RE 95148/2023-03-24
Replaces: 2020-07-09

rexroth
A Bosch Company

Contamination switch VS

- Detecting metallic contamination in oil

Contents

Product description

The contamination switch VS detects metallic ferromagnetic impurities in oil. Installed in an axial piston unit, the contamination switch VS provides early warning of wear processes and makes it possible to avoid consequential damage in good time.
The contamination switch VS is screwed into the existing bores (e.g. case drain ports) of hydraulic pumps and hydraulic motors. Most abrasion is likely to occur in the case drain area. The plug connector should be fitted so that it faces downwards in order to promote the accumulation of particles due to gravity.
Ferromagnetic impurities in the oil are attracted by a permanent magnet on the measuring surface of the contamination switch VS. As the particles accumulate, they form an electric bridge between the magnet and adjacent metal contacts. This switch signal can then be used to activate an alarm via a relay, for example, or to switch off the hydraulic system.
The magnet always forms one of the two switch contacts. A separate contact which is isolated from the switch housing forms the second switch contact.
Two different versions are also available for the electrical connection: either an integrated plug connector with mating plug or a free plug connector on the end of a connecting lead with two strands and a protective sheath.

Main part

- Supplied with sealing ring
- Supplied with mating plug (connection version S)

Type code

01	02	03	04		05	06
VS				**/**	**2**	**2**

Type

01	Contamination switch	**VS**

Electrical connection

02	Integrated plug connector to EN 175301-803 / IEC 4400	**S**
	Connecting strands with protective sheath and socket DEUTSCH DT04, 2-pin	**L**

Screw thread

03	M18 x 1.5	**18**
	M22 x 1.5	**22**
	M26 x 1.5	**26**
	M33 x 2	**33**

Switch contact

04	Separate contact	**S**

Series

05	**2**

Index

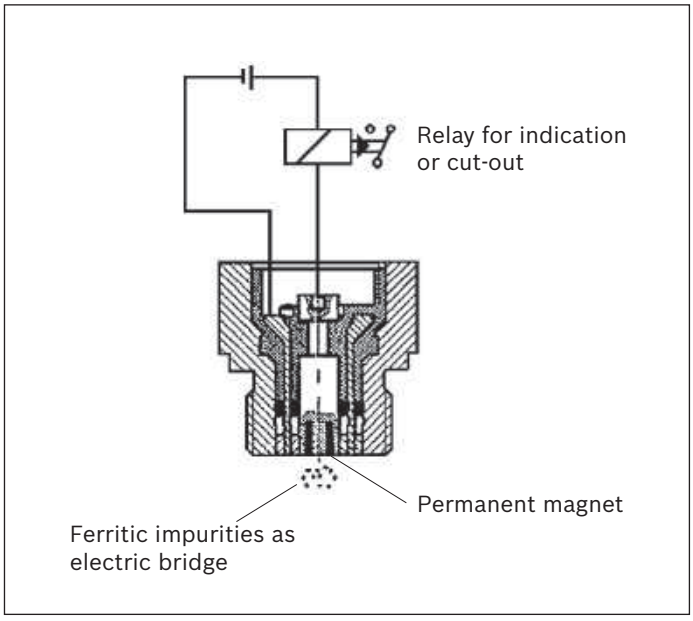
06	**2**

Technical data

Type			VSS18	VSS22	VSL22	VSS26	VSL26	VSS33	VSL33
Switching voltage maximum	U_{max}	V	30						
Switching current maximum	I_{max}	A	0.2						
Oil pressure maximum	p_{max}	bar	6						
Ambient temperature	ϑ	°C	-25 ... +90						
Screw-in torque maximum	T_{max}	Nm	25	60		70		140	
Installation position			Preferably with connector and cable outlet pointing downwards						
ROHS			EU-RoHS2-compliant						
Storage time			2 years at an average relative humidity of 60 % and a temperature between -5 °C and +20 °C, UV protected						

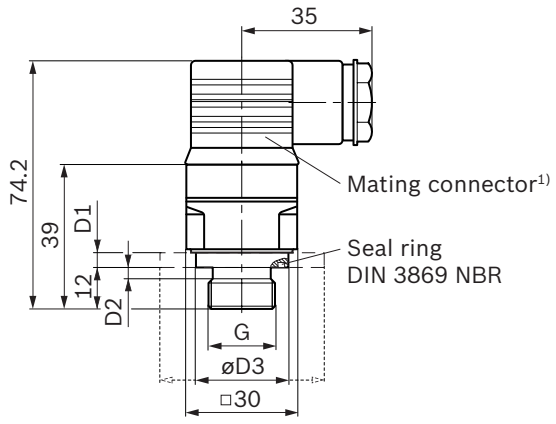
Electrical connection

Connection switch contact

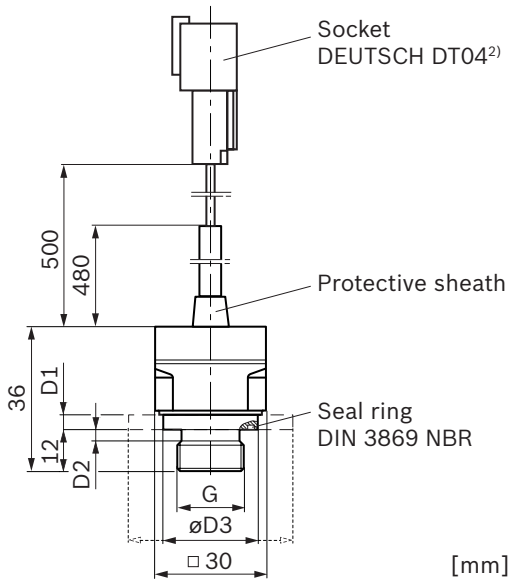


Dimensions

VSS



VSL



[mm]

Type	D1 mm	D2 mm	D3 mm	G
VSS18	4	3	23.9	M18 x 1.5
VSS22	4	3	27	M22 x 1.5
VSL22	4	3	27	M22 x 1.5
VSS26	4	3	31.4	M26 x 1.5
VSL26	4	3	31.4	M26 x 1.5
VSS33	4.5	4	39.2	M33 x 1.5
VSL33	4.5	4	39.2	M33 x 2

1) Connection version "S" is supplied complete with mating connector.
2) The mating connector DEUTSCH DT06-2S-EP04 for connection version
"L" is not included in ssupply and can be ordered under the material number R902601804.

Safety Instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modifications or repairs to the wiring could lead to dangerous malfunctions.
- The sensor may only be assembled/disassembled in a deenergized state.
- Only trained and experienced specialists who are adequately familiar with both the components used and the complete system should implement system developments or install and commission electronic systems for controlling hydraulic drives.
- When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- Do not use defective components or components not in proper working order. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to consider all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- The use of sensors by private users is not permitted, since these users do not typically have the required level of expertise.

Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- Cables/wires must be sealed individually to prevent water from entering the sensor.

Notes on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- If it is dropped, the sensor must not be used any longer, as invisible damage could have a negative impact on reliability.

Notes on wiring and circuitry

- Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The sensor mating connector must only be plugged and unplugged when it is in a deenergized state.
- The sensor lines are sensitive to spurious interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and approved in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.

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

Improper use

- Any use of the sensor other than that described in the chapter "Intended use" is considered to be improper.
- Use in explosive areas is not permitted.
- Damages which result from improper use and/or from unauthorized, unintended interventions in the device not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and determining the possible safety-related functions.
- In safety-related applications, the customer is responsible for taking proper measures to ensure safety (sensor redundancy, plausibility check, etc.).

Further information

- Further information about the sensor can be found at www.boschrexroth.de/mobilelektronik.
- The sensor must be disposed of in accordance with the national regulations of the country in which it is used.

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RE 95143/2024-03-07
Replaces: 2023-03-24

rexroth
A Bosch Company

BODAS Angle sensor AN2

- Angle determination at the tractor hitch control
- Measuring ranges ±17° to ±44°
- Output signal proportional voltage
- Supply voltage 5 V / 8 to 10.4 V
- Protection class IP67 / IP69K

Features

- Angle sensor element based on the Hall-effect principle
- Shaft can be mechanically rotated
- Integrated electronics with temperature compensation
- Output signal ratiometrically proportional to angle
- Zero point and sensitivity are calibrated

Contents

Product description

The AN2 angle sensor is used for angular measurement from ±17° to ±44°.
The sensor returns a ratiometric voltage with rising characteristic (positive course) or inverted characteristic (negative course).
This sensor is a typical part of an electro-hydraulic hitch control (EHC) and is supplied directly from a Rexroth EHR controller or an SRC controller.
This sensor is destined for the use in agricultural applications.

Type code

01	02	03	04	05		06
AN2					**/**	**30**

Type

01	Hall-effect	**AN2**

Version

02	Without pin	**V1**
	With pin to the bottom	**V2**
	With pin to the top	**V3**

Characteristic curve

03	Positive course	**A**
	Negative course	**B**

Angles

04	±17°	**17**
	±28°	**28**
	±35°	**35**
	±36°	**36**
	±41°	**41**
	±44°	**44**

	Supply voltage	**Signal voltage**	
05	5 ±0.5 V	10% ... 90% U_{sup}	**05**
	8 V ... 10.4 V	25% ... 75% U_{sup}	**10**

Series

06		**30**

Available variants

Type	Material number
AN2 V1 A 44 10/30	R917004856
AN2 V1 B 35 10/30	R917005164
AN2 V1 A 41 10/30	R917005165
AN2 V2 A 36 10/30	R917005166
AN2 V3 A 28 10/30	R917005167
AN2 V1 A 17 10/30	R917005168
AN2 V2 A 41 10/30	R917005169
AN2 V1 A 41 05/30	R917005568
AN2 V1 B 35 05/30	R917008154
AN2 V2 A 36 05/30	R917008155
AN2 V3 A 28 05/30	R917008156
AN2 V1 A 17 05/30	R917008157
AN2 V2 A 41 05/30	R917008158
AN2 V3 A 41 05/30	R917008159
AN2 V1 A 44 05/30	R917008160

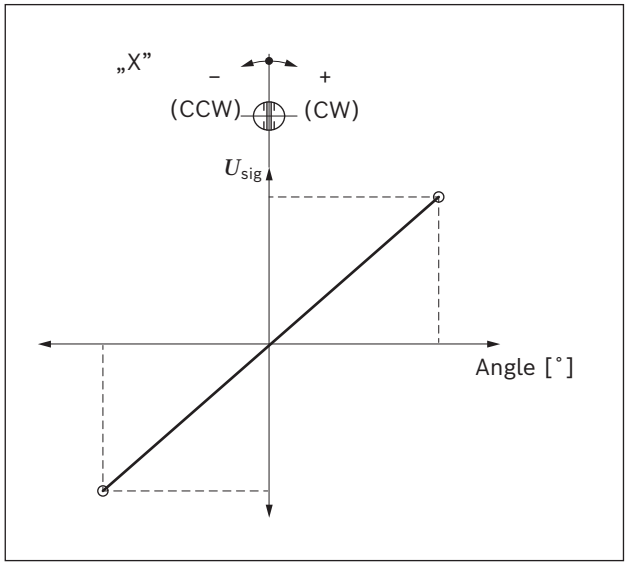
Technical data

Type			**AN2**					
Measurement principle			Hall-effect Maximum permissible external magnetic field: 0.3 mT					
Nominal angular range			±17°	±28°	±35°	±36°	±41°	±44°
			Shaft can be mechanically rotated					
Starting torque			≤5 Ncm					
Shaft loading	radial		≤10 N					
	axial		≤20 N					
Supply voltage		U_{sup}	8 V ... 10.4 V DC			5±0.5 V		
Supply current		I_{sup}	≤15 mA			≤15 mA		
Signal voltage	ratiometric	U_{sig}	25% ... 75% U_{sup}			10% ... 90% U_{sup}		
Load resistance			>3 kΩ			≥10 kΩ		
Linearity			< ±1%					
Zero position			Marking on shaft (see drawing)					
Sensitivity of the end points			< ±1% of the supply voltage					
Hysteresis			Immeasurable					
Resolution			0.025% U_{sup}					
Temperature coefficient of zero point			≤ ±0.15%/10 °C					
Temperature coefficient of sensitivity			≤ ±0.2%10 °C					
Operating temperature			-30 °C ... +85 °C					
Storage temperature			-35 °C ... +100 °C					
Housing material			PBT GF 30					
Shaft material			X 5 CrNi 18					
Type of protection with connected mating plug	DIN EN 60529:2019-06		IP67/IP69K					
Plug connection			3-pin connector with dust boot and single-wire seal					
Insulation resistance to housing			>100 MΩ					
Dielectric strength of insulation to housing			<200 V					
Electromagnetic compatibility (EMC)	ISO 11452-2	1 MHz ... 1 GHz	200 V/m, permissible deviation 1% U_{sup}					
		1 GHz ... 4 GHz	100 V/m, permissible deviation 1% U_{sup}					
Electrostatic discharge (ESD)	ISO TR 10605 Intensity IV	Contact discharge	±8 kV					
		Air discharge	±15 kV					
Conformity according to	EMC directive 2014/30/EU with CE mark		Applied standard: EN ISO 14982:2009					
	RoHS directive 2011/65/EU							
Overvoltage, reverse polarity, short-circuit resistance			Overvoltage protection up to 18 V, Resistance against inverse-polarity and short circuits					
Dynamic tests	IEC 68-2-64	Broadband noise test	α_{eff} = 0.05 g^2/Hz, 10 Hz ... 2000 Hz					
	IEC 60068-2-27	Transport shock	15 g, 11 ms, 3xeach direction (positive/negative)					
	IEC 60068-2-29	Continuous shock	25 g, 6 ms, 1000 x each direction (positive/negative)					
Storage time			5 years at an average relative humidity of 60% and a temperature between -10 °C and +30 °C. For short periods of time, a storage temperature of -20 °C to +40 °C is permissible for up to 100 hours.					

