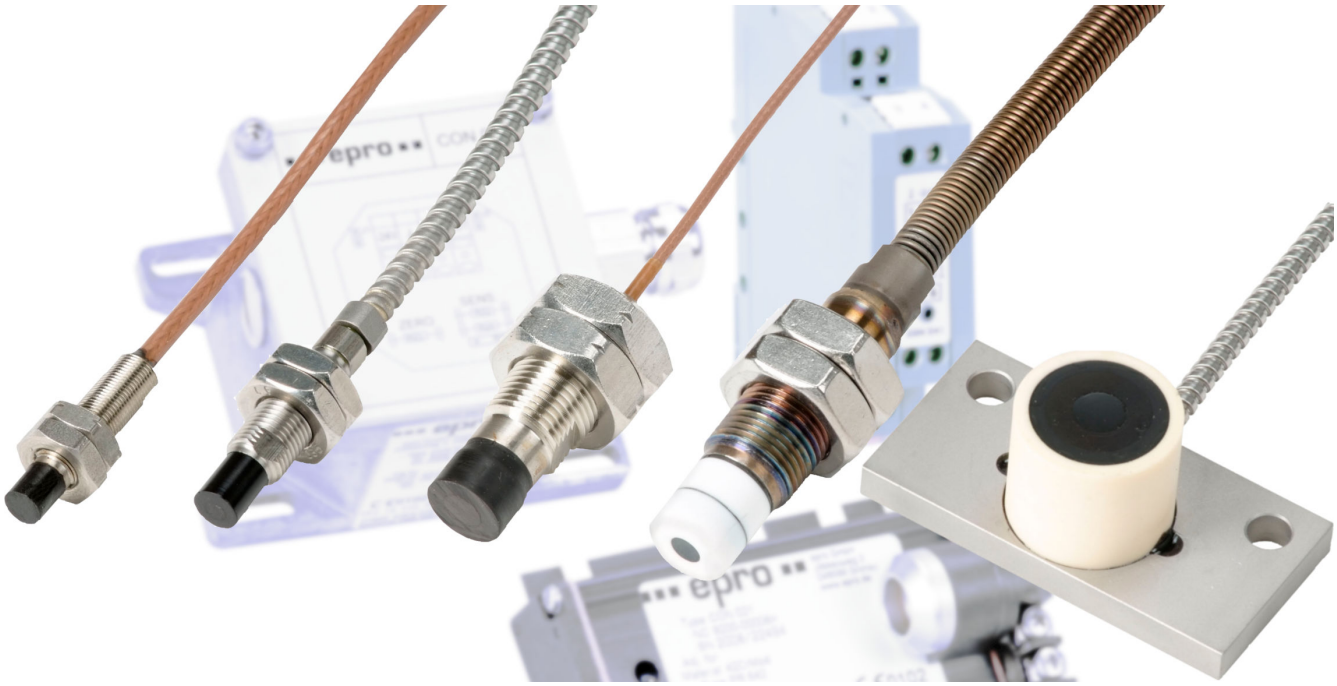
**Installation Guide**
MHM-97857 , Rev 1.5
January 2020

# Machinery Health™ Sensor

## PR 642x, Eddy Current Sensors

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# Contents

# 1 General

## 1.1 Using this manual

This manual contains information concerning the proper and correct use of the PR 6422, PR 6423, PR 6424, PR 6425 and PR 6426 eddy current transducers.

For correct and safe use of this device read the entire operating manual prior to installing and operating the device. In particular, comply with all safety instructions contained in the manual.

Do not transfer the device to third parties without including the operating manual.

**Note**
When requesting technical support for this device, please indicate type and serial number as shown on the type plate as well as the used converter type.

Table 1-1 shows a list of documents that are referred to in this installation guide.

**Table 1-1: Referenced documents**

| | |
|---|---|
| DfU_GA_CON011 HWRev04 | Operating manual of CON 011 eddy current signal converter |
| DfU_GA_CON 021_031 HWRev04 | Operating manual of CON 021 and CON 031 eddy current signal converters |
| DfU_GA_CON 041 HWRev04 | Operating manual of CON 041 eddy current signal converter |
| OM CSI 9360 | Operating manual of CSI 9360 4-20 mA loop powered eddy current transmitter |
| DfU_MMS_3110; DfU_ MMS_3210; DfU_MMS_3220; OM_MMS_3311 | Operating manuals of the devices of the MMS 3000 System which use eddy current sensors |

## 1.2 Symbol explanation

**Note**
This symbol marks passages that contain important information.

**⚠ CAUTION**

Operations that may lead to malfunctions or faulty measurements, without damaging the device, are marked with this symbol.

**⚠ DANGER**

A Danger indicates actions that can lead to property damage or personal injuries.

## 1.3 Liability and guarantee

Emerson Process Management is not liable for damages that occur due to improper use. Proper use also includes knowledge of, and compliance with this operating manual.

Customer changes to the device that have not been approved expressly by Emerson, will result in the loss of guarantee.

Due to continuous research and further development Emerson reserves the right to change technical specifications without notice.

