolution: Position 0.5…1000 µm (selectable)
Native cycle time
 stroke length | ≤ 50 mm | ≤ 715 mm | ≤ 2000 mm | ≤ 4675 mm | ≤ 6350 mm |
 cycle time | 250 µs | 500 µs | 1000 µs | 2000 µs | 4000 µs |
Extrapolation cycle time
 number of magnets | ≤ 10 magnets | 11…30 magnets |
 cycle time | 100 µs | 250 µs |
Linearity deviation
 stroke length | ≤ 500 mm | > 500 mm |
 linearity deviation | ≤ ±50 µm | < 0.01 % F.S. |
 optional internal linearity: Linearity tolerance (Applies for the first magnet for multi-position measurement)
 stroke length | 25…300 mm | 300…600 mm | 600…1200 mm | 1200…3000 mm | 3000…5000 mm | 5000…6350 mm |
 linearity | ±15 µm | ±20 µm | ±25 µm | ±45 µm | ±85 µm | ±95 µm |
 typical |
 maximum |
 Repeatability | < ±0.001 % F.S. | (minimum ±2.5 µm) |
 Hysteresis | < 4 µm typical |
 Temperature coefficient | < 15 ppm / K typical |

Operating conditions

Operating temperature | –40…+85 °C (−40…+185 °F) |
Humidity | 90 % relative humidity, no condensation |
Ingress protection | IP67 (connectors correctly fitted) |
Shock test | 150 g/11 ms, IEC standard 60068-2-27 |
Vibration test | 30 g/10…2000 Hz, IEC 60068-2-6 (excluding resonant frequencies) |
EMC test
 Electromagnetic emission according to EN 61000-6-3
 Electromagnetic immunity according to EN 61000-6-2
 The sensor meets the requirements of the EU directives and is marked with 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

Electrical connection

Connection type
 2 × M12 female connectors (5 pin), 1 × M8 male connector (4 pin) or
 2 × M12 female connectors (5 pin), 1 × M12 male connector (4 pin)
Operating voltage 12…30 VDC ±20 % (9.6…36 VDC)
Power consumption Less than 4 W typical
Dielectric strength 500 VDC (DC ground to machine ground)
Polarity protection Up to ~36 VDC
Overvoltage protection Up to 36 VDC

1/ With position magnet # 251 416-2
## TECHNICAL DRAWING

**RP5-M-A/-V, example: Connector outlet D58**

<table>
<thead>
<tr>
<th>Port 1 – Signal</th>
<th>Pin</th>
<th>Function</th>
<th>Port 2 – Signal</th>
<th>Pin</th>
<th>Function</th>
<th>Power supply</th>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M12 female connector (D-coded)</strong></td>
<td>1</td>
<td>Tx (+)</td>
<td>1</td>
<td>Tx (+)</td>
<td>1</td>
<td>+12...30 VDC (±20 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Rx (+)</td>
<td>2</td>
<td>Rx (+)</td>
<td>2</td>
<td>Not connected</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Tx (−)</td>
<td>3</td>
<td>Tx (−)</td>
<td>3</td>
<td>DC Ground (0 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Rx (−)</td>
<td>4</td>
<td>Rx (−)</td>
<td>4</td>
<td>Not connected</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Not connected</td>
<td>5</td>
<td>Not connected</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### D56

![Fig. 3: Temposonics® RP5 with U-magnet](image)

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

### D58

![Fig. 4: Connector wiring D56](image)

![Fig. 5: Connector wiring D58](image)
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. 25 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. 35 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)
Marked version for sensors with internal linearization: Part no. 254 226

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)
Fastening torque for M5 screw: 4.5 Nm

T-nut
Part no. 401 602

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

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

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

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

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

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.

