MTS SENSORS

Temposonics®

Magnetostrictive Linear Position Sensors

Temposonics® R-Series V POWERLINK

Operation Manual

THE NEW V GENERATION

Table of contents

1. Introduction

1.1 Purpose and use of this manual

Before starting the operation of Temposonics® position sensors, read this documentation thoroughly and follow the safety information. Keep this manual for future reference!

The content of this technical documentation and of its appendices is intended to provide information on mounting, installation and commissioning by qualified automation personnel [1] or instructed service technicians who are familiar with the project planning and dealing with Temposonics® sensors.

1.2 Used symbols and warnings

Warnings are intended for your personal safety and for avoidance of damage to the described product or connected devices. In this documentation, safety information and warnings to avoid danger that might affect the life and health of operating or service personnel or cause material damage are highlighted by the pictogram defined below.

Symbol	Meaning
NOTICE	This symbol is used to point to situations that may lead to material damage, but not to personal injury.

2. Safety instructions

2.1 Intended use

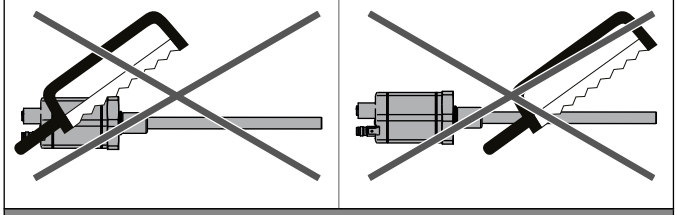
This product may be used only for the applications defined under item 1 and only in conjunction with the third-party devices and components recommended or approved by MTS Sensors. As a prerequisite of proper and safe operation the product requires correct transport, storage, mounting and commissioning and must be operated with utmost care.

1. The sensor systems of all Temposonics® series are intended exclusively for measurement tasks encountered in industrial, commercial and laboratory applications. The sensors are considered as system accessories and must be connected to suitable evaluation electronics, e.g. a PLC, IPC, indicator or other electronic control unit.

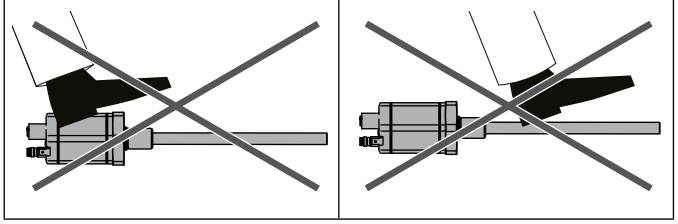
2.2 Foreseeable misuse

Foreseeable misuse	Consequence
Wrong sensor connection	The sensor will not work properly or can be damaged
Operate the sensor out of the operating temperature range	No signal output – the sensor can be damaged
Power supply is out of the defined range	Signal output is wrong / no signal output / the sensor will be damaged
Position measurement is influenced by an external magnetic field	Signal output is wrong
Cables are damaged	Short circuit – the sensor can be destroyed / sensor does not respond
Spacers are missing / installed in a wrong order	Error in position measurement
Wrong connection of ground / shield	Signal output is disturbed – the electronics can be damaged
Use of a magnet that is not specified by MTS Sensors	Error in position measurement

Do not alter the sensor subsequently.
➔ The sensor might be damaged.



Do not step on the sensor.
➔ The sensor might be damaged.



1/ The term "qualified technical personnel" characterizes persons who:
- are familiar with the safety concepts of automation technology applicable to the particular project
- are competent in the field of electromagnetic compatibility (EMC)
- have received adequate training for commissioning and service operations
- are familiar with the operation of the device and know the information required for correct operation provided in the product documentation

2.3 Installation, commissioning and operation

The position sensors must be used only in technically safe conditions. To maintain this condition and to ensure safe operation, installation, connection and service, work may be performed only by qualified technical personnel.
If danger of injury to persons or of damage to operating equipment is caused by sensor failure or malfunction, additional safety measures such as plausibility checks, limit switches, EMERGENCY STOP systems, protective devices etc. are required. In the event of trouble, shut down the sensor and protect it against accidental operation.

Safety instructions for commissioning
To maintain the sensor's operability, it is mandatory to follow the instructions given below.

1. Protect the sensor against mechanical damage during installation and operation.
2. Do not open or dismantle the sensor.
3. Connect the sensor very carefully and pay attention to the polarity of connections and power supply.
4. Use only approved power supplies.
5. Ensure the sensor is operating within the defined limits for supply voltage, environmental conditions, etc.
6. Check the function of the sensor regularly and provide documentation of the checks.
7. Before applying power, ensure that nobody's safety is jeopardized by starting machines.

2.4 Safety instructions for use in explosion-hazardous areas

The sensor is not suitable for operation in explosion-hazardous areas.

2.5 Warranty

MTS Sensors grants a warranty period for the Temposonics® position sensors and supplied accessories relating to material defects and faults that occur despite correct use in accordance with the intended application [2]. The MTS Sensors obligation is limited to repair or replacement of any defective part of the unit. No warranty can be provided for defects that are due to improper use or above average stress of the product, as well as for wear parts. Under no circumstances will MTS Sensors accept liability in the event of offense against the warranty rules, no matter if these have been assured or expected, even in case of fault or negligence of the company.
MTS Sensors explicitly excludes any further warranties. Neither the company's representatives, agents, dealers nor employees are authorized to increase or change the scope of warranty.

2.6 Return

For diagnostic purposes, the sensor can be returned to MTS Sensors or a repair facility explicitly authorized by MTS Sensors. Any shipment cost is the responsibility of the sender [2]. For a corresponding form, see chapter "11. Appendix I" on page 39.

NOTICE

When returning sensors, place protective caps on male and female connectors of the sensor. For pigtail cables, place the cable ends in a static shielding bag for electrostatic discharge (ESD) protection. Fill the outer packaging around the sensor completely to prevent damage during transport.

2/ See also applicable MTS Sensors terms of sales and delivery on: www.mtssensors.com

3. Identification

3.1 Order code of Temposonics® RP5

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
R	P	5										D	5	6	1	U	3		1
a			b	c	d					e		f			g	h			

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…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)

g	System
1	Standard

h	Output
U 3 0 1	POWERLINK, position and velocity (1…30 position(s))
U 3 1 1	POWERLINK, position and velocity, internal linearization (1…30 position(s))

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 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 (U311) in **h** “Output” is chosen, select a suitable magnet.

3.2 Order code of Temposonics® RH5

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
R	H	5										D	5	6	1	U	3		1
a			b	c	d					e		f			g	h			

a	Sensor model
R H 5	Rod

b	Design
B	Base unit (only for replacement)
J	Threaded flange M22×1.5-6g (rod Ø 12.7 mm), stroke length: 25…5900 mm (1…232 in.)
M	Threaded flange M18×1.5-6g (standard)
S	Threaded flange ¾"-16 UNF-3A (standard)
T	Threaded flange ¾"-16 UNF-3A (with raised-face)

c	Mechanical options
A	Standard
B	Bushing on rod end (only for design »M«, »S« & »T«)
M	Thread M4 at rod end (only for design »M«, »S« & »T«)
V	Fluorelastomer seals for the sensor electronics housing

d	Stroke length
X X X X M	0025…7620 mm

Standard stroke length (mm)	Ordering steps
25… 500 mm	5 mm
500… 750 mm	10 mm
750…1000 mm	25 mm
1000…2500 mm	50 mm
2500…5000 mm	100 mm
5000…7620 mm	250 mm

X X X . X U	001.0…300.0 mm

Standard stroke length (in.)	Ordering steps
1… 20 in.	0.2 in.
20… 30 in.	0.4 in.
30… 40 in.	1.0 in.
40…100 in.	2.0 in.
100…200 in.	4.0 in.
200…300 in.	10.0 in.

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

e	Number of magnets
X X	01…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)

g	System
1	Standard

h	Output
U 3 0 1	POWERLINK, position and velocity (1…30 position(s))
U 3 1 1	POWERLINK, position and velocity, internal linearization (1…30 position(s))

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 multi-position measurement, e.g. 2 × U-magnet (part no. 251 416-2).
- If the option for internal linearization (U311) in **h** "Output" is chosen, select a suitable magnet.

3.3 Nameplate

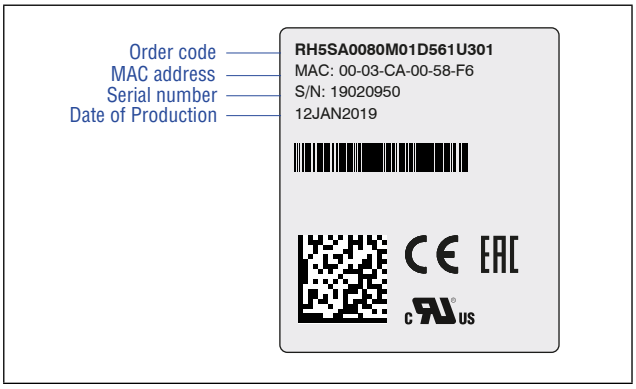


Fig. 1: Example of nameplate of a R-Series V RH5 sensor with POWERLINK output

3.4 Approvals

- CE certified
- EAC certified
- EPSG certified
- UL certified

3.5 Scope of delivery

RP5 (profile sensor):
- 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

RH5 (rod sensor):
- RH5-B: Base unit (without flange/rod assembly),
  3 socket screws M4
- RH5-J/M/S/T: Sensor, O-ring

4. Product description and commissioning

4.1 Functionality and system design

Product designation
- Position sensor Temposonics® R-Series V

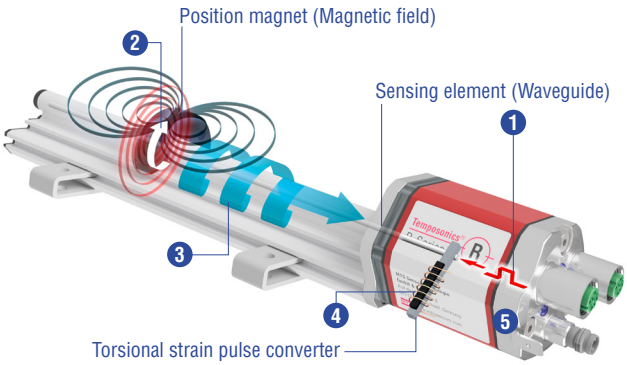
Sensor model
- Temposonics® R-Series V RP5 (profile sensor)
- Temposonics® R-Series V RH5 (rod sensor)

Stroke length
- Temposonics® R-Series V RP5 25…6350 mm (1…250 in.)
- Temposonics® R-Series V RH5 25…7620 mm (1…300 in.)

Output signal
- Ethernet POWERLINK

Application
The Temposonics® position sensors are used for measurement and conversion of the length (position) variable in the fields of automated systems and mechanical engineering.

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



Measurement Cycle

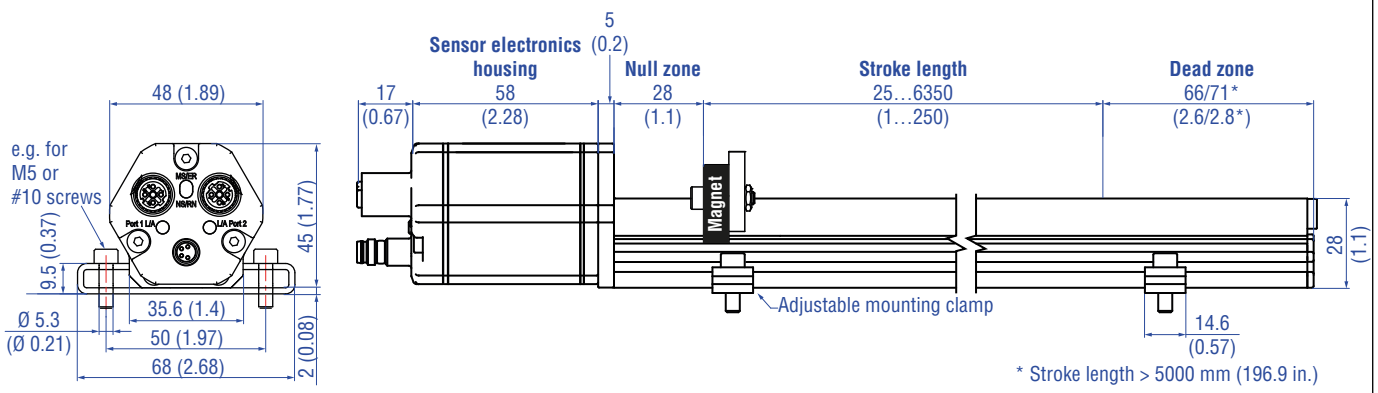
1	Current pulse generates magnetic field
2	Interaction with position magnet field generates torsional strain pulse
3	Torsional strain pulse propagates
4	Strain pulse detected by converter
5	Time-of-flight converted into position

Fig. 2: Time-of-flight based magnetostrictive position sensing principle

Modular mechanical and electronic construction
- The sensor rod or profile protects the inner sensor element.
- The sensor electronics housing, a rugged aluminum construction, contains the complete electronic interface with active signal conditioning.
- The external position magnet is a permanent magnet. Mounted on the mobile machine part, it travels along the sensor rod or profile and triggers the measurement through the sensor rod/profile wall.
- The sensor can be connected directly to a control system. Its electronics generates a strictly position-proportional signal output between start and end position.

4.2 Styles and installation of Temposonics® RP5

RP5-M-A/-V



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

Fig. 3: Temposonics® RP5 with U-magnet

Installation of RP5

The position sensor can be installed in any position. Normally, the sensor is firmly installed and the position magnet is fastened to the mobile machine part. Thus it can travel along the sensor profile. The sensor is fitted on a flat machine surface using the mounting clamps (Fig. 4). A length-dependent number of these clamps are delivered with the sensor and must be distributed over the profile at regular distances. For fastening use M5×20 screws to DIN 6912 that should be tightened with a fastening torque of 5 Nm.

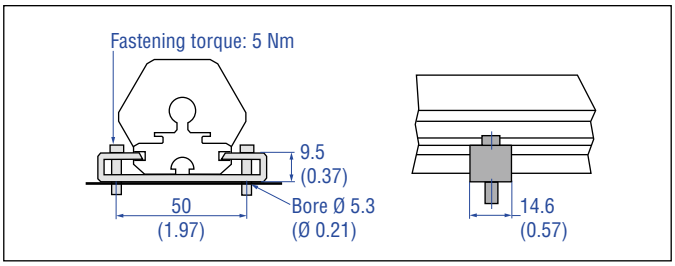


Fig. 4: Mounting clamps (part no. 400 802) with cylinder screw M5×20

Alternative:

If only limited space is available, the profile sensor can be mounted also via the T-rail in the profile bottom using an T-slot nut M5 (part no. 401 602) or a sliding block (Fig. 5).