Diagrams/characteristic curves

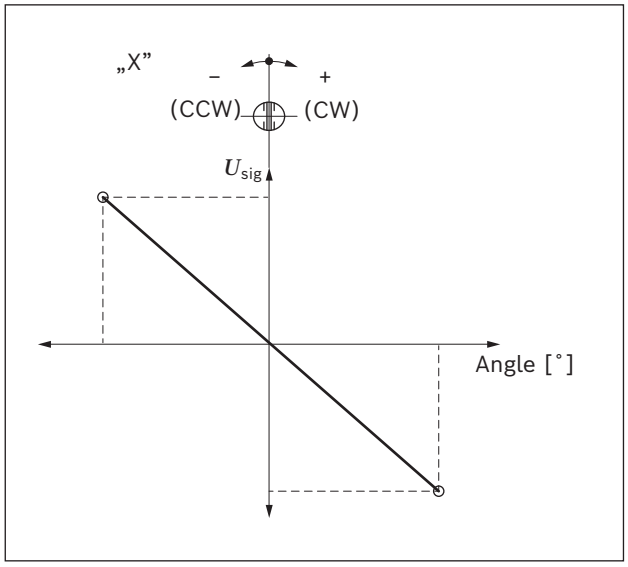
Characteristic curve A

Positive course



Characteristic curve B

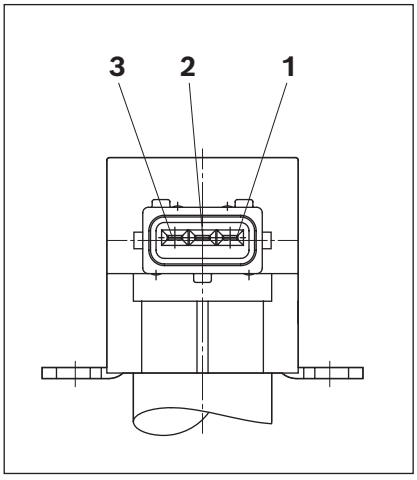
Negative course



Electrical connection

AMP connector

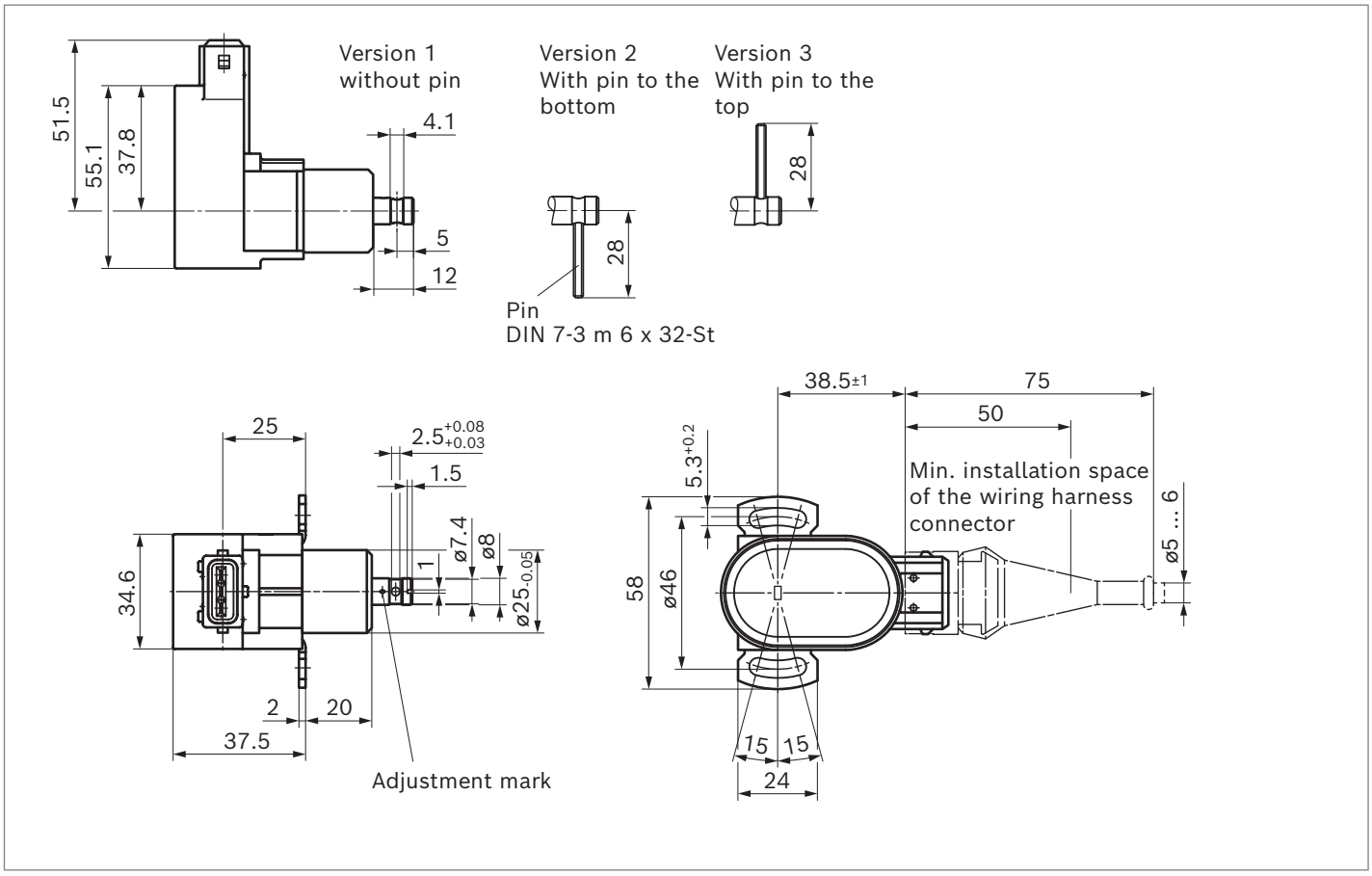
Pin Assignment



Pin	Connection	
1	GND	Signal ground
2	U_{sig}	Signal voltage
3	U_{sup}	Supply voltage

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

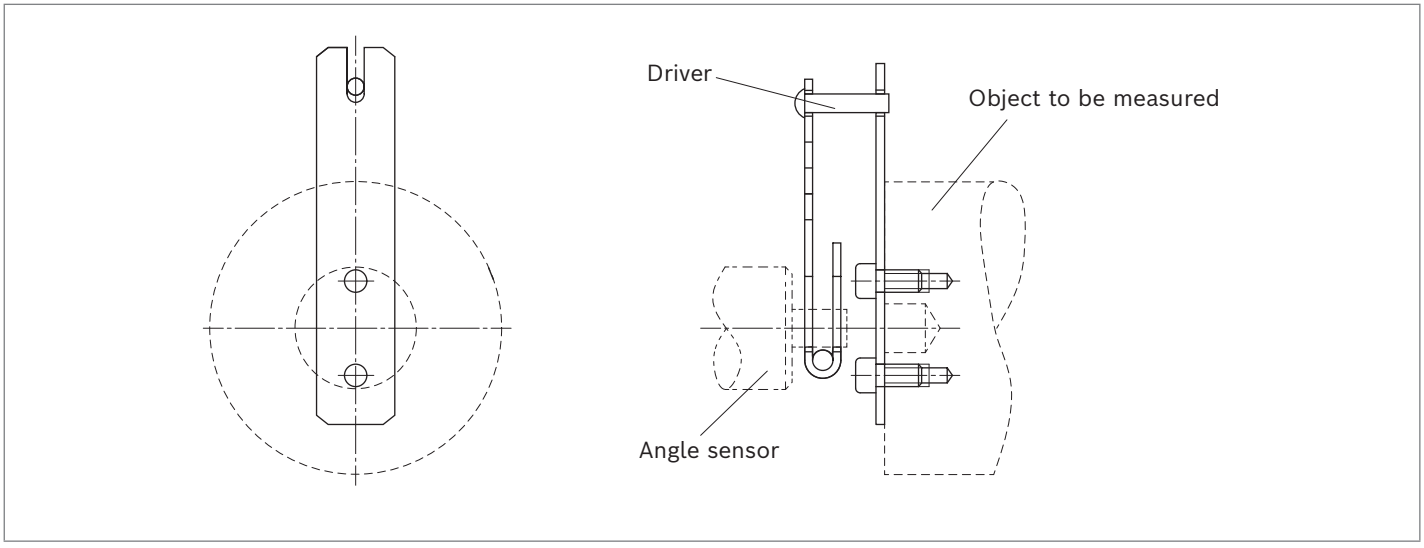
Dimensions


Version 1
without pin
Version 2
With pin to the
bottom
Version 3
With pin to the
top
51.5
55.1
37.8
4.1
5
12
28
28
Pin
DIN 7-3 m 6 x 32-St
25
2.5+0.08 +0.03
1.5
ø7.4
ø8
ø25 0.05
1
34.6
2
20
37.5
Adjustment mark
38.5±1
75
50
5.3+0.2
Min. installation space
of the wiring harness
connector
58
ø46
ø5 ... 6
15
15
24

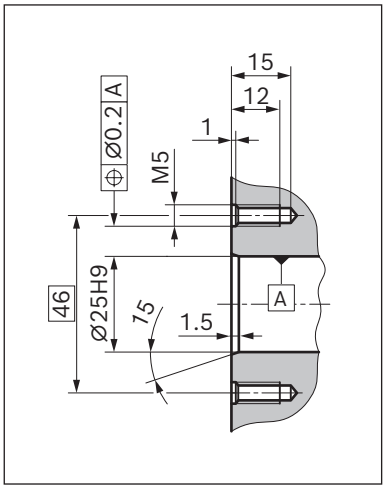
Mounting

Coupling example

The angle sensor shaft is to be coupled to the measurement object as free of force and play as possible.



Mounting hole



Mounting bolts		DIN 912-M5 x 20-8.8
Discs		DIN 125-A 5.3-St
Shaft loading	axial	20 N
	radial	10 N
Starting torque		<5 Ncm

Accessories

		Material number	
Mating connector		**R917000515**	
comprising:			
1	Housing	1928402579[1)]	
1	Protective cap	1280703022[1)]	
3	Contacts	929939[2)]	
3	Single-wire seal (wire size 0.5 ... 1 mm²)	828905-1[2)]	at FLK cable type
		828904-1[2)]	at FLKr, FLX cable
Not included in the scope of delivery			

1) Available from Bosch
2) Available from AMP

Safety Instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- It is not permissible to open the sensor or to modify or repair the sensor. Modifications or repairs to the wiring could lead to dangerous malfunctions.
- The sensor may only be assembled/disassembled in deenergized state.
- Only trained and experienced specialists who are adequately familiar with both the components used and the complete system should implement system developments or install and commission electronic systems for controlling hydraulic drives.
- When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- Do not use defective components or components not in proper working order. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to consider all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- The use of sensors by private users is not permissible, since these users do not typically have the required level of expertise.

Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- Cables/wires must be sealed individually to prevent water from entering the sensor.

Notes on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please immediately inform the transport company and Bosch Rexroth.
- If it is dropped, the sensor must not be used any longer as invisible damage could have a negative impact on reliability.

