MTS SENSORS

Temposonics®

Magnetostrictive Linear Position Sensors

R-Series Powerlink V2

Operation Manual

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 the manual for future reference!

The content of this technical documentation and of its appendix 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 preceding pictogram which is 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

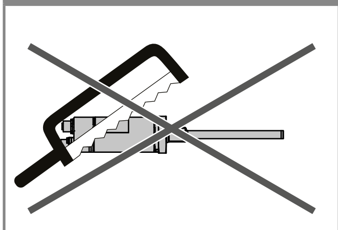
This product may be used only for the applications defined under item 1 and only in conjunction with the third-party devices and components recommended or approved by MTS Sensors. As a prerequisite of proper and safe operation the product requires correct transport, storage, mounting and commissioning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

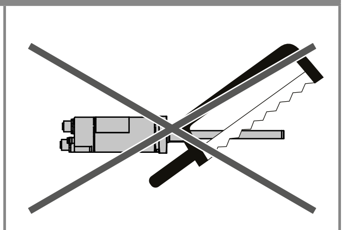
1. The sensor systems of all Temposonics® series are intended exclusively for measurement tasks encountered in industrial, commercial and laboratory applications. The sensors are considered as system accessories and must be connected to suitable evaluation electronics, e.g. a PLC, IPC, indicator or other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

2.2 Forseeable misuse

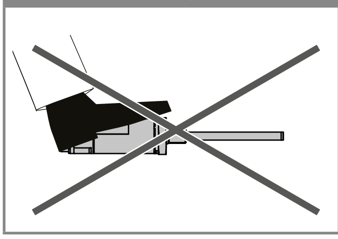
Forseeable misuse	Consequence
Wrong sensor connection	The sensor will not work properly or will be destroyed
Operate the sensor out of the operating temperature range	No signal output The sensor can be damaged
Power supply is out of the defined range	Signal output is wrong / no signal output / the sensor 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 / are 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 certified by MTS Sensors	Error in position measurement

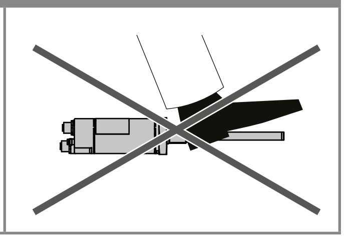
Do not reprocess the sensor afterwards.
➔ The sensor might be damaged.





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 condition. 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 operability, it is mandatory to follow the instructions given below.

1. Protect the sensor's 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. It is indispensable to ensure that the specified permissible limit values of the sensor for operating voltage, environmental conditions, etc. are met.
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. Any shipment cost is the responsibility of the sender [2].
For a corresponding form, see chapter "12. Appendix" on page 51.

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

3. Identification

3.1 Order code of Temposonics® RP

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
R	P							D	5	6	1	U	3	0	1			
a		b	c					d			e	f				g (optional)		

a	Sensor model
R P	Profile

b	Design
G	Magnet slider, joint on top, backslash free (part no. 253 421)
M	U-magnet, OD33 (part no. 251 416-2)
S	Magnet slider, joint on top (part no. 252 182)
V	Magnet slider, joint at front (part no. 252 184)

c	Stroke length
X X X X M	0025…5080 mm

Standard stroke length (mm)*	Ordering steps
25…500 mm	25 mm
500…2500 mm	50 mm
2500…5080 mm	100 mm

c	Stroke length
X X X X U	001.0…200.0 in.

Standard stroke length (in.)*	Ordering steps
1…20 in.	1 in.
2…100 in.	2 in.
100…200 in.	4 in.

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

e	Operating voltage
1	+24 VDC (−15 / +20 %)

f	Output
U 3 0 1	Powerlink V2

Optional:

g	Magnet number for multi-position measurement [3]
Z 0 2	2 magnets
Z 0 3	3 magnets
Z 0 4	4 magnets

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

3/ Note: Specify magnet number for your sensing application and order separately

3.2 Order code of Temposonics® RH

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
R	H							D	5	6	1	U	3	0	1			
a		b	c					d			e	f				g (optional)		

a	Sensor model
R H	Rod

b	Design
B	Base unit
D	Threaded flange M18×1.5-6g (bushing on rod end)
H	Threaded flange ¾"-16 UNF-3A (with fluoroelastomer housing-seal)
J	Threaded flange M22×1.5-6g (rod Ø 12.7 mm, 800 bar)
M	Threaded flange M18×1.5-6g (standard)
R	Threaded flange M18×1.5-6g (thread M4 at rod end)
S	Threaded flange ¾"-16 UNF-3A (standard)
T	Threaded flange ¾"-16 UNF-3A (with raised-face)
U	Threaded flange ¾"-16 UNF-3A (with raised-face & fluoroelastomer housing-seal)
V	Threaded flange M18×1.5-6g (with fluoroelastomer housing-seal)

c	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 in.

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

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

e	Operating voltage
1	+24 VDC (−15 / +20 %)

f	Output
U 3 0 1	Powerlink V2

Optional:

g	Magnet number for multi-position measurement [4]
Z 0 2	2 magnets
Z 0 3	3 magnets
Z 0 4	4 magnets

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

4/ Note: Specify magnet number for your sensing application and order separately

3.3 Order code of Temposonics® RD4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
R	D	4										D	5	6	U	3	0	1			
a			b	c			d					e			f				g (optional)		

a	Sensor model
R D 4	Detached sensor electronics

b	Design
C	Threaded flange M18×1.5-6g, A/F 46
D	Threaded flange ¾"-16 UNF-3A, A/F 46
G	Threaded flange M18×1.5-6g, A/F 24
M	Threaded flange M18×1.5-6g, A/F 23
S	Pressure fit flange Ø 26.9 mm f6
T	Threaded flange ¾"-16 UNF-3A, A/F 23

c	Integral cable of sensor rod
For side cable entry on sensor electronics housing	
D 1 S	PUR cable with M16 connector, length 250 mm (9.8 in.)
D 2 S	PUR cable with M16 connector, length 400 mm (15.7 in.)
D 3 S	PUR cable with M16 connector, length 600 mm (23.6 in.)
For bottom cable entry on sensor electronics housing	
R 2 B	PUR cable / wires with flat connector, length 65 mm (2.6 in.)
R 4 B	PUR cable / wires with flat connector, length 170 mm (6.7 in.)
R 5 B	PUR cable / wires with flat connector length 230 mm (9.1 in.)
R 6 B	PUR cable / wires with flat connector, length 350 mm (13.8 in.)

d	Stroke length
X X X X M	Flange »C«, »D«, »G«, »M«, »T«: 0025…5080 mm Flange »S«: 0025…2540 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…5080 mm	100 mm
X X X X . U	Flange »C«, »D«, »G«, »M«, »T«: 001.0…200.0 in. Flange »S«: 001.0…100.0 in.
Standard stroke length (in.)*	**Ordering steps**
1…20 in.	0.2 in.
20…30 in.	0.4 in.
30…40 in.	1.0 in.
40…100 in.	2.0 in.
100…200 in.	4.0 in.
200…300 in.	10.0 in.

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

Operating voltage
+24 VDC (−15 / +20 %); Standard, not indicated in order code

f	Output
U 3 0 1	Powerlink V2

Optional:

g	Magnet number for multi-position measurement [5]
Z 0 2	2 magnets
Z 0 3	3 magnets
Z 0 4	4 magnets

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

5/ Note: Specify magnet number for your sensing application and order separately

3.4 Order code of Temposonics® RF

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
R	F								D	5	6	1	U	3	0	1			
a		b	c						d			e	f				g		
																	optional		

a	Sensor model
R F	Flexible sensor rod

b	Design
C	Base unit
M	Threaded flange M18×1.5-6g
S	Threaded flange ¾"-16 UNF-3A

c	Stroke length (Longer strokes are available. Contact applications engineering for details.)	
X X X X X M	00150…10060 mm	
	Standard stroke length (mm)*	Ordering steps
	150…1000 mm	50 mm
	1000…5000 mm	100 mm
	5000…10,060 mm	250 mm
X X X X . X U	0006.0…0396.0 in.	
	Standard stroke length (in.)*	Ordering steps
	6…40 in.	2 in.
	40…197 in.	4 in.
	197…396 in.	10 in.

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

e	Operating voltage
1	+24 VDC (−15 / +20 %)

f	Output
U 3 0 1	Powerlink V2

Optional:

g	Magnet number for multi-position measurement [6]
Z 0 2	2 magnets
Z 0 3	3 magnets
Z 0 4	4 magnets

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

6/ Note: Specify magnet number for your sensing application and order separately

3.5 Nameplate

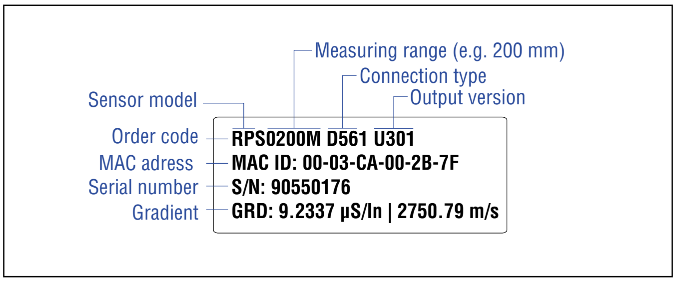


Fig. 1: Example of nameplate of an R-Series RP sensor

3.6 Approvals

- CE certified (RP / RH / RF)
- UL/cUL certified (RP / RH)
- GOST certified
- Ethernet POWERLINK Standardization Group (EPSG) certified

3.7 Scope of delivery

RP (profile sensor):
- Sensor
- Position magnet
- 2 mounting clamps up to 1250 mm (50 in.) stroke length + 1 mounting clamp for each 500 mm (20 in.) additional stroke length

RH (rod sensor):
- RH-B: Base unit, 2 socket screws M4
- RH-D / -H / -J / -M / -R / -S / -T / -U / -V: Sensor, O-ring

RD4 (detached sensor electronics):
- RD4-C / -D / -G / -M / -T: Sensor, O-ring
- RD4-S: Sensor, O-ring, back-up ring

RF (flexible sensor rod):
- RF-C: Base unit
- RF-M / -S: Sensor, O-ring

4. Product description and commissioning

4.1 Functionality and system design

Product designation
- Position sensor Temposonics® R-Series

Sensor model
- Temposonics® RP (profile sensor)
- Temposonics® RH (rod sensor)
- Temposonics® RD4 (detached sensor electronics)
- Temposonics® RF (flexible sensor rod)

Stroke length
- RP 25… 5080 mm (1…200 in.)
- RH 25… 7620 mm (1…300 in.)
- RD4 25… 5080 mm (1…200 in.)
- RF 150…10060 mm (6…396 in.)

Output signal
- Powerlink V2

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.

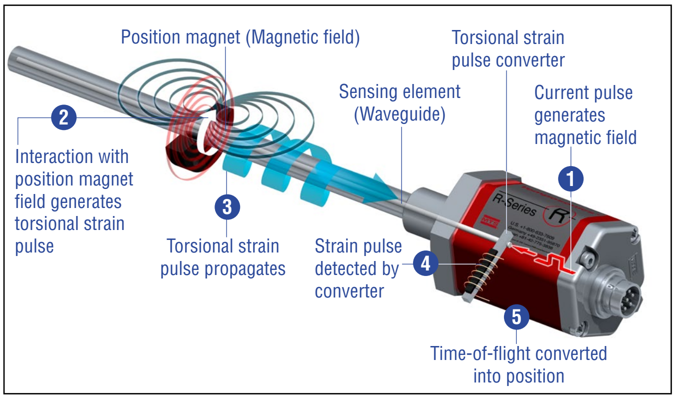


Fig. 2: Time-based magnetostrictive position sensing principle

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.

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.
- Double shielding ensures high safety of operation and optimum EMC (Electromagnetic Compatibility).
- 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 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® RP

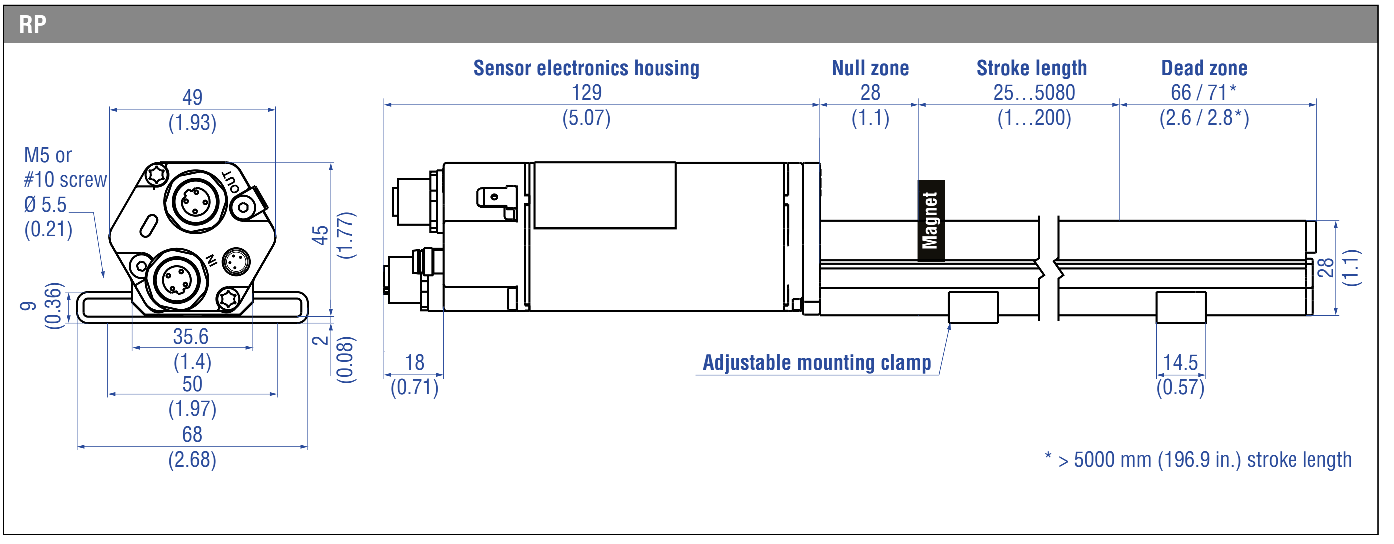


Fig. 3: Temposonics® RP-M with U-magnet

Installation of RP

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.

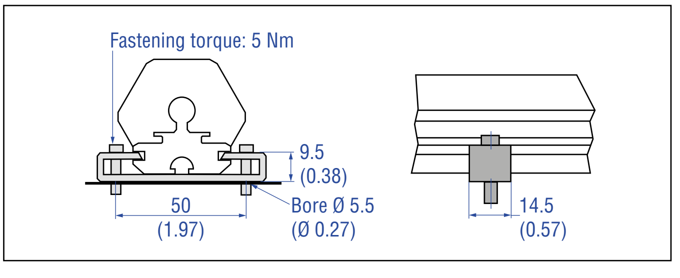


Fig. 4: Mounting clamps (part no. 400 802) with cylinder screw M5×20

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).

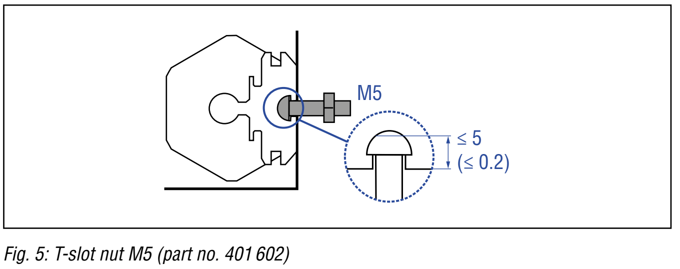


Fig. 5: T-slot nut M5 (part no. 401 602)

