The Drive & Control Company

# Speed sensor
# DSM series 10

**RE 95132**
Edition: 05.2016
Replaces: 12.2015

- Hall-effect sensor for contactless speed sensing

**Features**
- Direction of rotation detection
- Diagnostic signals
  - Standstill recognition
  - Critical air gap
  - Critical installation position
- Detects even low speeds
- Specially developed for the tough requirements of mobile applications
- Automotive quality
- Simple installation without adjustment work
- Current interface
- Type of protection IP69K

**Inhalt**

## Ordering code

| 01 | 02 | | 03 |
|---|---|---|---|
| **DSM** | **1** | **–** | **10** |

**Type**

| | | |
|---|---|---|
| 01 | Hall-effect speed sensor (for mobile applications) | **DSM** |

**Version**

| | | |
|---|---|---|
| 02 | | **1** |

**Series**

| | | |
|---|---|---|
| 03 | | **10** |

### Available variants

| Type | Material number |
|---|---|
| DSM1-10 | R917000301 |

## Description

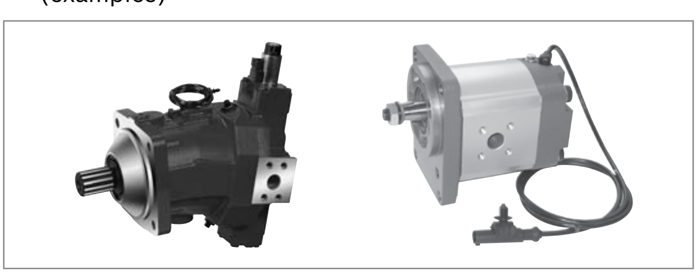
The DSM1-10 Hall-effect speed sensor was specially developed for tough use in mobile working machines. The sensor detects the speed signal of ferromagnetic gear wheels or cut panels. In this process, as an active sensor it supplies a signal with constant amplitude independent of the rotational speed. The sensor excels not just in its ability to detect the direction of rotation, but also through additional diagnostic functions, such as:

- Standstill recognition
- Critical air gap
- Critical installation position

### Example applications

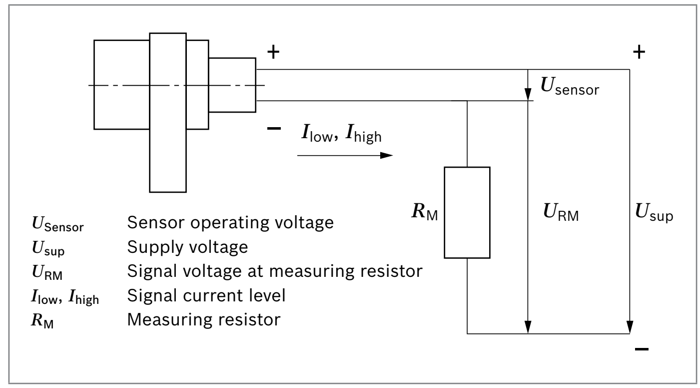
Due to its compact, sturdy design, the sensor is suitable for the following applications, among others:

- In Rexroth external gear and axial piston motors (examples)



- In the wheel bearing for measuring the wheel speed
- In gearboxes or gearbox stages
- In fan drives for buses, trucks and construction machinery (from 7 to 20 kW)
- In vibration drives for road rollers and construction machinery

### Block circuit diagram




A two-wire current interface is used for signal transmission. A current signal is supplied by the sensor. The low current ($I_{low}$ = induced current of the active element) is interpreted as low-signal. The high current ($I_{High} = I_{low} + \Delta I$; $\Delta I$ = additional current through a path parallel to the active element) is interpreted as high signal. In the controller, the current coming from the sensor is converted to a voltage signal by a measuring resistor $R_M$. The evaluation circuit detects whether the signal is high or low by the size of the voltage.

## Technical data

| **Type** | | **DSM1-10** |
|---|---|---|
| Nominal voltage | | 12 V |
| Sensor operating voltage ($U_{Sensor}$) | | 4.5 V to 20.0 V |
| Current consumption | | Maximum 16.8 mA |
| Sensor current | | |
| $I_{Low}$ | | 7 mA ±20 % |
| $I_{High}$ | | 14 mA ±20 % |
| Signal ratio $I_{High}$ / $I_{Low}$ | | ≥ 1.9 |
| Tooth frequency | | up to 5 kHz[1)] |
| Signal frequency ( = Tooth frequency x 2) | | up to 10 kHz[1)] |
| Measurement distance | | typically 1.5 to no more than 3 mm[2)] |
| Direction of rotation signal | | PWM-Signal (see page 4) |
| Electromagnetic compatibility EMC | | |
| Stripline (DIN 1145 2-5) | 1 MHz to 400 MHz | 200 V/m |
| Free field (DIN 1145 2-2) | 200 MHz to 1 GHz | 150 V/m |
| Overvoltage resistance | | 24 V, 10 • 5 min |
| Reverse polarity protection | | |
| Reverse polarity current | | ≤ 195 mA<br>Protective circuit must be provided<br>in controller or externally! |
| Vibration resistance (IEC 60068-2-34) | | |
| Random-shaped vibration | | 0.05 $g^2$/Hz<br>20 to 2000 Hz |
| Shock resistance (IEC 60068-2-27) | | 1000 $m/s^2$, 6 ms,<br>12x in each direction (positive/negative) |
| Resistance to salt spray (DIN 50 021-SS) | | 168 h |
| Type of protection (DIN 40 050-9) | | IP69K |
| Operating temperature range | | |
| Sensor zone | | −40 °C to +150 °C |
| Cable zone | | −40 °C to +115 °C |
| Storage temperature range (IEC 68-2-1 Aa, IEC 68-2-2 Ba) | | −40 °C to +50 °C |
| Materials | | Housing: Polyamide heat stabilized |
| | | Cable: Cover insulation Polyurethane elastomer 95 ±5 shore A |
| | | Bushing: Brass |
| Weight | | 55 g |
| Installation position | | see page 10 |
| Pressure resistance of measuring surface | | 5 bar |

