RE 95135/2024-02-21
Replaces: 2023-03-28

Speed sensor HDD

- Hall-measurement principle
- Measuring range 0.1 to 20 000 Hz
- Output signal voltage square-wave signals
- Supply voltage 8 to 32 V
- Protection class IP69K

Features

- Simple installation without setting work
- Detects even low rotational speeds
- Large temperature range
- Short circuit resistance, reverse polarity protection
- Pressure-resistant sensor measurement area
- O-ring seal
- The attachment is encoded by way of asymmetrical screw fastenings.
- CE conformity

Contents

Product description

The hall-effect speed sensor (HDD) is used for contact-free measurement, even at very low rotational speeds. Two hall-effect semiconductor elements inside the sensor measure changes in the magnetic flux caused by a ferromagnetic spline on the sensor. These are converted into square-wave signals by the integrated electronics. The frequency f of the square-wave voltage output from the sensor is calculated from the number of teeth z on the circumference of the gear wheel and the rotational speed n of the drive or output shaft according to the following formula:

$$f = \frac{z \times n}{60}$$

Key

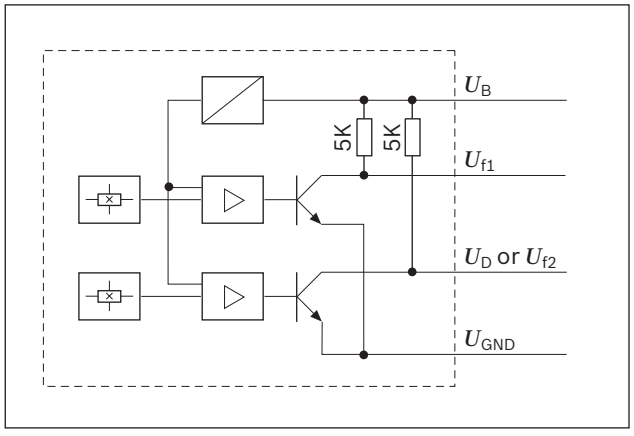
f	Frequency [Hz]
n	Rotational speed [min-1]
z	Number of teeth

The sensor is available in four basic versions:
HDD1 returns a square-wave signal that is proportional to the speed as well as a switching signal for detecting the direction of rotation.
HDD2 returns two square-wave signals that are phase shifted by approx. 90° which are suitable for the redundant detection of the rotational speed. In addition, this can be used, for example, to calculate the direction of rotation using a control unit from Rexroth.
Both variants are available with NPN (standard) or PNP output circuitry.

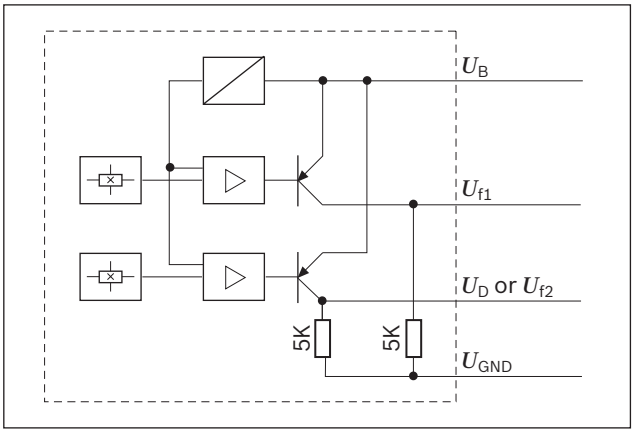
Main components
- Two integrated hall semiconductors with permanent magnets and amplifiers
- Robust plastic housing
- Pointed connection cable

