

Hall-effect speed sensor

HDD series 20

RE 95135

Edition: 01.2017

Replaces: 07.2016



- ▶ Dual sensor for contact-free speed sensing

Features

- ▶ Simple installation without setting work
- ▶ Detects even low speeds
- ▶ Large temperature range
- ▶ Short circuit resistance, reverse polarity protection
- ▶ Pressure-resistant sensor measurement surface
- ▶ O-ring seal
- ▶ High protection rating IP69k
- ▶ The attachment is encoded by way of asymmetrical screw fastenings.

Main components

- ▶ Two integrated hall semiconductors with permanent magnets and amplifiers
- ▶ Robust plastic housing
- ▶ Molded connection cable

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Ordering code

01	02	03	04	05	06	07
HDD					/	2 0

Type

01	Hall-effect speed sensor	HDD
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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

Electric port

05		HDD 1L16 HDD 1L32 HDD 2L32		HDD 2L16		
		N	P	N	P	
	Core end sleeve	●	●	●	●	A
	Connector DEUTSCH DT04-4P-EP04	●	-	-	-	D

Series

06		2
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Index

07		0
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● = Available - = Not available

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 the ferromagnetic teeth on the sensor. These are converted into square-wave signals by the integrated electronics. The frequency f of the square-wave voltage output by 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 using the following formula:

$$f = \frac{z \cdot n}{60} \quad \begin{matrix} f [\text{sec}^{-1}] \\ n [\text{rpm}] \\ z = \text{number} \\ \text{of teeth} \end{matrix}$$

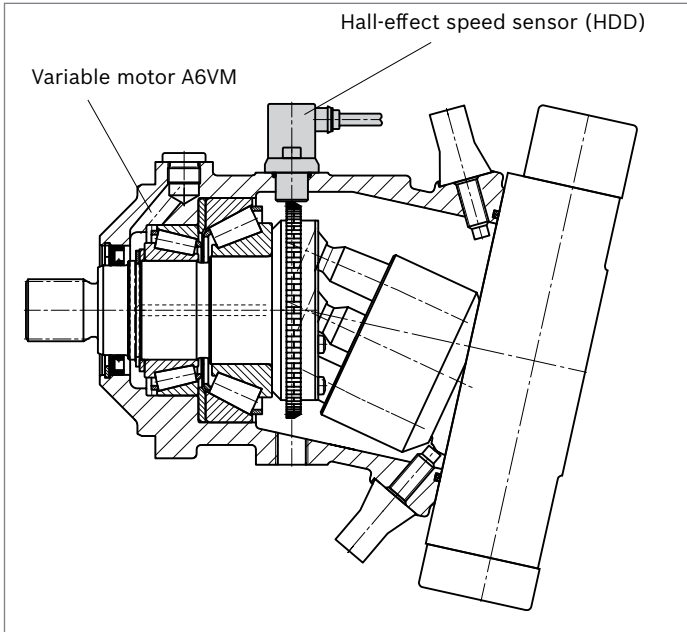
The sensor is available in four basic versions:

HDD1 returns a square-wave signal that is proportional to the speed plus a switching signal for identifying 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 speed. In addition, this can be used, for example, to calculate the direction of rotation using a controller from Rexroth.

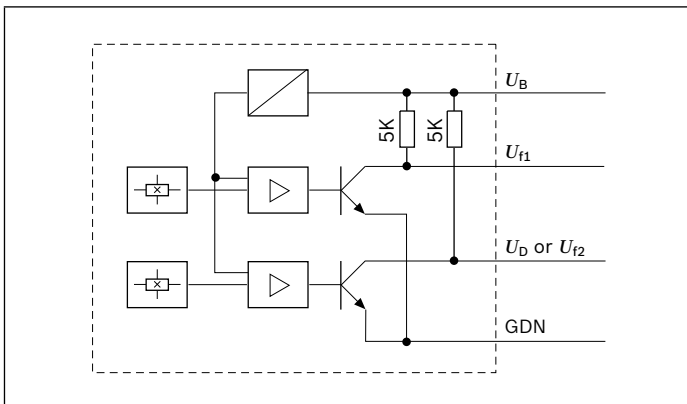
Both variants are available with NPN (standard) or PNP output circuitry.