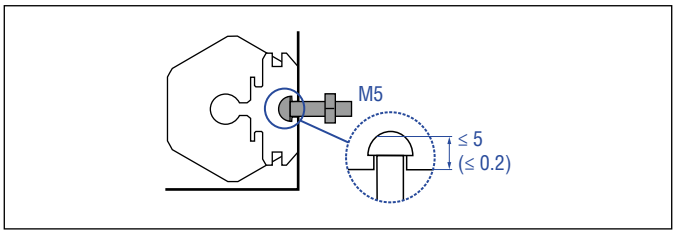


Fig. 5: T-slot nut M5 (part no. 401 602)

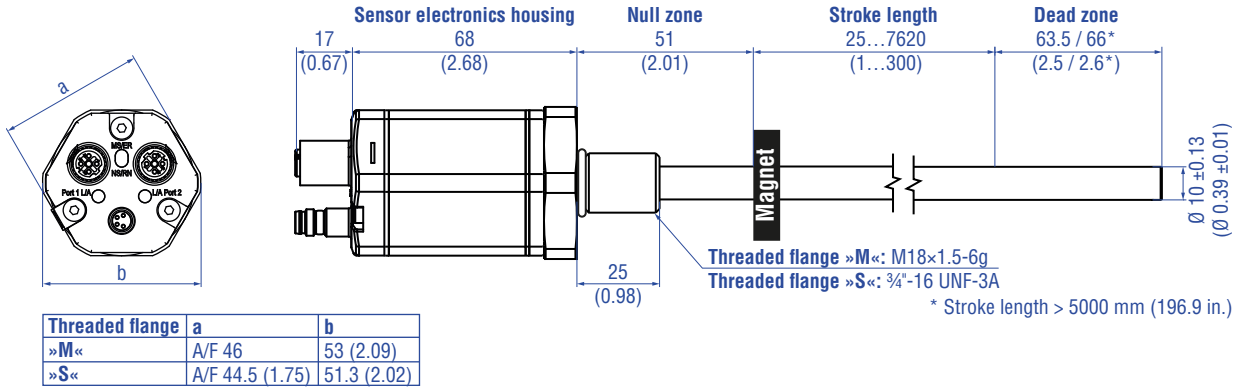
NOTICE

Take care to mount the sensor in an axially parallel position to avoid damage to magnet and sensor.

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

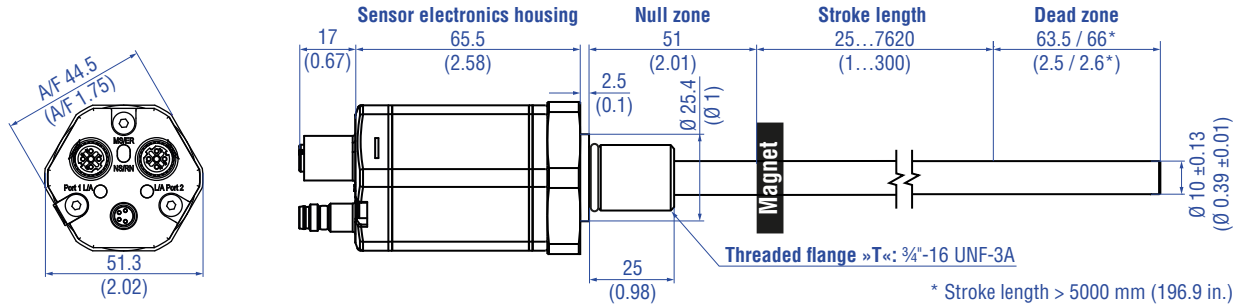
4.3 Styles and installation of Temposonics® RH5

RH5-M/S-A/-V – RH5 with threaded flange M18×1.5-6g or ¾"-16 UNF-3A

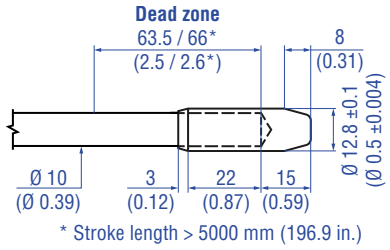


Threaded flange	a	b
»M«	A/F 46	53 (2.09)
»S«	A/F 44.5 (1.75)	51.3 (2.02)

RH5-T-A/-V – RH5 with threaded, raised-face flange ¾"-16 UNF-3A



Mechanical option »B«: Bushing on rod end for threaded flange M18×1.5-6g or ¾"-16 UNF-3A



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

Mechanical option »M«: Thread M4 at rod end for threaded flange M18×1.5-6g or ¾"-16 UNF-3A

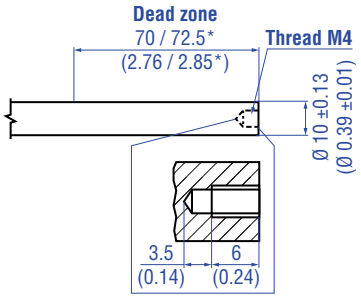
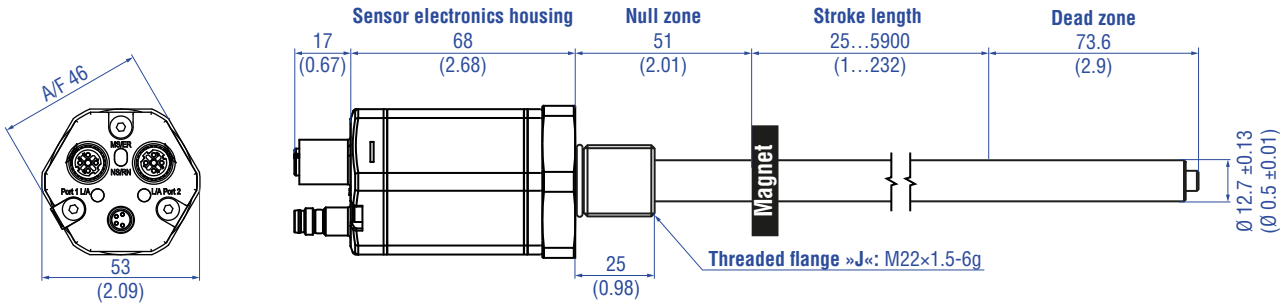
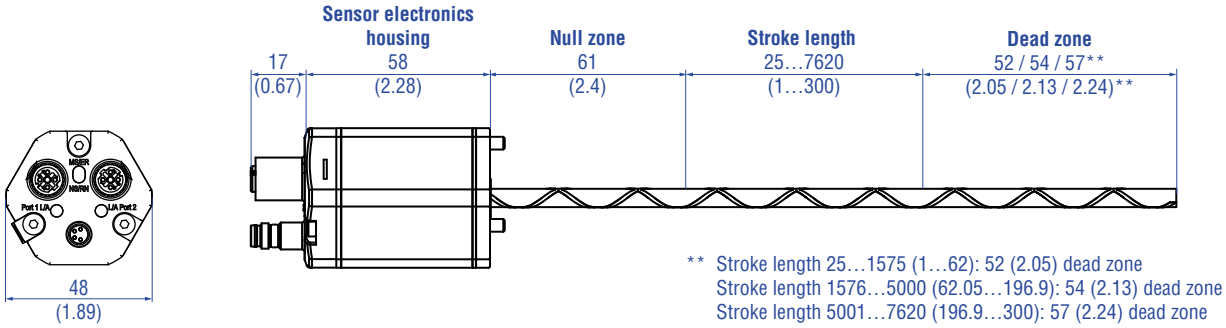


Fig. 6: Temposonics® RH5 with ring magnet, part 1

RH5-J-A/-V – RH5 with threaded flange M22×1.5-6g and Ø 12.7 mm rod



RH5-B-A/-V – RH5 base unit (only for replacement)



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

Fig. 7: Temposonics® RH5 with ring magnet, part 2

Installation of RH5 with threaded flange

Fix the sensor rod via threaded flange M18×1.5-6g, M22×1.5-6g or ¾"-16 UNF-3A.

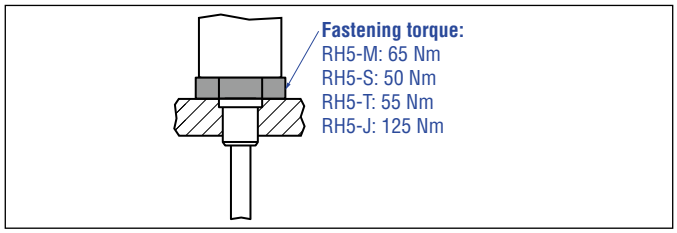


Fig. 8: Mounting example of threaded flange

Installation of a rod-style sensor in a fluid cylinder

The rod-style version has been developed for direct stroke measurement in a fluid cylinder. Mount the sensor via threaded flange or a hex nut.

- Mounted on the face of the piston, the position magnet travels over the rod without touching it and indicates the exact position through the rod wall – independent of the hydraulic fluid.
- The pressure resistant sensor rod is installed into a bore in the piston rod.
- The base unit is mounted by means of three screws. It is the only part that needs to be replaced if servicing is required, i.e. the hydraulic circuit remains closed. For more information see chapter "4.6 Replacement of sensor" on page 16.

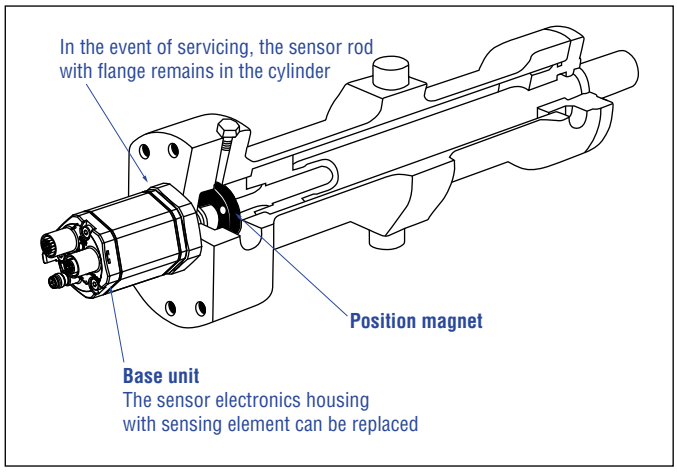


Fig. 9: Sensor in cylinder

Hydraulics sealing

There are two ways to seal the flange contact surface (Fig. 10):

1. A sealing by using an O-ring (e.g. 22.4 × 2.65 mm (0.88 × 0.1 in.), 25.07 × 2.62 mm (0.99 × 0.1 in.)) in a cylinder bottom groove.
2. A sealing by using an O-ring in the undercut.
   For threaded flange (¾"-16 UNF-3A):
   O-ring 16.4 × 2.2 mm (0.65 × 0.09 in.) (part no. 560 315)
   For threaded flange (M18×1.5-6g):
   O-ring 15.3 × 2.2 mm (0.60 × 0.09 in.) (part no. 401 133)
   For threaded flange (M22×1.5-6g):
   O-ring 19.2 × 2.2 mm (0.76 × 0.09 in.) (part no. 561 337)

In the case of threaded flange M18×1.5-6g or M22×1.5-6g, provide a screw hole based on ISO 6149-1 (Fig. 11). See ISO 6149-1 for further information.

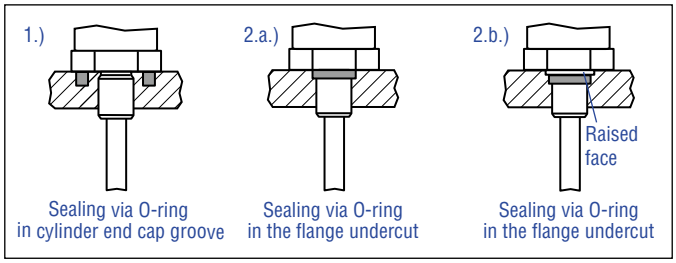
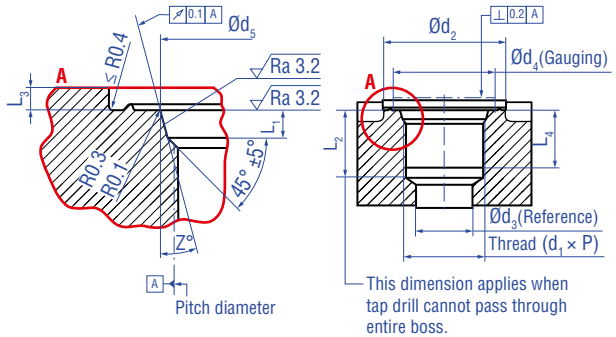


Fig. 10: Possibilities of sealing for threaded flange with flat face 1. + 2.a. (RH5-J/-M/-S) and with raised-face 2.b. (RH5-T)

- Note the fastening torque:
  RH5-M: 65 Nm
  RH5-S: 50 Nm
  RH5-T: 55 Nm
  RH5-J: 125 Nm
- Seat the flange contact surface completely on the cylinder mounting surface.
- The cylinder manufacturer determines the pressure-resistant gasket (copper gasket, O-ring, etc.).
- The position magnet should not grind on the sensor rod.
- The piston rod drilling
  (RH5-M/S/T-A/M/V with rod Ø 10 mm: ≥ Ø 13 mm (≥ Ø 0.51 in.);
  RH5-M/S/T-B with rod Ø 10 mm: ≥ Ø 16 mm (≥ Ø 0.63 in.);
  RH5-J-A/V with rod Ø 12.7 mm: ≥ Ø 16 mm (≥ Ø 0.63 in.))
  depends on the pressure and piston speed.
- Adhere to the information relating to operating pressure.
- Protect the sensor rod against wear.

Notice for metric threaded flanges

Thread (d_1×P)	d_2	d_3	d_4	d_5 +0.1 0	L_1 +0.4 0	L_2	L_3	L_4	Z° ±1°
RH5-M-A/V									
M18×1.5-6g	55	≥ 13	24.5	19.8	2.4	28.5	2	26	15°
RH5-M-B									
M18×1.5-6g	55	≥ 16	24.5	19.8	2.4	28.5	2	26	15°
RH5-J-A/V									
M22×1.5-6g	55	≥ 16	27.5	23.8	2.4	28.5	2	26	15°



Controlling design dimensions are in millimeters

Fig. 11: Notice for metric threaded flange M18×1.5-6g/M22×1.5-6g based on DIN ISO 6149-1

4.4 Magnet installation

Typical use of magnets

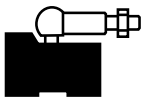
Magnet	Typical sensors	Benefits
Ring magnets 	**Rod model** (RH5)	• Rotationally symmetrical magnetic field
U-magnets 	**Profile & rod models** (RP5, RH5)	• Height tolerances can be compensated, because the magnet can be lifted off
Block magnets 	**Profile & rod models** (RP5, RH5)	• Height tolerances can be compensated, because the magnet can be lifted off
Magnet sliders 	**Profile models** (RP5)	• The magnet is guided by the profile • The distance between the magnet and the waveguide is strictly defined • Easy coupling via the ball joint

Fig. 12: Typical use of magnets

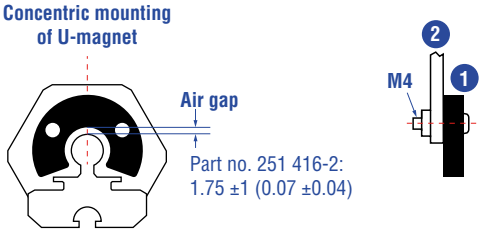
Mounting ring magnets, U-magnets & block magnets

Install the magnet using non-magnetic material for mounting device, screws, spacers etc.. The magnet must not grind on the sensor rod. Alignment errors are compensated via the air gap.

- Permissible surface pressure: Max. 40 N/mm² (only for ring magnets and U-magnets)
- Fastening torque for M4 screws: 1 Nm; use washers, if necessary
- Minimum distance between position magnet and any magnetic material has to be 15 mm (0.6 in.) (Fig. 15)
- If no other option exists and magnetic material is used, observe the specified dimensions (Fig. 15)

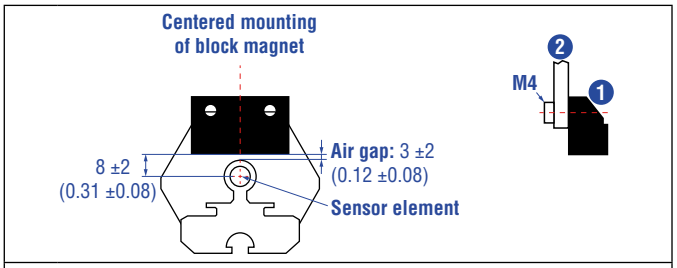
NOTICE

Mount ring magnets and U-magnets concentrically. Mount block magnets centrically over the sensor rod or the sensor profile. The maximum permissible air gap must not be exceeded (Fig. 13/Fig. 14). Take care to mount the primary sensor axis in parallel to the magnet path in order to avoid damage to the carriage, magnet and sensor rod/sensor profile.