Notes on wiring and circuitry

- Lines to the sensors must be designed 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.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness must be secured by mechanical means in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and released in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.

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

Improper use

- Any use of the sensor other than that described in chapter "Intended use" is considered to be improper.
- Use in explosive areas is not permissible.
- Damages which result from improper use and/or from unauthorized, unintended interventions in the device not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and determining the possible safety-related functions.
- In safety-related applications, the customer is responsible for taking proper measures to ensure safety (sensor redundancy, plausibility check, emergency switch, etc.).
- Product data that is necessary to assess the safety of the machine can be provided upon request or is included in this data sheet.

Disposal

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

Further information

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

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RE 95144/2024-06-06
Replaces: 2024-03-12

rexroth
A Bosch Company

BODAS Angle sensor AN3

- Angle determination at the tractor hitch control
- Measuring ranges ±28° to ±60°
- Output signal proportional voltage
- Supply voltage 5 V
- Protection class IP67 / IP69K

Features

- Angle sensor element based on the Hall-effect principle
- Shaft can be mechanically rotated
- Integrated electronics with temperature compensation
- Output signal ratiometrically proportional to angle
- Precise compensation for zero point and sensitivity
- CE conformity

Contents

Product description

Description

The angle sensor AN3 is used for the angular measurement till ±60°.
The sensor is supplying a ratio metric voltage, available with increasing curve (positive course) or inverted curve (negative course).
This sensor is a typical part of an electronic – hydraulic hitch control (EHC) and is supplied directly by a Rexroth EHC Controller or by a Rexroth SRC.
This sensor is destined for the use in agricultural applications.

Type code

01	02	03	04	05		06	07
AN3	**V1**			**5**	**/**	**1**	**0**

Type

01	Hall-effect angle sensor	**AN3**

Version

02	Without pin	**V1**

Characteristic curve

03	Positive course	**A**
	Negative course	**B**

Angles

04	±28°	**28**
	±35°	**35**
	±41°	**41**
	±44°	**44**
	±60°	**60**

Supply voltage

05	5±0.5 V at signal voltage 10 ... 90% U_{sup}	**5**

Series

06		**1**

Index

07		**0**

Available variants

Type	Material number
AN3 V1 B 28 5/10	R913029358
AN3 V1 A 28 5/10	R913029842
AN3 V1 B 35 5/10	R983055893
AN3 V1 A 35 5/10	R983055890
AN3 V1 B 41 5/10	R983055894
AN3 V1 A 41 5/10	R983055891
AN3 V1 B 44 5/10	R983055895
AN3 V1 A 44 5/10	R983055892
AN3 V1 B 60 5/10	R983095377

Further variants on request.

Technical data

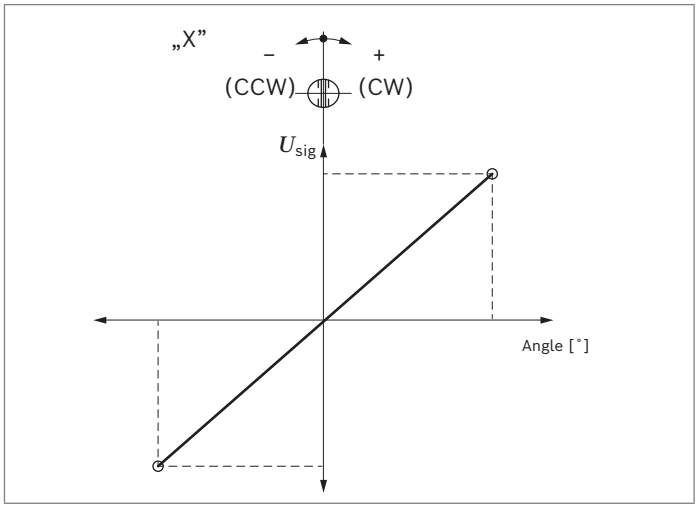
Type			**AN3**
Measurement principle			Hall-effect Maximum permissible external magnetic field: 25 mT
Nominal angular range			±28° ±35° ±41° ±44° ±60°
			Shaft can be mechanically rotated by 360°
Starting torque			≤5 Ncm
Shaft loading	radial		≤10 N
	axial		≤20 N
Supply voltage	U_{sup}		5±0.5 V DC
Supply current	I_{sup}		≤25 mA
Signal voltage	U_{sig}	ratiometric	10 ... 90% U_{sup}
Clamping voltage if nominal angular range is exceeded			6% U_{sup} when below range, 94% U_{sup} when above range
Load resistance			>10 kΩ
Linearity			< ±1%
Sensitivity of the end points			< ±1% of the supply voltage
Hysteresis			0.05°
Resolution			12 Bit / 0.025% U_{sup}
Temperature coefficient of zero point			±0.15%/ 10 K
Temperature coefficient of sensitivity			±0.2%/ 10 K
Operating temperature			–30 ... +80 °C
Storage time and storagetemperature			5 years at an average relative humidity of 60 % and a temperature between –10 °C and +30 °C. For short periods of up to 100 hours, a storagetemperature of –20 ... +40 °C is admissible.
Housing material			PA66 GF 30
Shaft material			X 5 CrNi 18-9
Type of protection with installed mating connector			IP67 and IP69K
Plug connection			3-pole TYCO AMP Superseal connector recommended
Electromagnetic compatibility (EMC)		1 MHz ... 1 GHz	100 V/m, no deviation >5% U_{sup} permissible
Electrostatic discharge (ESD)		Contact discharge	±8 kV
		Air discharge	±15 kV
Conformity according to	EMC directive 2014/30/EU with CE mark		Applied standards: ISO 14982:2009, 13766-1:2018, EN 12895:2020
	RoHS directive 2011/65/EU		
Overvoltage, reverse polarity, short-circuit resistance			Overvoltage: +16 V, reverse voltage: –16 V Short circuit monitoring
Dynamic tests	Broadband noise test	IEC 68-2-64	a_{eff} = 58 m/s², 20 ... 2000 Hz
	Transport shock	IEC 60068-2-27	Σ18 shocks; 6 directions; 6 ms; a_{max} = 400 m/s²
	Continuous shock	IEC 60068-2-29	25 g, 6 ms, 1000 x each direction (positive/negative)
Signal delay time			< 400 µs

These values are valid R_{load} = 30 kΩ (against ground) and room temperature.

Diagrams/characteristic curves

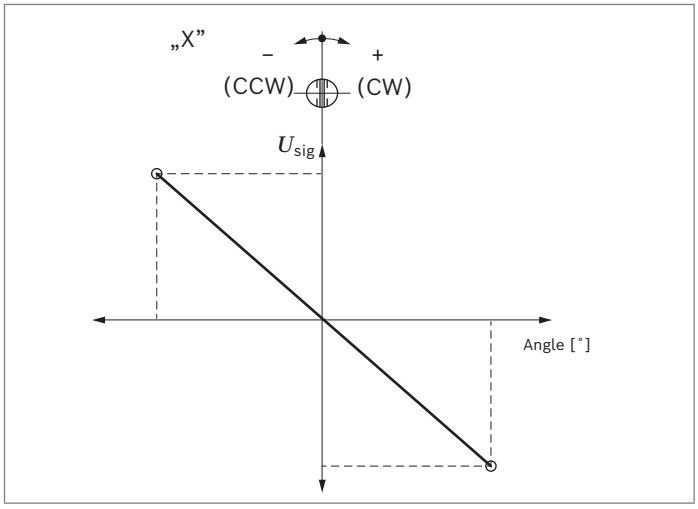
Characteristic curve A

Positive course



Characteristic curve B

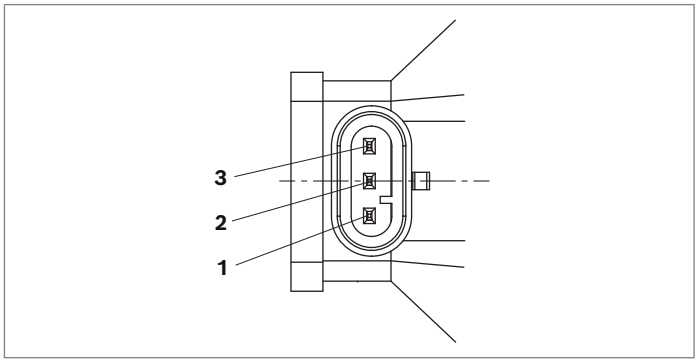
Negative course



Electrical connection

AMP Superseal connector

Pin Assignment

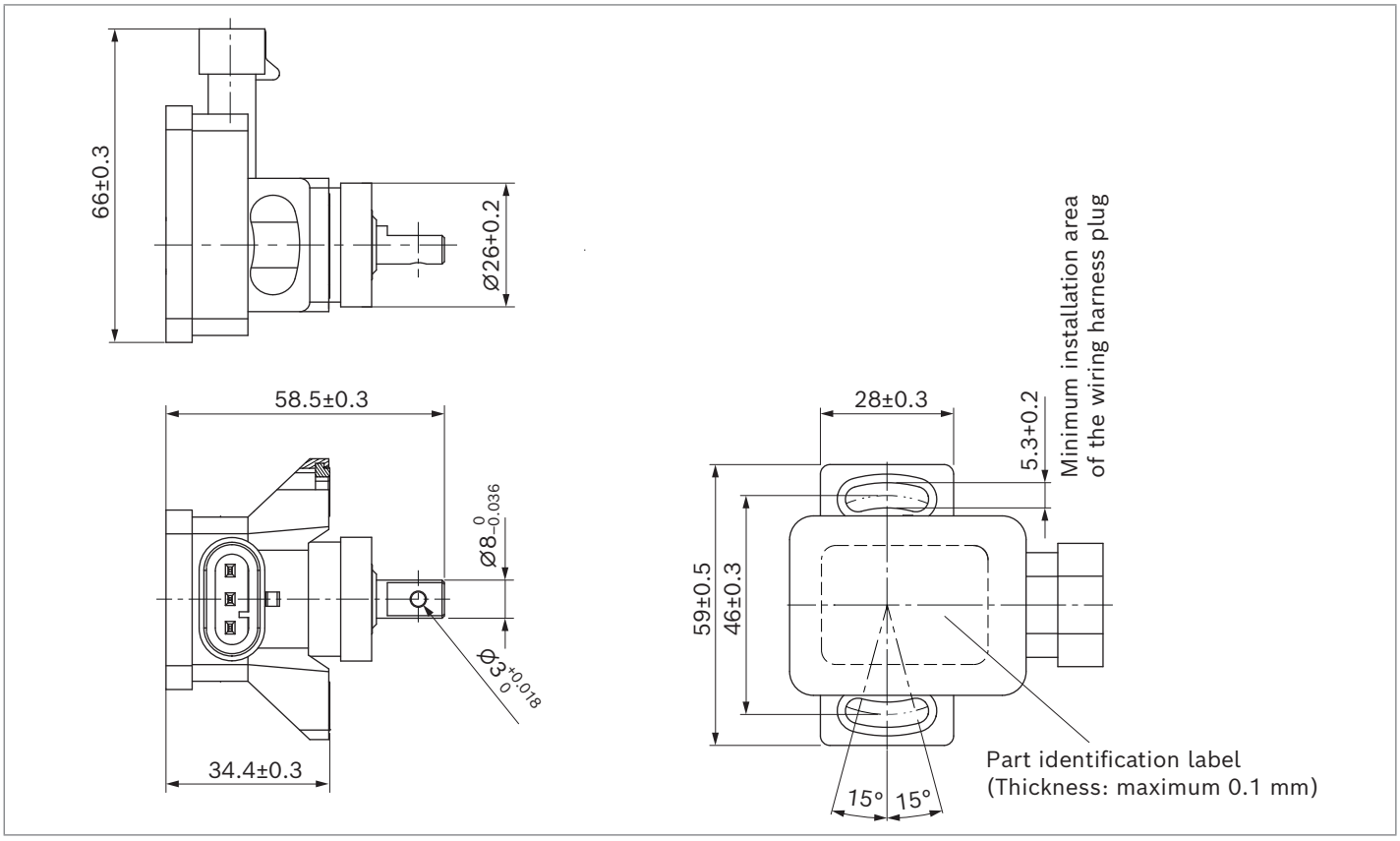


Pin	Connection	
1	GND	Signal ground
2	U_{sig}	Signal voltage
3	U_{sup}	Supply voltage

The mating connector is not included in the scope of delivery.