## 1.4 Incoming goods inspection

Check the content of the shipment to ensure that it is complete; visibly inspect the goods to determine if the device has been damaged during transport. The following parts are included in the scope of delivery and must be contained in the shipment.

- Eddy current sensor PR 6422, PR 6423, PR 6423, PR 6425 or PR 6426 (with protection cap)
- Lemo connection cable (only PR 642x/xxx-0xx types)
- Mounting nuts (respectively screws at PR 6426)
- Shrink sleeve for isolating the adapter plug (only PR642x/xxx-0xx types)
- Operating manual for installing and using the sensor

If the contents are incomplete, or if you observe any defects, file a complaint with the carrier immediately. Moreover, inform the responsible Emerson sales organization so your device can be replaced. In this case, attache to the device a non-detachable tag with customer name and the observed defect.

## 1.5 Technical support

You may need to ship this product for return, replacement, or repair to an Emerson Product Service Center. Before shipping this product, contact Emerson Product Support to obtain a Return Materials Authorization (RMA) number and receive additional instructions.

### Product Support

Emerson provides a variety of ways to reach your Product Support team to get the answers you need when you need them:

| | |
|---|---|
| **Phone** | Toll free 800.833.8314 (U.S. and Canada)<br>+1.512.832.3774 (Latin America)<br>+63.2702.1111 (Asia Pacific, Europe, and Middle East) |
| **Email** | ap-sms@emerson.com |
| **Web** | http://www.emerson.com/en-us/contact-us |

To search for documentation, visit http://www.emerson.com.

To view toll free numbers for specific countries, visit http://www.emersonprocess.com/technicalsupport.

**Note**
If the equipment has been exposed to a hazardous substance, a Material Safety Data Sheet (MSDS) must be included with the returned materials. An MSDS is required by law to be available to people exposed to specific hazardous substances.

## 1.6 Storage and transport

Store and transport the device only in its original packaging. x, "Technical Data", specifies the environmental conditions for storage and support.

## 1.7 Disposal of the device

Provided that no repurchase or disposal agreement exists, recycle the following components at appropriate facilities:

- Recyclable metal
- Plastic elements

Sort the remaining components for disposal, based on their condition. National laws or provisions on waste disposal and protection of the environment apply.

**Note**
Environmental hazards! Electrical waste and electronic components are subject to treatment as special waste and may only be disposed by approved specialized companies.

## 1.8 China RoHS Compliance

Our products manufactured later than June 30, 2016 and those which are sold in the People's Republic of China are marked with one of the following two logos to indicate the Environmental Friendly Use Period in which it can be used safely under normal operating conditions.

Products without below mentioned marking are either manufactured before June 30 or are non-electrical equipment products (EEP).

Circling arrow symbol with "e": The product contains no hazardous substances over the Maximum Concentration Value and it has an indefinite Environmental Friendly Use Period.


Circling arrow symbol with a number: This product contains certain hazardous substances over the Maximum Concentration Value and it can be used safely under normal operating conditions for the number of years indicated in the symbol. The names and contents of hazardous substances can be found in the folder "China RoHS Compliance Certificates" on the documentation CD or DVD enclosed with the product.

# 1.9 Installation awareness

**Note**

When planning a measurement, observe the following items:

- Consider environmental conditions which might have an influence on the measurement such as temperature, humidity, substances aggressive to the sensor, and pollution.
- Always use a stiff and vibration-free sensor holder.
- Define a suitable measuring range, not larger than necessary, in consultation with the operator of the plant.
- Define the trip limit in consultation with the operator of the plant.
- Take measurement deviations into account when defining the trip limit.
- Use a sensor that meets the requirements of the defined measuring range.
- Ensure an EMC-compatible installation including the use of proper cables.
- Ensure proper function of the measurement before activating the measurement for regular operation.

# 2 Safety Instructions

To ensure safe operation, carefully observe all instructions in this manual.

The correct and safe use of this device requires that operating and service personnel both understand and comply with general safety guidelines and observe the special safety comments listed in this manual. Where necessary, safety-sensitive points on the device are marked.

**⚠ DANGER**

Since the sensor is electrical equipment, commissioning and service may be performed only by trained personnel. Maintenance may be carried out only by trained, specialized, and experienced personnel.

## 2.1 Using the device

Measuring systems with eddy current sensors as PR 6422, PR 6423, PR 6424; PR 6425 and PR 6426 serve in conjunction with eddy current converters as CON 011, CON 021, CON 041, the transmitters with integrated converters of the MMS 3000 series or the transmitter CSI 9360 the measurement of mechanical quantities, such as shaft vibration, shaft displacement and speed (not if CSI 9360 is used).

## 2.2 Owner's responsibility

If there is a reason to suspect that hazard-free operation and thus adequate machine protection is no longer possible, take the device out of operation and safeguard it from unintentional operation. This is the case:

- if the device shows visible damage
- if the device no longer works
- after any kind of overload that has exceeded the permissible limits (such as those detailed in Environmental conditions).