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® RH

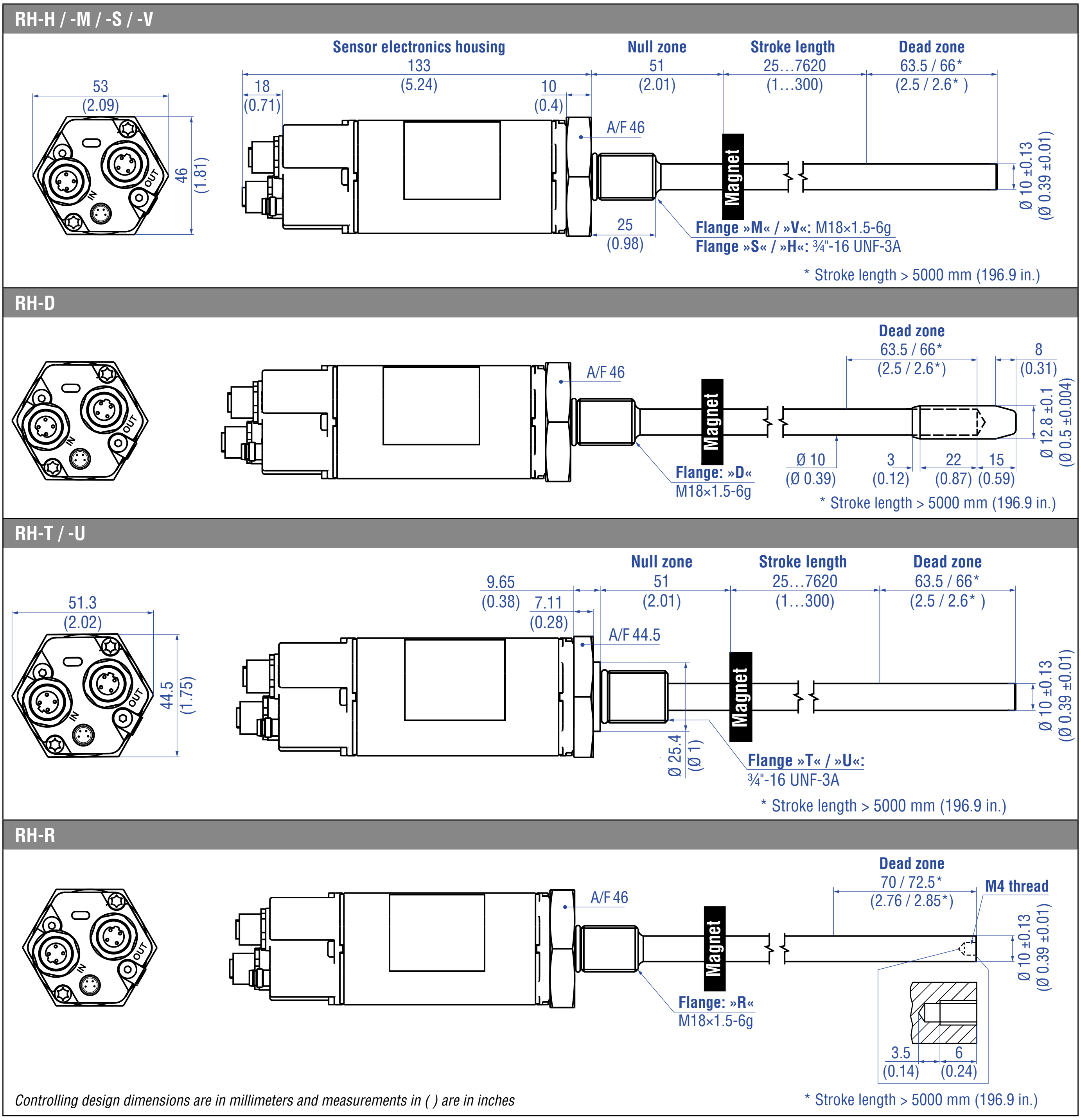


Fig. 6: Temposonics® RH with ring magnet part 1

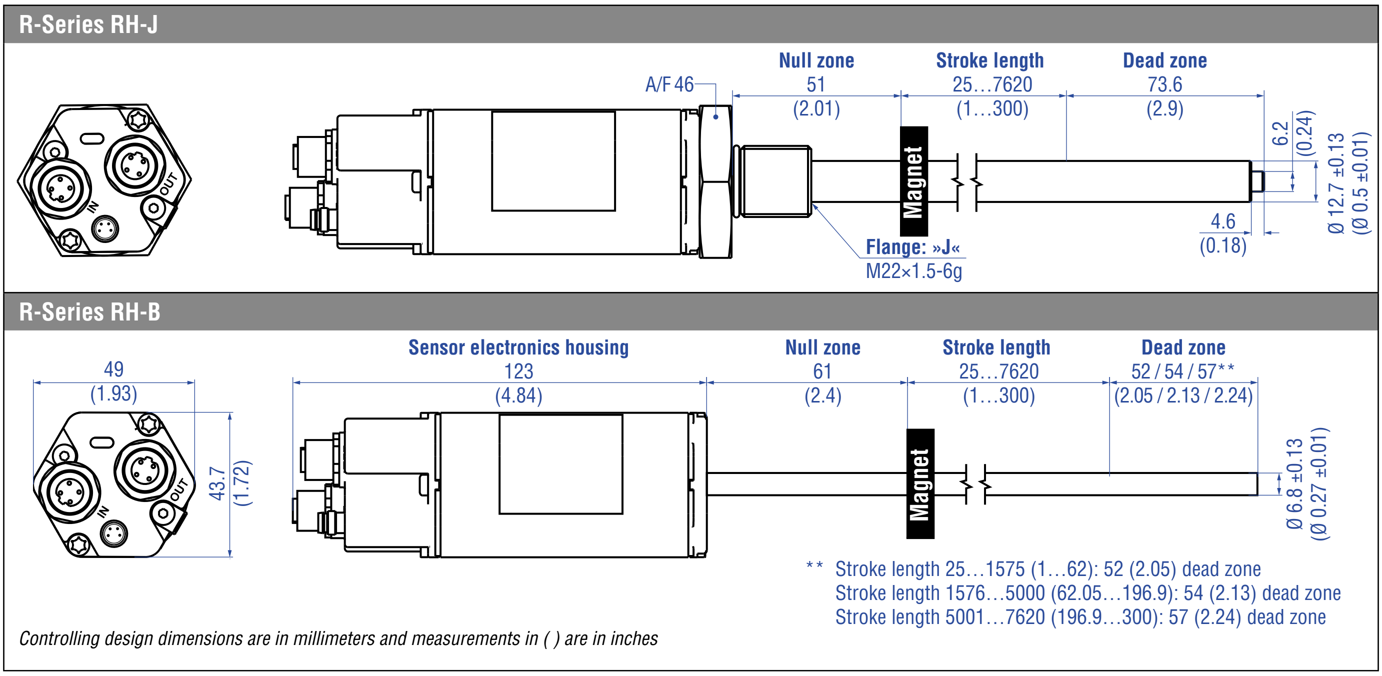


Fig. 9: Temposonics® RH with ring magnet part 2

Installation of RH with threaded flange »D«, »H«, »J«, »M«, »R«, »S«, »T«, »U« & »V«

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

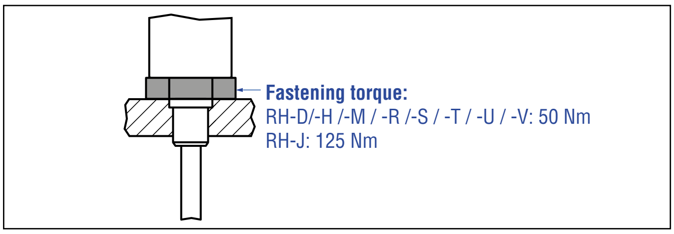


Fig. 7: Mounting example of threaded flange »D«, »H«, »J«, »M«, »R«, »S«, »T«, »U« & »V«

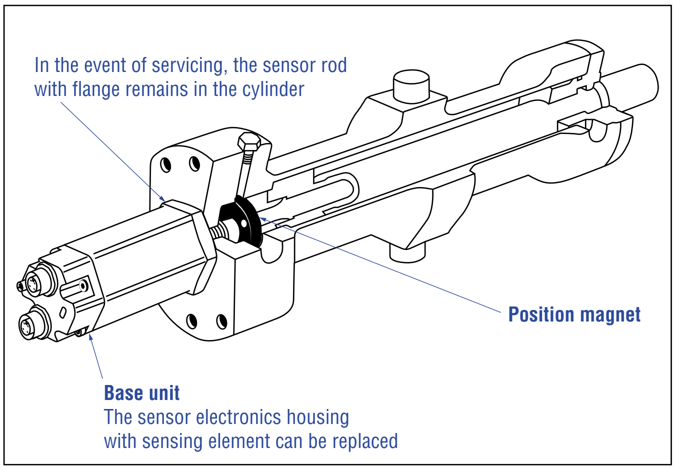


Fig. 8: Sensor in cylinder

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 only two 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 "4.7 Replacement of sensor" on page 25.

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.
   <u>For threaded flange (¾"-16 UNF-3A) »H« / »S« / »T« / »U«:</u>
   O-ring 16.4 × 2.2 mm (0.65 × 0.09 in.) (part no. 560 315)
   <u>For threaded flange (M18×1.5-6g) »D« / »M« / »R«/ »V«:</u>
   O-ring 15.3 × 2.2 mm (0.60 × 0.09 in.) (part no. 401 133)
   <u>For threaded flange (M22×1.5-6g) »J«:</u>
   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.

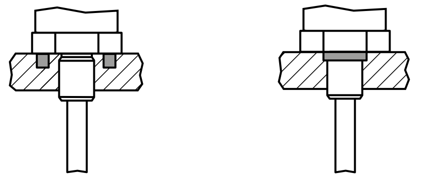
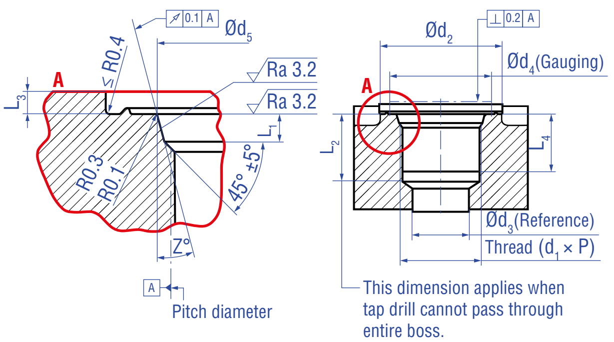


Fig. 10: Possibilities of sealing

- Note the fastening torque of:
  RH-D/-H /-M / -R /-S / -T / -U / -V: 50 Nm
  RH-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 (RH-H/-M/-R/-S/-T/-U/-V: rod Ø 10 mm: ≥ Ø 13 mm (≥ Ø 0.51 in.); RH-D: rod Ø 10 mm: ≥ Ø 16 mm (≥ Ø 0.63 in.); RH-J: 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°
RH-M / -R / -V									
M18×1.5-6g	55	≥ 13	24.5	19.8	2.4	28.5	2	26	15°
RH-D									
M18×1.5-6g	55	≥ 16	24.5	19.8	2.4	28.5	2	26	15°
RH-J									
M22×1.5-6g	55	≥ 16	27.5	23.8	2.4	28.5	2	26	15°

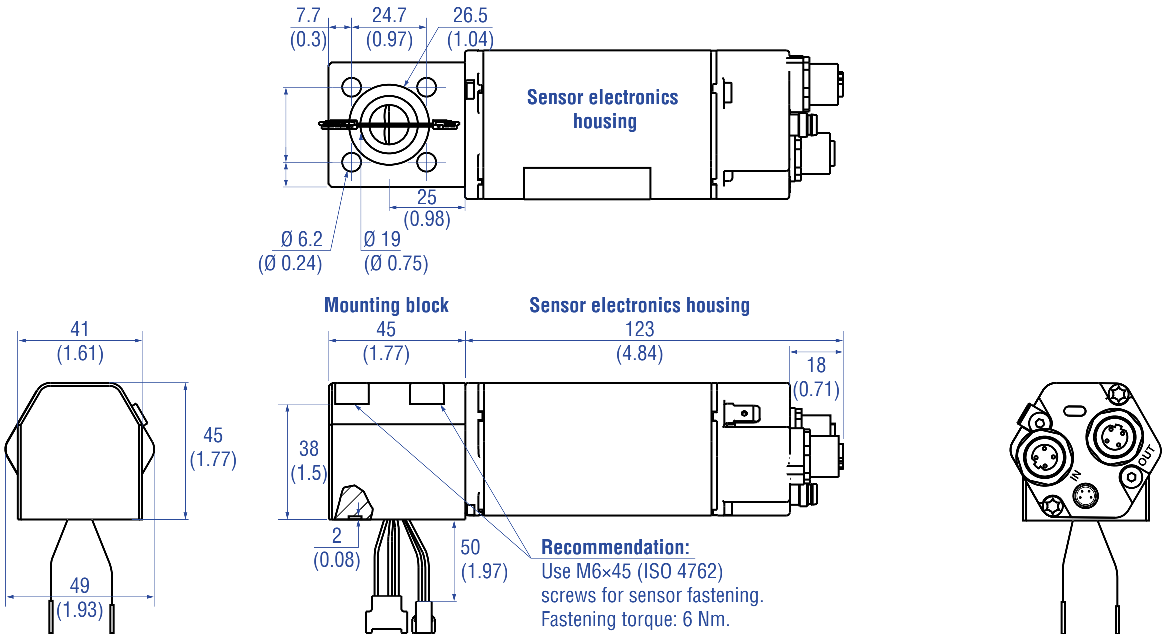


Controlling design dimensions are in millimeters

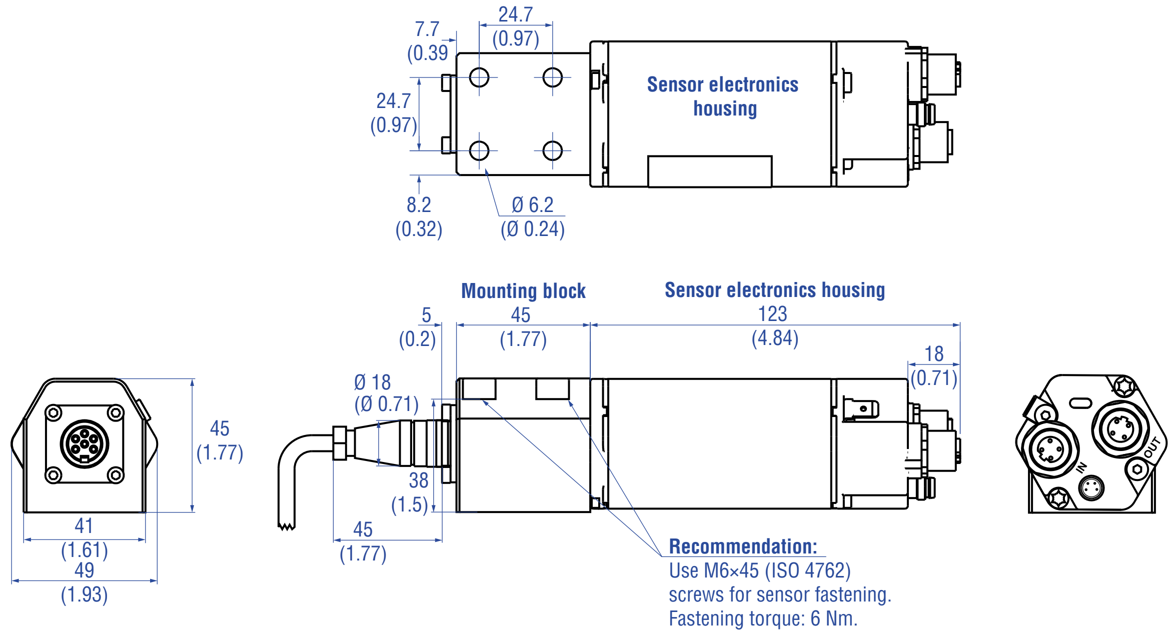
Fig. 11: Notice for metric threaded flange M18×1.5-6g / M22×1.5-6g based on DIN ISO 6149-1

4.4 Styles and installation of Temposonics® RD4

Sensor electronics housing with bottom cable entry



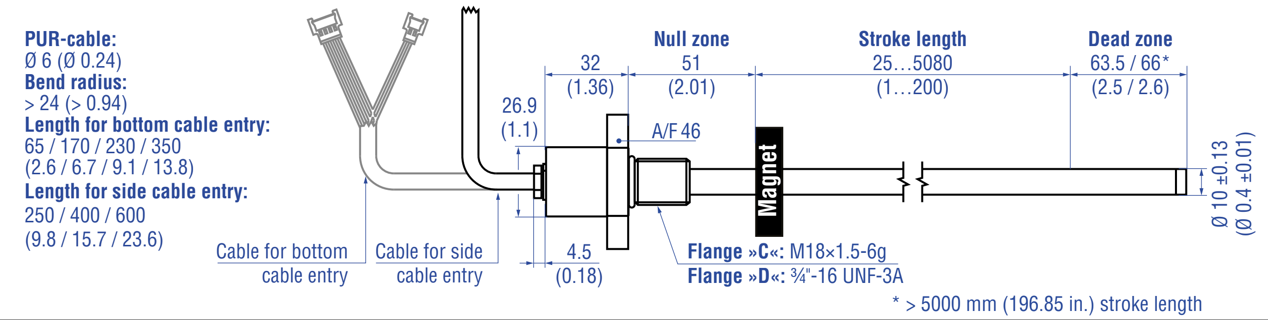
Sensor electronics housing with side cable entry



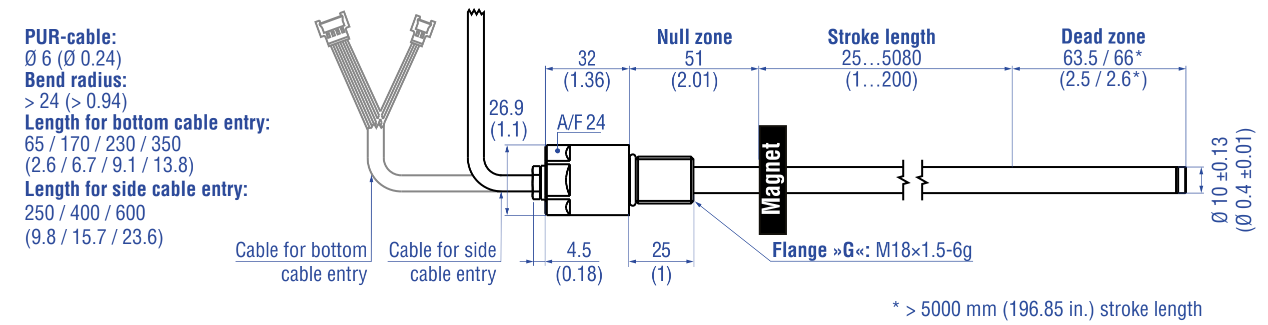
Controlling design dimensions are in millimeters and measurements in ( ) are in inches

Fig. 12: Temposonics® RD4 sensor electronics housings

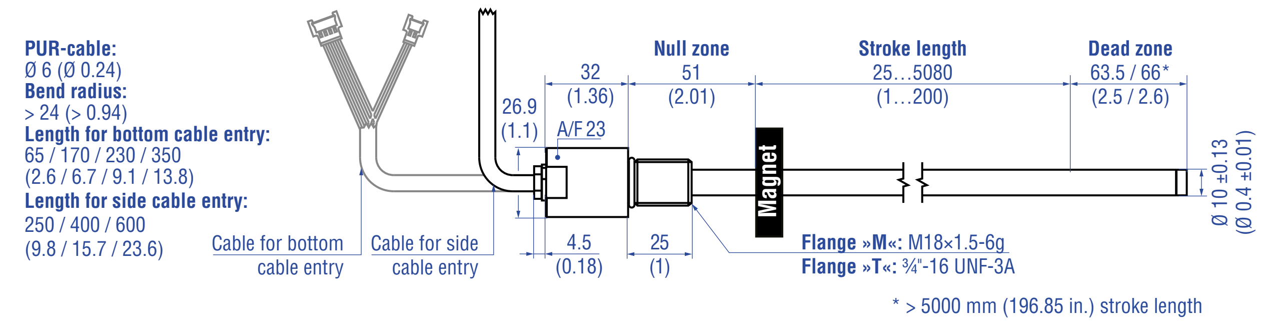
Threaded flange »C« & »D« (for bottom or side entry)



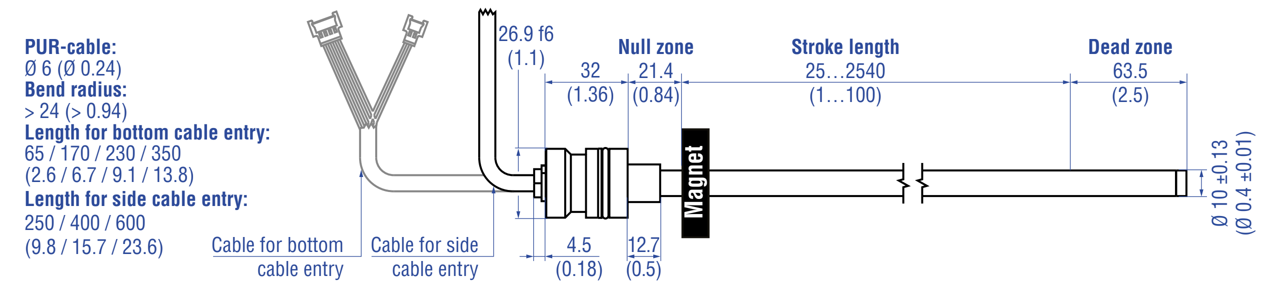
Threaded flange »G« (for bottom or side entry)



Threaded flange »M« & »T« (for bottom or side entry)



Pressure fit flange »S« (for bottom or side entry)



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

Fig. 13: Temposonics RD4 flanges with ring manget

NOTICE

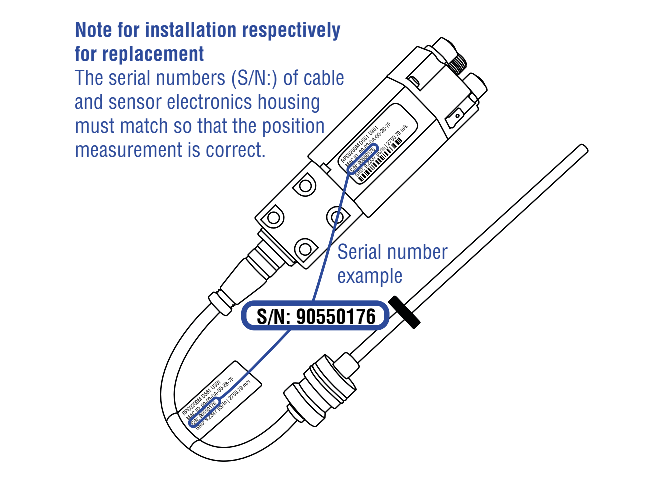


Fig. 14: Conformity of serial numbers

NOTICE

Mount the sensor as follows:

1. Mount the flange with sensor rod
2. Mount the sensor electronics housing
3. Connect the cable between flange and the sensor electronics housing

The steps mentioned above will be explained in chapter 4.4.1, chapter 4.4.2 and chapter 4.4.3.

