Rexroth
Bosch Group

Speed sensor DSM

RE 95132/11.08 **1**/12
Replaces: 07.05

Data Sheet

Series 10
Hall-effect sensor for contactless speed measurement

Contents

Features

– Rotary direction 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

Ordering code

DSM	1	–	10
01	02		03

Type

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

Version

02		**1**

Series

03		**10**

Material number: 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

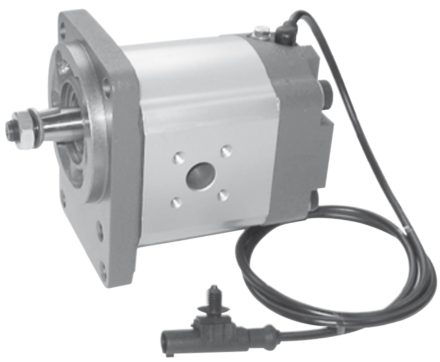
– In the wheel bearing for measuring the wheel speed

– 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

Example
External gear motor with integrated DSM speed sensor



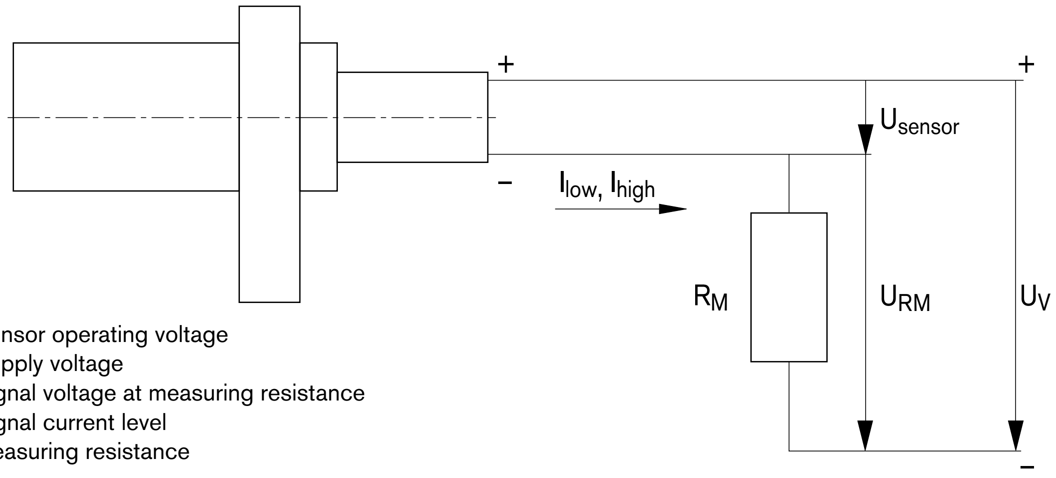
Example
Axial piston variable motor A6VM with integrated speed sensor DSM

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]
Rotary direction signal		PWM signal (see page 5)
Electromagnetic compatibility		
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
Inverse-polarity protection		
Inverse-polarity current		≤ 195 mA Protective circuit must be provided in controller or externally!
Vibration resistance (IEC 60068-2-34)		
Random-shaped vibration		0.05 g^2/Hz 20 to 2000 Hz
Shock resistance (IEC 60068-2-27)		1000 m/s^2, 6 ms, 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		
Sensor zone		–40 °C to +150 °C
Cable zone		–40 °C to +115 °C
Storage temperature (IEC 68-2-1 Aa, IEC 68-2-2 Ba)		–40 °C to +50 °C
Case material		Plastic/brass
Mass		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, ...)

Block circuit diagram



U_{Sensor}	Sensor operating voltage
U_V	Supply voltage
U_{RM}	Signal voltage at measuring resistance
I_{low}, I_{high}	Signal current level
R_M	Measuring resistance

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 ($I_{High} = I_{low} + \Delta I$; ΔI = 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.

