# Temposonics®

Magnetostrictive Linear Position Sensors

**Temposonics® R-Series V PROFINET IO RT & IRT**
Operation Manual

THE NEW GENERATION

**Temposonics® R-Series V Profinet RT & IRT**
Operation Manual

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# 1. Introduction

## 1.1 Purpose and use of this manual

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

The content of this technical documentation and of its 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 pictogram defined below.

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

# 2. Safety instructions

## 2.1 Intended use

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

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

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

## 2.2 Foreseeable misuse

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

**Do not alter the sensor afterwards.**
➔ **The sensor might be damaged.**
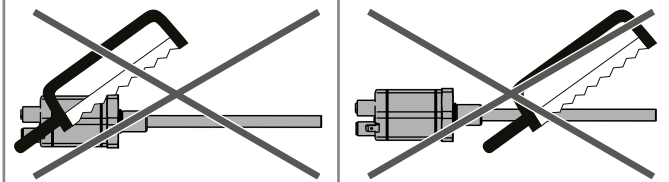


**Do not step on the sensor.**
➔ **The sensor might be damaged.**
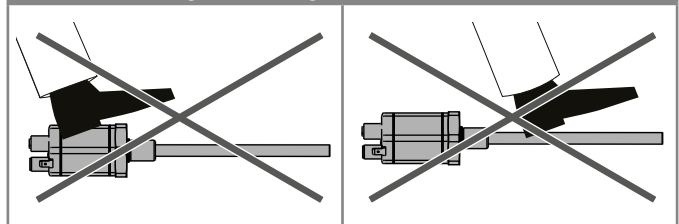
## 2.3 Installation, commissioning and operation

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

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

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

## 2.4 Safety instructions for use in explosion-hazardous areas

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

## 2.5 Warranty

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

## 2.6 Return

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

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

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

## 3. Identification

### 3.1 Order code of Temposonics® RP5

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

| a | Sensor model |
|---|---|
| R P 5 | Profile |

| b | Design |
|---|---|
| G | Magnet slider backlash free (part no. 253 421), suitable for internal linearization |
| L | Block magnet L (part no. 403 448) |
| M | U-magnet OD33 (part no. 251 416-2), suitable for internal linearization |
| N | Magnet slider longer ball-jointed arm (part no. 252 183), suitable for internal linearization |
| O | No position magnet |
| S | Magnet slider joint at top (part no. 252 182), suitable for internal linearization |
| V | Magnet slider joint at front (part no. 252 184), suitable for internal linearization |

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

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

| Standard stroke length (mm) | Ordering steps |
|---|---|
| 25… 500 mm | 25 mm |
| 500…2500 mm | 50 mm |
| 2500…5000 mm | 100 mm |
| 5000…6350 mm | 250 mm |

| X X X . X U | 001.0…250.0 in. |
|---|---|

| Standard stroke length (in.) | Ordering steps |
|---|---|
| 1… 20 in. | 1.0 in. |
| 20…100 in. | 2.0 in. |
| 100…200 in. | 4.0 in. |
| 200…250 in. | 10.0 in. |

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

| e | Number of magnets |
|---|---|
| X X | 01…30 position(s) (1…30 magnet(s)) |

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

| g | System |
|---|---|
| 1 | Standard |

| h | Output |
|---|---|
| U 4 0 2 | PROFINET RT & IRT, position and velocity, MTS profile (1…30 position(s)) |
| U 4 0 1 | PROFINET RT & IRT, position and velocity, encoder profile (1 position) |
| U 4 1 2 | PROFINET RT & IRT, position and velocity, MTS profile, internal linearization (1…30 position(s)) |
| U 4 1 1 | PROFINET RT & IRT, position and velocity, encoder profile, internal linearization (1 position) |

**NOTICE**

- Select the MTS profile (U402 or U412) in h "Output" for multi-position measurement.
- For the RP5, the magnet selected in b "Design" is included in the scope of delivery. Specify the number of magnets for your application. For multi-position measurements with more than 1 magnet, order the other magnets separately.
- The number of magnets is limited by the stroke length. The minimum allowed distance between magnets (i.e. front face of one to the front face of the next one) is 75 mm (3 in.).
- Use magnets of the same type for multi-position measurement, e.g. 2 × U-magnet (part no. 251 416-2).
- If the option for internal linearization (U411, U412) in h "Output" is chosen, select a suitable magnet.

## 3.2 Order code of Temposonics® RH5

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

| a | Sensor model |
|---|---|
| R H 5 | Rod |

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

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

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

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

| X X X . X U | 001.0…300.0 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. |

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

| e | Number of magnets |
|---|---|
| X X | 01…30 position(s) (1…30 magnet(s)) |

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

| g | System |
|---|---|
| 1 | Standard |

| h | Output |
|---|---|
| U 4 0 2 | PROFINET RT & IRT, position and velocity, MTS profile (1…30 position(s)) |
| U 4 0 1 | PROFINET RT & IRT, position and velocity, encoder profile (1 position) |
| U 4 1 2 | PROFINET RT & IRT, position and velocity, MTS profile, internal linearization (1…30 position(s)) |
| U 4 1 1 | PROFINET RT & IRT, position and velocity, encoder profile, internal linearization (1 position) |

> **NOTICE**
>
> - Select the MTS profile (U402 or U412) in h "Output" for multi-position measurement.
> - Specify the number of magnets for your application and order the magnets separately.
> - The number of magnets is limited by the stroke length. The minimum allowed distance between magnets (i.e. front face of one to the front face of the next one) is 75 mm (3 in.).
> - Use magnets of the same type for multi-position measurement, e.g. 2 × U-magnet (part no. 251 416-2).
> - If the option for internal linearization (U411, U412) in h "Output" is chosen, select a suitable magnet.
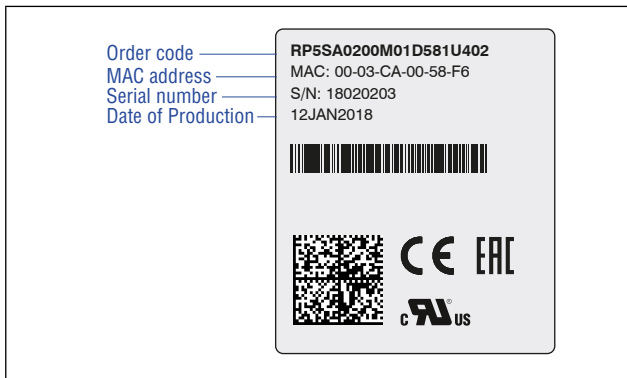
### 3.3 Nameplate



Order code —— **RP5SA0200M01D581U402**
MAC address —— MAC: 00-03-CA-00-58-F6
Serial number —— S/N: 18020203
Date of Production —— 12JAN2018

*Fig. 1: Example of nameplate of a R-Series V RP5 sensor with PROFINET output*

### 3.4 Approvals

• CE certified
• EAC certified
• PI certified
• UL certified

### 3.5 Scope of delivery

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

**RH5 (rod sensor):**
• RH5-B: Base unit, 3 socket screws M4
• RH5-J/M/S/T: Sensor, O-ring

# 4. Product description and commissioning

## 4.1 Functionality and system design

### Product designation
• Position sensor Temposonics® R-Series Ⅴ

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

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

### Output signal
• PROFINET RT & IRT

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

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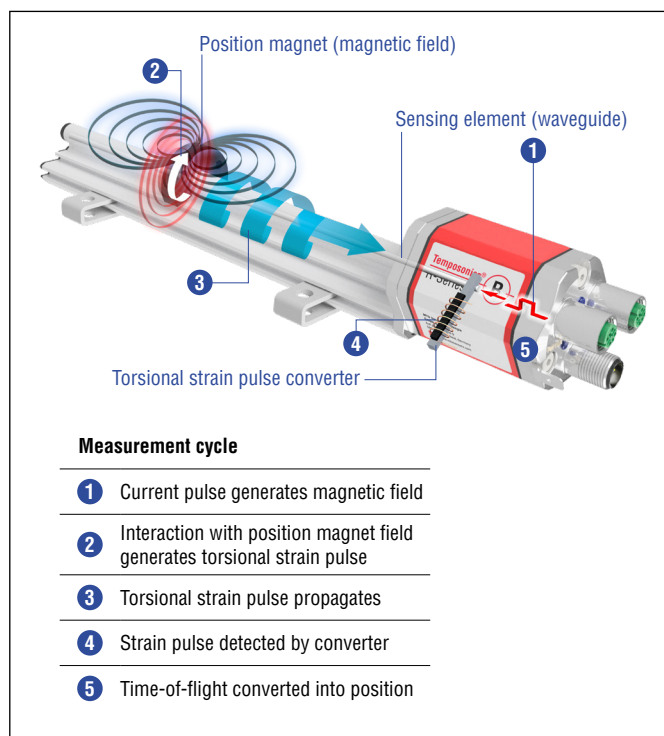


*Fig. 2: Time-based magnetostrictive position sensing principle*

### Modular mechanical and electronic construction
• The sensor rod or profile protects the inner sensor element.
• The sensor electronics housing, a rugged aluminum construction, contains the complete electronic interface with active signal conditioning. 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.
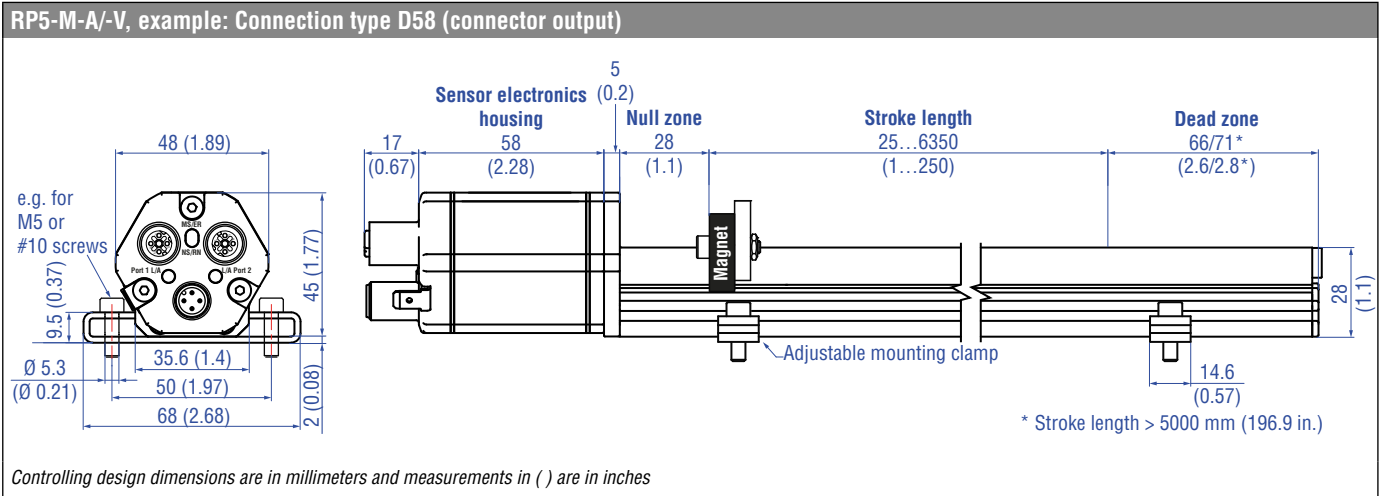
## 4.2 Styles and installation of Temposonics® RP5

### RP5-M-A/-V, example: Connection type D58 (connector output)



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

Fig. 3: Temposonics® RP5 with U-magnet

### Installation of RP5

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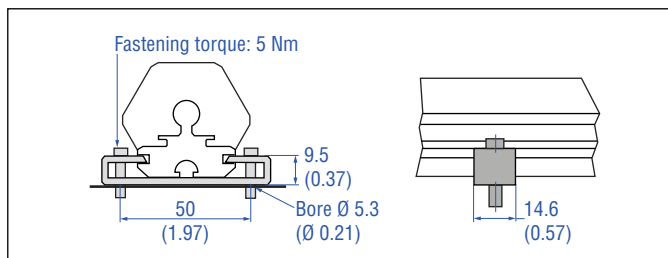


Fig. 4: Mounting clamps (part no. 400 802) with cylinder screw M5×20

### Alternative:

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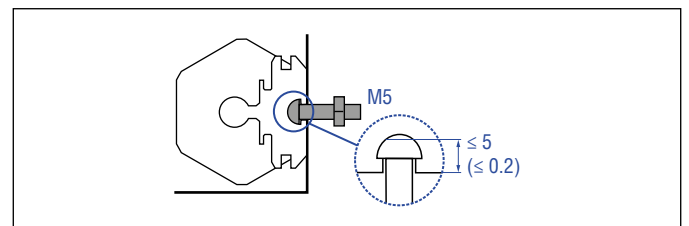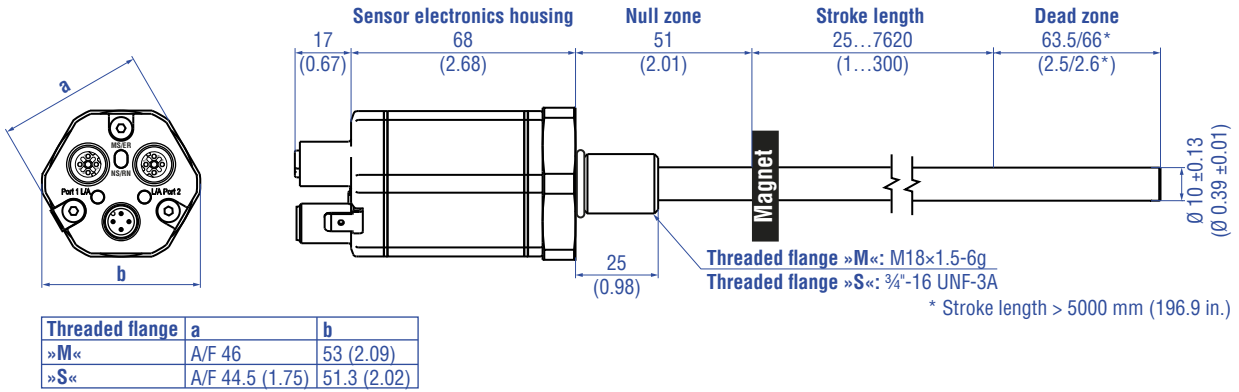


Fig. 5: T-slot nut M5 (part no. 401 602)

### NOTICE

Take care to mount the sensor in an axially parallel position to avoid damage to magnet and sensor.
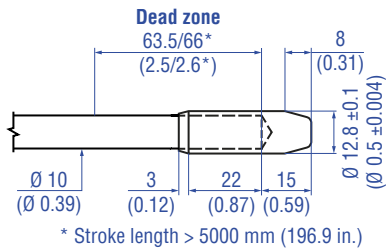
### 4.3 Styles and installation of Temposonics® RH5

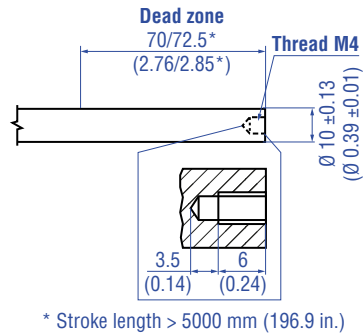**RH5-M/S-A/-V – RH5 with threaded flange M18×1.5-6g or ¾"-16 UNF-3A, example: Connection type D58 (connector output)**



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

Threaded flange »M«: M18×1.5-6g
Threaded flange »S«: ¾"-16 UNF-3A

\* Stroke length > 5000 mm (196.9 in.)