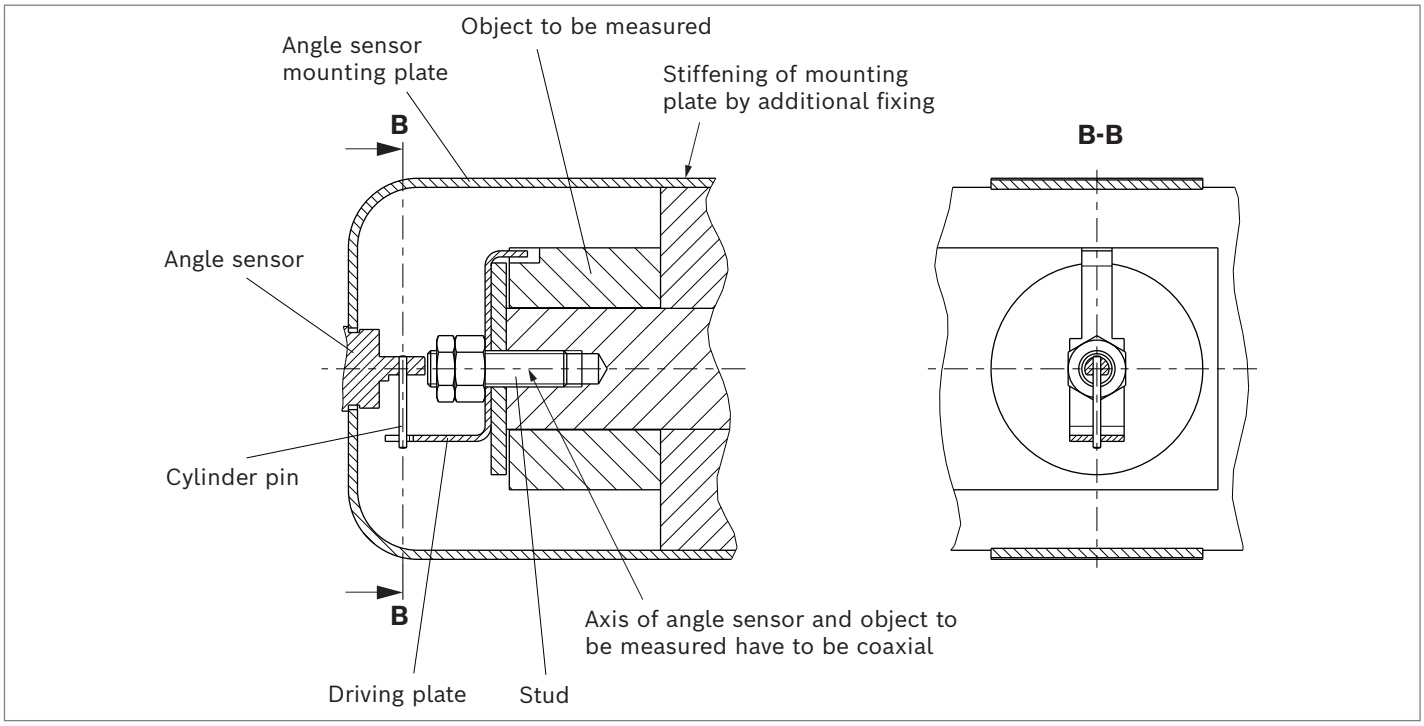
This can be supplied by Bosch Rexroth on request.

Dimensions


66±0.3
Ø26+0.2
58.5±0.3
Ø8 0 -0.036
Ø3 +0.018 0
34.4±0.3
28±0.3
5.3+0.2
Minimum installation area
of the wiring harness plug
59±0.5
46±0.3
15°
15°
Part identification label
(Thickness: maximum 0.1 mm)

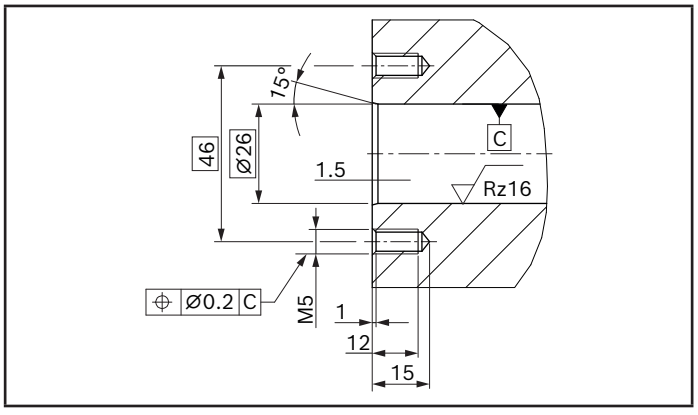
Project planning information

Coupling example



The angle sensor shaft is to be coupled to the measurement object as free of force and play as possible. It shall be ensured that maximum shaft loadings are not exceeded.

Assembly dimensions



Mounting bolts DIN 912-M5 x 12-8.8
Disc DIN 125-5.3–St
Shaft load: axial 20 N; radial 10 N
Starting torque ≤ 5 Ncm

Safety-related characteristics according to ISO 25119

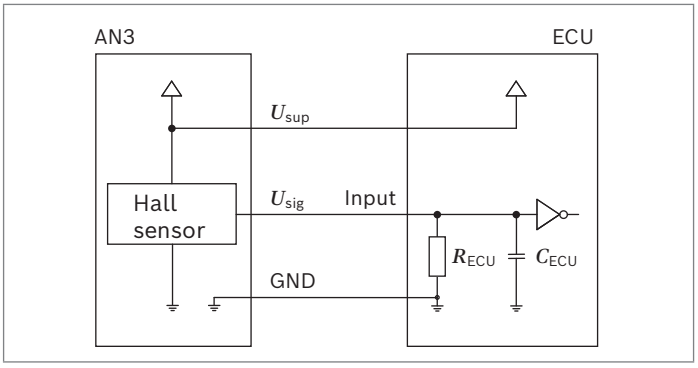
Safety function of the angle sensor AN3 is defined as the system integrity, i.e. AN3 shall sense and calculate the rotation of its shaft correctly and convert the angle into corresponding analog voltage output without failure.

- AN3 possesses a Category 1 architecture. This means single channel.
- AN3 fulfills the requirements of basic and well-tried safety principles.
- AN3 contains no safety-related software.

▼ **Temperature profile and corresponding $MTTF_D$ and diagnostic coverage (DC)**

Temperature [°C]	Self heating [°C]	Working hours [%]	$MTTF_D$ [years]	DC[1] [%]
10	5	2		
20	5	2		
30	5	3		
40	5	3		
50	5	12.5	1305	67
60	5	12.5		
70	5	20		
80	5	25		
85	5	20		

▼ **Failure detection possibilities**



In case of an open circuit failure of the GND cable, output U_{sig} of the AN3 is dependent of the ECU internal resistor R_{ECU}. During machine system integration, an open circuit failure of the GND cable shall be simulated and the corresponding output signal ($U_{OC\text{-}GND}$) of the AN3 shall be measured. Please make sure (e.g. by adding additional resistors) that $U_{OC\text{-}GND}$ > 95% U_{sup}.

1) It is assumed that the machine control unit will
- monitor the sensor supply voltage, and switch off the sensor in case of overcurrent, over- and undervoltage.
- react to the sensor out of range signal, and bring the machine into machine safe state

Failures of the AN3 that will cause out-of-range output signals and therefore detectable by the machine control system are listed in the following table:

Failure	Failure reaction	Failure response time
Connector/ wire break of U_{sig}, and/or AN3 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} < 5 % U_{sup}	immediately
U_{sig} short circuit to U_{sup} and/or AN3 internal failures that lead to the same effect	Sensor output out-of-range: : U_{sig} = U_{sup}	immediately
U_{sig} short circuit to GND and/or AN3 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} = 0 V	immediately
Connector/ wire break of U_{sup}, and/or AN3 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} < 5 % U_{sup}	5 ms[1)]
Connector/ wire break of GND, and/or AN3 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} > 95 % U_{sup}	5 ms[1)]
Hall IC internal failures	Sensor output out-of-range: U_{sig} < 4 % U_{sup}	5 ms

1) Failure response time is valid for control unit with R_{ECU} >= 50 kΩ and C_{ECU}= 100 nF

Accessories

Mating connector R902602132[1)]

Designation	Ordering code	Quantity
Socket housing	AMP 282087-1	1
Socket contacts	AMP 183025-1	3
Single-wire seals	AMP 281934-2	3

1) The mating connector is not included in the scope of delivery.

Safety Instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modifications or repairs to the wiring could lead to dangerous malfunctions.
- The sensor may only be assembled/disassembled in a deenergized state.
- Only trained and experienced specialists who are adequately familiar with both the components used and the complete system should implement system developments or install and commission electronic systems for controlling hydraulic drives.
- When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- Do not use defective components or components not in proper working order. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to consider all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- The use of sensors by private users is not permitted, since these users do not typically have the required level of expertise.

Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- Cables/wires must be sealed individually to prevent water from entering the sensor.

Notes on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- If it is dropped, the sensor must not be used any longer, as invisible damage could have a negative impact on reliability.

Notes on wiring and circuitry

- Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The sensor mating connector must only be plugged and unplugged when it is in a deenergized state.
- The sensor lines are sensitive to spurious interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and approved in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.

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

Improper use

- Any use of the sensor other than that described in the chapter "Intended use" is considered to be improper.
- Use in explosive areas is not permitted.
- Damages which result from improper use and/or from unauthorized, unintended interventions in the device not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the machine and determining the possible machine safety functions.
- It is customer's responsibility to evaluate the complete safety-related system and to determine the suitability of AN3 for any machine safety functions.
  - AN3 as a single component fulfills the requirements of ISO 25119:2018 AgPL c.
    If used as part of a Category 2 or Category 3 machine safety-related system, it is capable to support a safety level up to AgPL d.
  - AN3 failure responses are listed in the table in the chaper "Failure detection possibilities". It shall not be used if the failure reaction including the response time is determined to be insufficient for the machine safety functions.
- The machine control system shall monitor the sensor supply voltage, and switch off the sensor in case of over-current, over- and under-voltage.
- The machine control system shall monitor the sensor output and react to the out-of-range outputs by bring the machine into the safe state.
- If the AN3 is operated beyond the max. shaft loading, this can result in a shift of the sensor output or even the breakage of the bearing / shaft of the AN3. Appropriate methods must be implemented by the machine manufacturer to prevent these failures (e.g. by ensuring correct installation).
- An efficient field observation process shall be established by the customer. Any field failures involving the AN3 should be immediately notified to Bosch Rexroth, even if it is not covered by warranty.

Disposal

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

Further information

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

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RE 95160/2023-01-25
Replaces: 2022-11-10

rexroth
A Bosch Company

Position sensor PO1

- Position determination at the tractor hitch control
- Measuring range 0 to 10 mm
- Output signal proportional voltage
- Supply voltage 5 V / 8 ... 12 V
- Protection class IP69K

Features

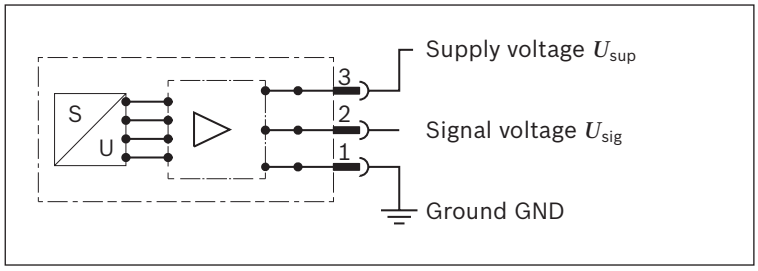
- Axially movable push-button with spring pretension
- Inductive element according to the differential throttle measurement principle
- Integrated electronics with temperature compensation
- Output signal ratiometric and proportional to the path
- Zero point and sensitivity are calibrated
- Housing with external thread M24 x 1.5 for mounting and adjustment

Contents

Product description

The PO1 is used to measure distances up to 10 mm. If an eccentric disc is mounted on an axis of rotation, the sensor can also be used for angular position control (see “Installation position” chapter).
The sensor supplies a ratiometric voltage with a rising characteristic curve (U_{sig} rises if compressed) or inverted characteristic curve (U_{sig} falls if compressed). For protection purposes, it may also be delivered together with bellows.
This sensor is a typical part of an electro-hydraulic hitch control (EHC) and is supplied directly by a Rexroth EHR control unit or by an SRC control unit.
This sensor is intended for being used in agricultural technology.