1 U-magnet
2 Non-magnetic mounting plate

Fig. 13: Mounting of U-magnet (part no. 251 416-2)



1 Block magnet
2 Non-magnetic mounting plate

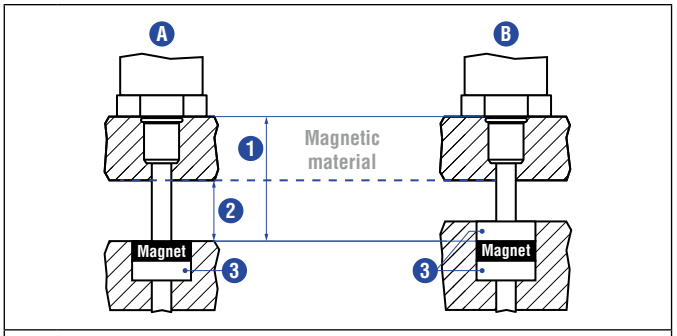
Fig. 14: Mounting of block magnet (part no. 403 448)

Magnet mounting with magnetic material

When using magnetic material the dimensions of Fig. 15 must be observed.

A. If the position magnet aligns with the drilled piston rod

B. If the position magnet is set further into the drilled piston rod, install another non-magnetic spacer (e.g. part no. 400 633) above the magnet.



1 Null zone, depends on sensor model
2 Distance between position magnet and any magnetic material (≥ 15 mm (≥ 0.6 in.))
3 Non-magnetic spacer (≥ 5 mm (≥ 0.2 in.)) – Recommendation: 8 mm (0.31 in.)

Fig. 15: Installation with magnetic material

Rod sensors with stroke lengths ≥ 1 meter (3.3 ft.)

Support horizontally installed rod sensors with a stroke length of one meter and more (3.3 ft.) mechanically. Without using a support, the sensor rod bends over and the rod and the position magnet may be damaged. A false measurement result is also possible. Longer rods require evenly distributed mechanical support over the entire length (e.g. part no. 561 481). Use an U-magnet (Fig. 16) for measurement.

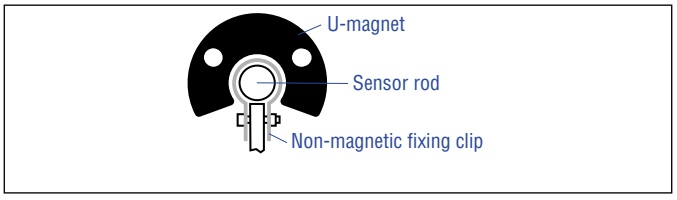


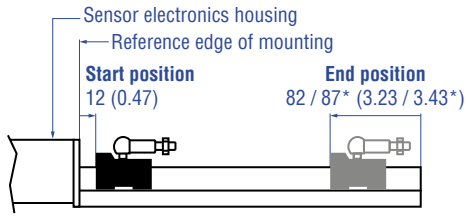
Fig. 16: Example of sensor support with the fixing clip (part no. 561 481)

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

Start- and end positions of the position magnets

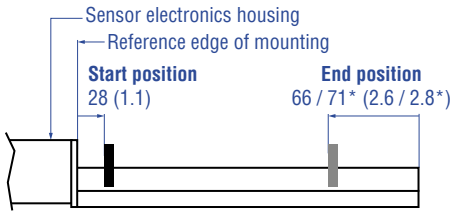
Consider the start and end positions of the position magnets during the installation. To ensure that the entire stroke length is electrically usable, the position magnet must be mechanically mounted as follows.

RP5 with magnet slider "S", "N", "V", "G"



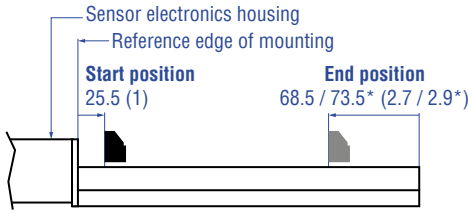
* Stroke length > 5000 mm (196.9 in.)

RP5 with U-magnet



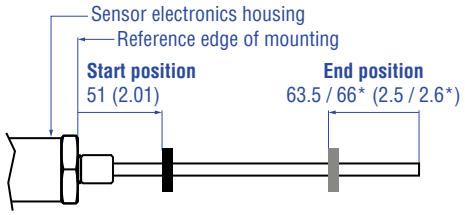
* Stroke length > 5000 mm (196.9 in.)

RP5 with block magnet



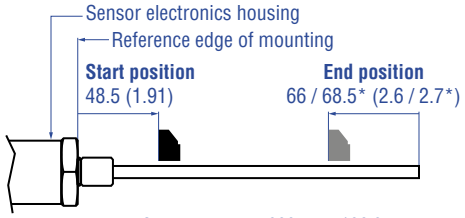
* Stroke length > 5000 mm (196.9 in.)

RH5 with ring magnet/U-magnet



* Stroke length > 5000 mm (196.9 in.)

RH5 with block magnet



* Stroke length > 5000 mm (196.9 in.)

Fig. 17: Start- & end positions of magnets

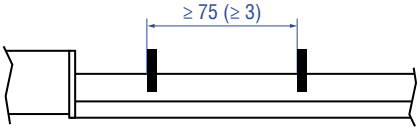
NOTICE

On all sensors, the areas left and right of the active stroke length are provided for null and dead zone. These zones should not be used for measurement, however the active stroke length can be exceeded.

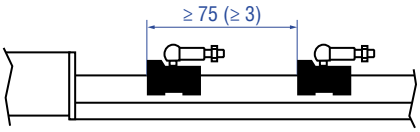
Multi-position measurement

The minimum distance between the magnets is 75 mm (3 in.).

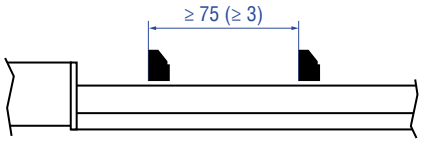
RP5 with U-magnet



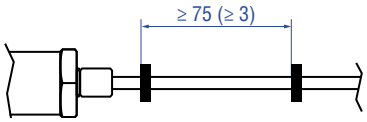
RP5 with magnet sliders



RP5 with block magnets



RH5 with ring magnets / U-magnets



RH5 with block magnets

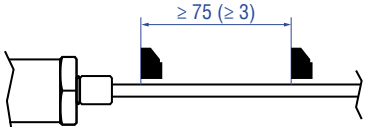


Fig. 18: Minimum distance for multi-position measurement

NOTICE

For multi-position measurement, use magnets of the same type e.g. 2 × U-magnet (part no. 251 416-2).
Do not fall below the minimum distance between the magnets of 75 mm (3 in.) for multi-position measurement. Contact MTS Sensors if you need a magnet distance < 75 mm (3 in.).

4.5 Alignment of the magnet with the option "Internal linearization"

The internal linearization offers improved linearity of the sensor.
The option must be specified in the order code of the sensor.
The internal linearization is set for the sensor during production.

A sensor with internal linearization is delivered with the magnet with which the sensor was squared during production. In order to achieve the best possible result, MTS Sensors recommends to operate the sensor with the supplied magnet.

For the internal linearization, the following magnets can be used:
- Ring magnet OD33 (part no. 253 620), for RH5 only
- U-magnet OD33 (part no. 254 226)
- Ring magnet OD25.4 (part no. 253 621), for RH5 only
- Magnet slider S (part no. 252 182), for RP5 only
- Magnet slider N (part no. 252 183), for RP5 only
- Magnet slider V (part no. 252 184), for RP5 only
- Magnet slider G (part no. 253 421), for RP5 only

The ring magnet and U-magnet will be marked for the internal linearization. During the installation, the magnets have to be aligned to the sensor electronics housing (see fig. 19, 20 and 21).

For RH5 POWERLINK sensors with ring magnet applies:
- Install the magnet until the marking on the magnet points to the sensor electronics housing.
- The marking on the magnet points to the same direction as the elongated status LED in the lid of the sensor electronics housing.

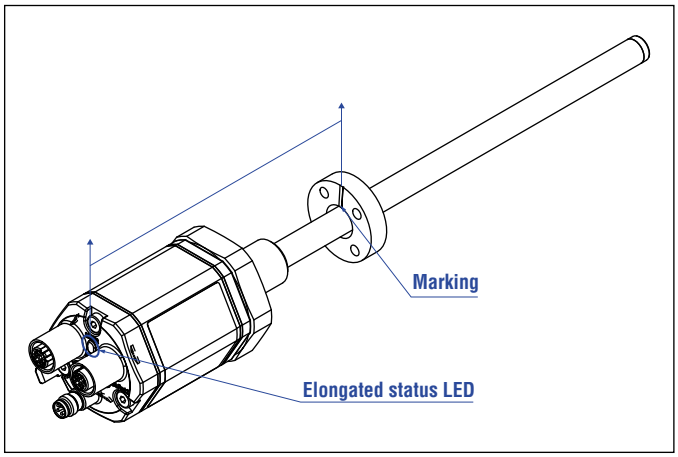


Fig. 19: Magnet alignment of ring magnet for RH5 POWERLINK with internal linearization

For RP5 POWERLINK sensors with U-magnet applies:
- Install the magnet until the marking on the magnet points to the sensor electronics housing.
- The marking on the magnet points to the same direction as the elongated status LED in the lid of the sensor electronics housing.

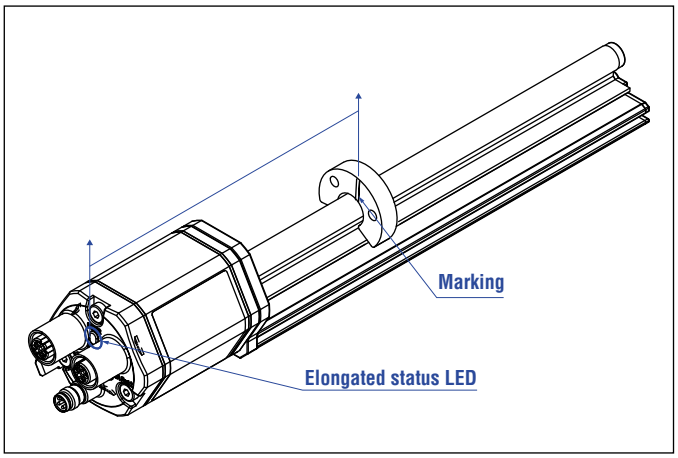


Fig. 20: Magnet alignment of U-magnet for RP5 POWERLINK with internal linearization

For RP5 POWERLINK sensors with magnet slider applies:
- ① Install the magnet sliders "S", "N" and "G" until the additional hole in the magnet points towards the sensor electronics housing.
- ② Install the magnet slider "V" until the joint points to the end of the profile.

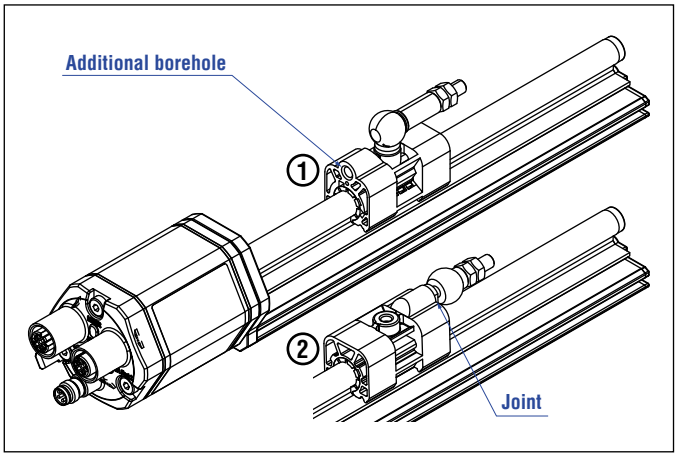


Fig. 21: Magnet alignment of magnet slider for RP5 POWERLINK with internal linearization

The internal linearization of the sensor is carried out under the following conditions:
- Supply voltage +24 VDC ± 0.5
- Operating time > 30 min
- No shock and no vibration
- Eccentricity of the position magnet to central axis of the sensor < 0.1 mm

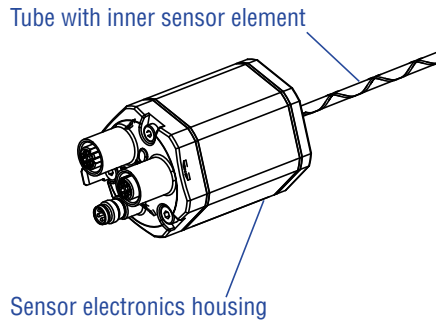
NOTICE

The generated linearization might deviate from the linearity tolerances regarding different environmental conditions. In addition, the use of a different position magnet or more position magnets may cause differences.

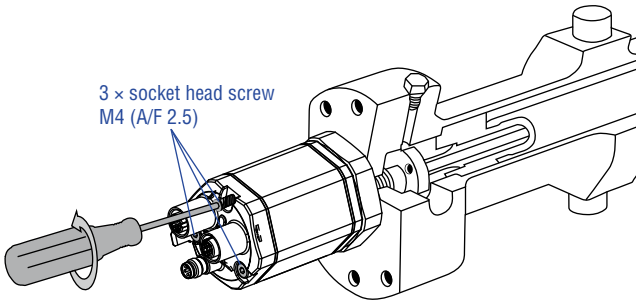
4.6 Replacement of sensor

The base unit of the sensor model RH5 (RH5-B) is replaceable as shown in Fig. 23 and Fig. 24 for the sensor designs »M«, »S« and »T«. The sensor can be replaced without interrupting the hydraulic circuit.

Base unit



1. Loosen the screws.



2. Pull out the base unit.

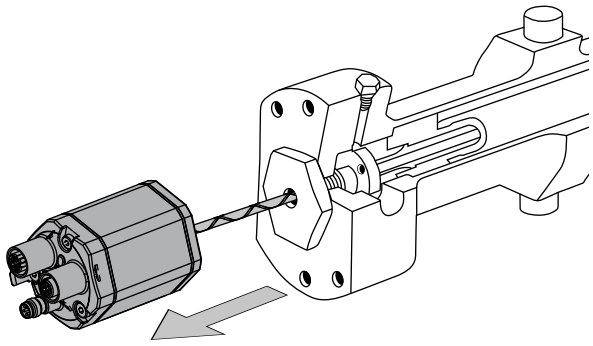


Fig. 22: Replacement of the base unit (e.g. RH5 sensor), part 1

3. Insert the new base unit.
Mount the ground lug on a screw.
Tighten the screws.

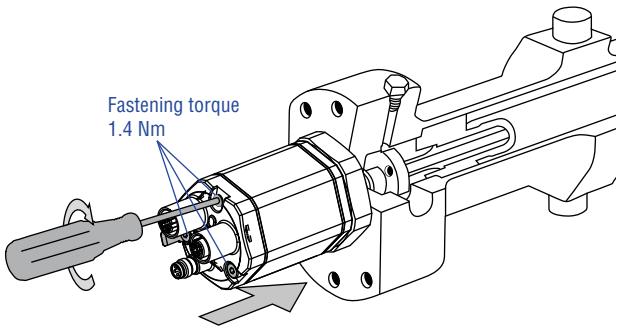


Fig. 23: Replacement of the base unit (e.g. RH5 sensor), part 2

NOTICE

- When replacing the base unit, make sure that no humidity enters the sensor tube. This may damage the sensor.
- Secure the base unit screws, e.g. using Loctite 243, before re-installing.
- If the R-Series V replaces a predecessor model of the R-Series, the plastic tube in the sensor rod must be removed.