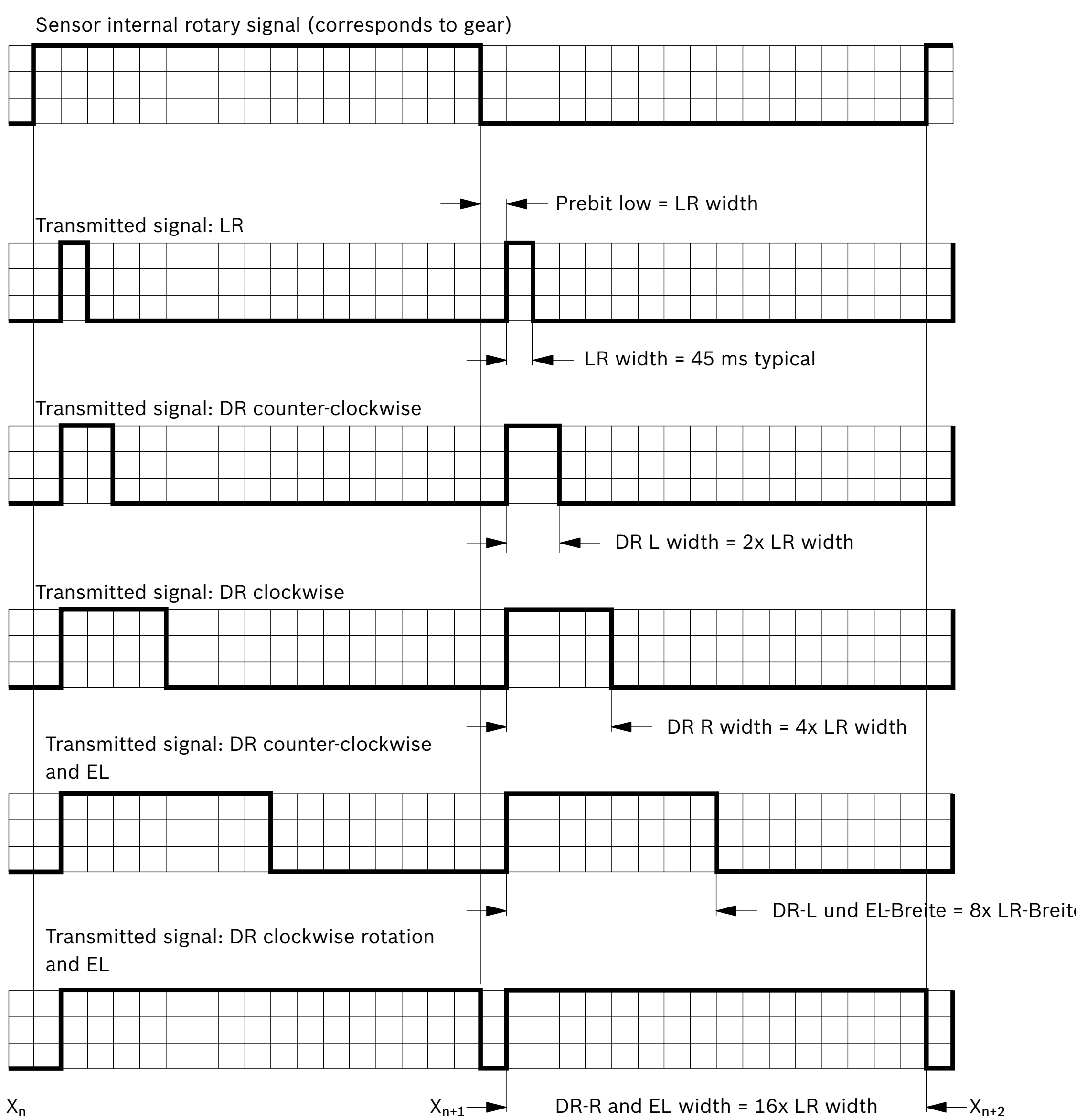
1) Tooth frequencies greater than 2500 Hz may have an effect on jitter and magnetic thresholds.
2) Optimum air gap strongly dependent on application (magnetic field, gear material, ... )

## Output signals

The output signal of the DSM1-10 consists of square-wave pulses of constant amplitude, which are generated by the evaluation electronics of the DSM1-10. The length of the individual pulses provides information about the direction of rotation and any errors that there may be in the installation position.
The evaluation electronics generate a high pulse of a certain length after every flank of the internal sensor speed signal. The length of the pulse is determined by the information to be transmitted. For example, the information 'counter-clockwise rotation' is described by a pulse 90 μs long, and the information 'clockwise rotation' by a pulse 180 μs long.

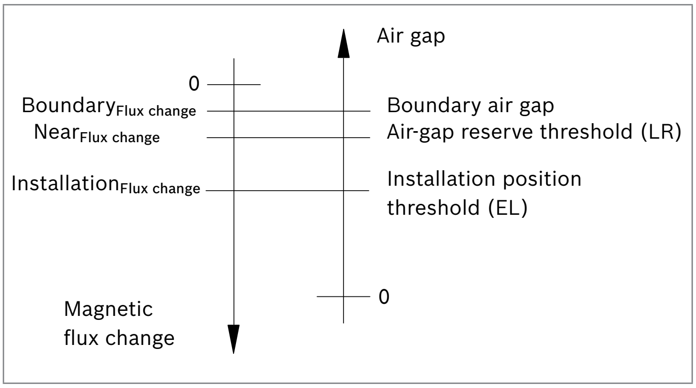
In order to ensure that the speed information can still be emitted at higher speeds even when pulses are longer, a low time (prebit low) is always placed ahead of the high pulse. So, the additional information from the signal is lost at high speeds (pulses are cut off by the low time), but the actual speed information can be output reliably up to a very high frequency (upstream low time + shortest high pulse).
If the air-gap reserve signal (AR) is emitted, the other signals are overshadowed (AR is dominant), i.e.neither a direction of rotation signal (DR) nor the installation position signal (MP) is emitted above the air-gap reserve threshold.

