RE 95131/2023-09-19
Replaces: 2023-04-18

rexroth
A Bosch Company

BODAS speed sensor DST series 10

- Sensor for contactless rotational speed, direction of rotation and temperature measurement.
- Output signals:
  - Rotational speed and direction of rotation: 7 / 14 mA
  - Temperature-dependent resistor: 0.1 to 200 kΩ
- Measurement ranges:
  - Rotational speeds from 0 to 8 / 12 kHz
  - Temperatures from −40 to +140 °C
- Type of protection of sensor with installed mating connector IP67 and IP69K

Features

- Electrical two-wire PWM current interface
- Direction of rotation recognition
- Temperature measurement
- Also capturing of low rotational speeds
- Especially developed for the rough requirements of mobile applications
- Dynamic self-calibration principle
- Simple installation without setting work
- Large working air gap
- CE and UKCA conformity

Contents

Type code

01	02	03	04	05	06		07	08
DST	**1**		**–**	**F12**	**M**	**/**	**10**	**F**

Type

01	Speed sensor with direction of rotation and temperature recording	**DST**

Version

02	One frequency output with 0 ... 12 kHz	**1**

Shaft length

03	18.4 mm	**S18**
	32.0 mm	**S32**

Cable

04	Without cable	**–**

Max. frequency

05	12 kHz	**F12**

Connector

06	TYCO MCON 1.2	**M**

Series

07	Series 1, index 0	**10**

Seal

08	FKM (fluorocarbon rubber)	**F**

Available variants[1)]

Type	Material number
DST1S18–F12M/10 F	R917012857
DST1S32–F12M/10 F	R917012859

1) More variants available on request

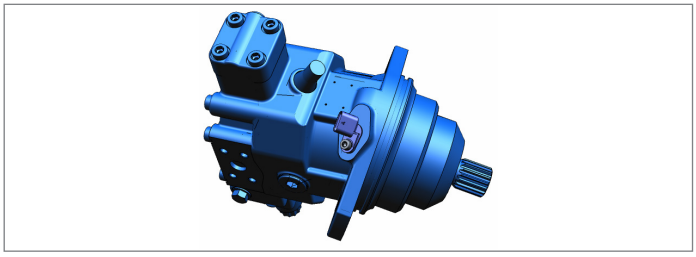
Description

The Hall effect-based DST1/10 speed sensor has been specially developed for use under harsh conditions in mobile working machines. The sensor records the rotational speed and the direction of rotation signal of ferromagnetic gear wheels or punching sheets.
As an active sensor, it delivers a signal with a constant amplitude that is independent of the rotational speed.
The sensor distinguishes itself not only due to the fact that it can detect the rotational speed and the direction of rotation, but also by the measurement of the temperature at the installation location.
For this purpose, the sensor has an integrated NTC thermistor.

Application examples

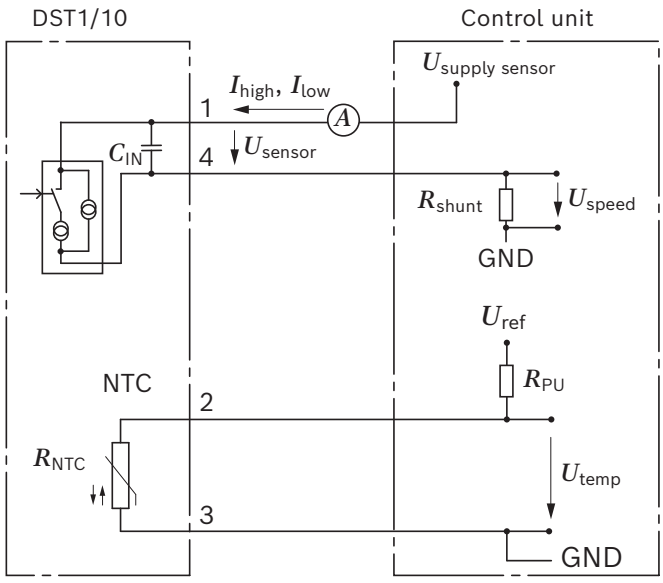
Due to its compact, sturdy design, the sensor is suitable for example, for integrated use with

- Rexroth axial piston units



- Rexroth radial piston units
- Rexroth external gear units
- Gears or gear stages
- Wheel bearing for wheel speed acquisition
- Vibration drives for road rollers and pavers

Block diagram



Key

GND	Electrical ground
C_{IN}	Input capacity (1.8 nF)
I_{high}	Signal sensor current high
I_{low}	Signal sensor current low
R_{shunt}	Internal resistance (75 ... 200 Ω)
U_{sensor}	Speed sensor – operating DC voltage
U_{speed}	Speed sensor – output voltage
$U_{supply\ sensor}$	Supply voltage
NTC	Thermistor with negative temperature coefficient (5 kΩ at 25 °C)
R_{PU}	Pull-up resistor – temperature signal control unit (1 kΩ)
U_{ref}	Temperature signal – operating DC voltage
U_{temp}	Temperature signal – output voltage

Measuring principle rotational speed and direction of rotation

For the signal transmission of the rotational speed and direction of rotation signal, a two-wire PWM current interface is used. The sensor generates a current signal with two changing fixed values. The low current (I_{low} = own power consumption of the active element) is interpreted as low signal. The high current (I_{high} = I_{low} + ΔI; ΔI = additional current by a path parallel to the active element) is interpreted as high signal.
In the control unit, the current coming from the sensor is converted at an R_{shunt} measuring resistance into a voltage signal. The analysis circuit in the connected control unit detects based on the voltage level whether there is a high or low signal.

Measuring principle of temperature measurement

The ambient temperature is measured using the integrated thermistor which has a negative temperature coefficient (NTC). This thermistor type is also referred to as “NTC thermistor”. With increasing temperature, the electric conductivity of NTC thermistors increases in a reproducible manner (low resistance).
The NTC thermistor integrated in the sensor is directly connected to the plug contacts of the sensor connector. By measuring the NTC thermistor resistor, the ambient temperature at the installation location of the sensor can be determined in the superior control unit.

Technical data

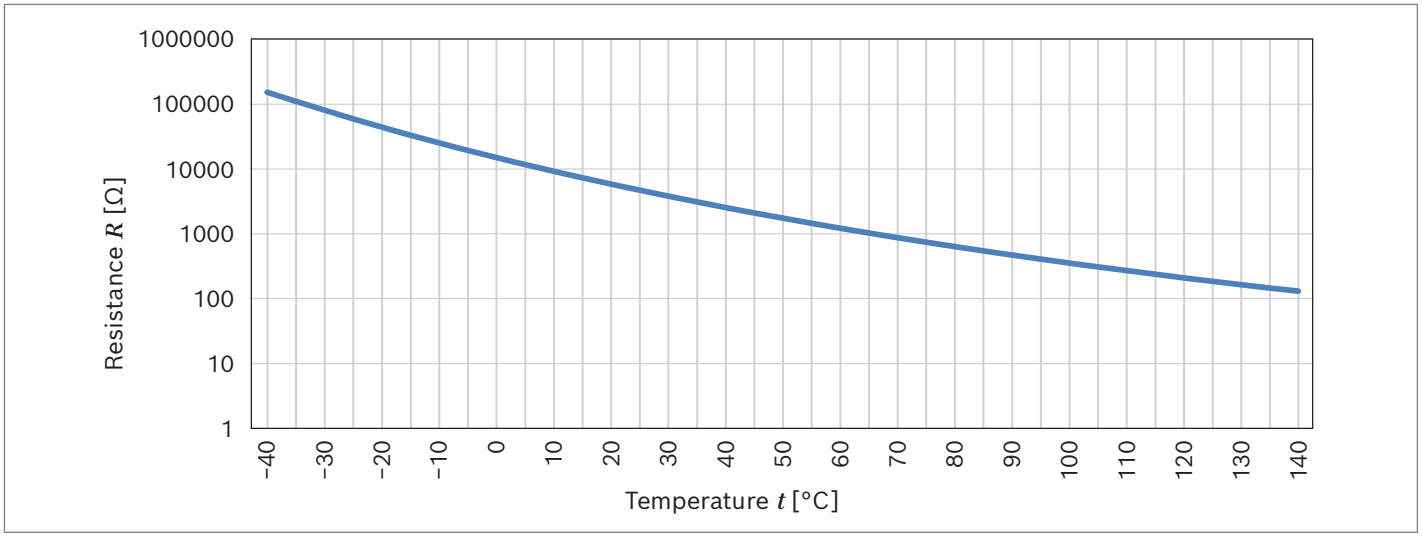
General			
Electromagnetic compatibility (EMC)	BCI (ISO 11452-4)	1 ... 400 MHz	100 mA
	Free field (ISO 11452-2)	20 ... 80 MHz	60 V/m
		80 ... 2700 MHz	150 V/m
Electrostatic discharge ESD	According to ISO 10605: 2008	Contact discharge	±8 kV
		Air discharge	±15 kV
	According to IEC 61000-4-2:2008	Direct contact discharge	±4 kV (±6 kV with EN 12016 Functional safety
		Air discharge	±8 kV (±15 kV with EN 12016 Functional safety and EN 12895)
Conformity with	EMC directive 2014/30/EU with CE marking		Applied standards: EN ISO 14982, ISO 13766-1, ISO 13766-1
	EMC directive SI 2016/1091 with UKCA marking		
	RoHS directive 2011/65/EU		
E1 type approval			UN ECE 10 Rev6
Vibration resistance (IEC 60068-2-34)	Random-shaped vibration		0.05 g^2/Hz 20 ... 2000 Hz
Shock resistance (IEC 60068-2-27)			1000 m/s^2, 6 ms, 12× in each direction (positive/negative)
Salt spray resistance (ISO 15003 / ISO 19014-3)			240 h at 35 °C with 5% NaCl
Type of protection with installed mating connector (ISO 20653: 2013-02)			IP6KX; IPX6; IPX7; IPX9K
Operating temperature range	Sensor zone		–40 ... +140 °C
	Connector zone		–40 ... +125 °C
Storage temperature range (IEC 68-2-1 Aa, IEC 68-2-2 Ba)			–40 ... +50 °C
Material			Housing: Polyphenylene sulfide (PPS)
Weights	DST1S18		13 g
	DST1S32		14 g
Installation position			See chapter "Installation instructions"
Pressure resistance			15 bar dynamic pressure 30 bar static pressure
Permissible fluids[1)]	Sensor zone		Hydraulic fluids based on mineral oils according to DIN 51524, HETG, HEPG, HFE, HLP, HVLP, HFA, HFC, HFD, HFDR, HD Mineral oils according to: ALI-C, API-CD; API-CF
	Connector zone		Hydraulic fluids based on mineral oils according to DIN 51524, HETG, HEPG, HFE, HLP, HVLP, HFA, HFC, HFD, HFDR, HD 15W-40, fertilizer, Ad-Blue, RME (biodiesel), battery acid, SAE80W-90, antifreeze, brake fluid, SAE15W40, gasoline, diesel, cleaner solvent
Service life			20,000 operating hours or 15 years