4.7 Electrical connection

Placement of installation and cabling have decisive influence on the sensor's electromagnetic compatibility (EMC). Hence correct installation of this active electronic system and the EMC of the entire system must be ensured by using suitable metal connectors, shielded cables and grounding. Overvoltages or faulty connections can damage its electronics despite protection against wrong polarity.

NOTICE

1. Do not mount the sensors in the area of strong magnetic or electric noise fields.
2. Never connect/disconnect the sensor when voltage is applied.

Instructions for connection

- Use low-resistant twisted pair and shielded cables. Connect the shield to ground externally via the controller equipment.
- Keep control and signal cables separate from power cables and sufficiently far away from motor cables, frequency inverters, valve lines, relays, etc..
- Use only connectors with metal housing and connect the shielding to the connector housing.
- Keep the connection surface at both shielding ends as large as possible. Connect the cable clamps to function as a ground.
- Keep all non-shielded leads as short as possible.
- Keep the earth connection as short as possible with a large cross section. Avoid ground loops.
- With potential differences between machine and electronics earth connections, no compensating currents are allowed to flow across the cable shielding.
  Recommendation:
  Install potential compensating leads with large cross section, or use cables with separate double shielding, and connect only one end of the shield.
- Use only stabilized power supplies in compliance with the specified electrical ratings.

Grounding of profile and rod sensors

Connect the sensor electronics housing to machine ground. Ground sensor types RP5 and RH5 via ground lug as shown in Fig. 24.
In addition you can ground the sensor type RH5 via thread.

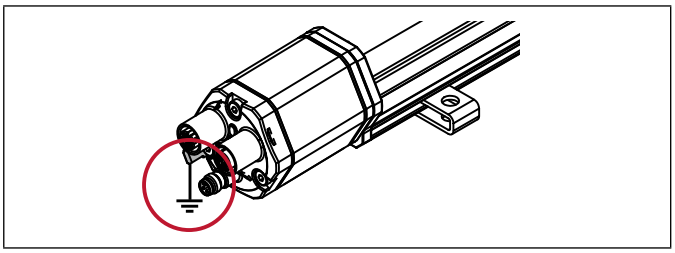


Fig. 24: Grounding via ground lug (e.g. RP5)

Connector wiring

Connect the sensor directly to the control system, indicator or other evaluating systems as follows:

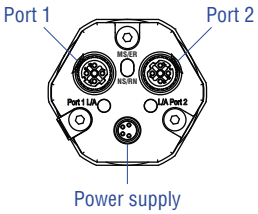


Fig. 25: Location of connections

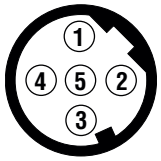
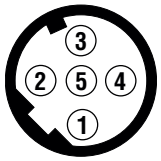
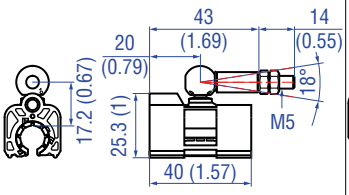
D56		
Port 1 – Signal		
M12 female connector (D-coded)	**Pin**	**Function**
 View on sensor	1	Tx (+)
	2	Rx (+)
	3	Tx (–)
	4	Rx (–)
	5	Not connected
Port 2 – Signal		
M12 female connector (D-coded)	**Pin**	**Function**
 View on sensor	1	Tx (+)
	2	Rx (+)
	3	Tx (–)
	4	Rx (–)
	5	Not connected
Power supply		
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. 26: Connector wiring D56

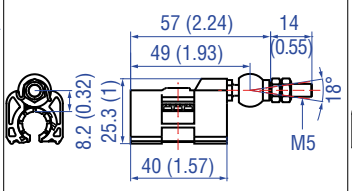
4.8 Frequently ordered accessories for RP5 design – Additional options available in our Accessories Guide 551 444

Position magnets



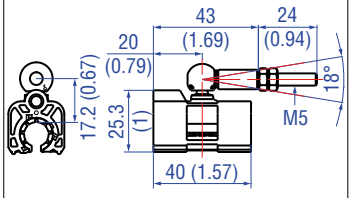
Magnet slider S, joint at top
Part no. 252 182

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



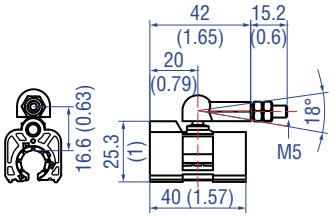
Magnet slider V, joint at front
Part no. 252 184

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

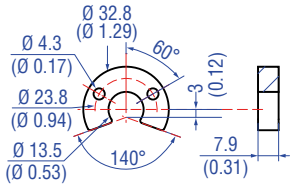
Material: GRP, magnet hard ferrite
Weight: Approx. 35 g
Operating temperature:
–40…+85 °C (–40…+185 °F)



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)

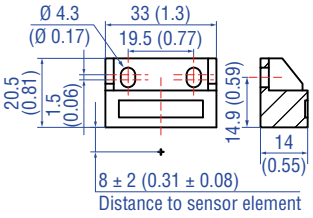
Position magnets



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)

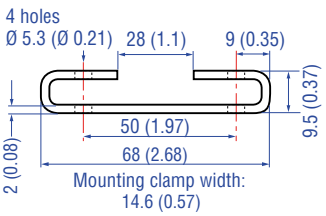
Marked version for sensors with internal linearization: Part no. 254 226



Block magnet L
Part no. 403 448

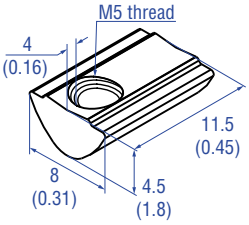
Material: Plastic carrier with hard ferrite magnet
Weight: Approx. 20 g
Fastening torque for M4 screws: 1 Nm
Operating temperature:
–40…+75 °C (–40…+167 °F)
This magnet may influence the sensor performance specifications for some applications.

Mounting accessories



Mounting clamp
Part no. 400 802

Material: Stainless steel (AISI 304)



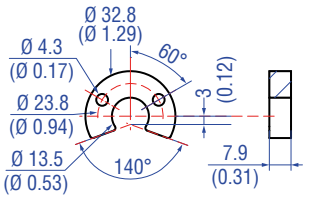
T-nut
Part no. 401 602

Fastening torque for M5 screw: 4.5 Nm

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

4.9 Frequently ordered accessories for RH5 design – Additional options available in our Accessories Guide 551 444

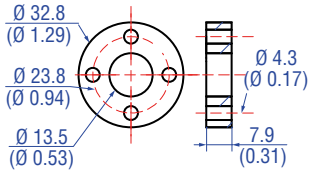
Position magnets



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)

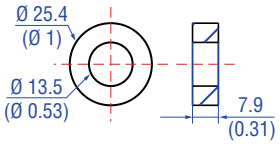
Marked version for sensors with internal linearization: Part no. 254 226



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)

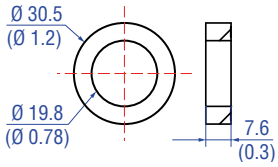
Marked version for sensors with internal linearization: Part no. 253 620



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)

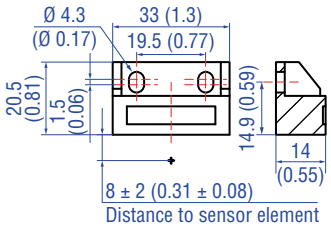
Marked version for sensors with internal linearization: Part no. 253 621



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)

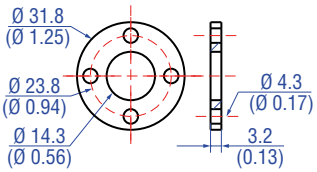
Position magnet



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.

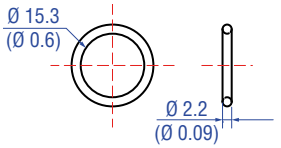
Magnet spacer



Magnet spacer
Part no. 400 633

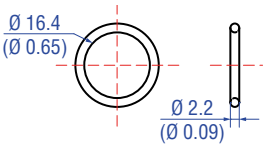
Material: Aluminum
Weight: Approx. 5 g
Surface pressure: Max. 20 N/mm²
Fastening torque for M4 screws: 1 Nm

O-rings



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

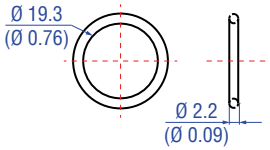
Material: Fluoroelastomer
Durometer: 75 ± 5 Shore A
Operating temperature:
–40…+204 °C (–40…+400 °F)



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)

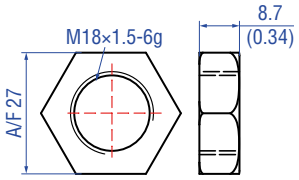
O-ring



O-ring for threaded flange
M22×1.5-6g
Part no. 561 337

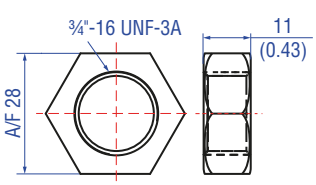
Material: FPM
Durometer: 75 Shore A
Operating temperature:
–20…+200 °C (–6…+392 °F)

Mounting accessories



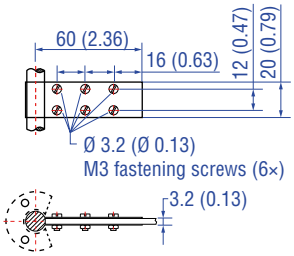
Hex jam nut M18×1.5-6g
Part no. 500 018

Material: Steel, zinc plated



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

Material: Zinc plated



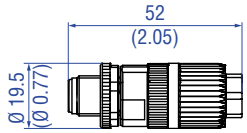
Fixing clip
Part no. 561 481

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

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

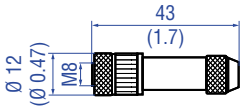
4.10 Frequently ordered accessories for POWERLINK output – Additional options available in our Accessories Guide 551 444

Cable connectors*



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

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 fi tted)
Fastening torque: 0.6 Nm



Power connector M8 female (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

Programming kit

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

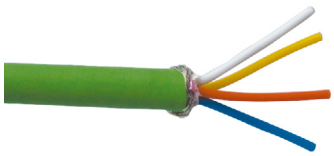
- Connect wirelessly via Wi-Fi enabled device or via USB with the diagnostic tool
- Simple connectivity to the sensor via 24 VDC power line (permissible cable length: 30 m)
- User friendly interface for mobile devices and desktop computers
- See product brief “TempoLink smart assistant” (document part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

Cables

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.))

Material: PUR jacket; gray
Features: Shielded
Cable Ø: 8 mm (0.3 in.)
Operating temperature:
–40…+90 °C (–40…+194 °F)

Cables



PUR signal cable
Part no. 530 125

Material: PUR jacket; green
Features: Cat 5, highly flexible, halogen free, energy chain capable, mostly oil & flame restistant
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)

PVC power cable
Part no. 530 108

Material: PVC jacket; gray
Features: Shielded, flexible, mostly flame restistant
Cable Ø: 4.9 mm (0.19 in.)
Cross section: 3 × 0.34 mm²
Bending radius: 10 × D
Operating temperature:
–30…+80 °C (–22…+176 °F)

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
Features: Cat 5e
Cable length: 5 m (16.4 ft)
Cable Ø: 6.5 mm (0.26 in.)
Ingress protection: IP65, IP67, IP68 (correctly fi tted)
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 M12 connector: IP67 (correctly fi tted)
Ingress protection RJ45 connector: IP20 (correctly fi tted)
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

5. Operation

5.1 Initial start-up

The position sensor R-Series V POWERLINK transfers position and velocity values via the POWERLINK output. POWERLINK is an Industrial Ethernet interface and is managed by the Ethernet POWERLINK Standardization Group (EPSG). The sensor and the corresponding XDD file (XML Device Description) are certified by EPSG.

NOTICE

Observe during commissioning

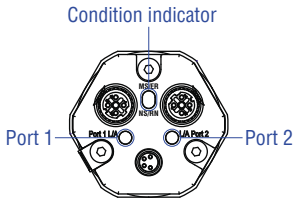
1. Before initial switch-on, check carefully if the sensor has been connected correctly.
2. Position the magnet in the measuring range of the sensor during first commissioning and after replacement of the magnet.
3. Ensure that the sensor control system cannot react in an uncontrolled way when switching on.
4. Ensure that the sensor is ready and in operation mode after switching on. The bus status LED is green.
5. Check the preset span start and end values of the measuring range (see chapter 4.4) and correct them via the customer's control system, if necessary.

5.2 LED status

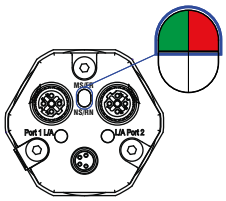
A diagnostic display on the lid of the sensor informs about the current status of the sensor. The R-Series V POWERLINK is equipped with three LEDs:

- LED for status indication (condition indicator)
- LED for activity of the Ethernet connection at port 1 (Link Activity)
- LED for activity of the Ethernet connection at port 2 (Link Activity)

POWERLINK LED status



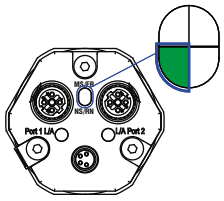
Device status LED



Green	Red	Information
○ OFF	● ON	- Number of magnets differs from configuration - Power supply outside specification
○ OFF	◐ Flashing	- Invalid configuration of the sensor - Internal error

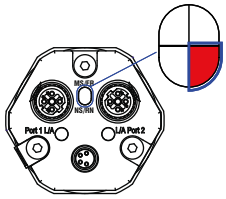
Fig. 27: LED status display, part 1

Bus status LED (when the sensor is started up, these statuses run through)



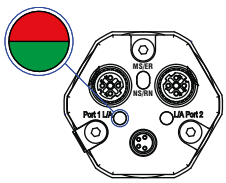
Green	Red	Information
◐ Flash evenly	○ OFF	Basic Ethernet Mode
◐ Single flash	○ OFF	Preoperational Mode 1
◐ 2× single flash	○ OFF	Preoperational Mode 2
◐ 3× single flash	○ OFF	Ready to operate
● ON	○ OFF	Connection establishment completed, sensor connected to controller

Bus error LED



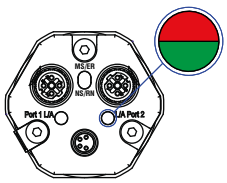
Red	Information
● ON	POWERLINK communication error

Port 1 L/A



Green	Red	Information
● ON	○ OFF	Connection to the next network node established
◐ Flashing	○ OFF	Connection to the next network node established & communication active

Port 2 L/A



Green	Red	Information
● ON	○ OFF	Connection to the next network node established
◐ Flashing	○ OFF	Connection to the next network node established & communication active

Fig. 28: LED status display, part 2

5.3 Topologies and hubs

POWERLINK supports various topologies when building up a network. Thus, the usage of linear, star, ring and tree topologies are supported. A hub is integrated in devices like the R-Series V POWERLINK sensors. With integrated hubs, a power failure will cause a communication interruption to the subsequent devices. This can be avoided for example by extending a line structure to a ring structure.