### Signal form



### Air-gap reserve (LR) and installation position (EL)

The sensor reacts to magnetic flux changes. If the air gap between gear and sensor is too great, the signal output may possibly be impaired:




### Boundary area boundary$_{flux\ change}$

When magnetic flux changes are smaller than the boundary$_{flux\ change}$, this may result in signal misfires.

### Near area near$_{flux\ change}$

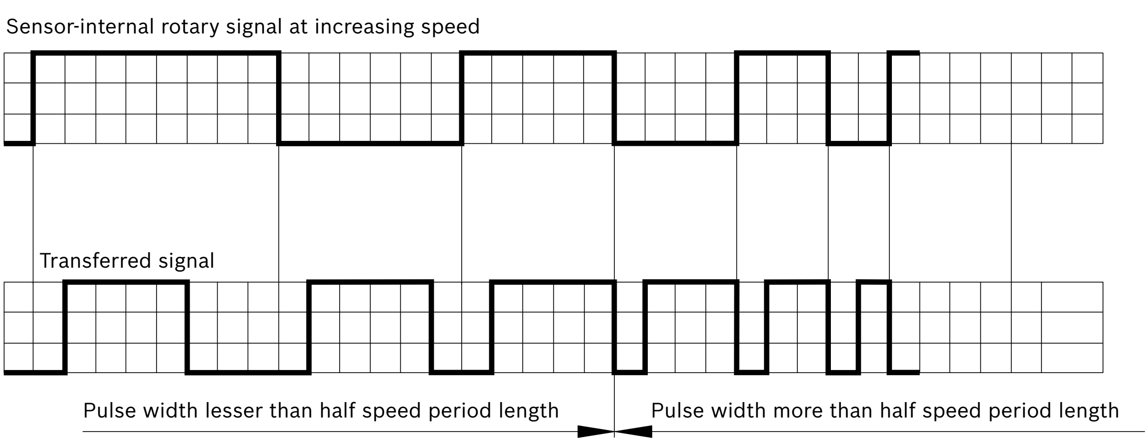
When magnetic flux changes are less than the near$_{flux\ change}$, the LR bit is output.

### Installation position installation$_{flux\ change}$

When magnetic flux changes are less than the installation$_{flux\ change}$ the EL bit is output.

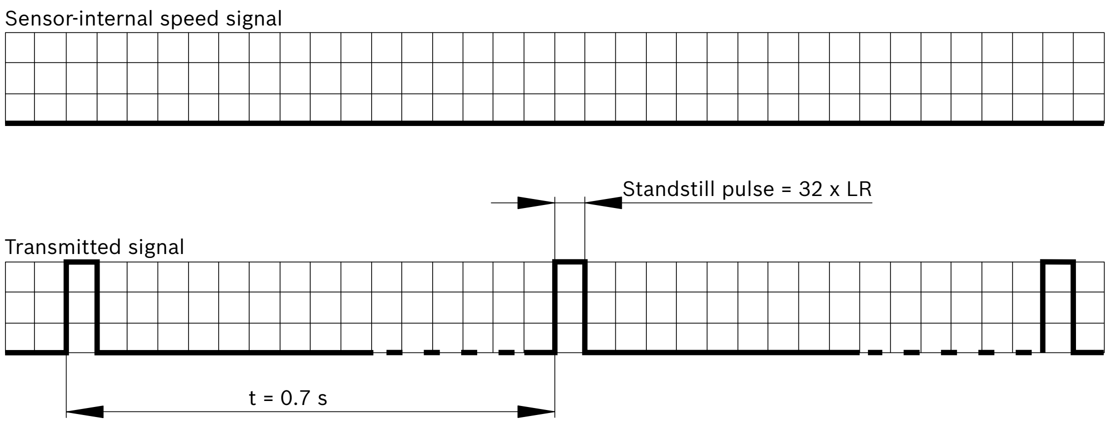
### Performance as speed increases

As speed increases, the next edge on the wheel is detected before the signal is output in its planned length. In these cases, the signal is shortened and the zero-time (45 µs) that comes after each edge, overwrites the signal. It is thereby ensured that the frequency of the pulse and, thus, the speed is always correctly transmitted. The loss of the direction of rotation information is then uncritical, as due to high speed, no change in the direction of rotation can occur at that time. If the speed is reduced (e.g. ranging from slow-down to change in the direction of rotation), the signal is completely output again and the change in the direction of rotation occurs.



**Response in case of standstill**

Sensor signal after no speed signal was detected within one second:




**Description**

When the vehicle is stationary, pulses 1.44 ms in length are emitted every 0.7 seconds by the sensor. These pulses are also output after undervoltage if no speed signal is detected.
In the standstill, an initialization is also performed. This initialization lasts between 255 and 345 µs. During this time, no signal change can be detected.