**⚠ DANGER**

If sensor tests have to be completed during operation, or if the sensor has to be replaced or decommissioned, it will impair the machine protection and may cause the machine to shut down. Make sure to deactivate machine protection before starting such work, and reactivate it after work has been completed.

# 3 Application and Design

## 3.1 The Measuring Chain

Together with signal converters of the series CON 0x1, integrated converters of the MMS 3000 series, or the CSI 9360 transmitter, the sensors PR 6422 to PR 6426 form eddy current measuring chains for contactless distance, vibration and speed measurements. Different types of sensors and converters allow an optimal adaption to the requirements of the machine to be monitored.

A additional electronic components, like the CSI 6500 system, allow static and dynamic distance measurements, which means it is possible to measure slow axial displacements and quick axial shaft vibrations of rotating machines.

To achieve a high accuracy, the measuring chains consisting of both converter and sensor are adjusted together and delivered as complete measuring chain.

## 3.2 The Sensors

The PR 642x series includes five eddy current sensor types in different variants as shown in chapter Order Matrix.

Which sensor type is applicable for a measuring application depends on several requirements as desired measuring range, available measuring track, and maximum environmental temperature.

The characteristics of the measuring chain are adapted to the material mainly used for turbo machinery (reference material: 42 Cr Mo 4, according to SAE 4140). The standard adjustment of the measuring chains is generally related to this material; during installation at the machine, you only need to adjust the distance between the head of the sensor and the measuring target. The signal output of the converter determines how you should adjust the sensor.

# 4 Installation and Mounting

## 4.1 Measuring chain and material of measuring target

To achieve a high accuracy of relative distance measurements, you must adjust the measuring chain precisely on the target material. For this reason, the manufacturer requires information on the material to adjust the converter. For the materials listed in the table in section Measuring targets, it is sufficient to indicate only the material. If you use another material, a sample of the target material with the following dimensions must be sent to the workshop: thickness ≥5 mm, diameter ≥50 mm.

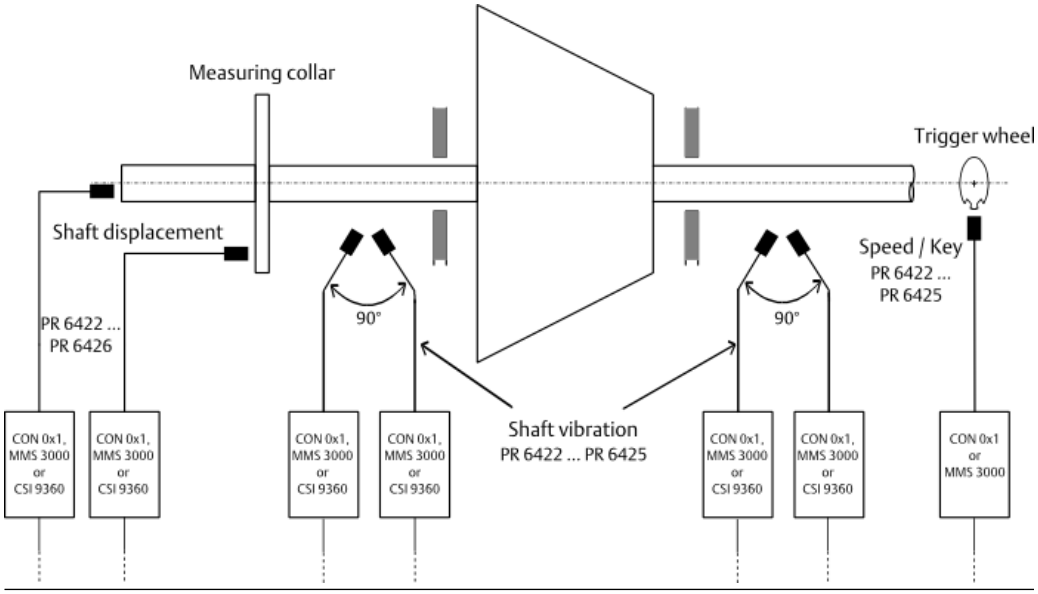
If, while ordering, information regarding your material is not available, the measuring chain will be adjusted on the standard material 42 CrMo 4 (SAE 4140).

## 4.2 Choosing the measuring place

Figure 4-1 is an example scheme for how to place the sensors at a turbine shaft to measure the axial displacement, shaft vibration, or speed. You must consider the minimum shaft diameter for this type of sensor, the minimum material width in front of the sensor head, and the minimum gap (refer to Requirements and hints for the sensor mounting).

To measure shaft vibration, Emerson recommends using a sensor holder between bearing and turbine housing as close as possible to the rotor.

**Figure 4-1: Example scheme where to place the sensors**



# 4.3 Mount the sensor

The following steps describe the mounting of sensor types PR 6422, PR 6423, PR 6424 and PR 6425. For mounting hints regarding the PR 6426 see PR 6426 installation. See also the respective converter manuals as listed inTable 1-1 for further details regarding sensor adjustment.

### Procedure

1. Screw in the sensor into the holder.

   Ensure that the threads are clean and smooth-running.

   Do not bend or twist the sensor cable. If the sensor cable has a LEMO adapter plug open it.