6. Node ID configuration of R-Series V POWERLINK

This chapter describes how to adjust the node ID of the R-Series V POWERLINK. The node ID is used to identify a device in a POWERLINK network. Each node ID only exists once in the network. The node ID can have a value between 1 and 240, where 240 is reserved for the Managing Node. The node ID set on the POWERLINK device must match the node ID assigned in the project. There are two ways to set the node ID on the R-Series V POWERLINK.
Section 6.1 describes the setting of the node ID via the TempoLink smart assistant.
Section 6.2 explains the setting of the node ID via Automation Studio by B&R (Bernecker + Rainer Industrie-Elektronik Ges.m.b.H.).

6.1 Setting the node ID via TempoLink smart assistant

TempoLink smart assistant is an accessory of the R-Series V family of sensors. On the R-Series V POWERLINK, it is used to set the node ID and provide additional status information for diagnostics of the sensor.

6.1.1 Connection of TempoLink smart assistant to sensor and power supply

Before changing the node ID at the sensor and connecting TempoLink smart assistant to the sensor, disconnect the sensor from the power supply and if the sensor is connected to a control disconnect it, too. Use the adapter cable for connection of the TempoLink smart assistant to the R-Series V sensor. Connect the barrel connector of the adapter cable to the connection point labeled “OUTPUT SENSOR” on the TempoLink smart assistant. Next, connect the female connector of the adapter cable to the power supply at the R-Series V POWERLINK sensor.

NOTICE
When disconnecting the power supply of the sensor possibly error messages occur at the connected controller.

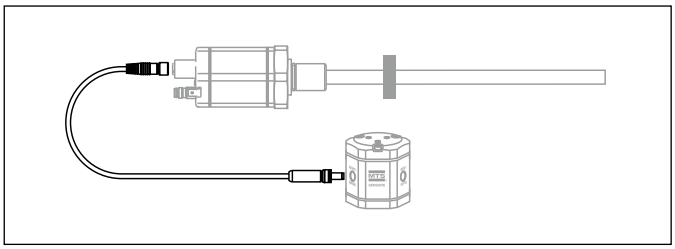


Fig. 29: Connection of TempoLink smart assistant to R-Series V sensor

Connect the TempoLink smart assistant to the power supply using the plug-in power supply with plug adapters. Connect the barrel connector to the “INPUT 24 VDC” port on the TempoLink smart assistant. Next, insert the plug into the outlet. Additional outlet adapters are supplied to support regional requirements.

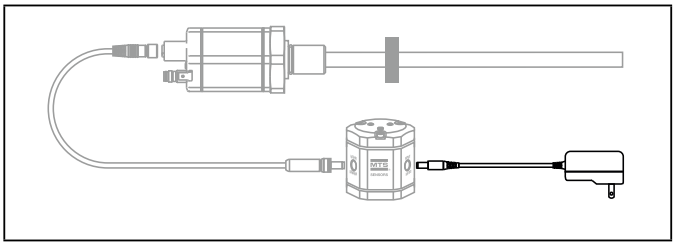


Fig. 30: Connection of TempoLink smart assistant with the plug-in power supply

6.1.2 Connection of TempoLink smart assistant to smartphone, tablet or computer

Connect to a smartphone, tablet or computer to display the graphical user interface of the TempoLink smart assistant.

Connecting a Wi-Fi enabled device to the integrated Wi-Fi access point [3]

Activate Wi-Fi on the device and choose the network “TempoLink_xxxx” (xxxx indicates the last four digits of the serial number). The default password is the serial number printed on the label on the bottom of the TempoLink smart assistant.

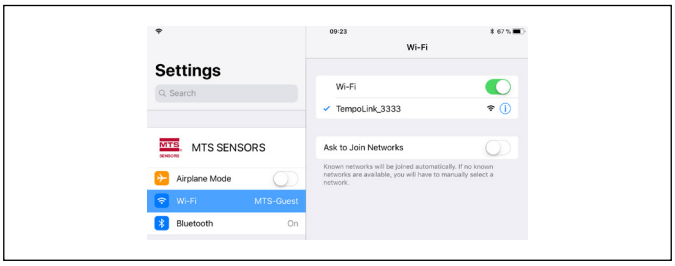


Fig. 31: Choose the network “TempoLink_xxxx” in the Wi-Fi settings of the Wi-Fi-enabled device

NOTICE

If you are using a mobile device, ensure cellular data is off. Depending on your operation system, message can appear, that there is no internet access. TempoLink smart assistant does not need internet access. Connecting to the user interface may take longer if other Wi-Fi and mobile data connections are active within range.

Connecting a computer via USB connection

The TempoLink smart assistant can also be connected via USB. If the computer is Wi-Fi enabled deactivate Wi-Fi on the computer before setting up the USB connection.

Connect the USB cable with the micro USB connector to the port labeled “USB” on the TempoLink smart assistant. Next, connect the USB type-A connector to a free USB port of the computer. The USB connection simulates a network card. In the folder “network connections” on the computer the connection is shown as “IP-over-USB” or “Remote NDIS”.

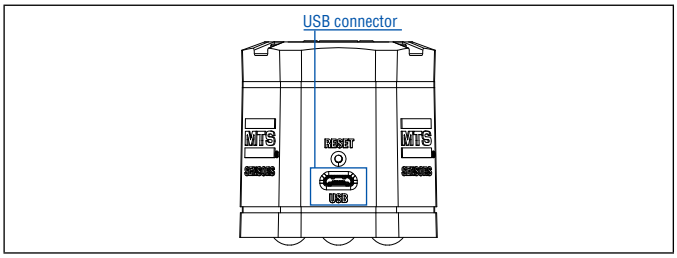


Fig. 32: USB port on the TempoLink smart assistant

NOTICE

- Only one device can be connected to the TempoLink smart assistant at a time in order to display the graphical user interface.
- Disable all Wi-Fi and LAN connections before connecting TempoLink smart assistant via USB. Connecting to the user interface may take longer if Wi-Fi and LAN connections are active.
- It may be useful to press CTRL + F5 to delete cached text and images from prior to launching the *tempolink.local* website.

6.1.3 Establishing a connection via browser

After the connection via Wi-Fi or USB is established, open the browser and go to the website-URL: **tempolink.local**

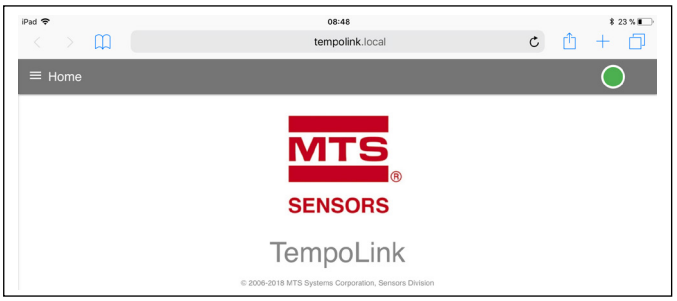


Fig. 33: Start page of the graphical user interface

The connection icon in the top right shows the status of the connection between the TempoLink smart assistant and the sensor.

Connection status	
Green	**Information**
● ON	Connection to sensor is established
Red	**Information**
● ON	Connection to sensor is not established
Blue	**Information**
● ON	Sensor in command mode

Fig. 34: Connection status

3/ The integrated Wi-Fi access point does not provide internet access

6.1.4 Graphical User Interface (GUI)

Click the menu symbol ≡ in the top left to get to the main menu:

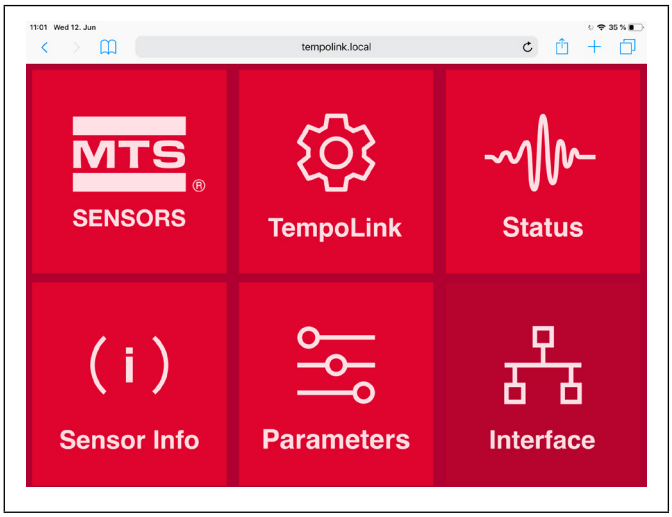


Fig. 35: Main menu of the graphical user interface (GUI)

To change the node ID of the connected sensor, select the menu item Interface (Fig. 35). Interface includes information about the network settings of the sensor. To change the settings you must start the command mode. In the command mode, the sensor does not output a position value. By clicking the ENTER COMMAND MODE button a new menu will open. After reading the information, enter the word COMMAND and confirm by clicking OK (Fig. 36).

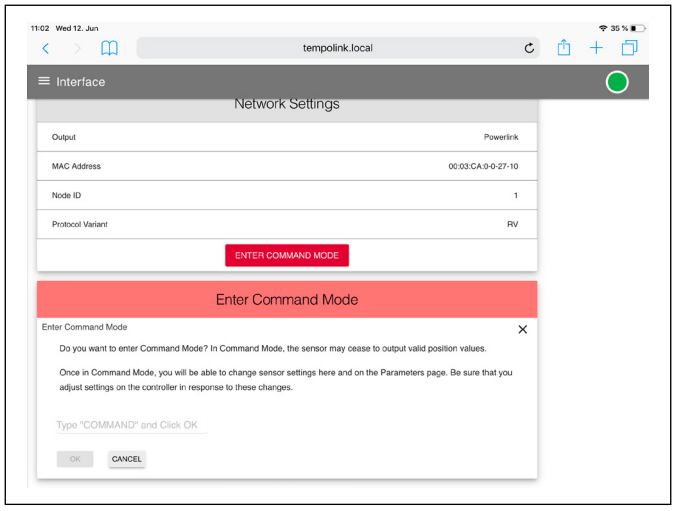


Fig. 36: Starting the command mode to change settings of the connected sensor

After entering the command mode the connection icon on the top right will turn from green to blue. A pencil icon will appear to the right of the node ID. By clicking the pencil icon a new window for configuring the node ID will open. Enter the new node ID of the sensor and confirm the change by clicking the SUBMIT button (Fig. 37). Only values between 1 and 239 are permitted. The value 240 is reserved for the Managing Node.

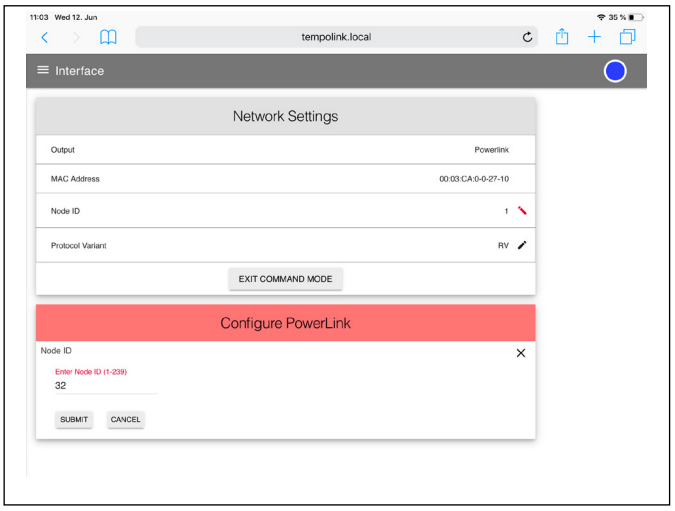


Fig. 37: Changing the node ID of the connected sensor

After the node ID has been configured, click the EXIT COMMAND MODE button. A new window for exiting the command mode will open (Fig. 38). Click the SAVE AND EXIT button to exit the command mode and to transfer the changed node ID to the sensor. The sensor returns to the normal function and outputs the current position value. When you exit the command mode the connection icon changes to green.

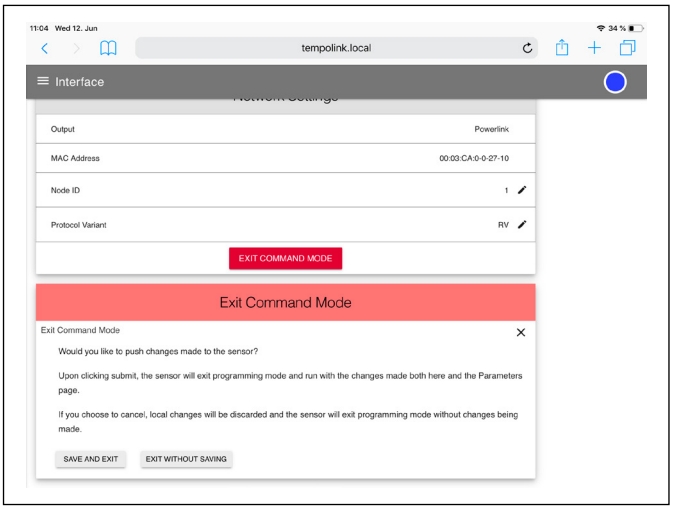


Fig. 38: Exiting the command mode

The other menu items contain the following information:

TempoLink: Includes information about the TempoLink smart assistant
Status: Includes current information about the sensor status
Sensor Info: Includes information about the connected sensor
Parameters: Includes information about the operational settings of the connected sensor

NOTICE

- To enable the controller to communicate with the sensor, the node ID set on the sensor must also be set on the controller.
- For detailed information about the TempoLink smart assistant see its operation manual (document no. 551986).

6.2 Setting the node ID via "Automation Studio"

The following is a description how to set the node ID of the R-Series POWERLINK as well as the R-Series V POWERLINK using “Automation Studio” by B&R (Bernecker + Rainer Industrie-Elektronik Ges.m.b.H.).

6.2.1 Hardware setup

In this example R-Series POWERLINK is used with node ID 32 (default value). It also applies to R-Series V POWERLINK with default node ID 1. In this example the sensor is connected to an interface module X20IF1082-2 which is mounted to a control system X20CP3485-1. The screenshot of the hardware setup in “Automation Studio” is shown in Fig. 39.

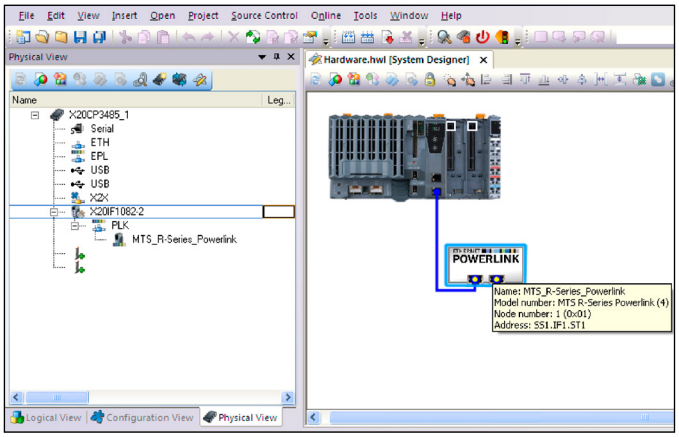


Fig. 39: Hardware setup in "Automation Studio"

6.2.2 Defined data types

To implement a state machine an enumeration type has to be defined that contains all used states (Fig. 40 and Fig. 41).