Block diagram

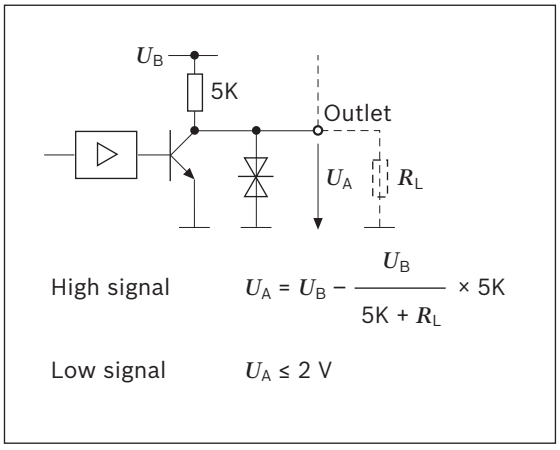
Output
NPN



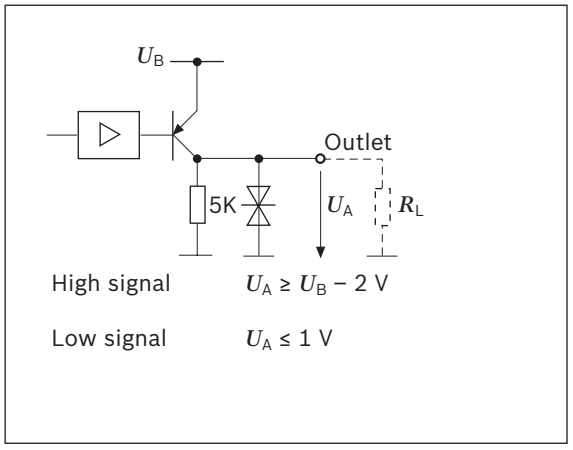
Output
PNP



Output signal level calculation
NPN



Output signal level calculation
PNP



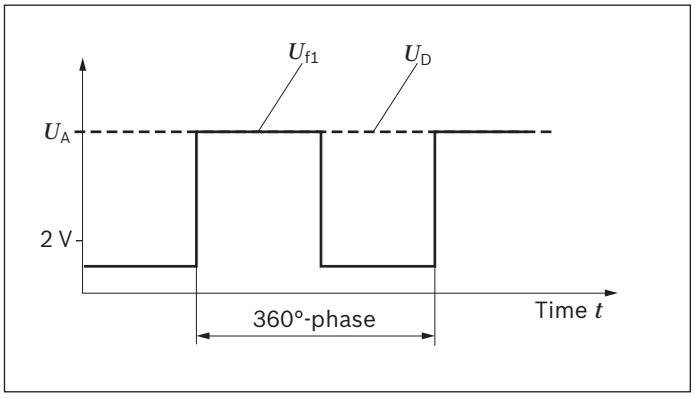
The output circuitry for the rotational speed signal and the direction of rotation signal are identical.