Block diagram



Type codes

01	02	03	04	05		06
PO1					**/**	**20**

Type

01	Mobile position sensor	**PO1**

Version

02	Without bellows	**1**
	With bellows	**2**

Characteristic curve

03	Standard	**S**
	Inverted	**V**

Supply voltage

04	5 ±0.5 V	**05**
	8 V ... 12 V	**10**

Signal voltage

05	15 ... 85% U_{sup}	**15**
	25 ... 75% U_{sup}	**25**

Series

06		**20**

Available variants

Type	Material number
PO1 2 S 10 25/20	R917001941
PO1 1 S 10 25/20	R917001942
PO1 2 V 10 25/20	R917001943
PO1 1 V 10 25/20	R917001944
PO1 2 S 05 15/20	R917008163
PO1 1 S 05 15/20	R917005712
PO1 2 V 05 15/20	R917008164
PO1 1 V 05 15/20	R917008165
PO1 2 S 05 25/20	R917002927

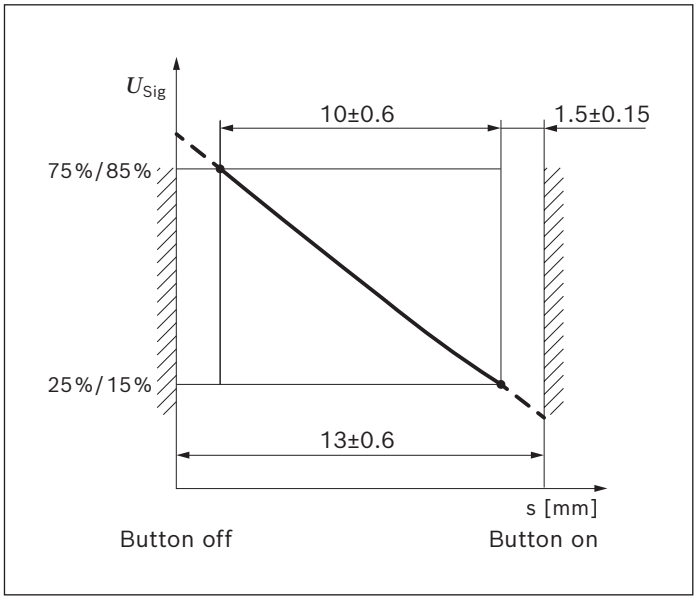
Further variants on request.

Technical data

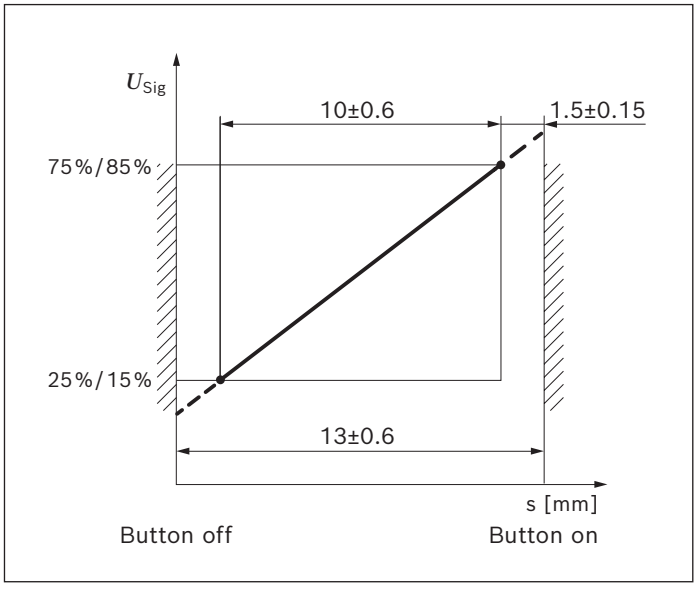
Type		PO1 x x 10 25/20	PO1 x x 05 15/20	PO1 2 S 05 25/20
Nominal stroke		10 mm	10 mm	10 mm
Mechanical stroke		13 mm	13 mm	13 mm
Actuating force		≤16 N	≤16 N	≤16 N
Supply voltage (no direct supply from the vehicle electrical system (battery))	U_{sup}	Standard 8 V ... 12 V	5±0.5 V	5±0.5 V
Inrush current		3 A	1 A	1 A
Supply current	I_{sup}	30 mA (pulsed between 10 mA and 50 mA)	20 mA (pulsed between 10 mA and 30 mA)	20 mA (pulsed between 10 mA and 30 mA)
Signal voltage	U_{sig}	25% ... 75% U_{sup}	15% ... 85% U_{sup}	25% ... 75% U_{sup}
Residual ripple		<20 mVss	<20 mVss	<20 mVss
Load resistance		>7 kΩ (≥ 50 kΩ, if used in safety-related applications, where GND wire break shall be detected)	≥10 kΩ (≥ 600 kΩ, if used in safety-related applications, where GND wire break shall be detected)	≥10 kΩ (≥ 50 kΩ, if used in safety-related applications, where GND wire break shall be detected)
Linearity (limiting point setting)		≤ ±2%	≤ ±2%	≤ ±2%
Scattering (upper limiting point)		≤ ±1.5%	≤ ±1.5%	≤ ±1.5%
Sensitivity scattering		≤ ±2.0%	≤ ±2.0%	≤ ±2.0%
Hysteresis		Immeasurable	Immeasurable	Immeasurable
Resolution		Unlimited	Unlimited	Unlimited
Temperature coefficient of limiting point		≤ ±0.15%/10 °C	≤ ±0.15%/10 °C	≤ ±0.15%/10 °C
Temperature coefficient of sensitivity		≤ ±0.15%/10 °C	≤ ±0.15%/10 °C	≤ ±0.15%/10 °C
Operating temperature		-30 ... +85 °C	-30 ... +85 °C	-30 ... +85 °C
Storage temperature		-35 ... +100 °C	-35 ... +100 °C	-35 ... +100 °C
Housing material		GD-Al Si 12 (Cu)	GD-Al Si 12 (Cu)	GD-Al Si 12 (Cu)
Type of protection	Coil and electronics	IP69K	IP69K	IP69K
	connector with installed mating connector	IP69K	IP69K	IP69K
Mating connector		3-pin connector with dust boot	3-pin connector with dust boot	3-pin connector with dust boot
Insulation resistance to housing		>100 MΩ	>100 MΩ	>100 MΩ
Dielectric strength of insulation to housing		<200 V	<200 V	<200 V
Electromagnetic compatibility	ISO 11452-2 1 MHz ... 1 GHz	100 V/m ≤ ±1% U_{sup}	100 V/m ≤ ±1% U_{sup}	100 V/m ≤ ±1% U_{sup}
Storage time		5 years at an average relative humidity of 60 % and a temperature between -10 °C and +30 °C. For short periods of time, a storage temperature of -20 ... +40 °C is permissible for up to 100 hours.		

Diagrams/characteristic curves

Inverted

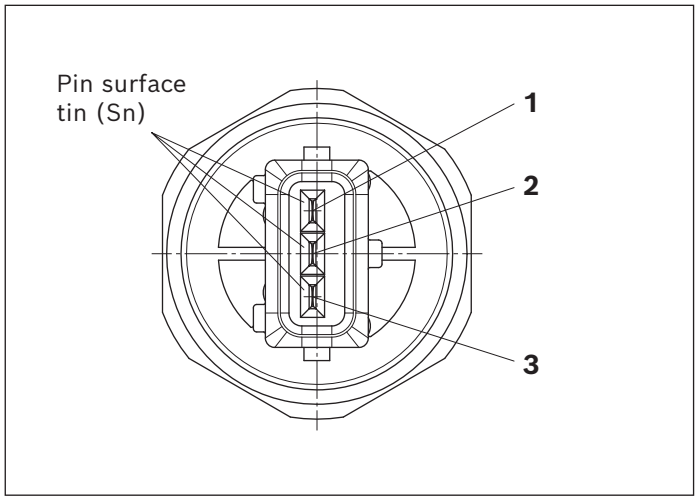


Standard (increasing)



Electrical connection

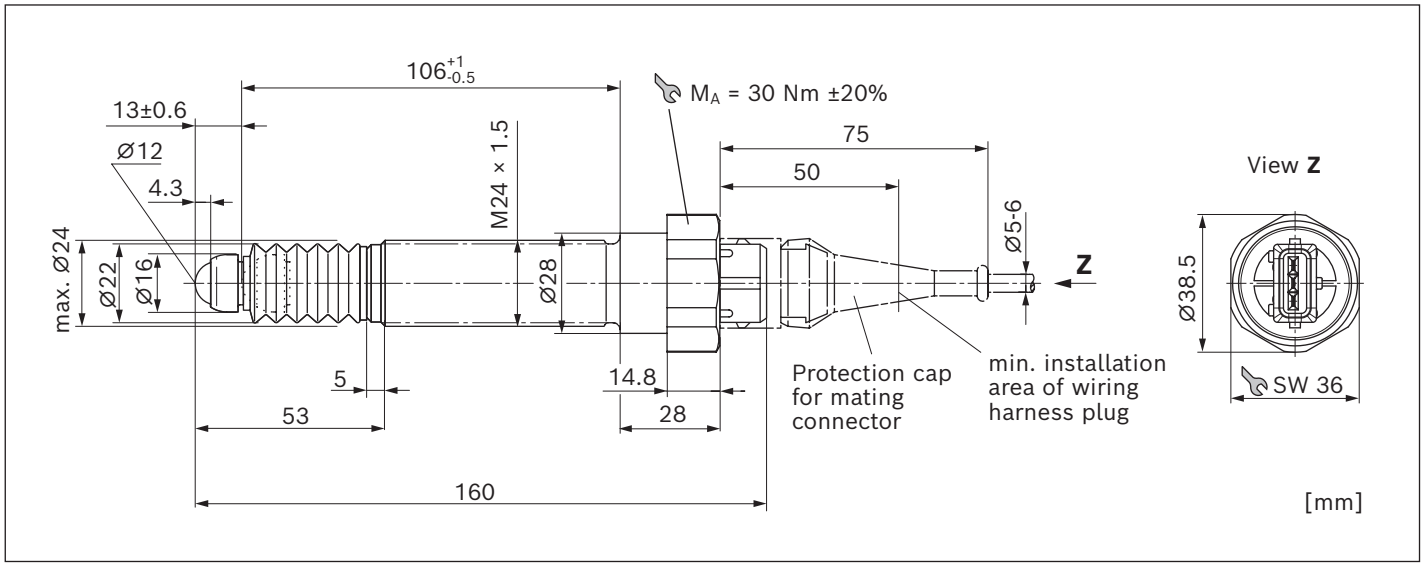
Pin Assignment



Pin	Connection	
1	GND	Signal ground
2	U_{sig}	Signal voltage
3	U_{sup}	Supply voltage

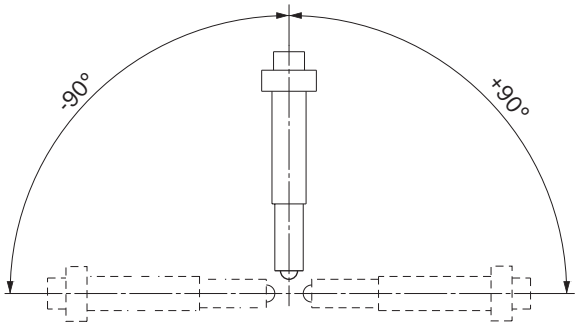
The mating connector is not included in the scope of delivery. This can be supplied by Bosch Rexroth on request.