Application example

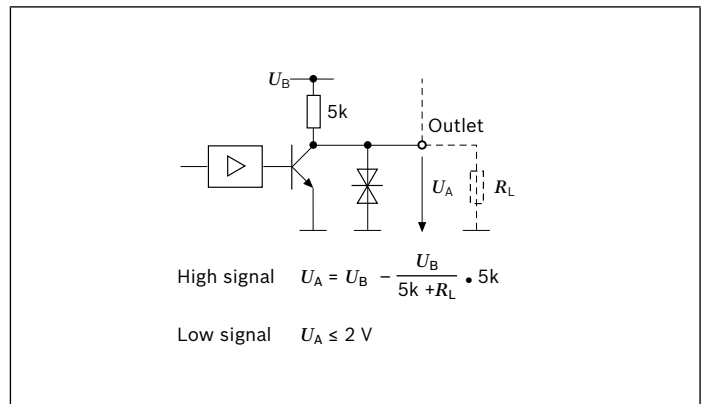


Block circuit diagram

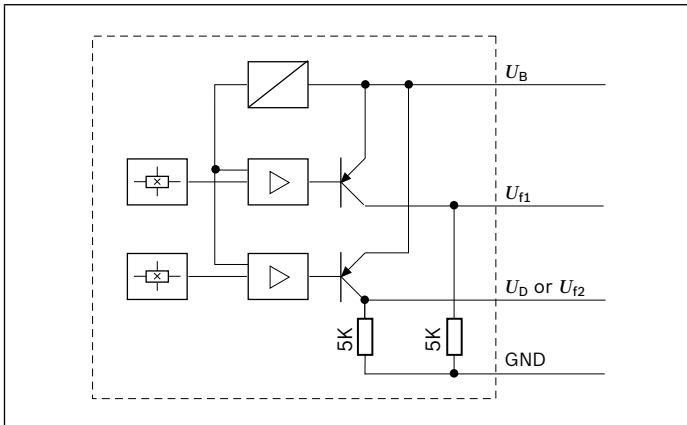
▼ **NPN output**



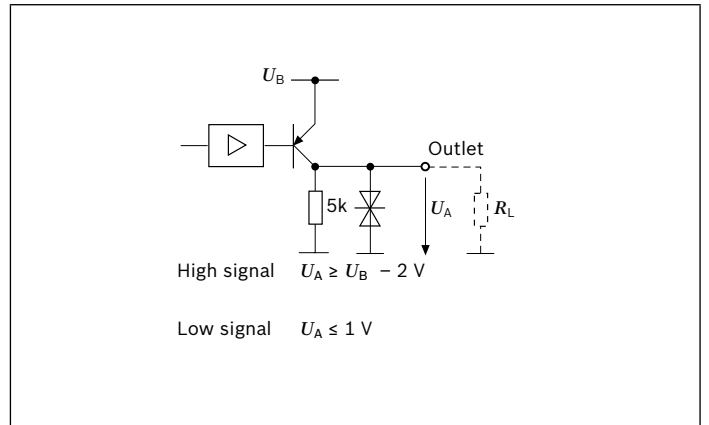
▼ **NPN output signal level calculation**



▼ **PNP output**



▼ **PNP output signal level calculation**



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

Technical data

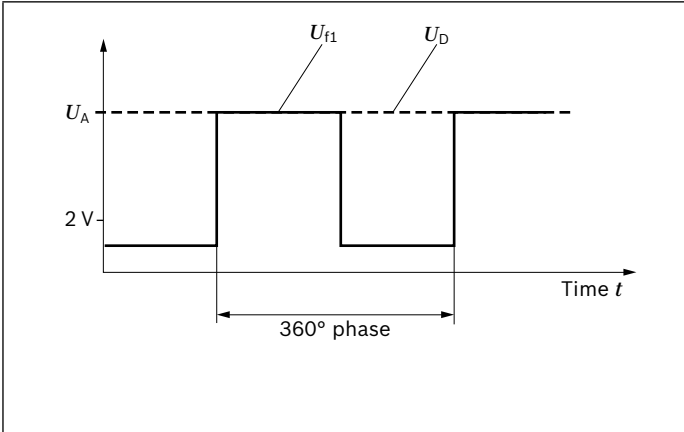
Type	HDD1, HDD2
Nominal voltage	12 V and 24 V DC
Residual ripple (DIN 40839, Part 1)	maximum ± 2 V DC
Supply voltage U_B , voltage range absolute	8 V to 32 V DC
Current consumption	maximum 33 mA AT 24 V DC
Current capacity	500 mA at 24 V and 25 °C 50 mA at 24 V and 125 °C
Frequency outputs	0.1 Hz to 20 kHz
Rotation direction signal	
Clockwise	high
Counter-clockwise	low
Standstill	undefined
Short circuit resistance to	supply voltage and ground
Reverse polarity protection	fitted
Electromagnetic compatibility (EMC)	
Spurious interference (Automotive Directive 95/54/EC)	100 V_{eff} /m
Line-bound interference (ISO 7637-1/-2/-3)	values on request
Load dump	maximum 70 V
Vibration resistance	
Sinusoidal vibrations (IEC 60086-2-6)	10 g / 57 to 2000 Hz 10 cycles per axis
Random-shaped vibrations (IEC 60086-2-36)	0.05 g^2 / Hz 20 to 2000 Hz
Shock resistance	
Transport shock (IEC 60068-2-27)	15 g /11 ms 3x in each direction (positive/negative)
Continuous shock (IEC 60068-2-29)	25 g /6 ms 1000x in each direction (positive/negative)
Moisture resistance	95% (+25 °C to +60 °C)
Salt spray resistance (DIN 50021)	48 h, 35 °C, 5% NaCl
Type of protection (IEC 60529) when installed and plugged	
with core end sleeves	IP 67 and IP 69 k
with DEUTSCH connector DT04-4P-EP04	IP 69 k with mating connector
Operating temperature range (IEC 68-2-14)	-40 °C to +125 °C
Storage temperature range (IEC 68-2-1, IEC 68-2-2)	-55 °C to +125 °C
Housing material	brass/plastic
Weight	approx. 95 g
Installation position	arbitrary
Measurement distance	0.2 to 2.5 mm for module 2
Pressure capability of measurement surface	10 bar