Output signals

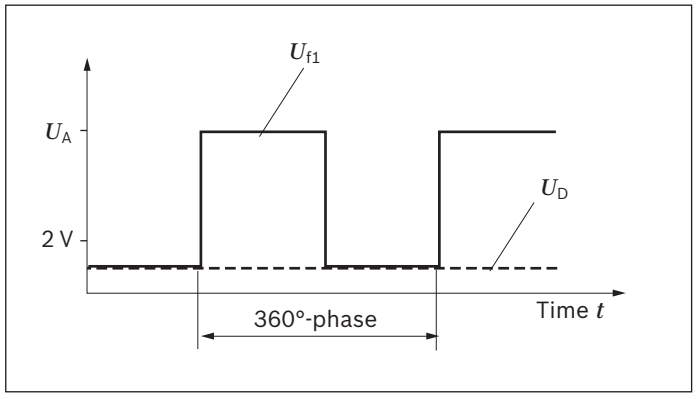
HDD1

Rotational speed signal and digital rotation direction signal

Direction of rotation clockwise



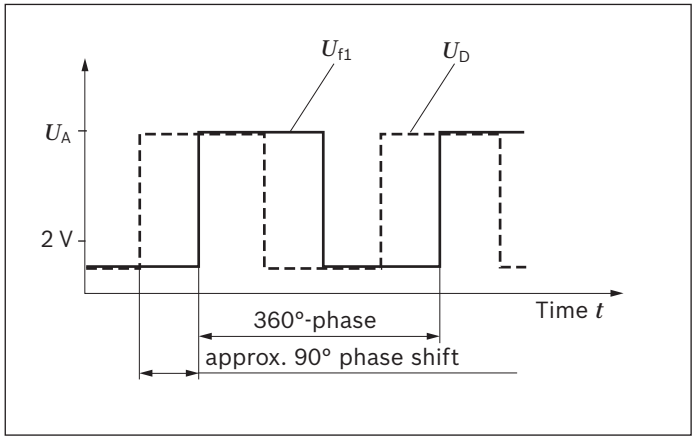
Direction of rotation counter-clockwise



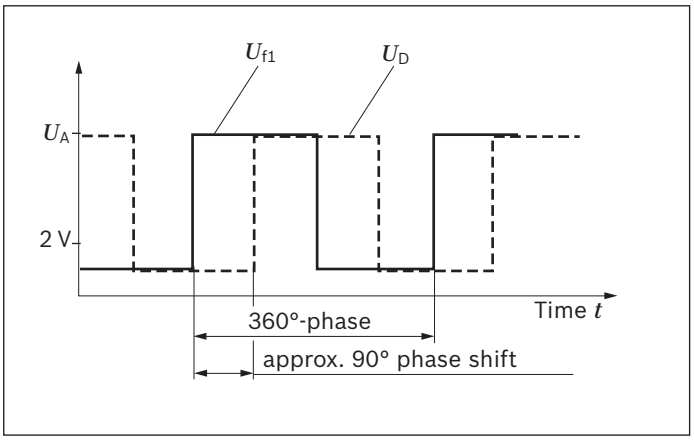
HDD2

Two partially redundant rotation direction signals

Direction of rotation clockwise

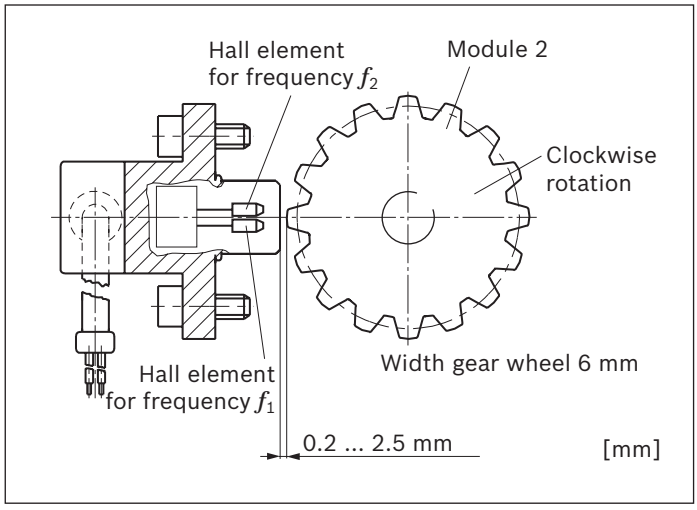


Direction of rotation counter-clockwise



Frequency signal and direction of rotation signal can be evaluated in the measurement range from 0.1 Hz to 20 kHz.

Measuring arrangement



Type code

01	02	03	04	05		06	07
HDD					**/**	**2**	**0**

Type

01	Hall-effect speed sensor	**HDD**

Version

02	One frequency output, one output for direction of rotation	**1**
	Two frequency outputs	**2**

Installation depth

03	16 mm	**L16**
	32 mm	**L32**

Output circuitry

04	NPN	**N**
	PNP	**P**

Electrical connection

05		**HDD 1L16 HDD 1L32 HDD 2L32**		**HDD 2L16**		
		N	**P**	**N**	**P**	
	End-splice	●	●	●	●	**A**
	Connector DEUTSCH DT04-4P-EP04	●	–	–	–	**D**