4.4.1 Installation of RD4 with threaded flange

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

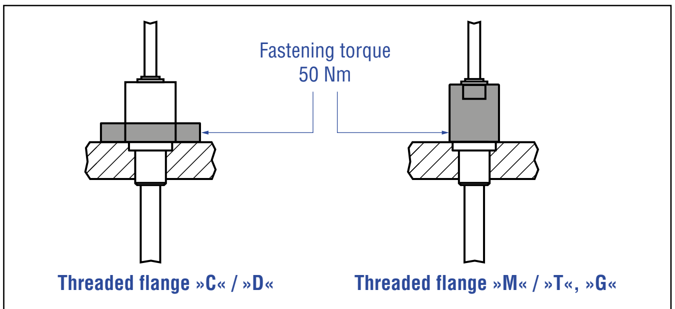


Fig. 15: Mounting example of threaded flange »C / D«, »M / T« & »G«

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.

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

Hydraulics sealing

There are the following ways to seal the flange contact surface (Fig. 16):

For threaded flange »C« / »D«:

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 end cap groove.

For threaded flange (¾"-16 UNF-3A) »D« / »T«:

2. A sealing by using an O-ring 16.4 × 2.2 mm (0.65 × 0.09 in.) (part no. 560 315) in the undercut.

For threaded flange (M18×1.5-6g) »C« / »M« & »G«:

3. A sealing by using O-ring 15.3 × 2.2 mm (0.6 × 0.09 in.) (part no. 401 133) in the undercut. In this case a screw hole based on ISO 6149-1 (Fig. 17) must be provided. See ISO 6149-1 for further information.

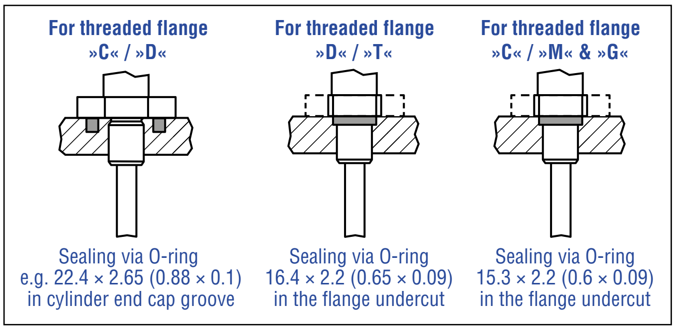


Fig. 16: Possibilities of sealing

- Note the fastening torque of 50 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 (≥ Ø 13 mm (≥ Ø 0.51 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°
RD4-C									
M18×1.5-6g	55	≥ 13	24.5	19.8	2.4	28.5	2	26	15°
RD4-G / -M									
M18×1.5-6g	30	≥ 13	24.5	19.8	2.4	28.5	2	26	15°

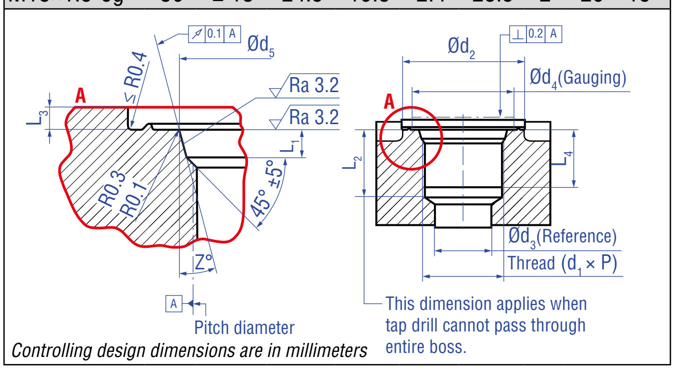


Fig. 17: Notice for metric threaded flange M18×1.5-6g based on DIN ISO 6149-1

4.4.2 Installation of RD4 with pressure fit flange

Cylinder mounting

Install the rod using the pressure fit flange. Seal it off by means of the O-ring and the back-up ring. Block the pressure fit flange using a shoulder screw (Fig. 18). For details of the pressure fit flange »S« see Fig. 19. Also note the mounting examples in Fig. 20 and Fig. 21.

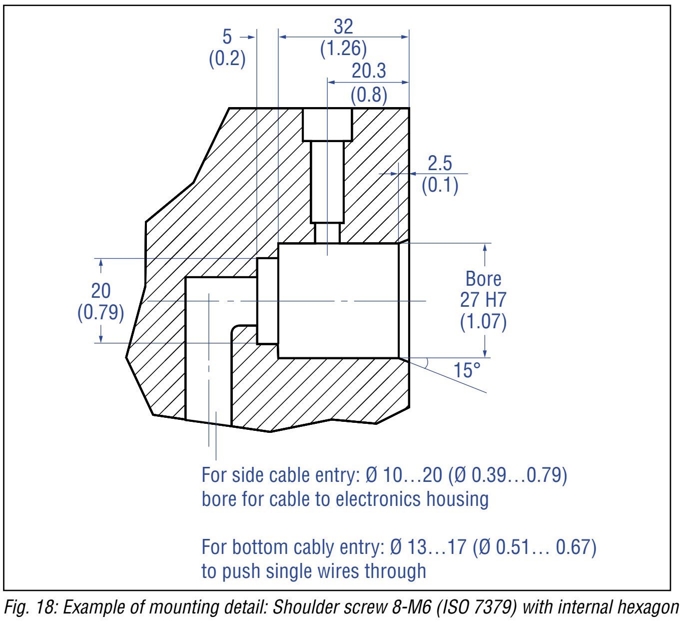


Fig. 18: Example of mounting detail: Shoulder screw 8-M6 (ISO 7379) with internal hexagon

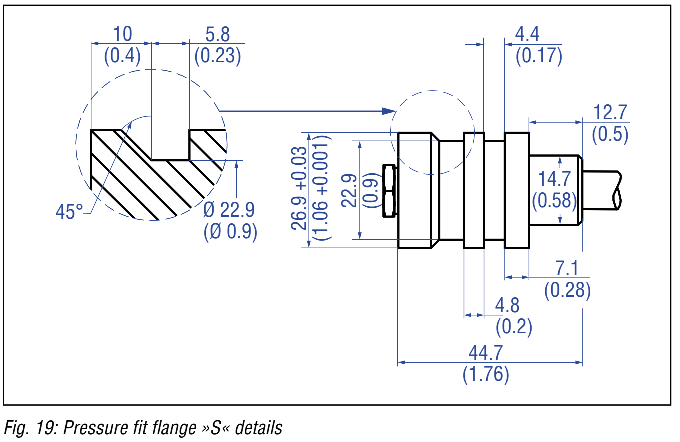


Fig. 19: Pressure fit flange »S« details

Note for cylinder installation:
- The position magnet should not grind on the sensor rod.
- The piston rod drilling (≥ Ø 13 mm (≥ Ø 0.51 in.)) depends on the pressure and piston speed.
- Adhere to the information relating to operating pressure.
- Protect the sensor rod against wear.

4.4.3 Installation of RD4's sensor electronic housing

The following section explains the connection of a RD4 sensor with bottom cable entry (Fig. 20) and side cable entry (Fig. 21) based on RD4-S. The sensor electronics of RD4 sensors with threaded flange are mounted in the same way.

Sensor electronics with bottom cable entry

Connect the rod via the connector to the sensor electronics. Mount the sensor electronics so that you can lead the cables below the bottom of the housing. Thus the sensor system including the connection cables is fully encapsulated and protected against external disturbances (Fig. 20). Note the bending radius of the cable if you run the cable between sensor electronics and rod (see Fig. 13).

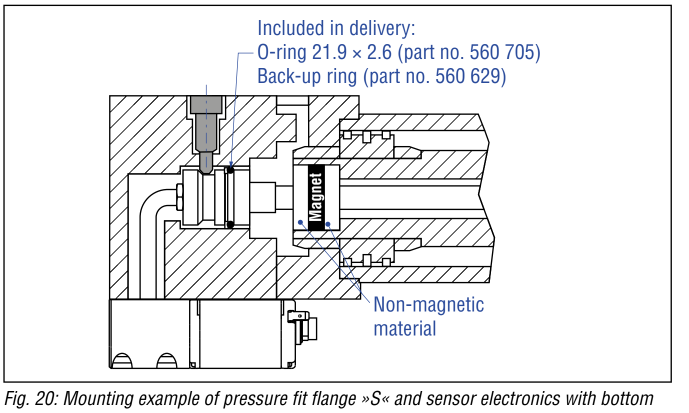


Fig. 20: Mounting example of pressure fit flange »S« and sensor electronics with bottom cable entry

Sensor electronics with side cable entry

Connect the rod via the cable to the sensor electronics on the side. Encapsulate the sensor system including the connection cables (Fig. 21). Note the bending radius of the cable if you run the cable between sensor electronics and rod (see Fig. 13).

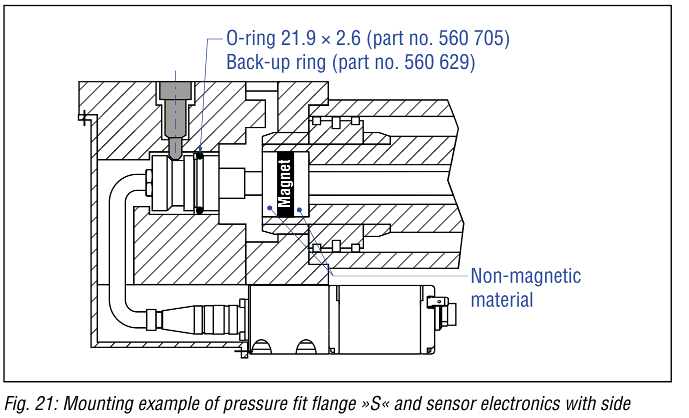


Fig. 21: Mounting example of pressure fit flange »S« and sensor electronics with side cable entry

NOTICE

To fulfill the EMC standards for emission and immunity the following points are necessary:
- The sensor electronics housing has to be connected to machine ground.
- The cable between the sensor and the electronics must be integrated into a metallic housing.

Connect the flange to the sensor electronics housing via the molex connectors for bottom cable entry respectively via the 6 pin cable for side cable entry.

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

Mounting of sensor electronics housing

Mount the sensor electronics housing with 4 M6×45 (ISO 4762) screws via the mounting block. Note the fastening torque of 6 Nm.

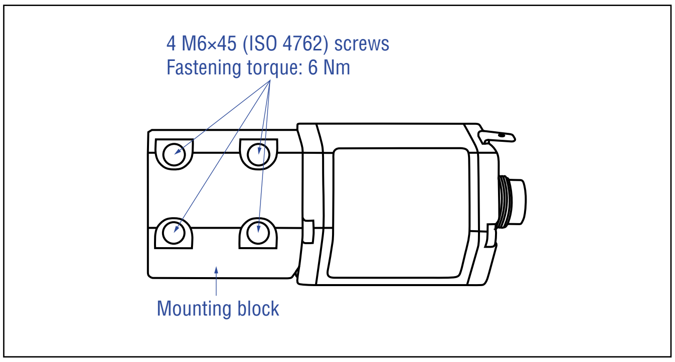
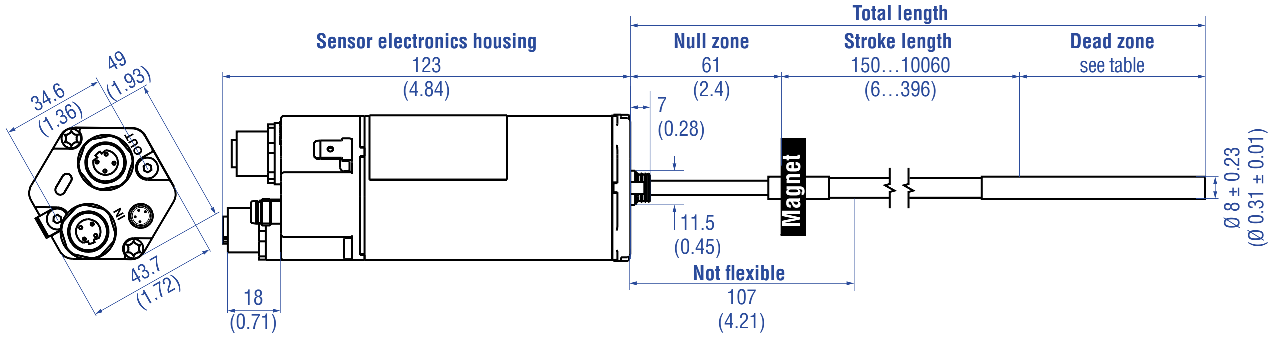


Fig. 22: Mounting of RD4's sensor electronics housing (example of bottom cable entry)

4.5 Styles and installation of Temposonics® RF

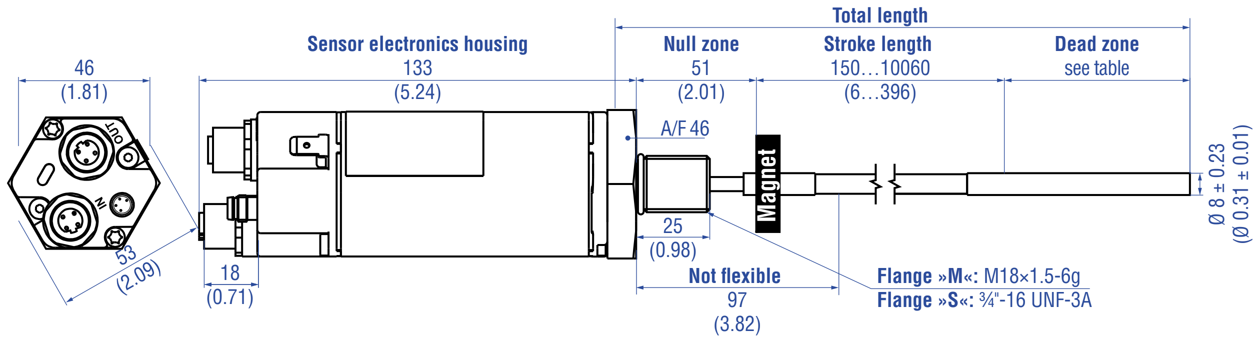
RF-C



Stroke length	Tolerance of total length	Dead zone
Up to 7620 mm (300.00 in.)	+8 mm (0.31 in.) / –5 mm (0.20 in.)	94 mm (3.70 in.)
Up to 10,000 mm (393.70 in.)	+15 mm (0.59 in.) / –15 mm (0.59 in.)	100 mm (3.94 in.)
Up to 15,000 mm (590.55 in.)	+15 mm (0.59 in.) / –30 mm (1.18 in.)	120 mm (4.72 in.)
Up to 20,000 mm (787.00 in.)	+15 mm (0.59 in.) / –45 mm (1.77 in.)	140 mm (5.51 in.)

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

RF-M / -S



Stroke length	Tolerance of total length	Dead zone
Up to 7620 mm (300.00 in.)	+8 mm (0.31 in.) / –5 mm (0.20 in.)	94 mm (3.70 in.)
Up to 10,000 mm (393.70 in.)	+15 mm (0.59 in.) / –15 mm (0.59 in.)	100 mm (3.94 in.)
Up to 15,000 mm (590.55 in.)	+15 mm (0.59 in.) / –30 mm (1.18 in.)	120 mm (4.72 in.)
Up to 20,000 mm (787.00 in.)	+15 mm (0.59 in.) / –45 mm (1.77 in.)	140 mm (5.51 in.)

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

Fig. 23: Temposonics® RF base unit with ring magnet (top) and RF with threaded flange with ring magnet (bottom)

Note the following information when mounting a RF sensor:

1. Always insert the flexible sensor rod in a support tube (e.g. pressure rod HD / HL / HP or HFP profile). The support tube with an inside diameter of 9.4 mm (0.37 in.) consists of non-magnetic material. The support tube can be straight or bent (note the bending radius in Fig. 25).
2. Use non-magnetic material for mounting support.
3. Do never bend beyond the minimum bending radius of 250 mm (9.84 in.)
4. Note the minimum distance to a spatial limitation of 300 mm (11.81 in.), when mounting / dismounting the sensor (Fig. 25).
5. Note that the first 107 mm (4.21 in.) (for RF-C) respectively 97 mm (3.82 in.) (for RF-M) of the sensor rod are not flexible.

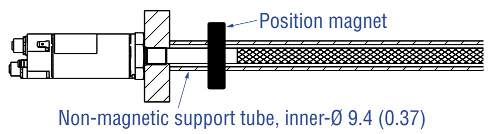


Fig. 24: Linear measurement

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

NOTICE

Smaller radiuses cause damage to the flexible sensor rod.