**RH5-T-A/-V – RH5 with threaded flange ¾"-16 UNF-3A with raised-face, example: Connection type D58 (connector output)**



Threaded flange »T«: ¾"-16 UNF-3A

\* Stroke length > 5000 mm (196.9 in.)
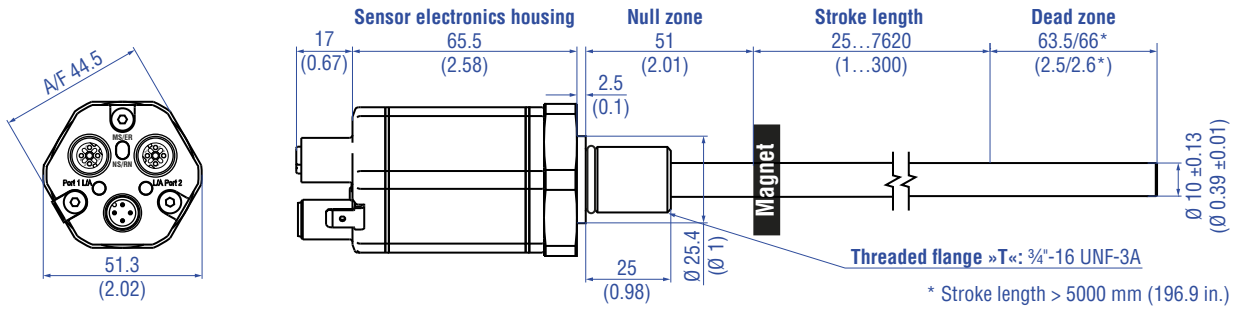
**Mechanical option »B«: Bushing on rod end for threaded flange M18×1.5-6g or ¾"-16 UNF-3A**



\* Stroke length > 5000 mm (196.9 in.)

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



\* Stroke length > 5000 mm (196.9 in.)

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

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

| RH5-J-A/-V – RH5 with threaded flange M22×1.5-6g and Ø 12.7 mm rod, example: Connection type D58 (connector output) |
|---|

A/F 46

53
(2.09)

| Sensor electronics housing | | Null zone | Stroke length | Dead zone |
|---|---|---|---|---|
| 17 (0.67) | 68 (2.68) | 51 (2.01) | 25…5900 (1…232) | 73.6 (2.9) |

Magnet

Ø 12.7 ±0.13 (Ø 0.5 ±0.01)

25
(0.98)

**Threaded flange »J«: M22×1.5-6g**
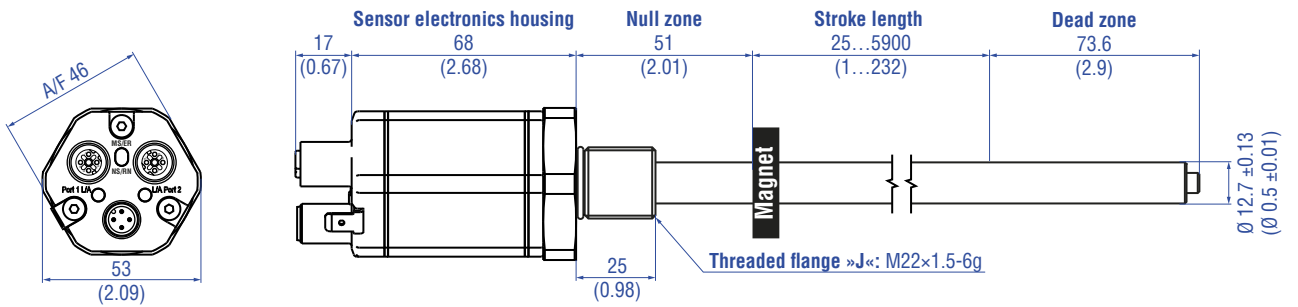
| RH5-B-A/-V – RH5 base unit (only for replacement), example: Connection type D58 (connector output) |
|---|

48
(1.89)

| Sensor electronics housing | | Null zone | Stroke length | Dead zone |
|---|---|---|---|---|
| 17 (0.67) | 58 (2.28) | 61 (2.4) | 25…7620 (1…300) | 52/54/57** (2.05/2.13/2.24)** |

** Stroke length 25…1575 (1…62): 52 (2.05) dead zone
Stroke length 1576…5000 (62.05…196.9): 54 (2.13) dead zone
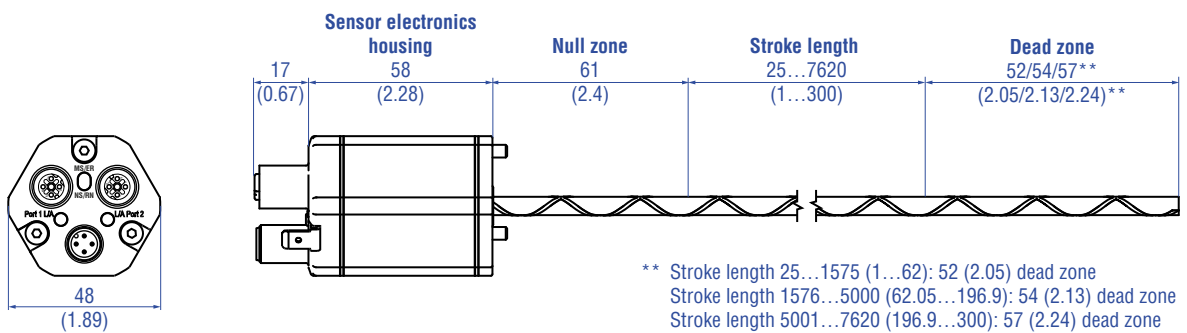Stroke length 5001…7620 (196.9…300): 57 (2.24) dead zone

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

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

## Installation of RH5 with threaded flange

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



**Fastening torque:**
RH5-M: 65 Nm
RH5-S: 50 Nm
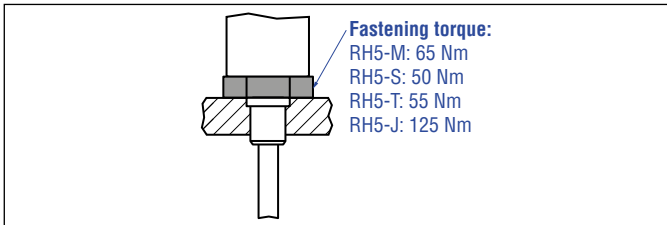RH5-T: 55 Nm
RH5-J: 125 Nm

*Fig. 8: Mounting example of threaded flange*

## Installation in a fluid cylinder

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

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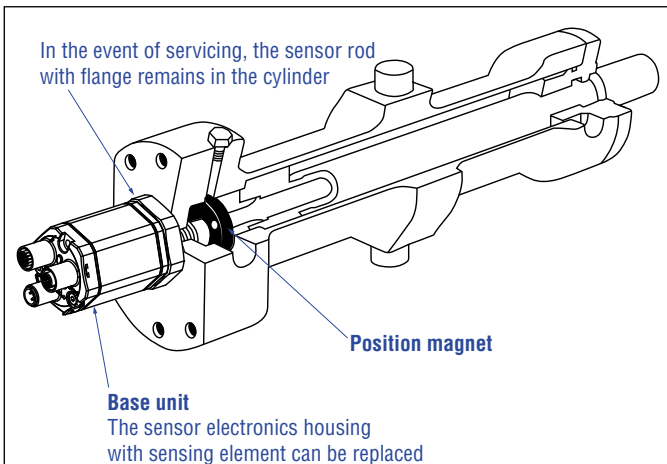


In the event of servicing, the sensor rod with flange remains in the cylinder

**Position magnet**

**Base unit**
The sensor electronics housing with sensing element can be replaced

*Fig. 9: Sensor in cylinder*

## Hydraulics sealing

There are two ways to seal the flange contact surface (Fig. 10):
1. A sealing by using an O-ring (e.g. 22.4 × 2.65 mm (0.88 × 0.1 in.), 25.07 × 2.62 mm (0.99 × 0.1 in.)) in a cylinder bottom groove.
2. A sealing by using an O-ring in the undercut.
   For threaded flange (¾"-16 UNF-3A):
   O-ring 16.4 × 2.2 mm (0.65 × 0.09 in.) (part no. 560 315)
   For threaded flange (M18×1.5-6g):
   O-ring 15.3 × 2.2 mm (0.60 × 0.09 in.) (part no. 401 133)
   For threaded flange (M22×1.5-6g):
   O-ring 19.2 × 2.2 mm (0.76 × 0.09 in.) (part no. 561 337)

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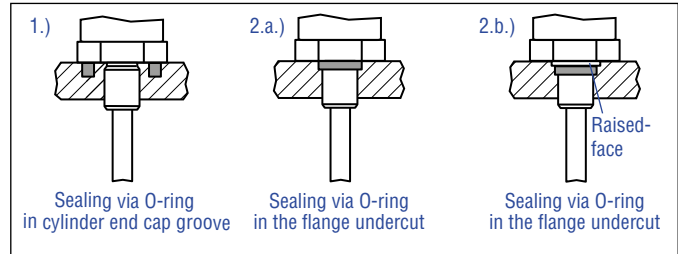


1.) Sealing via O-ring in cylinder end cap groove

2.a.) Sealing via O-ring in the flange undercut

2.b.) Raised-face — Sealing via O-ring in the flange undercut

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

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

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



Pitch diameter

This dimension applies when tap drill cannot pass through entire boss.

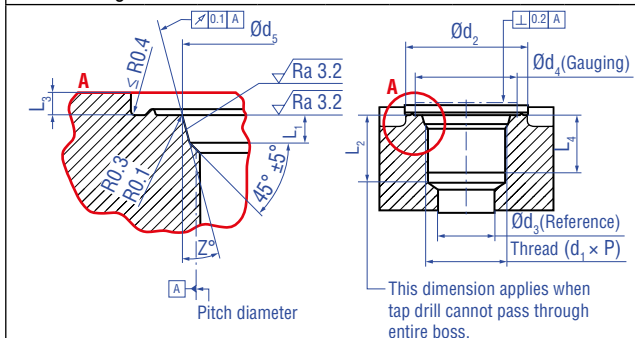*Controlling design dimensions are in millimeters*

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

### 4.4 Magnet installation

**Typical use of magnets**

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

*Fig. 12: Typical use of magnets*

**Mounting ring magnets, U-magnets & block magnets**
Install the magnet using non-magnetic material for mounting device, screws, spacers etc.. The magnet must not grind on the sensor rod. Alignment errors are compensated via the air gap.
• Permissible surface pressure: Max. 40 N/mm² (only for ring magnets and U-magnets)
• Fastening torque for M4 screws: 1 Nm; use washers, if necessary
• Minimum distance between position magnet and any magnetic material has to be 15 mm (0.6 in.) (Fig. 15).
• If no other option exists and magnetic material is used, observe the specified dimensions (Fig. 15).

### NOTICE

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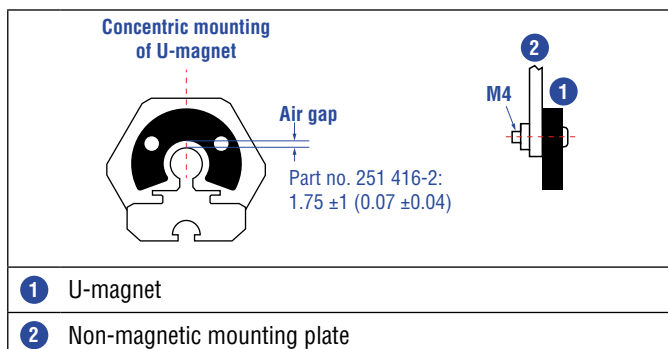


| ❶ | U-magnet |
|---|---|
| ❷ | Non-magnetic mounting plate |

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



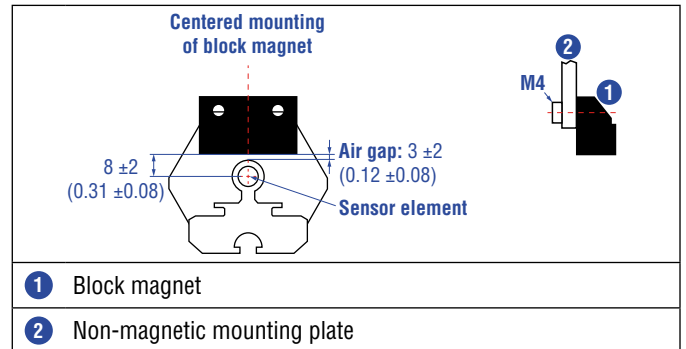| ❶ | Block magnet |
|---|---|
| ❷ | Non-magnetic mounting plate |

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

**Magnet mounting with magnetic material**
When using magnetic material the dimensions of Fig. 15 must be observed.
**A.** If the position magnet aligns with the drilled piston rod
**B.** If the position magnet is set further into the drilled piston rod, install another non-magnetic spacer (e.g. part no. 400 633) above the magnet.
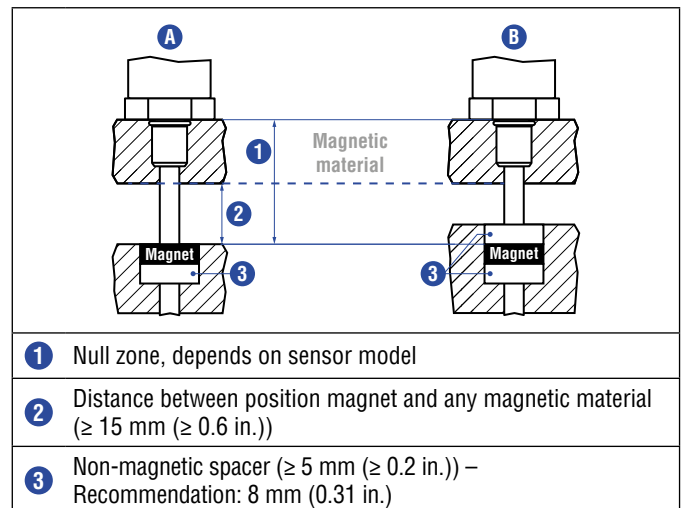


| ❶ | Null zone, depends on sensor model |
|---|---|
| ❷ | Distance between position magnet and any magnetic material (≥ 15 mm (≥ 0.6 in.)) |
| ❸ | Non-magnetic spacer (≥ 5 mm (≥ 0.2 in.)) – Recommendation: 8 mm (0.31 in.) |

*Fig. 15: Installation with magnetic material*

**Rod sensors with stroke lengths ≥ 1 meter (3.3 ft.)**
Support horizontally installed 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. 16) for measurement.
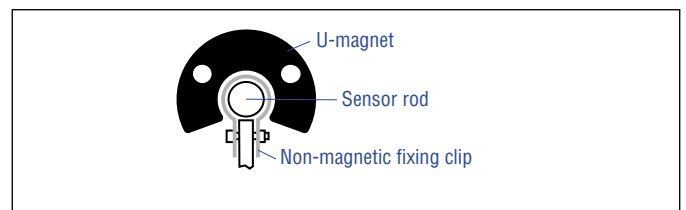


*Fig. 16: Example of sensor support (part no. 561 481)*

*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.



