RE 95126/2023-02-22
Replaces: 2022-10-04

rexroth
A Bosch Company

Speed sensor
DSA series 20

- Sensor for measuring the contact-less rotational speed, direction of rotation and temperature.
- Nominal output signals:
  - Rotational speed and direction of rotation: $U_{\text{supply sensor}}$ −0.9 VDC / GND+0.7 VDC
  - Temperature-dependent resistor: 0.185 to 215 kΩ
- Measuring ranges:
  - Rotational speeds from 0 to 20 kHz
  - Temperatures from −40 to +125 °C
- Type of protection of the sensor with assembled mating connector IP67 and IP69K

Features

- Two versions
  - With two frequency signals
  - With frequency signal and direction of rotation signal for easy connection to control units
- Improved diagnosis options in combination with the control unit input circuit
  - Cable break
  - Short circuit
- Nominal voltage
  - Rotational speed measurement: 8 to 27 VDC
  - Temperature measurement: 3.3 VDC or 5 VDC
- Sealing for static pressures up to a maximum of 30 bar
- Large working air gap
- Rugged construction thanks to full metal housing
- Easy installation without set-up
- CE and UKCA conformity

Contents

Type code

01	02	03	04	05	06	07	07	08
DSA			**K0250**	**F20**	**A**	**/**	**20**	**H**

Type

01	Hall-effect speed sensor (direction of rotation, rotational speed and temperature)	**DSA**

Version

02	0 ... 20 kHz	One frequency and one direction of rotation signal	**1**
		Two 90° phase-shifted frequency signals	**2**

Shaft length

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

Cable length

04	250 mm	**K0250**

Maximum frequency

05	20 kHz	**F20**

Connector

06	AMP seal 16	**A**

Series

07	Series 2, index 0	**20**

Seal

08	HNBR (hydrated nitrile rubber)	**H**

Available variants[1)2)]

Type	Material number
DSA 1 S18 K0250 F20 A / 20 H	R917013493
DSA 1 S32 K0250 F20 A / 20 H	R917013495
DSA 2 S18 K0250 F20 A / 20 H	R917013393
DSA 2 S32 K0250 F20 A / 20 H	R917013366

1) More variants available on request
2) Assembly kits of these sensors will no longer be offered in the future.

Product description

Description

In connection with a gear wheel, the DSA series 20 speed sensor is suitable for generating frequency signals proportional to the speed. The sensor exhibits a static behavior, i.e. it guarantees pulse generation up to a rotational speed corresponding to a frequency of 0 Hz. The monitoring element consists of a HALL-ASIC supplying two output signals. The internal two-channel structure requires a perfect alignment of the sensor.
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 according to the following formula:

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

Key	
f	Frequency [Hz]
n	Rotational speed [rpm]
z	Number of teeth[1)]

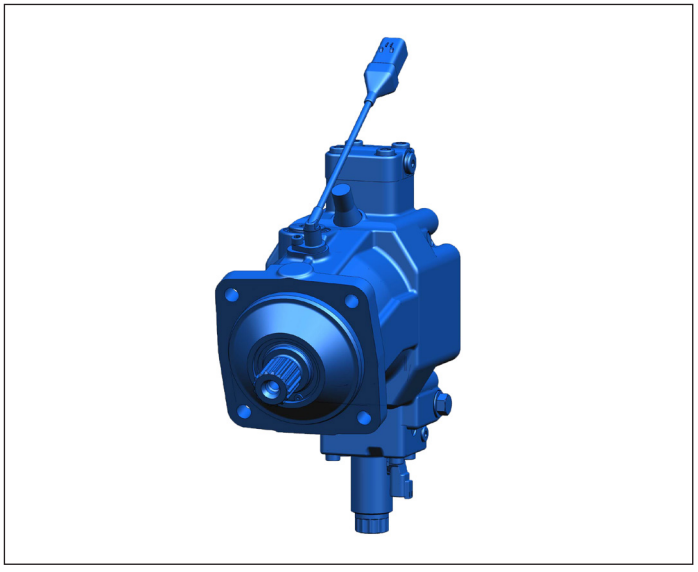
Two basic variants available

- DSA1 series 20 returns a square-wave signal which is proportional to the speed as well as a switching signal for detecting the direction of rotation.
- DSA2 series 20 provides two square-wave signals (90±20° phase shift) for the redundant recording of the rotational speed. A connected control unit can determine the direction of rotation, e.g. of the hydraulic motor, through the evaluation of the phase shift.
- Additionally, both variants comprise of an NTC thermistor, which enables measuring the temperature in the installation location of the sensor.

Application examples

The sensor is suitable e.g. for the integrated use with Rexroth axial piston units, thanks to its compact and sturdy design.
Various different BODAS controllers with application software are available for evaluating the DSA series 20 speed sensor. Further information can also be found online under www.boschrexroth.com/mobile-electronics.

▼ **Example**
A6VM axial piston variable displacement motor with mounted DSA series 20 speed sensor



1) The numbers of teeth of the axial piston units are given in their data sheets.

Technical data

General				
Electromagnetic compatibility (EMC)	Line-bound transient interference	ISO 7637-1/-2/-3	Values on request	
	Load dump 5b according to ISO 16750-2[1)]	at 12 VDC	$U_{\text{supply sensor}}$ = 35 VDC	
		at 24 VDC	$U_{\text{supply sensor}}$ = 58 VDC	
	Irradiation BCI	DIN 11452-4	1 ... 400 MHz, 125 mA	
	Irradiation free field	DIN 11452-2	20 ... 80 MHz, 100 V/m, 80 ... 6000 MHz, 150 V/m	
Electrostatic discharge (ESD)	According to ISO 10605: 2008 and IEC 61000-4-2:2008	Contact discharge	±8 kV (powered up and unpowered)	
		Air discharge	±15 kV (powered up and unpowered)	
Conformity according to	EMC directive 2014/30/EU with CE mark		Applied standards: ISO 13766-1:2019, ISO 13766-2:2018, EN ISO 14982:2009, DIN EN 12895:2015 (2020), EN 61000-6-2:2006, EN 61000-6-3:2011, EN 61000-6-4:2011	
	EMC directive SI 2016/1091 with UKCA mark			
	RoHS directive 2011/65/EU			
Isolation			The housing and the electronics are electrically isolated	
Vibration resistance	Sinusoidal vibration	IEC 60068-2-6	2 mm / 5 ... 57 Hz 30 g / 57 ... 2000 Hz 10 cycles per axis	
	Random-shaped vibration	IEC 60068-2-64:2008	5 Hz / 0.015 g^2 / Hz	120 ... 250 Hz / 0.13 g^2 / Hz
			23 Hz / 0.025 g^2 / Hz	270 Hz / 0.05 g^2 / Hz
			25 ... 50 Hz / 0.09 g^2 / Hz	330 ... 500 Hz / 0.04 g^2 / Hz
			60 Hz / 0.035 g^2 / Hz	1000 ... 2000 Hz / 0.09 g^2 / Hz
			100 Hz / 0.04 g^2 / Hz	
Shock resistance	Transport shock	IEC 60068-2-27:2009	30 g / 18 ms 3 x for each direction (positive/negative)	
	Continuous shock	IEC 60068-2-27:2009	50 g / 11 ms 1000 x each direction (positive/negative)	
Moisture resistance		EN 60068-2-30	Relative humidity of 95 % at 25 ... 55 °C, for the duration of 21 cycles × 24 h = 540 h	
Salt spray resistance		EN 60068-2-11	240 h	
Type of protection (DIN EN 60529:2019-06) when installed and plugged in See “AMPSEAL 16” mating connector			IP67 and IP69K	
Operating temperature range	Sensor zone		−40 ... +125 °C	
	Cable zone and connector		−40 ... +115 °C	
Pressure resistance of measuring surface			30 bar maximum (static)	
Permissible fluids[2)]	Sensor zone		Hydraulic fluids based on mineral oils according to DIN 51524, HETG, HEPG, HEES, HFA[3)], HFB[3)], HFC	
	Cable zone and connector		Hydraulic fluids based on mineral oils according to DIN 51524, HETG, HEPG, HEES, HFA[3)], HFB[3)], HFC, 10W-40MC, fertilizer, AdBlue, RME (biodiesel), battery acid, SAE80W-90, antifreeze, brake fluid, SAE20W20, gasoline, diesel, tar remover, cleaner solvent	
Weights	Shaft length S18		80 g	
	Shaft length S32		83 g	
Service life			15000 operating hours or 15 years.	
Storage time and storage temperature			5 years at an average relative humidity of 60% and a temperature between -10 °C and +30 °C. A storage temperature of −20 °C ... +40 °C is permissible for a short-term period of up to 100 hours.	
Safty values ($MTTF_D$ and DC_{avg}) according to ISO SO 25119 and ISO 13849 see capture , 17				

1) For the compliance with the load dump 5a according to ISO 16750-2, the customer shall provide for the use of a load dump diode in the vehicle electrical system.