1) More on request

Rotational speed and direction of rotation sensor		
Sensor operating DC voltage (U_{sensor})[2]		4.5 ... 20 V, measured between PIN 1 and PIN 4
Reverse polarity	Minimum reverse polarity voltage	−20 V Only valid in combination with a resistor (measuring resistance, typically in the analyzing electronics) of R_{shunt} = 75 Ω ≤ 200 Ω. R_{shunt} limits the power dissipation of the sensor.
Maximum current consumption		16.0 mA
Sensor current	I_{low}	7.0 mA
	I_{high}	14.0 mA
Tooth frequency		Up to 12 kHz
Signal frequency (= tooth frequency)		Up to 12 kHz
Measurement distance / air gap		0.2 ... 2.0 mm **Notice:** The minimum distance may be infinitely small as long as there is no contact between the sensor and the encoder wheel.
Direction of rotation signal		Coded in the pulse width of the signal (see "Output signals" chapter)

Temperature sensor		
Temperature measuring range		−40 ... +140 °C
Resistance (nominal values)	at 0 °C	16.51 kΩ
Tolerance	at 25 °C	5 kΩ
	at 100 °C	0.3359 kΩ
Operating DC voltage		5 V ±150 mV
Maximum permissible current		5 mA
Time constant τ_{63}		180 s (measured in fluid with a temperature jump from +20 °C to +100 °C)
Loss factor[3]		0.72 mW/K

▼ **Transmission characteristic**



2) See circuit diagrams "Basic use for ECUs equipped with an internal pull-up resistor" or "Basic use for ECUs equipped with an internal pull-down resistor" in chapter "Application at control units"

3) Additional temperature increase (temperature offset) due to the power dissipation in the thermistor (NTC)

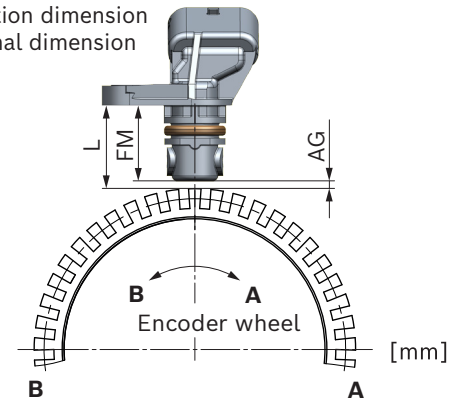
Electrical characteristics

Resistance value dependent on temperature R_{NTC}							
Temperature [°C]	**Minimum resistance [kΩ]**	**Nominal resistance [kΩ]**	**Maximum resistance [kΩ]**	**Temperature [°C]**	**Minimum resistance [kΩ]**	**Nominal resistance [kΩ]**	**Maximum resistance [kΩ]**
-40.0	154.5	174.4	196.8	55.0	1.411	1.479	1.550
-35.0	111.6	125.3	140.6	60.0	1.178	1.232	1.287
-30.0	81.54	91.08	101.7	65.0	0.9882	1.030	1.074
-25.0	60.18	66.89	74.30	70.0	0.8330	0.8663	0.9005
-20.0	44.87	49.63	54.87	75.0	0.7054	0.7318	0.7587
-15.0	33.77	37.19	40.93	80.0	0.6000	0.6210	0.6423
-10.0	25.65	28.12	30.81	85.0	0.5126	0.5292	0.5461
-5.0	19.65	21.46	23.41	90.0	0.4397	0.4530	0.4664
0.0	15.18	16.51	17.94	95.0	0.3787	0.3893	0.3999
5.0	11.83	12.81	13.86	100.0	0.3275	0.3359	0.3443
10.0	9.281	10.01	10.80	105.0	0.2831	0.2909	0.2988
15.0	7.338	7.889	8.475	110.0	0.2456	0.2529	0.2603
20.0	5.842	6.258	6.700	115.0	0.2138	0.2207	0.2276
25.0	4.683	4.999	5.334	120.0	0.1869	0.1932	0.1997
30.0	3.778	4.020	4.275	125.0	0.1638	0.1697	0.1757
35.0	3.067	3.253	3.449	130.0	0.1441	0.1496	0.1552
40.0	2.505	2.649	2.799	135.0	0.1272	0.1323	0.1374
45.0	2.057	2.169	2.286	140.0	0.1126	0.1173	0.1221
50.0	1.699	1.787	1.877				

Installation instructions

Installation position

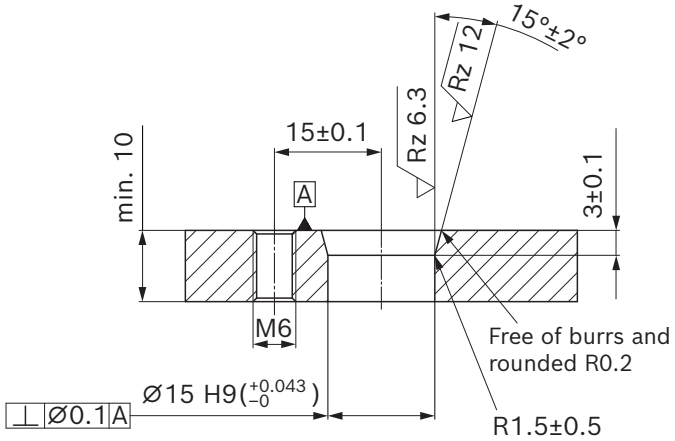
L = installation dimension
FM = functional dimension
AG = air gap



Encoder wheel direction of rotation counterclockwise (CCW)
90 µs output signal

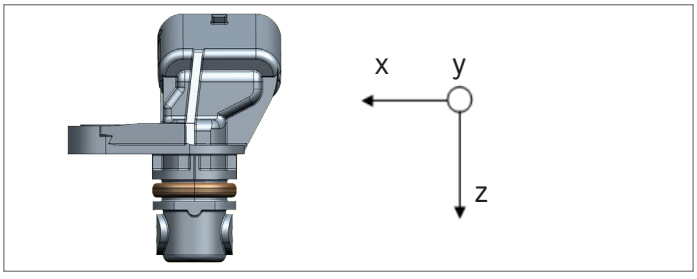
Encoder wheel direction of rotation clockwise (CW)
45 µs output signal

Installation bore



Maximum tightening torque 9 $^{+0}_{-1}$ Nm

Positioning



Key	
x	Tangential (x = 0 means without offset in x-direction)
y	Axial (y = 0 means without displacement in the y direction), detection point of the sensor centrally above the tooth
z	Radial (significant for AG, FM and L)

Installation dimension and working air gap

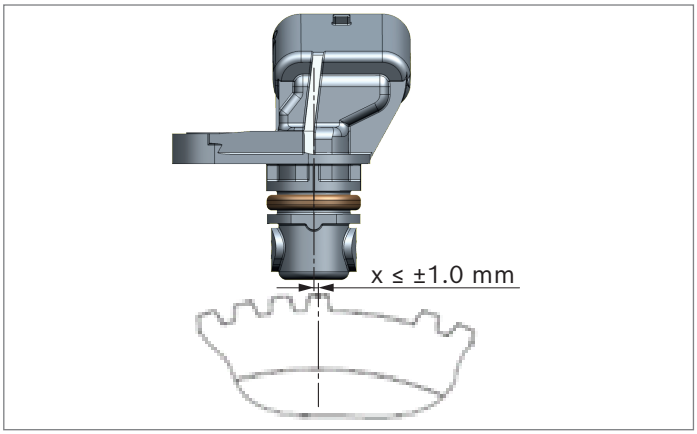
The installation dimension (L) is dependent on the air gap (AG) and the tolerance of the functional dimension (FM). It must be within the following limits:

AG_{min} = 0.2 mm
AG_{max} = 2.0 mm
$L_{min} = FM_{max} + AG_{min}$
$L_{max} = FM_{min} + AG_{max}$

Other air gap limits are possible, must, however, be evaluated by Bosch Rexroth with the customer-specific encoder wheel design. The accuracy of the speed recording depends on the air gar range and the encoder wheel design.