Output signals

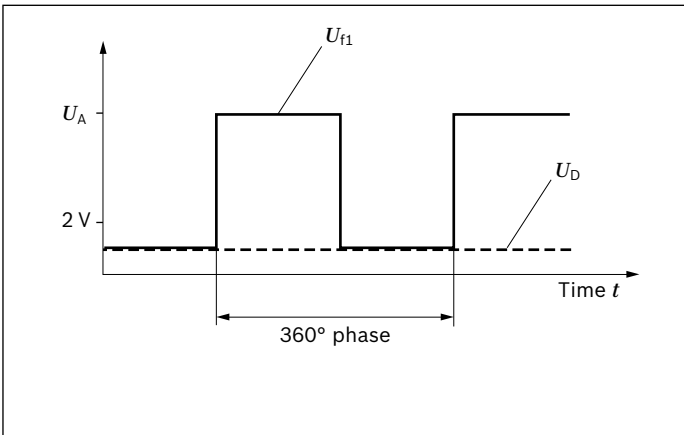
HDD1

Rotational speed signal and rotation direction signal

▼ Clockwise



▼ Counter-clockwise

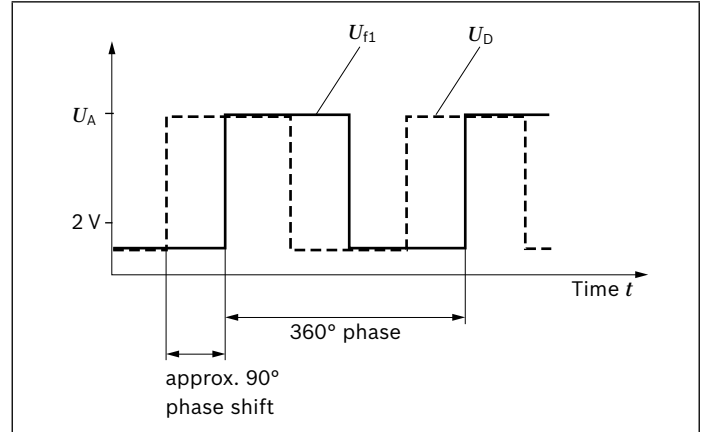


Frequency signal and direction of rotation signal can be evaluated in the measurement range from 0.1 Hz to 20 kHz.