Output signals

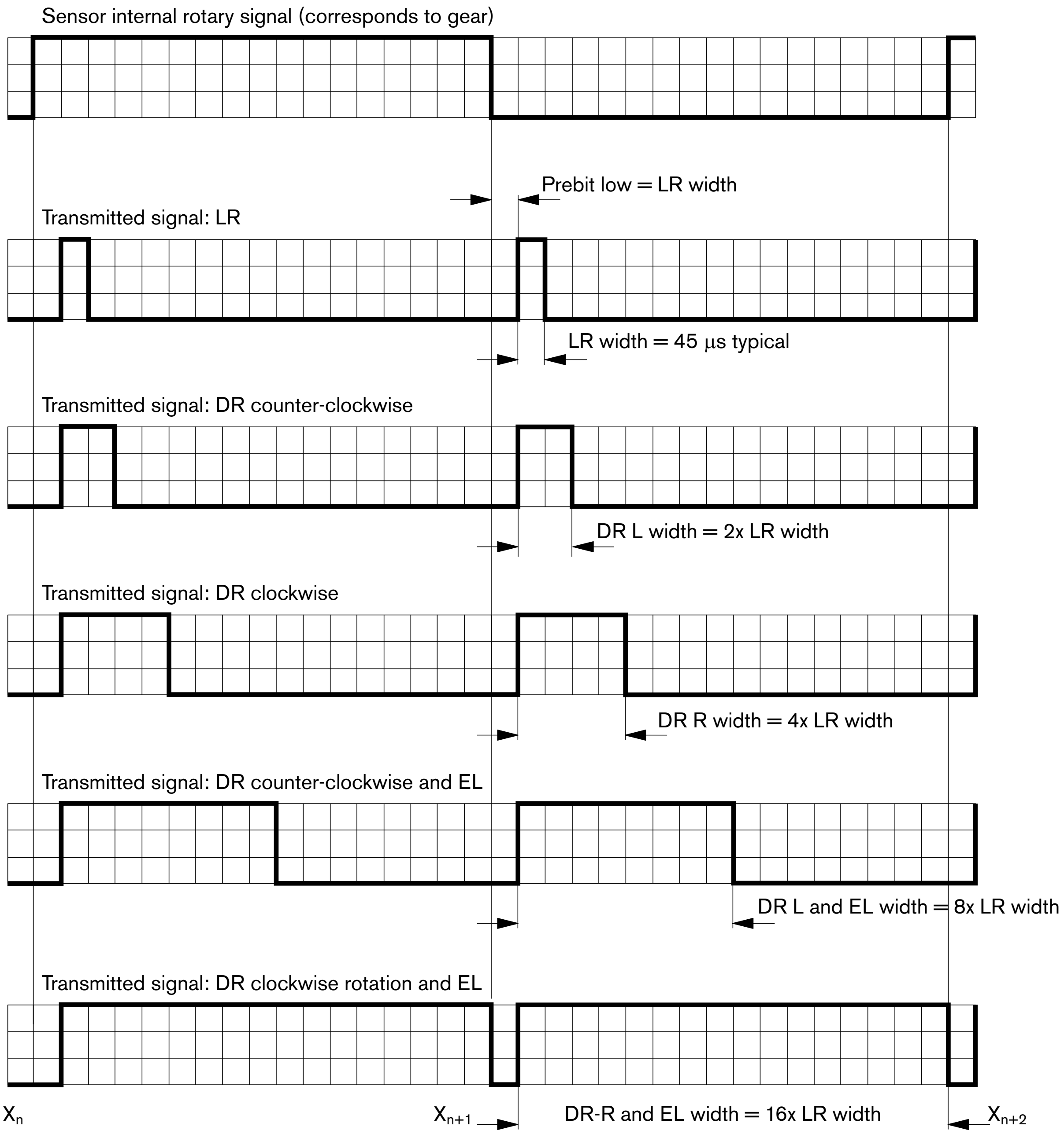
The output signal of the DSM1-10 consists of square-wave pulses of a constant amplitude, which are generated by the evaluation electronics of the DSM1-10. The length of the individual pulses provides information about the direction of rotation and any errors that there may be in the installation position.

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.