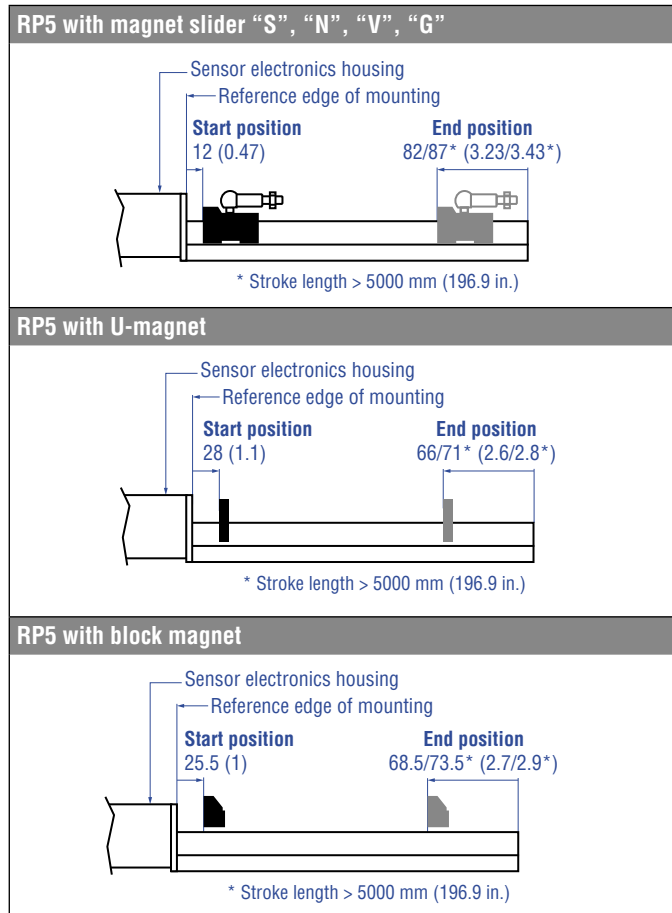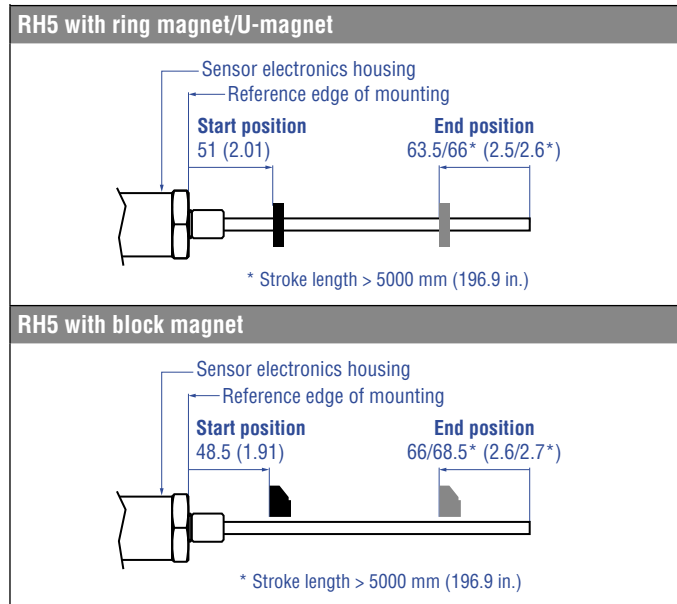Fig. 17: Start- & end positions of magnets, part 1



Fig. 18: Start- & end positions of magnets, part 2

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

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

**Multi-position measurement**
The minimum distance between the magnets is 75 mm (3 in.).

**RP5 with U-magnets**

≥ 75 (≥ 3)

**RP5 with magnet sliders**

≥ 75 (≥ 3)

**RP5 with block magnets**

≥ 75 (≥ 3)

**RH5 with ring magnets/U-magnets**

≥ 75 (≥ 3)

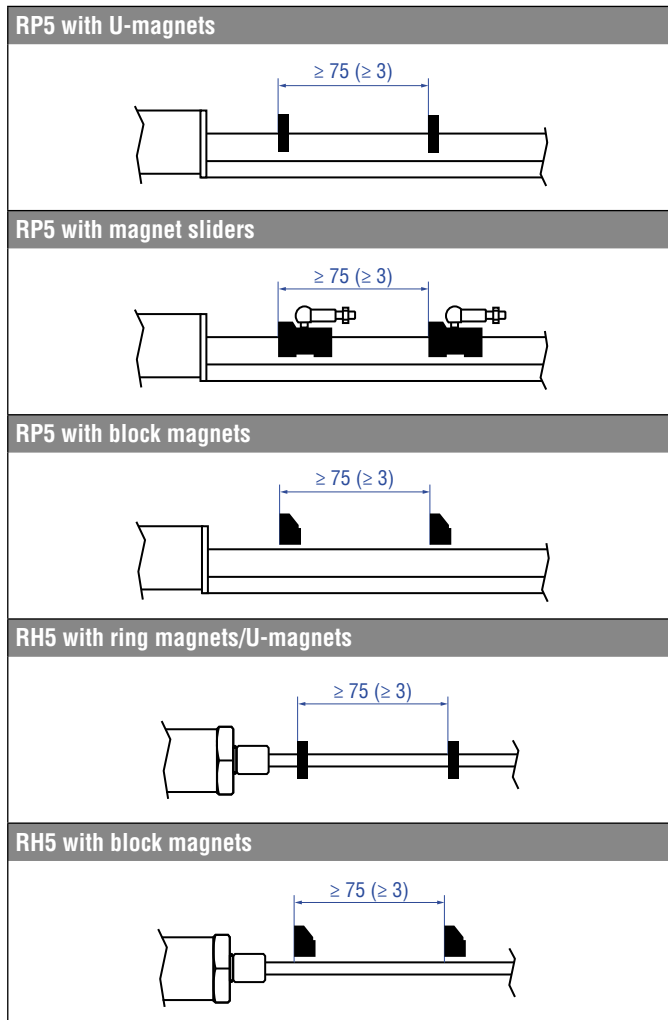**RH5 with block magnets**

≥ 75 (≥ 3)

*Fig. 19: Minimum distance for multi-position measurement*

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

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

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

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

For the internal linearization, the following magnets can be used:
• Ring magnet OD33 (part no. 253 620), only for RH5
• U-magnet OD33 (part no. 254 226)
• Ring magnet OD24.4 (part no. 253 621), only for RH5
• Magnet slider S (part no. 252 182), only for RP5
• Magnet slider N (part no. 252 183), only for RP5
• Magnet slider V (part no. 252 184), only for RP5
• Magnet slider G (part no. 253 421), only for RP5

The ring magnet and U-magnet will be marked for the internal linearization. During the installation, the magnets have to be aligned to the sensor electronic housing, see Fig. 20, Fig. 21 and Fig. 22.

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



Marking

Elongated status LED

*Fig. 20: Alignment of the ring magnet on the RH5 PROFINET with internal linearization*

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

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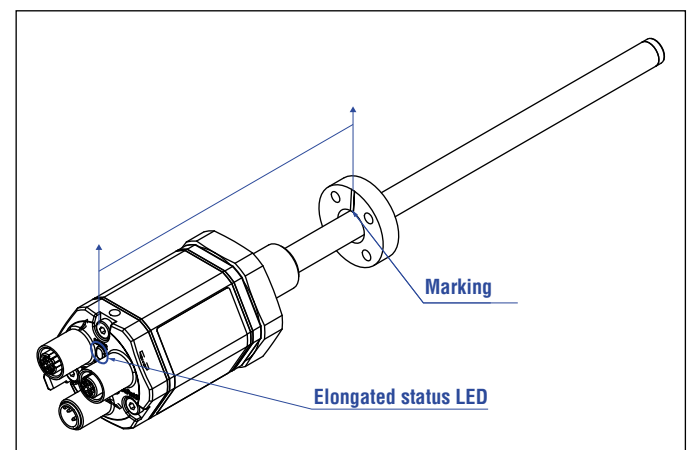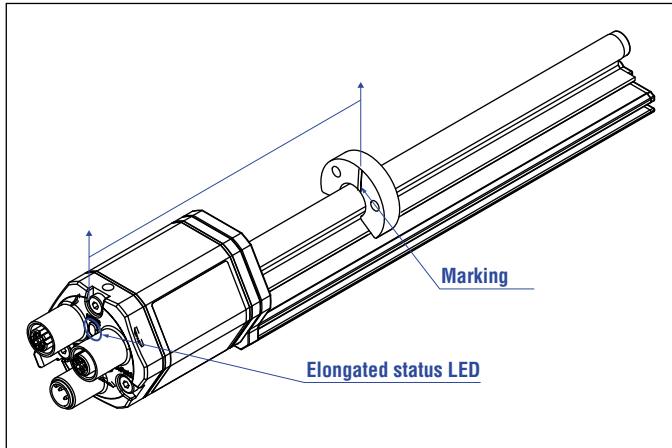


*Fig. 21: Magnet alignment of U-magnet for RP5 PROFINET with internal linearization*

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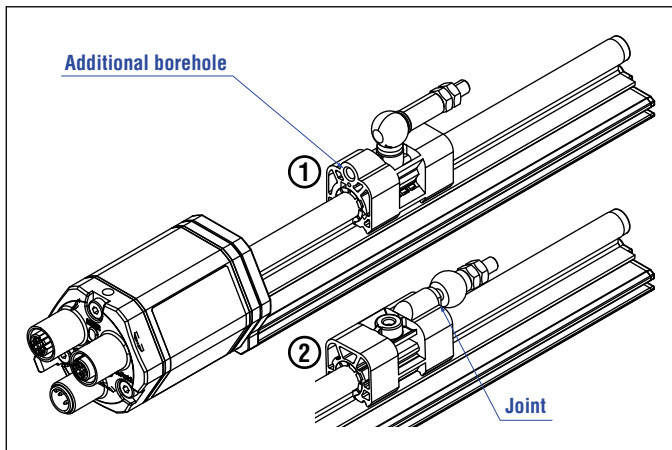- ② Install the magnet slider "V" until the joint points to the end of the profile.



*Fig. 22: Magnet alignment of magnet slider for RP5 PROFINET with internal linearization*

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

---

***NOTICE***

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

---

**4.6 Replacement of sensor**

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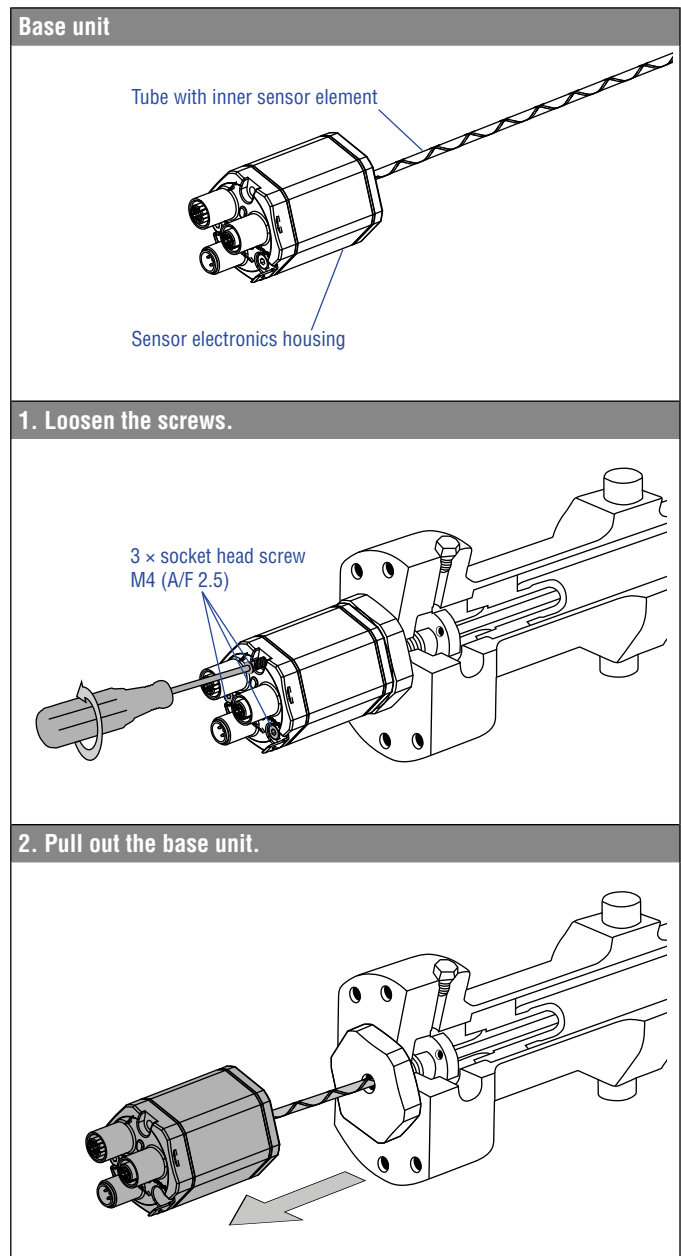
**Base unit**



**1. Loosen the screws.**



**2. Pull out the base unit.**



*Fig. 23: Replacement of the base unit (e.g. RH5 sensor), part 1*

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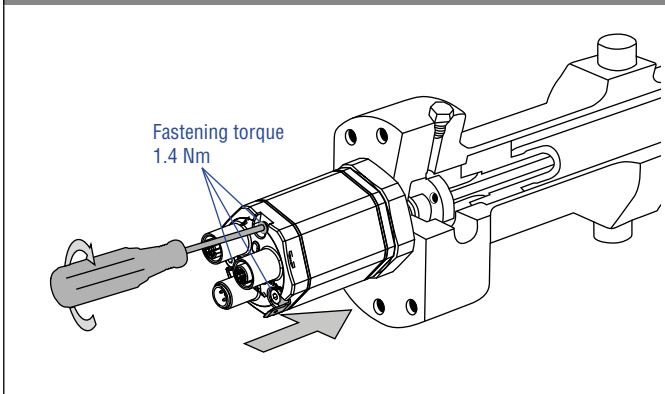   **Tighten the screws.**



Fastening torque
1.4 Nm

*Fig. 24: Replacement of the base unit (e.g. RH5 sensor), part 2*

---

**NOTICE**

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

---

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

**Grounding of profile and rod sensors**
Connect the sensor electronics housing to machine ground. Ground sensor types RP5 and RH5 via ground lug as shown in Fig. 25. In addition you can ground the sensor type RH5 via thread.
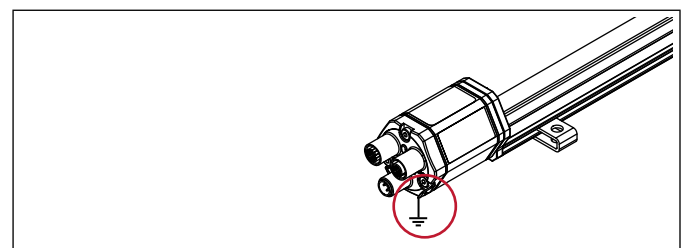