Series

06		**2**

Index

07		**0**

● = Available – = Not available

Technical data

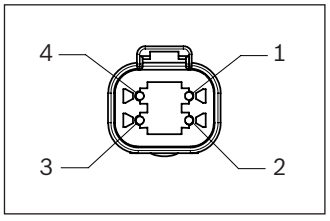
Type			**HDD1, HDD2**
Nominal voltage			12 V and 24 V DC
Maximum residual ripple		DIN 16750-2:2010	±2 V DC
Supply voltage	Absolute voltage range	U_B	8 ... 32 V DC
Input current maximum			33 mA at 24 V DC
Current capacity			500 mA at 24 V and 25 °C 50 mA at 24 V and 125 °C
Frequency outputs			0.1 ... 20 000 Hz
rotary direction signal	Direction of rotation clockwise		High
	Direction of rotation counter-clockwise		Low
	Standstill		Undefined
Short circuit resistance to			Supply voltage and earth
Polarity mismatch protection			Fitted
Electromagnetic compatibility (EMC)	Broadcast noise	ISO 13766-2	100 V_{eff}/m
	Line-borne interference	ISO 7637-1/-2/-3	Values on request
	Load Dump maximum for 24 V System		202 V, R_i = 8 Ω
Electrostatic discharge (ESD)	According to ISO 10605: 2023-06	Contact discharge	±6 kV (powered up and unpowered)
		Air discharge	±8 kV (powered up and unpowered)
Conformity according to	EMC directive 2014/30/EU with CE mark		Applied standards: ISO 13766-1:2019
	RoHS directive 2011/65/EU		
Vibration resistance	Oscillation, sinusoidal	IEC 60068-2-6	10 g/ 57 ... 2000 Hz 10 cycles per axis
	Oscillation, noise	IEC 60068-2-64:2008	0.05 g^2/Hz 20 ... 2000 Hz