Dimensions

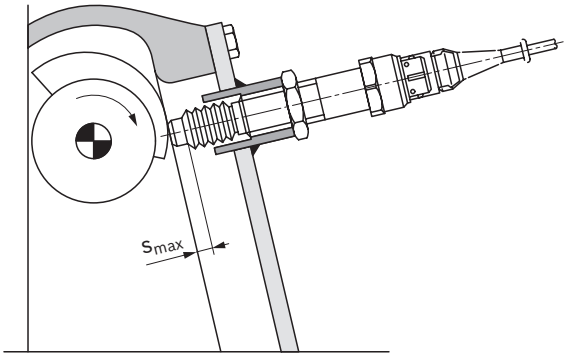


Project planning information

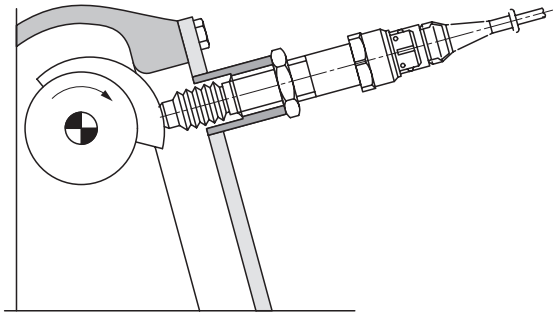
Installation position



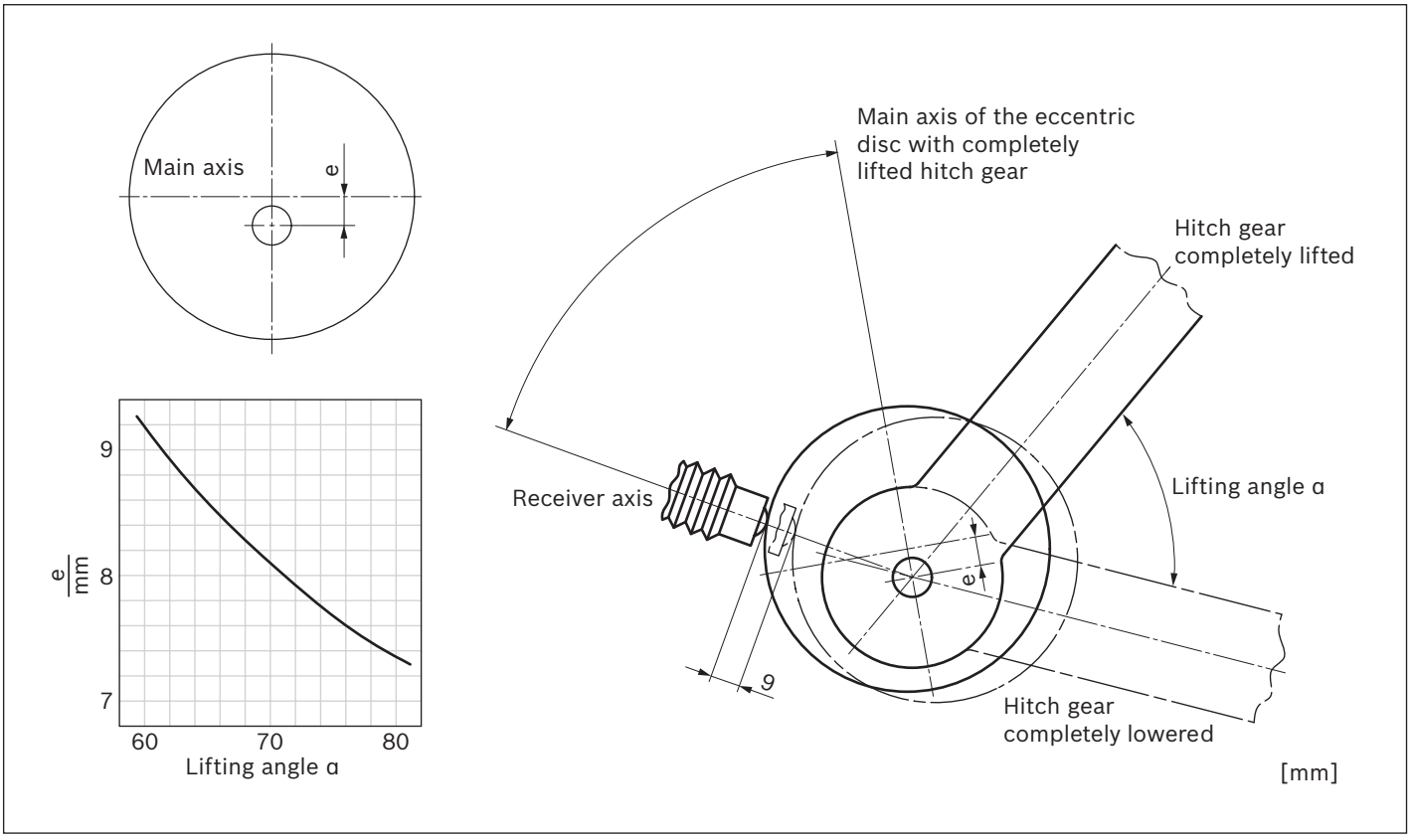
Variant 1: inverted characteristic



Variant 2: standard (increasing characteristic)



Dimensions: Excenter for position control



Accessories

Mating connector R917000515[1)]

Designation	Number	Ordering No.
Housing	1	1928402579 [2)]
Protective cap	1	1280703022 [2)]
Contacts	3	929939 [3)]
Single-wire seal (wire size 0.5 ... 1 mm²)	3	828905-1 [3)] at FLK cable type
	3	828904-1 [3)] at FLKr, FLX cable

1) The mating connector is not included in the scope of delivery.
2) Available from Bosch
3) Available from AMP

Safety-related characteristics according to ISO 25119

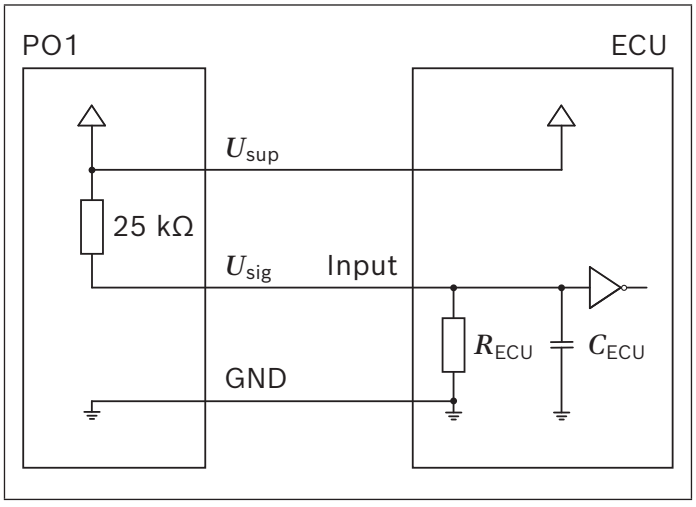
Safety function of the position sensor PO1 is defined as the system integrity, i.e. PO1 shall sense and calculate its axial movement correctly and convert it into corresponding analog voltage output without failure.

- PO1 possesses a Category B architecture (single channel)
- PO1 fulfills the requirements of basic and well-tried safety principles
- PO1 contains no safety-related software

Temperature Profile and $MTTF_D$ and DC

Temperature [°C]	Self heating [°C]	Working hours [%]	$MTTF_D$ [years]	DC[1)] [%]
10	5	2		
20	5	2		
30	5	12		
40	5	13		
50	5	17	741	41
60	5	18		
70	5	15		
80	5	15		
85	5	6		

Failure detection possibilities



PO1 contains an internal resistance of 25 KΩ between the supply voltage U_{sup} and the output signal U_{sig}. At an open circuit failure of the PO1 GND cable, the PO1 internal resistance will work with the ECU internal input resistance R_{ECU} as a voltage divider and results in a U_{sig} that is less than U_{sup} but dependent of the R_{ECU}. During machine system integration, an open circuit failure of the PO1 GND cable shall be simulated and the corresponding PO1 output signal ($U_{OC\text{-}GND}$) shall be measured. Please make sure (e.g. by adding additional resistors) that

- PO1 x x 10 25/20:
  $U_{OC\text{-}GND}$ > 85% U_{sup}
- PO1 x x 05 15/20:
  $U_{OC\text{-}GND}$ > 89% U_{sup}
- PO1 2 S 05 25/20:
  $U_{OC\text{-}GND}$ > 85% U_{sup}

1) It is assumed that the machine control unit will
   – monitor the sensor power supply, and switch off the sensor in case of overcurrent, over- and undervoltage.
   – react to the sensor out of range signal, and bring the machine into safe state.

Failure reaction

Failure	Failure reaction	Failure response time
Connector/ wire break of U_{sig}, and/or PO1 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} < 5% U_{sup}	immediate
U_{sig} short circuit to U_{sup} and/or PO1 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} = U_{sup}	immediate
U_{sig} short circuit to GND and/or PO1 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} = 0 V	immediate
Connector/ wire break of U_{sup}, and/or PO1 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} < 5% U_{sup}	250 ms
Connector/ wire break of GND, and/or PO1 internal failures that lead to the same effect	Sensor output out-of-range:	
	PO1 x x 10 25/20 and PO1 2 S 05 25/20: U_{sig} > 85% U_{sup}	250 ms[1)]
	PO1 x x 05 15/20: U_{sig} > 89% U_{sup}	250 ms[2)]

1) Valid for control unit with
R_{ECU} = 50 kΩ and C_{ECU} = 100 nF
2) Valid for control unit with
R_{ECU} = 600 kΩ and C_{ECU} = 100 nF

Safety Instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modifications or repairs to the wiring could lead to dangerous malfunctions.
- The sensor may only be assembled/disassembled in a deenergized state.
- Only trained and experienced specialists who are adequately familiar with both the components used and the complete system should implement system developments or install and commission electronic systems for controlling hydraulic drives.
- When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- Do not use defective components or components not in proper working order. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to consider all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- Furthermore, the responsibility of the above mentioned companies for machine EMC testing remains unaffected in principle.
- The use of sensors by private users is not permitted, since these users do not typically have the required level of expertise.

Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- The connector of the sensor is to be unplugged during electrical welding and painting operations.
- Cables/wires must be sealed individually to prevent water from entering the sensor.
  Notes on transport and storage
- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- If it is dropped, the sensor must not be used any longer, as invisible damage could have a negative impact on reliability.

Notes on wiring and circuitry

- Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The sensor mating connector must only be plugged and unplugged when it is in a deenergized state.
- The sensor lines are sensitive to spurious interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and approved in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.

- Use outside of the specified and approved boundary conditions may result in danger to life and/or cause damage to components which could result in sequential damage to the mobile working machine.

Improper use

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

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 machine safety-related system and to determine the suitability of PO1 for any machine safety functions.
  - PO1 as a single component fulfills the requirements of ISO 25119 AgPL b, restricted by DC=“low”. However, if used as part of a Category 2 safety-related system, where the behavior of the PO1 is monitored by the machine control unit, it is capable to support a safety level up to AgPL c.
  - PO1 failure responses are listed in the table "Failure reaction" in the chapter "Failure detection possibilities". PO1 shall not be used if the failure responses including the response time is determined to be insufficient for the machine safety functions.
- The machine control system shall monitor the sensor power supply, and switch off the sensor in case of overcurrent, over- and undervoltage.
- The machine control system shall monitor the sensor output and react to the out-of-range signals properly (e.g. bring the machine into safe state).
- If the PO1 is operated outside the mechanical specification, this can result in damage and/or breakage of the sensor, which can lead to wrong sensor output signals. Appropriate methods shall be implemented by the customer to prevent and detect these failures.
- An efficient field observation process shall be established by the customer. Any field failures involving the PO1 should be immediately notified to Bosch Rexroth, even if it is not covered by warranty.

Disposal

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

Further information

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

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RE 95171/2024-03-13
Replaces: 2023-03-06

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BODAS Draft sensor DP1-25

- Sensor for draft measurement

Features

- Draft sensor according to Category 2 rear three-point attachment (ISO 730-1)
- Sensor element with hall-effect measuring principle
- Integrated electronics
- Output signal ratiometric for supply voltage
- Output signal proportional to draft
- Zero point and sensitivity are calibrated

Inhalt

Ordering code

01	02	03	04	05	06		07		08
DP1	**25**		**05**	**1**	**A**	**/**	**10**	**–**	

Type

01	Draft measurement pin	**DP1**

Diameter

02	∅25	**25**

Load range

03	±12.5 kN	**012**
	±15 kN	**015**
	±25 kN	**025**

Supply voltage

04	5 ±0.5 V	**05**

Cable version

05	Cable without protective sleeve	Straight	**1**
		90° angular	**2**

Connector

06	AMP connector, 3-pin	**A**

Series

07		**10**

Cable length

08	170 mm	**01**
	250 mm	**02**
	1500 mm	**15**

Available variants

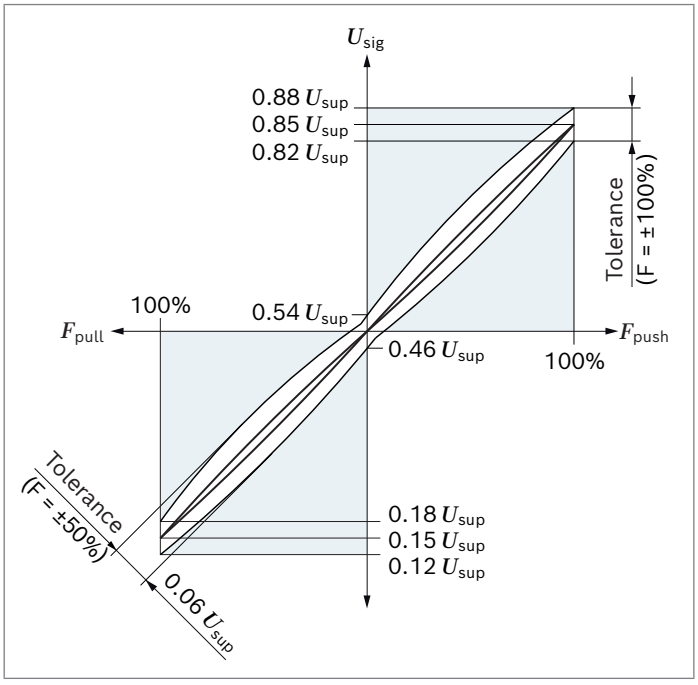
Type	Material number
DP1 25 012 05 1 A / 10 – 02	R983089156
DP1 25 012 05 1 A / 10 – 15	R983072445
DP1 25 015 05 1 A / 10 – 15	R983072446
DP1 25 025 05 1 A / 10 – 15	R983072447
DP1 25 012 05 2 A / 10 – 01	R917013907

Further variants on request.