**Signal when departing from a standstill or during startup**

When the output values (frequency, direction of rotation, ...) are being determined, a certain number of pulses are needed so that the supplied information can be ensured after a certain number of pulses.
When starting out from a standstill or after the undervoltage state, the sensor is first set in an uncalibrated state (signal not offset-compensated).
Also during this phase, the sensor supplies a correct frequency signal at the beginning of the second signal pulse and under typical conditions also supplies a correct direction of rotation signal as of the third signal pulse. The correct output of the rotating direction demands up to seven teeth/flanks depending on the installation position.
In this mode, the minima and maxima of the magnetic input signal are used as trigger points.
During the output of the signal in the uncalibrated mode, a calibration (offset calibration) of the signal is performed by the sensor. The sensor then automatically switches into the calibrated mode. From that point on, the zero crossings of the magnetic input signals are used as trigger points.

1) The pulse DR-L/EL or DR-R/EL is output only up to a signal frequency of approx. 117 Hz. Above this frequency, this pulse is then released via the shorter DR-L or DR. R

When switching over into the calibrated mode, a phase shift of the output signal can occur in infrequent cases (maximum -90 ° or +90 °).
The number of signal pulses output in uncalibrated mode is not more than five.

**Signal tolerances**

From the tolerances of the internal components in the sensor, the following periods (minimum, nominal, maximum) are determined for the individual cases:

| Pulse designation | | | Pulse width $t_{pulse}$ | | |
|---|---|---|---|---|---|
| | | | **min** | **nom** | **max** |
| Prebit (Low) | $t_{Prebit}$ | µs | 37 | 45 | 53 |
| Air-gap reserve LR | $t_{LR}$ | µs | 37 | 45 | 53 |
| Counter-clockwise rotation DR-L | $t_{DR-L}$ | µs | 74 | 90 | 106 |
| Clockwise rotation DR-R | $t_{DR-R}$ | µs | 149 | 180 | 211 |
| Counter-clockwise rotation und EL DR-L/EL[1)] | $t_{DR-L/EL}$ | µs | 298 | 360 | 422 |
| Clockwise rotation and EL DR-R/EL[1)] | $t_{DR-R/EL}$ | µs | 597 | 720 | 843 |
| Standstill STOP | $t_{Pulse-Stop}$ | µs | 1194 | 1440 | 1685 |
| Standstill recognition | $t_{Stop}$ | ms | 611 | 737 | 863 |

**Vibrations**

Vibrations of the not rotating sensor ring possibly can cause wrong sensor signals.

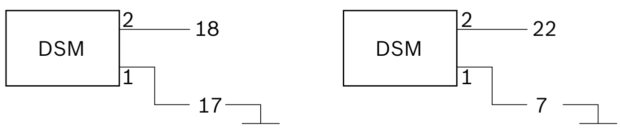
## Application on controllers

**Application with Rexroth BODAS controllers**

The reading of the DSM1-10 is possible with the following BODAS controllers: Series 21, 22 and 30.

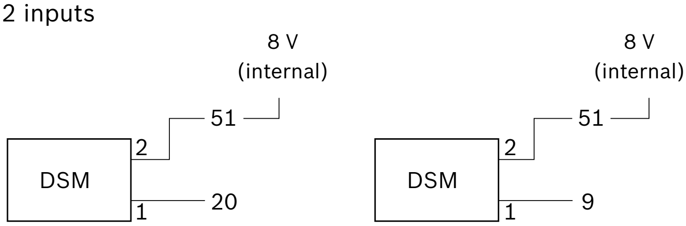
**RC2-2/21**

2 inputs




**RCE12-4/22**

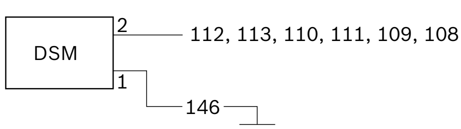
2 inputs




**RC4-6/22** (2 inputs), **RC8-8/22** (4 inputs), **RC12-8/22** (4 inputs)
comparable with RCE12-4/22

**RC36-20/30**

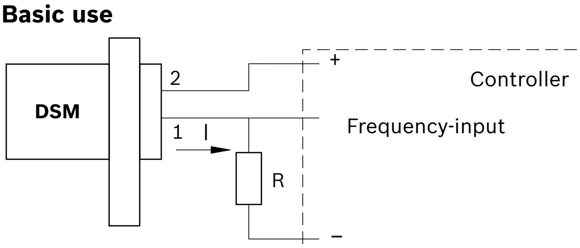
6 inputs




**Note**
The current data sheet of the controller being used is to be considered.

**Application with different controllers**

**Basic use**

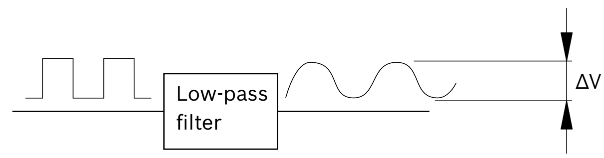



Current $I$ supplies the sensor information in the form of pulses (details see page 4) whose low and high levels are as follows:

| $I$ | Unit | minimum | nominal | maximal |
|---|---|---|---|---|
| $I$ low | mA | 5.9 | 7 | 8.4 |
| $I$ high | mA | 11.8 | 14 | 16.8 |

The minimum pulse width is 52 µs. This corresponds to a frequency of 10 kHz.

In order to interpret the signal, it must be ensured that at 30 kHz input frequency the signal (after any low-pass filter that may be present) still exhibits a sufficient voltage difference (ΔV) for the evaluation.




Through resistor R, a voltage is generated that is applied to the frequency input of the RC controllers.
In an example with $R$ = 200 Ω , the following voltages are read:

| U Input<br>(R = 200 Ω) | Unit | minimum | nominal | maximal |
|---|---|---|---|---|
| U low | V | 1.18 | 1.4 | 1.68 |
| U high h | V | 2.36 | 2.8 | 3.36 |

The resistor $R$ to be installed should be selected so that:

- ▶ The voltage difference for the internal signal evaluation in the controller is sufficient.
- ▶ The maximum voltage across resistor R does not become too high (adapted to the sensor supply), in order for at least 4.5 V always to be applied at the sensor pins.