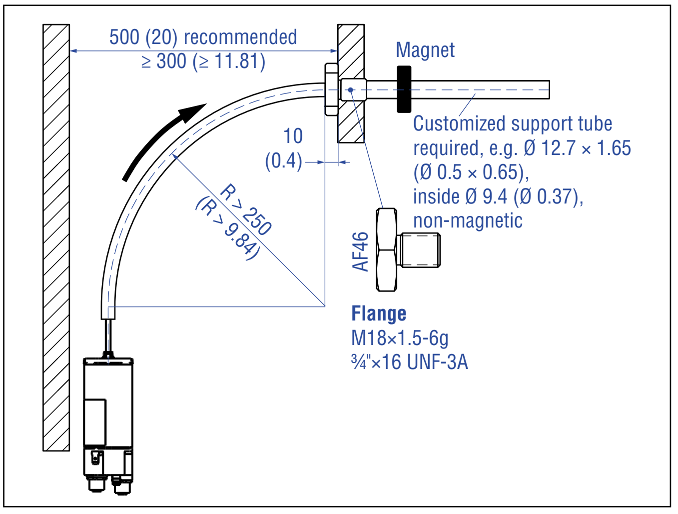


Fig. 25: Clearances for installation

This is the way you mount the RF sensors:

Sensor design	Mounting
RF-C	• Insert the flexible sensor rod in a support tube. • Mount the sensor electronics housing by means of two non-magnetic socket head screws M4×90. Fastening torque: 2 Nm (see Fig. 26) <u>Recommendation:</u> Seal the sensor via flange.
RF-C with pressure rod HD / HL / HP or HFP profile (see accessories)	<u>Advantage:</u> The flexible sensor rod is inserted in a support tube. • Mount the sensor electronics housing by means of two non-magnetic socket head screws M4×59. Fastening torque: 2 Nm (see Fig. 26)
RF-M / RF-S	• Insert the flexible sensor rod in a support tube. • Mount the sensor via flange.

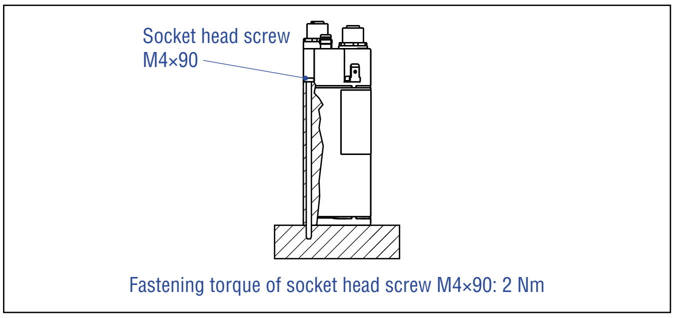


Fig. 26: Mounting with socket head screws M4×90

NOTICE

Connect the sensor electronics housing to machine ground to fulfill the EMC standards for emission and immunity.

Installation of RF with threaded flange »M«, »S« respectively with pressure rod HD / HL / HP

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

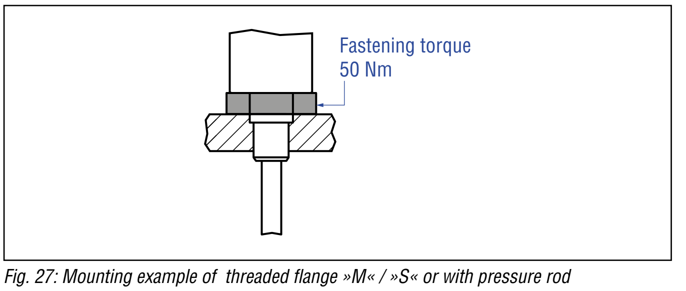


Fig. 27: Mounting example of threaded flange »M« / »S« or with pressure rod HD / HL / HP

Installation of a RF sensor with pressure rod HD / HL / HP 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 only two 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 "4.7 Replacement of sensor" on page 25.

Hydraulics sealing when using a RF sensor in a pressure rod HD / HL / HP

There are two ways to seal the flange contact surface (Fig. 29):

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 end cap groove.
2. A sealing by unsing an O-ring in the undercut.
   <u>For threaded flange (¾"-16 UNF-3A) »S«:</u>
   O-ring 16.4 × 2.2 mm (0.65 × 0.09 in.)
   <u>For threaded flange (M18×1.5-6g) »M«:</u>
   O-ring 15.3 × 2.2 mm (0.60 × 0.09 in.)
   In this case, a screw hole based on ISO 6149-1 (Fig. 28) must be provided. See ISO 6149-1 for further information.

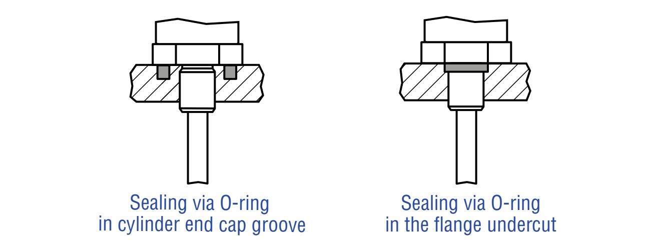


Fig. 29: Possibilities of sealing

Note the following points when using a RF-M / -S sensor or RF-C with pressure rod HD / HL / HP:

- Note the fastening torque of 50 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 for RF sensors with pressure rod (rod Ø 12.7 mm (0.5 in.)) is ≥ 16 mm (≥ 0.63 in.). The borehole 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°
RF-M / Optional pressure rod HD									
M18×1.5-6g	55	≥ 13	24.5	19.8	2.4	28.5	2	26	15°

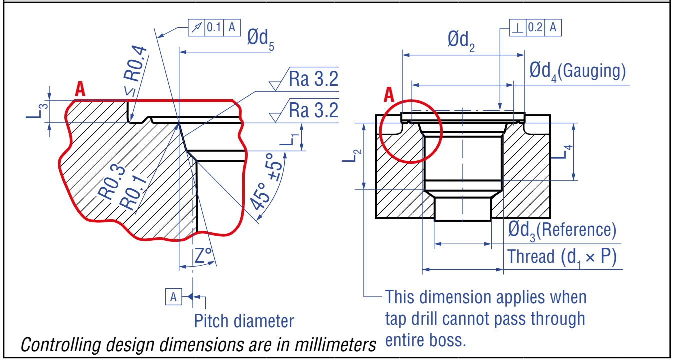


Fig. 28: Notice for metric threaded flange M18×1.5-6g based on DIN ISO 6149-1

For additional information about optional accessories see:

- HFP Profile (document part number: 551 442)
- Pressure rod HD / HL / HP (document part number: 551 770)

4.6 Magnet installation

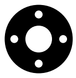
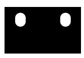
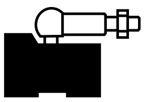
Magnet	Typical sensors	Benefits
Ring magnets 	**Rod models** (RH, RD4, RF)	• Rotationally symmetrical magnetic field
U-magnets 	**Profile & rod models** (RP, RH, RD4, RF)	• Height tolerances can be compensated
Block magnets 	**Profile & rod models** (RP, RH, RF)	• The magnet can be lifted off • Height tolerances can be compensated
Magnet sliders 	**Profile models** (RP)	• The magnet is guided through the profile • The distance between the magnet and the waveguide is strictly defined • Easy coupling via the ball joint

Fig. 30: Typical use of magnets

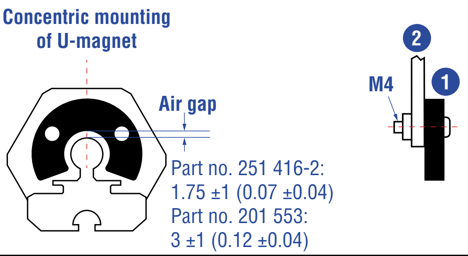
Mounting ring magnets, U-magnets & block magnets

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. 33).
- If no other option exists and magnetic material is used, observe the specified dimensions (Fig. 33).

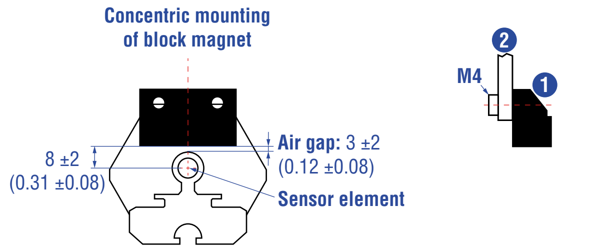
NOTICE

Mount ring magnets and U-magnets concentrically.
Mount block magnets centrically over the sensor rod or the sensor profile. Do not exceed the maximum acceptable gap.



1. U-magnet
2. Non-magnetic mounting plate

Fig. 31: Mounting of U-magnet (part no. 251 416-2 or part no. 201 553)



1. Block magnet
2. Non-magnetic mounting plate

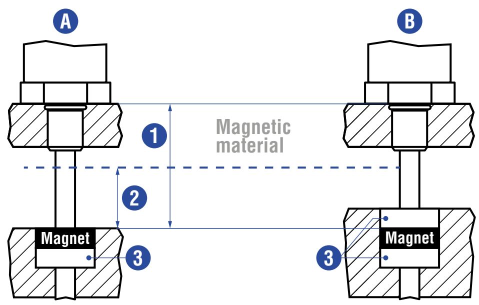
Fig. 32: Mounting of block magnet (part no. 403 448)

Magnet mounting with magnetic material

When using magnetic material the dimensions of Fig. 33 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 (see Fig. 35 / 36 / 37)
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. 33: Installation with magnetic material

Sensors with stroke lengths ≥ 1 meter (3.3 ft.)

Support horizontally installed sensors with a stroke length from 1 meter (3.3 ft.) mechanically at the rod end. Without the use of a support, rod and 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. 34) for measurement.

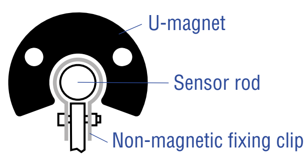


Fig. 34: Example of sensor support (part no. 561 481)

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.

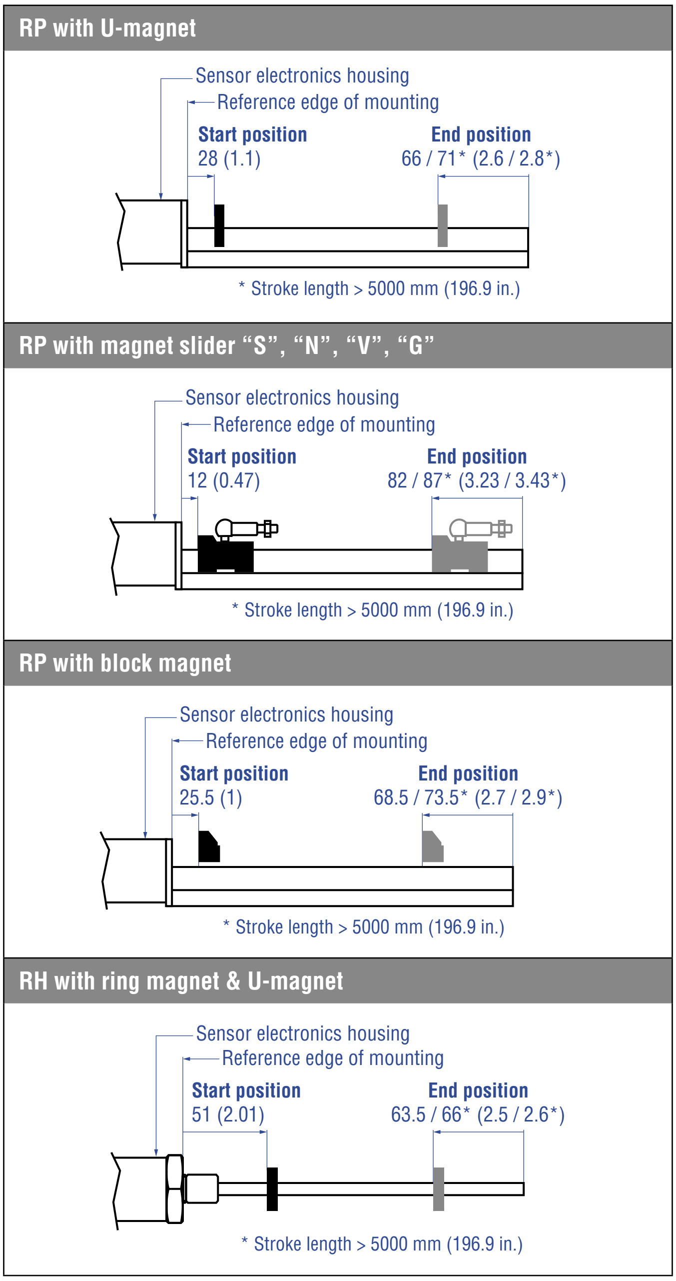


Fig. 35: Start- & end positions of magnets, part 1

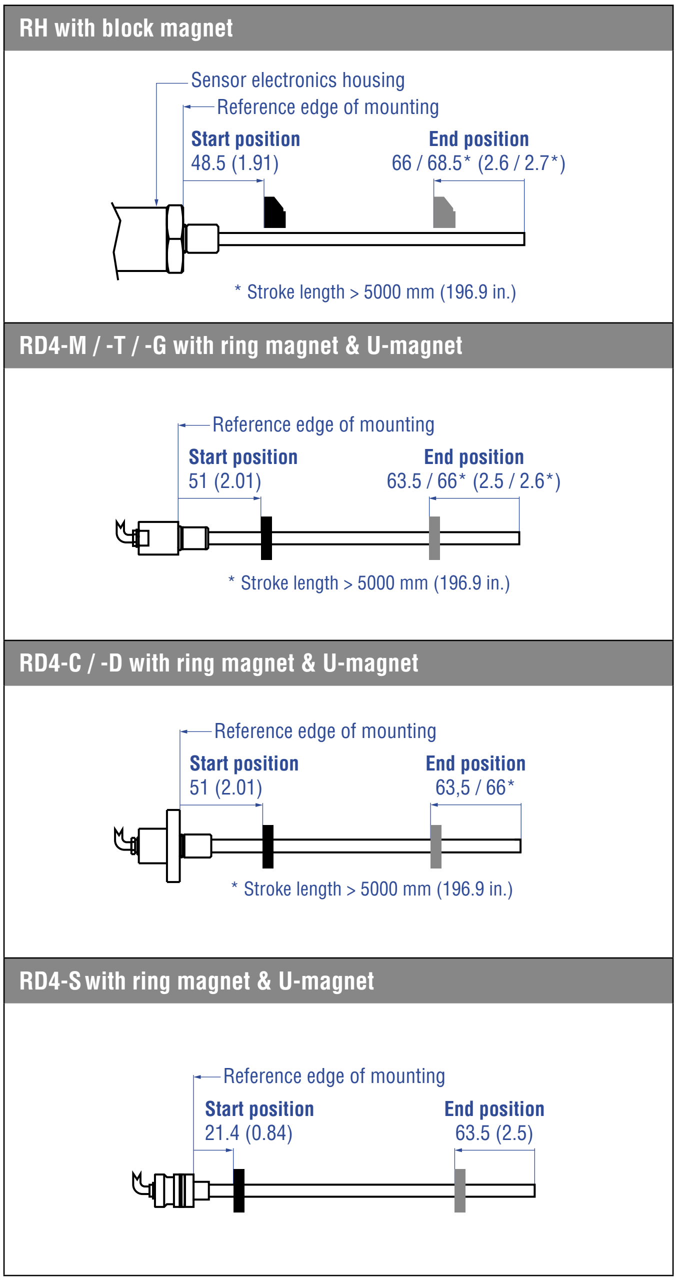
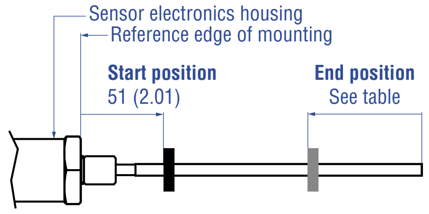


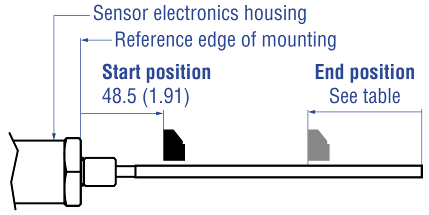
Fig. 36: Start- & end positions of magnets, part 2

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

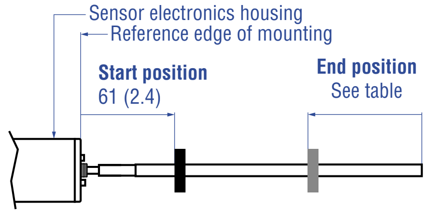
R-Series RF-M / -S with ring magnet & U-magnet



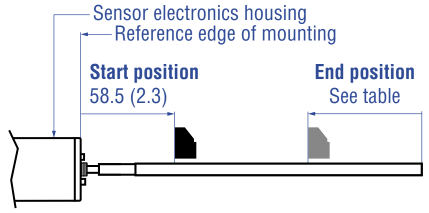
R-Series RF-M / -S with block magnet



R-Series RF-C with ring magnet & U-magnet



R-Series RF-C with block magnet



Stroke length RF	Tolerance of total length	End position of ring magnet / U-magnet	End position of block magnet
Up to 7620 mm (300 in.)	+8 mm (0.31 in.) / –5 mm (0.20 in.)	94 mm (3.70 in.)	96.5 mm (3.8 in.)
Up to 10,000 mm (393.70 in.)	+15 mm (0.59 in.) / –15 mm (0.59 in.)	100 mm (3.94 in.)	102.5 mm (4.04 in.)
Up to 10,060 mm (396 in.)	+15 mm (0.59 in.) / –30 mm (1.18 in.)	120 mm (4.72 in.)	122.5 mm (4.82 in.)

Fig. 37: Start- and end positions of magnets (Part 3)

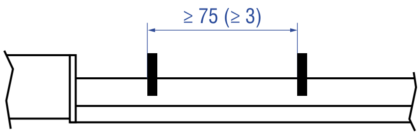
NOTICE

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, but the active stroke length can be exceeded.

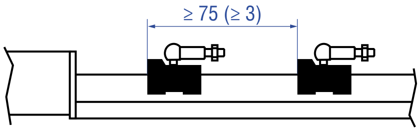
Multi-position measurement

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

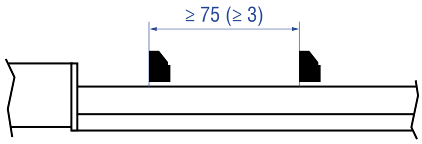
Profile models with U-magnets



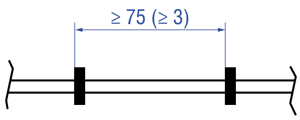
Profile models with magnet sliders



Rod models with ring magnets & U-magnets



Profile models with block magnets



Rod models with block magnets

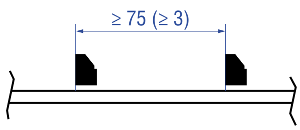


Fig. 38: Minimum distance for multi-position measurement

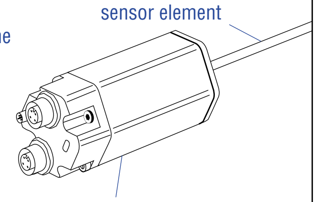
NOTICE

Use magnets of the same type (e.g. 2 ring magnets) for multi-position measurement.