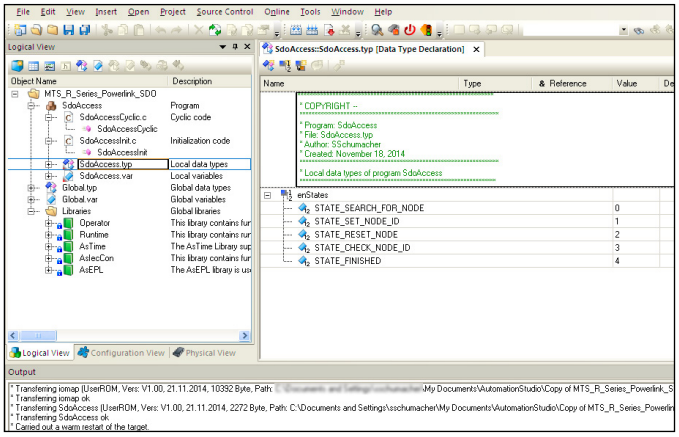


Fig. 40: Defining an enumeration type

Name	Description
STATE_SEARCH_FOR_NODE	This is the initial state in this project. In this state, PLC tries to read the vendor ID of controlled nodes starting from node ID 1 up to node ID 239 (all node IDs which are supposed to be controlled nodes. The node ID 240 is reserved for the managing node) until it detects a controlled node with vendor ID 0x40 (MTS vendor ID).
STATE_SET_NODE_ID	PLC enters into this state when the operations of STATE_SEARCH_FOR_NODE have been finished. In this example the node ID of the first controlled node found with vendor ID 0x40 is set to 1.
STATE_RESET_NODE	PLC enters into this state when the operations of STATE_SET_NODE_ID have been finished. The sensor has to be reset in order to communicate using the new node ID. In this state a reset of the sensor is done.
STATE_CHECK_NODE_ID	PLC enters into this state when the operations of STATE_RESET_NODE have been finished. The node ID of the sensor is read and stored to a local variable.
STATE_FINISHED	PLC enters into this state when the operations of STATE_CHECK_NODE_ID have been finished.

Fig. 41: Defined data types

6.2.3 Used variables

The following local variables are used to change the node ID (Fig. 42).

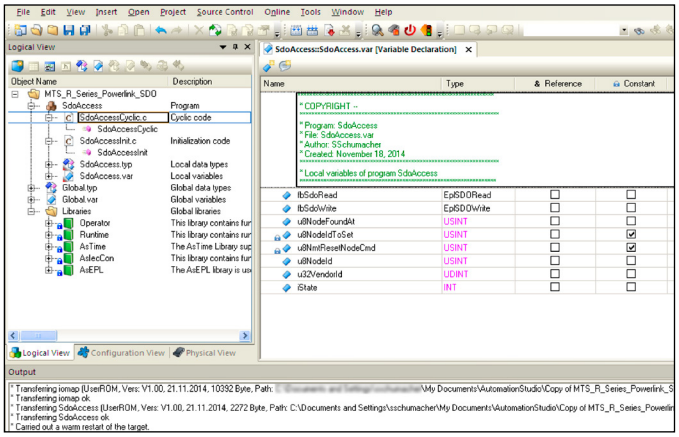


Fig. 42: Screenshot of used variables

Name	Description
fbSdoRead	Predefined function block (AsEPL library) to execute read operations on POWERLINK nodes.
fbSdoWrite	Predefined function block (AsEPL library) to execute write operations on POWERLINK nodes.
u8NodeFoundAt	Unsigned 8 bit integer to store the node ID of the first controlled node with MTS vendor ID which has been found.
u8NodeIdToSet	Constant unsigned 8 bit integer which contains the node ID that shall be set.
u8NmtResetNodeCmd	Constant unsigned 8 bit integer for the command which has to be sent to the reset SDO in order to reset the sensor.
u32VendorID	Unsigned 32 bit integer to store the vendor ID of the node which is currently checked in state STATE_SEARCH_FOR_NODE.
iState	Integer variable which represents the current state of the implemented state machine.

Fig. 43: Variables used

6.2.4 Program executed by PLC once after start-up (SdoAccessInit.c)

This program initializes the state of the implemented state machine as well as the node ID variable. It also sets the variable which is used to store the node ID of the first found controlled node with vendor ID from MTS Sensors to a value which is invalid for a controlled node (source code below).

Source Code “SdoAccessInit.c”

```
/********************************************************************
 * COPYRIGHT --
 ********************************************************************
 * Program: SdoAccess
 * File: SdoAccessInit.c
 * Author: SSchumacher
 * Created: November 18, 2014
 ********************************************************************
 * Implementation of program SdoAccess
 ********************************************************************/

#include <bur/plctypes.h>
#ifdef _DEFAULT_INCLUDES
	#include <AsDefault.h>
#endif

void _INIT SdoAccessInit(void)
{
	iState = STATE_SEARCH_FOR_NODE;		//initialize current state
	u8NodeId = 0;				//initialize node id currently using for search
	u8NodeFoundAt = 255;			//set node id found to invalid node id
}
```

6.2.5 Program executed by PLC cyclically (SdoAccessCyclic.c)

This program implements the state machine and changes the node ID of R-Series POWERLINK as well as R-Series V POWERLINK (source code on page 27).

Source Code “SdoAccessCyclic.c”

```
/********************************************************************
 * COPYRIGHT --
 ********************************************************************
 * Program: SdoAccess
 * File: SdoAccessCyclic.c
 * Author: SSchumacher
 * Created: November 18, 2014
 ********************************************************************
 * Implementation of program SdoAccess
 ********************************************************************/

#include <bur/plctypes.h>
#ifdef _DEFAULT_INCLUDES
	#include <AsDefault.h>
#endif
void _CYCLIC SdoAccessCyclic(void)
{
	if (fbSdoRead.status != ERR_FUB_BUSY && fbSdoWrite.status != ERR_FUB_BUSY)
	{
		//currently there is no SDO operation in progress
		//initiate SDO operation
		switch (iState)
		{
			case STATE_SEARCH_FOR_NODE:
				if (u32VendorId == 0x40)
				{
					//go to next step
					u8NodeFoundAt = u8NodeId;
					iState++;
					break;
				}
				else
				{
					//search at next ID
					u8NodeId++;
				if	(u8NodeId > 239)
						u8NodeId = 1;
				}
				fbSdoRead.pDevice	= “SS1.IF1”;			//interface sensor is connected to
				fbSdoRead.node		= u8NodeId;			//node id of sensor
				fbSdoRead.index		= 0x1018;			//index of vendor ID
				fbSdoRead.subindex	= 1;				//subindex of vendor ID
				fbSdoRead.pData		= &u32VendorId;			//variable to store value to
				fbSdoRead.datalen	= sizeof(u32VendorId);		//size of the variable to store value to
				fbSdoRead.enable	= 1;				//enable the read operation
				fbSdoWrite.enable	= 0;				//disable write operation
				break;
			case STATE_SET_NODE_ID:
				fbSdoWrite.pDevice	= “SS1.IF1”;			//interface sensor is connected to
				fbSdoWrite.node		= u8NodeFoundAt;		//node id of sensor
				fbSdoWrite.index	= 0x1f93;			//index of node ID
				fbSdoWrite.subindex	= 3;				//subindex of node ID
				fbSdoWrite.pData	= &u8NodeIdToSet;		//variable containing value to set
				fbSdoWrite.datalen	= sizeof(u8NodeIdToSet);	//size of the variable containing value to set
				fbSdoWrite.enable	= 1;				//enable write operation
				fbSdoRead.enable	= 0;				//disable read operation
										//go to next step
				iState++;
				break;
			case STATE_RESET_NODE:
				fbSdoWrite.pDevice	= “SS1.IF1”;			//interface sensor is connected to
				fbSdoWrite.node		= u8NodeFoundAt;		//node id of sensor
				fbSdoWrite.index	= 0x1f9e;			//index of nmt reset
				fbSdoWrite.subindex	= 0;				//subindex of nmt reset
				fbSdoWrite.pData	= &u8NmtResetNodeCmd;		//variable containing value to set
				fbSdoWrite.datalen	= sizeof(u8NmtResetNodeCmd);	//size of the variable containing value to set
				fbSdoWrite.enable	= 1;				//enable write operation
				fbSdoRead.enable	= 0;				//disable read operation
										//go to next step
				iState++;
				break;
			case STATE_CHECK_NODE_ID:
				fbSdoRead.pDevice	= “SS1.IF1”;			//interface sensor is connected to
				fbSdoRead.node		= u8NodeIdToSet;		//node id of sensor
				fbSdoRead.index		= 0x1f93;			//index of node ID
				fbSdoRead.subindex	= 3;				//subindex of node ID
				fbSdoRead.pData		= &u8NodeId;			//variable to store value to
				fbSdoRead.datalen	= sizeof(u8NodeId);		//size of the variable to store value to
				fbSdoRead.enable	= 1;				//enable the read operation
				fbSdoWrite.enable	= 0;				//disable write operation
										//go to next step
				iState++;
				break;
			default:
				fbSdoRead.enable	= 0;				//disable read operation
				fbSdoWrite.enable	= 0;				//disable write operation
				break;
		}
	}
		//execute SDO read if enabled
	EplSDORead(&fbSdoRead);
	//execute SDO write if enabled
	EplSDOWrite(&fbSdoWrite);
}
```

6.2.6 Variable watch after successful execution of the implemented state machine

As shown in the screenshot of the variable watch, a controlled node with vendor ID from MTS Sensors has been found at node ID 32. The node ID has been successfully set to 1.

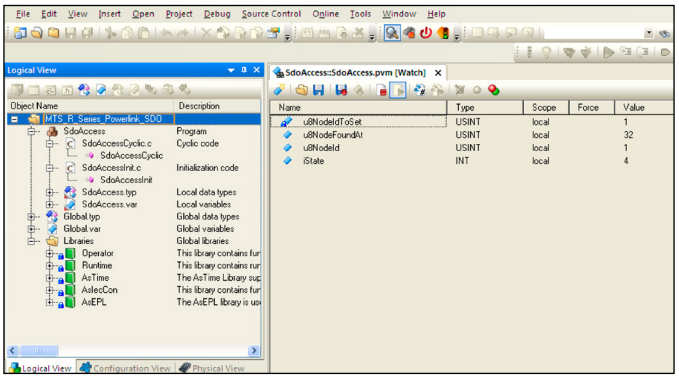


Fig. 44: Variable watch

As shown in the screenshot of the I/O mapping, the sensor is working well using its new node ID.

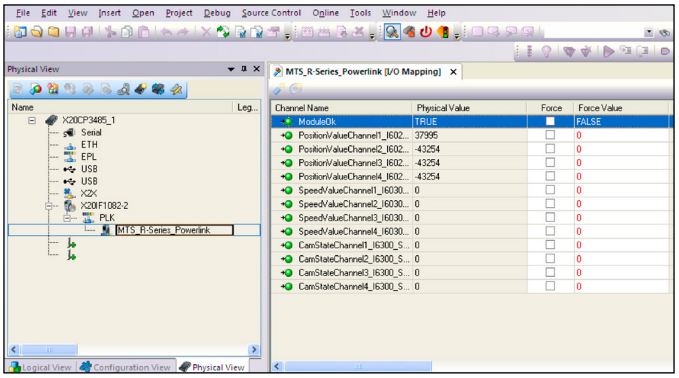


Fig. 45: I/O mapping of sensor with changed node ID

7. Integration of R-Series V POWERLINK in the control system

Project integration
The project integration is described using an example with a B&R (Bernecker + Rainer Industrie-Elektronik Ges.m.b.H.) controller and the “Automation Studio” project engineering tool. In principle, you can integrate the device with any project planning tool and any hardware that uses a POWERLINK network.

XDD file
A XDD file (XML Device Description) describes the properties and functions of the device, such as timing and configurable device parameters. The XDD file enables simple and easy integration of a POWERLINK device into a project engineering tool. The XDD file for R-Series V POWERLINK is packed in a zip file which is available for download on our homepage www.mtssensors.com.

NOTICE
Follow the information given in the controller operation manual.

7.1 Importing R-Series V POWERLINK sensor into the project tool

In the main menu "Tools", select the entry "Manage 3rd-Party Devices" (Fig. 46).

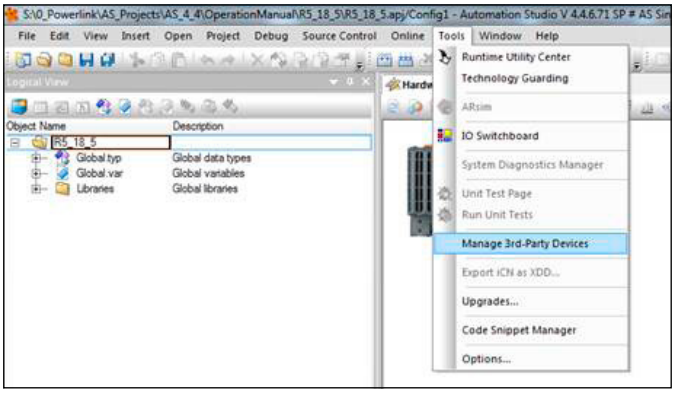


Fig. 46: Starting the 3rd-Party Device Manager

In the opening window the already imported 3rd-Party Devices are displayed. Click the button "Import Fieldbus Device(s)" (Fig. 47).

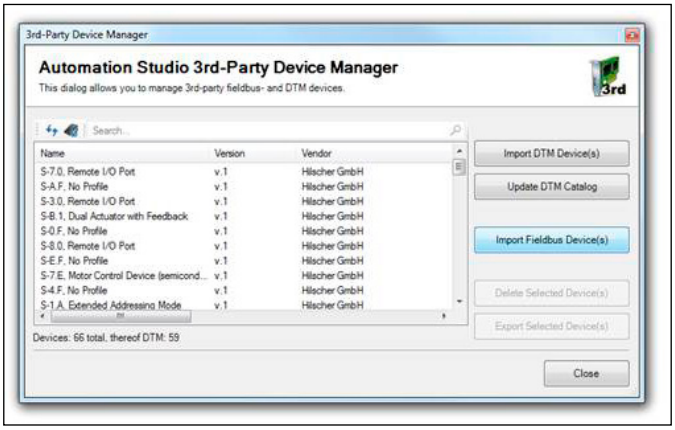


Fig. 47: Importing Fieldbus Devices with the 3rd-Party Device Manager

Navigate to the location where the XDD file for the R-Series V POWERLINK is stored. Select the XDD file and confirm by clicking the OK button. The import of the file begins (Fig. 48).

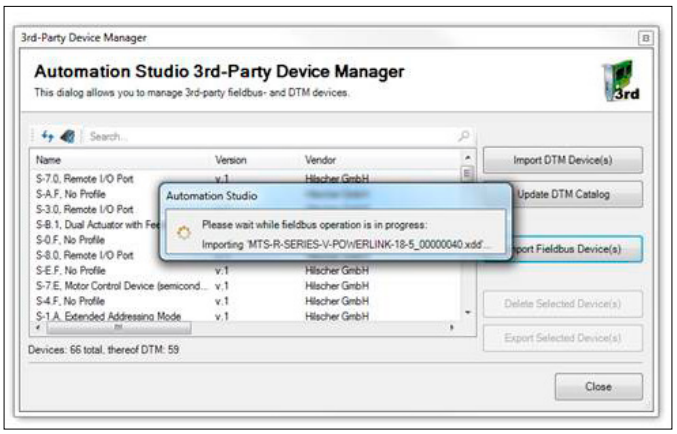


Fig. 48: Importing the XDD file for R-Series V POWERLINK

After the successful import, the XDD file can be displayed via the search in the manager (Fig. 49).