Tangential offset

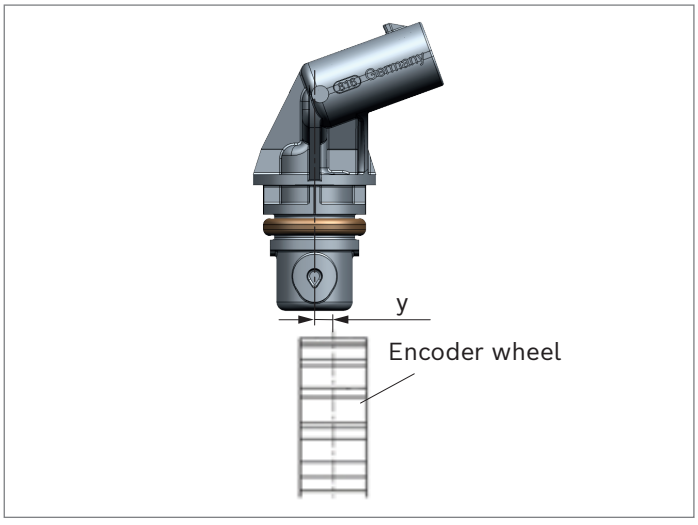
The fluctuations (jitter) of the period length output of speed sensors are dependent on the tangential position "x" of the sensor referring to the encoder wheel center. In this document, the switching accuracy ranges are specified for an ideally set sensor, i.e. for x = 0.0 mm. The position of the recording point is in the center of the sensor axis.
With a tangential offset of the sensor, the switching accuracy values may slightly differ.
The permissible tangential offset without deviating values for the standard encoder wheel (see chapter "Gear wheel specification") is specified to be ≤ ±1.0 mm.



Axial offset

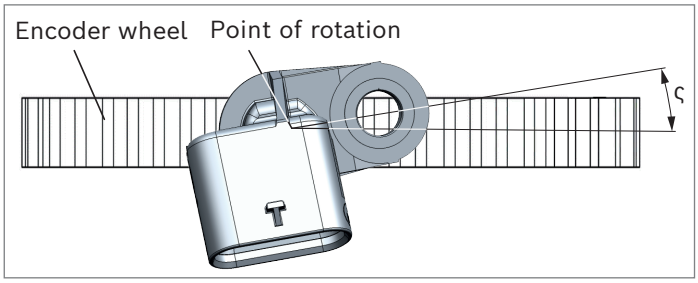
The fluctuation (jitter) of the period length output of the sensor is influenced by the axial "y" position of the sensor referring to the scanning track of the encoder wheel (see figure). To achieve the specified accuracy, the sensor has to be mounted as follows:

- Nominal scanning track:
  Centered over teeth / tooth space
- Axial offset:
  y ≤ ± 1.0 mm (valid for standard encoder wheel see chapter "Gear wheel specification")



Rotation of sensor

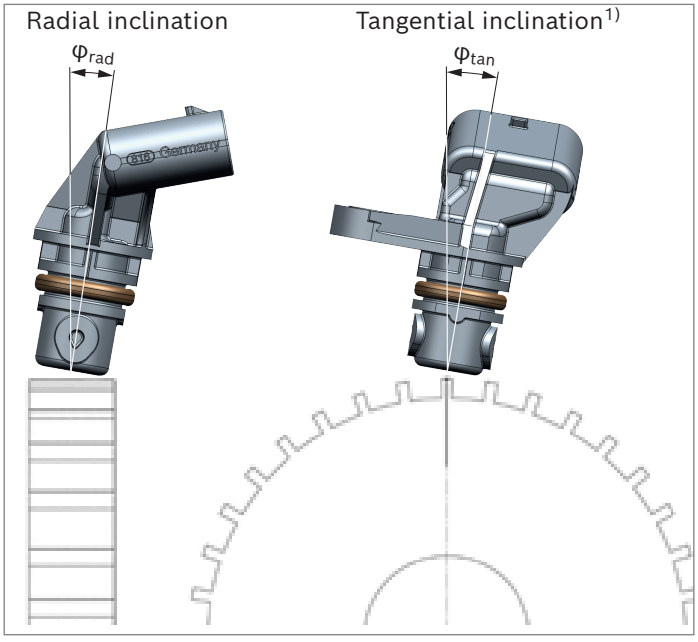
Due to the position of the Hall plates in the sensor, the fluctuation (jitter) of the period length output of the sensor is dependent on the angle of rotation ς around the z-axis. The rotation must not exceed ς_{max} = ±5.0°.
This specification is valid for a standard encoder wheel (see chapter "Gear wheel specification").
Other configurations than described are possible, the sensor power must, however, be re-calibrated.



Inclination

The fluctuation (jitter) of the period length output of the sensor is influenced when the sensor is tilted with regard to the encoder wheel, i.e. when it is rotated with regard to the y-axis (for the definition of the axes see chapter "Installation instructions, figure: positioning").

The value of the tangential inclination φ_{tan} and the radial inclination φ_{rad} must be less than ±3°
(valid for the standard encoder wheel see chapter "Gear wheel specification"). Other configurations than described are possible, the sensor function must, however, be re-evaluated by Bosch Rexroth.



1) Tangential inclination (φ = 0 means without inclination)

Gear wheel specification

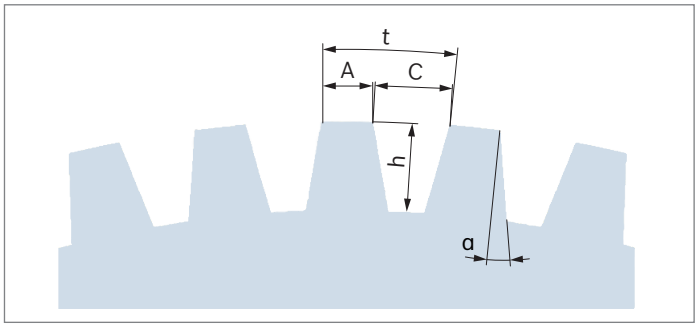
Material

The pulse wheels must be magnetically conductive.
The material should be magnetically soft. The following have been tested to date: free-cutting steels, tempered steels, sintered materials (e.g. St37, 9SMn28, C45, GG20, GGG40, X8Cr17).

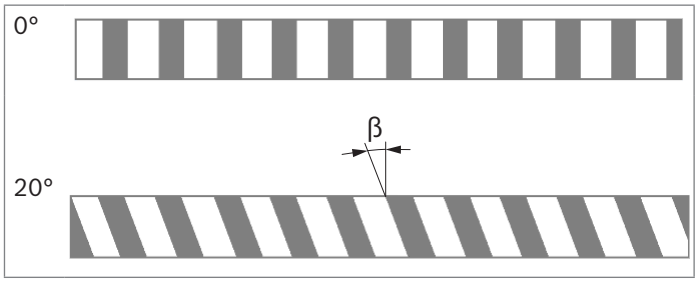
Notice

For the use of the sensor outside of Rexroth products, please consult your Bosch Rexroth contact person.