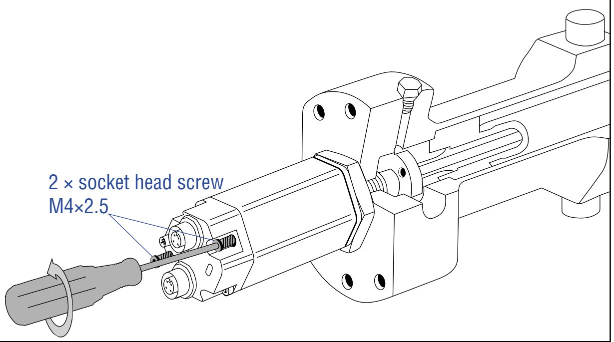
4.7 Replacement of sensor

The base unit of the sensor models RH (RH-B) and RF (RF-C) is replaceable as shown in Fig. 39 and Fig. 40. The sensor can be replaced without interrupting the hydraulic circuit.

Base unit



1. Loosen the screws



2. Pull out the base unit

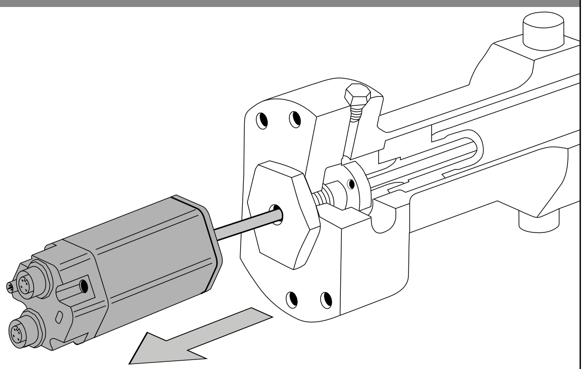


Fig. 39: Replacement of the base unit (e.g. RH sensor), part 1

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

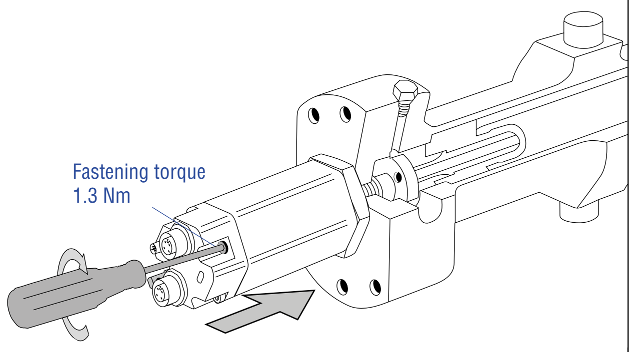


Fig. 40: Replacement of the base unit (e.g. RH sensor), part 2

NOTICE

- If necessary, the sensor electronics of sensor model RD4 can be replaced. Contact MTS Sensors for further information.
- Secure the base unit screws, e.g. using Loctite 243, before re-installing.

4.8 Electrical connections

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 leads 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 connecting values.

Grounding of profile and rod sensors

Connect the sensor electronics housing to machine ground. Ground sensor types RP, RH, RD4 and RF via ground lug as shown in Fig. 41. In addition you can ground the sensor type RH via thread.

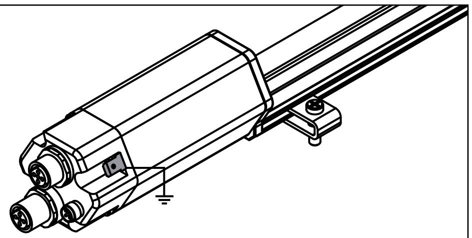


Fig. 41: Grounding via ground lug (e.g. profile sensor)

Connector wiring

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

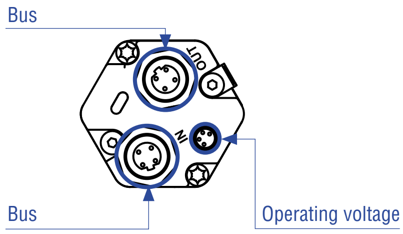


Fig. 42: Location of connections

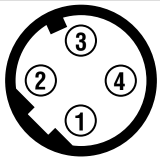
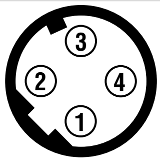
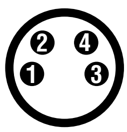
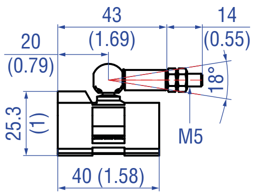
D56		
Signal		
M12 male connector (D-coded)	**Pin**	**Function**
 View on sensor	1	Tx (+)
	2	Rx (+)
	3	Tx (–)
	4	Rx (–)
M12 male connector (D-coded)	**Pin**	**Function**
 View on sensor	1	Tx (+)
	2	Rx (+)
	3	Tx (–)
	4	Rx (–)
Power supply		
M8 male connector	**Pin**	**Function**
 View on sensor	1	+24 VDC (–15 / +20 %)
	2	Not connected
	3	DC Ground (0 V)
	4	Not connected

Fig. 43: Connector wiring D56

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

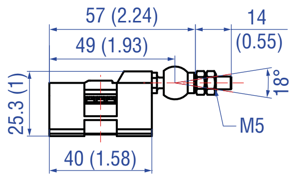
Position magnets



Magnet slider S
Part no. 252 182

For: **RP**

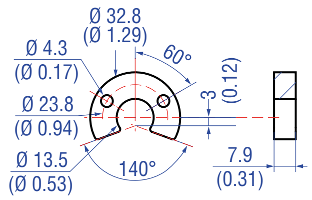
Material: GFK, magnet hard ferrite
Weight: Ca. 35 g
Operating temperature:
–40…+75 °C (–40…+167 °F)



Magnet slider V
Part no. 252 184

For: **RP**

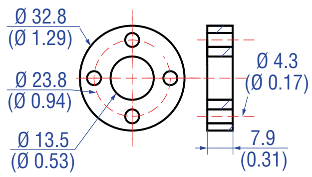
Material: GFK, magnet hard ferrite
Weight: Ca. 35 g
Operating temperature:
–40…+75 °C (–40…+167 °F)



U-magnet OD33
Part no. 251 416-2

For: **RP, RH, RD4**

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

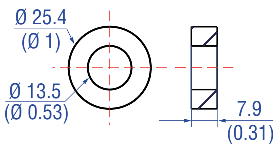


Ring magnet OD33
Part no. 201 542-2

For: **RH, RD4, RF**

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

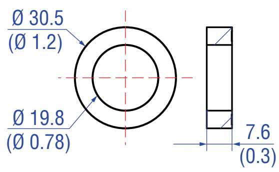
Position magnets



Ring magnet OD25.4
Part no. 400 533

For: **RH, RD4**

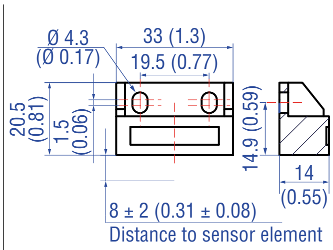
Material: PA ferrite
Weight: Ca. 10 g
Surface pressure: Max. 40 N/mm²
Operating temperature:
–40…+105 °C (–40…+221 °F)



Ring magnet
Part no. 402 316

For: **RH, RD4, RF**

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

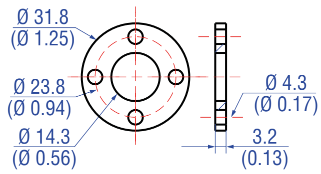


Block magnet
Part no. 403 448

For: **RP, RH, RD4**

Material: Hard ferrite
Weight: Ca. 20 g
Fastening torque for M4 screws: 1 Nm
Operating temperature:
–40…+75 °C (–40…+167 °F)

Magnet spacer

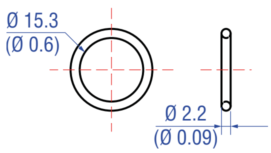


Magnet spacer
Part no. 400 633

For: **RH, RD4**

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

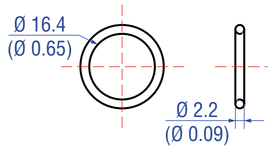
Sealing



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

For: **RH, RD4, RF**

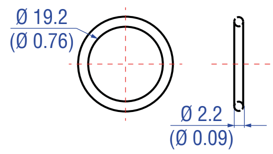
Application: Flange M18×1.5
Material: Fluoroelastomer
75 ± 5 durometer



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

For: **RH, RD4, RF**

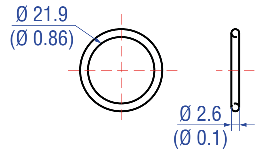
Application: Flange ¾"-16 UNF
Material: Fluoroelastomer
75 ± 5 durometer



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

For: **RH**

Application: Flange M22×1.5
Material: FPM



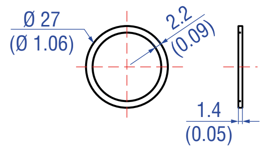
O-ring for pressure fit flange
Part no. 560 705

For: **RD4**

Application: Pressure fit flange
Material: Nitrile rubber

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

Sealing

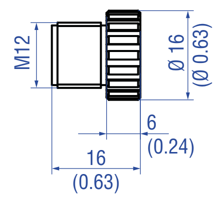


Back-up ring for pressure fit flange
Part no. 560 629

For: **RD4**

Application: Pressure fit flange
Material: Polymyte
90 durometer

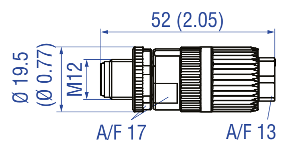
Accessory for M12 cable connector



Connector end cap
Part no. 370 537

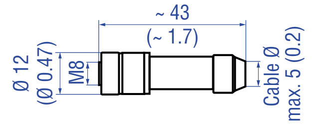
Female connectors M12 should be covered by this protective cap
Material: Brass nickel-plated
Ingress protection: IP67
Fastening torque: 0.39…0.49 Nm

Cable connectors [7]



M12 male connector (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.)
Operating temperature:
−25…+85 °C (−13…+185 °F)
Ingress protection: IP65 / IP67
Fastening torque: 0.6 Nm



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

Material: CuZn nickel plated
Termination: Solder 0.25 mm²
Cable Ø: 3.5…5 mm (0.14…0.28 in.)
Operating temperature:
−40…+85 °C (−40…+185 °F)
Ingress protection: IP67

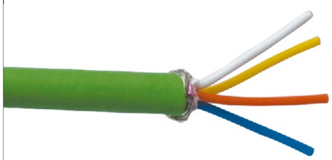
Cables

Cable (bus) with M12 male connector – M12, 5 m male connector (16.4 ft.)
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.)
Operating temperature:
−40…+70 °C (−40…+158 °F)

Cable (bus) with M12 male connector – RJ45 male connector, 5 m (16.4 ft.)
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.)
Operating temperature:
−40…+70 °C (−40…+158 °F)



Cable (bus cable)
Pigtail – pigtail
Part no. 530 125

Material: PUR jacket; green
Features: Cat 5
Cable Ø: 6.5 mm (0.26 in.)
Dimensions: 2×2×0.35 mm²
(22/7 AWG)

Cable (power supply)
M8 female connector – 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.))

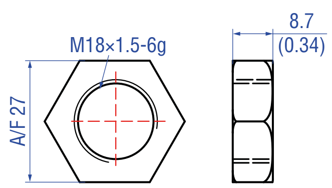
Material: PUR jacket; gray
Features: Shielded
Cable Ø: 8 mm (0.3 in.)
Operating temperature:
−40…+90 °C (−40…+194 °F)

Cable

Cable (power supply)
Pigtail – pigtail
Part no. 530 108

Material: PVC jacket; gray
Features: Shielded
Cable Ø: 4.9 mm (0.19 in.)
Dimensions: 3 × 0.34 mm²
Operating temperature:
−30…+80 °C (−22…+176 °F)

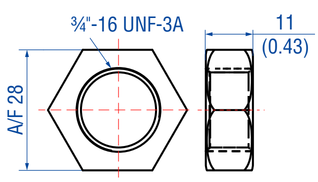
Hex nut



Hex-jam nut M18
Part no. 500 018

For: **RH, RD4, RF**

Application: M18×1.5 thread
Material: Steel, 2 zinc, plated

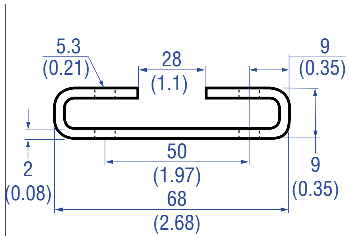


Hex-jam nut ¾"
Part no. 500 015

For: **RH, RD4, RF**

Application: ¾"-16 UNF thread
Material: Zinc plated with nylon insert

Mounting hardware



Mounting clamp width: 14.6 (0.57)

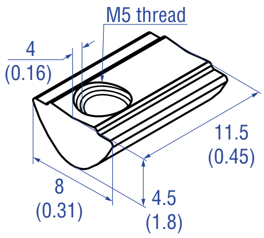
Mounting clamp
Part no. 400 802

For: **RP**

Material: Stainless steel (AISI 304)

7/ Follow the manufacturer's mounting instructions

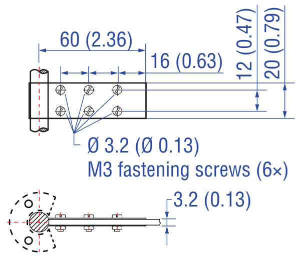
Mounting hardware



T-slot nut
Part no. 401 602

For: **RP**

Fastening torque for M5 screw: 4.5 Nm



Fixing clip
Part no. 561 481

For: **RH, RD4**

Application: Used to secure sensor rods (Ø 10 mm (Ø 0.39 in.)) when using an U-magnet
Material: Brass, non-magnetic

Pressure rods (RF)

Pressure rod with flange M18×1.5-6g (flat-faced flange) and O-ring
HD [length mm: XXXX] M
HD [length in.: XXX.X] U

For: **RF-C**

Pressure rod Ø: 12.7 mm (0.5 in.)
Length: 255…7500 mm (10…295 in.)
Operating pressure: 350 bar
Material flange:
Stainless steel 1.4305 (AISI 303)
Material rod:
Stainless steel 1.4301 (AISI 304)
See technical bulletin "RF pressure housing pipe" (Document Part No.: 551 770) for further information

Pressure rod with flange ¾"-16 UNF-3A (flat-faced flange) and O-ring
HL [length mm: XXXX] M
HL [length in.: XXX.X] U

For: **RF-C**

Pressure rod Ø: 12.7 mm (0.5 in.)
Length: 255…7500 mm (10…295 in.)
Operating pressure: 350 bar
Material flange:
Stainless steel 1.4305 (AISI 303)
Material rod:
Stainless steel 1.4301 (AISI 304)
See technical bulletin "RF pressure housing pipe" (Document Part No.: 551 770) for further information

Pressure rod (RF)

Pressure rod with flange ¾"-16 UNF-3A (raised-faced flange) and O-ring
HP [length mm: XXXX] M
HP [length in.: XXX.X] U

For: **RF-C**

Pressure rod Ø: 12.7 mm (0.5 in.)
Length: 255…7500 mm (10…295 in.)
Operating pressure: 350 bar
Material flange:
Stainless steel 1.4305 (AISI 303)
Material rod:
Stainless steel 1.4301 (AISI 304)
See technical bulletin "RF pressure housing pipe" (Document Part No.: 551 770) for further information

Flanges (RF)

Flange M18×1.5-6g
Part no. 402 704

For: **RF-C**

Material:
Stainless steel 1.4305 (AISI 303)

Flange ¾"-16 UNF-3A
Part no. 402 641

For: **RF-C**

Material:
Stainless steel 1.4305 (AISI 303)

Profile (RF)

Profile with flange
HFP [length mm: XXXXX] M
HFP [length in.: XXXX.X] U

For: **RF-C**

Length: Max. 20 000 mm (max. 787 in.)
Ingress protection: IP30
Material: Aluminum
See "Product Flash RF Profile" (Document Part No.: 551 442) for further information

Manuals & Software available at:
www.mtssensors.com

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

5. Operation

5.1 Getting started

The sensor is factory-set to its order sizes and adjusted, i.e. the required output signal corresponds exactly to the selected stroke length.

Example: Output Powerlink V2 = 0…100 % stroke length

Diagnostic display
LEDs (red / green) in the sensor electronics housing lid provide information on the current sensor condition.

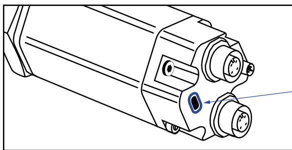


Fig. 44: LED display

Powerlink LED status		
Bus status		
Green	**Red**	**Information**
● ON	○ OFF	Connection established
Port 1		
Green	**Red**	**Information**
● ON	○ OFF	LINK activity on port 1
◐ Flashing	○ OFF	Data activity on port 1
○ OFF	● ON	Missing magnet
Port 2		
Green	**Red**	**Information**
● ON	○ OFF	LINK activity on port 2
◐ Flashing	○ OFF	Data activity on port 2
Bus error		
Green	**Red**	**Information**
○ OFF	● ON	Fault detected

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 lights permanently green.
5. Check the preset span start and end values of the measuring range (see chapter 4) and correct them via the customer's control system, if necessary.

6. Node ID configuration

This chapter describes how to adjust the node ID of the sensor. There are two procedures available. Chapter 6.1 describes how to change the node ID with the MTS Powerlink software, and chapter 6.2 explains how to change the node ID via Automation Studio by B&R (Bernecker + Rainer Industrie-Elektronik Ges.m.b.H.).

6.1 Introduction of "MTS Powerlink Configurator"

These instructions describe the configuration of the node ID of a MTS Sensors Temposonics® R-Series Powerlink sensor using the MTS Powerlink software (download at www.mtssensors.com).

System requirements
- Operating system:
  Microsoft Windows 2000, XP, Vista, 7, 8
- Network interface controller with RJ-45 LAN port

The Powerlink protocol uses a managing node (MN) that directs all traffic to the control nodes (CN). Only one active managing node is permitted on a Powerlink network. For configuration and service of the CNs, the basic ethernet mode is used. Data between the nodes is exchanged via UDP / IP protocol. During configuration, the status LED will be flickering. The sensor will connect to the computer by using an ethernet card or adapter.