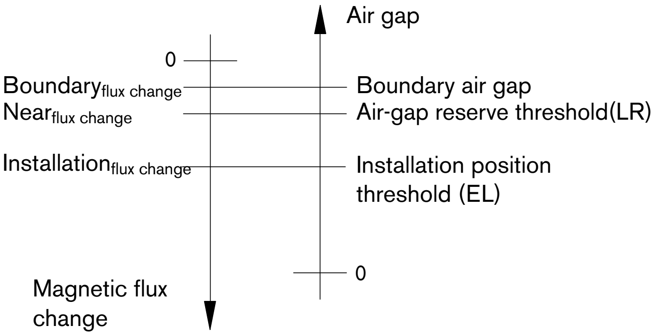
Signal form



Output signals

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:



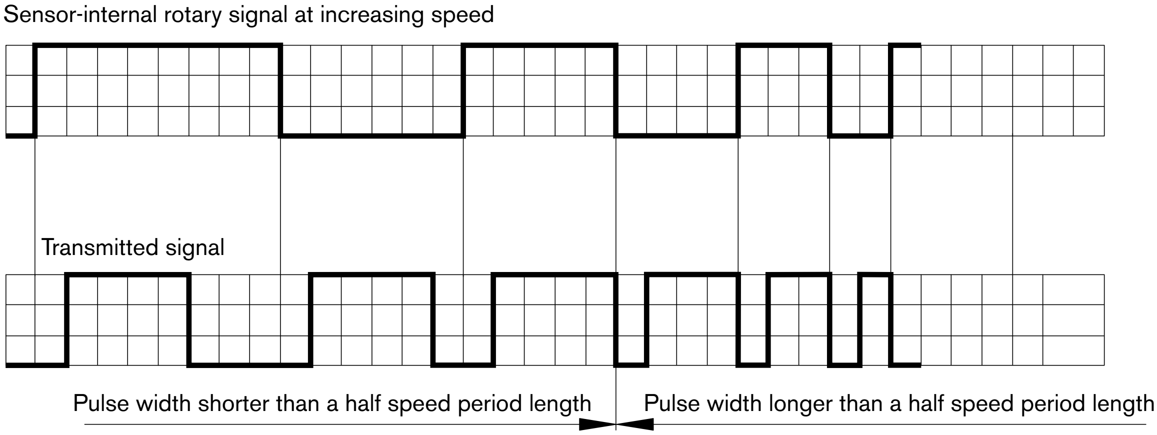
Boundary area boundary $_{flux\ change}$
When magnetic flux changes are smaller than the boundary $_{flux\ change}$, this may result in signal misfires.

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

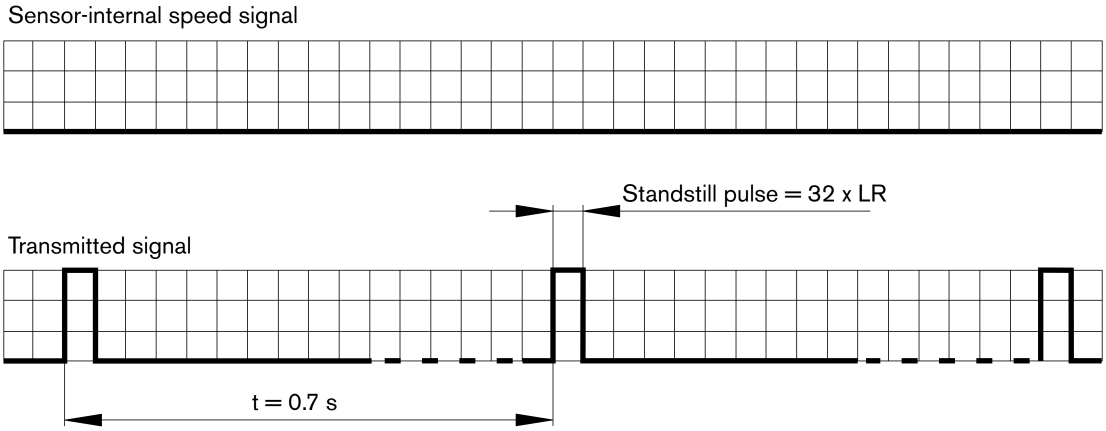
As speed increases, the next edge on the wheel is detected before the signal is output in its planned length. In these cases, the signal is shortened and the zero-time (45 µs) that comes after each edge, overwrites the signal. It is thereby ensured that the frequency of the pulse and, thus, the speed is always correctly transmitted. The loss of the direction of rotation information is then uncritical, because at the time, because of the high speed, no change in the direction of rotation can occur. 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.