   To avoid touching the shaft during installation, the maximum distance between measuring target and sensor head must be adjusted first - screw in the sensor until the converter output voltage starts changing (approximately at -20V DC). Close the LEMO adapter plug for measuring the converter output voltage.

2. Adjust the distance between measuring target and sensor head in accordance to the measuring task.

   Use a voltmeter connected to the converter output to measure the output voltage. Open the LEMO adapter plug at every two turns of the sensor to untwist the cable.

   Ensure that in direction to the sensor head at least two of the threads remain free as shown in Figure 4-2.

3. Secure the sensor by fixing the nuts.

   The maximum torque for fixing the nuts is:

   - PR 6422: 1 Nm (0,1 kpm)
   - PR 6423: 15 Nm (1,5 kpm)
   - PR 6424, PR 6425: 98 Nm (10 kpm)

## 4.3.1 Requirements and hints for the sensor mounting

This section contains information and installation requirements for the sensor. The final adjustment of the sensor depends on the measuring task and requires a complete measuring chain. The converter, MMS 3000 and CSI 9360 manuals, and the manuals for the evaluation electronics, contain detailed information regarding the final adjustment.

### General holder requirement

To mount the sensor, use a stiff and vibration-free holder with a mounting thread for the relevant sensor (PR 6422 to PR6425).

### General distance adjustment

For distance adjustment the complete measuring chain consisting of sensor and converter is required as the distance will be generally adjusted by means of the converter output voltage.

### Sensor fastening

- Use the enclosed nuts when installing sensors with mounting threads
- When installing sensors with mounting threads captive nuts must be used to avoid loosen of the sensor. Loose parts can fall into the machine and cause damages. A medium grade removable thread locked (for example Loctite® 242, blue) is recommended to secure the sensor.

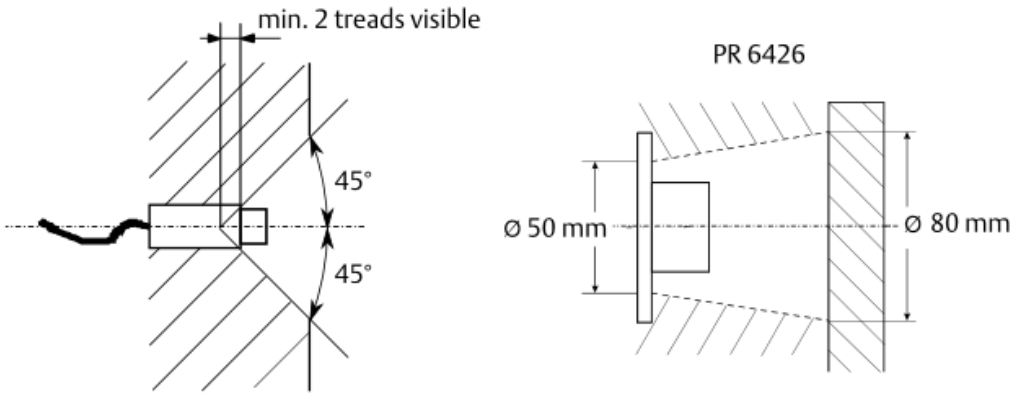
### Measuring track on the measuring target

The measuring track on the measuring target must be free from irregularities as scratches, corrosion, stress concentrations, metallurgical segregation, high concentricity, etc. These irregularities may cause changes in the sensor output voltage which are not related to a real position or vibration signal. The signal caused by these irregularities is called runout. For the measuring track a surface finish of 0.41 µm to 0.76 µm is recommended.

### Free space

Ensure there is 45° of free space around the sensor head for all sensor types except PR 6426, as shown in the left diagram of Figure 4-2. The right drawing in Figure 4-2 shows the required free space around the PR 6426.

**Figure 4-2: Free space around sensor head**




Free space PR 6422, PR 6423, PR 6424 and PR 6425: ± 45°

Free space PR 6426: minimum = 80 mm; for nominal range ±4 mm and for extended ranges

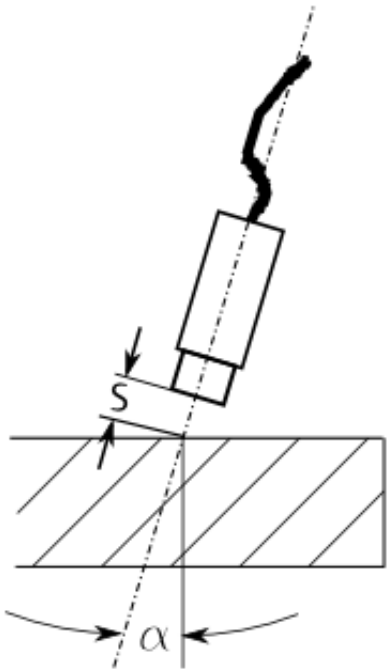
**⚠ CAUTION**

If you do not ensure the free space specifications, the measuring range at the upper end reduces and the linearity error increases.