*Fig. 25: Grounding via ground lug (e.g. RP5)*

## Connector wiring

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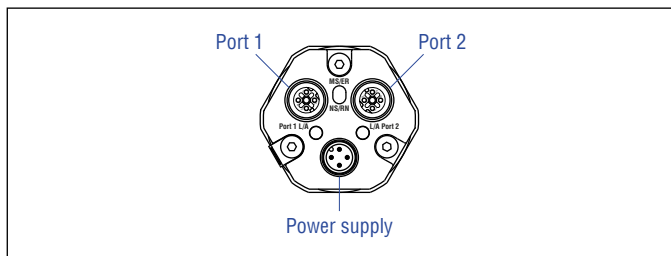


*Fig. 26: Location of connections*

| D58 | | |
|---|---|---|
| **Port 1 – Signal** | | |
| **M12 female connector (D-coded)** | **Pin** | **Function** |
| | 1 | Tx (+) |
| | 2 | Rx (+) |
| | 3 | Tx (−) |
| View on sensor | 4 | Rx (−) |
| **Port 2 – Signal** | | |
| **M12 female connector (D-coded)** | **Pin** | **Function** |
| | 1 | Tx (+) |
| | 2 | Rx (+) |
| | 3 | Tx (−) |
| View on sensor | 4 | Rx (−) |
| **Power supply** | | |
| **M12 male connector (A-coded)** | **Pin** | **Function** |
| | 1 | +12…30 VDC (±20 %) |
| | 2 | Not connected |
| | 3 | DC Ground (0 V) |
| View on sensor | 4 | Not connected |

*Fig. 27: Connector wiring D58*

| D56 | | |
|---|---|---|
| **Port 1 – Signal** | | |
| **M12 female connector (D-coded)** | **Pin** | **Function** |
| | 1 | Tx (+) |
| | 2 | Rx (+) |
| | 3 | Tx (−) |
| View on sensor | 4 | Rx (−) |
| **Port 2 – Signal** | | |
| **M12 female connector (D-coded)** | **Pin** | **Function** |
| | 1 | Tx (+) |
| | 2 | Rx (+) |
| | 3 | Tx (−) |
| View on sensor | 4 | Rx (−) |
| **Power supply** | | |
| **M8 male connector** | **Pin** | **Function** |
| | 1 | +12…30 VDC (±20 %) |
| | 2 | Not connected |
| | 3 | DC Ground (0 V) |
| View on sensor | 4 | Not connected |

*Fig. 28: Connector wiring D56*

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

## Position magnets



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

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

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

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

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

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

**Magnet slider G, backlash free**
**Part no. 253 421**

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

## Position magnets                    Mounting accessories



**U-magnet OD33**
**Part no. 251 416-2**

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

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

**Block magnet L**
**Part no. 403 448**

Material: Plastic carrier with hard ferrite magnet
Weight: Approx. 20 g
Fastening torque for M4 screws: 1 Nm
Operating temperature:
–40…+75 °C (–40…+167 °F)

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

**Mounting clamp**
**Part no. 400 802**

Material: Stainless steel (AISI 304)

**T-nut**
**Part no. 401 602**

Fastening torque for M5 screw: 4.5 Nm

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

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

### Position magnets

| | | | |
|---|---|---|---|
| **U-magnet OD33**<br>**Part no. 251 416-2** | **Ring magnet OD33**<br>**Part no. 201 542-2** | **Ring magnet OD25.4**<br>**Part no. 400 533** | **Ring magnet**<br>**Part no. 402 316** |
| Material: PA ferrite GF20<br>Weight: Approx. 11 g<br>Surface pressure: Max. 40 N/mm²<br>Fastening torque for M4 screws: 1 Nm<br>Operating temperature:<br>–40…+105 °C (–40…+221 °F)<br><br>Marked version for sensors with internal linearization: Part no. 254 226 | Material: PA ferrite GF20<br>Weight: Approx. 14 g<br>Surface pressure: Max. 40 N/mm²<br>Fastening torque for M4 screws: 1 Nm<br>Operating temperature:<br>–40…+105 °C (–40…+221 °F)<br><br>Marked version for sensors with internal linearization: Part no. 253 620 | Material: PA ferrite<br>Weight: Approx. 10 g<br>Surface pressure: Max. 40 N/mm²<br>Operating temperature:<br>–40…+105 °C (–40…+221 °F)<br><br>Marked version for sensors with internal linearization: Part no. 253 621 | Material: PA ferrite coated<br>Weight: Approx. 13 g<br>Surface pressure: Max. 20 N/mm²<br>Operating temperature:<br>–40…+100 °C (–40…+212 °F) |

### Position magnet  ·  Magnet spacer  ·  O-rings
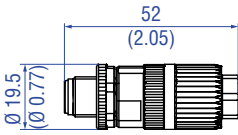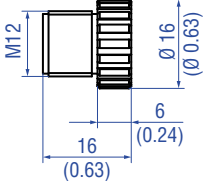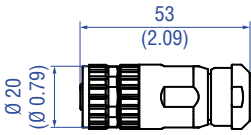
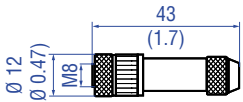| | | | |
|---|---|---|---|
| **Block magnet L**<br>**Part no. 403 448** | **Magnet spacer**<br>**Part no. 400 633** | **O-ring for threaded flange**<br>**M18×1.5-6g**<br>**Part no. 401 133** | **O-ring for threaded flange**<br>**¾"-16 UNF-3A**<br>**Part no. 560 315** |
| Material: Plastic carrier with hard ferrite magnet<br>Weight: Approx. 20 g<br>Fastening torque for M4 screws: 1 Nm<br>Operating temperature:<br>–40…+75 °C (–40…+167 °F)<br><br>This magnet may influence the sensor performance specifications for some applications. | Material: Aluminum<br>Weight: Approx. 5 g<br>Surface pressure: Max. 20 N/mm²<br>Fastening torque for M4 screws: 1 Nm | Material: Fluoroelastomer<br>Durometer: 75 ± 5 Shore A<br>Operating temperature:<br>–40…+204 °C (–40…+400 °F) | Material: Fluoroelastomer<br>Durometer: 75 ± 5 Shore A<br>Operating temperature:<br>–40…+204 °C (–40…+400 °F) |
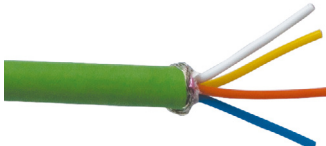
### O-ring  ·  Mounting accessories

| | | | |
|---|---|---|---|
| **O-ring for threaded flange**<br>**M22×1.5-6g**<br>**Part no. 561 337** | **Hex jam nut M18×1.5-6g**<br>**Part no. 500 018** | **Hex jam nut ¾"-16 UNF-3A**<br>**Part no. 500 015** | **Fixing clip**<br>**Part no. 561 481** |
| Material: FPM<br>Durometer: 75 Shore A<br>Operating temperature:<br>–20…+200 °C (–6…+392 °F) | Material: Steel, zinc plated | Material: Steel, zinc plated | Application: Used to secure sensor rods (Ø 10 mm (Ø 0.39 in.)) when using an U-magnet or block magnet<br>Material: Brass, non-magnetic |

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

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

### Cable connectors* – Signal | Cable connectors* – Power

| M12 D-coded male connector (4 pin), straight Part no. 370 523 | M12 connector end cap Part no. 370 537 | M12 A-coded female connector (4 pin/5 pin), straight Part no. 370 677 | M8 female connector (4 pin), straight Part no. 370 504 |
|---|---|---|---|
| Material: Zinc nickel-plated Termination: Insulation-displacement Cable Ø: 5.5…7.2 mm (0.2…0.28 in.) Wire: 24 AWG – 22 AWG Operating temperature: −25…+85 °C (−13…+185 °F) Ingress protection: IP65 / IP67 (correctly fitted) Fastening torque: 0.6 Nm | Female connectors M12 should be covered by this protective cap Material: Brass nickel-plated Ingress protection: IP67 (correctly fitted) Fastening torque: 0.39…0.49 Nm | Material: GD-Zn, Ni Termination: Screw Contact insert: CuZn Cable Ø: 4…8 mm (0.16…0.31 in.) Wire: 1.5 mm² Operating temperature: −30…+85 °C (−22…+185 °F) Ingress protection: IP67 (correctly fitted) Fastening torque: 0.6 Nm | Material: CuZn nickel plated Termination: Solder Cable Ø: 3.5…5 mm (0.14…0.28 in.) Wire: 0.25 mm² Operating temperature: −40…+85 °C (−40…+185 °F) Ingress protection: IP67 (correctly fitted) Fastening torque: 0.5 Nm |

### Programming kit | Cables

| TempoLink kit for Temposonics® R-Series Ⅴ Part no. TL-1-0-EM08 (D56) Part no. TL-1-0-EM12 (D58) | PUR signal cable Part no. 530 125 | Signal cable with M12 D-coded male connector (4 pin), straight – M12 D-coded, male connector (4 pin), straight Part no. 530 064 | Signal cable with M12 D-coded male connector (4 pin), straight – RJ45 male connector, straight Part no. 530 065 |
|---|---|---|---|
| • Connect wirelessly via Wi-Fi enabled device or via USB with the diagnostic tool • Simple connectivity to the sensor via 24 VDC power line (permissible cable length: 30 m) • User friendly interface for mobile devices and desktop computers • See data sheet "TempoLink smart assistant" (document part no.: 552070) for further information | Material: PUR jacket; green Features: Cat 5, highly flexible, halogen free, suitable for drag chains, mostly oil & flame resistant Cable Ø: 6.5 mm (0.26 in.) Cross section: 2 × 2 × 0.35 mm² (22 AWG) Operating temperature: −20…+60 °C (−4…+140 °F) | Material: PUR jacket; green Features: Cat 5e Cable length: 5 m (16.4 ft) Cable Ø: 6.5 mm (0.26 in.) Ingress protection: IP65, IP67, IP68 (correctly fitted) Operating temperature: −30…+70 °C (−22…+158 °F) | Material: PUR jacket; green Features: Cat 5e Cable length: 5 m (16.4 ft) Cable Ø: 6.5 mm (0.26 in.) Ingress protection M12 connector: IP67 (correctly fitted) Ingress protection RJ45 connector: IP20 (correctly fitted) Operating temperature: −30…+70 °C (−22…+158 °F) |

**\*/** Follow the manufacturer's mounting instructions

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

## Cables

| PVC power cable<br>Part no. 530 108 | Power cable with M8 female connector (4 pin), straight – pigtail<br>Part no. 530 066 (5 m (16.4 ft.))<br>Part no. 530 096 (10 m (32.8 ft.))<br>Part no. 530 093 (15 m (49.2 ft.)) |
|---|---|
| Material: PVC jacket; gray<br>Features: Shielded, flexible, mostly flame resistant<br>Cable Ø: 4.9 mm (0.19 in.)<br>Cross section: 3 × 0.34 mm²<br>Bending radius: 10 × D<br>Operating temperature:<br>–30…+80 °C (–22…+176 °F) | Material: PUR jacket; gray<br>Features: Shielded<br>Cable Ø: 8 mm (0.3 in.)<br>Operating temperature:<br>–40…+90 °C (–40…+194 °F) |

# 5. Operation

## 5.1 Initial start-up

The position sensor R-Series Ⅴ PROFINET transfers position and velocity values via the PROFINET output.

PROFINET was developed by the PROFIBUS & PROFINET International (PI) organization and is a standard for transmissions in Industrial Ethernet. The sensor and the corresponding GSDML file (General Device Description) are certified by the Profibus Nutzerorganisation e.V. (PNO).

The sensor can be ordered with different protocol options:

- MTS profile (U402/U412): The MTS profile was developed by MTS Sensors for linear position sensors. With this profile, the position and the velocity of up to 30 position magnets can be measured and transferred simultaneously.
- Encoder profile (U401/U411): the encoder profile corresponds to the specification of the encoder profile V4.2 (PNO no. 3.162). With this profile, the position and the velocity of one position magnet can be measured and transferred simultaneously.

The R-Series Ⅴ PROFINET supports both RT mode and IRT mode. With PROFINET RT (Real Time) the data exchange is without clock synchronization. In this case, the application, the data transmission and the field devices operate according to their own processing cycle. With PROFINET IRT (Isochronous Real Time) a clock-synchronous data transmission takes place. The application, the data transmission as well as the device cycle are synchronous. IRT enables a clock-synchronous data exchange with a minimum cycle time of 250 µs in the network.

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### NOTICE

**Observe during commissioning**

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

---

## 5.2 LED Status

A diagnostic display on the lid of the sensor informs about the current status of the sensor. The R-Series Ⅴ is equipped with three LEDs:
- LED for status indication (condition indicator)
- LED for link activity of port 1 (port 1 L/A)
- LED for link activity of port 2 (port 2 L/A)

**PROFINET RT & IRT LED status**
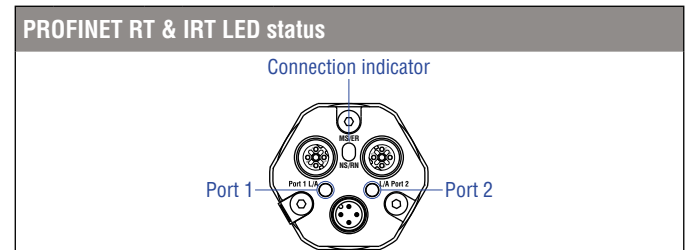


**Device status LED**



| Green | | Red | | Information |
|---|---|---|---|---|
| ● | ON | ○ | OFF | No error |
| ○ | OFF | ● | ON | Operating voltage out of range or magnet error |

**Bus status LED**



| Red | | Information |
|---|---|---|
| ○ | OFF | No error |
| ● | ON | No connection to controller |
| ◐ | Flashing | Parameterization error |

**LED for sensor identification**



| Green | | Information |
|---|---|---|
| ◐ | Flashing | Sensor identification activated |

*Fig. 29: LED status, part 1*

| Port 1 L/A | | | |
|---|---|---|---|
|  | | | |
| **Green** | **Red** | | **Information** |
| ● ON | ○ | OFF | Connection to the next network node established |
| ● ON | ◐ | Flashing | Connection to the next network device established & communication active |

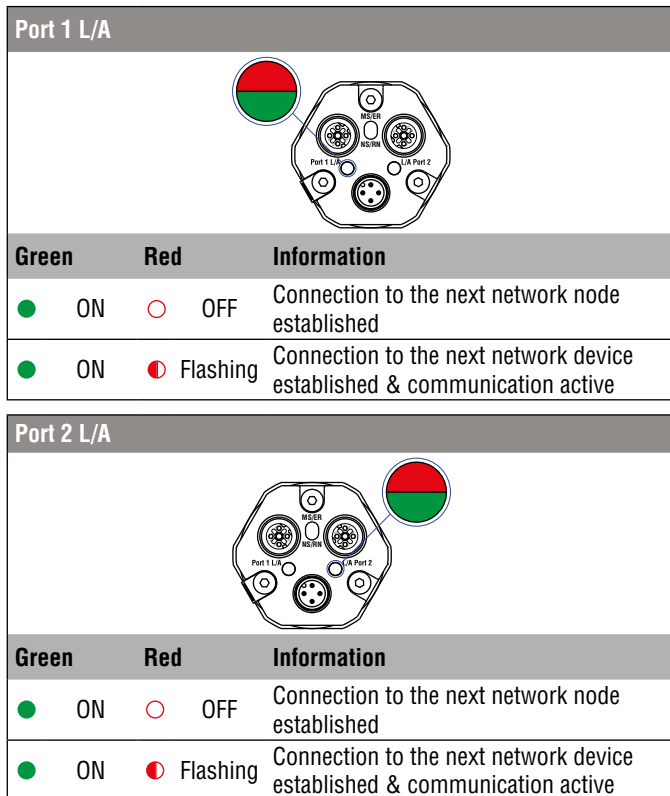| Port 2 L/A | | | |
|---|---|---|---|
|  | | | |
| **Green** | **Red** | | **Information** |
| ● ON | ○ | OFF | Connection to the next network node established |
| ● ON | ◐ | Flashing | Connection to the next network device established & communication active |

*Fig. 30: LED status, part 2*

### 5.3 Supported network functions

**Following network functions are supported:**
- RTC (Class 1 & Class 3) (Real Time Cyclic Protocol):
  Protocol for cyclic IO data (process data and measured values)
- RTA (Real Time Acyclic Protocol):
  Protocol for acyclic real time data (e.g. alarms)
- DCP (Discover and Basic Configuration Protocol):
  Assignment of IP configuration and device name
- DCE/RPC (Distributed Computing Environment Remote Procedure Call):
  Remote Procedure Calls via IP (e.g. parameter configuration)
- LLDP (Link Layer Discovery Protocol):
  Protocol used for neighborhood detection
- SNMP (Simple Network Management Protocol):
  Protocol used for network node diagnosis
- MRP (Media Redundancy Protocol):
  Searches for alternative routes in case of cable error or node error

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

## 6. Programming and configuration in the TIA Portal

### 6.1 General Information

This instruction describes as an example the integration and programming of a Temposonics® R-Series Ⅴ sensor with PROFINET into the TIA Portal (Totally Integrated Automation Portal) of Siemens AG. For controllers and software of other versions and manufacturers, the operation may differ.