Output signals

Performance during 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 only 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. 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. 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 no 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	typical	max	
Prebit (low)	t_{Prebit}	37	45	53	µs
Air-gap reserve LR	t_{LR}	37	45	53	µs
Counter-clockwise rotation DR-L	t_{DR-L}	74	90	106	µs
Clockwise rotation DR-R	t_{DR-R}	149	180	211	µs
Counter-clockwise rotation and EL DR-L/EL[1)]	$t_{DR-L/EL}$	298	360	422	µs
Clockwise rotation and EL DR-R/EL[1)]	$t_{DR-R/EL}$	597	720	843	µs
Standstill STOP	$t_{Pulse\ stop}$	1194	1440	1685	µs
Standstill recognition	t_{Stop}	611	737	863	ms

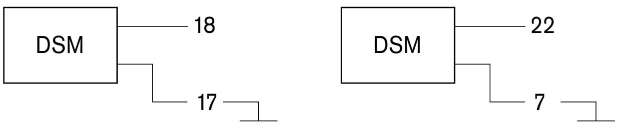
1) The pulse DR-L/EL or DR-R/EL is output only up to a signal frequency of approx. 117 Hz. Above this frequency, this pulse is then released via the shorter DR-L or DR.R

Application on controllers

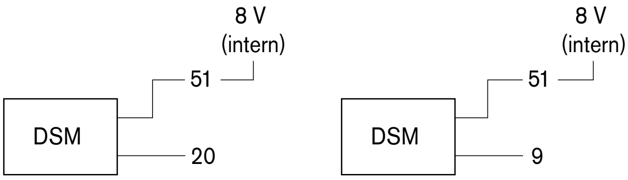
Application with Rexroth BODAS controllers

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

RC2-2/21
2 inputs

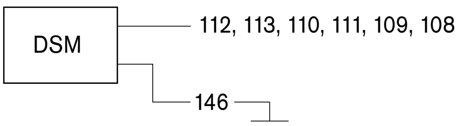


RCE12-4/22
2 inputs



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

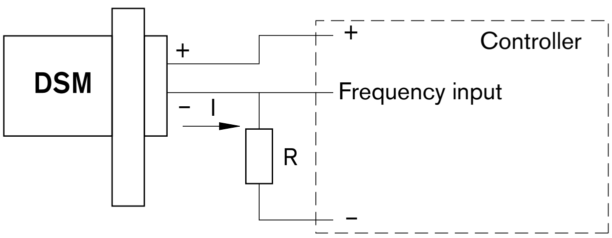
RC36-20/30
6 inputs



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

Application with different controllers

Basic use

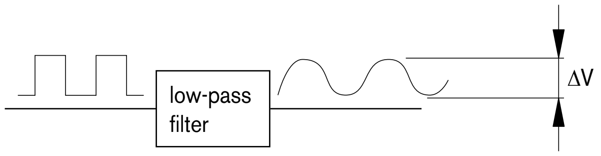


Current I supplies the sensor information in the form of pulses (details see Page 5) whose low and high levels are as follows:

I	minimum	nominal	maxi-mum	unit
I low	5.9	7	8.4	mA
I high	11.8	14	16.8	mA

The minimum pulse width is 37 µs. This corresponds to a frequency of 27 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 resistance 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 (R = 200 Ω)	minimum	nominal	maxi-mum	unit
U low	1.18	1.4	1.68	V
U high	2.36	2.8	3.36	V

The resistance 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 resistance 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.

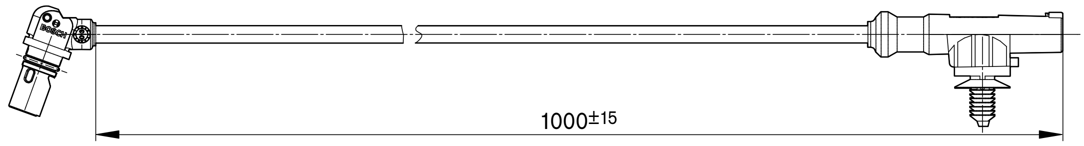
Speed
Due to the properties of the DSM, which sees both flanks of each gear tooth, the actual speed frequency of the gear is determined as follows