Shock resistance	Transport shock	IEC 60068-2-27:2008	15 g/11 ms 3 x each direction (positive/negative)
	Continuous shock	IEC 60068-2-27:2008	25 g/6 ms 1000 x each direction (positive/negative)
Moisture resistance			95 % (25 °C ... 60 °C)
Salt spray resistance		DIN EN ISO 9227:2023-03	48 h, 35 °C, 5% NaCl
Type of protection (DIN EN 60529:2019-06) when installed and plugged in, with	End-splice		IP67 and IP69K
	Plug DEUTSCH DT04-4P-EP04		IP69K with mating connector
Operating temperature range		EN 60068-2-14	−40 ... +125 °C
Housing material			Brass and plastic
Weight			approx. 95 g
Installation position			any
Measurement distance	for module 2		0.2 ... 2.5 mm
Pressure resistance of measuring surface			10 bar
Maximum length of signal line			< 30 m
Storage time			5 years at an average relative humidity of 60 % and a temperature between −10 °C and +30 °C. For short periods of up to 100 hours a storage temperature of -20 ... +40 °C is permissible.

The HDD is released for the following fluids:

HETG, HEES, HFD, HVLP, HLP
Other fluids: On request

Electrical connection

Pin Assignment



Pin Assignment

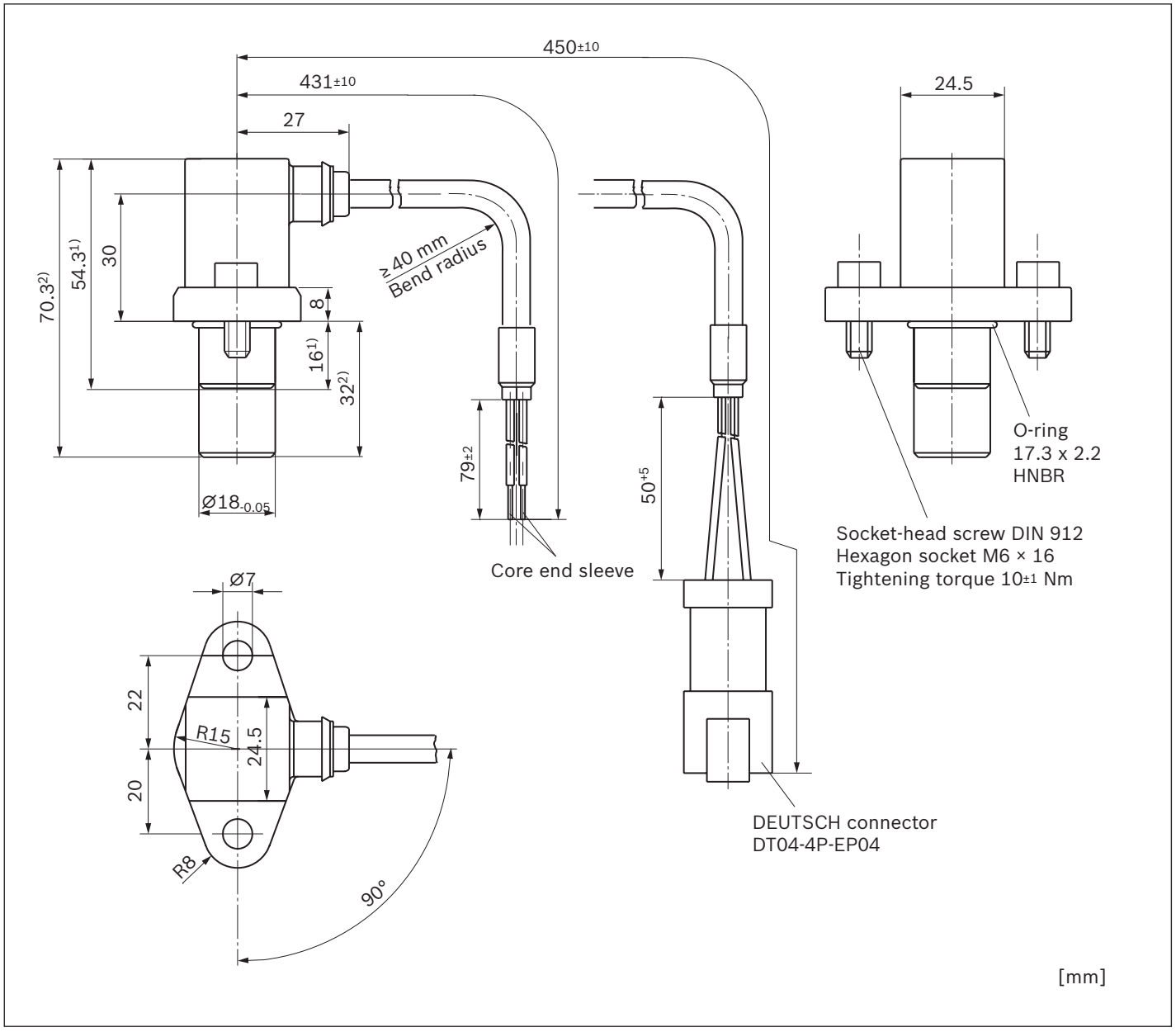
Pin number	Core color	Connection	
1	Brown	U_B	Supply voltage 8 ... 32 V DC
2	Blue	GND	Ground
3	Black	U_{f1}	Frequency
4	White	U_D	for HDD1 Direction of rotation
		U_{f2}	for HDD2 Frequency