▼ **Definition of gear wheel parameters**



▼ **Helix angle**

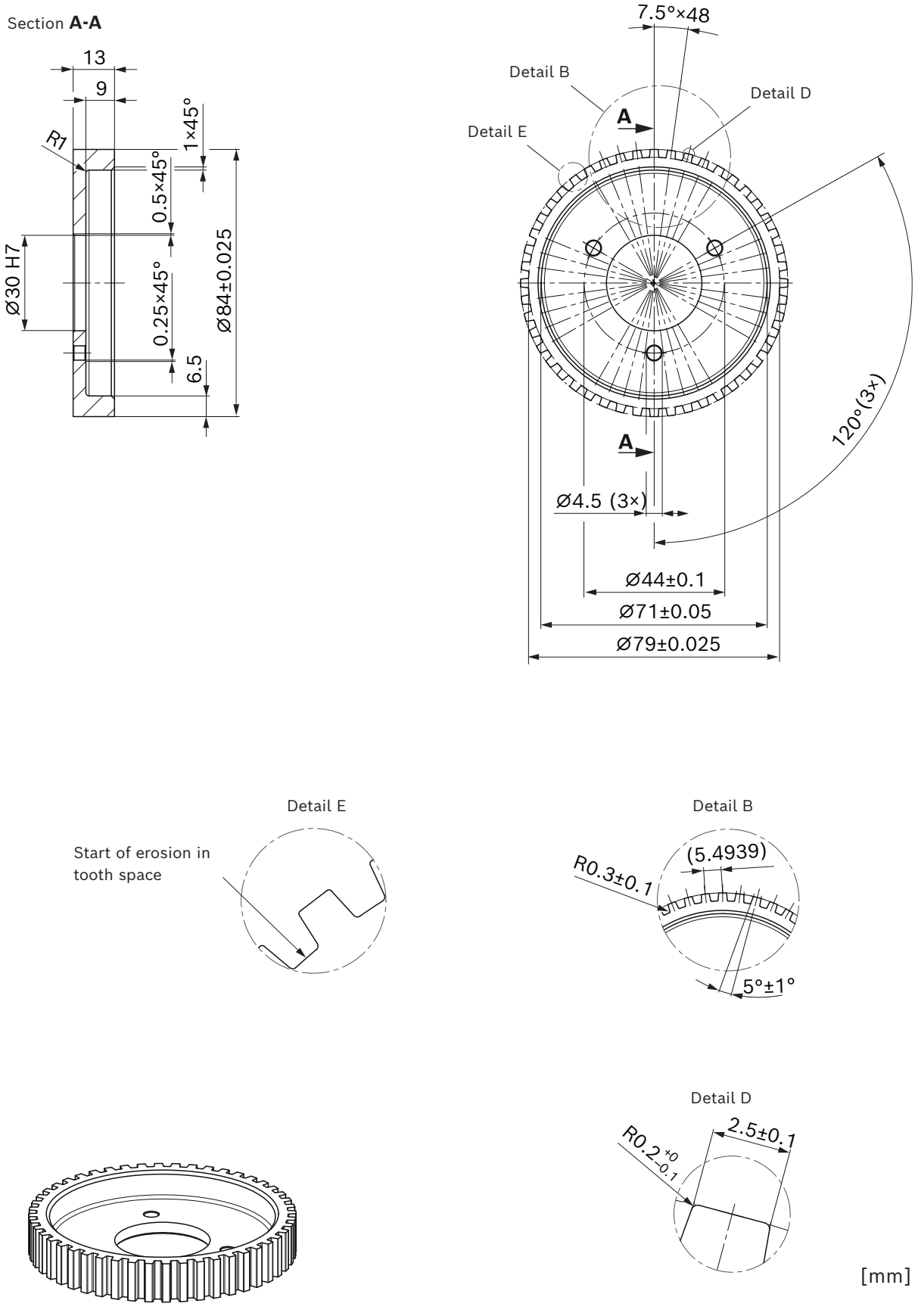


▼ **Spline specifications valid for basic number of teeth 48**

			Variant 1		Variant 2	
			Minimum	**Maximum**	**Minimum**	**Maximum**
β	Helix angle	°	0	30	0	40
t	Spacing (A+C)	mm	6	12	8	12
A/t	Ratio tooth top width/spacing		0.1	0.3	0.1	0.2
α	Pressure angle		0	30	0	30
h	Tooth height (t/2)	mm	3	6	4	6
A	Tooth top width (calculated from A/t)					
z	Basic number of teeth 48					
	Tooth shape		Rectangle and trapezoid (other shapes by arrangement)			
	Magnetic permeability μr		≥ 1000			

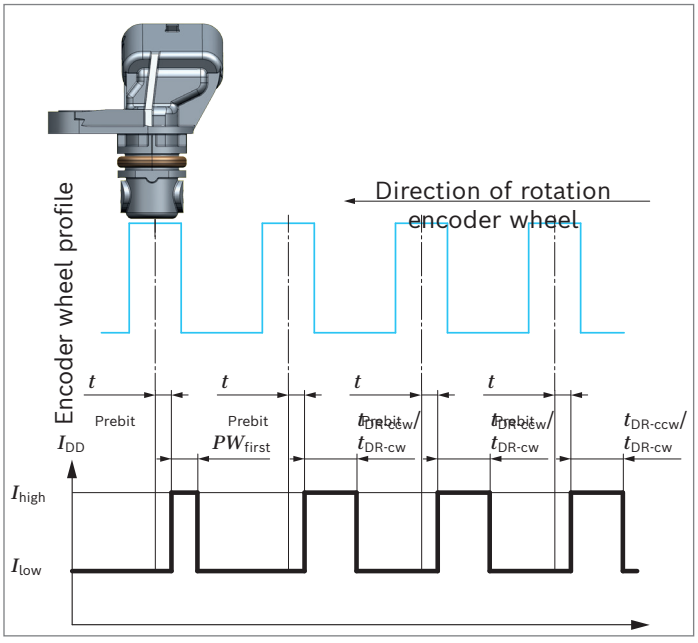
The information given here is a recommendation.
Other geometries are possible after consultation with your Bosch Rexroth contact person.

Standard gear wheel



Output signals

The output signal for the rotational speed and the direction of rotation of DST1/10 consists of rectangular pulses with constant pulse widths that are generated by the application specific integrated circuit (ASIC) of DST1/10. The distance of the consecutive high pulses is the dimension for the measured frequency (and/or rotational speed). The length of the individual pulses provides information about the direction of rotation. Counter-clockwise rotation is described by a nominal 90 µs pulse and clockwise rotation by a nominal 45 µs pulse. So that the rotational speed information can still be output at higher rotational speeds even with long high pulses, a low time (prebit low) with a nominal length of 15 µs is generally connected upstream the high pulse.



Speed range

The maximum permissible rotational speed depends on the number of gears at the encoder wheel.
For the customer-specific encoder wheel, the maximum recordable rotational speed can be calculated using the following formula.

$$n_{max} = \frac{\text{max. switching frequency}}{\text{Number of teeth}} \times 60$$

Signal tolerances

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

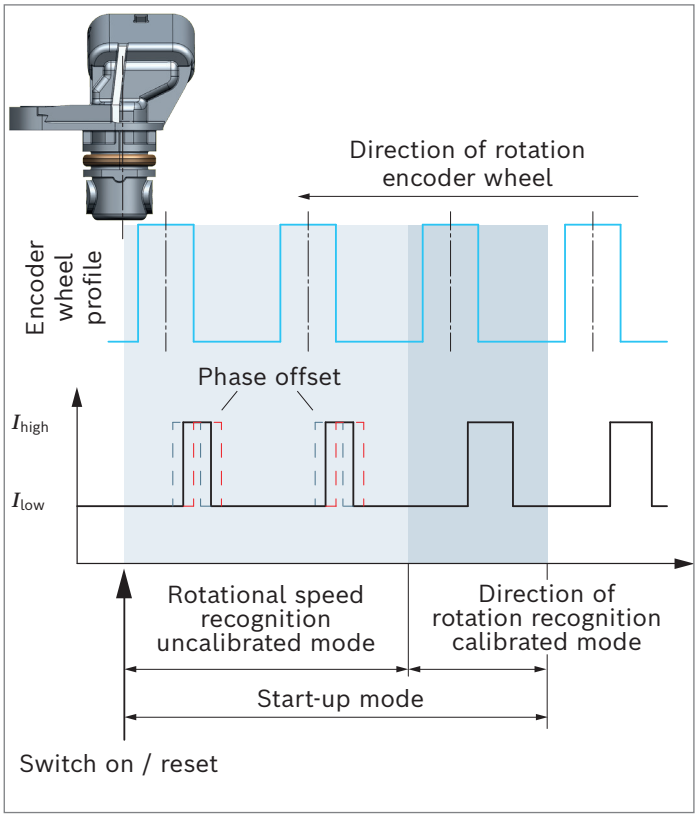
Pulse designation			Pulse width t_{Pulse}		
			min	nom	max
Prebit (low)	t_{Prebit}	µs	13.12	15	16.87
Length of the first pulse after switch-on	PW_{first}	µs	26.25	30	33.75
Counter-clockwise rotation	t_{DR-ccw}	µs	78.75	90	101.25
Clockwise rotation	t_{DR-cw}	µs	39.37	45	50.62
Frequency including direction of rotation recognition	f_{cw}	kHz	12		
	f_{ccw}	kHz	8		

Vibrations

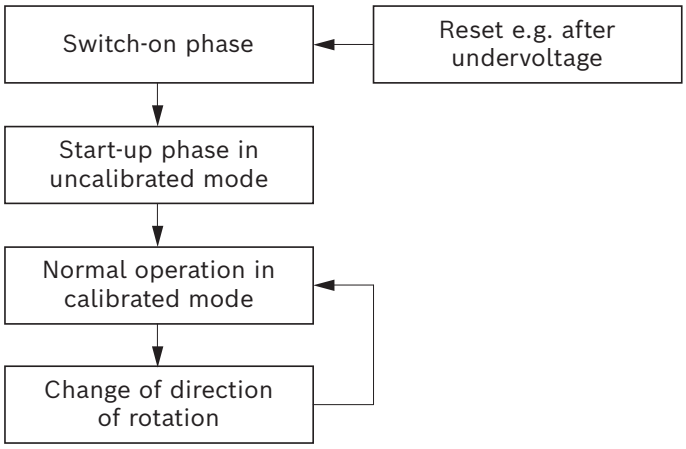
Vibrations of the standing encoder wheel may lead to incorrect sensor signals.

Signal upon start-up

In the determination of the output values (frequency, direction of rotation, ...) a certain number of pulses may be required to ensure the supplied information.
Upon start-up from standstill or after undervoltage condition, the sensor is first of all set into an uncalibrated condition (signal not offset-compensated). Also during this phase, the sensor will supply a correct frequency signal from the start of the second signal pulse and under typical conditions also a correct direction of rotation signal from the third signal pulse. Depending on the installation situation, correct output of the direction of rotation requires a maximum of up to four teeth / flanks. In this mode, the minima and maxima of the magnetic input signal are used as trigger points.
During the signal output in uncalibrated mode, the sensor caries out calibration (offset compensation) of the signal. The sensor will then automatically switch into the calibrated mode. From that, the zero passages of the magnetic input signal will be used as trigger points.
Upon switch-over into the calibrated mode, phase displacement of the output signal may occur in rare cases (maximum –90° and/or +90°).
The maximum number of signal pulses output in the uncalibrated mode is three.