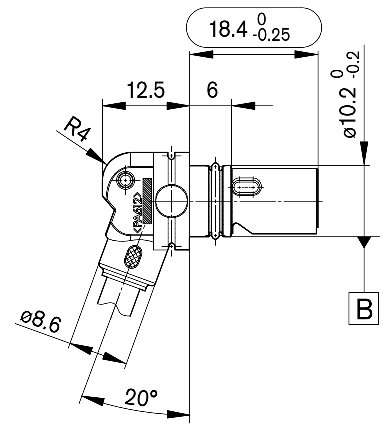
$f_{gear} = f_{read} / 2$

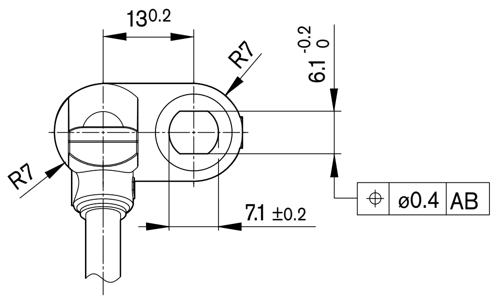
Direction of rotation, critical air gap, standstill
To determine this information, the length of the pulse should be measured. This can be accomplished by the start time and end time of the pulse being measured in the controller.

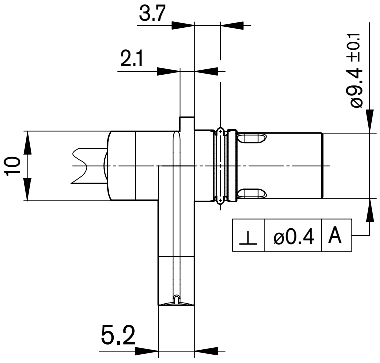
Nevertheless, the speed can always be read from this frequency without this evaluation. However, the performance during standstill should be considered (1.44 ms every 0.7 s). It can be detected in the excess length of the pulse (1.44 ms).

Dimensions

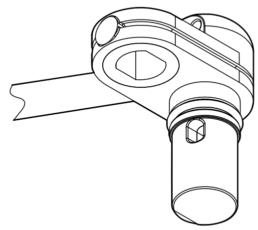


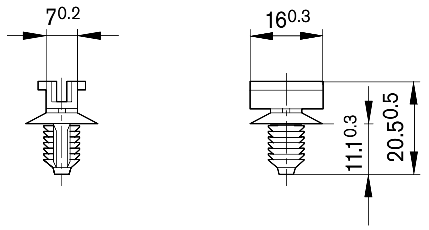






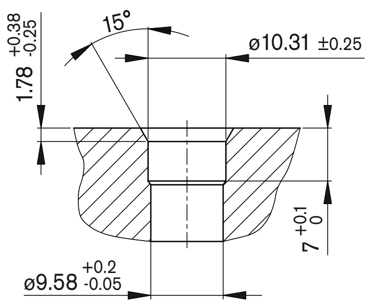
3-D Ansicht



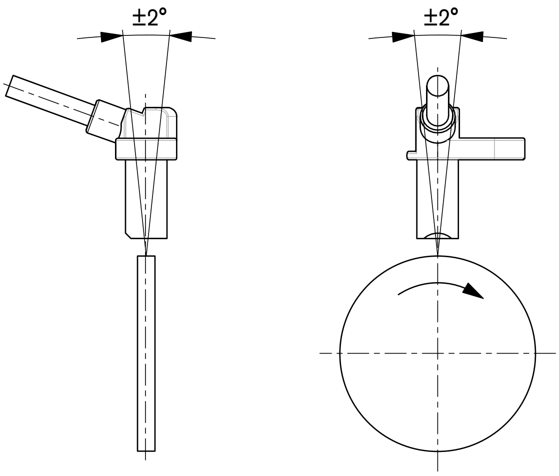


The connector is supplied with a clip for securing to the vehicle body. It is suitable for panel thicknesses of 0.7 to 6.0 mm and a vehicle body hole diameter of 6.5 to 7.0 mm.