The mating connector DEUTSCH DT06-4S-EP04 is not included in the scope of delivery.
This can be supplied by Bosch Rexroth on request
(see chapter “Accessories”)

Cable dimensions

	Dimensions
Outer diameter of cable sheath	6.2±0.2 mm
Wire diameter	2.2±0.1 mm
Maximum strand diameter	1.2 mm (0.75 mm^2)
End-splice	0.75 mm^2

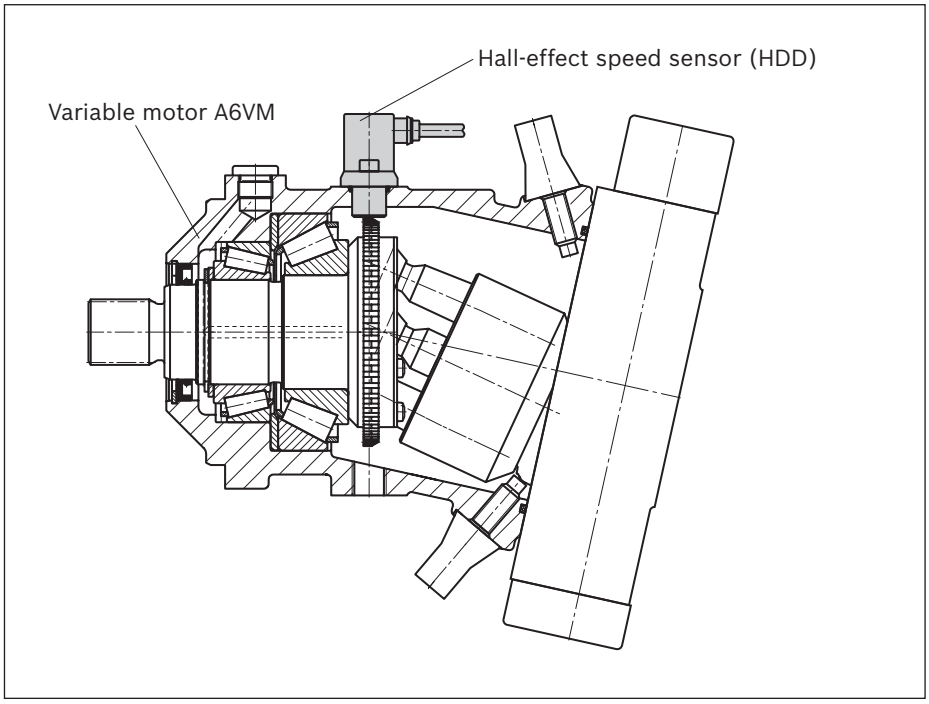
Dimensions



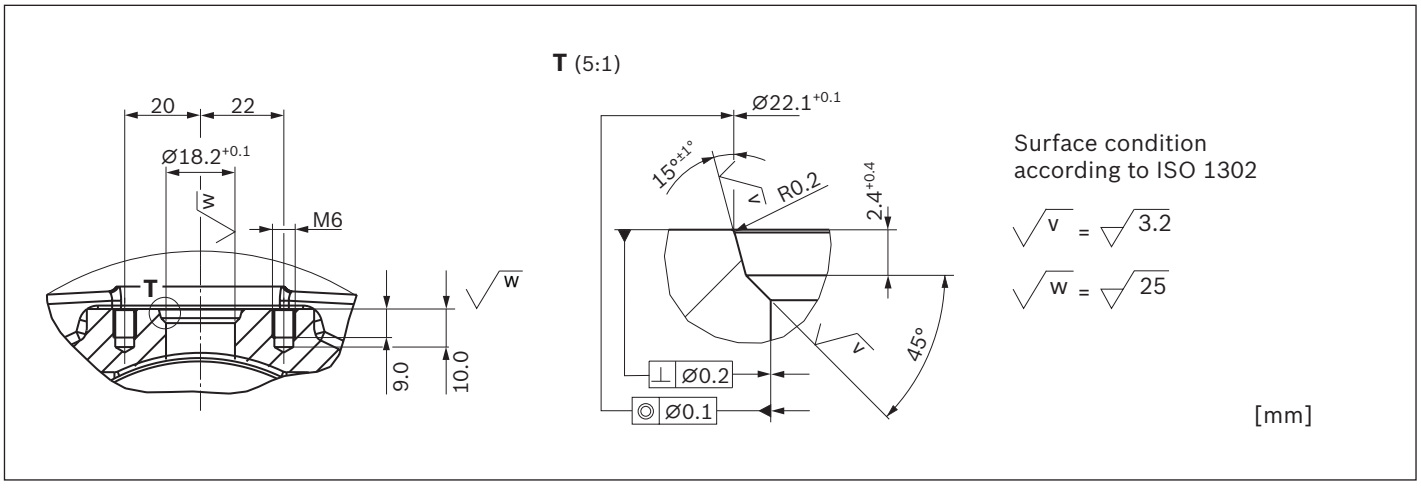
1) HDD.L16
2) HDD.L32

Mounting

Application example



Installation cavity



Information

Manufacturer Confirmation of $MTTF_D$-HDD values

The product meets the basic and proven safety requirements as per ISO 13849-2 as they apply to the product. The product is not a safety component in the sense of the Machinery Directive 2006/42/EC and has not been developed according to ISO 13849.

The following measured values can be used for rating:

$MTTF_D$ value [years]	Temperature [°C]
1255	60
847	70
388	90
173	110
TM = 10 years	

The specifications referred to in the table are valid under the following conditions:

- Components are used under the responsibility of the user.
- Specifications relating to installation and operating conditions must be observed in accordance with the operating instructions and the data sheet.
- The user must take into account the requirements of ISO 13849-1 (such as CCF, DC, software, systematic errors).
- In the interest of preventive maintenance, it is advisable to exchange the components within the maximum TM period of use.
- The fundamental safety principles of ISO 13849-2 for implementing and operating the component must also be met.
- The fundamental safety principles as per ISO 13849-2 for implementing and operating the component must also be met for categories 1, 2, 3 or 4.
- The components must be replaced only by spare parts that have the properties specified for the components being changed as a minimum.
- The $MTTF_D$Values were calculated according to SN29500-1, -2, -3, -4 and according to ISO 13849-1, Appendix D Parts Count.