2) Further on request.

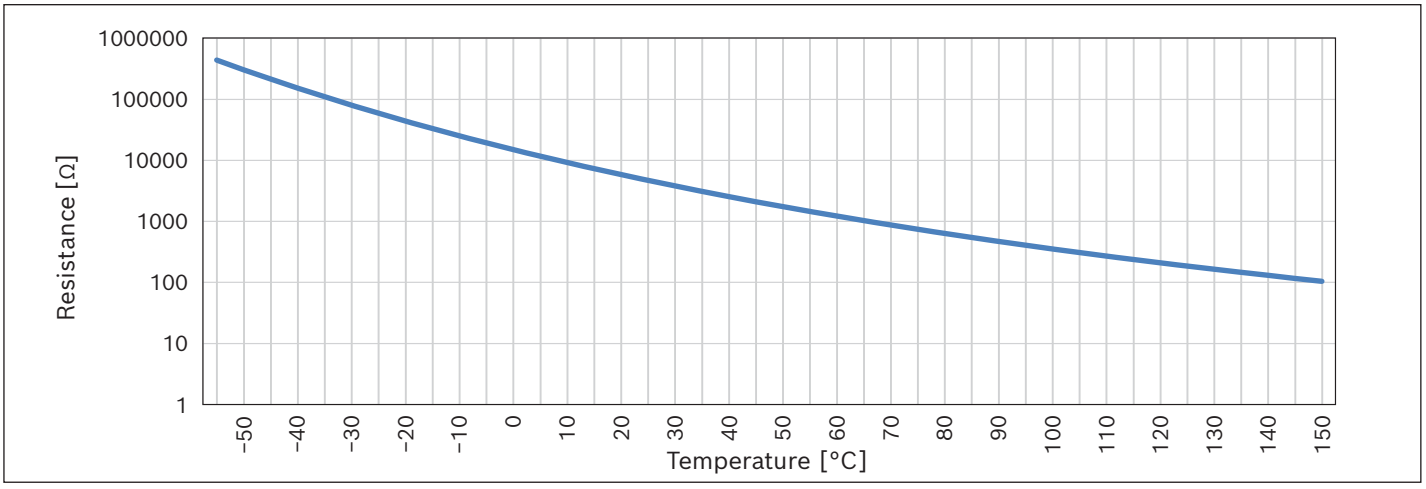
3) Only suitable for HNBR seal

Rotational speed and direction of rotation sensor		
Sensor operating voltage[1)]	$U_{\text{supply sensor}}$	8 ... 32 VDC, measured between PIN 1 and PIN 2
Permissible overvoltage range		Up to 36 VDC for 5 minutes
Reverse polarity resistance		
Minimum reverse polarity voltage		–32 VDC
Short circuit resistance of the outputs against every other connection		Yes
Maximum current consumption		17.5 mA electronic supply without signal output
Maximum sensor signal current (sink / source)	I_{low}	±50 mA
Tooth frequency		Up to 20 kHz
Signal frequency (= tooth frequency)		0 ... 20 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	DSA1/20	Encoded in the voltage level of the static output signal
	DSA2/20	Encoded in the phasing between the two outputs F1 and F2

1) See “Calculation” page 12 and/or “Block diagram” page 15

Temperature sensor		
Temperature measuring range		–40 ... +125 °C
Resistor (nominal values)	at 0 °C	15 kΩ
Tolerance	at 25 °C	4.7 kΩ
	at 100 °C	0.3547 kΩ
Nominal voltage		3.3 V or 5 V±150 mV depending on the control unit
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[1)]		3.0 mW/K

▼ **Transmission characteristic**



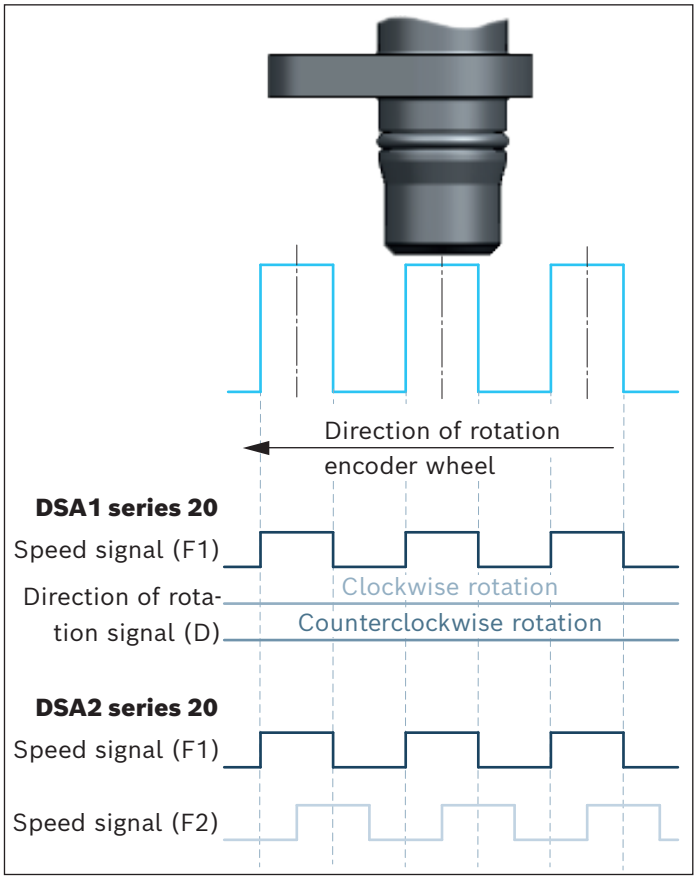
Electrical characteristics

Resistor dependent on temperature							
Temperature [°C]	**Minimum resistance [Ω]**	**Nominal resistance [Ω]**	**Maximum resistance [Ω]**	**Temperature [°C]**	**Minimum resistance [Ω]**	**Nominal resistance [Ω]**	**Maximum resistance [Ω]**
-45.0	189639.5	214532.2	239424.9	55.0	1394.8	1456.8	1518.8
-40.0	136321.3	152831.9	169342.5	60.0	1168	1222.4	1276.7
-35.0	99130	110192.5	121255	65.0	983.2	1030.9	1078.5
-30.0	72887.4	80369.1	87850.9	70.0	831.7	873.6	915.6
-25.0	54163.8	59267.3	64370.8	75.0	706.8	743.8	780.8
-20.0	40661.5	44169.7	47677.8	80.0	603.4	636.1	668.8
-15.0	30824.2	33252.2	35680.1	85.0	517.4	546.4	575.3
-10.0	23585.9	25276.2	26966.4	90.0	444.7	471.2	497.7
-5.0	18209.4	19391.7	20574.1	95.0	383.8	408	432.2
0.0	14179.3	15009.3	15839.4	100.0	332.6	354.7	376.8
5.0	11131.9	11716	12300	105.0	289.2	309.4	329.6
10.0	8808.3	9219.5	9630.8	110.0	252.4	270.9	289.4
15.0	7022.2	7311.4	7600.6	115.0	221.1	238.01	254.9
20.0	5638.7	5841.3	6043.9	120.0	194.3	209.79	225.2
25.0	4559	4700	4841	125.0	171.3	185.5	199.7
30.0	3684.6	3807.5	3930.3	130.0	151.5	164.53	177.5
35.0	2997.5	3104.5	3211.5	135.0	134.4	146.36	158.3
40.0	2454	2547.2	2640.4	140.0	119.6	130.57	141.5
45.0	2021.2	2102.4	2183.6	145.0	106.7	116.8	126.9
50.0	1674.3	1745.3	1816.2	150.0	95.5	104.76	114.1

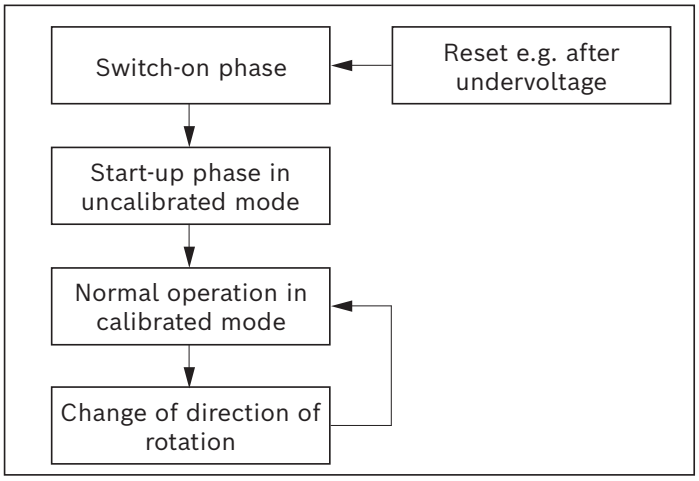
1) Additional temperature increase (temperature offset) due to the power dissipation in the thermistor (NTC)

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.
Once the internal calibration is complete the phase shift between F1 and F2 or the direction of rotation signal in the work area are also complete.