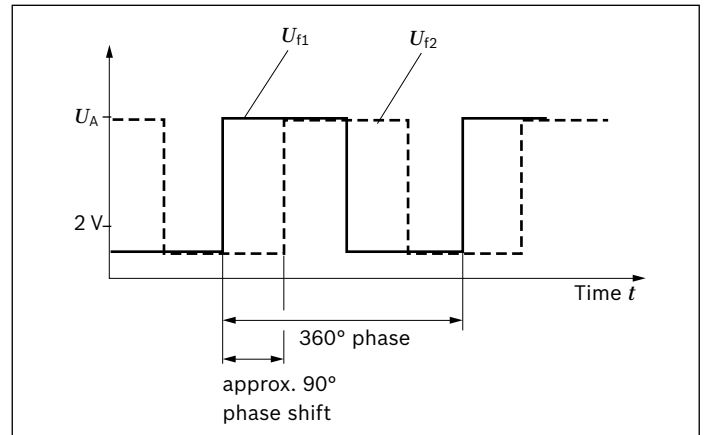
HDD2

Two partially redundant rotation direction signals

▼ Clockwise

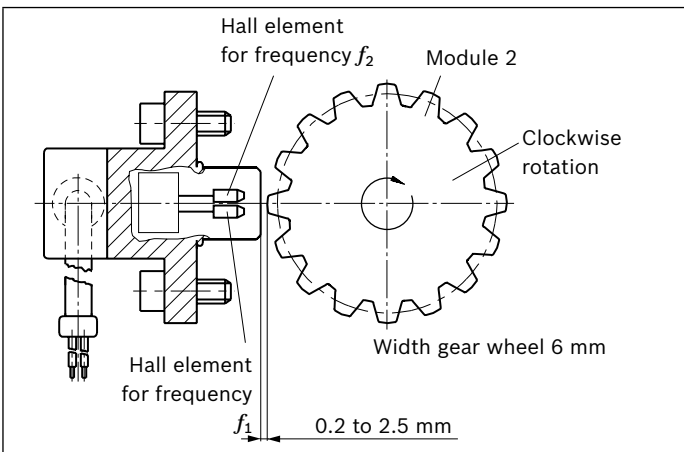


▼ Counter-clockwise

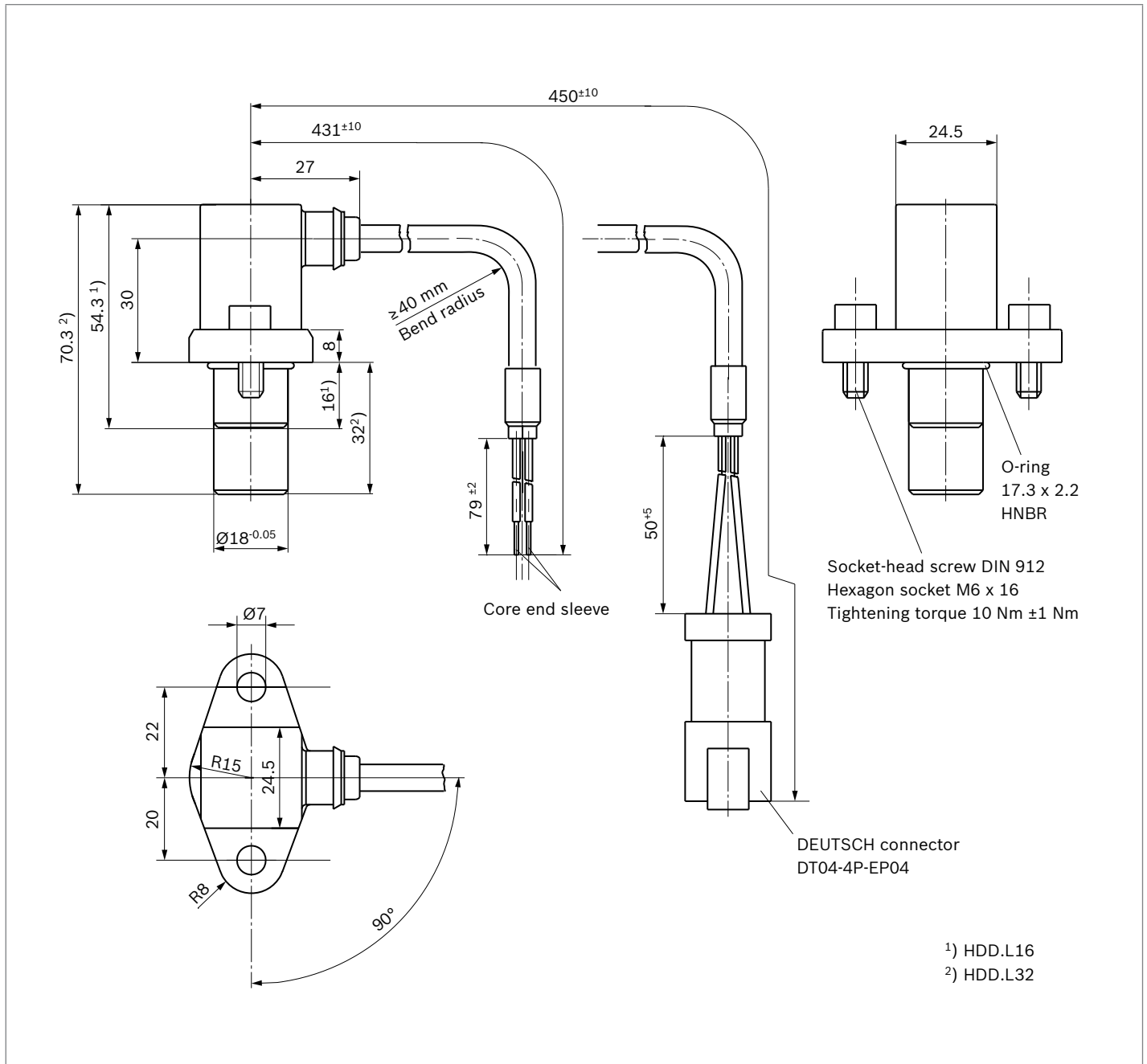


Frequency signals can only be evaluated in the measurement range from 0.1 Hz to 20 kHz.