Assessment of safety principles

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

General safety principles A1	Comment	Manufacturer assessment
Suitable selection, combination, arrangement, assembly and installation of the components/system	Consideration of the manufacturer's application instructions, e.g. catalog sheets, installation instructions, specifications, as well as application of proven technical experience with similar components/systems.	User follows installation instructions. Associated documentation in the product data sheet.
Adequate mounting	Manufacturer's application instructions must be observed when using screw locks. An appropriate torque limitation method can be used to prevent excessive stress and to achieve adequate resistance to prevent the connection from loosening.	User follows installation instructions. Associated documentation in the product data sheet.
Limitation of the range of environmental parameters	Temperature, air humidity and contamination at the installation location are examples of these parameters. ISO 13849-2 Section 10 and the manufacturer's application instructions must be observed.	The sensor meets the specifications according to the product data sheet. The user must ensure that these conditions are not exceeded. The product data sheet must be observed.
Limitation of speed and similar parameters	Observe the speed, acceleration and deceleration that are required by the application.	This must be done in the higher-level system.
Protection against unexpected start-up	Accounting for unexpected start-up caused by stored energy and after reestablishment of energy supply for different operating states, such as operating mode, maintenance mode, etc. A special mechanism for discharging stored energy may be necessary. Special applications, e.g., for saving energy for clamping device or for ensuring of a position have to be considered separately.	The sensor itself cannot produce any unexpected start-up. The higher-level system must be designed to prevent unexpected start-up.
Adequate protection to keep out fluids and dust	Observance of IP type of protection (see IEC 60529).	This must be done in the higher-level system.
Well-tried safety principles A2		
Secured position	The mobile element of the component is mechanically held in a secure position (friction alone is insufficient). The application of force is required for movement out of the secured position.	The sensor is fastened and has no mechanical moving parts. The specifications for this are given in the product data sheet.
Careful selection, combination, arrangement, assembly and installation of the components/systems for the relevant application		Observe specifications for installation and intended use, as well as documentation in the product data sheet.
Careful selection of the mounting type for each application	Avoidance of mounting by friction only.	The sensor is fastened. The specifications for this are given in the product data sheet.
Reduced speed range and similar parameters	Set the required limitation depending according to experience and the respective application. Examples include centrifugal governor, secure monitoring of speed and travel limitation.	If necessary, this must be done in the higher-level system. Not applicable to the sensor.
Reduced environmental parameters range	Determining the necessary limitations. Examples are temperature, air humidity and contamination during installation. ISO 13849-2, observe section 10 and the manufacturer's application instructions.	Observe specifications for installation and intended use, as well as documentation in the product data sheet. The sensor meets the specifications according to the product data sheet. The user must ensure that these conditions are not exceeded.

General safety principles **D1**		
	Following the manufacturer's application instructions, e.g., catalog sheets, installation instructions, specifications, as well as application of proven technical experience.	Instructions for installation and intended use are described in the product data sheet
Protection against unexpected start-up	Protection of unexpected start-up, e.g., after restoring the energy supply (see ISO 12100:2010, 6.2.11.4, ISO 14118, IEC 60204-1).	The sensor itself cannot produce any unexpected start-up. The higher-level system must be designed to prevent unexpected start-up.
Use of sequential switching for circuits with series connections of redundant signals	To prevent the common cause failure of both contacts during welding, no simultaneous switching on and off occurs, thereby ensuring that one contact always operates without power.	This must be done in the higher-level system. The sensor must not meet this requirement.
Well-tried safety principles **D2**		
Avoidance of faults in cables	To avoid short circuits between two adjacent lines, either: ▶ Use cables with shielding that is connected to the protective conductor system on every single line. **or** ▶ Use a protective conductor between all signal lines in flat cables	The sensor cable must be placed by the user in such a way that this requirement is met.
Distances between electrical conductors	Use of sufficient distance between terminals, components and lines to prevent any unintentional connections	The sensor cable must be placed by the user in such a way that this requirement is met.
Limitation of electrical parameters	Limiting of the voltage, current, energy or frequencies in order to restrict movement, e.g. by torque limitation, offset/time-limited running and reduced speed to prevent any unsafe condition.	This must be taken into account by the user in the higher-level system. The product data sheet must be observed.
Prevention of undefined conditions	Undefined conditions in the control system should be avoided. The control system must have a structural design that enables all expected control system operating conditions, e.g. output/outputs, to be predetermined.	This must be taken into account by the user in the higher-level system. The sensor does not represent the control system.
State switchover in event of failure	If possible, all mechanisms/circuits should transition to a safe state or be safe to operate.	For HDD1 and HDD2, see separate table below.
Directed failure	If feasible, components or systems should be used whose failure type is known in advance (see ISO 12100:2010, 6.2.12.3).	For HDD1 and HDD2, see separate table below.