If these conditions are met and the signal is present inside the controller, the sensor information can be determined.

**Speed**

Due to the properties of the DSM, which sees both flanks of each gear tooth, the actual speed frequency of the gear is determined as follows

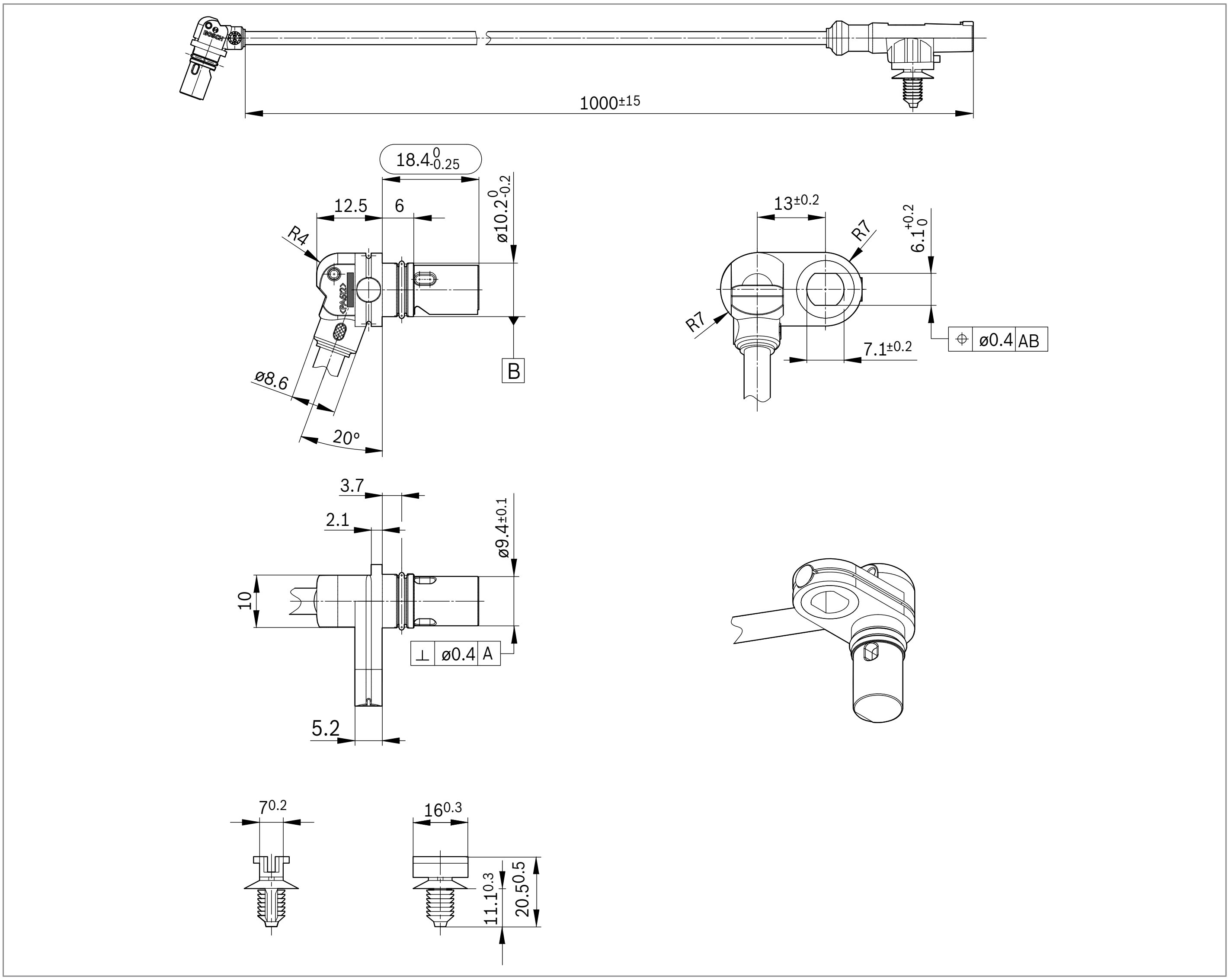
$f_{gear} = f_{read} / 2$

**Direction of rotation, critical air gap, standstill**

To determine this information, the length of the pulse should be measured. This can be accomplished by the start time and end time of the pulse being measured in the controller.
Nevertheless, the speed can always be read from this frequency without this evaluation. However, the performance during standstill should be considered (1.44 ms every 0.7 s). It can be detected in the excess length of the pulse (1.44 ms).

Dimensions [mm]

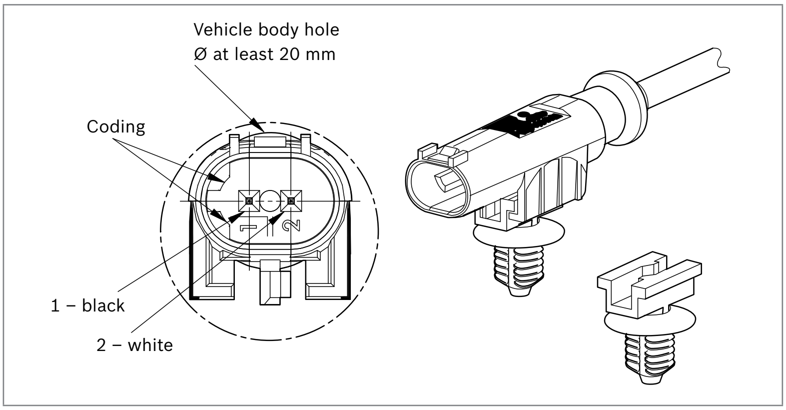
## Dimensions




The connector is supplied with a clip for securing to the vehicle body. It is suitable for panel thicknesses of 0.7 to 6.0 mm and a vehicle body hole diameter of 6.5 to 7.0 mm.