Measuring arrangement

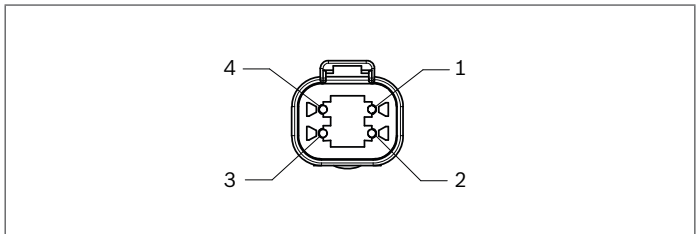


Dimensions

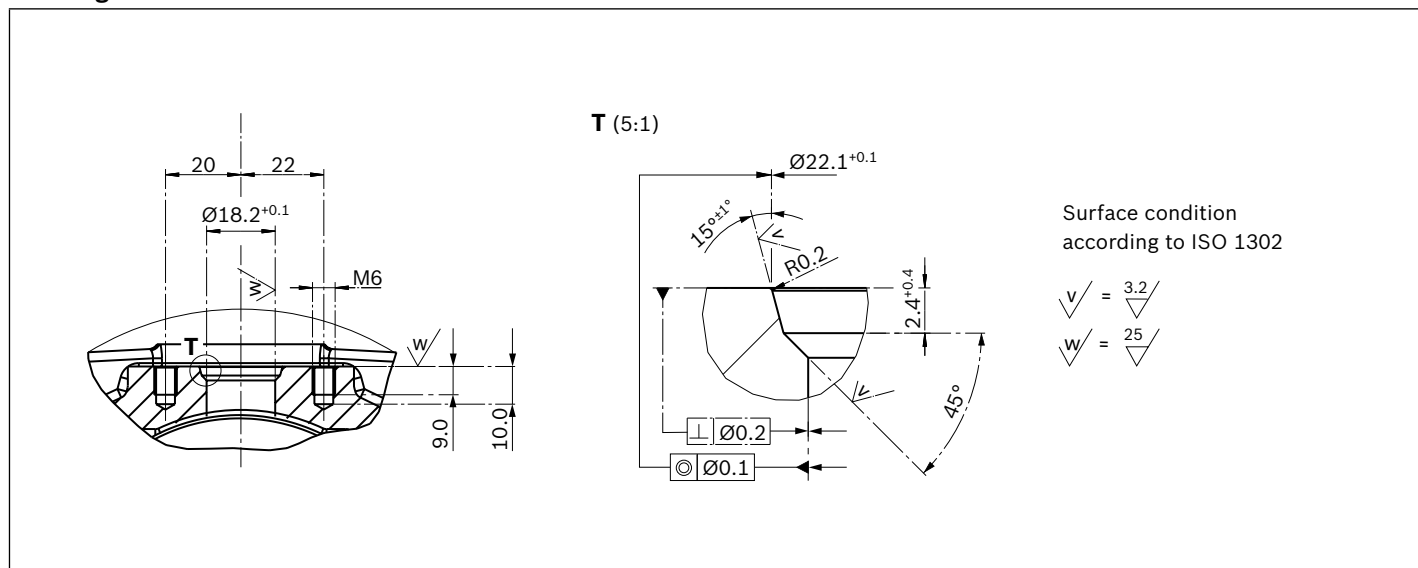


Pin assignment

Pin	Port
1	8 ... 32 VDC
2	ground
3	frequency signal 1
4	frequency signal 2 or direction of rotation