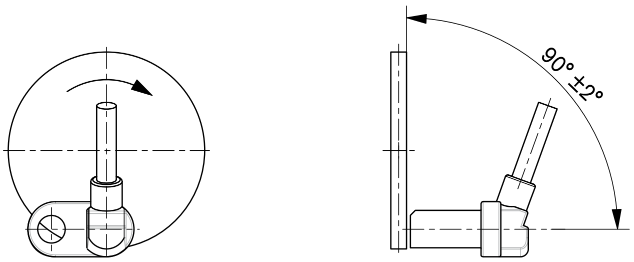
Installation hole



Installation position



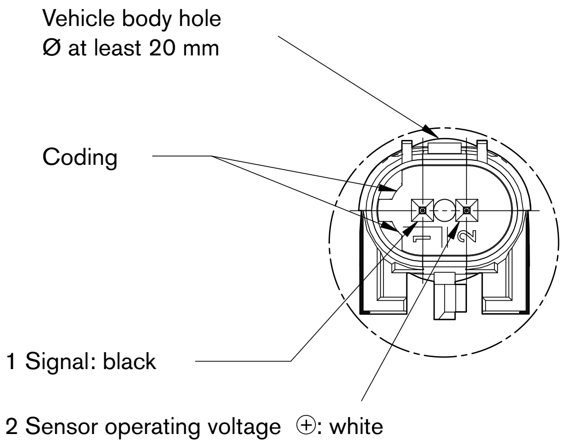
Radial installation / radial tap

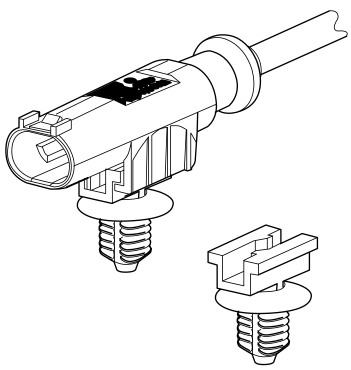


Axial installation / axial tap

Connector

Pin assignment





Mating connector

Connector case consisting of protective cap /case seal ring/ contact lock/socket case AMP part number	Socket contact AMP part number	Conductor cross section (mm^2)	Insulation diameter (mm)	Single seal AMP part 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 delivery contents.
Rexroth can supply it on request (material number R917002704).

Gear specifications

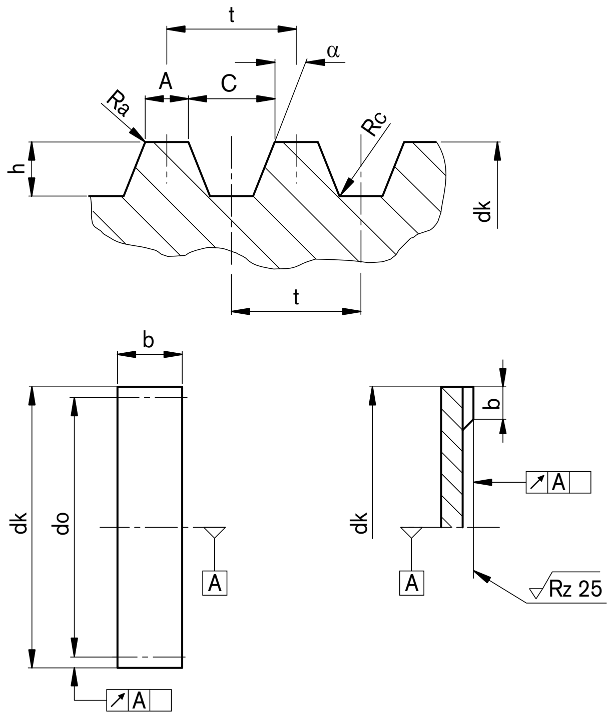
Material

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 120mm, 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
O	Tooth tip (top land) 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=2mm) to < 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



Safety instructions

General instructions

- The suggested circuits do not imply any technical liability for the system on the part of Rexroth.
- System developments, installations and commissioning of electronic systems for controlling hydraulic drives must only be carried out by trained and experienced specialists who are sufficiently familiar with the components used and with the complete system.
- No components that are defective or not working properly should be used. If components fail and/or exhibit malfunction, repair must be carried out immediately.
- Before commissioning the system, you must ensure that the vehicle and the hydraulic system are in a safe condition. Make certain that no persons are present in the danger zone of the machine.
- A sufficiently large distance to radio systems must be maintained.
- All connectors must be unplugged from the electronics during electrical welding operations.
- Cables to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.

Conventional 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 complete system.
- Damage which result from improper use and/or from unauthorized, unintended interventions in the device not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

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