IP addressing
The private class C Net ID 192.168.100.0 has been assigned to the Powerlink network. Each Powerlink CN is addressed by a node ID. The managing node ID has been designated as 240. Node IDs from 1…239 are valid for CNs. The last byte of the IP address (host ID) has the same value as the Powerlink node ID. Thus the IP address can easily be determined using the node ID of a Powerlink node.

6.1.1 Connection between sensor and computer

- Connect the sensor via in port or out port with the computer via ethernet cable (part no. 530 065)
- Connect the power supply of the sensor via power cable (part no. 530 066 / 530 096 / 530 093)

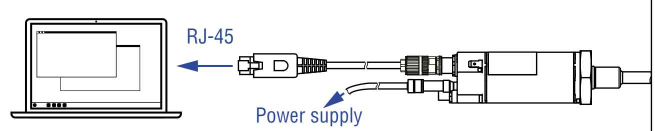


Fig. 45: Network connections

NOTICE
Never connect / disconnect the sensor when voltage is applied.

6.1.2 Network adapter set-up

☐ **Step 1: Network adapter set-up**
☐ Step 2: Node ID configuration
☐ Step 3: Process data

1. Open the “Control Panel” > “Network and Internet” > “Network Connections” (Fig. 46).

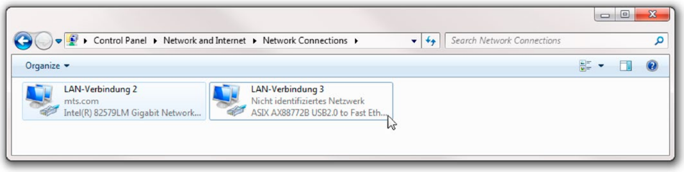


Fig. 46: Network Connections

2. Double click the LAN card which is connected with the sensor. A menu will open (Fig. 47).

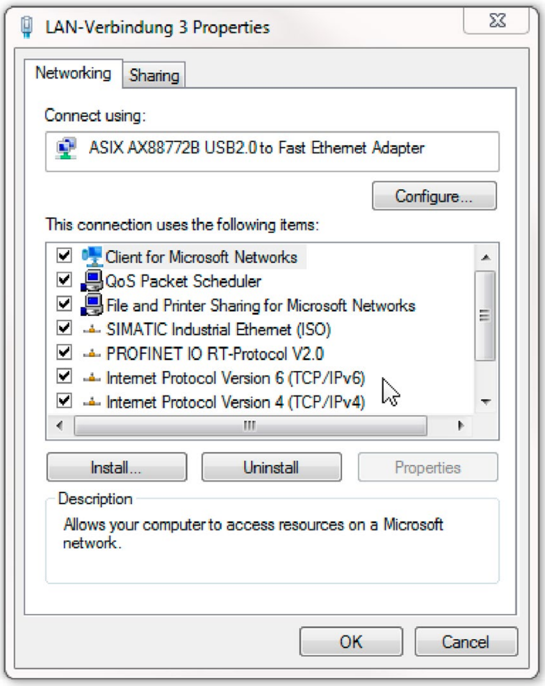


Fig. 47: LAN connections

3. Disable “Internet Procotol Version 6 (TCP/IPv6)” (Fig. 48).

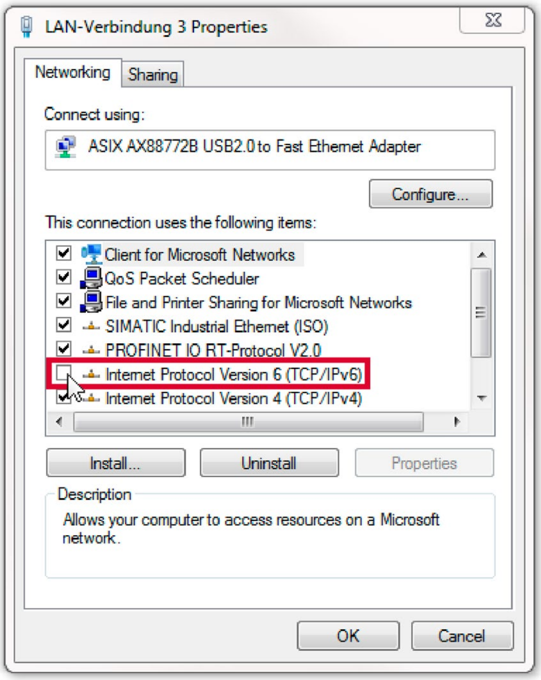


Fig. 48: Disable TCP/IPv6

4. Choose “Internet Procotol Version 4 (TCP/IPv4)” and click “Properties” (Fig. 49).

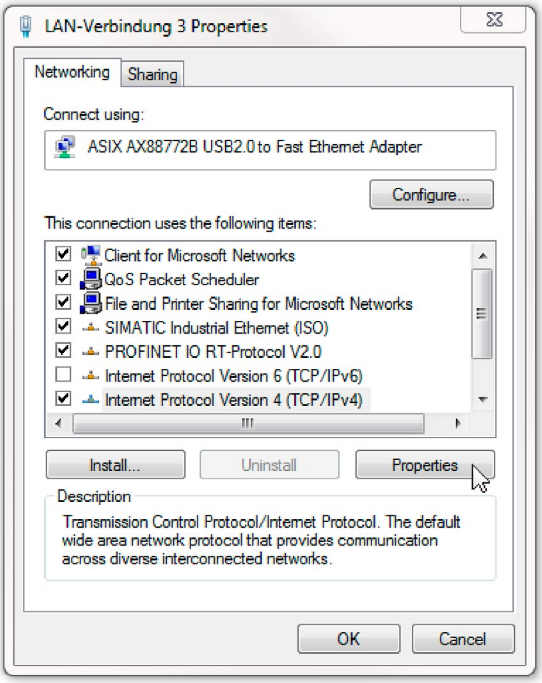


Fig. 49: Choose TCP/IPv4

5. Click the radio button "Use the following IP address" and set an own static IP adress (Fig. 50).

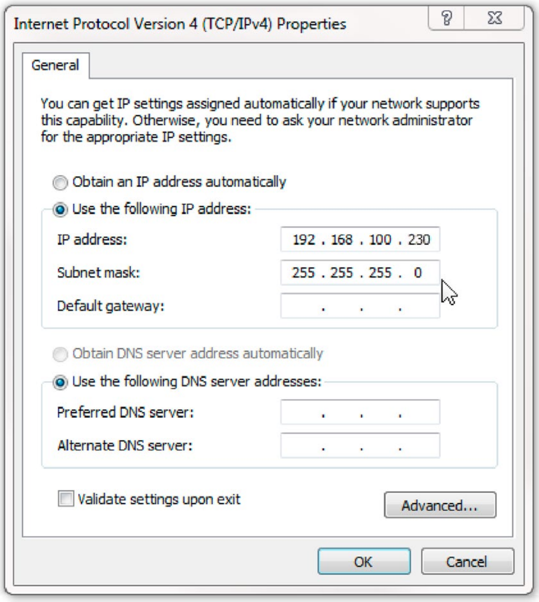


Fig. 50: Static IP address

NOTICE

MTS Sensors recommends for the IP settings:
Net ID: 192.168.100.XXX
Host ID: 1 – 239
Subnet mask: 255.255.255.0

Example (Fig. 50)**:**
IP: 192.168.100.230
Subnet mask: 255.255.255.0

6. Reboot the computer.

6.1.3 Node ID configuration

☑ Step 1: Network adapter set-up
☐ **Step 2: Node ID configuration**
☐ Step 3: Process data

1. Start the MTS Powerlink software (download at www.mtssensors.com). Choose the correct ethernet adapter from the drop-down menu (Fig. 51).

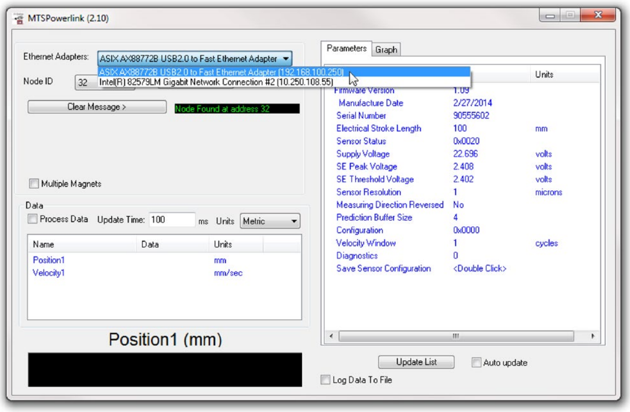


Fig. 51: Choose ethernet adapter

2. Click on "Search for Node" to figure out which node ID the connected sensor has (Fig. 52). The default node ID is 32.

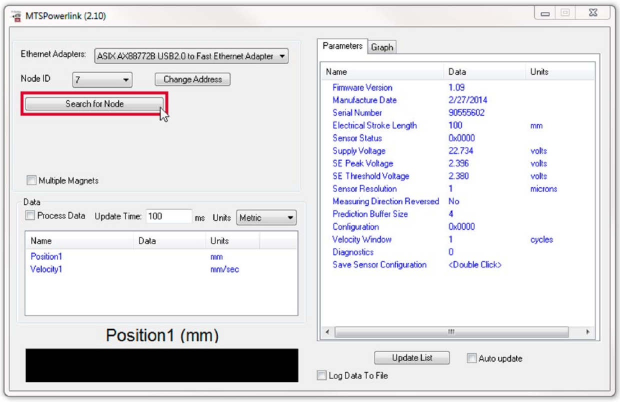


Fig. 52: Search for node ID

3. The current node ID is displayed (Fig. 53).

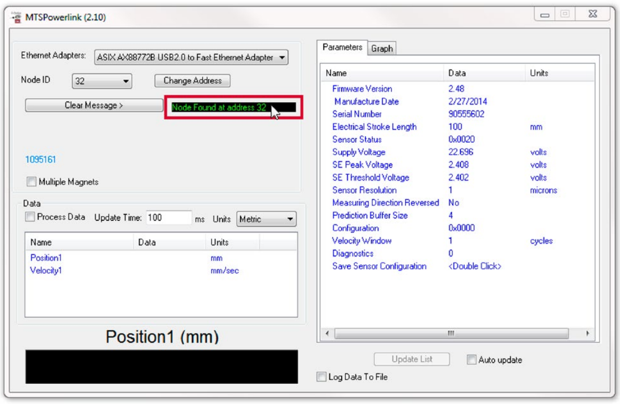


Fig. 53: Node ID found

4. The node ID can be changed by “Change Address”. A window pops up. Fill in the new node address and click “Ok” (Fig. 54).

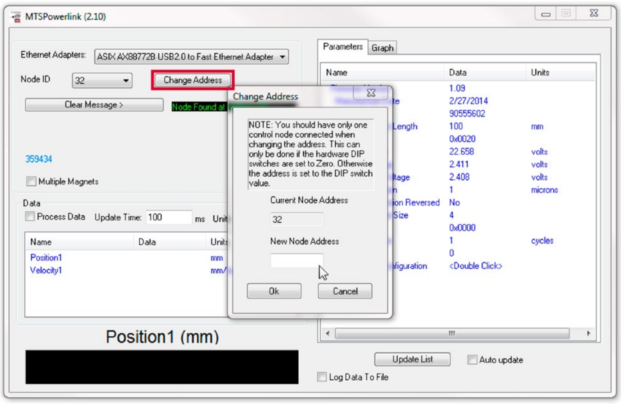


Fig. 54: Choose new node ID

5. An acknowledgement will be displayed after it (Fig. 55).

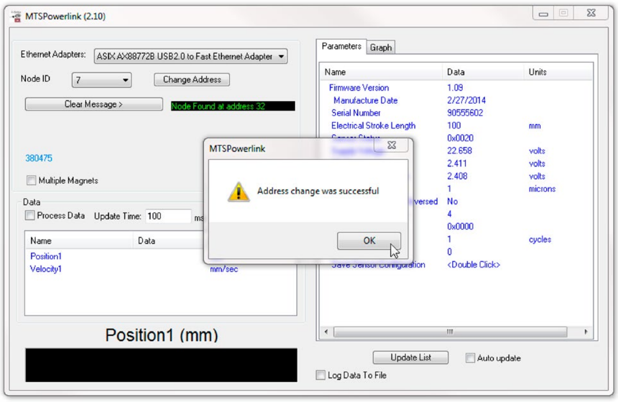


Fig. 55: Address change was successful

6. After software adjustment the sensor needs a hardware reboot to adapt the new node ID. Disconnect the power supply of the sensor and connect the power supply once again.

6.1.4 Process data

☑ Step 1: Network adapter set-up
☑ Step 2: Node ID configuration
☐ **Step 3: Process data**

The tab “Parameters” on the right shows different attributes of the connected sensor (Fig. 56).

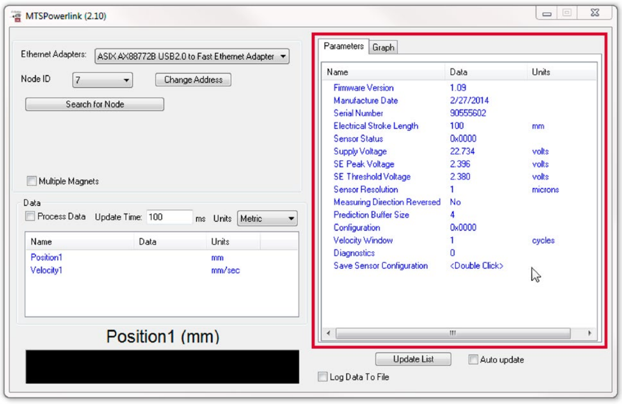


Fig. 56: Sensor parameters

There is also the possibility to show the process data in figures and graphs.
Click on the tab “Graph”, choose an update time and the prefered unit value and activate the checkbox “Process Data”.
The box on the lower left side will show the figures of the magnet's position and the field on the right side will show the process graphically (Fig. 57).

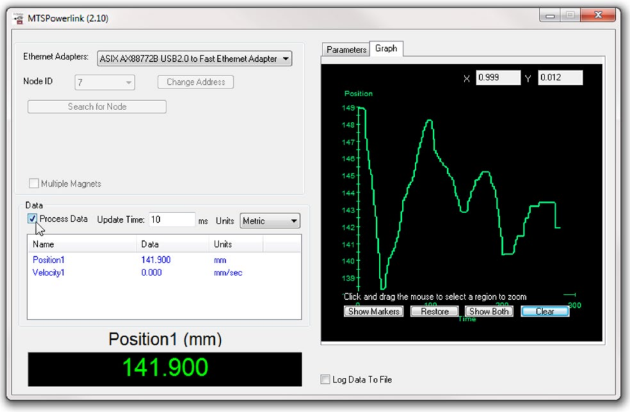


Fig. 57: Process data

6.2 Introduction of "Automation Studio"

The following is a description how to set the node ID of a Temposonic® R-Series sensor with Powerlink interface using "Automation Studio" by B&R (Bernecker + Rainer Industrie-Elektronik Ges.m.b.H.).

6.2.1 Hardware setup

The sensor in this example is configured to node ID 32 (default value) and connected to a control system X20IF1082-2 which is mounted to a control system X20CP3485-1. The screenshot of the hardware setup in "Automation Studio" is shown in Fig. 58.

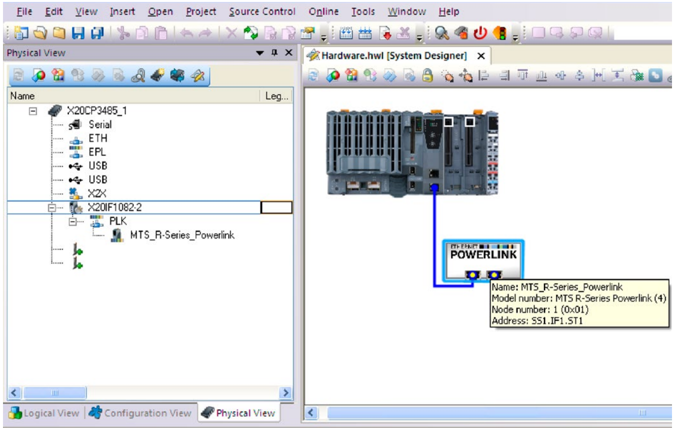


Fig. 58: Hardware setup in "Automation Studio"

6.2.2 Defined data types

To implement a state machine an enumeration type has to be defined that contains all used states (Fig. 59 and Fig. 60).

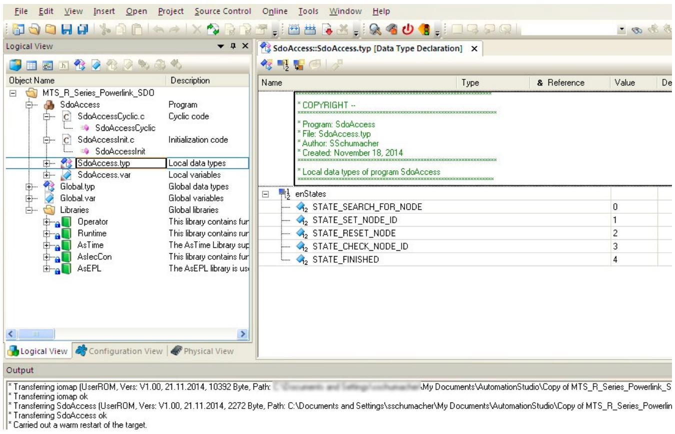


Fig. 59: Hardware setup in "Automation Studio"

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) 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. 60: Defined data types

6.2.3 Used variables

The following local variables are used to change the node ID (Fig. 61).

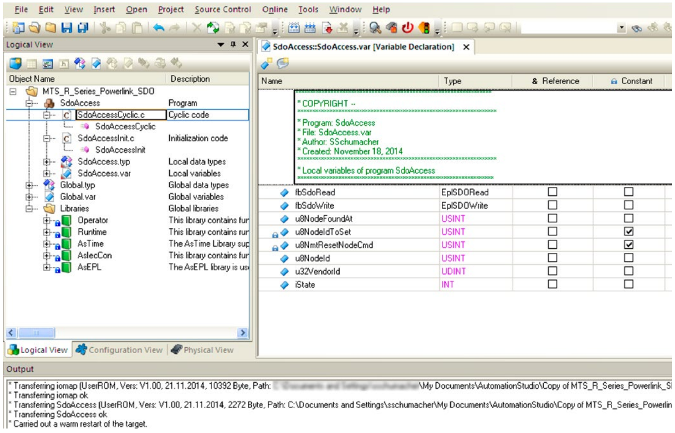


Fig. 61: Screenshot of used variables

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. 62: 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 MTS controlled node 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 (source code on page 36).