▼ **Start sequence**



▼ **Description of the start sequence**

Switch-on state	$U_{out\ high}$ for F1 bzw. F2 / D
Maximum switch-on phase	1 ms
Calibration phase	2 teeth after switch-on, the sensor provides correct speed/direction information with continuous movement of the encoder wheel in forward or reverse direction. Spontaneous air gap or direction changes within the calibration phase leads to an extension of the calibration.

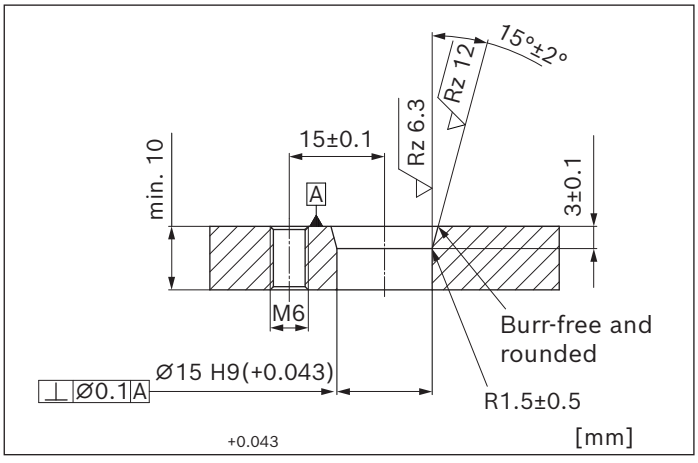
Installation instructions

General instructions

- Remove the protective cap before the installation. Handle the sensor with caution to prevent damage to the front side.
- When installing the sensor, make sure that the O-ring is not damaged.
  First press the sensor into the installation bore until the screw-on flange lies on the housing. Then tighten the mounting screw to the required torque.

Notice
Function only approved with Rexroth axial piston unit. Deviating air gaps and eccentricities can impede the function of the sensor. Consultation is therefore required before use in other applications.

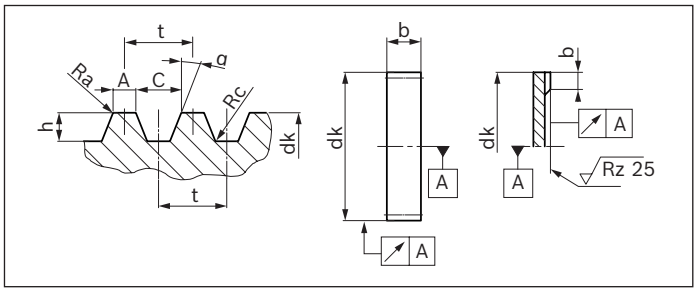
▼ **Installation bore**



Gear wheel specifications

Material

The impulse wheels must be magnetically conductive. The material should be magnetically soft. The following have been tested to date: Machining steels, non-alloy steel, heat-treated steels and sintered steels have been tested to date (e. g. St37, USt37, 9SMn28, C45, C45R, GG20, GGG40, X8Cr17, 34CrAlMo5-10)



Notice

The DSA series 20 speed sensor has been developed for use in the following Bosch Rexroth units:

- Axial piston unit
- Radial piston unit
- External gear unit

After consultation with Bosch Rexroth, the DSA series 20 can also be used in other units (e.g. gear unit) with other gear wheel specifications.

Toothing data for radial scanning valid for basic number of teeth 48

		Size	Permissible deviation
z	Basic number of teeth 48		
t	Spacing	> 4.1 mm	
	Ideal spacing for 90° phase shift	6.3 mm	
t_p	Individual spacing deviation		±4%
T_p	Total spacing deviation		4%
A/t	Ratio of tooth tip width to spacing	0.4 ... 0.5	±10%
dk	Outside diameter	60 ... 120 mm	
h	Tooth height	> 2.5 mm	
A	Width of tooth tip	Calculated from A/t	10%
b	Pulse wheel width	> 5 mm	
α	Pressure angle	0 ... 20	±1
Ra	Radius at tooth tip	< 0.3 mm (at A = 2 mm) ... < 0.6 mm (at A = 6 mm)	
Rc	Radius at tooth depth	< 0.6 mm	±0.2 mm
	Tooth shape	Rectangular and trapezoidal	Other shapes upon agreement

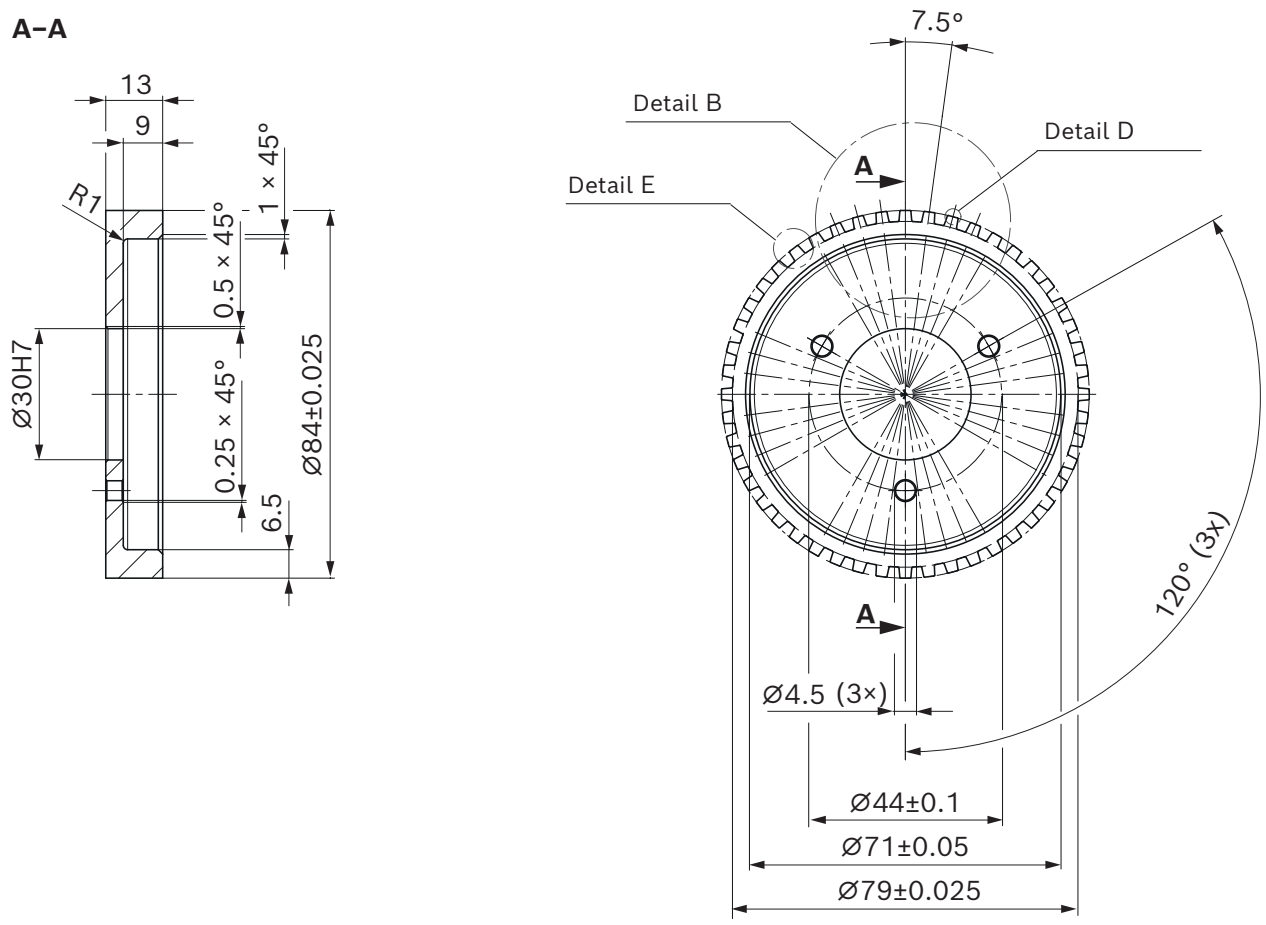
Distance of the gear wheel to the sensor

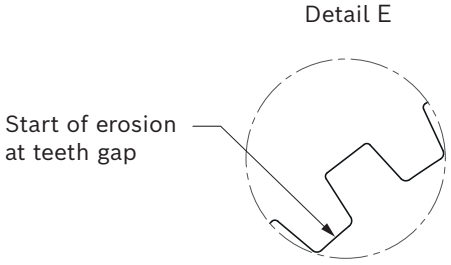
Spacing	Distance
4.1 ... 6.3 mm	0.3 ... 1.4 mm
6.3 ... 10.0 mm	0.3 ... 2.0 mm
>10.0 mm	Case-by-case examination required