HDD1

Component	Output 1 (F1) failure mode	Output 2 (direction of rotation) failure mode
Voltage regulator/supply voltage for Hall ICs faulty	Not determined, no information from the linear regulator manufacturer	Not determined, no information from the linear regulator manufacturer
Hall IC1 faulty	Not determined, no information from the Hall IC manufacturer	Not determined, no information from the Hall IC manufacturer
Hall IC2 faulty	Normal function	Normal functionNot determined, no information from the Hall IC manufacturer
Output Driver 1 (F1) faulty	Not determined, not specified by output driver manufacturer	Normal function
Output Driver 2 (direction of rotation) faulty	Normal function	Not determined, not specified by output driver manufacturer
Pullup/pulldown resistances in output 1 (F1) faulty	NPN variants: Low-level PNP versions: High level	Normal function
Pullup/pulldown resistances in output 2 (direction of rotation) faulty	Normal function	NPN variants: Low-level PNP versions: High level
EMC measures on output 1 (F1) or output 2 (direction of rotation) overvoltage diode faulty	Low level	Low level
EMC measures on output 1 and 2 capacitors faulty	Not determined	Not determined

HDD2

Component	Output 1 (F1) failure mode	Output 2 (F2) failure mode
Voltage regulator/supply voltage for Hall ICs faulty	Not determined, no information from the linear regulator manufacturer	Not determined, no information from the linear regulator manufacturer
Hall IC1 faulty	Not determined, no information from the Hall IC manufacturer	Normal function
Hall IC2 faulty	Normal function	Not determined, no information from the Hall IC manufacturer
Output Driver 1 (F1) faulty	Not determined, not specified by output driver manufacturer	Normal function
Output driver 2 (F2) faulty	Normal function	Not determined, not specified by output driver manufacturer
Pullup/pulldown resistances in output 1 (F1) faulty	NPN variants: Low-level PNP versions: High level	Normal function
Pullup/pulldown resistances in output 2 (F2) faulty	Normal function	NPN variants: Low-level PNP versions: High level
EMC measures on output 1 (F1) or output 2 (F2) overvoltage diode faulty	Low level	Low level
EMC measures on output 1 and 2 capacitors faulty	Not determined	Not determined

Accessories

Mating connector

	Number	Designation
Housing	1	DT06-4S-EP04
Wedge	1	W4S
Sockets	4	0462-201-16141

Technical data		
Maximum current		13 A
Maximum voltage	DC	250 V

The mating connector can be supplied by Bosch Rexroth on request (Bosch Rexroth material number R902601805).

Safety Instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modifications or repairs to the wiring could lead to dangerous malfunctions.
- The sensor may only be assembled/disassembled in a deenergized state.
- Only trained and experienced specialists who are adequately familiar with both the components used and the complete system should implement system developments or install and commission electronic systems for controlling hydraulic drives.
- When commissioning the sensor, the machine may pose unforeseen hazards. 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.
- Do not use defective components or components not in proper working order. 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 consider all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- The use of sensors by private users is not permitted, since these users do not typically have the required level of expertise.

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 sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- Cables/wires must be sealed individually to prevent water from entering the sensor.

Notes on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- 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 in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The sensor mating connector must only be plugged and unplugged when it is in a deenergized state.
- The sensor lines are sensitive to spurious 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 secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- 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 approved in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.

- Use outside of the specified and approved boundary conditions may result in danger to life and/or cause damage to components which could result in sequential damage to the mobile working machine.
- Serious personal injury and/or damage to property may occur in case of non-compliance with the appropriate regulations.

Improper use

- Any use of the sensor other than that described in the chapter "Intended use" is considered to be improper.
- Use in explosive areas is not permitted.
- Damages 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.

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 proper measures to ensure safety (sensor redundancy, plausibility check, emergency switch, etc.).
- Product data that is required to assess the safety of the machine is included in this data sheet.

Disposal

- Disposal of the sensor and packaging must be in accordance with the national environmental regulations of the country in which the sensor is used.

Further information

- Further information about the sensor can be found at www.boschrexroth.com/mobile-electronics.

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