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 variable watch, a MTS controlled node has been found at node ID 32 (default node ID when sensors are shipped). The node ID has been successfully set to 1.

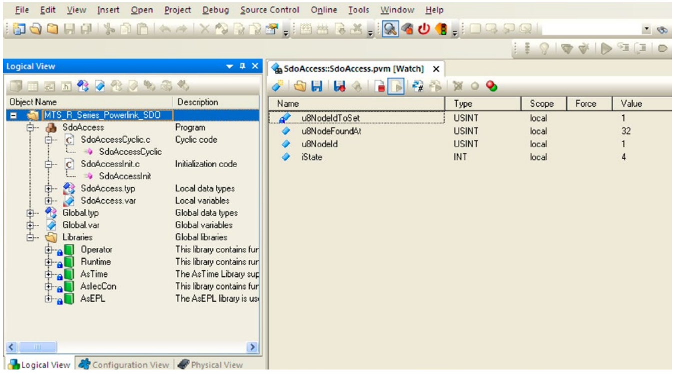


Fig. 63: Variable watch

As shown at the IO-Mapping the sensor is working well using its new node ID.

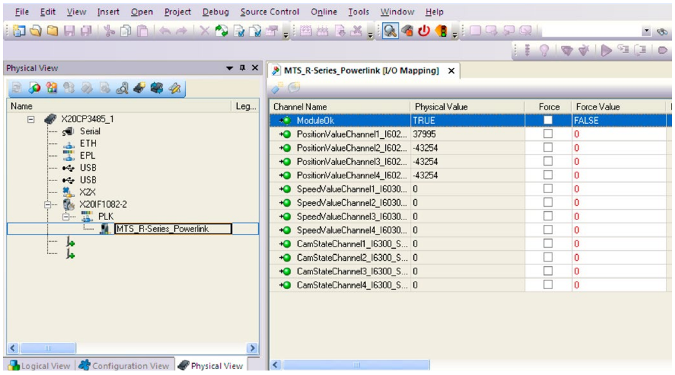


Fig. 64: IO-Mapping of sensor with changed node ID

7. Integration in Automation Studio

7.1 Programming and configuration

NOTICE

Follow the information given in the controller operation manual.

Project integration

The project integration is described below using the example of a B&R (Bernecker + Rainer Industrie-Elektronik Ges.m.b.H.) controller and the "Automation Studio" project planning 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 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 tool. The XDD file is available at www.mtssensors.com.

Importing the Temposonics® position sensor into the project tool

In the main menu "Tools", select the entry "Import Fieldbus Device" as shown in the screenshot (Fig. 65).

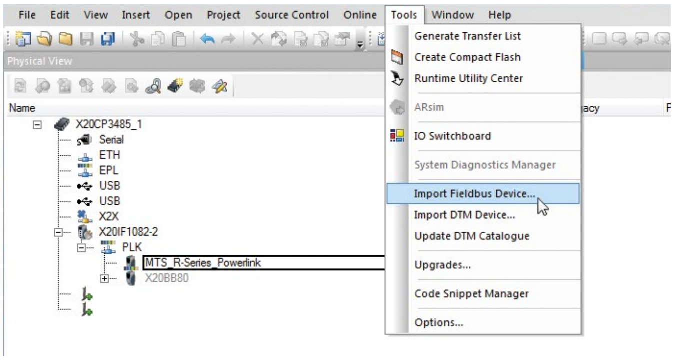


Fig. 65: "Import Fieldbus Device"

Adding Temposonics® position sensor to a network

In the right of the main view is the "Toolbox – Hardware Catalog" (Fig. 66). Choose the sensor in the "Toolbox – Hardware Catalog" and move the sensor via drag and drop in the physical view where the sensor should be integrated in the network (Fig. 67).

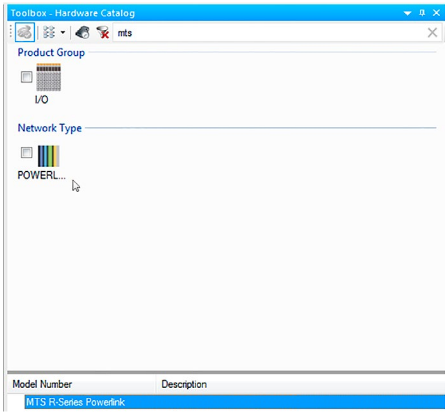


Fig. 66: "Toolbox – Hardware Catalog"

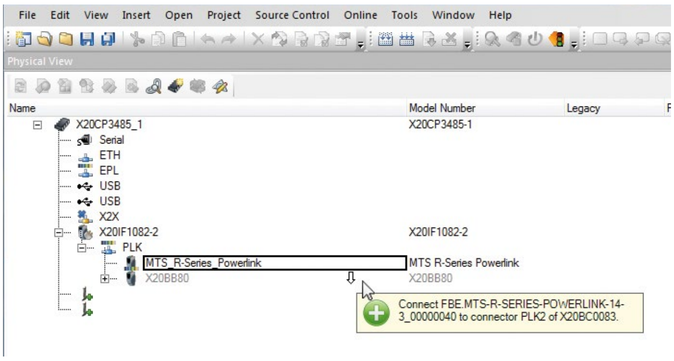


Fig. 67: Integrate sensor in the network

NOTICE
Make sure that the node ID, which is set in the “Automation Studio” project for the inserted sensor, matches the node ID of the sensor. To change the node ID of the sensor see page 30.

I/O Mapping

After completing this configuration the newly added device (MTS Temposonics® R-Series Powerlink) is displayed in the left part of the window (physical view). Select this device with a right click, to open the option “I/O Mapping” (Fig. 68).

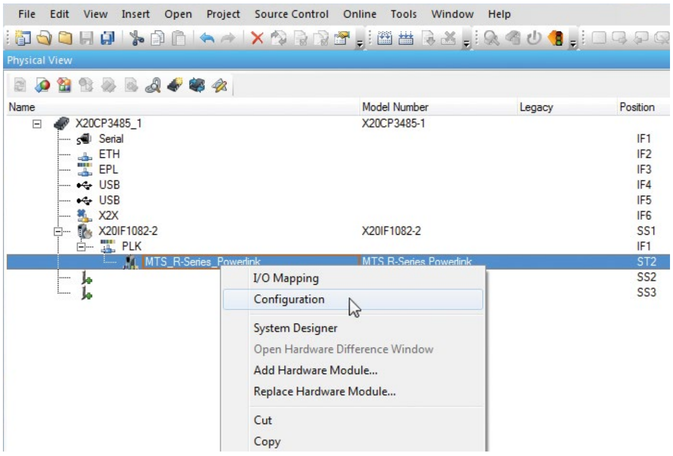


Fig. 68: Open “I/O Mapping”

Configuration

To configure the Temposonics® position sensor, select the MTS Sensors R-Series Powerlink sensor on the left side (physical view) again. The right mouse button takes you to the menu entry “Configuration”. The Powerlink parameters are the following:

Name	Description
Mode	Operating mode of the Powerlink device
Response timeout	For controlled nodes the response time can be adjusted in micro seconds.
Output in PResMN	If this parameter is enabled the output data will be transferred in a global network frame

Fig. 69: Powerlink parameters

NOTICE
For detailed information see controller operation manual.

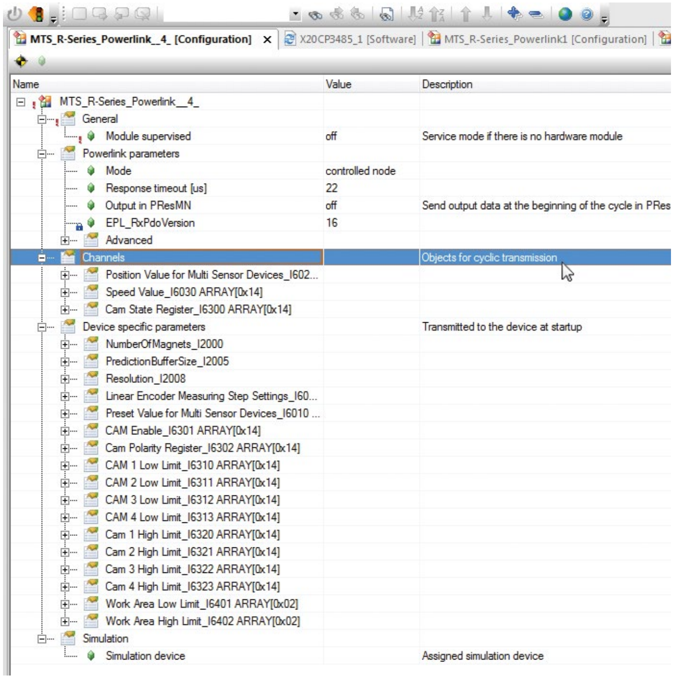


Fig. 70: Configuration

All available data of the sensor are divided in two groups:

- **Channels:**
  Parameters of the sensor, which are transferred cyclically. The position and speed values, which are mapped to the output data are shown. The mapping is fixed and a change is not possible.
- **Device specific parameters:**
  Parameters of the sensor, which are transferred in the startup phase. However, this is only the case if the configuration of the MTS Sensors R-Series Powerlink sensor has been changed, i.e., if the configuration differs from the values in the project tool.

7.2 Communication Segement

Index	Subindex	Name	Object type	PDO mapping	Attribute	Data type	Description
2000		**Number of magnets**	Variable	no	rw	Integer32	Indicates the number of magnets with which the sensor is operated (maximum 4 magnets)
2001		**Measuring direction**	Variable	no	rw	Integer32	Measuring direction forward: Head to rod end Measuring direction backward: Rod end to head
2002		**Velocity window size**	Variable	no	rw	Integer32	Number of position measurements between 2 sampling points for velocity calculation
2003		**Supply voltage counts**	Variable	no	ro	Integer32	Displays the supply voltage. This voltage needs to be divided by 100,000 be in units of volts
2005		**Prediction buffer size**	Variable	no	ro	Integer32	Term which describes the relation between dynamic and resolution
2006		**Firmware version**	Variable	no	ro	Integer32	This object contains the running firmware version
2008		**Resolution**	Variable	no	rw	Unsigned32	Position measurement resolution: 1, 2, 5, 10, 50, 100 µm
6005		**Linear encoder measuring step settings**	Array				The parameter "Linear Encoder Measuring Step Settings" defines the measuring step settings for the position value(s) and the speed value(s) for linear encoders. Mandatory for C2 devices. Only mandatory for linear encoders.
	0	Number of elements	Variable	no	ro	Unsigned8	
	1	Position measuring step	Variable	no	rw	Unsigned32	
	2	Speed measuring step	Variable	no	rw	Unsigned32	
	3	Speed acceleration step 0.1 m/s^2	Variable	no	rw	Unsigned32	
	4	Jerk step	Variable	no	rw	Unsigned32	
6010		**Preset value for multi-sensor devices**	Array				This object supports adaption of the encoder zero point to the mechanical zero point of the system for multi-sensor devices. Mandatory for C2 devices.
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Preset value channel 1	Variable	no	rw	Integer32	
	2	Preset value channel 2	Variable	no	rw	Integer32	
	3	Preset value channel 3	Variable	no	rw	Integer32	
	4	Preset value channel 4	Variable	no	rw	Integer32	
6020		**Position value for multi-sensor devices**	Array				This object defines the output position value for multi-sensor devices. Mandatory for C1 devices.
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Position value channel 1	Variable	default	ro	Integer32	
	2	Position value channel 2	Variable	default	ro	Integer32	
	3	Position value channel 3	Variable	default	ro	Integer32	
	4	Position value channel 4	Variable	default	ro	Integer32	
6030		**Speed value**	Array				This object is only mandatory for multi-sensor encoders (encoder type code 10). Mandatory for C2 devices.
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Speed value channel 1	Variable	default	ro	Integer32	
	2	Speed value channel 2	Variable	default	ro	Integer32	
	3	Speed value channel 3	Variable	default	ro	Integer32	
	4	Speed value channel 4	Variable	default	ro	Integer32	
6200		**Cyclic timer value**	Variable	no	rw	Unsigned16	

Table 1: Index 2000, 2001, 2002, 2003, 2005, 2006, 2008, 6005, 6010, 6020, 6030, 6200

Index	Subindex	Name	Object type	PDO mapping	Attribute	Data type	Description
6300		**Cam state register**	Array				The parameter “Cam state register” defines the status bit of the cam in a cam channel. The status bit set to 1 defines “cam active”. The status bit set to 0 defines “cam inactive”.
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam state channel 1	Variable	default	ro	Unsigned32	
	2	Cam state channel 2	Variable	default	ro	Unsigned32	
	3	Cam state channel 3	Variable	default	ro	Unsigned32	
	4	Cam state channel 4	Variable	default	ro	Unsigned32	
6301		**Cam enable**	Array				The parameter “Cam enable” enables the cam channels. The bit value 1 means “cam active”. The bit value 0 means “cam inactive”.
	0	Number of available channels	Variable	no	rw	Unsigned8	
	1	Cam enable channel 1	Variable	no	rw	Unsigned8	
	2	Cam enable channel 2	Variable	no	rw	Unsigned8	
	3	Cam enable channel 3	Variable	no	rw	Unsigned8	
	4	Cam enable channel 4	Variable	no	rw	Unsigned8	
6302		**Cam polarity register**	Array				If the polarity bit of a cam is set the actual cam state will be inverted.
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam polarity channel 1	Variable	no	rw	Unsigned8	
	2	Cam polarity channel 2	Variable	no	rw	Unsigned8	
	3	Cam polarity channel 3	Variable	no	rw	Unsigned8	
	4	Cam polarity channel 4	Variable	no	rw	Unsigned8	
6310		**Cam 1 low limit**	Array				This object determines the lower limit of position for cam 1.
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam 1 low limit channel 1	Variable	no	rw	Integer32	
	2	Cam 1 low limit channel 2	Variable	no	rw	Integer32	
	3	Cam 1 low limit channel 3	Variable	no	rw	Integer32	
	4	Cam 1 low limit channel 4	Variable	no	rw	Integer32	
6311		**Cam 2 low limit**	Array				This object determines the lower limit of position for cam 2.
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam 2 low limit channel 1	Variable	no	rw	Integer32	
	2	Cam 2 low limit channel 2	Variable	no	rw	Integer32	
	3	Cam 2 low limit channel 3	Variable	no	rw	Integer32	
	4	Cam 2 low limit channel 4	Variable	no	rw	Integer32	
6312		**Cam 3 low limit**	Array				This object determines the lower limit of position for cam 3.
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam 3 low limit channel 1	Variable	no	rw	Integer32	
	2	Cam 3 low limit channel 2	Variable	no	rw	Integer32	
	3	Cam 3 low limit channel 3	Variable	no	rw	Integer32	
	4	Cam 3 low limit channel 4	Variable	no	rw	Integer32	
6313		**Cam 4 low limit**	Array				This object determines the lower limit of position for cam 4.
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam 4 low limit channel 1	Variable	no	rw	Integer32	
	2	Cam 4 low limit channel 2	Variable	no	rw	Integer32	
	3	Cam 4 low limit channel 3	Variable	no	rw	Integer32	
	4	Cam 4 low limit channel 4	Variable	no	rw	Integer32	

Table 2: Index 6300, 6301, 6302, 6310, 6311, 6312, 6313

Index	Subindex	Name	Object type	PDO mapping	Attribute	Data type	Description
6320		**Cam 1 high limit**	Array				This object determines the higher limit of position for cam 1
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam 1 high limit channel 1	Variable	no	rw	Integer32	
	2	Cam 1 high limit channel 2	Variable	no	rw	Integer32	
	3	Cam 1 high limit channel 3	Variable	no	rw	Integer32	
	4	Cam 1 high limit channel 4	Variable	no	rw	Integer32	
6321		**Cam 2 high limit**	Array				This object determines the higher limit of position for cam 2
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam 2 high limit channel 1	Variable	no	rw	Integer32	
	2	Cam 2 high limit channel 2	Variable	no	rw	Integer32	
	3	Cam 2 high limit channel 3	Variable	no	rw	Integer32	
	4	Cam 2 high limit channel 4	Variable	no	rw	Integer32	
6322		**Cam 3 high limit**	Array				This object determines the higher limit of position for cam 3
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam 3 high limit channel 1	Variable	no	rw	Integer32	
	2	Cam 3 high limit channel 2	Variable	no	rw	Integer32	
	3	Cam 3 high limit channel 3	Variable	no	rw	Integer32	
	4	Cam 3 high limit channel 4	Variable	no	rw	Integer32	
6323		**Cam 4 high limit**	Array				This object determines the higher limit of position for cam 4
	0	Number of available channels	Variable	no	ro	Unsigned8	
	1	Cam 4 high limit channel 1	Variable	no	rw	Integer32	
	2	Cam 4 high limit channel 2	Variable	no	rw	Integer32	
	3	Cam 4 high limit channel 3	Variable	no	rw	Integer32	
	4	Cam 4 high limit channel 4	Variable	no	rw	Integer32	

Table 3: Index 6320, 6321, 6322, 6323

Index	Subindex	Name	Object type	PDO mapping	Attribute	Data type	Description
6400		**Area state register**	Array				This object contains the actual area status of the encoder position. If the position is out of range, a bit will be set in the related position line.
	0	Number of available work areas	Variable	no	ro	Unsigned8	
	1	Work area state channel 1	Variable	no	ro	Unsigned8	
	2	Work area state channel 2	Variable	no	ro	Unsigned8	
	3	Work area state channel 3	Variable	no	ro	Unsigned8	
	4	Work area state channel 4	Variable	no	ro	Unsigned8	

Bit								Hex	Description
7	6	5	4	3	2	1	0		
0	0	0	0	0	1	0	0	0x4	If the position is lower than the position value set in object 6401h then bit 2 flags the underflow.
0	0	0	0	0	0	1	0	0x2	If the position is higher than the position value set in object 6402h then bit 1 flags the overflow.
0	0	0	0	0	0	0	1	0x1	If the manufacturer minimum position value or the manufacturer maximum position value (refer to object 650A-module identification) is reached, bit 0 flags “out of range”.

Table 4: Index 6400

Index	Subindex	Name	Object type	PDO mapping	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 flags the underflow of the related work area.
	0	Number of available work areas	Variable	no	ro	Unsigned8	
	1	Low limit work area 1	Variable	no	rw	Integer32	
	2	Low limit work area 2	Variable	no	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 flags the underflow of the related work area.
	0	Number of available work areas	Variable	no	ro	Unsigned8	
	1	High limit work area 1	Variable	no	rw	Integer32	
	2	High limit work area 2	Variable	no	rw	Integer32	

Table 5: Index 6401, 6402

8. Set the LossSoC threshold for a R-Series Powerlink sensor

The following description is an example of changing threshold LossSoC using SDO objects of a R-Series sensor with Powerlink interface.