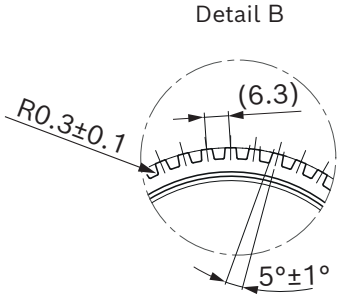
Toothing data for axial scanning

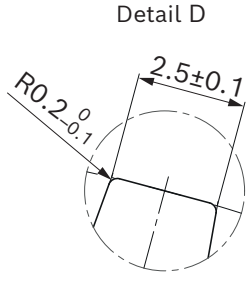
		Size	Permissible deviation
A/t	Ratio of tooth tip width to spacing	0.5	±10%
h	Tooth height	> 6 mm	
b	Pulse wheel width	> 2 mm	
α	Pressure angle	0	±1

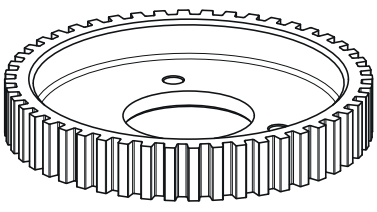
The further values are identical to the values for radial scanning.


A–A
13
9
R1
1 × 45°
0.5 × 45°
0.25 × 45°
Ø30H7
Ø84±0.025
6.5
7.5°
Detail B
Detail D
Detail E
A
A
120° (3x)
Ø4.5 (3×)
Ø44±0.1
Ø71±0.05
Ø79±0.025


Detail E
Start of erosion
at teeth gap

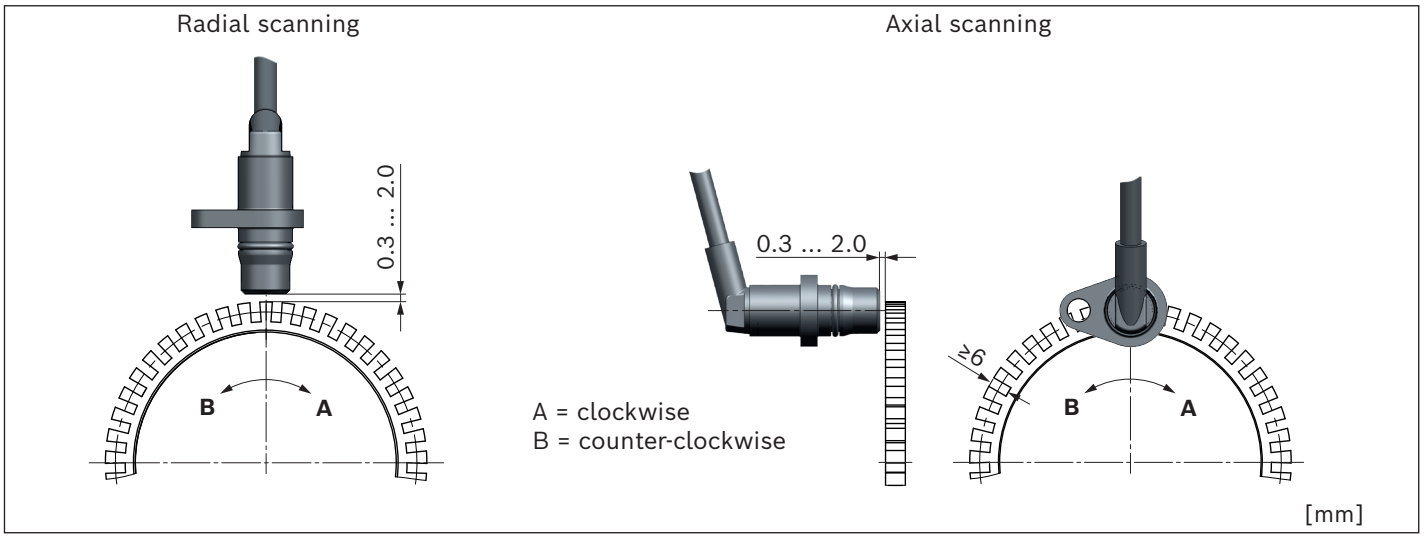

Detail B
R0.3±0.1
(6.3)
5°±1°


Detail D
2.5±0.1
R0.2 0 -0.1



Output signals

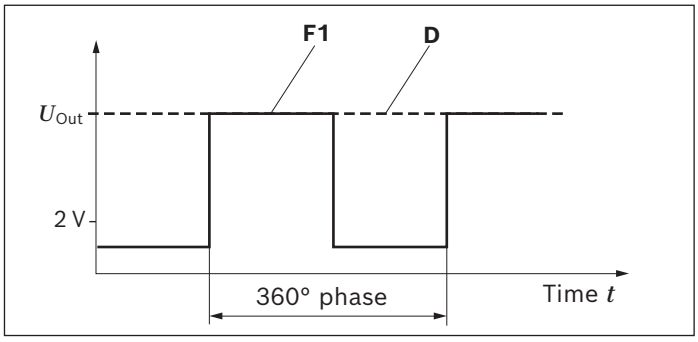
▼ **Assigning the direction of rotation to the sensor**



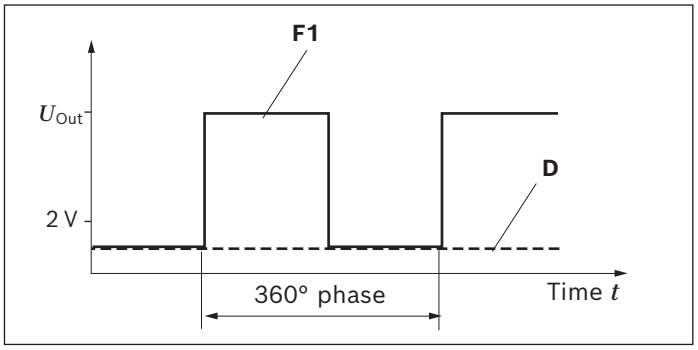
Signal output DSA1 series 20

One square-wave signal (F1) and one digital direction of rotation signal (D)

▼ **Clockwise**



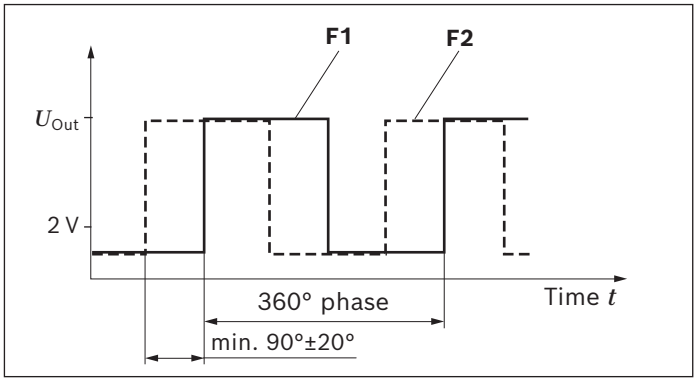
▼ **Counter-clockwise**



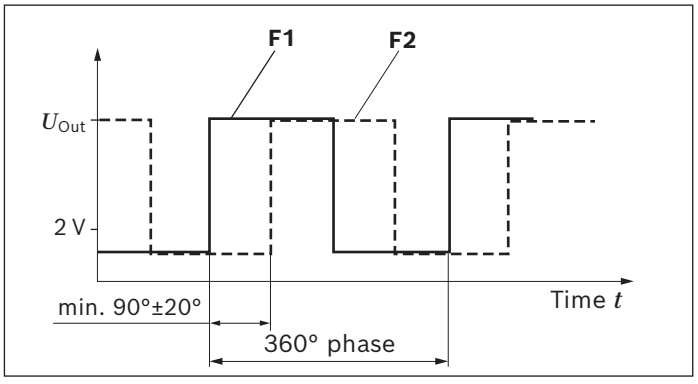
Signal output DSA2 series 20

Two phase-shifted square-wave signals with a minimum defined phase shift of 90°±20° between output 1 (F1) and output 2 (F2).