> **NOTICE**
> Follow the information given in the controller operation manual.

Chapter 6.2 contains the integration and programming of the R-Series Ⅴ PROFINET with MTS profile (U402/U412). The implementation and configuration of the R-Series Ⅴ with encoder profile (U401/U411) is described in chapter 6.3.

### 6.2 Parameter description for MTS profile

After you have created a project, you can include the sensor via its GSDML file. The properties and functions of a PROFINET IO field device are described in a GSDML (General Station Description) file. The XML-based GSDML file contains all relevant data that is important for both the implementation of the device in the controller and the data exchange during operation.

The GSDML file for the R-Series Ⅴ PROFINET is available on our homepage www.mtssensors.com. The GSDML file of the R-Series Ⅴ PROFINET is packed into a zip file containing the data for the MTS profile and encoder profile.
Download the GSDML file and save it on your computer. To include the GSDML file, select "Tools" from the menu bar of the TIA portal and click on "Manage device description file (GSD)". The "Manage device description files" window opens (Fig. 311). Enter the source path where the R-Series Ⅴ PROFINET with MTS profile GSDML file is stored. Specify the location and press the "Install" button to install the GSDML file. The default name of the R-Series Ⅴ PROFINET sensor is "MTS-R-Series-PNIO-MIF". This name can be changed.
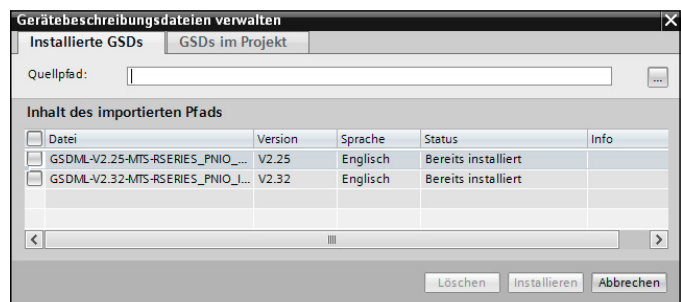


*Fig. 31: The installed GSDML files*

The R-Series V PROFINET supports both RT mode and IRT mode. The sensor is set to the respective mode during connection setup with the controller. By default, the sensor operates in RT mode. To operate the sensor in IRT mode, select the tab "General" in the section "Advanced options". Select RT class "IRT" in the sub-section "Real time settings". The IRT mode prioritizes the data packets (Fig. 322).
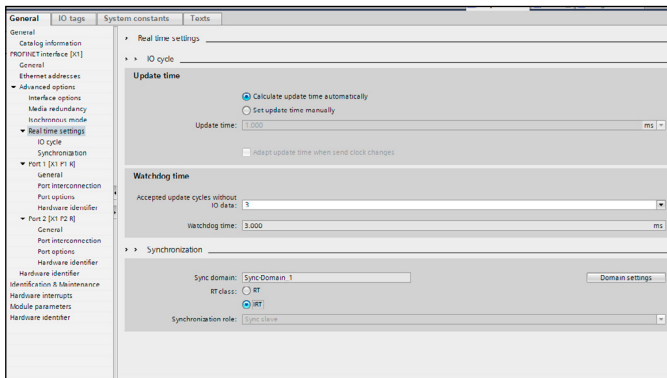


*Fig. 32: Setting of the IRT mode*

In order for the control unit to be able to access the sensor data isochronously, the isochronous mode in the "Advanced options" section of the "General" tab, has to be activated. This results in a synchronization to the transmission clock to the controller. By default, the isochronous mode is deactivated (Fig. 333).
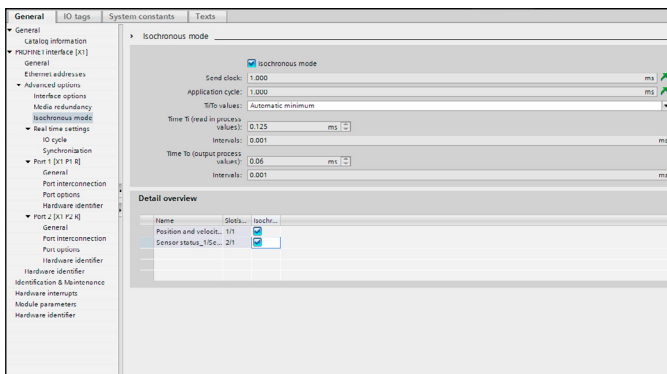


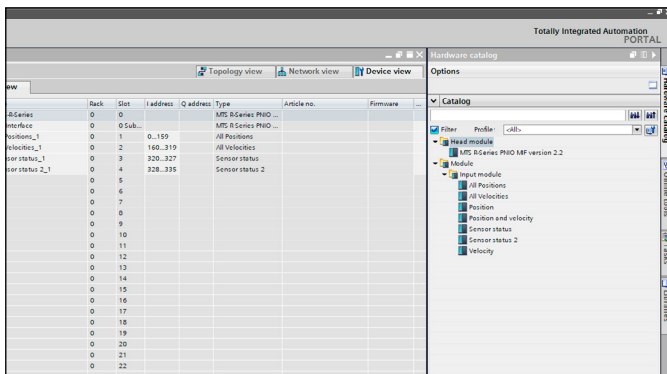*Fig. 33: Activation of isochronous control mode*



*Fig. 34: Hardware Catalog*

Different input modules are available for the R-Series V PROFINET with MTS profile. The following "Input modules" can be selected in the "Catalog" section:

- **All positions:** This module contains the positions of up to 30 magnets. The number of magnets shown in this module depends on the number of magnets specified in the parameter "Number of magnets". With this module, 160 bytes are always transferred. Each magnet is assigned 4 bytes for the position value (1st magnet: 0…3 bytes, 2nd magnet: 4…7, etc.). If less than 30 magnets are operated on the sensor the unused bytes written with "0".

- **All velocities:** This module contains the velocity of up to 30 magnets. The number of magnets shown in this module depends on the number of magnets specified in the parameter "Number of magnets". With this module, 160 bytes are always transferred. Each magnet is assigned 4 bytes for the velocity value (1st magnet: 0…3 bytes, 2nd magnet: 4…7, etc.). If less than 30 magnets are operated on the sensor, the unused bytes are written with "0".

- **Position:** This module contains the position of a magnet. Afterwards you must assign a magnet to this module.

- **Position and velocity:** This module contains the position and velocity of a magnet. This module transfers 8 bytes. The bytes 0…3 contain the position value and the bytes 4…7 contain the velocity value of the selected magnet. Afterwards you must assign a magnet to this module.

- **Sensor status:** This module shows the following values of the sensor:
  - Current power supply in mV
  - Number of magnets on the sensor rod
  - Bit mask for indicating which magnet number is detected on the sensor

  Reading these status values is described on page 27.

- **Sensor status 2:** This module indicates when a high limit is exceeded or a low limit is not reached. The switching points mark the beginning and the end of a work area (Fig. 36). According to Fig. 35, the status of the switching points is displayed via bits 0 and 1 of this module.

  Reading these status values is described on page 27.

| Bit | Description |
|-----|-------------|
| **Bit 0** | Low limit<br>• Bit value 0: Low limit not undershot<br>• Bit value 1: Low limit undershot |
| **Bit 1** | High limit<br>• Bit value 0: High limit not exceeded<br>• Bit value 1: Low limit exceeded |

*Fig. 35: Reported values of the switching points at module „Sensor status 2"*
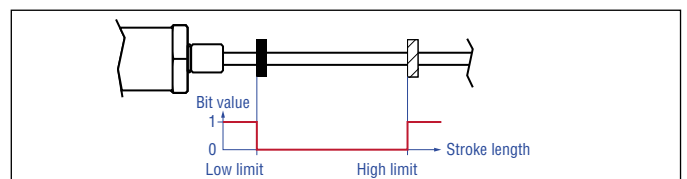


*Fig. 36: Switching points for R-Series V PROFINET with MTS profile*

- **Velocity:** This module contains the velocity of a magnet. Afterwards you must assign a magnet to this module.

Drag the selected module into the "Device Overview" window. While the "All positions" and "All velocities" modules contain up to 30 magnets, the "Position","Velocity" and "Position and velocity" modules contain the values of only one magnet at a time. Therefore, a magnet must be assigned to these modules. This assignment is carried out in the "Module parameters" section of the module. Select a magnet for the selected module under "Position parameters". By default, all modules are assigned to magnet 1 (Fig. 377).
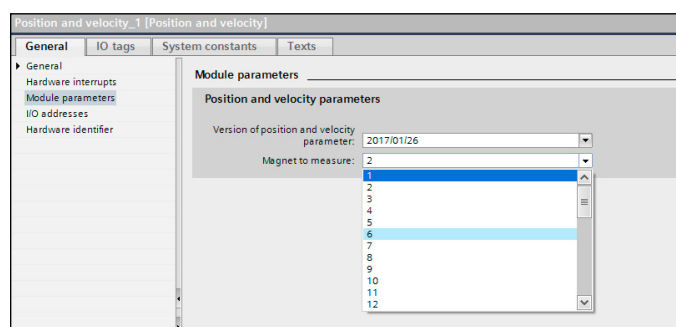


*Fig. 37: Assignment of the magnets to the selected input modules*

The parameters of the R-Series V PROFINET sensor are set in the sub-section "Module parameters" of the sensor. The following parameters can be adjusted in the "Sensor parameters" section (Fig. 4141):
- **Resolution** (Setting of the resolution for position measurement)
  Possible values: 0.5 µm; 1 µm; 2 µm; 5 µm; 10 µm; 50 µm or 100 µm
- **Filter Type** (Setting of the filter for the output value)
  - No filter *(default value)*
  - FIR (Finite Impulse Response Filter)
  - IIR (Infinite Impulse Response Filter)
- **Filter Window Size** (Setting of the number of position values for calculating the filter of the output value)
  Possible values: 2…16
- **Velocity Window Size** (Setting of the number of position values for determining the velocity of the position magnet)
  Possible values: 2…16
- **Velocity Output Unit** (Setting the unit of the velocity output)
  Possible value: steps/1000 ms; steps/100 ms; steps/10 ms; mm/s
- **Measuring Direction** (Setting of the measuring direction for position or velocity measurement)
  - Forward *(default value)*
  - Reverse
- **Number of Magnets** (Setting of the number of position magnets that are used simultaneously on the sensor). If more magnets are configured than specified in the order code, a parameterization error is output. The alarm is output via alarm ID 16 (Fig. 4040).

- **Wrong Number of Magnets** (Setting of the alarm behavior when the actual number of position magnets differs from the specified number of position magnets)
  - More or less than configured
  - More than configured
  - Less than configured
  - Magnet detection alarm off *(default value)*
  The alarm is output via alarm ID 27 (Fig. 388).

| Alarm ID decimal (hexadecimal) | Meaning |
|---|---|
| 27 (1B) | Wrong number of magnets |

*Fig. 38: Alarm messages: Wrong number of magnets – MTS Profile*

- **Power Supply Alarm** (Setting of the alarm behaviour when the power supply is out of the specified range).
  - Supply voltage too high or too low
  - Supply voltage too low
  - Supply voltage too high
  - Power supply alarm off *(default value)*
  The alarm is output via alarm ID 17 (Fig. 399).

| Alarm ID decimal (hexadecimal) | Meaning |
|---|---|
| 17 (11) | Invalid operating voltage |

*Fig. 39: Alarm messages: Invalid operating voltage – MTS Profile*

- **Extrapolation Mode** (Setting of the sensor behaviour in case of oversampling)
  - On (The minimum cylce time of the sensor when the Extrapolation Mode is on is 250 µs, independent of the number of magnets)
  - Off *(default value)*
- **Internal Linearization** (Setup of the internal linearization)
  - Enabled (Internal linearization can only be activated if the table of internal linearization is stored on the sensor.)
  - Disabled *(default value)*
If the internal linearization is to be activated although the corresponding table is not stored on the sensor, a parameterization error is reported (Fig. 4040).

| Alarm ID decimal (hexadecimal) | Meaning |
|---|---|
| 16 (10) | Parameterization error |

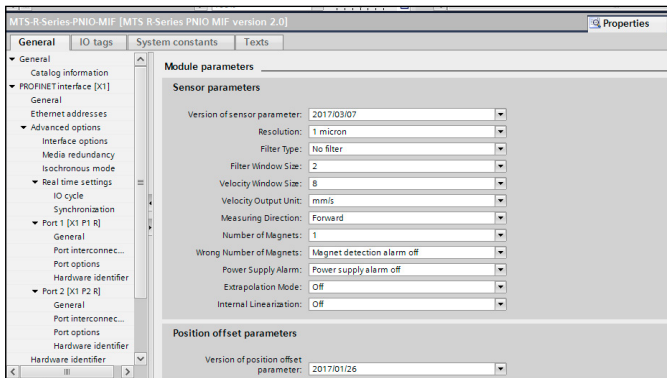*Fig. 40: Alarm messages: Parameterization error – MTS Profile*