### Maximum axial tilting angle

Ensure that the maximum axial tilting angle alpha is < 2° if using PR 6422, PR 6423, PR 6424 or PR 6425 as shown in Figure 4-3, or alpha < 1.6° if using PR 6426 as shown in Figure 4-4. There is no significant influence on the measuring result in this case.

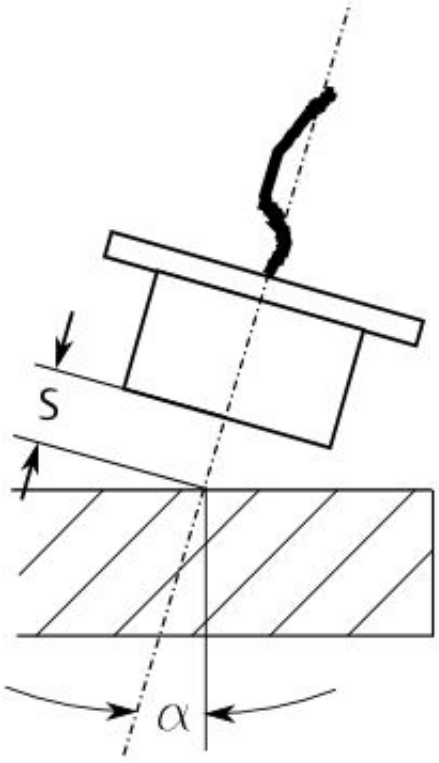
**Figure 4-3: Maximum axial tilting if using PR 6422, PR 6423, PR 6424 or PR 6425**




S: distance between measuring target and sensor head

Alpha: max. axial tilting angle < 2°

**Figure 4-4: Maximum axial tilting if using PR 6426**




S: distance between measuring target and sensor head

Alpha: max. axial tilting angle < 1.6°

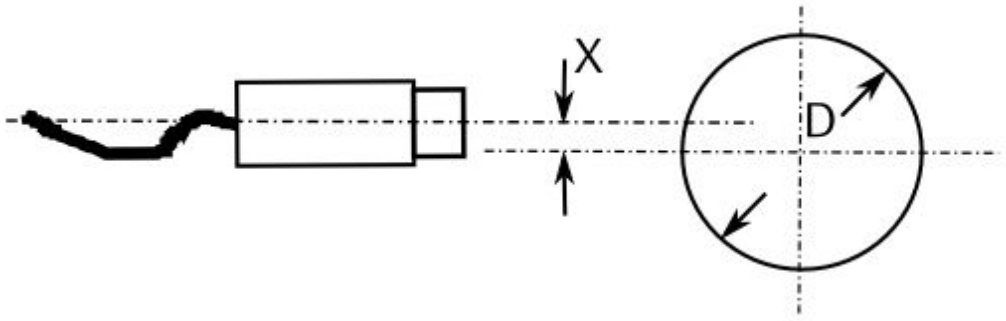
### Maximum tangential offset

Ensure the maximum tangential offset matches the values in Table 4-1. Figure 4-5 shows the definition of the tangential offset.

**Table 4-1: Maximum tangential offset**

| Sensor type | Max. offset X | Shaft diameter D |
|---|---|---|
| PR 6422 | 0.2 mm | ≥ 15 mm |
| PR 6423 | 0.5 mm | ≥ 28 mm |
| PR 6424 | 0.5 mm | ≥ 60 mm |
| PR 6425 | 0.5 mm | ≥ 60 mm |

**Figure 4-5: Maximum tangential offset**




X: max. tangential offset

D: shaft diameter

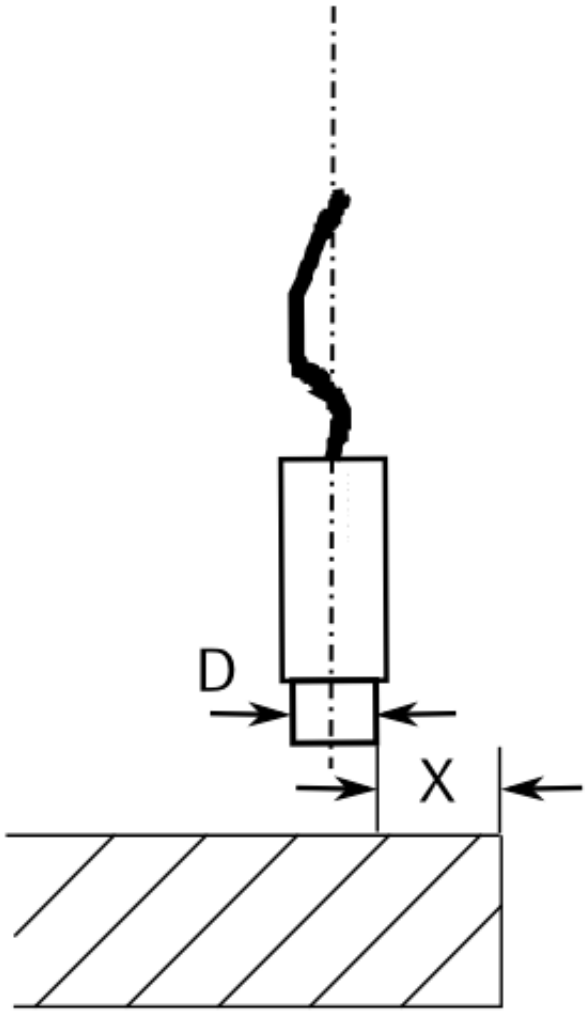
### Minimum measuring area

Ensure that the minimum measuring area matches the values in Table 4-2. Figure 4-6 defines of the minimum measuring area.