▼ **Clockwise**

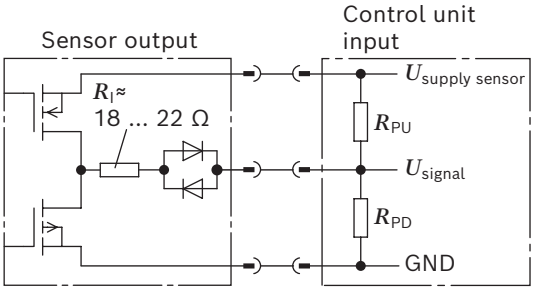
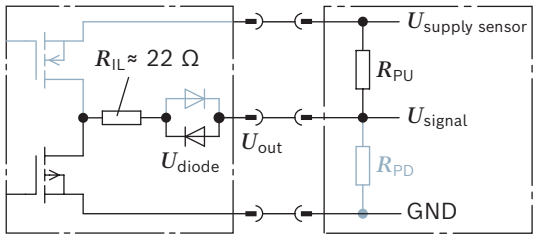
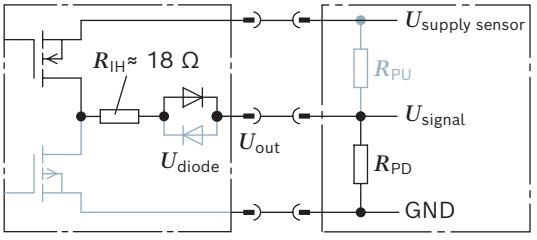


▼ **Counter-clockwise**



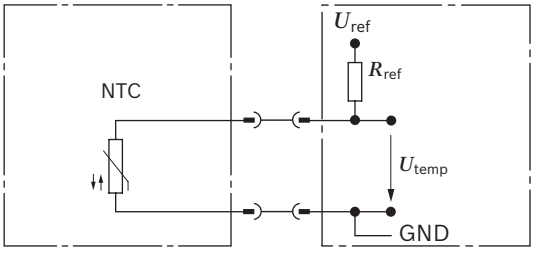
Calculation of the output voltage of the speed signal in dependence of the evaluating control unit

The output voltage U_{Out} depends on the sensor resistance R_I and the external load resistances R_{PU}, R_{PD} as well as the supply voltage. The calculation is performed using the following formulas.

	DSA1/20 frequency signal F1, direction of rotation signal D DSA2/20 frequency signal F1, F2
	$U_{out\ low} \approx U_{diode} + \frac{(U_{supply\ sensor} - U_{diode}) \times R_I}{R_{PU} + R_I}$ $U_{out\ high} \approx \frac{(U_{supply\ sensor} - U_{diode} - 0.2\ V) \times R_{PD}}{R_{PD} + R_I}$ Tolerance of the diode voltage via temperature and aging U_{diode} = (0.7±0.3 V)
	$U_{out\ low} \approx U_{diode} + \frac{(U_{supply\ sensor} - U_{diode}) \times R_{IL}}{R_{PU} + R_{IL}}$ $U_{out\ high} \approx U_{supply\ sensor} - U_{diode} - 0.2\ V$ Tolerance of the diode voltage via temperature and aging U_{diode} = (0.7±0.3 V)
	$U_{out\ low} \approx U_{diode}$ $U_{out\ high} \approx \frac{(U_{supply\ sensor} - U_{diode} - 0.2\ V) \times R_{PD}}{R_{PD} + R_{IH}}$ Tolerance of the diode voltage via temperature and aging U_{diode} = (0.7±0.3 V)

gray = Inactive components with corresponding wiring (control unit input)
black = Active components with corresponding wiring (control unit input)

Calculation of the output voltage of the temperature signal in dependence of the evaluating control unit

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

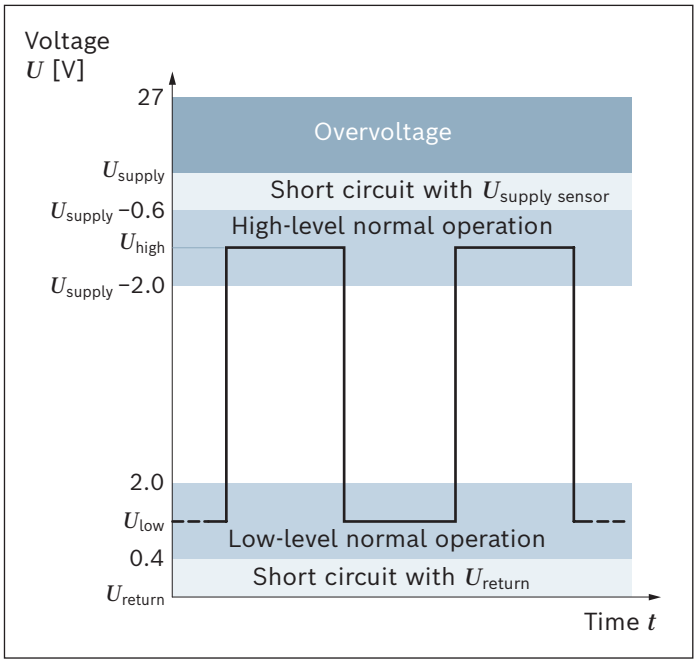
Key

GND	Ground
NTC	Thermistor (5 kΩ at 25 °C)
R_I	Internal sensor resistance
U_{ref}	Temperature signal - Operating voltage
U_{signal}	Signal voltage
$U_{supply\ sensor}$	Supply voltage of the sensor
U_{temp}	Temperature signal - output voltage
R_{PD}	Pull-down resistor - speed input control unit
R_{PU}	Pull-up resistor - speed input control unit
R_{ref}	Pull-up resistance - temperature (1 kΩ at U_{ref} = 3.3 V)

Connection to control units

- The sensor output signals F1 and F2 are connected to the control unit inputs, which are suited for measuring the rotational speed and/or also the phasing with the DSA2 series 20.
- The sensor output signal D can either be connected to the digital control unit inputs, provided that no short circuit detection is necessary, or to a corresponding analog input enabling the measurement of the signal voltage if a short-circuit detection is necessary.

Diagnosis function and short circuit detection[1)]



Short circuit protection for DSA series 20[1)]

The output stages comprise of a thermal short circuit limitation.

This works as follows:

- If, at one of the two output stages, the output stage is thermally overloaded by a output current greater than the specified 50 mA, this leads to a timely limited deactivation of the output stage. This deactivation lasts for approx. 50 µs. During this time, the output stage becomes highly resistive.
- From this moment until the output stage is reactivated, the output level is exclusively determined by the load at the output terminal (pull-up/pull-down).
- The output stage will be reactivated after approx. 50 µs.
- This shutdown process is repeated for as long as the output stage is thermally overloaded.
- The time behavior of the shutdown results from the temperature conditions on the output stage and depends
  - on the ambient temperature and cooling
  - of the short circuit current
  - Signal path (ratio high/low frequency)
- The output voltage in the event of a short circuit depends on the (short circuit) resistances at the output and can be calculated using the formulas, (see “Output signals” chapter, see page 11).

Cable break detection with DSA series 20[1)]

In the event of a line break (supply and/or ground) longer than 1 ms, both signal output levels become highly resistive.

In the event of a line break (signal 1 or 2), the corresponding signal output level becomes highly resistive.

In the event of a fault, the voltage is only determined by the voltage divider of the external evaluation unit.

By importing the levels, the upstream control unit can differentiate between a short circuit and the signal ground or the supply voltage of a valid output signal.

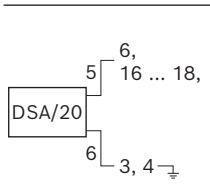
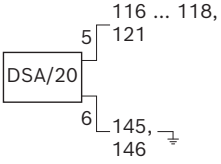
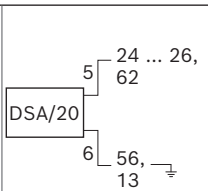
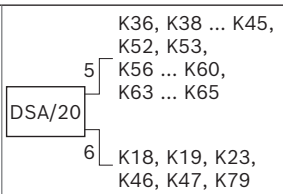
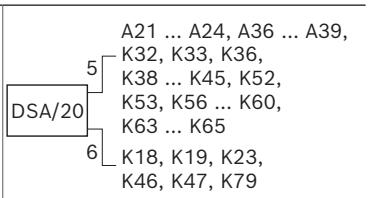
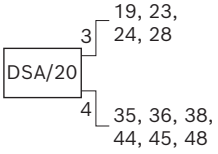
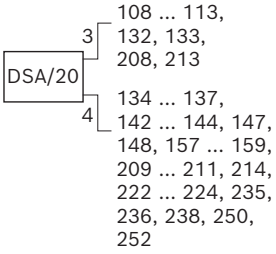
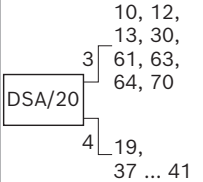
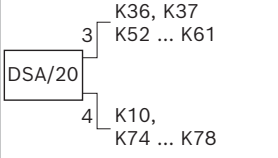
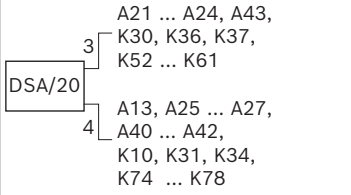
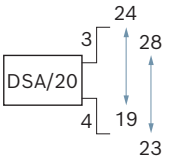
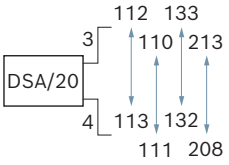
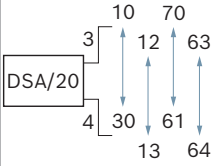
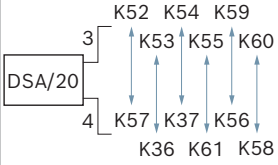
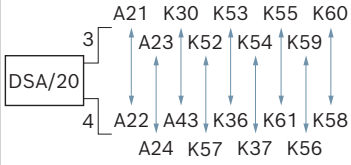
1) See also “Error detection” see page 18

Application at control units

Importing the DSA series 20 is possible with the following BODAS control units:
RC series 30, 31 and 40.