*Fig. 41: Setting of the parameters*

- **Offset:** In the subsection „Position offset parameters" you can set the offset, a shift of the measurement range start, separately for each magnet – independent of further magnets on the sensor rod/sensor profile (Fig. 42). You can set the values with a step size of 1 µm in the range between -214...+214 m.
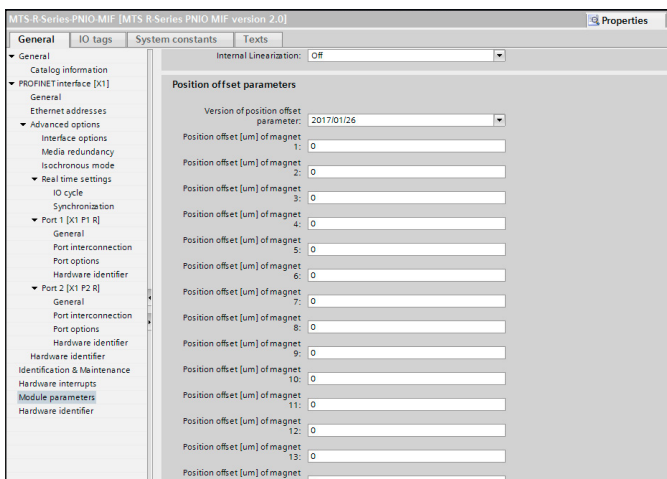


*Fig. 42: Setting of the offset*

- **Preset:** You can set a preset separately for each magnet – independently of other magnets on the sensor rod/sensor profile. To set the preset, move the magnet to the desired position. Then, edit the address API 0 Slot 0 Subslot 1 Index 0x2800. The 64 bit word for entering the preset is structured as follows (Fig. 43):
  - The first 24 bits represent the version identifier. Enter the word 0x00200414 at this point. This is to avoid an unintentional change of the preset.
  - The following 8 bits indicate the magnet for which the preset is to be changed. Enter the magnet number at this point.
  - The last 32 bits specify the value that is to be reported at this position in the future. Enter the desired value for this position.

| 24 bit | 8 bit | 32 bit |
|---|---|---|
| Version identifier | Magnet no. | Preset (future value at this position) |

*Fig. 43: Structure of 64 bit word for entering a preset at R-Series Ⅴ PROFINET with MTS profile*

- **Reading the values of the input module "Sensor status":** To read the information from the input module "Sensor status", drag this module into the "Device Overview" window. The module "Sensor status" consists of 64 bits (Fig. 44):
  - The first 16 bit indicate the current power supply.
  - The following 8 bit indicate the number of magnets detected on the sensor rod/sensor profile.
  - The last 40 bits form the bit mask for displaying the detected magnets. For each magnet one bit with the following values is available:
    - Bit value 0: No magnet is detected for this magnet number
    - Bit value 1: A magnet is detected for this magnet number

| 16 bit | 8 bit | 40 bit | | |
|---|---|---|---|---|
| | | 40 39 38 … Magnet no. … 3 2 1 | | |
| Power supply | Number of magnets | Bit mask 1 bit per magnet | | |

*Fig. 44: Structure of the input module "Sensor status" at R-Series Ⅴ PROFINET with MTS profile*

- **Setting the switching points for input module „Sensor status 2":** To read the information from the input module "Sensor status 2", drag this module into the "Device Overview" window. In the "Module parameters" section of the sensor, you can set the parameters for switching points under "Work area parameters" (Fig. 45):
  - Work area checking (setting for checking):
    - On (Active the checking of the swichting points)
    - Off (Deactivate the checking of the switching pointd) *(default value)*
  - Magnet to check for work area low limit (Select the magnet for checking the low limit)
  - Magnet to check for work area high limit (Select magnet for checking the high limit)
  - Work area low limit (Position of the low limit in µm)
  - Work area high limit (Position of the high limit in µm)
  - Work area check hysteresis (Setting the hysteresis for the switching points in µm)
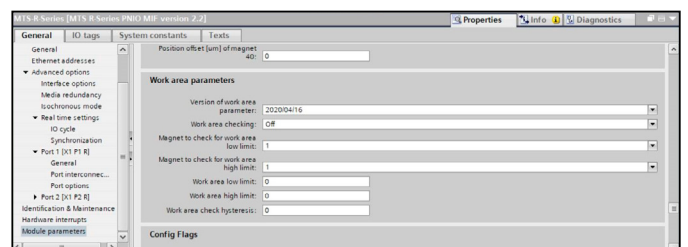


*Fig. 45: Setting the switching points for the work area*

The status of the switching points is reported in parallel to the position values or velocity values via the PROFINET protocol. A magnet must be specified for each switching point, which is used to check the respective limit. For a single position measurement with one magnet, the same magnet is assigned to the high and the low limit. For a multi-position measurement, you can assign different magnets on the sensor to the high and the low limit. Fig. 46 shows an example with three magnets. Magnet 1 is used to check the low limit, while the magnet 3 is used to monitor the high limit. Magnet 2 has no influence on the checking of the work area.
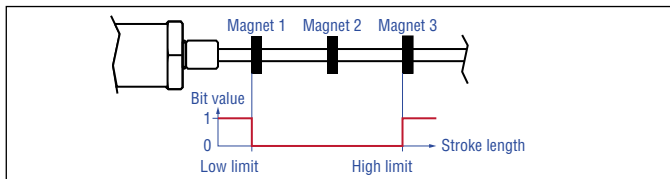


*Fig. 46: Example of checking the switching points at R-Series Ⅴ PROFINET with 3 magnets*

- **Ignoring offsets configured in the project:** You can use the "Config Flags 1" entry to set whether the sensor should accept or ignore the offsets transmitted by the controller when establishing the connection. You can adjust this in the module parameters of the sensor in the "Config Flags" section (Fig. 47). You can set the following values for bit 1 of the "Config Flags 1" entry:
    - Value 0: The offsets configured in the project are accepted by the sensor
    - Value 1: The offsets configured in the project are ignored by the sensor

The other bits of "Config Flags 1" as well as the entries "Config Flags 2" and "Config Flags 3" have no influence on the MTS profile.



*Fig. 47: Config Flags – MTS profile*

• **Reading additional information regarding the sensor status:** In parallel to the position values and the velocity values, the sensor can output further information on the sensor status via the PROFINET protocol. This information is stored in an array with 19 Integer32 values, which you call via the address API 0 Slot 0 Subslot 1 Index 2000.

| Index | Subindex in array | Name | Object type | Attribute | Data type | Description |
|---|---|---|---|---|---|---|
| 0x2000 | | **Sensor status** | | | | |
| | 0 | Number of entries | Variable | ro | Integer32 | |
| | 1 | Time since last update | Variable | ro | Integer32 | Age of the status data in ms |
| | 2 | Status data version | Variable | ro | Integer32 | Version number |
| | 3 | Operational time | Variable | ro | Integer32 | Total operational time of the sensor |
| | 4 | Odometer | Variable | ro | Integer32 | Total distance travelled by the position magnet in cm |
| | 5 | Magnet cycles | Variable | ro | Integer32 | Total number of directional changes of the magnet |
| | 6 | Minimum input voltage | Variable | ro | Integer32 | Minimum input voltage so far in mV |
| | 7 | Maximum input voltage | Variable | ro | Integer32 | Maximum input voltage so far in mV |
| | 8 | Current input voltage | Variable | ro | Integer32 | Current input voltage |
| | 9 | Minimum temperature | Variable | ro | Integer32 | Minimum temperature inside the sensor electronics housing so far in °C |
| | 10 | Maximum temperature | Variable | ro | Integer32 | Maximum temperature inside the sensor electronics housing so far in °C |
| | 11 | Current temperature | Variable | ro | Integer32 | Current temperature inside the sensor electronics housing in °C |
| | 12 | Input voltage out of range | Variable | ro | Integer32 | Duration of exceeding or falling below the permissible power supply range in ms |
| | 13 | Temperature out of range | Variable | ro | Integer32 | Duration of exceeding or falling below the permissible operating temperature range in ms |
| | 14 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |
| | 15 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |
| | 16 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |
| | 17 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |
| | 18 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |

*Fig. 48: Array with additional information regarding the sensor status*

### 6.3 Parameter description for encoder profile V4.2

After you have created a project, you can include the sensor via its GSDML file. The properties and functions of a PROFINET IO field device are described in a GSDML (General Station Description) file. The XML-based GSDML file contains all relevant data that is important for both the implementation of the device in the controller and the data exchange during operation.

The GSDML file for the R-Series Ⅴ PROFINET is available on our homepage www.mtssensors.com. The GSDML file of the R-Series Ⅴ PROFINET is packed into a zip file containing the data for the MTS profile and encoder profile. Download the GSDML file and save it on your computer. To include the GSDML file, select "Tools" from the menu bar of the TIA portal and click on "Manage device description file (GSD)". The "Manage device description files" window opens (Fig. 499). Enter the source path where the GSDML file of the R-Series Ⅴ PROFINET with encoder profile is stored. Specify the location and press the "Install" button to install the GSDML file. The default name of the R-Series Ⅴ PROINET sensor is "MTS-R-Series-PNIO-EP". This name can be changed.
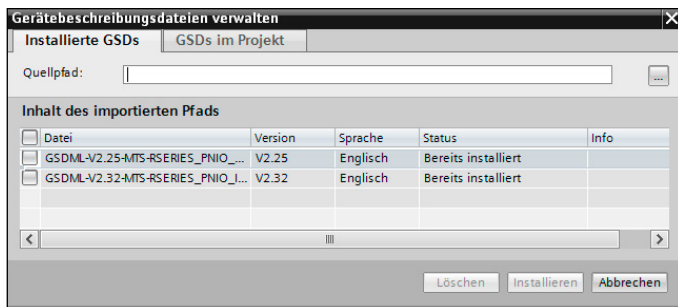


*Fig. 49: View the installed GSDML files*

The R-Series Ⅴ PROFINET supports both RT mode and IRT mode. The sensor is set to the respective mode during connection setup with the controller. By default, the sensor operates in RT mode. To operate the sensor in IRT mode, select the tab "General" in the section "Advanced options". Select RT class "IRT" in the sub-section "Real time settings". The IRT mode prioritizes the data packets (Fig. 5050).
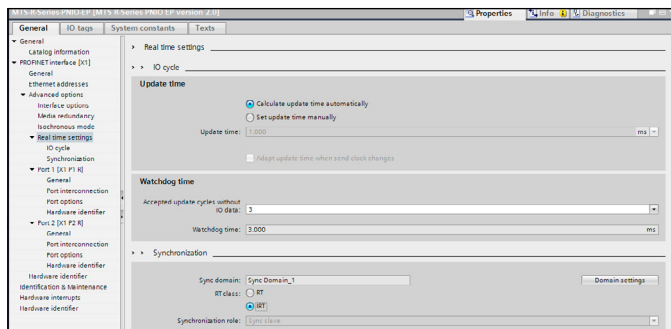


*Fig. 50: Setting of the IRT-mode*

To enable the control to access the sensor data isochronously, the isochronous mode must be activated in the "Advanced options" section of the "General" tab. This results in a synchronization to the transmission clock to the controller. The isochronous mode is deactivated by default (Fig. 5151).
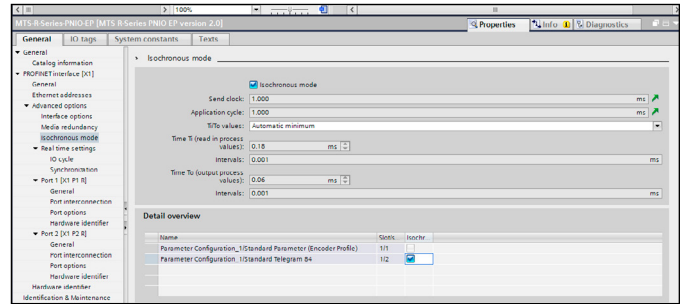


*Fig. 51: Activation of the isochronous mode*

Different telegrams are available for the sensor. The telegrams can be selected in the "Catalog" section. A detailed description of the telegrams is shown in Fig. 5252 & Fig. 5353.

### Standard telegram 81

Standard telegram 81 uses 4 bytes for output data from the IO controller to the sensor and 12 bytes of input data from the sensor to the IO-controller.

**Output data from the IO controller (control ➔ sensor)**

| IO Data | 1 | | 2 | |
|---|---|---|---|---|
| Byte | 0 | 1 | 2 | 3 |
| Actual value | STW2_ENC | | G1_STW | |
| Description | Encoder control word 2 | | Sensor control word | |

**Input data to the IO controller (sensor ➔ control)**

| IO Data | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Actual value | ZSW2_ENC | | G1_ZSW | | G1_XIST1 | | | | G1_XIST2 | | | |
| Description | Status word 2 | | Status word | | Position value | | | | Position value 2 | | | |

### Standard telegram 82

Standard telegram 82 uses 4 bytes for output data from the IO controller to the sensor and 14 bytes of input data from the sensor to the controller.

**Output data from the IO controller (control ➔ sensor)**

| IO Data | 1 | | 2 | |
|---|---|---|---|---|
| Byte | 0 | 1 | 2 | 3 |
| Actual value | STW2_ENC | | G1_STW | |
| Description | Encoder Control Word 2 | | Sensor Control Word | |

**Input data to the IO controller (sensor ➔ control)**

| IO Data | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Actual value | ZSW2_ENC | | G1_ZSW | | G1_XIST1 | | | | G1_XIST2 | | | | NIST_A | |
| Description | Status word 2 | | Status word | | Position value | | | | Position value 2 | | | | Velocity | |

### Standard telegram 83

Standard telegram 83 uses 4 bytes for output data from the controller to the sensor and 16 bytes of input data from the sensor to the controller.

**Output data from the IO controller (control ➔ sensor)**

| IO Data | 1 | | 2 | |
|---|---|---|---|---|
| Byte | 0 | 1 | 2 | 3 |
| Actual value | STW2_ENC | | G1_STW | |
| Description | Encoder Control Word 2 | | Sensor Control Word | |

**Input data to the IO controller (sensor ➔ control)**

| IO Data | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Actual value | ZSW2_ENC | | G1_ZSW | | G1_XIST1 | | | | G1_XIST2 | | | | NIST_B | | | |
| Description | Status word 2 | | Status word | | Position value | | | | Position value 2 | | | | Velocity | | | |

### Standard telegram 84

Standard telegram 84 uses 4 bytes for output data from the controller to the sensor and 20 bytes of input data from the sensor to the controller.