## Connector

▼ **Pin assignment**




**Pin assignments of the DSM speed sensor on controller (SG)**

| | Series 22 | RC2-2/21<br>RC36-20/30 |
|---|---|---|
| Pin 1 | Signal | Ground |
| Pin 2 | Supply | Signal |

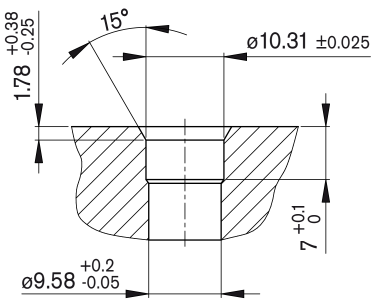
▼ Mating connector

| Connector housing consisting of protective cap / housing seal ring / contact lock / socket housing AMP material number | Socket contact AMP material number | Conductor cross section ($mm^2$) | Insulation diameter (mm) | Single seal AMP material number |
|---|---|---|---|---|
| 1-967644-1 | 965906-1 | 0.75 | 1.4 to 1.9 | 967067-1 |
| | 962885-1 | 0.5 | | |
| | | 0.35 | 0.9 to 1.4 | 967067-2 |
| | | 0.2 | | |

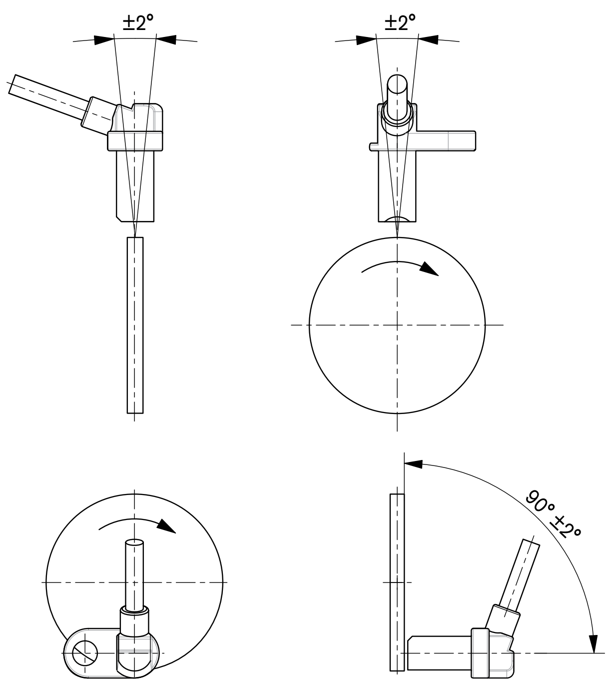
The mating connector is not included in the scope of supply. This can be supplied by Bosch Rexroth on request (material number R917002704).

# Notes on installation

## Installation hole




## Installation position



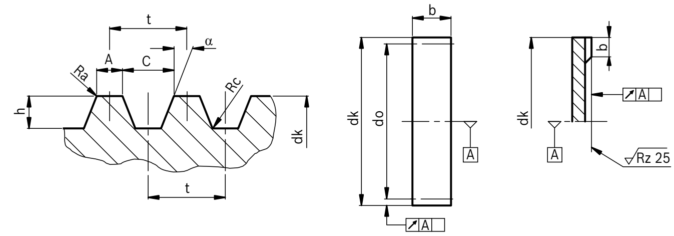

Radial installation / radial tap

Axial installation / axial tap

## Gear specifications

### Material

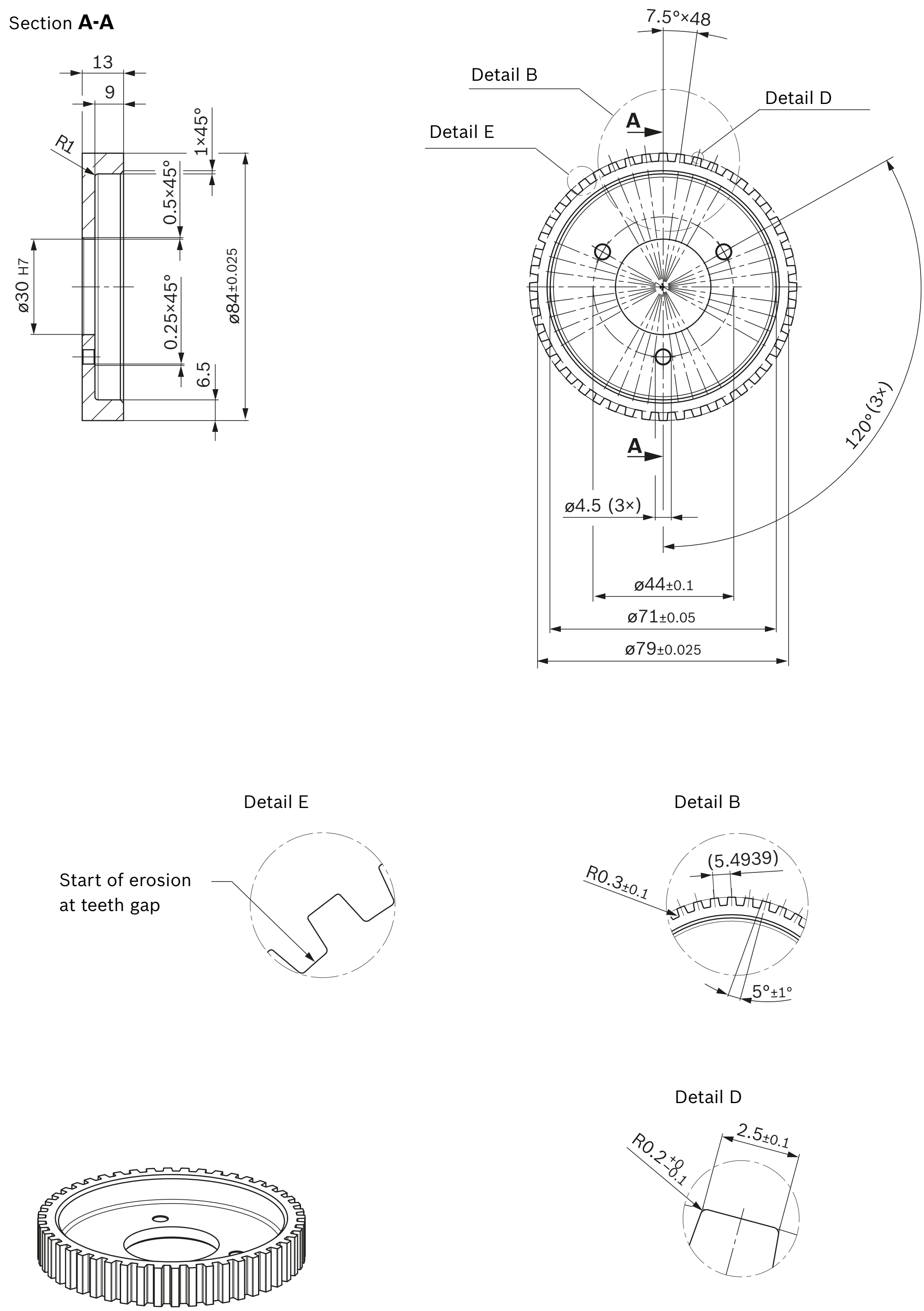
The sensor rings must be magnetically conductive. The material should be magnetically soft. So far free-cutting steels, hardened steels, sintered material (e.g. St37, 9SMn28, C45, GG20, GGG40, X8Cr17) have been tested.