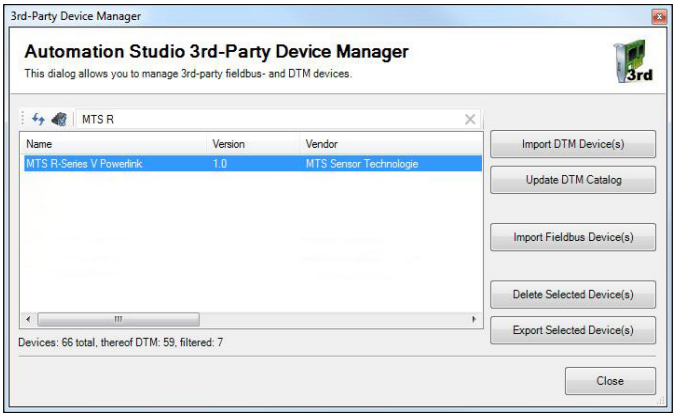


Fig. 49: Searching for R-Series V POWERLINK sensor via the 3rd–Party Device Manager

Adding R-Series V POWERLINK to a network

In the right of the main view is the “Toolbox - Hardware Catalog”. Choose the R-Series V POWERLINK in the “Toolbox - Hardware Catalog” and move it via drag and drop in the system designer where the sensor should be integrated in the network (Fig. 50).

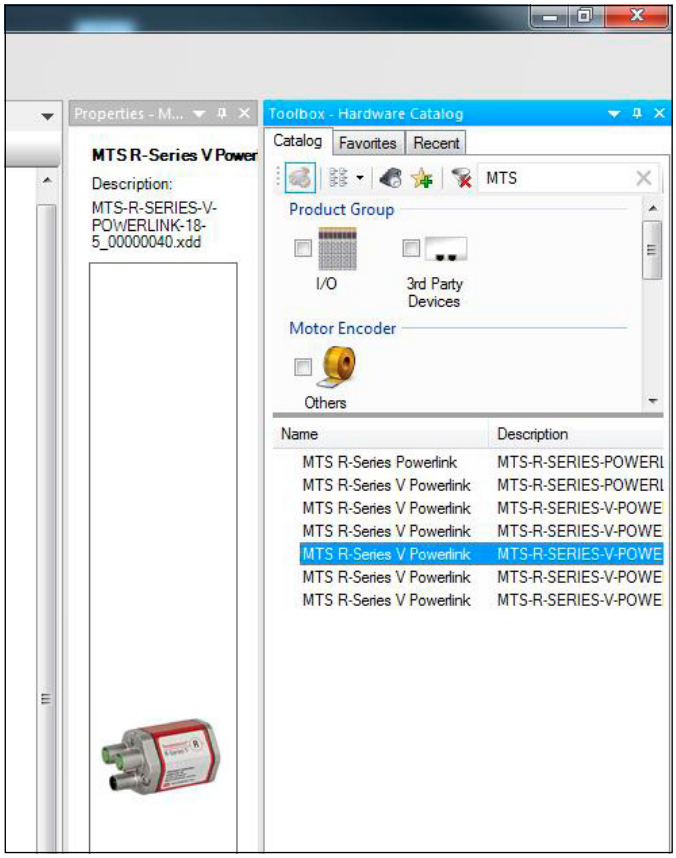


Fig. 50: Selecting R-Series V POWERLINK in the “Toolbox - Hardware Catalog”

Connect the sensor with the control (Fig. 51).

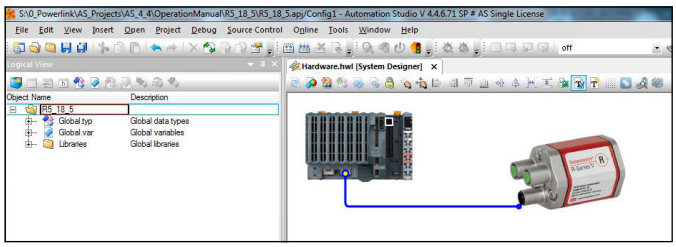


Fig. 51: Selecting R-Series V POWERLINK in the “Toolbox - Hardware Catalog”

As in the system designer also in the physical view on the left the sensor is connected to the control. To enable the controller to communicate with the sensor, the node ID previously set on the sensor must be set on the controller. Click on the sensor in the physical view with the right mouse button and select the entry “Node Number → Change Node Number” (Fig. 52). The node number on the control must be identical to the node ID of the device. The default node ID of R-Series V POWERLINK is 1. See the sections 6.1 and 6.2 to change the node ID of R-Series V POWERLINK.

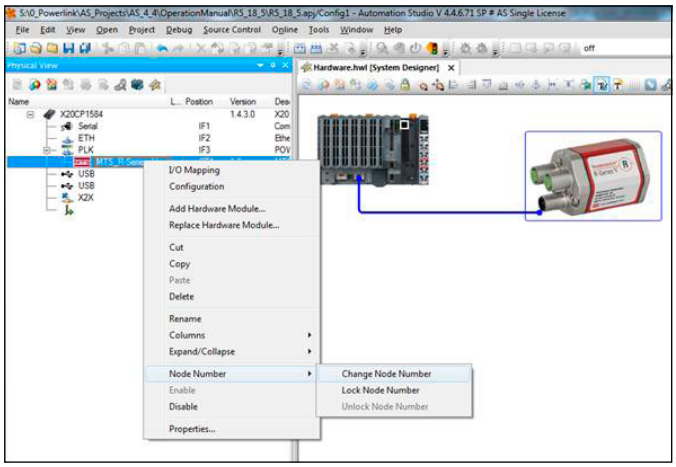


Fig. 52: Setting the node number of the connected device on the controller

To configure the sensor, select the R-Series V POWERLINK sensor on the left side (physical view) again. The right mouse button takes you to the menu entry “Configuration” (Fig. 53). The configuration tab in the main window will open.

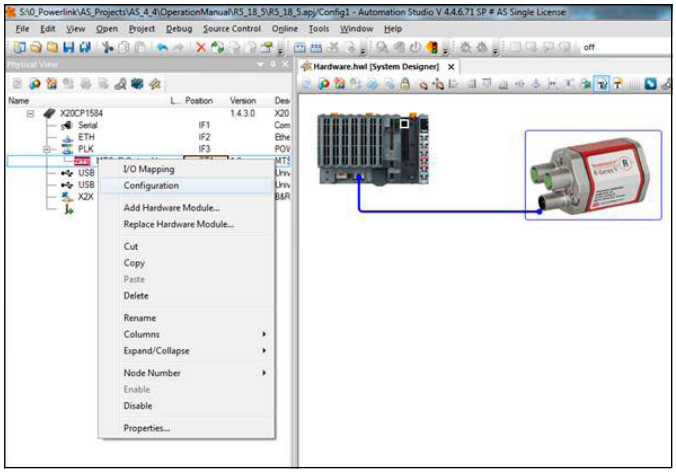


Fig. 53: Setting the node number of the connected device on the controller

The available configuration data of the sensor is divided into two groups:

- Channels: Measurement data of the sensor, that can be transferred cyclically. To activate cyclic transmission of a specific data item, click on the data item column called "Value" and change the entry from "None" to "Read" (Fig. 54).
- Device specific parameters: Configuration parameters of the sensor, which are transferred in the startup phase.

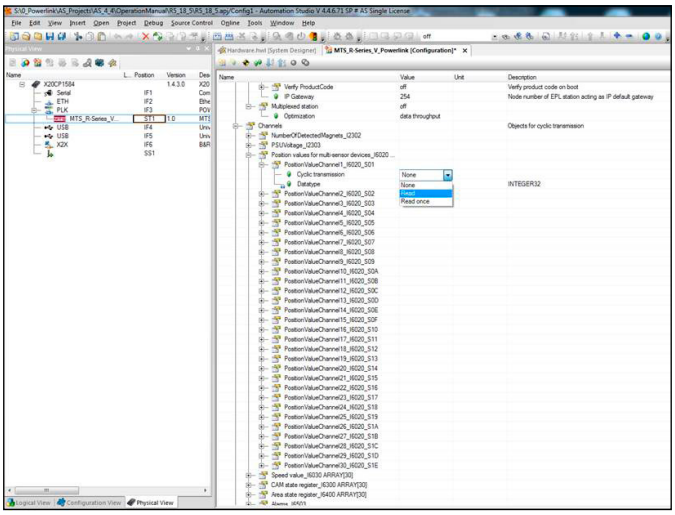


Fig. 54: Activating the mapping of the parameters of the group “Channels”

7.2 Communication segment

The parameters of the group "Channels" (available data items for cyclical transmission):

Index	Subindex	Name	Object type	Attribute	Data type	Description
2302		**Number of detected magnets**	Variable	rw	Unsigned8	Current number of magnets detected on the sensor
2303		**PSU voltage**	Variable	rw	Unsigned16	Current power supply in mV
6020		**Position values for multi-sensor devices**	Array			Current position value of up to 30 magnets
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	Position value for magnets 1…30	Variable	ro	Integer32	
6030		**Speed value**	Array			Current velocity value of up to 30 magnets
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	Speed value for magnets 1…30	Variable	ro	Integer16	
6300		**CAM state register**	Array			With the sensor you can configure a CAM switch. For each magnet there is one CAM channel. Each CAM channel supports up to four CAM positions. The parameter “CAM state register” defines the status bit of the CAM in a CAM channel for up to 30 magnets • Bit value 0: CAM inactive • Bit value 1: CAM active
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM state register for magnets 1…30	Variable	ro	Unsigned8	
6400		**Area state register**	Array			This object contains the actual area status of the encoder position for up to 30 magnets. If the position is out of range, a bit will be set in the related position line
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	Area state register for magnets 1…30	Variable	ro	Unsigned8	
6503		**Alarms**	Variable	rw	Unsigned16	This parameter includes different alarms: • Bit 0: The number of magnets detected on the sensor differs from the number of magnets configured in the engineering tool (index 2201 subindex 0) • Bit 12: Power supply out of range • Bit 13: Device error **Note: To output alarms the operating parameter "commissioning diagnostic control" (object 6500) must be activated.**
6505		**Warnings**	Variable	rw	Unsigned16	Bit 12: Synchronization error: Sensor is not synchronized to the clock of the control **Note: To output warnings the parameter "commisioning diagnostic control" (object 6500) must be activated.**

Table 1: Index 2302, 2303, 6020, 6030, 6300, 6400, 6503, 6505

The parameters of the group “Device Specific Parameters”:

Index	Subindex	Name	Object type	Attribute	Data type	Description
2201		**Number of magnets**	Variable	rw	Unsigned8	Setting the number of position magnets that are used simultaneously on the measuring rod/profile **Note: If the number is greater than in the order code, an alarm is issued.**
2202		**Filter settings**	Array			Setting the filter for the output value
	0	Number of entries	Variable	ro	Unsigned8	
	1	Filter type	Variable	rw	Unsigned8	Setting the filter for the output value • Bit value 0: No filter • Bit value 1: FIR (finite impulse response filter) • Bit value 2: IIR (infinite impulse response filter)
	2	Filter window size	Variable	rw	Unsigned8	Setting the number of position values for calculating the filter of the output value Possible values: 2…16
	3	Velocity window size	Variable	rw	Unsigned8	Setting the number of position values for determining the velocity of the position magnet Possible values: 2…16
2203		**Position offsets**	Array			Position offset for up to 30 magnets
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	Position offset for magnets 1…30	Variable	rw	Integer32	
2204		**Lower limit for measurement cycle time**	Variable	rw	Unsigned32	Setting the lower limit for the cycle time. If no short cycle time is required, reflections can be excluded with this parameter
2305		**Sensor status**				
	0	Number of entries	Variable	ro	Unsigned8	
	1	Time since last update	Variable	ro	Integer32	Age of the status data in ms
	2	Status data version	Variable	ro	Integer32	Version number
	3	Operational time	Variable	ro	Integer32	Total operational time of the sensor
	4	Odometer	Variable	ro	Integer32	Total distance travelled by the position magnet
	5	Magnet cycles	Variable	ro	Integer32	Total number of directional changes of the magnet
	6	Minimum input voltage	Variable	ro	Integer32	Minimum input voltage so far
	7	Maximum input voltage	Variable	ro	Integer32	Maximum input voltage so far
	8	Minimum temperature	Variable	ro	Integer32	Minimum temperature inside sensor electronics housing so far
	9	Maximum temperature	Variable	ro	Integer32	Maximum temperature inside sensor electronics housing so far
	10	Current temperature	Variable	ro	Integer32	Current temperature inside sensor electronics housing
	11	Input voltage out of range	Variable	ro	Integer32	Duration of exceeding or falling below the permissible power supply range
	12	Temperature out of range	Variable	ro	Integer32	Duration of exceeding or falling below the permissible operating temperature range
6000		**Operating parameters**		rw	Unsigned16	See table 5, page 35
6002		**Total measuring range in measuring units**	Variable	rw	Unsigned32	If the scaling function is activated (see object 6000: Operating parameters), this parameter includes the maximum value
6005		**Linear encoder measuring step settings**	Array			
	1	Position step setting	Variable	rw	Unsigned32	Resolution of the position output in nm
	2	Speed step setting	Variable	rw	Unsigned32	Resolution of the velocity output in 0.01 mm/s

Table 2: Index 2201, 2202, 2203, 2204, 2305, 6000, 6002, 6005

Index	Subindex	Name	Object type	Attribute	Data type	Description
6010		**Preset values for multi-sensor devices**	Array			The preset can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	Preset for 1…30 magnets	Variable	rw	Integer32	
6301		**CAM enable register**	Array			Via the “CAM enable register” the CAM channels can be enabled: • Bit value 0: CAM inactive • Bit value 1: CAM active It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM enable register for 1…30 magnets	Variable	rw	Unsigned8	
6302		**CAM enable polarity**	Array			With "CAM enable polarity", the polarity of each CAM can be definated. If the polarity bit of a CAM is set, the current CAM state will be inverted. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM enable polarity for 1…30 magnets	Variable	rw	Unsigned8	
6310		**CAM 1 low limit**	Array			This object determines the lower limit of position for CAM 1. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 1 low limit for 1…30 magnets	Variable	rw	Integer32	
6311		**CAM 2 low limit**	Array			This object determines the lower limit of position for CAM 2. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 2 low limit for 1…30 magnets	Variable	rw	Integer32	
6312		**CAM 3 low limit**	Array			This object determines the lower limit of position for CAM 3. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 3 low limit for 1…30 magnets	Variable	rw	Integer32	
6313		**CAM 4 low limit**	Array			This object determines the lower limit of position for CAM 4. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 4 low limit for 1…30 magnets	Variable	rw	Integer32	
6320		**CAM 1 high limit**	Array			This object determines the upper limit of position for CAM 1. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 1 high limit for 1…30 magnets	Variable	rw	Integer32	
6321		**CAM 2 high limit**	Array			This object determines the upper limit of position for CAM 2. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 2 high limit for 1…30 magnets	Variable	rw	Integer32	
6322		**CAM 3 high limit**	Array			This object determines the upper limit of position for CAM 3. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 3 high limit for 1…30 magnets	Variable	rw	Integer32	
6323		**CAM 4 high limit**	Array			This object determines the upper limit of position for CAM 4. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 4 high limit for 1…30 magnets	Variable	rw	Integer32	
6330		**CAM 1 hysteresis**	Array			Via this parameter the delay setting of the switch points for CAM 1 can be set. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 1 hysteresis for 1…30 magnets	Variable	rw	Integer32	
6331		**CAM 2 hysteresis**	Array			Via this parameter the delay setting of the switch points for CAM 2 can be set. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 2 hysteresis for 1…30 magnets	Variable	rw	Integer32	
6332		**CAM 3 hysteresis**	Array			Via this parameter the delay setting of the switch points for CAM 3 can be set. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 3 hysteresis for 1…30 magnets	Variable	rw	Integer32	
6333		**CAM 4 hysteresis**	Array			Via this parameter the delay setting of the switch points for CAM 4 can be set. It can be set for up to 30 magnets.
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	CAM 4 hysteresis for 1…30 magnets	Variable	rw	Integer32	