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

▼ **Application with Rexroth BODAS controllers** [1] ▼

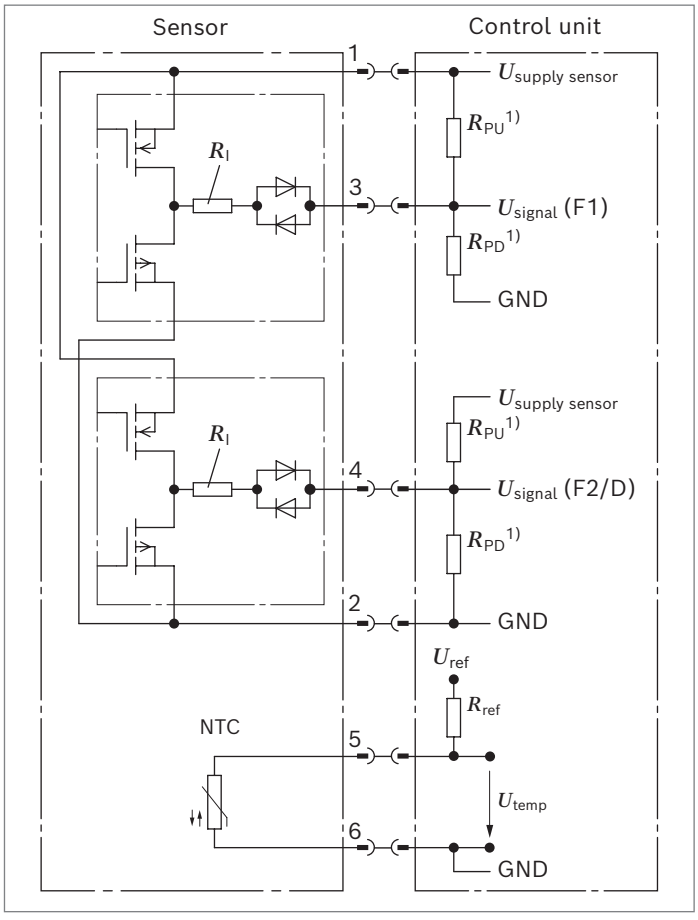
RC4-5/30 (Data sheet 95205)	**RC12-10/30, RC20-10/30 RC28-14/30,** (Datenblatt 95204)	**RC10-10/31** (Datenblatt 95206)	**RC5-6/40** (Datenblatt 95207)	**RC18-12/40, RC27-18/40** (Datenblatt 95208)
Temperature signals				
				
Frequency signals, DSA1 series 20				
				
Frequency signals, DSA2 series 20				
				

The base software of the control unit facilitates the detection of the direction of rotation by means of the phase measurement between two frequency outputs of a speed sensor. The two frequency signals (primary signal and secondary signal) have to be acquired via predefined pairs of inputs. When connecting the sensor to the control unit, the pin assignment in pairs is to be observed, e.g. for RC28-14/30, the frequency input pair 110 and 111.

The pairs have been selected such that an analog read-out of the signals for diagnosis purposes is implemented via different input modules.

1) The supply pins 1 and 2 are not listed in the connection diagrams.

Block diagram

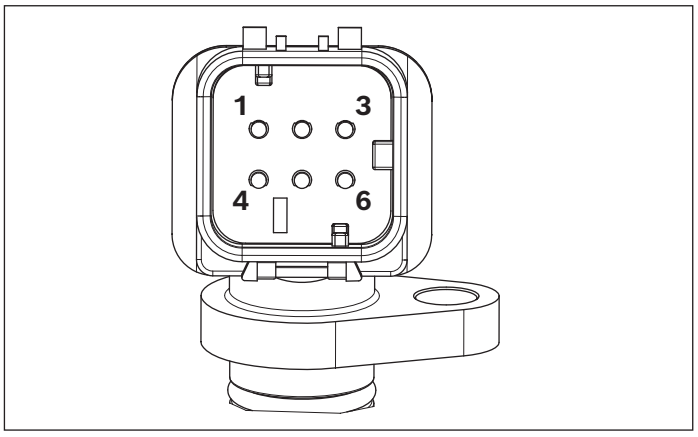


Key

GND	Ground
NTC	Thermistor (5 kΩ at 25 °C)
R_I	Internal sensor resistance
U_{ref}	Temperature signal - Operating voltage
U_{signal}	Signal voltage
$U_{supply\ sensor}$	Supply voltage of the sensor
U_{temp}	Temperature signal - output voltage
R_{PD}	Pull-down resistor - speed input control unit
R_{PU}	Pull-up resistor - speed input control unit
R_{ref}	Pull-up resistance - temperature (1 kΩ at U_{ref} = 3.3 V)

Electrical connection

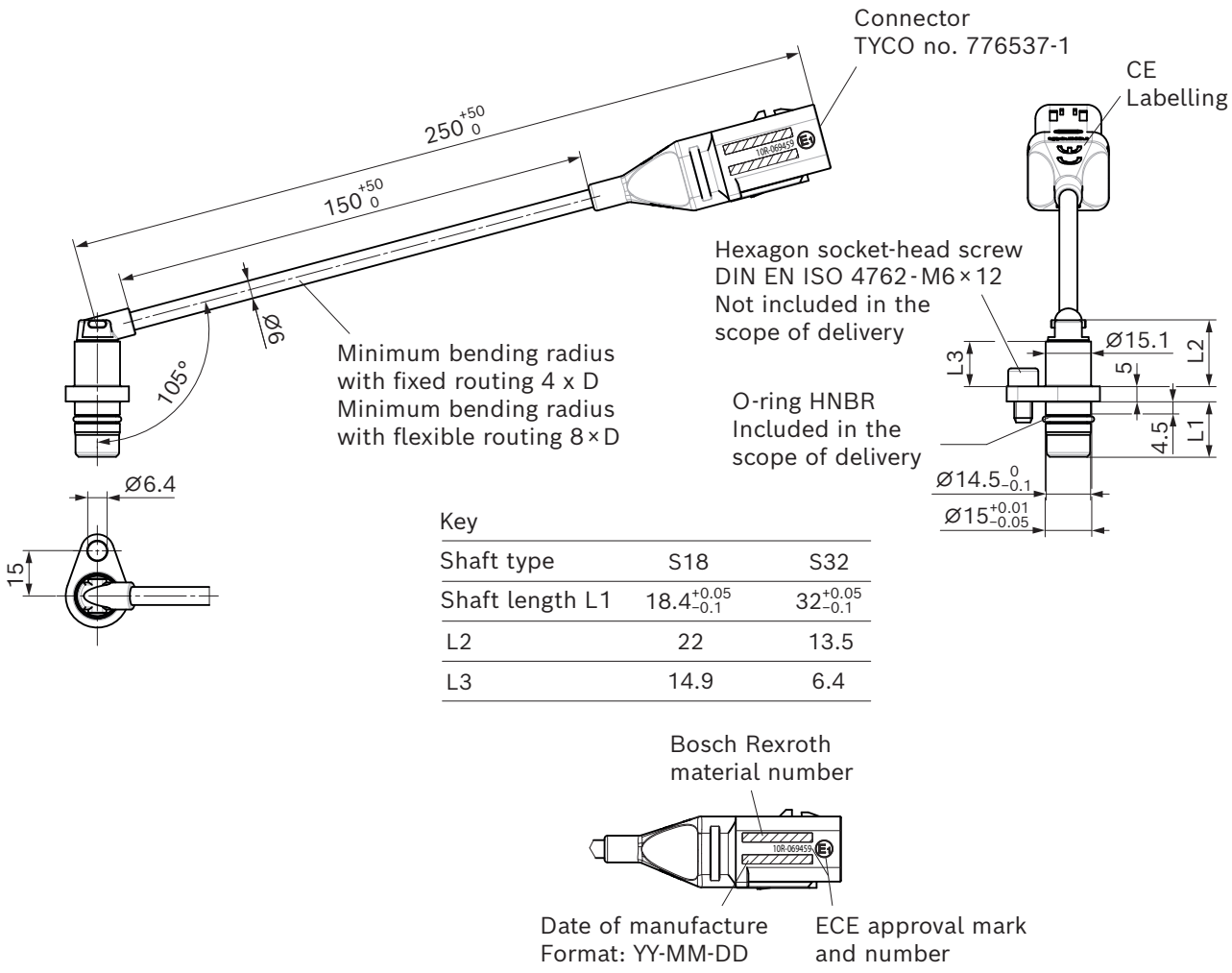
▼ **Pin assignment**



PIN	Connection	
1	Supply voltage	$U_{supply\ sensor}$
2	Ground	GND
3	Frequency (DSA1/20 and DSA2/20)	F1
4	Direction of rotation (DSA1/20) Frequency (DSA2/20)	D F2
5	NTC thermistor	
6	NTC thermistor	

1) R_{PU} and R_{PD} must be considered depending on the connected control unit.