▼ **Start sequence**

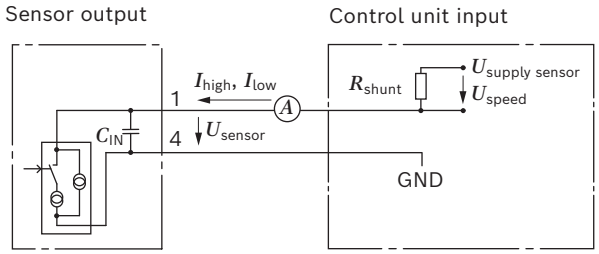


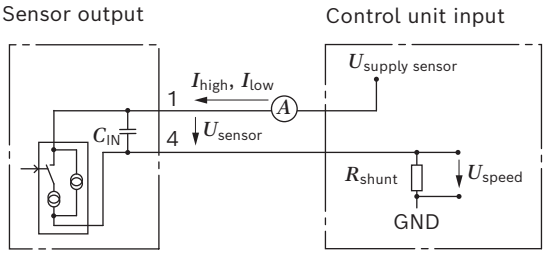
Description of the start sequence	Number of teeth
Number of teeth until transmission of the first rotational speed signal	≤2 (uncalibrated mode)
Number of teeth until transmission of the direction of rotation signal	≤ 3 (calibrated mode)
Maximum number of teeth that are required until transmission of all signals	≤ 4

Application at control units

Calculation of the output voltage of the rotational speed signal as a function of the evaluating control unit

Basic use for ECUs equipped with an internal pull-up resistor	Basic use for ECUs equipped with an internal pull-down resistor	Calculation of the output voltage of the rotational speed signal





$U_{speed\ high\ and/or\ low} = R_{shunt} \times I_{high\ and/or\ low}$

Application with Rexroth BODAS Controllers

The control unit-internal measuring resistance R_{shunt} generates a voltage applied to the frequency input of the RC control units.

This internal measuring resistance R_{shunt} must be selected so that:

- The voltage difference to the internal signal evaluation in the control unit is sufficient.
- The maximum voltage at the resistor R_{shunt} does not become too high (adapted to the sensor supply).
- So that the voltage U_{sensor} at the sensor pins 1 and 4 is always at least 4.5 V.

If these conditions are satisfied and the signal is internally available in the control unit, the sensor information can be determined.

Calculation example:

At R_{shunt} = 200 Ω and impulse values

Parameters	Symbol	Unit	minimum	nominal	maximum
Sensor current high	I_{high}	mA	12.0	14.0	16.0
Sensor current low	I_{low}	mA	6.0	7.0	8.0

result in the following voltages:

U input (R = 200 Ω)	Unit	minimum	nominal	maximum
U_{high}	V	2.4	2.8	3.2
U_{low}	V	1.2	1.4	1.6

Notice

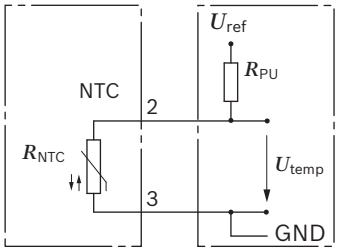
Please note in the dimensioning of the switching thresholds in the control unit that also the combination $I_{high\ minimum}$ with $I_{low\ maximum}$ may occur.

This leads to a sensor current ratio of 1.9.

Parameters	Symbol	minimum	nominal	maximum
Sensor current ratio	I_{high} / I_{low}	1.9	2.0	2.2

Calculation of the output voltage of the temperature signal as a function of the evaluating control unit

Sensor output	Control unit input	Calculation of the output voltage of the temperature signal



$$U_{temp} = U_{ref} \times \left[\frac{R_{NTC}}{(R_{PU} + R_{NTC})} \right]$$

The DST1/10 can be read in using the following BODAS controllers: RC series 30, 31 and 40.

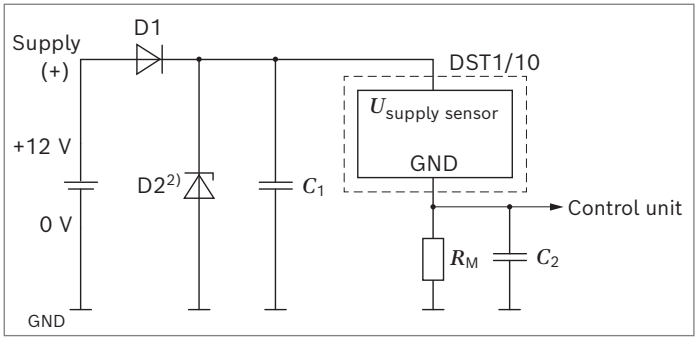
Notice
The current data sheet of the control unit used must be considered.

▼ **Application with Rexroth BODAS Controllers**

RC4-5/30 (data sheet 95205)	**RC28-14/30**, **RC20-10/30, RC12-10/30** (data sheet 95204)	**RC10-10/31** (data sheet 95206)	**RC5-6/40** (data sheet 95207)	**RC18-12/40, RC27-18/40** (data sheet 95208)
Frequency signals				
DST: 1 → 41; 4 → 19, 23	DST: 1 → 109 ... 113; 4 → 145, 146	DST: 1 → 8; 4 → 10, 12, 13, 30, 61, 70	DST: 1 → K20; 4 → K37, K54, K55, K61	DST: 1 → K20; 4 → A43, K30, K37, K54, K55, K61
Temperature signals				
DST: 2 → 6, 16, 17, 18; 3 → 3, 4	DST: 2 → 116 ... 118, 121; 3 → 145, 146	DST: 2 → 24 ... 26, 62; 3 → 56, 13	DST: 2 → K36, K38 ... K45, K52, K53, K56 ... K60, K63 ... K65; 3 → K18, K19, K23, K46, K47, K79	DST: 2 → A36 ... A39, A21 ... A24, K32, K33, K36, K38 ... K45, K52, K53, K56 ... K60, K63 ... K65; 3 → K18, K19, K23, K46, K47, K79

If the sensor is directly supplied from the electrical 12 V system of the machine, it is to be protected against an occurring load release, also referred to as "load dump", by means of a central load dump protection which ensures that the maximum peak voltage does not rise to or beyond 86 V[1)].
If there is no central overvoltage protection (load dump), you can alternatively also use the following protection circuit:

▼ **Application with direction connection to the 12 V voltage supply**



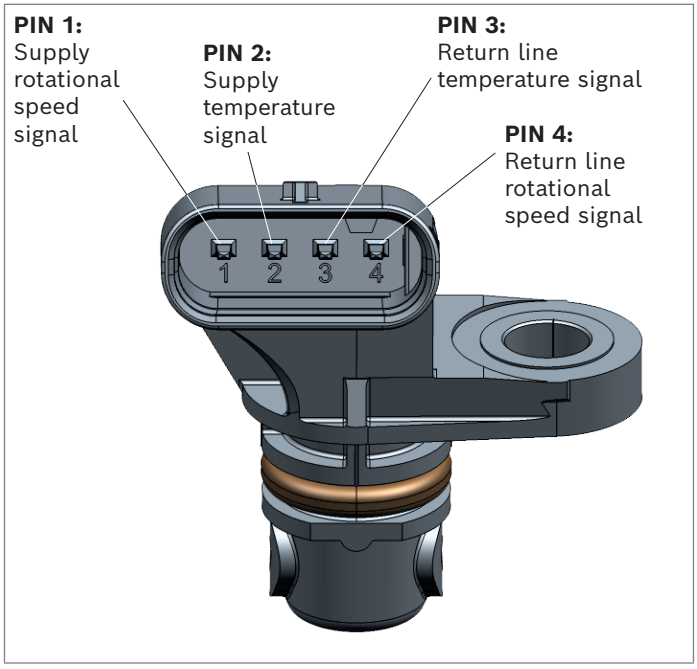
Key

D1	1N4007	D2	T 5Z27 1J	C_1	10 µF/35 V
C_2	1 nF/1000 V				

1) Test pulse 5a according to ISO7637-2; 2004
maximum supply voltage = 13.5 V; F_b= 100 Hz; T_j = 25 °C; R_m = 75 Ω
2) Installation of a suppressor diode D2 with sufficient energy absorption capability into the supply line

Connector

Pin assignment

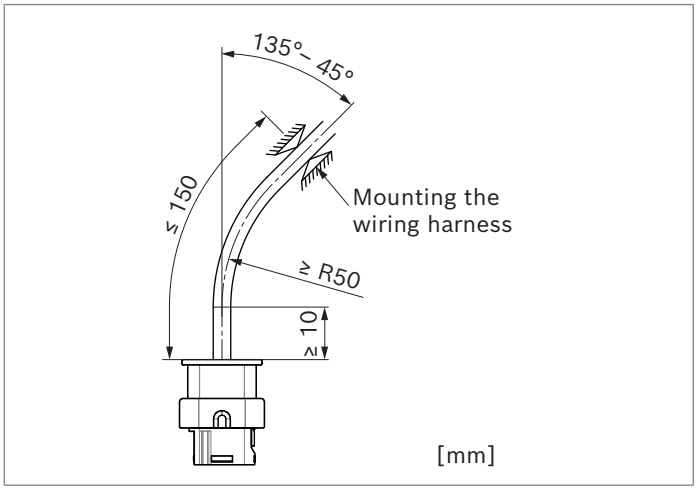


Installation

Mechanical connection
Before installing or removing the sensor, ensure that the system is in a safe condition (e.g. pressure-free).

Tightening torque
Before installing the DST speed sensor, the maximum tightening torque of the hydraulic component or housing must be checked.
If the torque for the installation of the sensor in the respective hydraulic component is not specified, the following recommended tightening torque applies: 8±1 Nm
A tightening torque of 11 Nm can only be guaranteed for the bush. However, the surface pressure of the respective housing must be validated by the customer.
The screw head shall have a contact surface of at least Ø9.8 mm.