▼ **Gear meshing data valid for base tooth count 48**

| | | Nominal size | Permissible deviations |
|---|---|---|---|
| z | Base tooth count 48 | | – |
| t | Pitch | > 4.1 mm | – |
| $t_p$ | Adjacent pitch error | | ± 4 % |
| $T_p$ | Total pitch error | | 4 % |
| A/t | Tooth tip (top land) width to pitch ratio | 60 to 120 mm, A/t = 0.4 to 0.5 | ± 10 % |
| dk | Tooth tip diameter | > 60 mm | ± 0.05 mm |
| h | Tooth depth | > 2.5 mm | ± 0.1 mm |
| A | Tooth tip width | calculated from A/t | 10 % |
| b | Sensor ring width | > 5 mm | |
| α | Engagement angle | 0 to 20 | ± 1 |
| Ra | Radius at the tooth tip (top land) | < 0.3 mm (at A = 2 mm) to<br>< 0.6 mm (at A = 6 mm) | |
| Rc | Radius at the bottom land | < 0.6 mm | ± 0.2 mm |
| | Tooth form | Rectangular and trapezoidal | other forms per agreement |

## Standard gear



## Manufacturer confirmation of DSM $MTTF_d$-values

The $MTTF_d$-values were determined in accordance with ISO 13849-1:2008-12, Appendix D, Parts Count Method, and the specified temperature profiles below.

| **Ambient temperature Control unit [°C]** | **Self-heating [°C]** | **Temperature profile, Operating time share [%]** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** |
| 10 | 15 | 1 | 1 | 1 | 1 | 1 | 0 |
| 30 | 15 | 2 | 2 | 2 | 2 | 1 | 0 |
| 40 | 15 | 3 | 3 | 3 | 3 | 1 | 0 |
| 50 | 15 | 4 | 3 | 3 | 3 | 1 | 100 |
| 60 | 15 | 5 | 3 | 3 | 3 | 1 | 0 |
| 70 | 15 | 6 | 3 | 3 | 3 | 1 | 0 |
| 80 | 15 | 79 | 85 | 3 | 3 | 1 | 0 |
| 90 | 15 | 0 | 0 | 82 | 3 | 1 | 0 |
| 100 | 15 | 0 | 0 | 0 | 79 | 92 | 0 |
| 110 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| $MTTF_d$-value [years] with | 4h use per day | 7240 | 7016 | 4660 | 3196 | 2876 | 20748 |
| | 8h use per day | 4525 | 4385 | 2913 | 1998 | 1798 | 12968 |
| | 16h use per day | 2588 | 2508 | 1666 | 1143 | 1028 | 7417 |
| | 24h use per day | 1810 | 1754 | 1165 | 799 | 719 | 5187 |

| **Ambient temperature Control unit [°C]** | **Self-heating [°C]** | **Temperature profile, Operating time share [%]** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **7** | **8** | **9** | **10** | **11** | **12** |
| 10 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 50 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 | 15 | 100 | 0 | 0 | 0 | 0 | 0 |
| 70 | 15 | 0 | 100 | 0 | 0 | 0 | 0 |
| 80 | 15 | 0 | 0 | 100 | 0 | 0 | 0 |
| 90 | 15 | 0 | 0 | 0 | 100 | 0 | 0 |
| 100 | 15 | 0 | 0 | 0 | 0 | 100 | 0 |
| 110 | 15 | 0 | 0 | 0 | 0 | 0 | 100 |
| $MTTF_d$-value [years] with | 4h use per day | 14340 | 9408 | 6332 | 4068 | 2700 | 1864 |
| | 8h use per day | 8963 | 5880 | 3958 | 2543 | 1688 | 1165 |
| | 16h use per day | 5127 | 3363 | 2264 | 1454 | 965 | 666 |
| | 24h use per day | 3585 | 2352 | 1583 | 1017 | 675 | 466 |

According to ISO 13849-2: 2008-09, the product meets the basic safety principles and the well-tried safety principles to the extent that they apply to the product.