Dimensions



Key

Shaft type	S18	S32
Shaft length L1	$18.4^{+0.05}_{-0.1}$	$32^{+0.05}_{-0.1}$
L2	22	13.5
L3	14.9	6.4

Notice
Mounting bolt tightening torque:
Maximum 10 Nm
Recommended: 8±2 Nm

Safety-related characteristics according to ISO 25119 and ISO 13849

Safety function of the DSA series 20 speed sensor is defined as the system integrity, i.e., it shall sense and process the rotational speed and the direction of rotation correctly and convert them into the corresponding output signals without failure.

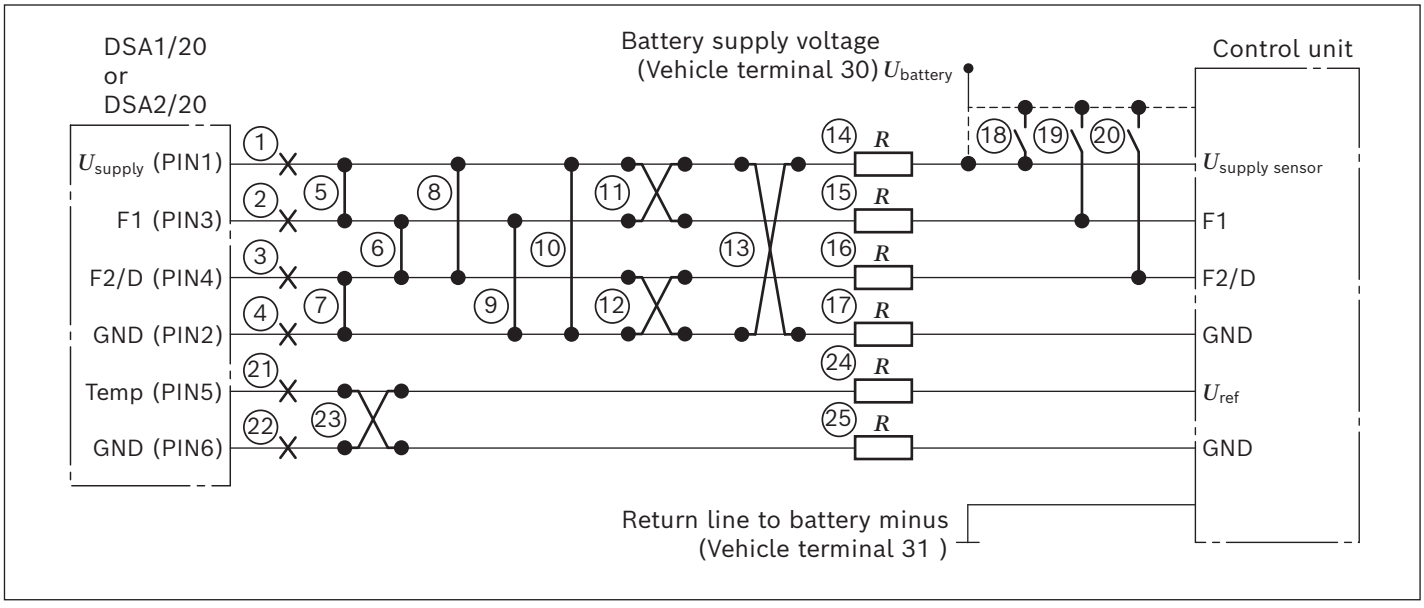
The temperature signal of the DSA series 20 speed sensor is not safety-related.

- The DSA series 20 speed sensor possesses a single channel architecture
- The DSA series 20 speed sensor fulfills the requirements of basic and well-tried safety principles
- The DSA series 20 speed sensor meets the requirements on common cause failures and well-tried components
- The DSA series 20 speed sensor contains no safety-related software

▼ **Temperature profile and corresponding $MTTF_D$ and diagnostic coverage (DC_{avg})**

Operating temperature [°C]	Working hours [%]	$MTTF_D$ [years]		DC_{avg} [1] [%]
		Operating time 24h / day	Operating time 16h / day	
–40	0.5	539	809	90
0	2			
23	5			
60	15			
85	67			
100	10			
125	0.5			

▼ **Error detection**



Definitions:

$U_{supply\ sensor}$ =10 V

Recommended on-board supply –2 V but higher than 8 V. The supply voltage for the sensor is provided by the control unit.

All failures considered are permanent failures (short-term and fluctuating failures were not considered)

1) If the sensor is used for safety-relevant functions, the diagnostic functions in chapter “Diagnostic functions to be performed by the control unit of the machine” (see page 19) must be observed.

Fault No	Description	Sensor output signal F1	Sensor output signal F2 or D
1	Open circuit $U_{\text{supply sensor}}$	Variable, depending on the control unit input circuitry	Variable, depending on the control unit input circuitry
2	Open circuit F1	Variable, depending on the control unit input circuitry	No impact on F2 or D
3	Open circuit F2/D	No impact on F1	Variable, depending on the control unit input circuitry
4	Open circuit GND	Variable, depending on the control unit input circuitry	Variable, depending on the control unit input circuitry
5	Short circuit between $U_{\text{supply sensor}}$ and F1	$U_{\text{supply sensor}}$	No impact on F2 or D
6	Short circuit between F1 and F2/D	Superimposition of F1 and F2/D	Superimposition of F1 and F2/D
7	Short circuit between F2/D and GND	No impact on F1	GND
8	Short circuit between $U_{\text{supply sensor}}$ and F2/D	No impact on F1	$U_{\text{supply sensor}}$
9	Short circuit between F1 and GND	GND	No impact on F2 or D
10	Short circuit between $U_{\text{supply sensor}}$ and GND	Variable, depending on the control unit input circuitry (see page 12)	Variable, depending on the control unit input circuitry
11	Interchange of $U_{\text{supply sensor}}$ and F1, F2/D	Variable, depending on the control unit input circuitry	Variable, depending on the control unit input circuitry
12	Interchange of GND and F1, F2/D	Variable, depending on the control unit input circuitry	Variable, depending on the control unit input circuitry
13	Interchange of $U_{\text{supply sensor}}$ and GND	Variable, depending on the control unit input circuitry	Variable, depending on the control unit input circuitry
14	Transistion resistance in $U_{\text{supply sensor}}$, ≤10 Ω	Additional voltage drop compared to normal $U_{\text{out high}}$; Additional: $U_{\text{add}} = -R \times (I_{\text{out supply}} + I_{\text{out high F1}} + I_{\text{out high F2}})$	Additional voltage drop compared to normal $U_{\text{out high}}$; Additional: $U_{\text{add}} = -R \times (I_{\text{out supply}} + I_{\text{out high F1}} + I_{\text{out high F2}})$
15	Transistion resistance in F1, ≤10 Ω	Additional voltage drop compared to normal $U_{\text{out low}}$ and $U_{\text{out high}}$; In addition to $U_{\text{out low}}$: $U_{\text{add}} = R \times I_{\text{out low F1}}$ In addition to $U_{\text{out high}}$: $U_{\text{add}} = -R \times I_{\text{out high F1}}$	No impact on F2 or D
16	Transistion resistance in F2/D, ≤10 Ω	No impact on F1	Additional voltage drop compared to normal $U_{\text{out low}}$ and $U_{\text{out high}}$; In addition to $U_{\text{out low}}$: $U_{\text{add}} = R \times I_{\text{out low F2}}$ In addition to $U_{\text{out high}}$: $U_{\text{add}} = -R \times I_{\text{out high F2}}$
17	Transistion resistance in GND, ≤10 Ω	Additional voltage drop compared to normal $U_{\text{out low}}$; Additional: $U_{\text{add}} = R \times (I_{\text{out supply}} + I_{\text{out low F1}} + I_{\text{out low F2}})$	Additional voltage drop compared to normal $U_{\text{out low}}$ Additional: $U_{\text{add}} = R \times (I_{\text{out supply}} + I_{\text{out low F1}} + I_{\text{out low F2}})$
18	$U_{\text{supply sensor}}$ – battery voltage (27 V)	Output voltage $U_{\text{out low}}$ and $U_{\text{out high}}$ out of valid range (see page 12)	Output voltage $U_{\text{out low}}$ and $U_{\text{out high}}$ out of valid range
19	F1 – battery voltage (27 V)	Output voltage $U_{\text{out low}}$ and $U_{\text{out high}}$ out of valid range	No impact on F2 or D
20	F2/D – battery voltage (27 V)	No impact on F1	Output voltage $U_{\text{out low}}$ and $U_{\text{out high}}$ out of valid range