8.1 Hardware setup

In this example the sensor is configured to node ID 1 and connected to a control system X20IF1082-2, which is mounted to a control system X20CP3485-1. The screenshot of the hardware setup in “Automation Studio” by B&R is shown in Fig. 71.

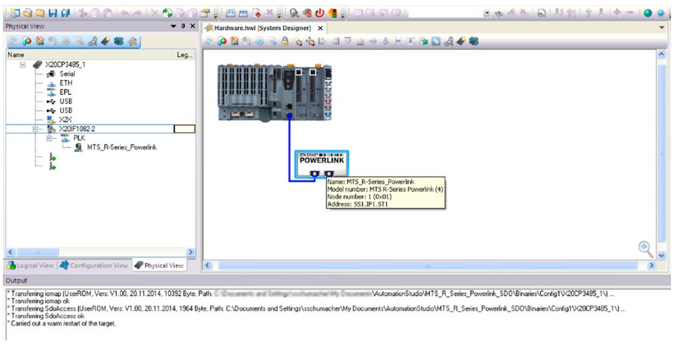


Fig. 71: Hardware setup in “Automation Studio”

8.2 Defined data types

To implement a state machine, an enumeration type has been defined that contains all used states (Fig. 72).

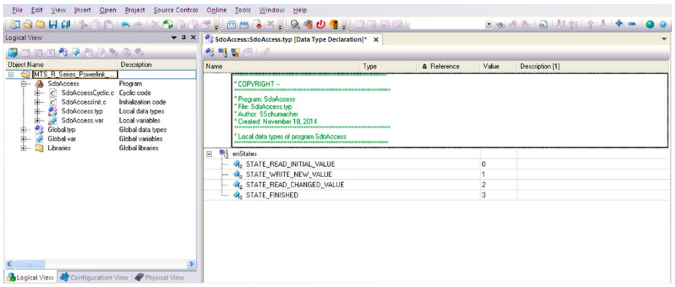


Fig. 72: Enumeration type to implement the used state machine

Name	Description
STATE_READ_INITIAL_VALUE	This is the initial state in this project. In this state PLC reads the current LossSoC threshold from the sensor and stores it to a local variable.
STATE_WRITE_NEW_VALUE	PLC enters into this state when the operations of STATE_READ_INITIAL_VALUE have been finished. The LossSoC threshold value is set to the given value.
STATE_READ_CHANGED_VALUE	PLC enters into this state when the operations of STATE_WRITE_NEW_VALUE have been finished. The current LossSoC threshold value is read by the PLC and stored to a local variable here.
STATE_FINISHED	PLC enters into this state when the operations of STATE_READ_CHANGED_VALUE have been finished.

Fig. 73: Description of enStates

8.3 Used variables

The following local variables are used to read and write values from / to the SDO objects (Fig. 74).

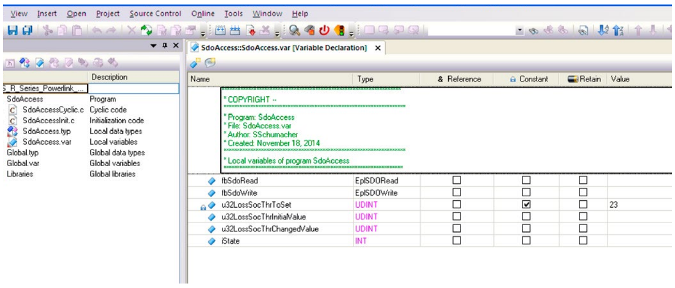


Fig. 74: Variables used

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.
u32LossSocThrToSet	Constant unsigned 32 bit integer which represents the LossSoC threshold which should be set. In this example the threshold is set to 23. This value is recommended for Powerlink networks with media redundancy.
u32LossSocThrInitialValue	Unsigned 32 bit integer which is used to store the initial value of sensors LossSoC threshold.
u32LossSocThrChangedValue	Unsigned 32 bit integer which is used to store the value of sensors LossSoC threshold after its change.
iState	Integer variable which represents the current state of the implemented state machine.

Fig. 75: Description of variables

8.4 Program executed by PLC once after start-up

This program just initializes the state of the implemented state machine (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)
{
	//initialize current state
	iState = STATE_READ_INITIAL_VALUE;
}
```

8.5 Program executed by PLC cyclically

This program implements the state machine and accesses the LossSoC threshold of R-Series Powerlink (source code below).

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_READ_INITIAL_VALUE:
				fbSdoRead.pDevice	= "SS1.IF1";	//interface sensor is connected to
				fbSdoRead.node		= 1;		//node id of sensor
				fbSdoRead.index		= 0x1c0b;	//index of LossSoC Threshold
				fbSdoRead.subindex	= 3;		//subindex of LossSoC Threshold
				fbSdoRead.pData		= &u32LossSocThrInitialValue;	//variable to store value to
				fbSdoRead.datalen	= sizeof(u32LossSocThrInitialValue);	//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;
			case STATE_WRITE_NEW_VALUE:
				fbSdoWrite.pDevice	= "SS1.IF1";	//interface sensor is connected to
				fbSdoWrite.node		= 1;		//node id of sensor
				fbSdoWrite.index	= 0x1c0b;	//index of LossSoC Threshold
				fbSdoWrite.subindex	= 3;		//subindex of LossSoC Threshold
				fbSdoWrite.pData	= &u32LossSocThrToSet;	//variable containing value to set
				fbSdoWrite.datalen	= sizeof(u32LossSocThrToSet);	//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_READ_CHANGED_VALUE:
				fbSdoRead.pDevice	= "SS1.IF1";	//interface sensor is connected to
				fbSdoRead.node		= 1;		//node id of sensor
				fbSdoRead.index		= 0x1c0b;	//index of LossSoC Threshold
				fbSdoRead.subindex	= 3;		//subindex of LossSoC Threshold
				fbSdoRead.pData		= &u32LossSocThrChangedValue;	//variable to store value to
				fbSdoRead.datalen	= sizeof(u32LossSocThrChangedValue);	//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);
}
```

8.6 Variable watch after successful execution of the implemented state machine

As shown in the variable watch the LossSoC threshold value has been changed from 15 (default value) to 23 (recommended value for Powerlink networks with media redundancy).

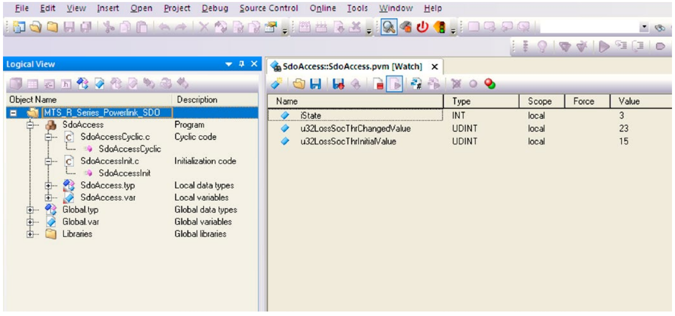


Fig. 76: Variable watch

9. Maintenance and troubleshooting

9.1 Error conditions, troubleshooting

See chapter "5. Operation" on page 30.

9.2 Maintenance

The sensor is maintenance-free.

9.3 Repair

Repairs of the sensor may be performed only by MTS Sensors or a repair facility explicitly authorized by MTS Sensors.

9.4 List of spare parts

No spare parts are available for this sensor.

9.5 Transport and storage

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

10. Removal from service / dismantling

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

11. Technical data

11.1 Technical data of Temposonics® RP

Output	
Interface	Ethernet POWERLINK
Data protocol	POWERLINK V2 according to IEEE 802.3
Measured value	Position, velocity / option: multi-position measurement (2…4 positions)
Measurement parameters	
Resolution	1 µm, 2 µm, 5 µm, 10 µm, 50 µm or 100 µm (selectable)
Cycle time	1.0 ms up to 2400 mm stroke length, 2.0 ms up to 4800 mm stroke length, 4.0 ms up to 5080 mm stroke length
Linearity [8]	< ±0.01 % F.S. (minimum ±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…+75 °C (−40…+167 °F)
Humidity	90 % rel. humidity, no condensation
Ingress protection [9]	IP65 (if mating connectors are correctly fitted)
Shock test	100 g (single shock), IEC standard 60068-2-27
Vibration test	15 g (10…2000 Hz), IEC standard 60068-2-6 (resonance frequencies excluded)
EMC test	Electromagnetic immunity EN 61000-6-2 Electromagnetic emission EN 61000-6-3 The sensor meets the requirements of the EC directives and is marked with CE
Magnet movement velocity	Any (with magnet slider: max. 10 m/s)
Design / Material	
Sensor electronics housing	Aluminum
Sensor profile	Aluminum
Stroke length	25…5080 mm (1…200 in.)
Mechanical mounting	
Mounting position	Any
Mounting instruction	Please consult the technical drawings
Electrical connection	
Connection type	2 × M12 female connector (4 pin), 1 × M8 male connector (4 pin)
Operating voltage [10]	+24 VDC (−15 / +20 %); UL Recognition requires an approved power supply with energy limitation (UL 61010-1), or Class 2 rating according to the National Electrical Code (USA) / Canadian Electrical Code.
Ripple	≤ 0.28 V_{PP}
Current consumption [10]	110 mA typical
Dielectric strength	500 VDC (DC ground to machine ground)
Polarity protection	Up to −30 VDC
Overvoltage protection	Up to 36 VDC

8/ With position magnet # 252 182
9/ The IP rating is not part of the UL approval
10/ Power supply must be able to provide current of 1A for power up process

11.2 Technical data of Temposonics® RH

Output	
Interface	Ethernet POWERLINK
Data protocol	POWERLINK V2 according to IEEE 802.3
Measured value	Position, velocity / option: multi-position measurement (2…4 positions)
Measurement parameters	
Resolution	1 µm, 2 µm, 5 µm, 10 µm, 50 µm or 100 µm (selectable)
Cycle time	1.0 ms up to 2400 mm stroke length, 2.0 ms up to 4800 mm stroke length, 4.0 ms up to 7620 mm stroke length
Linearity [11]	< ±0.01 % F.S. (minimum ±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…+75 °C (−40…+167 °F)
Humidity	90 % rel. humidity, no condensation
Ingress protection [12]	IP67 (if mating connectors are correctly fitted)
Shock test	100 g (single shock), IEC standard 60068-2-27
Vibration test	15 g (10…2000 Hz), IEC standard 60068-2-6 (resonance frequencies excluded)
EMC test	Electromagnetic immunity EN 61000-6-2 Electromagnetic emission EN 61000-6-3 The sensor meets the requirements of the EC directives and is marked with CE
Operating pressure	350 bar (5076 psi); Peak: 700 bar (10 007 psi); RH-J: Peak 800 bar (13053.4 psi)
Magnet movement velocity	Any
Design / Material	
Sensor electronics housing	Aluminum
Sensor flange	Stainless steel 1.4305 (AISI 303) / RH-J: Stainless steel 1.4305 (AISI 303)
Sensor rod	Stainless steel 1.4306 (AISI 304L) / RH-J: Stainless steel 1.4301 (AISI 304)
Stroke length	25…7620 mm (1…300 in.)
Mechanical mounting	
Mounting position	Any
Mounting instruction	Please consult the technical drawings
Electrical connection	
Connection type	2 × M12 female connector (4 pin), 1 × M8 male connector (4 pin)
Operating voltage [13]	+24 VDC (−15 / +20 %); UL Recognition requires an approved power supply with energy limitation (UL 61010-1), or Class 2 rating according to the National Electrical Code (USA) / Canadian Electrical Code.
Ripple	≤ 0.28 V_{PP}
Current consumption [13]	110 mA typical
Dielectric strength	500 VDC (DC ground to machine ground)
Polarity protection	Up to −30 VDC
Overvoltage protection	Up to 36 VDC

11/ With position magnet # 251 416-2
12/ The IP rating is not part of the UL approval
13/ Power supply must be able to provide current of 1 A for power up process

11.3 Technical data of Temposonics® RD4

Output	
Interface	Ethernet POWERLINK
Data protocol	POWERLINK V2 according to IEEE 802.3
Measured value	Position, velocity / option: multi-position measurement (2…4 positions)
Measurement parameters	
Resolution	1 µm, 2 µm, 5 µm, 10 µm, 50 µm or 100 µm (selectable)
Cycle time	1.0 ms up to 2400 mm stroke length, 2.0 ms up to 4800 mm stroke length, 4.0 ms up to 5080 mm stroke length
Linearity [14]	< ±0.02 % F.S. (minimum ±50 µm) [15]
Repeatability	< ±0.001 % F.S. (minimum ±2.5 µm) typical
Hysteresis	< 4 µm typical
Operating conditions	
Operating temperature electronics	−40…+75 °C (−40…+167 °F)
Operating temperature rod	−40…+100 °C (−40…+212 °F)
Humidity	90 % rel. humidity, no condensation
Ingress protection for sensor electronics [16]	IP67
Ingress protection sensor rod with connecting cable for side cable entry [16]	IP65
Ingress protection sensor rod with single wires and flat connector with bottom cable entry [16]	IP30
Shock test	100 g (single shock), IEC standard 60068-2-27
Vibration test	10 g (10…2000 Hz), IEC standard 60068-2-6 (resonance frequencies excluded)
EMC test [17]	Electromagnetic immunity EN 61000-6-2 Electromagnetic emission EN 61000-6-3
Operating pressure	350 bar (5076 psi); Peak: 700 bar (10 152 psi)
Magnet movement velocity	Any
Design / Material	
Sensor electronics housing	Aluminum
Sensor flange	Stainless steel 1.4305 (AISI 303)
Sensor rod	Stainless steel 1.4306 (AISI 304L)
Stroke length	25…5080 mm (1…200 in.)
Mechanical mounting	
Mounting position	Any
Mounting instruction	Please consult the technical drawings
Electrical connection	
Connection type	2 × M12 female connector (4 pin), 1 × M8 male connector (4 pin)
Operating voltage [18]	+24 VDC (−15 / +20 %)
Ripple	≤ 0.28 V_{PP}
Current consumption [18]	110 mA typical
Dielectric strength	500 VDC (DC ground to machine ground)
Polarity protection	Up to −30 VDC
Overvoltage protection	Up to 36 VDC

14/ With position magnet # 251 416-2
15/ For pressure fit flange »S« the linearity deviation can be higher in the first 30 mm (1.2 in.) of stroke length
16/ The IP rating is not part of the UL approval
17/ Sensor rod and connecting cable have to be mounted in a metal housing (e.g. in a cylinder)
18/ Power supply must be able to provide current of 1 A for power up process

11.4 Technical data of Temposonics® RF

Output	
Interface	Ethernet POWERLINK
Data protocol	POWERLINK V2 according to IEEE 802.3
Measured value	Position, velocity / option: multi-position measurement (2…4 positions)
Measurement parameters	
Resolution	1 µm, 2 µm, 5 µm, 10 µm, 50 µm or 100 µm (selectable)
Cycle time	1.0 ms up to 2400 mm stroke length, 2.0 ms up to 4800 mm stroke length, 4.0 ms up to 7620 mm stroke length
Linearity [19]	< ±0.02 % F.S. (minimum ±100 µm)
Repeatability	< ±0.001 % F.S. (minimum ±2.5 µm) typical
Hysteresis	< 4 µm typical
Operating conditions	
Operating temperature	−40…+75 °C (−40…+167 °F)
Humidity [20]	90 % rel. humidity, no condensation
Ingress protection [21]	IP30 (IP65 rating only for professional mounted guide pipe and if mating connectors are correctly fitted)
Shock test	100 g (single shock), IEC standard 60068-2-27
Vibration test	5 g (10…150 Hz), IEC standard 60068-2-6 (resonance frequencies excluded)
EMC test	Electromagnetic immunity EN 61000-6-2 Electromagnetic emission EN 61000-6-3 The sensor meets the requirements of the EC directives and is marked with CE [22]
Magnet movement velocity	Any
Design / Material	
Sensor electronics housing	Aluminum
Sensor flange	Stainless steel 1.4305 (AISI 303)
Sensor rod	Stainless steel conduct with PTFE coating
Stroke length	150…10,060 mm (6…396 in.)
Mechanical mounting	
Mounting position	Any
Mounting instruction	Please consult the technical drawings
Electrical connection	
Connection type	2 × M12 female connector (4 pin), 1 × M8 male connector (4 pin)
Operating voltage [23]	+24 VDC (−15 / +20 %)
Ripple	≤ 0.28 V_{PP}
Current consumption [23]	110 mA typical
Dielectric strength	500 VDC (DC ground to machine ground)
Polarity protection	Up to −30 VDC
Overvoltage protection	Up to 36 VDC

19/ With position magnet # 251 416-2
20/ For professional mounted guide pipe and if mating connectors are correctly fitted
21/ The IP rating is not part of the UL approval
22/ The conformity is fulfilled assumed the wave guide of the sensor is embedded in an EMC-sealed and grounded housing
23/ Power supply must be able to provide current of 1 A for power up process

12. Appendix

MTS SENSORS

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 / 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

USA
MTS Systems Corporation
Sensors Division
3001 Sheldon Drive
Cary, N.C. 27513, USA
Tel. +1 919 677-0100
Fax +1 919 677-0200
info.us@mtssensors.com
www.mtssensors.com

GERMANY
MTS Sensor Technologie
GmbH & Co.KG
Auf dem Schüffel 9
58513 Lüdenscheid, Germany
Tel. +49-23 51-95 87 0
Fax. +49-23 51-5 64 91
info.de@mtssensors.com
www.mtssensors.com

JAPAN
MTS Sensors Technology Corp.
737 Aihara-machi,
Machida-shi,
Tokyo 194-0211, Japan
Tel. +81 42 775-3838
Fax +81 42 775-5512
info.jp@mtssensors.com
www.mtssensors.com

UNITED STATES
MTS Systems Corporation
Sensors Division
3001 Sheldon Drive
Cary, N.C. 27513
Phone: +1 919 677-0100
E-mail: info.us@mtssensors.com

GERMANY
MTS Sensor Technologie
GmbH & Co. KG
Auf dem Schüffel 9
58513 Lüdenscheid
Phone: +49 2351 9587-0
E-mail: info.de@mtssensors.com

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

FRANCE
Branch Office
Phone: +33 1 58 4390-28
E-mail: info.fr@mtssensors.com

GREAT BRITAIN
Branch Office
Phone: +44 79 44 15 03 00
E-mail: info.uk@mtssensors.com

CHINA
Branch Office
Phone: +86 21 6485 5800
E-mail: info.cn@mtssensors.com

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

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