Controlling design dimensions are in millimeters and measurements in ( ) are in inches.
Temposonics® R-Series V RP5 EtherCAT®
Data Sheet

### Cable connectors*

<table>
<thead>
<tr>
<th>Signal connector M12 D-coded male (4 pin), straight</th>
<th>Signal connector M12 end cap</th>
<th>Power connector M12 A-coded female (5 pin), straight</th>
<th>Power connector M8 female (4 pin), straight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part no. 370 523</td>
<td>Part no. 370 537</td>
<td>Part no. 370 677</td>
<td>Part no. 370 504</td>
</tr>
</tbody>
</table>

- **Material:** Zinc nickel-plated
- **Termination:** Insulation-displacement
- **Cable Ø:** 5.5…7.2 mm (0.2…0.28 in.)
- **Wire:** 24 AWG – 22 AWG
- **Operating temperature:** −25…+85 °C (−13…+185 °F)
- **Ingress protection:** IP65/IP67 (correctly fitted)
- **Fastening torque:** 0.6 Nm

- **Material:** Brass nickel-plated
- **Contact insert:** CuZn
- **Cable Ø:** 4…5 mm (0.16…0.20 in.)
- **Wire:** 24 AWG – 22 AWG
- **Operating temperature:** −25…+85 °C (−13…+185 °F)
- **Ingress protection:** IP65/IP67
- **Fastening torque:** 0.3…0.4 Nm

- **Material:** CuZn nickel plated
- **Cable Ø:** 3.5…5 mm (0.14…0.20 in.)
- **Wire:** 16 AWG
- **Operating temperature:** −40…+85 °C (−40…+185 °F)
- **Ingress protection:** IP67 (correctly fitted)
- **Fastening torque:** 0.5 Nm

### Programming kit

- **TempoLink® kit for Temposonics® R-Series V**
  - Part no. TL-1-0-EM08 (D56)
  - Part no. TL-1-0-EM12 (D58)

- **Features:**
  - Connect wirelessly via Wi-Fi enabled device or via USB with the diagnostic tool
  - Simple connectivity to the sensor via 24 VDC power line (permmissible cable length: 30 m)
  - User friendly interface for mobile devices and desktop computers
  - See product brief “TempoLink smart assistant” (document part no.: 551976) for further information

- **PUR signal cable**
  - Part no. 530 125
  - **Material:** PUR jacket; green
  - **Features:** Cat 5, highly flexible, halogen free, energy chain capable, mostly oil & flame resistant
  - **Cable Ø:** 6.5 mm (0.26 in.)
  - **Cross section:** 2 × 2 × 0.35 mm² (22 AWG)
  - **Operating temperature:** −20…+60 °C (−4…+140 °F)

- **Signal cable with M12 D-coded male connector (4 pin), straight — M12 D-coded, male connector (4 pin), straight**
  - Part no. 530 664
  - **Material:** PUR jacket; green
  - **Features:** Cat 5e
  - **Cable length:** 5 m (16.4 ft)
  - **Cable Ø:** 6.5 mm (0.26 in.)
  - **Ingress protection:** IP65/IP67/IP68 (correctly fitted)
  - **Operating temperature:** −30…+70 °C (−22…+158 °F)

- **Signal cable with M12 D-coded male connector (4 pin), straight — RJ45 male connector, straight**
  - Part no. 530 065
  - **Material:** PUR jacket; green
  - **Features:** Cat 5e
  - **Cable length:** 5 m (16.4 ft)
  - **Cable Ø:** 6.5 mm (0.26 in.)
  - **Ingress protection:** IP67 (correctly fitted)
  - **Operating temperature:** −30…+70 °C (−22…+158 °F)

### Cables

- **PUR signal cable**
  - Part no. 530 125
  - **Features:** Cat 5, highly flexible, halogen free, energy chain capable, mostly oil & flame resistant
  - **Cable Ø:** 6.5 mm (0.26 in.)
  - **Cross section:** 2 × 2 × 0.35 mm² (22 AWG)
  - **Operating temperature:** −20…+60 °C (−4…+140 °F)

- **Signal cable with M12 D-coded male connector (4 pin), straight — M12 D-coded, male connector (4 pin), straight**
  - Part no. 530 664
  - **Material:** PUR jacket; green
  - **Features:** Cat 5e
  - **Cable length:** 5 m (16.4 ft)
  - **Cable Ø:** 6.5 mm (0.26 in.)
  - **Ingress protection:** IP65/IP67/IP68 (correctly fitted)
  - **Operating temperature:** −30…+70 °C (−22…+158 °F)