**Table 4-2: Minimum measuring area**

| Sensor type | X minimum | Sensor head diameter |
|---|---|---|
| PR 6422 | 5 mm | 5.2 mm |
| PR 6423 | 3 mm | 8 mm |
| PR 6424 | 3 mm | 16 mm |
| PR 6425 | 2 mm | 15.8 mm |
| PR 6426 | 2 mm | 32 mm |

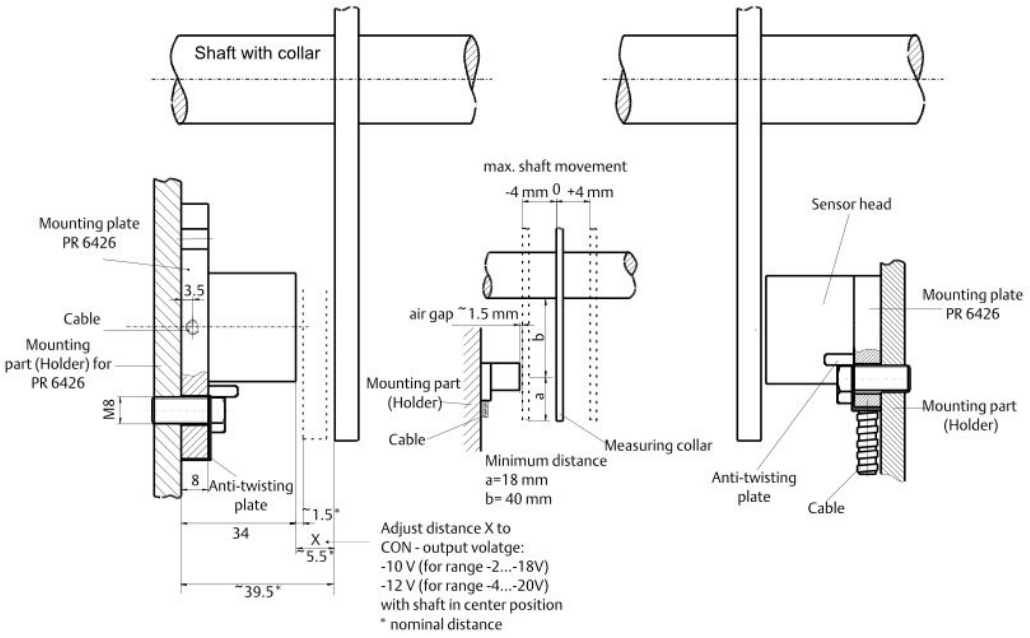
**Figure 4-6: Minimum measuring area**




## 4.3.2 PR 6426 installation

Figure 4-7 shows an installation example for the sensor PR 6426. Its reference area is the mounting plate. The nominal distance of the mounting plate to the measuring target in the center position is approx. 39.5 mm. After you fix the mounting screws, bend the safety plate (anti-twisting plate) to prevent the screws from getting loose.

**Figure 4-7: Mounting example PR 6426**




# 4.4 Wiring hints

This section contains general information and wiring hints regarding the sensor cable installation. The necessary measures for the proper cable installation depend always on the situation on-site. Observe the following points for a reliable cable installation:

- Do not bend or twist the sensor cables. Cables and connectors must be movable when the sensor is adjusted in its holder.
- Install the cable strain-free and spin-free such that it is protected against mechanical damages.
- Do not shorten the sensor cable or the extension cable of PR 6422 and PR 6423. Rollup the excess cable (rolling diameter ≥100 mm).
- Ensure that no parts of the cable, including the adapter plug, touch any rotating parts of the machine.
- Note that machines can expand or shrink due to temperature influences. Always install the sensor cable with a cable length reserve to compensate for the thermal behavior of the machine.
- Only install cables with a minimum bending radius of 25 mm. For sensor cables with metal protection tubes, the minimum bending radius is 35 mm.
- Avoid oil stream areas for sensor cableways. Be sure that no oil stream or other agitations will permanently move the cable.
- Avoid sensor cableways where the cable is permanently submerged into oil.
- Affix the sensor cable at recurring short distances.

- Do not bend or twist the sensor cables. Cables and connectors must be movable when the sensor is screwed into the holder.
- Do not squeeze the cable; for example, between metal plates for fixing. Squeezing the cable will damage the outer isolation, which could allow oil into the cable or causes short-circuits.
- Lead the sensor cable through the bearing pedestal wall (machine case), below the horizontal joint of the machine and above the residual oil level in the bearing pedestal. Do not lead the sensor cable through the upper and / or removable pedestal cover. This could cause problems during machine maintenance, and represents a safety concern.
- Place junction boxes on a higher level than the sensor to stop oil from entering the cable protection tubes. You can also use swan-necks for the same purpose.