The component is not a safety component in the sense of Directive on Machinery 2006/42/EC and has not been developed according to ISO 13849:2008.

**Note**

The $MTTF_d$-values given are only valid for the sensor. For assessment of the functional safety for sensors according to ISO 13849, the entire signal chain has to be considered. For this reason, the corresponding kinematics (e.g. geared ring) are also to be taken into account for sensor application in hydraulic drive units.

### Assessment of Safety Principles

List of the safety principles that must be to take into account in the higher-level system.

| Chapter | Well-tried safety principles (SP) | Remarks | Technology | Area of use | Implemented in product |
|---|---|---|---|---|---|
| D.1.7 | Suppression of **voltage peaks** | A set up for suppressing voltage peaks (an RC element, a diode or a varistor) must be used parallel to the applied load but not parallel to the contacts.<br>NOTE: A diode increases the switching off time. | Electrical system | Components | For unlimited operation, the higher-level system must ensure that the supply voltage of 20 V is not exceeded. Voltage peaks of 24 V are permissible for maximum 10 × 5 minutes. |
| D.1.12 | Protection from **unexpected restarting** after restoring the energy suppl | Avoiding unexpected start-up, e.g. after restoring the energy supply [see EN 292-2:1991 (ISO/TR 12100-2:1992), 3.7.2, EN 1037 (ISO 14118), EN 60204-1 (IEC 60204-1)].<br>Special applications, e.g. maintaining the energy for clamping devices or securing a position, need to be considered separately. | Electrical system | Components | Expected start-up characteristics:<br>A phase shift of 0 to 80° is possible after the first two pulses if, after a reset (vehicle standstill or undersupply), the sensor is supplied with a supply voltage ranging from 4.5 V to 20 V. The sensor is calibrated to pulse 6. During the calibration phase, a phase shift of −45° to 120° (>−135° to 300° phase difference between following pulses) is possible after the first two pulses.After a vehicle standstill or undersupply, the sensor therefore requires six magnetic flanks in order to be able to output the rotational speed correctly. |
| D.3.4 | **Energy limitation** | A capacitor must be used to supply a limited amount of energy, e.g. when using a time cycle control. | Electrical system | Components | Not complied for the component.<br>The maximum current level of 16.8 mA and/or maximum voltage level of 20 V defined the component must be guaranteed/limited via the higher-level system. |
| D.3.5 | **Limiting electrical parameters** | Limiting of the voltage, current, energy or frequencies to avoid an unsafe status, e.g. by torque limitation, offset/time-limited running and reduced speed. | Electrical system | Components | Not complied for the component.<br>The maximum current level of 16.8 mA and/or maximum voltage level of 20 V defined the component must be guaranteed/limited via the higher-level system. |
| D.3.8 | **Status orientation in the case of failures** | If possible, all equipment/circuits should enter a safe condition or be safe to operate. | Electrical system | Components | Not complied with for the component.<br>The higher-level system must detect faulty operating conditions of the sensor and appropriate remedies must be defined and implemented. |
| D.3.9 | **Directed failure** | If it is possible to implement, components or systems should be used whose types of failure are known in advance [see EN 292-2:1991 (ISO/TR 12100-.2:1992), 3.7.4]. | Electrical | Systems | |
| D.3.11 | **Reduction of possible faults/separation** | Separation of safety-related functions from other ones. | Electrical | Components | Not relevant to the component, since it is a complex signal that contains several items of information.<br>The higher-level system must detect faulty operating status conditions of the sensor and appropriate remedies must be defined and implemented. |

## Safety instructions

### General instructions

- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- It is not permissible to open the sensor or to modify or repair the sensor. Modifications or repairs to the wiring could result in dangerous malfunctions.
- Connections in the hydraulic system may only be opened in depressurized state.
- The sensor may only be assembled/disassembled in depressurized and deenergized state.
- System developments, installation and commissioning of electronic systems for controlling hydraulic drives must only be carried out by trained and experienced specialists who are sufficiently familiar with both the components used and with the complete system.
- While commissioning the sensor, the machine may pose unforeseen dangers. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine‘s danger zone.
- No defective or incorrectly functioning components may be used. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to take into account all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.

### Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficiently large distance to radio systems must be maintained.
- The connector of the sensor is to be unplugged during electrical welding and painting operations.
- Cables/wires must be sealed individually to prevent water from entering the device.

### Notes on transport and storage

- Please inspect the device for any damages which may have occurred during transport. If there are obvious signs of damage, please immediately inform the transport company and Bosch Rexroth.
- If it is dropped, the sensor must not be used any longer as invisible damage could have a negative impact on reliability.

### Notes on wiring and circuitry

- Lines to the sensors must be designed as short as possible and be shielded. The shielding must be connected to the electronics on one side or to the machine or vehicle ground via a low-resistance connection.
- The sensor should only be plugged and unplugged when it is in a de-energized state.
- The sensor lines are sensitive to radiation interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be fixated so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting points).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

### Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and released in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.
- Use outside of the specified and released boundary conditions may result in danger to life and/or cause damage to components which could result in consequential damage to the mobile working machine.

### Improper use

- Any use of the sensor other than that described in chapter "Intended use" is considered to be improper.
- Use in explosive areas is not permissible.
- Damages which result from improper use and/or from unauthorized, interference in the component not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

### Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and determining the possible safety-related functions.
- In safety-related applications, the customer is responsible for taking suitable measures for ensuring safety (sensor redundancy, plausibility check, emergency switch, etc.).
- Product data that is necessary to assess the safety of the machine can be provided on request or are listed in this data sheet.

### Further information

- Further information about the sensor can be found at www.boschrexroth.com/mobile-electronics.
- The sensor must be disposed according the national regulations of your country.

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