**Output data from the IO controller (control ➔ sensor)**

| IO Data | 1 | | 2 | |
|---|---|---|---|---|
| Byte | 0 | 1 | 2 | 3 |
| Actual value | STW2_ENC | | G1_STW | |
| Description | Encoder control word 2 | | Sensor control word | |

**Input data to the IO controller (sensor ➔ control)**

| IO Data | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Actual value | ZSW2_ENC | | G1_ZSW | | G1_XIST3 | | | | | | | | G1_XIST2 | | | | NIST_B | | | |
| Description | Status word 2 | | Status word | | Position value | | | | | | | | Position value 2 | | | | Velocity | | | |

*Fig. 52: Source: PROFIBUS Nutzerorganisation e.V.; 2017; Encoder Profile Technical Specification for PROFIBUS and PROFINET related to PROFIdrive Version 4.2*

| Control word 2 (STW2_ENC) | | | |
|---|---|---|---|
| **Bit** | **Value** | **Significance** | **Comments** |
| **0…6** | – | – | Reserved |
| **7** | 1 / 0 | Fault acknowledge (0 ➜ 1) | The fault signal is acknowledged with a positive edge; the sensor reaction to a fault depends on the type of fault. |
| **8, 9** | – | – | Reserved |
| **10** | 1 | Control by PLC | Control via interface, EO IO data is valid. |
| | 0 | No control by PLC | EO IO data not valid; except sign-of-life. |
| **11** | – | – | Reserved |
| **12…15** | – | Controller sign-of-life | Supported in IRT mode |

| Status word 2 (ZSW2_ENC) | | | |
|---|---|---|---|
| **Bit** | **Value** | **Significance** | **Comments** |
| **0…2** | – | – | Reserved |
| **3** | 1 | Fault present | Unacknowledged faults or currently not acknowledged faults (fault messages) are present (in the buffer). The fault reaction is fault-specific and device-specific. The acknowledging of a fault may only be successful, |
| | 0 | No fault | if the fault cause has disappeared or has been removed before. If the fault has been removed the sensor returns to operation. The related fault numbers are in the fault buffer. |
| **4…8** | – | – | Reserved |
| **9** | 1 | Control request | The automation system is requested to assume control. |
| | 0 | No control request | Control by automation system is not possible, only possible at the device or by another interface. |
| **10, 11** | – | – | Reserved |
| **12…15** | – | Encoder sign-of-life | Supported in IRT mode |

| Sensor status word (G1_ZSW) | | |
|---|---|---|
| **Bit** | **Function** | **Comments** |
| **0…7** | Reference mark search, measurement on the fly | – |
| **8** | Probe 1 deflected | – |
| **9** | Probe 2 deflected position mode (preset) | – |
| **10** | Reserved, set to zero | – |
| **11** | Requirements of error acknowledgment detected | – |
| **12** | Set/shift of home position (preset) executed | – |
| **13** | Transmit absolute value cyclically | If bit 13 transmits absolute value cyclically or bit 15 sensor error is not set there is no valid value or error code transferred in G1_XIST2. Bit 13 transmits absolute value cyclically cannot be set at the same time as bit 15 sensor error. These bits are used to indicate either a valid position value transmission (bit 13) or the error code transmission (bit 15) in G1_XIST2. |
| **14** | Parking sensor active | – |
| **15** | Sensor error | – |

| Sensor control word (G1_STW) | | |
|---|---|---|
| **Bit** | **Function** | **Comments** |
| **0…7** | Reference mark search, measurement on the fly | |
| **8…10** | Reserved (without effect) | |
| **11** | Home position mode position mode (preset) | |
| **12** | Request set/shift of home position (preset) | |
| **13** | Request absolute value cyclically | |
| **14** | Activate parking sensor | If the sensor parking is activated (bit 14 = 1) the sensor is still on the bus with the slave sign-of-life active and the sensor error and diagnostics switched off. |
| **15** | Acknowledging a sensor error | |

*Fig. 53: Source: PROFIBUS Nutzerorganisation e.V.; 2017; Encoder Profile Technical Specification for PROFIBUS and PROFINET related to PROFIdrive Version 4.2*

The selected telegram must be dragged into the "Device Overview" window. In the example shown, telegram 84 was selected and assigned to slot 1 subslot 2 (Fig. 5554).
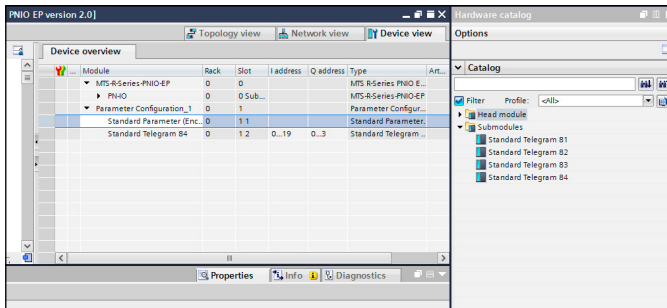


*Fig. 54: Hardware Catalog*

To configure the parameters, select the entry "Standard Parameters (Encoder Profile)" in the "Device Overview" window. The parameters of the R-Series Ⅴ sensor can be set in the sub-section "Module Parameters" of the "General" tab (Fig. 5555).
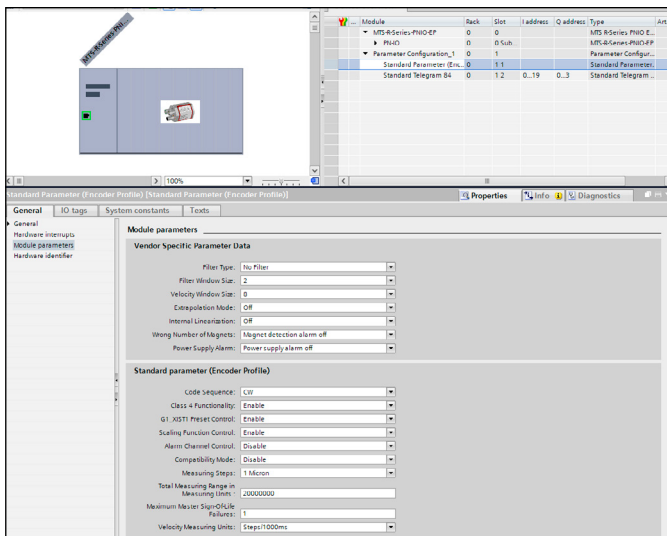


*Fig. 55: Setting of the parameters*

**Vendor Specific Parameter Data:**
- **Filter Type** (Setting of the filter for the output value)
  - No filter *(default value)*
  - FIR (finite impulse response filter)
  - IIR (infinite impulse response filter)
- **Filter Window Size** (Setting of the number of position values for calculating the filter of the output value)
  Possible values: 2…16 *(default value = 2)*
- **Velocity Window Size** (Setting of the number of position values for determining the velocity of the position magnet)
  Possible values: 2…16 *(default value = 8)*

- **Extrapolation Mode** (Setting of the sensor behaviour in case of oversampling)
  - On (The minimum cylce time of the sensor when the Extrapolation Mode is on is 250 µs)
  - Off *(default value)*
- **Internal Linearization** (Setting of the internal linearization)
  - On (Internal linearization can only be activated if the table of internal linearization is stored on the sensor)
  - Off *(default value)*

If the internal linearization is to be activated although the corresponding table is not stored on the sensor, a parameterization error is reported (Fig. 56)

- **Wrong Number of Magnets** (Setting of the alarm behaviour when the actual number of position magnets differs from the specified number of position magnets)
  - More or less than one magnet
  - More than one magnet
  - Less than one magnet
  - Magnet detection alarm off *(default value)*
- **Power Supply Alarm** (Setting of the alarm behaviour when the power supply is out of the specified range)
  - Supply voltage too high or too low
  - Supply voltage too low
  - Supply voltage too high
  - Power supply alarm off *(default value)*

These diagnostic outputs are implemented via alarm messages and the PROFINET interface. The R-Series Ⅴ PROFINET sensors support the following diagnostic messages:

| Alarm ID | | Meaning |
|---|---|---|
| decimal | hexadecimal | |
| 37137 | 9111 | High operating voltage |
| 37136 | 9110 | Low operating voltage |
| 37120 | 9100 | Wrong number of magnets |
| 16 | 10 | Parametrization error |

*Fig. 56: Alarm messages – Encoder Profile V4.2*

- **Accepting negative preset values:** You can use the "Config Flags 1" entry to set that negative preset values are also accepted in addition to positive preset values. You can adjust this in the module parameters of the module "standard parameters" in the "Config Flags" section (Fig. 57). You can set the following values for bit 2 of the "Config Flags 1" entry:
  - Value 0: Only positive preset values are accepted. Negative preset values are not accepted.
  - Value 1: Positive and negative preset values are accepted
  The other bits of "Config Flags 1" as well as the entry "Config Flags 3" have no influence on the encoder profile.

- **Setting the parameter P65005:** You can use the "Config Flags 1" entry to set how to change the parameter P65005. You can adjust this in the module parameters of the module "standard parameters" in the "Config Flag" section (Fig. 57). You can set the following values for bit 3 of the "Config Flags 1" entry:
  - Value 0: Parameter P65005 is not overwritten by the parameter set.
  - Value 1: Parameter P65005 is set to the value of Config Flag 2. Enter the value for parameter P65005 in Config Flag 2. For further information about parameter P65005 see document "Profile Drive Technology Encoder-Profile (Version 4.2)" by the PROFIBUS Nutzerorganisation e.V..



*Fig. 57: Config Flags – Encoder profile*

- **Reading additional information regarding the sensor status:** In parallel to the position values and the velocity values, the sensor can output further information on the sensor status via the PROFINET protocol. This information is stored in an array with 19 Integer32 values, which you call via the address API 0x3d00 Slot 1 Subslot 1 Index 2000.

| Index | Subindex in array | Name | Object type | Attribute | Data type | Description |
|---|---|---|---|---|---|---|
| 0x2000 | | **Sensor status** | | | | |
| | 0 | Number of entries | Variable | ro | Integer32 | |
| | 1 | Time since last update | Variable | ro | Integer32 | Age of the status data in ms |
| | 2 | Status data version | Variable | ro | Integer32 | Version number |
| | 3 | Operational time | Variable | ro | Integer32 | Total operational time of the sensor |
| | 4 | Odometer | Variable | ro | Integer32 | Total distance travelled by the position magnet in cm |
| | 5 | Magnet cycles | Variable | ro | Integer32 | Total number of directional changes of the magnet |
| | 6 | Minimum input voltage | Variable | ro | Integer32 | Minimum input voltage so far in mV |
| | 7 | Maximum input voltage | Variable | ro | Integer32 | Maximum input voltage so far in mV |
| | 8 | Current input voltage | Variable | ro | Integer32 | Current input voltage |
| | 9 | Minimum temperature | Variable | ro | Integer32 | Minimum temperature inside the sensor electronics housing so far in °C |
| | 10 | Maximum temperature | Variable | ro | Integer32 | Maximum temperature inside the sensor electronics housing so far in °C |
| | 11 | Current temperature | Variable | ro | Integer32 | Current temperature inside the sensor electronics housing in °C |
| | 12 | Input voltage out of range | Variable | ro | Integer32 | Duration of exceeding or falling below the permissible power supply range in ms |
| | 13 | Temperature out of range | Variable | ro | Integer32 | Duration of exceeding or falling below the permissible operating temperature range in ms |
| | 14 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |
| | 15 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |
| | 16 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |
| | 17 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |
| | 18 | Reserved for future use | Variable | ro | Integer32 | Reserved for future use |

*Fig. 58: Array with additional information regarding the sensor status*

**In addition to the manufacturer-specific parameters, there are the following standard parameters according to the encoder profile:**

- **Code sequence:**
  Specifies the measurement direction for position measurement
  - CW (clockwise) = forward (values increasing from sensor electronics housing to rod end/profile end) *(default value)*
  - CCW (counter clockwise) = reverse (values decreasing from sensor electronics housing to rod end/profile end)
- **Class 4 functionality:**
  Activating/deactivating the following parameters: Code sequence, scaling function, measuring step, total measuring range, velocity unit and G1_XIST1 preset control. With "Class 4 functionality" de-activated, the sensor measures with a resolution of 1 µm. Any configured "Preset" is not taken into account and the measuring direction is forward. If the parameter "G1_XIST1 preset control" is activated this will affect G1_XIST1, G1_XIST2 and G1_XIST3.
- **G1_XIST1 preset control (preset affects XIST1):**
  Specifies the effect of a preset on G1_XIST1. This parameter is without function if the parameter Class 4 funtionality is deactivated. If Class 4 functionality is activated and G1_XIST1 preset control is disabled, the position value in G1_XIST1 will not be affected by a preset. Should be selected, if the preset should have an impact not only on G1_XIST2 and G1_XIST3, but also on G1_XIST1.
- **Scaling function control:**
  Activating/deactivating the scaling function. The "Scaling function"- parameter can be used to change the encoder resolution. Note that the "Scaling function" parameters can be activated only, if "Class 4 functionality" and "Scaling function control" are activated. Otherwise, the scaling function is disabled and the resolution is 1 µm.
- **Alarm channel control:**
  Activating/deactivating the alarm channel. This parameter is used to limit the amount of data sent. This parameter is only supported in compatibility mode and can be deactivated only in compatibility mode V3.1.
- **Compatibility mode V3.1:**
  Activating/deactivating the compatibility mode. This parameter indicates, if the sensor should run in a mode compatible with encoder profile 3.1. The functions which are affected when this parameter is activated are listed in Fig. 611.
- **Measurement step:**
  Position measurement resolution 0.5, 1, 2, 5, 10, 50, 100 µm, provided that the "Scaling function" is activated.
- **Measurement range:**
  Limits the measuring range to the number of measurement steps, provided that the "Scaling function" is activated.

- **Maximum master sign-of-life failures:**
  Specifies the number of allowed failures of the masters sign-of-life. This parameter is only supported in compatibility mode V3.1. If the maximum number of permissible errors is exceeded, the position sensor sends a sign of life error in G1_XIST2.
- **Velocity unit [3]:**
  Specifies the coding of the velocity units used to configure the signals NIST_A and NIST_B (Fig. 5959).

| Velocity measuring units | Value |
|---|---|
| Steps/s | 0 |
| Steps/100 ms | 1 |
| Steps/10 ms | 2 |

*Fig. 59: Velocity units*

| Attribute | Meaning | Value |
|---|---|---|
| Enable | Compatibility with encoder profile V3.1 | 0 |
| Disable | No backward compatibility (default) | 1 |

*Fig. 60: Compatibilty mode*

| Function | Compatibility mode enabled (= 0) | Compatibility mode disabled (= 1) |
|---|---|---|
| Control by PLC (STW2_ENC) | Ignored, the control word (G1_STW) and the set point values are always valid. Control requested (ZSW2_ENC) is not supported and is set to 0. | Supported |
| User parameter alarm channel control | Supported | Not supported, the application alarm channel is active and controlled by a PROFIdrive parameter. |
| P965 Profile Version | 31 (V3.1) | 42 (V4.2) |

*Fig. 61: Function*

For more information about the standard parameters and functions according to the encoder profile V4.2 please refer to the document "Profile Drive Technology Encoder-Profile (Version 4.2)" from PROFIBUS Nutzerorganisation e.V..

The operation manual and the GSD file for the R-Series Ⅴ PROFINET with encoder profile 4.1 (Profinet firmware < 2.2) can be found at www.mtssensors.com under "Legacy Products".

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**3/** A "step" corresponds to the selected resolution

## 7. TempoLink smart assistant with R-Series V PROFINET

The TempoLink smart assistant supports the R-Series V PROFINET. The TempoLink smart asssitant can be used to read current status information of the sensor and to adjust settings for identification of the sensor in the network. In addition, the current parameter settings can be viewed via the TempoLink smart assistant. This allows the sensor to be checked offline, i.e. without integration into a network. For further information see the TempoLink smart assistant operation manual (document number: 551986).

## 8. Maintenance and troubleshooting

### 8.1 Error conditions, troubleshooting

See chapter "5. Operation" on page 23.

### 8.2 Maintenance

The sensor is maintenance-free.

### 8.3 Repair

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

### 8.4 List of spare parts

No spare parts are available for this sensor.