## 4.5 Sensor cables with LEMO adapter plug

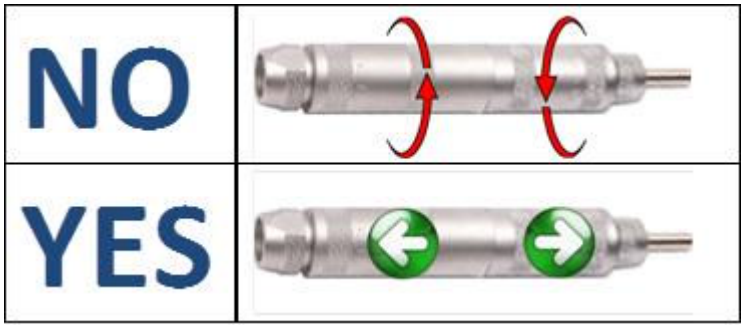
The sensor cables are available with open cable end or with a LEMO connector. Some sensor types have a LEMO adapter plug after the first meter of the sensor cable. The following hints apply, regardless of the size of the LEMO connector.

- To connect, push the LEMO plug into an according socked or counterpart. The LEMO connector locks with an audible click.
- To unlock the connector, pull it out of the socket.

**Note**
The LEMO connector as well as the LEMO adaptor plug are pluggable connectors. Do not turn the connectors for opening.

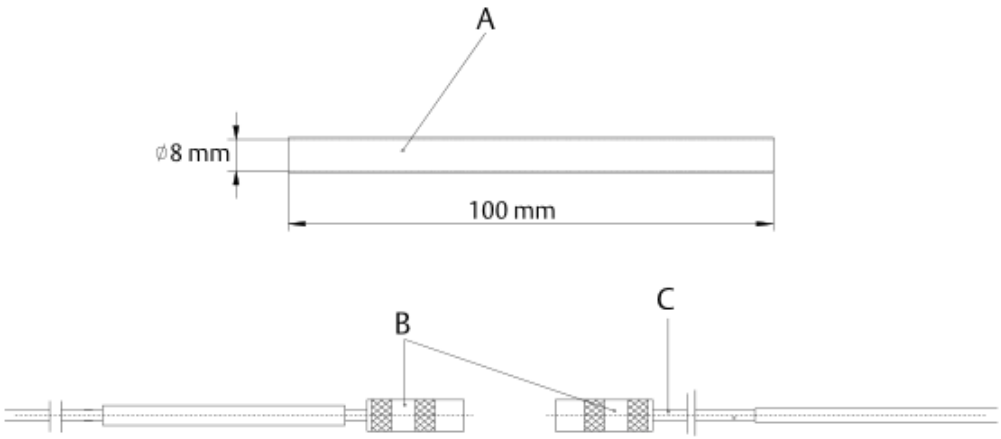
Figure 4-8 is a label that is attached to the sensor cable. It illustrates how to properly disconnect the LEMO connectors.

**Figure 4-8: Label: Use of LEMO plug**




Cover the LEMO adapter plug with the shrink sleeve included into the delivery. The shrinking temperature of the shrink sleeve with an approximately length of 100 mm is approximately 200°C. Applying a shrink sleeve to the LEMO connector isolates and protects the connection and is always required - even when using metal protection tubes. Figure 4-9 shows the shrink sleeve.

**Figure 4-9: Measurement specifications for applying shrink sleeve**




A: Shrink sleeve

B: Adapter plug

C: Sensor cable

### Apply shrink sleeve to a connector

1. At the open adapter connection, push the shrink sleeve over one connector so that the sleeve completely covers the sensor cable.
2. Close the LEMO connection.
3. Move the shrink sleeve over the closed connection. The LEMO adapter plug should be completely covered by the shrink sleeve. The shrink sleeve should evenly overlap the adapter plug.
4. Use a hot air gun to evenly shrink the sleeve. The required shrinking temperature is approximately 200°C.
5. Ensure that the shrank sleeve touches sensor cable and adapter plug. It is important that the shrink sleeve cannot slip form the adapter plug.

# 5 Technical data

Only specifications with tolerances are guaranteed. Data without tolerance or without error limits are informative data and not guaranteed.

All specifications are valid for a measuring chain consisting of a sensor PR 6422, PR 6423, PR 6424, PR 6425 or PR 6426 and one of the following converters CON 011, 021, 031 or 041 respectively an integrated converter in a MMS 3000 transmitter adjusted on it.