Key see 19

Fault No	Description	Sensorausgangssignal Temp
21	Cable break U_{ref}	Signal out of valid range / Variable, depending on the control unit input circuitry.
22	Cable break GND	Signal out of valid range / Variable, depending on the control unit input circuitry.
23	Exchange U_{ref} with GND	No impact on Temp
24[1)]	Transistion resistance in the supply to the sensor ≤10 Ω	Additional voltage drop compared to normal U_{temp}
25[1)]	Transistion resistance in GND, ≤10 Ω	Additional voltage drop compared to normal U_{temp}

Key to page 18 and 19

F1	Sensor output signal F1
F2/D	Sensor output signal F2 or D
GND	Ground
R	Transistion resistance
U_{add}	Difference of supply voltage
$U_{out\ low}$	Output voltage of the sensor “Low-level”
$U_{out\ high}$	Output voltage of the sensor “High-level”
U_{ref}	Temperature signal - Operating voltage
$U_{supply\ sensor}$	Supply voltage of the sensor
U_{temp}	Temperature signal - output voltage
$I_{out\ low\ F1}$	F1 current from the signal input of the control unit to the signal output of the sensor
$I_{out\ high\ F1}$	F1 output current from the signal output of the sensor to the signal input of the control unit
$I_{out\ low\ F2}$	F2/D current from the signal input of the control unit to the signal output of the sensor
$I_{out\ high\ F2}$	F2/D output current from the signal output of the sensor to the signal input of the control unit
$I_{out\ ref}$	Signal current of the temperature measurement
$I_{out\ supply}$	Current consumption of the sensor (typical 17.5 mA in no-load operation)

Diagnostic functions to be implemented by the machine control unit

Following diagnostic functions shall be implemented by the machine control unit, in order to prevent damages to the sensor and to enable the sensor to reach the specified functional safety features.

Diagnostic functions	Frequency of monitoring	Failure reaction
Detection of the high-impedance output signals via e.g., current and/ or voltage monitoring Examples: ▶ Detection of $U_{out\ low}$ ▶ Detection of $U_{out\ high}$ ▶ Detection of higher current consumption (>17.5 mA + signal output current Iout ...) ▶ Detection of lower current consumption (< 5 mA)	Periodically. The exact frequency depends on the target reaction time and the rotational speed.	Bring the system into a safe state
Detection of power supply over-voltage	Periodically	A permanent supply voltage > 36 VDC should be prevented. A supply voltage > 36 VDC may be applied for a maximum of 5 minutes.

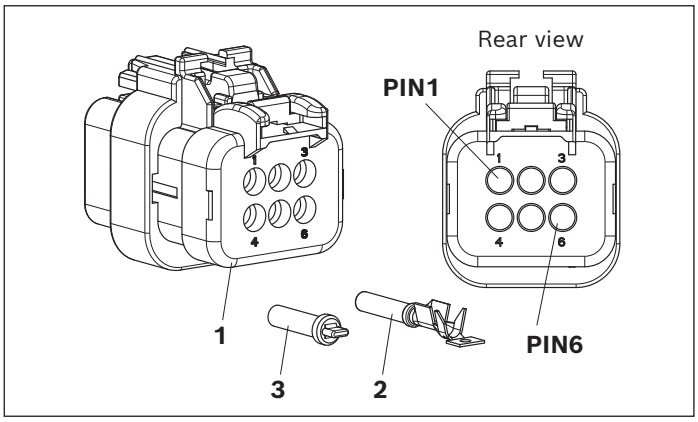
Notice

There is no internal monitoring of the speed over 20 kHz and no dedicated indication of standstill. If it is required by the machine safety concept, additional diagnostic methods need to be implemented by the machine control unit.

1) The effect would be an increase in resistance, which means a too low measured temperature.
The higher the actual temperature, the larger the deviation.

Accessories

▼ **Mating connector**



Notice
The tools prescribed by the connector manufacturer are to be used for the assembly.
It is to be assembled according to the assembly instructions provided by the connector manufacturer.

▼ **AMPSeal 16 mating connector set, suitable for wire thicknesses 0.50 ... 0.82 mm² (material number: R917013180)**

Item	Designation		Quantity	Order number	Manufacturer	Comment
1	AS 16, 6P PLUG ASSY, KEY 1		1	776531-1	TYCO Electronics	
2	Nickel PIN coating	tape and reel	6	1924464-2	TYCO Electronics	Contact coating: Nickel Suitable for wire thicknesses: 20-18AWG, 0.51 ... 0.82 mm²
				776493-2	TYCO Electronics	Contact coating: Nickel Suitable for wire thicknesses: 20-18AWG, 0.5 ... 0.75 mm²
3	Sealing plug		2	776364-1	TYCO Electronics	

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

▼ **AMPSeal 16 mating connector set, suitable for wire thicknesses 0.8 ... 2 mm²**

Item	Designation		Quantity	Order number	Manufacturer	Comment
1	AS 16, 6P PLUG ASSY, KEY 1		1	776433-1	TYCO Electronics	
2	Nickel PIN coating	bush	6	776299-2	TYCO Electronics	Contact coating: Nickel Suitable for wire thicknesses: 14-18AWG, 0.8 ... 2 mm²
		tape and reel	6	776492-2	TYCO Electronics	Contact coating: Nickel Suitable for wire thicknesses: 14-18AWG, 0.8 ... 2 mm²
3	Sealing plug		2	776363-1	TYCO Electronics	

This mating connector kit is not included in the scope of delivery. It can be ordered from TYCO Electronics.

▼ **Retaining clip**

Version	Order number	Manufacturer	Comment
1	1924487-1	TYCO Electronics	Operating temperature range −40 ... +120 °C
2 (with anti-rotation fixture)	1924487-2	TYCO Electronics	Operating temperature range −40 ... +120 °C
3	1924487-3	TYCO Electronics	Operating temperature range −40 ... +125 °C

The retaining clip is not included in the scope of delivery. It can be ordered from TYCO Electronics.

▼ **Spare O-rings (material number: R917013978)**

Version	Quantity per bag	Packing type
11.8 × 1.8-HNBR-PTFE-COATED-BLACK	20 piece	ZIP bag

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

Safety instructions

General information

- Before establishing your design, consult your Bosch Rexroth contact if you wish to install the DSA series 20 in a unit which has not been produced by Rexroth.
- 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.
- System developments, installations and the 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.
- 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 permitted since these users do not typically have the required level of expertise.
- If other or additional specifications apply to the marketing of the product or if it is to be marketed outside of the specified target markets, the 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 data sheet and the related agreed documents, Bosch Rexroth guarantees that the product corresponds to 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 data 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 data 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 systems).
- 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

- 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 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 attached as far away as possible from large electric machines (e.g. alternator, motor-generator) and not be routed close to other power-conducting lines in the device or vehicle.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- The wiring harness, from the sensor to the control unit, should not exceed a cable length of 30 m.
- 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.
- Its use in 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 machine safety functions.
- It is customer’s responsibility to evaluate the complete safety-related system and to determine and validate the suitability of the DSA series 20 speed sensor for any machine safety functions.
  - The DSA series 20 speed sensor fulfills the requirements of PL c/ AgPL c when integrated properly following all relevant requirements in this document.
  - If used redundantly as part of a Category 3 machine safety-related system, the DSA series 20 speed sensor is capable to support a safety level up to PL d/ AgPL d.
  - The failure reactions of the DSA series 20 speed sensor are listed in the table in the chapter “Safety-related characteristics according to ISO 25119 and ISO 13849” chapter “Error detection” (see page 17). The sensor shall not be used if the failure reaction is determined to be insufficient for the machine safety functions.
- The control unit of the machine shall monitor the sensor with the required diagnostic functions given in this document.
- An efficient field observation process shall be established by the customer. Any field failures involving the DSA series 20 speed sensor should be immediately notified to Bosch Rexroth, even if it is not covered by 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 about the sensor can be found at www.boschrexroth.com/mobile-electronics.

Bosch Rexroth AG
Robert-Bosch-Straße 2
71701 Schwieberdingen
Germany
Service phone +49 9352 40 50 60
info.bodas@boschrexroth.de
www.boschrexroth.com