### 8.5 Transport and storage

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

## 9. Removal from service/dismantling

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

## 10. Technical data

### 10.1 Technical data Temposonics® R-Series Ⅴ RP5

| Output | |
|---|---|
| Interface | PROFINET RT<br>PROFINET IRT version 2.3 |
| Data protocol | MTS Profile and Encoder Profile V4.2 |
| Data transmission rate | 100 MBit/s (maximum) |
| Measured value | Position, velocity/option: Simultaneous multi-position and multi-velocity measurements up to 30 magnets |

| **Measurement parameters** | | | | | | |
|---|---|---|---|---|---|---|
| Resolution: Position | 0.5…100 µm (selectable) | | | | | |
| Cycle time | Stroke length | ≤ 50 mm | ≤ 715 mm | ≤ 2000 mm | ≤ 4675 mm | ≤ 6350 mm |
| | Cycle time | 250 µs | 500 µs | 1000 µs | 2000 µs | 4000 µs |

| Linearity deviation [4] | Stroke length | ≤ 500 mm | > 500 mm |
|---|---|---|---|
| | Linearity deviation | ≤ ±50 µm | < 0.01 % F.S. |

Optional internal linearization: Linearity tolerance (applies for the first magnet for multi-position measurement)

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

| | |
|---|---|
| Repeatability | < ±0.001 % F.S. (minimum ±2.5 µm) typical |
| Hysteresis | < 4 µm typical |
| Temperature coefficient | < 15 ppm/K typical |

| **Operating conditions** | |
|---|---|
| Operating temperature | –40…+85 °C (–40…+185 °F) |
| Humidity | 90 % relative humidity, no condensation |
| Ingress protection | IP67 (connectors correctly fitted) |
| Shock test | 150 g/11 ms, IEC standard 60068-2-27 |
| Vibration test | 30 g/10…2000 Hz, IEC standard 60068-2-6 (excluding resonant frequencies) |
| EMC test | Electromagnetic emission according to EN 61000-6-3<br>Electromagnetic immunity according to EN 61000-6-2<br>The sensor meets the requirements of the EC directives and is marked with C E |
| Magnet movement velocity | Magnet slider: Max. 10 m/s; U-magnet: Any; block magnet: Any |

| **Design/Material** | |
|---|---|
| Sensor electronics housing | Aluminum (painted), zinc die cast |
| Sensor profile | Aluminum |
| Stroke length | 25…6350 mm (1…250 in.) |

| **Mechanical mounting** | |
|---|---|
| Mounting position | Any |
| Mounting instruction | Please consult the technical drawings on |

| **Electrical connection** | |
|---|---|
| Connection type | 2 × M12 female connectors (D-coded), 1 × M12 male connector (A-coded)<br>2 × M12 female connectors (D-coded), 1 × M8 male connector |
| Operating voltage | +12…30 VDC ±20 % (9.6…36 VDC) |
| Power consumption | Less than 4 W typical |
| Dielectric strength | 500 VDC (DC ground to machine ground) |
| Polarity protection | Up to –36 VDC |
| Overvoltage protection | Up to 36 VDC |

**4/** With position magnet # 252 182

### 10.2 Technical data Temposonics® R-Series V RH5

| Output | | | | | |
|---|---|---|---|---|---|
| Interface | PROFINET RT<br>PROFINET IRT version 2.3 | | | | |
| Data protocol | MTS Profile and Encoder Profile V4.2 | | | | |
| Data transmission rate | 100 MBit/s (maximum) | | | | |
| Measured value | Position, velocity/option: Simultaneous multi-position and multi-velocity measurements up to 30 magnets | | | | |

| Measurement parameters | | | | | |
|---|---|---|---|---|---|
| Resolution: Position | 0.5…100 µm (selectable) | | | | |
| Cycle time | Stroke length | ≤ 50 mm | ≤ 715 mm | ≤ 2000 mm | ≤ 4675 mm | ≤ 7620 mm |
| | Cycle time | 250 µs | 500 µs | 1000 µs | 2000 µs | 4000 µs |
| Linearity deviation [5] | Stroke length | ≤ 500 mm | > 500 mm | | | |
| | Linearity deviation | ≤ ±50 µm | < 0.01 % F.S. | | | |
| | Optional internal linearization: Linearity tolerance (applies for the first magnet for multi-position measurement) | | | | | |
| | Stroke length | 25…300 mm | 300…600 mm | 600…1200 mm | | |
| | typical | ± 15 µm | ± 20 µm | ± 25 µm | | |
| | maximum | ± 25 µm | ± 30 µm | ± 50 µm | | |
| Repeatability | < ±0.001 % F.S. (minimum ±2.5 µm) typical | | | | |
| Hysteresis | < 4 µm typical | | | | |
| Temperature coefficient | < 15 ppm/K typical | | | | |

| Operating conditions | |
|---|---|
| Operating temperature | –40…+85 °C (–40…+185 °F) |
| Humidity | 90 % relative humidity, no condensation |
| Ingress protection | IP67 (connectors correctly fitted) |
| Shock test | 150 g/11 ms, IEC standard 60068-2-27 |
| Vibration test | 30 g/10…2000 Hz, IEC 60068-2-6 (excluding resonant frequencies) /<br>RH5-J: 15 g/10…2000 Hz, IEC standard 60068-2-6 (excluding resonant frequencies) |
| EMC test | Electromagnetic emission according to EN 61000-6-3<br>Electromagnetic immunity according to EN 61000-6-2<br>The sensor meets the requirements of the EC directives and is marked with $C\!\!\in$ |
| Operating pressure | 350 bar (5,076 psi)/700 bar (10,153 psi) peak (at 10 × 1 min) for sensor rod/RH5-J: 800 bar (11,603 psi) |
| Magnet movement velocity | Any |

| Design/Material | |
|---|---|
| Sensor electronics housing | Aluminum (painted), zinc die cast |
| Sensor flange | Stainless steel 1.4305 (AISI 303) |
| Sensor rod | Stainless steel 1.4306 (AISI 304L)/RH5-J: Stainless steel 1.4301 (AISI 304) |
| Stroke length | 25…7620 mm (1…300 in.)/RH5-J: 25…5900 mm (1…232 in.) |

| Mechanical mounting | |
|---|---|
| Mounting position | Any |
| Mounting instruction | Please consult the technical drawings on |

| Electrical connection | |
|---|---|
| Connection type | 2 × M12 female connectors (D-coded), 1 × M12 male connector (A-coded)<br>2 × M12 female connectors (D-coded), 1 × M8 male connector |
| Operating voltage | +12…30 VDC ±20 % (9.6…36 VDC) |
| Power consumption | Less than 4 W typical |
| Dielectric strength | 500 VDC (DC ground to machine ground) |
| Polarity protection | Up to –36 VDC |
| Overvoltage protection | Up to 36 VDC |

**5/** With position magnet # 251 416-2

## 11. Appendix I

### Safety declaration

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

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

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

**The sensor has been in contact with the following materials:**

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

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

**Short description of malfunction:**

**Corporate information**

Company: _____

Address: _____

_____

**Contact partner**

Name: _____

Phone: _____

E-mail: _____

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

Stamp

Signature

Date

## 12. Appendix II

# C Y L I N D E R   P O R T   D E T A I L S

## PORT DETAIL (PD) FOR RH5-S:
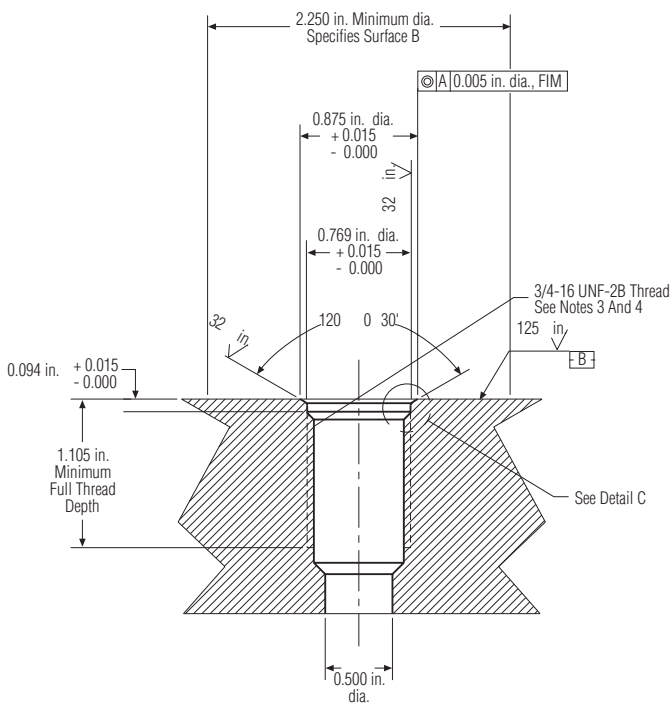
**NOTES:**
1. Dimensions and tolerances based on ANSI Y14.5-1982.
2. MTS has extracted all pertinent information from MS33649 to generate this document.
3. PD must be square with surface B within 0.005 FIM across 2.250 dia minimum.
4. PD must be concentric with 2.250 dia within 0.030 FIM and with 0.769 dia within 0.005 FIM.
5. Surface texture ANSI B46.1-1978
6. Use O-ring MTS part number 560315 for correct sealing.
7. The thread design shall have sufficient threads to meet strength requirements of material used.
8. Finish counter-bore shall be free from longitudinal and spiral tool marks. Annular tool marks up to 32 microinches maximum will be permissible.
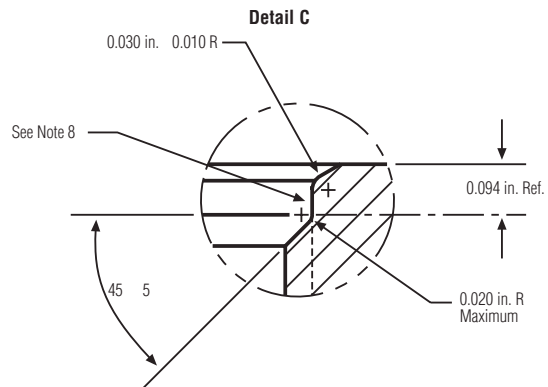
**Detail C**

## PORT DETAIL (PD) FOR RH5-T:
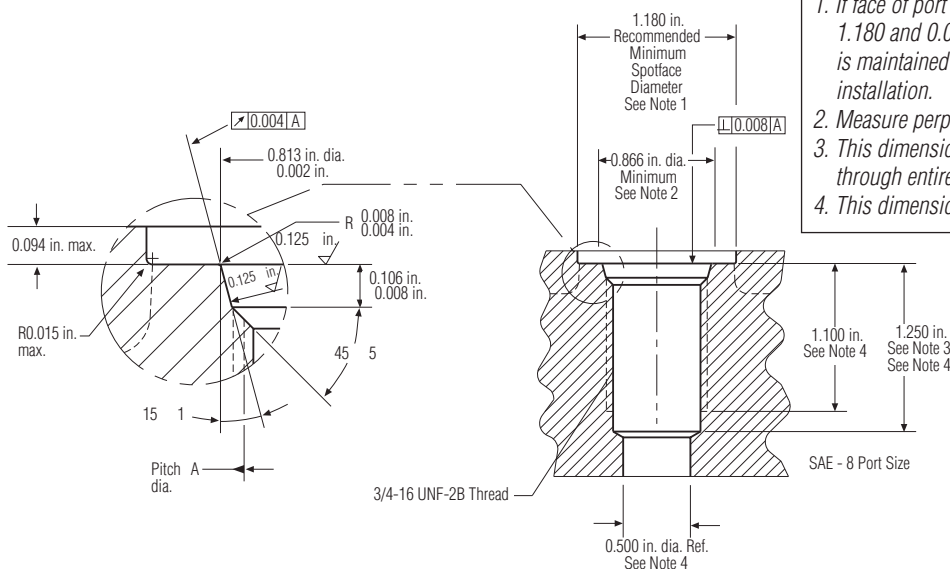
**NOTES:**
1. If face of port is on a machined surface, dimensions 1.180 and 0.094 need not apply as long as R0.008/0.004 is maintained to avoid damage to the O-ring during installation.
2. Measure perpendicularity to A at this diameter.
3. This dimension applies when tap drill cannot pass through entire boss.
4. This dimension does not conform to SAE J1926/1.

## 13. Glossary

### E

**Encoder Profile**
The encoder profile corresponds to the specification of the encoder profile V4.2 (PNO no. 3.162). With this profile, the position and the velocity of one magnet can be measured and transferred simultaneously. (→ MTS Profile)

**Extrapolation**
The native measurement cycle time of a sensor increases with the stroke length. With extrapolation, the sensor is able to report data faster than the native cycle time, independent of the stroke length of the sensor. Without extrapolation, if data is requested faster than the native cycle time, the last measured value is repeated.

### F

**FIR Filter**
The FIR filter (**F**inite **I**mpulse **R**esponse) is used to smooth the measured position value before output. To determine the output value, only input values corresponding to the window (filter window size) are used for filter calculation. The output value is calculated from these input values in the form of a moving average value. (→ IIR Filter)

### G

**GSDML**
The properties and functions of a PROFINET IO field device are described in a GSDML file (**G**eneral **S**tation **D**escription). The XML-based GSDML file contains all relevant data that are important for the implementation of the device in the controller as well as for data exchange during operation. The GSDML file of the R-Series V PROFINET is available on the homepage www.mtssensors.com.

### I

**IIR Filter**
The IIR filter (**I**nfinite **I**mpulse **R**esponse) is used to smooth the measured position value before output. To determine the outputvalue, the input values corresponding to the fi lter grade (fi lter window size) are used for the fi lter calculation. The previous values are also taken into account when calculating the output value. (→ FIR Filter)

**Internal Linearization**
The internal linearization offers an improved linearity for an overall higher accuracy of the position measurement. The internal linearization is set for the sensor during production.

**IRT**
With PROFINET IRT (**I**sochronous **R**eal **T**ime) a clock-synchronous data transmission takes place. The application, the data transmission as well as the device cycle are synchronous. IRT enables a clock-synchronous data exchange with a minimum cycle time of 250 µs in the network. The R-Series V PROFINET supports PROFINET RT and IRT. (→ RT)

### M

**Measuring Direction**
When moving the position magnet, the position and velocity values increase in the measuring direction.
• Forward: Values increasing from sensor electronics housing to rod end/profile end
• Reverse: Values increasing from rod end/profile end to sensor electronics housing

**MTS Profile**
The MTS profile was developed by MTS Sensors and is tailored to the characteristics of magnetostrictive position sensors. With this profile, the positions and velocities of up to 30 magnets can be reported and transferred simultaneously. (→ Encoder Profile)

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

### O

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

### P

**PLC**
A PLC (**P**rogrammable **L**ogic **C**ontroller) is a device for controlling or regulating machines and systems.

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

**PROFINET**
PROFINET (**Pro**cess **Fi**eld **Net**work) is an Industrial Ethernet interface and is managed by the **P**ROFIBUS **N**utzer**o**rganiation e.V. (PNO). The R-Series V PROFINET and its corresponding GSDML file are certitified by the PNO.

### R

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

**RT**
With PROFINET RT (**R**eal **T**ime) the data exchange is without clock synchronization. In this case, the application, the data transmission and the field devices operate according to their own processing cycle. The R-Series V PROFINET supports PROFINET RT and IRT. (→ IRT)

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

![MTS SENSORS logo]

**www.mtssensors.com**