▼ **Specification for cable routing**

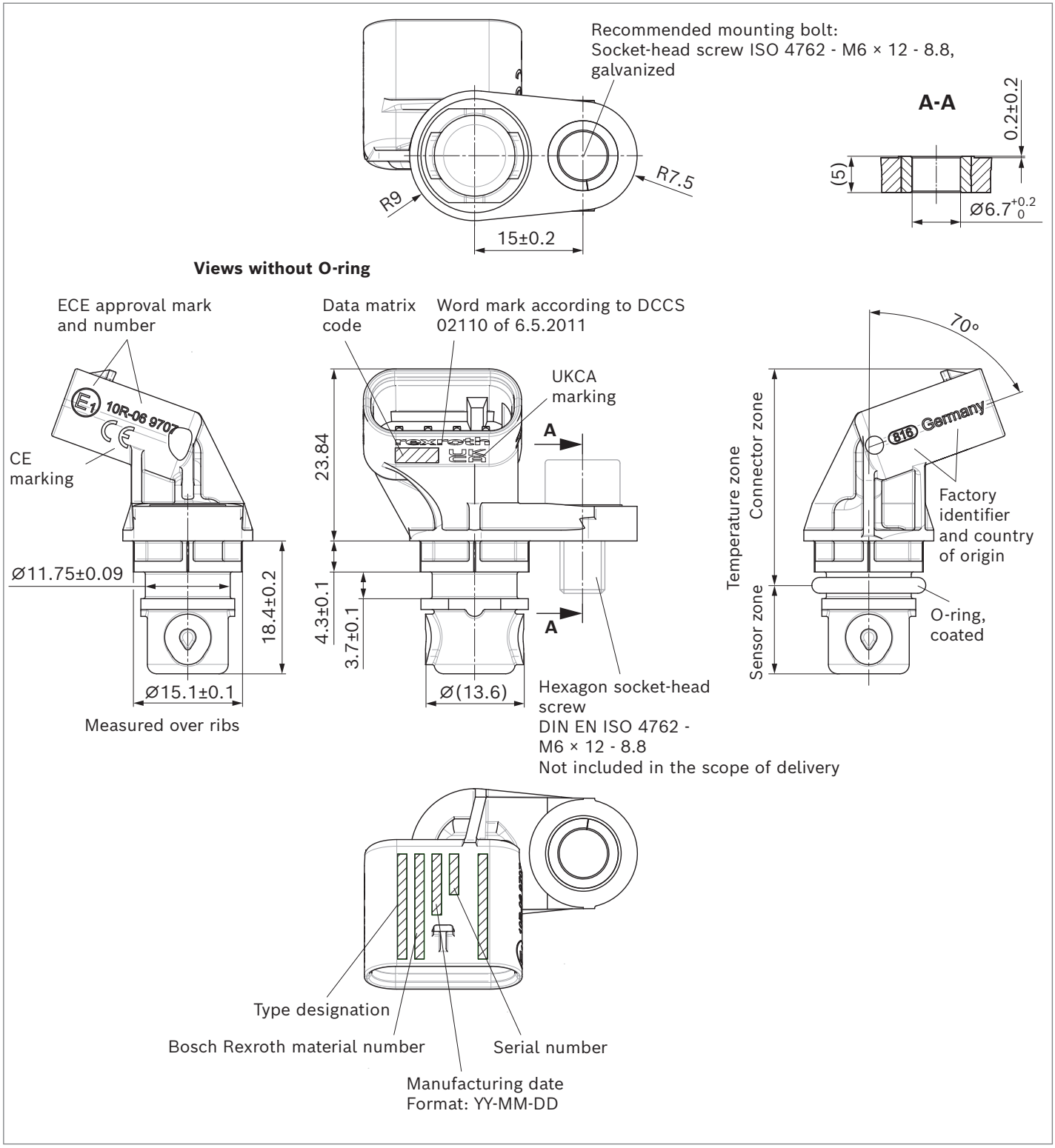


Notice
- Installation of the quick connectors:
  - Observe the assembly instructions for plug-in connections.
  - For information on the mating connector, see chapter "Accessories".
- Installation of the connector in the vehicle:
  - Fasten the wiring harness at a distance ≤ 150 mm from the connector.
  - Fix the wiring harness so that there is excitation in-phase with the sensor.
  - Use the wiring harness connector specified in chapter "Accessories" to protect against water ingress into the sensor connector chamber.

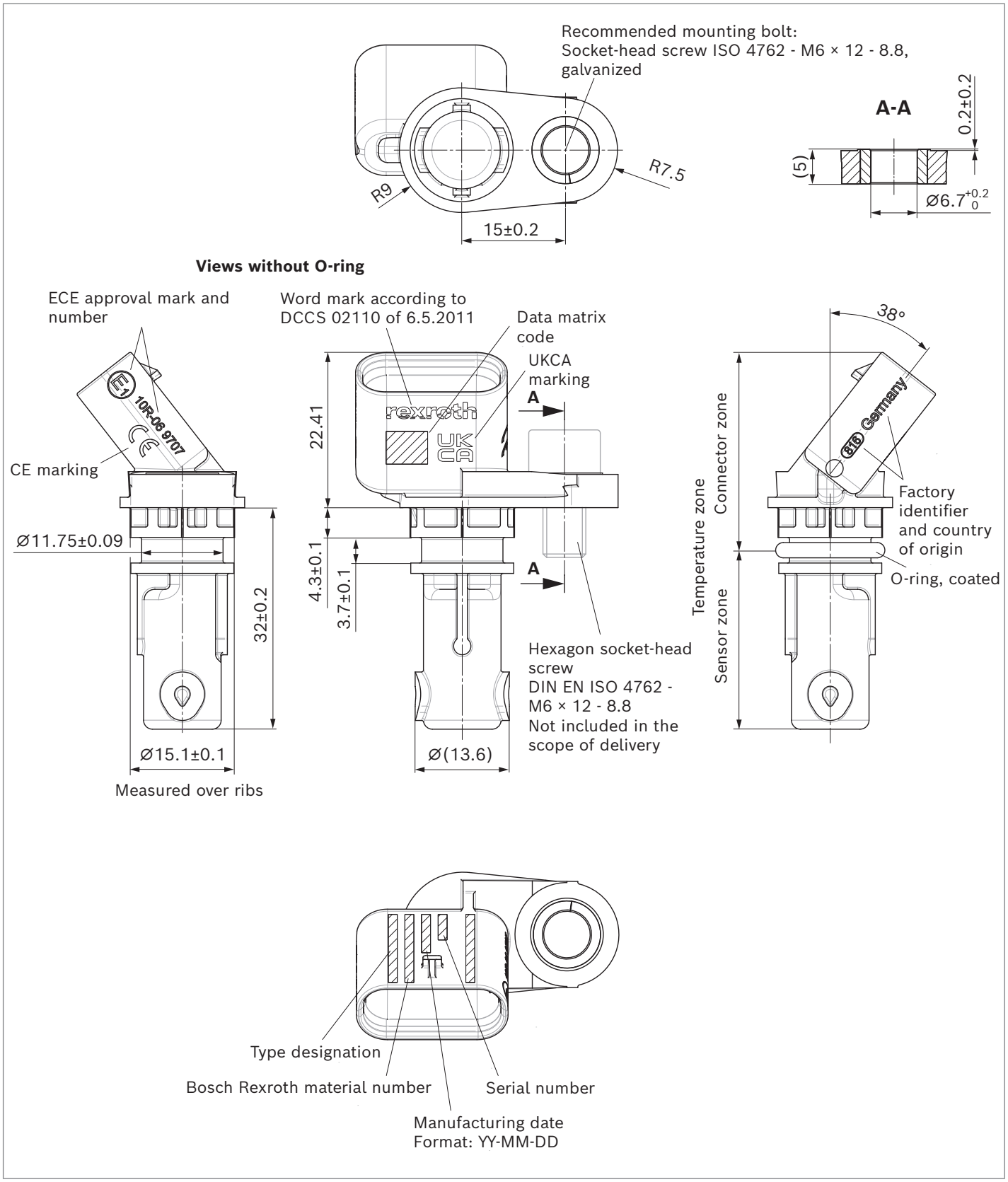
Electrical connection
- The sensor may only be installed by skilled personnel (electrician).
- National and international specifications for installation of electrotechnical systems must be observed.
- Voltage supply according to SELV, PELV.
- The contacts in the connector of the sensor must not be touched during installation work.
- When connecting the mating connector, "hot plugging" must be prevented (= connection of the mating connector with live voltage).