Description

The draft sensor is designed as a bearing bolt for the upper link of a tractor hitch. The sensor is flexed between two bearings by the operational force. This deflection is recorded using the magnet hall system.
The output voltage is proportional to the acting draft. The signal is amplified in an integrated evaluation circuit.
The sensor supplies a ratiometric output voltage (15% to 85% of supply voltage). It is available with various measurement ranges. This sensor is a typical part of an electro-hydraulic hitch control (EHC).
This sensor is designated for the use in agricultural applications.

▼ **Characteristic curve**

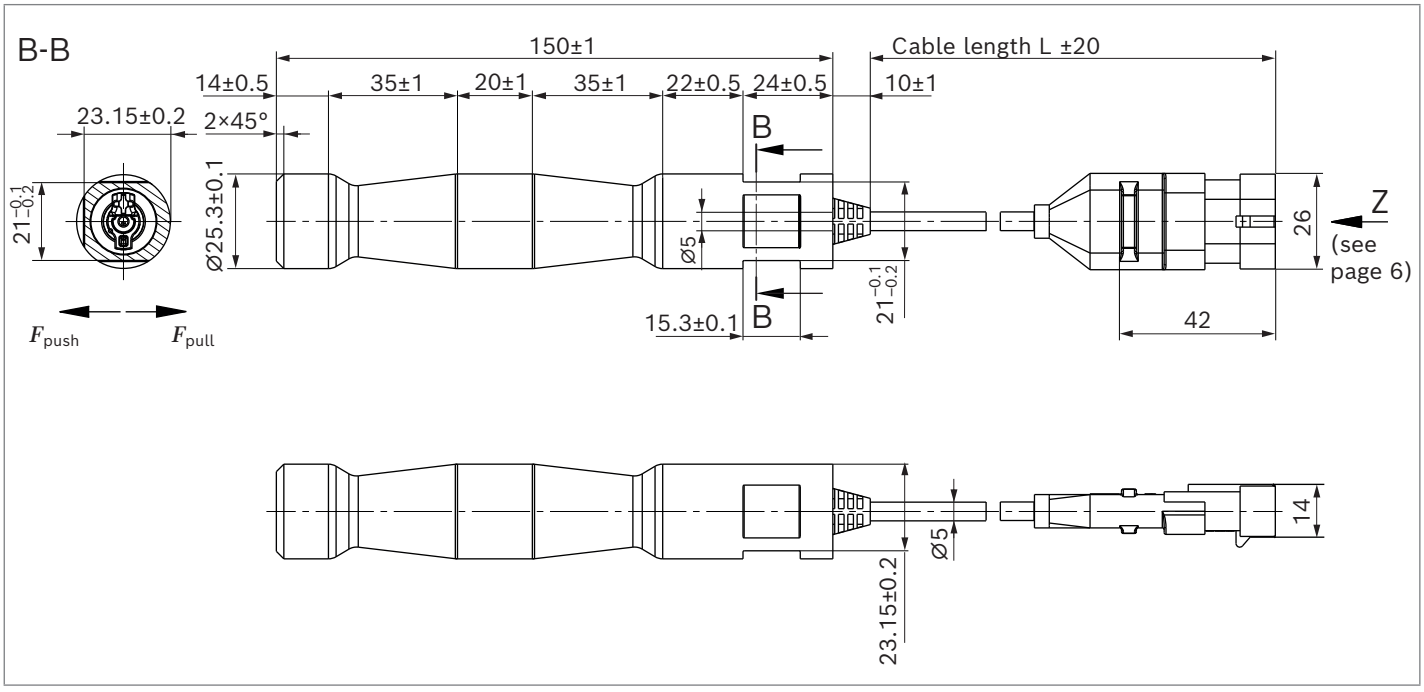


Technical data

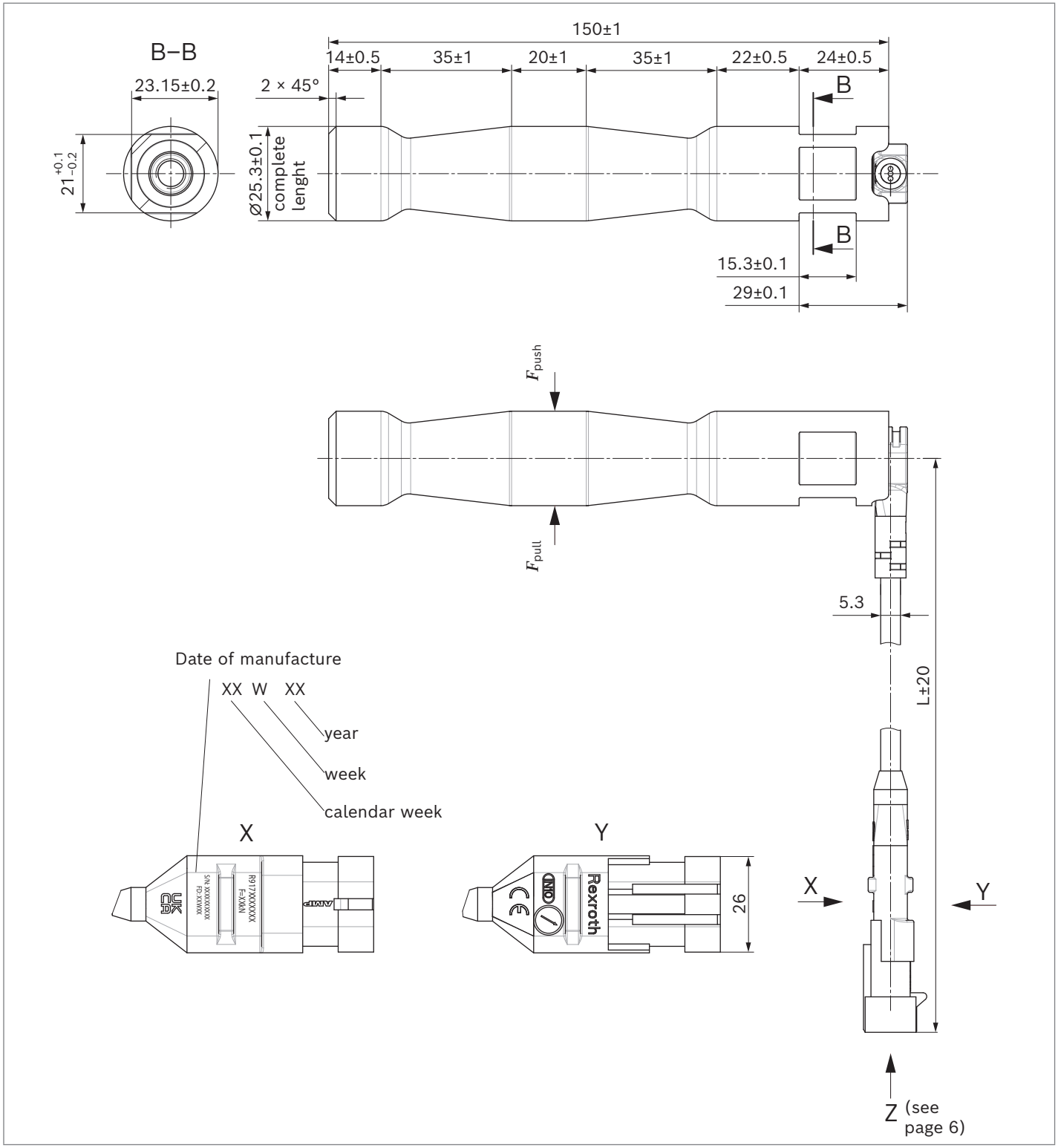
Type			**012**	**015**	**025**
Load range F			±12.5 kN	±15 kN	±25 kN
Standard overload range			±50 kN		
Supply voltage U_{sup}			5 ±0.5 V		
Signal voltage U_{sig}			15% to 85% U_{sup}		
Load resistance to ground			≥ 10 kΩ		
Operating temperature range			–40 °C to +85 °C		
Type of protection with installed mating connector			IP67 and IP69K, DIN EN 60068-2-27:2010, DIN EN 60068-2-6:2008 and DIN EN 60068-2-64:2009		
Mating connector			3-pin connector with single-wire seal		
Electromagnetic compatibility EMV according to ISO 11452-2:2004 according to ISO 11452-4:2001			400 MHz to 1 GHz: 200 V/m ≤ ±0.5% U_{sup} 1 GHz to 4 GHz: 100 V/m ≤ ±0.5% U_{sup} 1 MHz to 400 MHz: 100 mA		
Hysteresis			6%		
Linearity			4%		
Zero offset during lifetime caused by temperature fluctuations			8%		
Storage time			5 years at an average relative humidity of 60% and a temperature between -10 °C and +30 °C. For short periods of time, a storage temperature of -20 °C to +40 °C is permissible for up to 100 hours.		
Functional safety according to ISO 25119			The sensor can support a machine safety function up to incl. AgPL c (according to ISO 25119:2018)		
Conformity according to	EMC directive 2014/30/EU with CE mark		Applied standards: EN ISO 14982:2009		
	EU-RoHS2				
Current consumption			≤ 15 mA		
ESD	Contact		8 kV		
	Air		25 kV		
	Networks:	Power ON test	330 pF/2 kΩ		
		Unpowered test	150 pF/ 2000 Ω		
Signal delay time			0.5 ms		
Clamping voltage			5% and 95% from U_{sup}		
Resolution			8 bit		

Dimensions

▼ **DP1-25 with straight cable version**

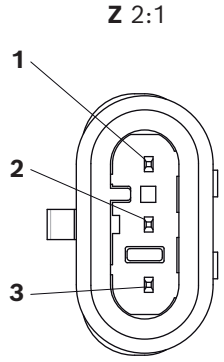


▼ **DP1-25 with 90° angular cable version**



Connector AMP Superseal

▼ **Pin assignment**

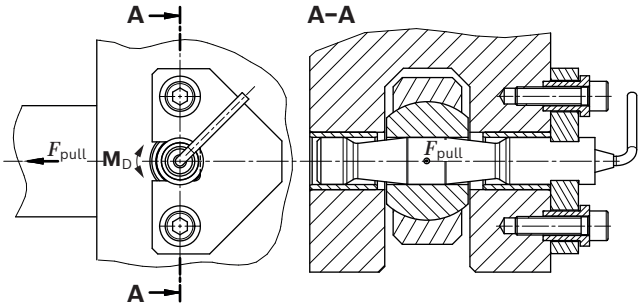


1 Ground GND
2 Output
3 Supply voltage 5 V±5%

Mating connector R902602132[1)]

Designation	Ordering code	Quantity
Socket housing	AMP 282087-1	1
Socket contacts	AMP 183025-1	3
Single-wire seals	AMP 281934-2	3

Installation drawing



- See installation drawing RA51761184, to minimize measuring uncertainties
- Defined draft application, e.g., ball bushing
- Floating mount in radial direction with key plate

1) The mating connector is not included in the scope of supply.

Safety-related characteristics in accordance with ISO 25119

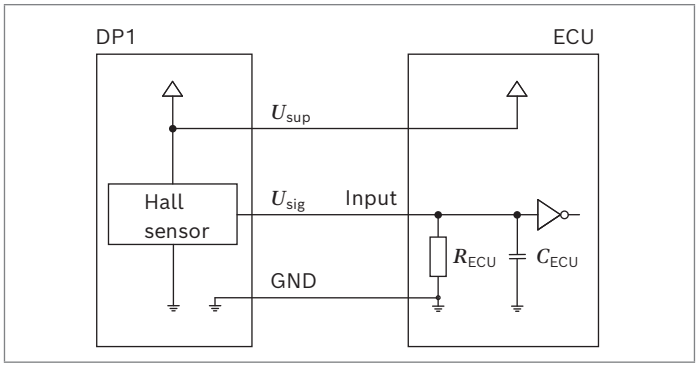
Safety function of the draft sensor DP1-25 is defined as the system integrity, i.e. DP1-25 shall sense and calculate the force applied on it correctly and convert the force into corresponding analog voltage output without failure.