Table 3: Index 6010, 6301, 6302, 6310, 6311, 6312, 6313, 6320, 6321, 6322, 6323, 6330, 6331, 6332, 6333

Index	Subindex	Name	Object type	Attribute	Data type	Description
6401		**Work area low limit**	Array			This object contains the position value, at which bit 2 of the according p406_work_area_state_channel in object 6400h (Working Area State Register) flags the underflow of the related work area
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	Work area low limit for 1…30 magnets	Variable	rw	Integer32	
6402		**Work area high limit**	Array			This object contains the position value, at which bit 1 of the according p406_work_area_state_channel in object 6400h (Working Area State Register) flags the overflow of the related work area
	0	Number of entries	Variable	ro	Unsigned8	
	1…30	Work area high limit for 1…30 magnets	Variable	rw	Integer32	

Table 4: Index 6401, 6402

Operating parameters

Index	Subindex	Bit	Name	Attribute	Description
6000	0	1	**Comissioning diagnostic control**	0: Disabled 1: Enabled	This parameter must be enabled to send out alarms (object 6503)
		2	**Scaling function**	0: Disabled 1: Enabled	This parameter is used to change the position resolution of the encoder
		3	**Measuring direction**	0: Forward 1: Reverse	Setting the measuring direction
		12	**Synchronization mode**	0: Disabled 1: Enabled	Setting the synchronization of the sensor to the clock of the controller
		13	**Extrapolation**	0: Disabled 1: Enabled	Setting the sensor behavior in case of oversampling
		14	**Internal linearization**	0: Disabled 1: Enabled	Setup of the internal linearization

Table 5: Explanation of the operating parameters

NOTICE

In order to operate the sensor in synchronous mode, the controller must be set so that the tasks are executed synchronously in the POWERLINK cycle. In synchronous mode, the sensor supports a bus cycle time of 200 µs. If the extrapolation is disabled, identical values can be output repeatedly. For a multi-position measurement (number of magnets ≥ 2) in synchronous mode, the minimum bus cycle time of the sensor is 400 µs.

8. Maintenance and troubleshooting

8.1 Error conditions, troubleshooting

See chapter "5. Operation" on page 21.

8.2 Maintenance

The sensor is maintenance-free.

8.3 Repair

Repairs of the sensor may be performed only by MTS Sensors or a repair facility explicitly authorized by MTS Sensors. For return see section "2.6 Return" on page 4.

8.4 List of spare parts

No spare parts are available for this sensor.

8.5 Transport and storage

The conditions of transport and storage of the sensor match the operating conditions mentioned in this document.

9. Removal from service/dismantling

The product contains electronic components and must be disposed of in accordance with the local regulations.

10. Technical data

10.1 Technical data Temposonics® RP5

Output						
Interface	Ethernet POWERLINK					
Data protocol	POWERLINK V2					
Measured value	Position, velocity/option: Simultaneous multi-position and multi-velocity measurements up to 30 magnets					
Measurement parameters						
Resolution: Position	0.5…100 µm (selectable)					
Cycle time	Stroke length	≤ 50 mm	≤ 715 mm	≤ 2000 mm	≤ 4675 mm	≤ 6350 mm
	Cycle time	250 µs [4]	500 µs	1000 µs	2000 µs	2800 µs
Linearity deviation [5]	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
	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)					
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 drawing on page 9					
Electrical connection						
Connection type	2 × M12 female connectors (5 pin), 1 × M8 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					

4/ Minimum cycle time for multi-position measurements (number of magnets ≥ 2): 400 µs
5/ With position magnet # 252 182

10.2 Technical data Temposonics® RH5

Output	
Interface	Ethernet POWERLINK
Data protocol	POWERLINK V2
Measured value	Position, velocity/option: Simultaneous multi-position and multi-velocity measurements up to 30 magnets
Measurement parameters	
Resolution: Position	0.5…100 µm (selectable)
Cycle time	Stroke length: ≤ 50 mm | ≤ 715 mm | ≤ 2000 mm | ≤ 4675 mm | ≤ 7620 mm Cycle time: 250 µs [6] | 500 µs | 1000 µs | 2000 µs | 3200 µs
Linearity deviation [7]	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 typical: ± 15 µm | ± 20 µm | ± 25 µm maximum: ± 25 µm | ± 30 µm | ± 50 µm
Repeatability	< ±0.001 % F.S. (minimum ±2.5 µm) typical
Hysteresis	< 4 µm typical
Temperature coefficient	< 15 ppm/K typical
Operating conditions	
Operating temperature	–40…+85 °C (–40…+185 °F)
Humidity	90 % relative humidity, no condensation
Ingress protection	IP67 (connectors correctly fitted)
Shock test	150 g/11 ms, IEC standard 60068-2-27
Vibration test	30 g/10…2000 Hz, IEC standard 60068-2-6 (excluding resonant frequencies)/ RH5-J: 15 g/10…2000 Hz, IEC standard 60068-2-6 (excluding resonant frequencies)
EMC test	Electromagnetic emission according to EN 61000-6-3 Electromagnetic immunity according to EN 61000-6-2 The sensor meets the requirements of the EC directives and is marked with CE
Operating pressure	350 bar (5076 psi)/700 bar (10,153 psi) peak (at 10 × 1 min) for sensor rod/RH5-J: 800 bar (11,603 psi)
Magnet movement velocity	Any
Design / Material	
Sensor electronics housing	Aluminum (painted), zinc die cast
Sensor flange	Stainless steel 1.4305 (AISI 303)
Sensor rod	Stainless steel 1.4306 (AISI 304L)/RH5-J: Stainless steel 1.4301 (AISI 304)
Stroke length	25…7620 mm (1…300 in.)/RH5-J: 25…5900 mm (1…232 in.)
Mechanical mounting	
Mounting position	Any
Mounting instruction	Please consult the technical drawings on page 10 and 11
Electrical connection	
Connection type	2 × M12 female connectors (5 pin), 1 × M8 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

6/ Minimum cycle time for multi-position measurements (number of magnets ≥ 2): 400 µs
7/ With position magnet # 251 416-2

11. Appendix I

Safety Declaration

Dear Customer,
If you return one or several sensors for checking or repair, we need you to sign a safety declaration. The purpose of this declaration is to ensure that the returned items do not contain residues of harmful substances and / or that people handling these items will not be in danger.

MTS Sensors order number: _____ Sensor type(s): _____

Serial number(s): _____ Sensor length(s): _____

The sensor has been in contact with the following materials:

Do not specify chemical formulas.
Please include safety data sheets of the substances, if applicable.

In the event of suspected penetration of substances into the sensor, consult MTS Sensors to determine measures to be taken before shipment.

Short description of malfunction:

Corporate information

Company: _____

Address: _____

_____

Contact partner

Name: _____

Phone: _____

E-mail: _____

We hereby certify that the measuring equipment has been cleaned and neutralized.
Equipment handling is safe. Personnel exposure to health risks during transport and repair is excluded.

Stamp

Signature

Date

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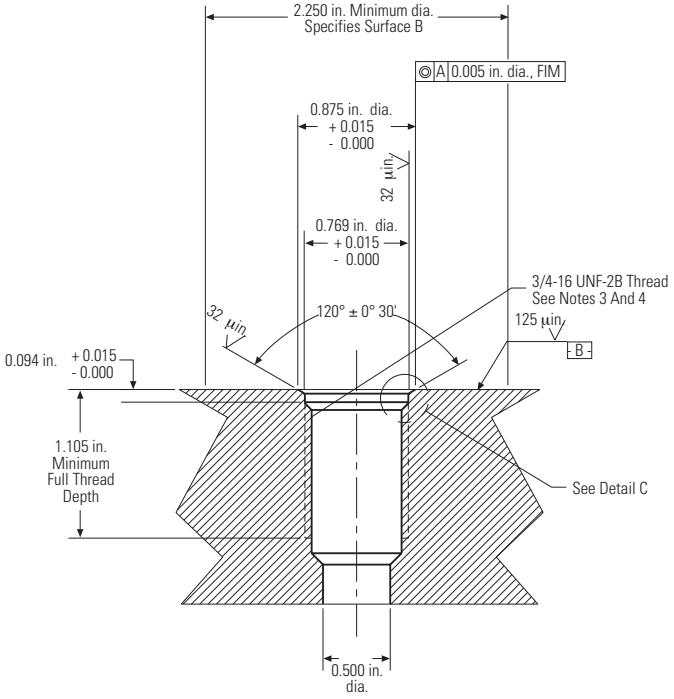
12. Appendix II

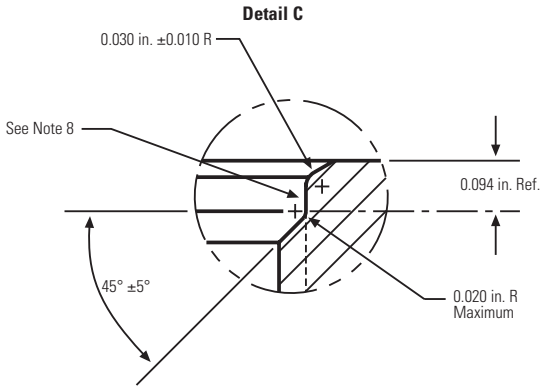
CYLINDER PORT DETAILS

PORT DETAIL (PD) FOR RH5-S:

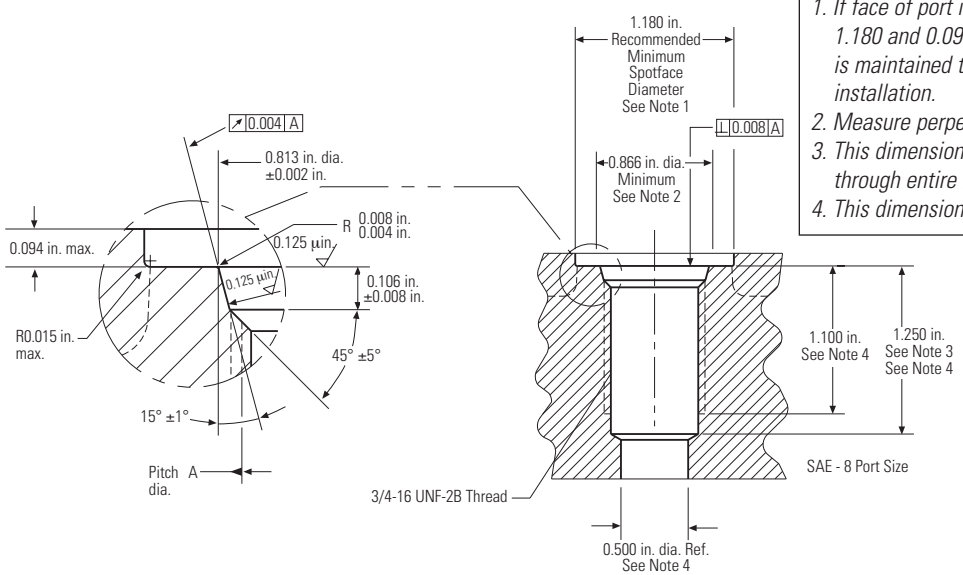


NOTES:

1. *Dimensions and tolerances based on ANSI Y14.5-1982.*
2. *MTS has extracted all pertinent information from MS33649 to generate this document.*
3. *PD must be square with surface B within 0.005 FIM across 2.250 dia minimum.*
4. *PD must be concentric with 2.250 dia within 0.030 FIM and with 0.769 dia within 0.005 FIM.*
5. *Surface texture ANSI B46.1-1978*
6. *Use O-ring MTS part number 560315 for correct sealing.*
7. *The thread design shall have sufficient threads to meet strength requirements of material used.*
8. *Finish counter-bore shall be free from longitudinal and spiral tool marks. Annular tool marks up to 32 microinches maximum will be permissible.*



PORT DETAIL (PD) FOR RH5-T:



NOTES:

1. *If face of port is on a machined surface, dimensions 1.180 and 0.094 need not apply as long as R0.008/0.004 is maintained to avoid damage to the O-ring during installation.*
2. *Measure perpendicularity to A at this diameter.*
3. *This dimension applies when tap drill cannot pass through entire boss.*
4. *This dimension does not conform to SAE J1926/1.*

13. Glossary

C

CAM
Cam position of a CAM channel in a cam gear. Each CAM position can be configured separately. With R-Series V POWERLINK, for each position magnet there is one CAM channel. Each CAM channel supports up to four CAM positions.

Controlled Node (CN)
All devices in the network, except the Managing Node, are Controlled Nodes. The Controlled Nodes may send their data only after being requested by the Managing Node. The R-Series V POWERLINK can only be used as a Controlled Node. (→ Managing Node)

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
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 form of a moving average value (→ IIR).

I

I/O Mapping
I/O mapping is used to configure the cyclical data that is transfered between sensor and controller. The assignment of the inputs (IN) and outputs (OUT) is performed from the perspective of the controller. Cyclical data from the sensor to the controller are, for example, the position and the velocity.

IIR
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 window (filter window size) are used for the filter calculation. The previous values are also taken into account when calculating the output value (→ FIR).

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

Managing Node (MN)
The Managing Node, usually an industrial PC or a PLC, controls the communication in the network as master and sets the clock for the synchronization of all devices. In a network there is only one Managing Node. All other devices of the POWERLINK network are Controlled Nodes. (→ Controlled Node)

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.

N

Node ID
The addressing of the devices in a POWERLINK network is done via the node ID. Each node ID only exists once in a network. It can have a value between 1 and 240 (while 240 is reserved for the Managing Node). Meaning that a POWERLINK network can comprise up to 240 devices. With the R-Series V POWERLINK, the node ID (delivered with node ID 1) can be set via the TempoLink smart assistant, for example.

O

Offset
A value which will be added or subtracted to the actual position value. This leads to a shift of the measurement range start (→ Preset).

P

PLC (Programmable Logic Controller)
Device for controlling or regulating machines and systems.

Preset
With the preset, a value is entered for the current position which is to be output at this position in the future. The difference between the entered value and the currently measured position is calculated as an offset. (→ Offset)

R

RO
RO (**R**ead **O**nly) means that the value of the variable can only be read but is not modifiable.

RW
RW (**R**ead/**W**rite) means that the value of the variable can be read and written. The value of the variable is modifiable.

S

Synchronization mode
R-Series V POWERLINK supports Synchronization Mode. The synchronization mode enables clock-synchronous data exchange between sensor and control. The synchronous measurement is an essential requirement for motion-controlled applications.

V

Vendor ID
A unique **id**entification number (ID) assigned to each piece of computer hardware.

X

XDD file
The properties and functions of a POWERLINK device are described in a XDD file (**X**ML **D**evice **D**escription). The XML-based XDD 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 XDD file of the R-Series V POWERLINK is available on the homepage www.mtssensors.com

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