Dimensions

DST 1 S18

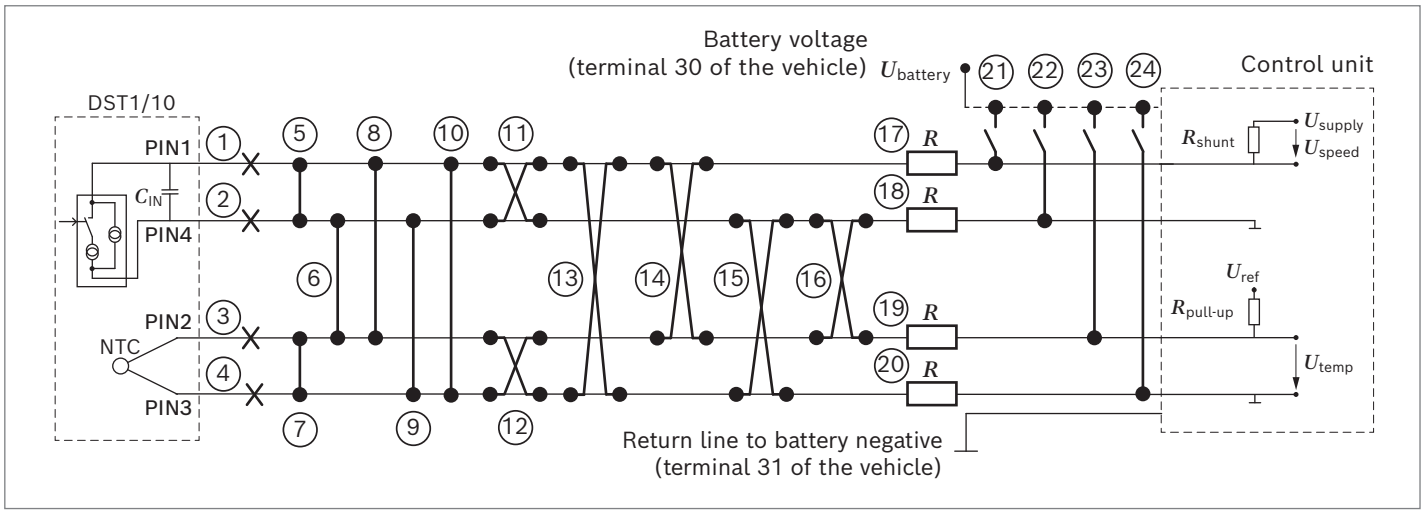


DST 1 S32

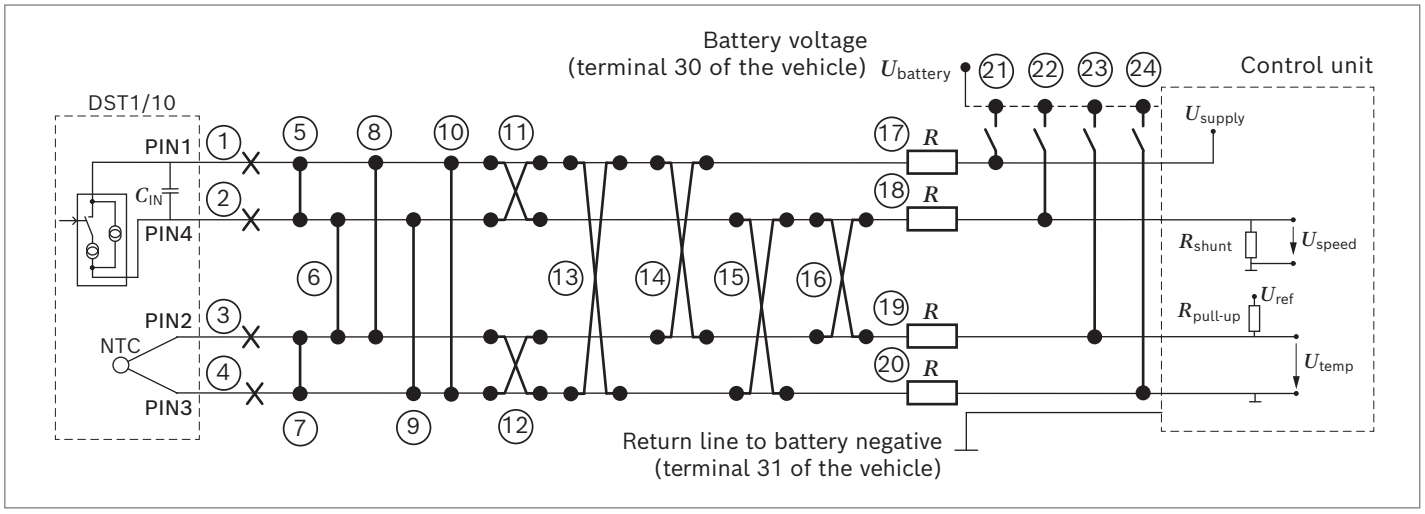

Recommended mounting bolt:
Socket-head screw ISO 4762 - M6 × 12 - 8.8, galvanized
R7.5
R9
15±0.2
A-A
0.2±0.2
(5)
Ø6.7 +0.2 0
Views without O-ring
ECE approval mark and number
Word mark according to DCCS 02110 of 6.5.2011
Data matrix code
UKCA marking
CE marking
Ø11.75±0.09
32±0.2
22.41
4.3±0.1
3.7±0.1
A
A
Ø15.1±0.1
Measured over ribs
Ø(13.6)
Hexagon socket-head screw
DIN EN ISO 4762 - M6 × 12 - 8.8
Not included in the scope of delivery
38°
Temperature zone
Connector zone
Sensor zone
Factory identifier and country of origin
O-ring, coated
Type designation
Bosch Rexroth material number
Serial number
Manufacturing date
Format: YY-MM-DD

Fault detection

▼ **Fault detection for ECU with an internal pull-up resistor**



▼ **Fault detection for ECUs with an internal pull-down resistor**



PIN 1 = supply rotational speed signal
PIN 2 = supply temperature signal
PIN 3 = return line temperature signal
PIN 4 = return line rotational speed signal

Error number	Description	ECU with internal pull-up	ECU with internal pull-down
1	Cable break Supply rotational speed signal	No valid rotational speed signal, current out of range	No valid rotational speed signal, current out of range
2	Cable break return line rotational speed signal	No valid rotational speed signal, current out of range	No valid rotational speed signal, current out of range
3	Cable break supply temperature signal	No valid temperature signal, signal out of range	No valid temperature signal, signal out of range
4	Cable break return line temperature signal	No valid temperature signal, signal out of range	No valid temperature signal, signal out of range
5	Short circuit between rotational speed signal supply – return line	No valid rotational speed signal, overcurrent	No valid rotational speed signal, overcurrent
6	Short circuit between return line rotational speed signal – supply temperature signal	No valid rotational speed and temperature signal, powered up	No valid rotational speed and temperature signal, powered up
7	Short circuit between temperature signal supply – return line	No valid temperature signal, overcurrent	No valid temperature signal, overcurrent

Error number	Description	ECU with internal pull-up	ECU with internal pull-down
8	Short circuit between supply rotational speed signal – supply temperature signal	No valid rotational speed and temperature signal	No valid rotational speed and temperature signal
9	Short circuit between return line rotational speed signal – return line temperature signal	Normal operation	No valid rotational speed signal, current out of range
10	Short circuit between supply rotational speed signal – return line temperature signal	No valid rotational speed signal, overcurrent	No valid rotational speed signal, overcurrent
11	Switching the polarity of the rotational speed signal	No valid rotational speed signal	No valid rotational speed signal
12	Switching the polarity of the temperature signal	Normal operation	Normal operation
13	Switching the polarity of supply rotational speed signal ↔ return line temperature signal	No valid rotational speed and temperature signal	No valid rotational speed and temperature signal
14	Switching the polarity of supply rotational speed signal ↔ supply temperature signal	No valid rotational speed and temperature signal, overcurrent temperature signal	No valid rotational speed and temperature signal, overcurrent temperature signal
15	Switching the polarity of return line rotational speed signal ↔ return line temperature signal	Normal operation	No valid rotational speed and temperature signal
16	Switching the polarity of return line rotational speed signal ↔ supply temperature signal	No valid rotational speed and temperature signal	No valid rotational speed and temperature signal
17	Additional resistor in the supply rotational speed sensor (high current level is still achievable)	<10 Ω: Normal operation	<10 Ω: Normal operation
18	Additional resistor in the return line rotational speed signal (high current level is still achievable)	<10 Ω: Normal operation	<10 Ω: Normal operation
19	Additional resistor in the supply temperature signal	No valid temperature signal	No valid temperature signal
20	Additional resistor in the return line temperature signal	No valid temperature signal	No valid temperature signal
21	Short circuit to battery – supply rotational speed signal	No valid rotational speed signal, possible subsequential damage for sensor and/or control unit	Battery 12 V: Normal operation if the sensor is supplied from the boardnet and protected against overvoltage Battery 24 V: No valid rotational speed signal, possible subsequential damage for sensor and/or control unit
22	Short circuit to the battery – return line rotational speed signal	No valid rotational speed signal, possible subsequential damage for sensor and/or control unit	No valid rotational speed signal, possible subsequential damage for sensor and/or control unit
23	Short circuit to battery – supply temperature signal	No valid temperature signal, possible subsequential damage for sensor and/or control unit	No valid temperature signal, possible subsequential damage for sensor and/or control unit
24	Short circuit to the battery – return line temperature signal	No valid temperature signal, possible subsequential damage for sensor and/or control unit	No valid temperature signal, possible subsequential damage for sensor and/or control unit

Behavior of the sensor at undervoltage

When the first output signals are sent after switching on, undervoltage recognition is activated. If the supply voltage then falls below the values specified in the operating range, the output level is switched to high level (I_{High}) and remains at this level until the specified supply voltage is applied.
If the supply voltage falls below 2.3 V (typical), the sensor performs a reset and restarts. In doing so, it first undergoes a new calibration.

Safety-related characteristics according to ISO 25119 and ISO 13849

The safety function of the DST series 10 speed sensor is defined as system integrity, i.e. it must correctly detect the rotational speed and the direction of rotation, as well as process and convert faultlessly them into the corresponding output signals.

The temperature signal of the DST series 10 speed sensor is not classified as safety relevant.