- **Signal cable with M12 D-coded male connector (4 pin), straight — RJ45 male connector, straight**
  - Part no. 530 065
  - **Material:** PUR jacket; green
  - **Features:** Cat 5e
  - **Cable length:** 5 m (16.4 ft)
  - **Cable Ø:** 6.5 mm (0.26 in.)
  - **Ingress protection:** IP67 (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
## Cables

<table>
<thead>
<tr>
<th>PVC power cable</th>
<th>Power cable with M8 female connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part no. 530 108</td>
<td>Part no. 530 066 (5 m (16.4 ft.))</td>
</tr>
<tr>
<td></td>
<td>Part no. 530 096 (10 m (32.8 ft.))</td>
</tr>
<tr>
<td></td>
<td>Part no. 530 093 (15 m (49.2 ft.))</td>
</tr>
</tbody>
</table>

- **Material:** PVC jacket; gray
- **Features:** Shielded, flexible, mostly flame retardant
- **Cable Ø:** 4.9 mm (0.19 in.)
- **Cross section:** $3 \times 0.34 \text{ mm}^2$
- **Bending radius:** $10 \times D$
- **Operating temperature:** $-30 \ldots +80 ^\circ C\ (-22 \ldots +176 ^\circ F)$

- **Material:** PUR jacket; gray
- **Features:** Shielded
- **Cable Ø:** 8 mm (0.3 in.)
- **Operating temperature:** $-40 \ldots +90 ^\circ C\ (-40 \ldots +194 ^\circ F)$
**ORDER CODE**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| R | P | S |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

a **Sensor model**

R P S 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…30 Position(s) (1…30 magnet(s))

f **Connection type**

D 5 6 2 × M12 female connectors (5 pin), 1 × M8 male connector (4 pin)

D 5 8 2 × M12 female connectors (5 pin), 1 × M12 male connector (4 pin)

g **System**

1 Standard

h **Output**

U 1 0 1 EtherCAT®, position, velocity and acceleration (1…30 positions)

U 1 1 1 EtherCAT®, position, velocity and acceleration internal linearization (1…30 positions)

| NOTICE |
---|
- For the RP5, the magnet selected in **b “Design”** is included in the scope of delivery. For multi-position measurements with more than 1 magnet, order the other magnets separately.
- The number of magnets is limited by the stroke length. The minimum allowed distance between magnets (i.e. front face of one to the front face of the next one) is 75 mm (3 in.).
- Use magnets of the same type for multi-position measurement, e.g. 2 × U-magnet (part no. 251 416-2).
- If the option for internal linearization (U111) in **h “Output”** is chosen, select a suitable magnet.

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

Accessories have to be ordered separately.

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

<table>
<thead>
<tr>
<th><strong>D</strong></th>
<th>Distributed Clock</th>
</tr>
</thead>
<tbody>
<tr>
<td>EtherCAT® uses a logical network of Distributed Clocks to synchronize the time on all local bus devices on the network. The EtherCAT® master selects the first slave device as a Reference Clock, and then maintains a precise mapping of frame delays for all other slave devices in order to adjust their time to match the system time.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>E</strong></th>
<th>ESI</th>
</tr>
</thead>
<tbody>
<tr>
<td>The properties and functions of an EtherCAT® device are described in an ESI file (EtherCAT® Slave Information). The XML-based ESI file contains all relevant data that are important for the implementation of the device in the controller as well as for data exchange during operation. The ESI file of the R-Series V EtherCAT® is available on the homepage <a href="http://www.temposonics.com">www.temposonics.com</a>.</td>
<td></td>
</tr>
</tbody>
</table>

| **EtherCAT®** | EtherCAT® (Ethernet for Control Automation Technology) is an Industrial Ethernet interface and is managed by the EtherCAT® Technology Group (ETG). The R-Series V EtherCAT® and its corresponding ESI file are certified by the ETG. |

<table>
<thead>
<tr>
<th><strong>E</strong></th>
<th>Extrapolation</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>I</strong></th>
<th>Internal Linearization</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>M</strong></th>
<th>Multi-position measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>During the measurement cycle, the positions of every magnet on the sensor are simultaneously reported. The velocity and acceleration are continuously calculated based on these changing position values as the magnets are moved.</td>
<td></td>
</tr>
</tbody>
</table>