Locating hole



Connector

Pin assignment

Pin	Wire color	Port
1	Brown	supply voltage U_B
2	Blue	ground GND
3	Black	frequency U_{f1}
4	White	for HDD1 direction of rotation U_D for HDD2 frequency U_{f2}

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)
Core end sleeve	0.75 mm ²

Mating connector

DEUTSCH DT06-4S-EP04

Bosch Rexroth Mat. No. R902601805

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

Technical Data

Maximum current	13 A
Maximum voltage	250 VDC

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

Manufacturer confirmation of MTTF_d HDD values

The product meets the basic and proven requirements as per ISO 13849-2: 2008-09 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 13849:2008.

The following measured values can be used for rating:

MTTF _d value (years)	At 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 EN 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 value was calculated according to SN29500 and according to ISO 13849-1:2008-12, Appendix D Parts Count.

Assessment of safety principles

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

Basic safety principle A1	Remarks	Manufacturer rating
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.	Observe the specifications for installation by the user. 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.	Observe the specifications for installation by the user. Associated documentation in the product data sheet.
Limitation of the environmental parameters range	Temperature, air humidity and contamination at the installation location are examples of these parameters. 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	Consideration of unexpected start-up caused by stored energy and after reestablishment of energy supply for different operation categories like operating mode, maintenance mode etc. A special device for releasing the 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	IP protection type observance (see IEC 60529)	This must be done in the higher-level system.
Well-tried safety principle A2		
Secured position	The mobile element of the component is held mechanically in a secure position (friction alone is not sufficient). The application of a force is required for movement out of the secured position.	The sensor is tightened 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	Avoid mounting by friction only.	The sensor is tightened. 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. 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.

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 Manufacturer confirmation of MTTFd HDD values

Basic safety principle D1	Remarks	Manufacturer rating
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.	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.
Consideration 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. This is not a requirement to be met by the sensor.
Well-tried safety principle D2		
Avoidance of errors 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 fitted by the user in such a way that this requirement is met.
Distances between electrical conductors	Ensure that sufficient distance is used to prevent any unintentional connections between terminals, components and cables.	The sensor cable must be fitted by the user in such a way that this requirement is met.
Limiting 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.
Status orientation in the case of failures	If possible, all equipment/circuits should enter a safe condition or be safe to operate.	For HDD1 and HDD2, see separate table below.
Directed failure	If practicable, all components or systems should be applied for which the type of failure is known in advance, (see ISO 12100:2010, 6.2.12.3).	For HDD1 and HDD2, see separate table below.

HDD1

Component	Error direction output 1 (F1)	Error direction output 2 (direction of rotation)
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 function Not determined, no information from the Hall IC manufacturer
Output driver 1 (F1) faulty	Not determined, no information from the output driver manufacturer	Normal function
Output driver 2 (direction of rotation) faulty	Normal function	Not determined, no information from the output driver manufacturer
Pullup/pulldown resistances in output 1 (F1) faulty	NPN variants: Low level PNP variants: High level	Normal function
Pullup/pulldown resistances in output 2 (direction of rotation) faulty	Normal function	NPN variants: Low level PNP variants: 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	Error direction output 1 (F1)	Error direction output 2 (F2)
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, no information from the output driver manufacturer	Normal function
Output driver 2 (F2) faulty	Normal function	Not determined, no information from the output driver manufacturer
Pullup/pulldown resistances in output 1 (F1) faulty	NPN variants: Low level PNP variants: High level	Normal function
Pullup/pulldown resistances in output 2 (F2) faulty	Normal function	NPN variants: Low level PNP variants: 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

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.
- ▶ It is not permissible to open the sensor or to modify or repair the sensor. Modifications or repairs to the wiring could lead to 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, 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 both the components used and the complete system.
- ▶ 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.
- ▶ 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.
- ▶ Sensors do not fall under the scope of EMC-RL 2004/108/EC or 2014/30/EU. A declaration of conformity and the CE marking for individually sold sensors is not required, since the sensors are only sold to machine manufacturers (OEM) or to companies with the necessary expertise (i.e. certified Bosch Rexroth partners or companies with trained and qualified service personnel).
Furthermore, the responsibility of the above mentioned companies for machine EMC testing remains unaffected in principle.
- ▶ The use of sensors by private users is not permissible, 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 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 sensor.

Notes on transport and storage

- ▶ Please examine the sensor 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 mating connector should only be plugged and unplugged when it is in a deenergized 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 to the national regulations of your country

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