- The DST series 10 has a single-channel architecture.
- The DST series 10 meets the requirements of the basic and proven safety principles.
- The DST series 10 meets the requirements for failures due to common causes and proven components.
- The DST series 10 is not equipped with safety-related software.

$MTTF_D$

The $MTTF_D$ of the DST series 10 speed sensor has been calculated for the following temperature profiles:

Ambient temperature sensor [°C]	**Duration of use per day [h]**	**Temperature profile, operating time share [%]**											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
-40		0	0	0	0	0	0	0	0	0	0	0	0.5
0		0	0	0	0	0	0	0	0	0	0	0	2
10		1	1	1	1	1	0	0	0	0	0	0	0
23		0	0	0	0	0	0	0	0	0	0	0	5
30		2	2	2	2	1	0	0	0	0	0	0	0
40		3	3	3	3.6	1.2	0	0	0	0	0	0	0
50		4	3	3	0	0	100	0	0	0	0	0	0
60		5	3	3	3.6	1.2	0	100	0	0	0	0	15
70		6	3	3	3.6	1.2	0	0	100	0	0	0	0
80		79	85	3	3.6	1.2	0	0	0	100	0	0	0
85		0	0	0	0	0	0	0	0	0	0	0	67
90		0	0	82	3.6	1.2	0	0	0	0	100	0	0
100		0	0	0	79	92	0	0	0	0	0	100	9.3
125		0	0	0	0	0	0	0	0	0	0	0	1
140		0	0	0	0	0	0	0	0	0	0	0	0.2
$MTTF_D$ value [years] with the following use	8 h per day	4052	3923	2644	1769	1598	12194	8126	5377	3532	2307	1503	2917
	24 h per day	1620	1569	1057	707	639	4877	3250	2151	1413	923	601	1166

Diagnostic coverage level DC

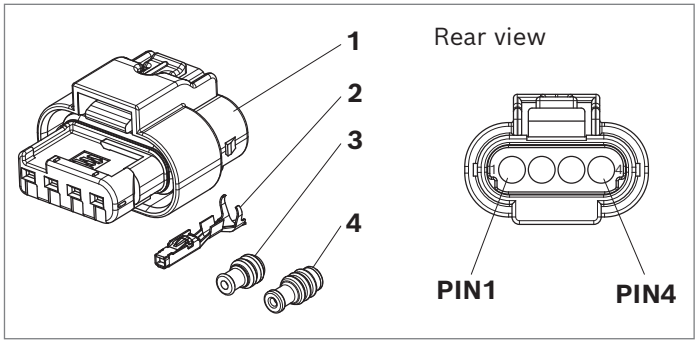
The DC is given according to ISO 138491:2023 Table E.1 and ISO 25119-2:2019 Table C.6. This requires the diagnosis functions described in the table.

The following diagnosis functions shall be implemented by the parent controller to achieve the specified 60% DC according to ISO 25119 and ISO 13849.

Diagnosis functions	Frequency of monitoring	Error reaction
Detection of the output current I_{high} and I_{low} outside the range	Periodic The frequency depends on the required error reaction time of the respective safety function at machine level.	Put the system in a safe state
Detection of pulse width output t_{pulse} outside the range		
Detection of implausible change in direction of rotation (e.g. change of direction at high frequency)		
Detection of the implausible frequency change rate (e.g. frequency monitoring rate is beyond the physical capabilities of the system)		

Accessories

Mating connector



Notice

For the assembly, the tools prescribed by the connector manufacturer - MCON unpinning tool/unlocking tool and crimping pliers - are to be used (see TYCO Electronics drawing 1534326).
To process the connector, refer to the user manual supplied by TYCO Electronics (408-828).

▼ **Mating connector set (material number: R917012863)**

Pos.	Designation	Quantity	Order number	Manufacturer	Comment
1	4POS, MCON 1.2 CB REC 2p TL SEALED	1	1-1456426-5	TYCO Electronics	
2	MCON 1.2 CB REC SWS SN	4	1670146-1	TYCO Electronics	For line cross-section (AWG): 20 or 0.5 mm² and 0.75 mm²
3	Single wire seal, rubber, red	4	2098582-1	TYCO Electronics	Accepted cable insulation diameter range: 1.35 ... 1.9 mm
4	Plug, blue	2	967056-1	TYCO Electronics	If the NTC thermistor is not connected, use blind plugs

The mating connector kit is not included in the scope of delivery. It is available from Bosch Rexroth on request.

▼ **Mating connector set for larger line cross-sections**

Pos.	Designation	Quantity	Order number	Manufacturer	Comment
1	4POS, MCON 1.2 CB REC 2p TL SEALED	1	1-1456426-5	TYCO Electronics	
2	MCON 1.2 CB REC SWS SN	4	14188550-1	TYCO Electronics	For line cross-section (AWG): 20 or 1 mm² and 1.5 mm²
3	Single wire seal, rubber, yellow	4	964972-1	TYCO Electronics	Accepted cable insulation diameter range: 1.9 ... 2.4 mm
4	Plug, blue	2	967056-1	TYCO Electronics	If the NTC thermistor is not connected, use blind plugs

The mating connector kit is not included in the scope of delivery. The parts can be purchased directly from the manufacturer or through dealers.

▼ **Replacement O-rings (material number: R917015673)**

Version	Quantity per bag	Type of packaging
11.3±0.2 × 2.2-FKM-PTFE-COATED-RED	20 pieces	ZIP bag

The replacement O-rings are not included in the scope of delivery. They can be ordered from Bosch Rexroth.

Safety instructions

General instructions

- Before determining your construction, consult your Bosch Rexroth contact partner if the DST1/10 is installed in a unit not coming from the Rexroth company.
- Attention! This speed sensor contains electronic components and may thus be damaged by electrostatic discharge. The handling regulations for electronically sensitive components shall be complied with.
- 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 result in dangerous malfunctions.
- The connections in the hydraulic system may only be opened if the system is depressurized.
- The sensor may only be assembled/disassembled in a depressurized and de-energized 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 which are not in a proper working order. If the sensor fails or demonstrates a faulty operation, it must be replaced.
- Despite the greatest care being taken when compiling this document, it is impossible to consider all feasible applications. If information on your specific application is missing, please contact Bosch Rexroth.
- The use of sensors by private users is not permissible, since these users do not typically have the required level of expertise.
- If other or more specifications apply to the marketing of the product or if there is marketing outside the specified target markets, customer must demand compliance with the target market-specific regulations from Bosch Rexroth or ensure their compliance themselves.

If the sensor is used within the conditions (environmental, application, installation conditions and loads) described in this RE sheet and the related agreed documents, Bosch Rexroth guarantees that the product complies with the agreed quality. Any more far-reaching promises require the written confirmation by Bosch Rexroth. The product is regarded as suitable for the intended use after it has passed the testing scope according to the RE sheet and the agreed documents.

The customer is responsible for safeguarding the application of the product in the complete system/vehicle.

Bosch Rexroth does not accept any responsibility for changes in the product environment differing from the RE sheet and the agreed documents.

Information on installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust system).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- The connector of the sensor is to be unplugged during electrical welding and painting operations.
- Use wiring harness connectors to protect the sensor against ingress of water.
- Cables/wires must be equipped with an individual seal at the wiring harness connector to prevent water from entering the sensor.

Information on transport and storage

- Protect the sensor during transport, processing and/or assembly against the ingress of humidity, paints or other substances into the connector chamber.
- 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 the sensor is dropped, it is not permissible to use it any longer, as invisible damage could have a negative impact on reliability.

Information on wiring and circuitry

- The lines to the sensors shall be designed in such a way as to ensure adequate signal quality. This means as short as possible and, if necessary, shielded. In case of a shielding, this must be connected on one side to the electronics (housing ground not signal ground) or via a low resistance connection to the device or the vehicle ground.
- The sensor mating connector must only be plugged and unplugged when it is in a de-energized 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 laid as far as possible from large electrical machines (e.g. alternator, motor generator) and not in the vicinity of other power lines in the device or vehicle.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- The wiring harness should be mechanically secured in the area in which the sensor is installed (distance < 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 of the vehicle, their secure mounting is to be ensured.
- 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.
- Its use outside of these 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.
- The sensor contains a strong solenoid. As most types of electronic storage media are sensitive to magnetic fields, they have to be stored separately from permanent magnets. Persons with implanted cardiac pacemakers must take special precautions.

Improper use

- Any use of the sensor other than that described in chapter "Intended use" is considered to be improper use.
- Use in potentially explosive areas is not permitted.
- Damage resulting from its improper use and/or from an unauthorized intervention which is not specified in this data sheet voids all warranty and liability claims against the manufacturer.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the machine and determining the possible safety functions of the machine.
- It is the responsibility of the customer to evaluate the entire safety-relevant system and to determine and validate the suitability of the DST series 10 speed sensor for any safety functions of the machine.
  - The DST series 10 speed sensor is capable of supporting a safety level of PL c/ AgPL c or even higher if it is integrated properly in a Cat.2 or Cat.3 machine safety relevant system while complying with all relevant requirements in this document.
  - The failure reactions of the DST series 10 speed sensor are listed in this data sheet. Do not use the sensor if the failure reaction is considered insufficient for the safety functions of the machine.
- The control unit of the machine must monitor the sensor with the required diagnosis functions specified in this document.
- An efficient field monitoring process must be set up by the customer. All field failures of the DST series 10 speed sensor must be reported to Bosch Rexroth immediately, even if they are not covered by the warranty.

Disposal

- The sensor and its packaging must be disposed of according to the national environmental regulations of the country in which the sensor is used.

Further information

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

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