## 5.1 Measuring targets

| Measuring target | shafts and plain surfaces | | | |
|---|---|---|---|---|
| Sensor | PR 6422 | PR 6423 | PR 6424 / PR 6425 | PR 6426 |
| Shaft diameter | >20 mm | >40 mm | >80 mm | --- |
| Height of target (measuring collar) on the shaft | >20 mm | >25 mm | >40 mm | >80 mm * |
| Speed of shaft circumference | 0 ... 2500 m/s | | | |
| Object material | electrical conducting materials | | | |
| Reference material | 1.7224 (42 Cr Mo 4; SAE 4140) | | | |

* may be less for special installation of the PR 6426

| Upon request, measuring chains can be adjusted on the following materials. | Material | Description | Material | Description |
|---|---|---|---|---|
| | 1.7733 | 24 CrMo V5 5 | 1.7220 | 34 CrMo 4 |
| | 1.0060 | St 60−2 | 1.7258 | 24 CrMo 5 |
| | 1.0501 | C 35 | 1.1181 | CK 35 |
| | 1.1191 | CK 45 | 1.8519 | 31 CrMo V9 |
| | 1.4021 | X 20 Cr 13 | 1.4057 | X 22 CrNi 17 |
| | 1.4122 | X 35 CrMo 17 | 1.4922 | X 20 CrMo V12 |
| | 1.6582 | 34 NiCrMo 6 | 1.7218 | 25 CrMo 4 |

Adjustments on brass, copper or other electric conducting materials are possible − in this case differences of the specifications will apply, refer to section Measuring chain and material of measuring target.

# 5.2 Measuring ranges and sensitivity

| Sensor | PR 6422 | PR 6423 | PR 6424 | PR 6425 | PR 6426 |
|---|---|---|---|---|---|
| Nominal measuring range, static measurements | ±0,5 mm | ±1,0 mm | ±2,0 mm | ±2,0 mm | ±4,0 mm |
| Nominal measuring range, dynamic, peak – peak (recommended) | 25 ... 250 µm | 50 ... 500 µm | 100 ... 1000 µm | 100 ... 1000 ±m | --- |
| Sensitivity for 42 Cr Mo 4 | 16 V/mm | 8 V/mm | 4 V/mm | 4 V/mm | 2 V/mm |
| Approximate value for nominal distance at the center point of converter output signal * | approx. 0,8 mm | approx. 1,5 mm | approx. 2,7 mm | approx. 2,6 mm | approx. 5,5 mm |
| Basic air gap * | approx. 0,15 ... 0,35 mm | approx. 0,4 ... 0,7 mm | approx. 0,55 ... 0,95 mm | approx. 0,5 ... 1,0 mm | approx. 1,2 ... 1,8 mm |

* With standard measuring ranges (not valid for use of extended measuring ranges)

The sensor PR 6423 corresponds to the API 670 / DIN 45670 standard.

Calibration: If no other material was stated, sensor and converter are adjusted on the standard material (42 Cr Mo 4), refer to section Measuring chain and material of measuring target .

# 5.3 Environmental conditions

| | |
|---|---|
| **Environmental temperature** | |
| Reference value | +23°C |
| Nominal operating range PR 6422 ... PR 6424, PR 6426 | −35°C ... +180°C (short time , up to +200°C) |
| PR 6425 only sensor and first part of the cable | |
| - nominal operating range | permanent 0 ... +380°C |
| - limit range | short time 0 ... +400°C (max. 4 hours, without vibration) |
| Nominal range for cable in protection hose and connector | permanent 0 ...+180°C<br>short time up to +200°C |
| Limits for storage and transport | −40°C ... +70°C |
| Temperature error (according to API 670, only sensor) | PR 6423, PR6424: 4 % per 100 K<br>PR 6425: 4 % per 100 K |
| Resistance to chemicals (at room temperature) | Sensor and cable are resistant to: water, steam, natural gas, helium, bearing oils, gasoline, benzol, nitric acid, tetracarbonchloride, tetrachlorideethylen |
| **Pressure** | |
| Pressure resistance to sensor head | PR 6422, PR 6423, PR 6424: 10000 hPa<br>PR 6425: 2000 hPa<br>PR 6426: 6500 hPa |
| Pressure and differential pressure resistance at cable outlet | On request |
| max. Vibration | 5g at 60 Hz |
| Dimensions | see Figure 6-1 to Figure 6-5 |
| Sensor and extension cable | up to 200°C temperature resistant, PTFE cable resistant to oil and chemicals; connection of sensor cable and extension cable with coax connector. |
| Connection to converter | self arresting and water proof LEMOSA − connector for CON 011, CON 021, respective devices of the CSI 3000 system and CSI 9360 or stripped cable ends with crimped sleeves for CON 031 and CON 041 |
| PR 6425 | High temperature resistant cable at the head (up to 380°C) in a gas-proof metal protection hose, directly connected with PTFE - cable in a not gas-proof metal protection tube |
| Metal protection tube (PR 642x/x1x−xxx) | stainless steel, not gas−proof |

### Table 5-1: Additional error

| Sensor type | Temperature range | Zero point | Sensitivity |
|---|---|---|---|
| PR 6425 | at +300 ... +380°C | --- | 0.8% per 10 K |
| PR 6426 | at +23 ...+100°C | ≤ -0,3 % per 10 K | ≤ 0,15 % per 10 K |
| | at +100 ...+180°C | ≤ -0,6 % per 10 K | ≤ 0,65 % per 10 K |
| | at -35 ... +23°C | ≤ -0,2 % per 10 K | ≤ 0,20 % per 10 K |