- DP1-25 possesses a Category 1 architecture (single channel)
- DP1-25 fulfills the requirements of basic and well-tried safety principles
- DP1-25 contains no safety-related software

▼ **Temperature profile and $MTTF_D$ and DC_{avg}**

Temperature [°C]	Self heating [°C]	Working hours [%]	$MTTF_D$ [years]	DC_{avg} [%]
10	5	2		
20	5	2		
30	5	3		
40	5	3		
50	5	12.5	1361	67[1)]
60	5	12.5		
70	5	20		
80	5	25		
85	5	20		

▼ **Failure detection possibilities**



In case of an open circuit failure of the GND cable, output U_{sig} of the DP1-25 is dependent of the ECU internal resistor R_{ECU}. During machine system integration, an open circuit failure of the GND cable shall be simulated and the corresponding output signal ($U_{OC\text{-}GND}$) of the DP1-25 shall be measured. Please make sure (e.g. by adding additional resistors) that $U_{OC\text{-}GND}$ > 95% U_{sup}.

1) It is assumed that the machine control unit will
- Monitor the sensor supply voltage, and switch off the sensor in case of overcurrent, over- and undervoltage.
- React to the sensor out of range signal, and bring the machine into machine safe state

Failures of the DP1-25 that will cause out-of-range output signals and therefore detectable by the machine control system are listed in the following table:

Failure	Failure reaction	Failure response time
Connector/ wire break of U_{sig}, and/or DP1-25 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} < 5% U_{sup}	immediately
U_{sig} short circuit to U_{sup} and/or DP1-25 internal failures that lead to the same effect	Sensor output out-of-range: : U_{sig} = U_{sup}	immediately
U_{sig} short circuit to GND and/or DP1-25 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} = 0 V	immediately
Connector/ wire break of U_{sup}, and/or DP1-25 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} < 5% U_{sup}	5 ms[1)]
Connector/ wire break of GND, and/or DP1-25 internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} > 95% U_{sup}	5 ms[1)]
Hall IC internal failures	Sensor output out-of-range: U_{sig} < 4% U_{sup}	5 ms

1) Failure response time is valid for control unit with R_{ECU} ≥ 50 kΩ and C_{ECU} = 100 nF

Safety instructions

General Instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- It is not permissible to open the sensor or to modify or repair the sensor. Modifications or repairs to the wiring could result in dangerous malfunctions.
- The sensor may only be assembled/disassembled in depressurized and deenergized state.
- System developments, installation and commissioning of electronic systems for controlling hydraulic drives must only be carried out by trained and experienced specialists who are sufficiently familiar with both the components used and with the complete system.
- While commissioning the sensor, the machine may pose unforeseen dangers. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine‘s danger zone.
- No defective or incorrectly functioning components may be used. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to take into account all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- The use of sensors by private users is not permissible, since these users do not typically have the required level of expertise.

Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficiently large distance to radio systems must be maintained.
- The connector of the sensor is to be unplugged during electrical welding and painting operations.
- Cables/wires must be sealed individually to prevent water from entering the device.

Notes on transport and storage

- Please inspect the device for any damages which may have occurred during transport. If there are obvious signs of damage, please immediately inform the transport company and Bosch Rexroth.
- If it is dropped, the sensor must not be used any longer as invisible damage could have a negative impact on reliability.
- The sensor must not be transported by holding it at the cable.

Notes on wiring and circuitry

- Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The sensor should only be plugged and unplugged when it is in a de-energized state.
- The sensor lines are sensitive to radiation interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be fixated so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting points).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and released in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.
- Use outside of the specified and released boundary conditions may result in danger to life and/or cause damage to components which could result in consequential damage to the mobile working machine.
- Serious personal injury and/or damage to property may occur in case of non-compliance with the appropriate regulations.

Improper use

- Any use of the sensor other than that described in chapter “Intended use“ is considered to be improper.
- Use in explosive areas is not permissible.
- Damages which result from improper use and/or from unauthorized, interference in the component not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the tractor and determining the possible tractor safety functions.
- It is customer’s responsibility to evaluate the complete safety-related system and to determine the suitability of DP1-25 for any tractor safety functions.
  - DP1-25 is able to support a safety level up to AgPL c, if integrated properly into a Category 2 tractor safety system following all relevant instructions in this datasheet.
  - The DP1-25 failure responses are listed in the table (page 6). It shall not be used if the failure responses including the response time is determined to be insufficient for the machine safety functions.
- The machine control system shall monitor the sensor supply voltage, and switch off the sensor in case of overcurrent, over- and undervoltage.
- The machine control system shall monitor the sensor output and react to the out-of-range voltages by bringing the machine into the safe state.
- If DP1-25 is operated outside the mechanical specification, this can result in a zero shift of the sensor output or even the breakage. Appropriate methods must be implemented by the machine manufacturer to prevent and detect these failures.
- An efficient field observation process shall be established by the customer. Any field failures involving the DP1-25 should be immediately notified to Bosch Rexroth, even if it is not covered by warranty.

Disposal

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

More detailed information

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

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RE 95170/2023-09-19
Replaces: 2023-04-18

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BODAS Draft sensor KMB

- Force measurement for hitch control and baling presses
- Measuring ranges ±25 kN to ±160 kN
- Output signal proportional voltage
- Supply voltage 5 V / 8 to 10 V
- Protection class up to IP67 / IP69K

Features

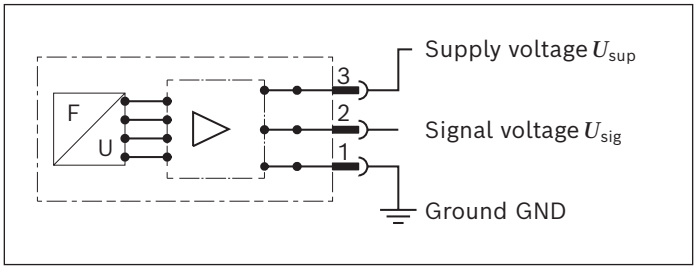
- Force sensor according to category 3 of ISO 730-1 rear-mounted three-point linkage
- Sensor element with magneto-elastic measurement principle
- Integrated electronics
- Output signal ratiometric and proportional to the force
- Zero point and sensitivity are calibrated

Contents

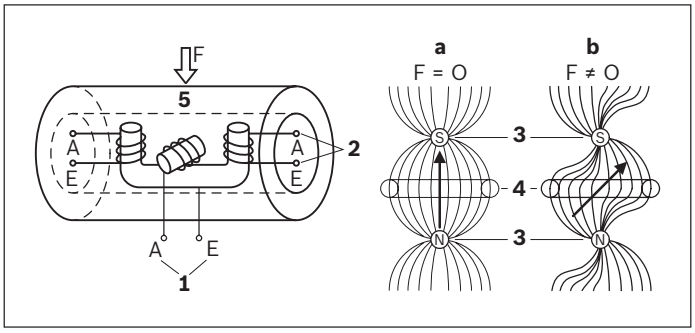
Product description

The force sensor is constructed as a bearing bolt. Shear stress arises at the bearing position which is analyzed as a magneto-elastic effect.
In the unloaded state a symmetrical magnetic field forms between the poles due to the primary coil. If tensile or compressive forces are introduced, the magnetic properties of the originally isotropic material change. The magnetic field becomes asymmetric as a result. This leads to a magnetic potential difference between the secondary poles. This causes a magnetic flux through the secondary circuit so that a voltage is induced in the secondary coils.
This voltage is proportional to the force that is exerted. It is amplified an rectified in an integrated evaluation circuit.
The sensor provides a ratiometric voltage (25 % to 75 % of the supply voltage). It is available for various measuring ranges and versions of cable. This sensor is a typical integral part of electro-hydraulic hitch control (EHC).
This sensor is intended for being used in agricultural technology.

▼ **Block diagram**



▼ **Functional principle**



1	Primary coil
2	Secondary coil
3	Primary pole area
4	Secondary pole area
5	Steel sleeve
a	Symmetrical magnetic field
b	Asymmetrical magnetic field

Type code

01	02	03	04	05		06	07
KMB					**/**	**30**	

Type

01	Force measurement pin	**KMB**

Load range

02	±25 kN	**025**
	±40 kN	**040**
	±50 kN	**050**
	±60 kN	**060**
	±90 kN	**090**
	±110 kN	**110**
	±150 kN	**150**
	±160 kN	**160**

Supply voltage

03	5 ±0.5 V	**05**
	8 V ... 12 V	**10**

Cable versions

04	Cable without protective sheath	**1**
	Cable with protective spiral sheath	**2**
	Cable with protective metal sheath	**3**
	Cable with protective plastic sheath	**4**

Connector

05	AMP JPT Connector, 3-pin	**A**
	DEUTSCH connector; 3-pin	**B**
	AMP Superseal 1.5	**C**

Series

06		**30**

Cable length

07	800 mm	**08**
	965 mm	**09**
	1000 mm	**10**
	1500 mm	**15**
	1600 mm	**16**
	1800 mm	**18**
	2700 mm	**27**

Available variants

Type	Material number
KMB 025 05 1A/30–15	R917007592
KMB 025 05 4A/30–08	R917008079
KMB 025 05 4A/30–15	R917008045
KMB 025 10 1A/30–15	R917000161
KMB 025 10 4A/30–08	R917000177
KMB 025 10 4A/30–10	R917000158
KMB 025 10 4A/30–15	R917000175
KMB 040 05 1A/30–15	R917008099
KMB 040 05 3A/30–15	R917008667
KMB 040 05 4A/30–18	R917008003
KMB 040 10 1A/30–15	R917000153
KMB 040 10 2A/30–27	R917000160
KMB 040 10 3A/30–15	R917000155
KMB 040 10 3A/30–15	R917001320
KMB 040 10 4A/30–08	R917000167
KMB 040 10 4A/30–16	R917000159
KMB 040 10 4A/30–18	R917000180
KMB 050 05 2A/30–08	R917008224
KMB 050 05 2C/30–08	R917014886
KMB 050 10 2A/30–08	R917000157
KMB 060 05 1A/30–15	R917008098
KMB 060 10 1A/30–15	R917000154
KMB 060 10 2A/30–27	R917000164
KMB 060 05 3A/30–15	R917008077
KMB 060 10 3A/30–15	R917000156
KMB 060 05 4A/30–08	R917009962
KMB 060 05 4A/30–18	R917008060
KMB 060 10 4A/30–08	R917000166
KMB 060 10 4A/30–15	R917000173
KMB 060 10 4A/30–16	R917000165
KMB 060 10 4A/30–18	R917000181
KMB 090 10 1A/30–15	R917000168
KMB 090 10 1A/30–15	R917000171
KMB 090 10 2A/30–27	R917001969
KMB 090 05 3A/30– 15	R917008078
KMB 090 10 3A/30–15	R917000163
KMB 090 05 4A/30–18	R917008061
KMB 090 10 4A/30–15	R917000172
KMB 090 10 4A/30–18	R917000275
KMB 110 05 1A/30–15	R917005142

Type	Material number
KMB 110 10 1A/30–15	R917000179
KMB 110 10 2A/30–08	R917000162
KMB 150 10 1A/30–15	R917A05986

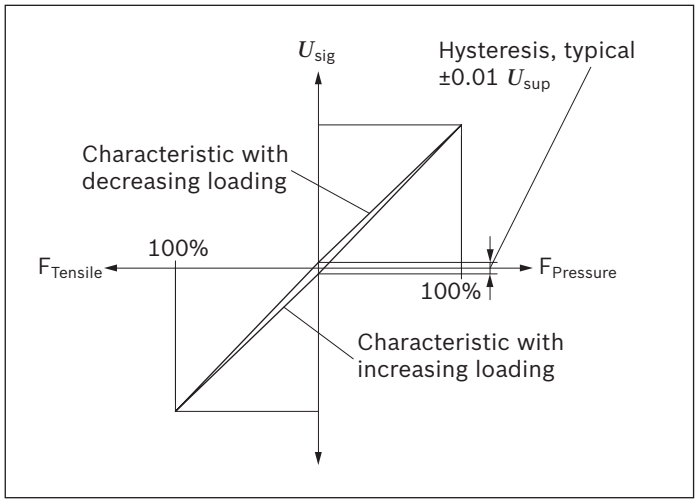
Further variants on request.

Technical data

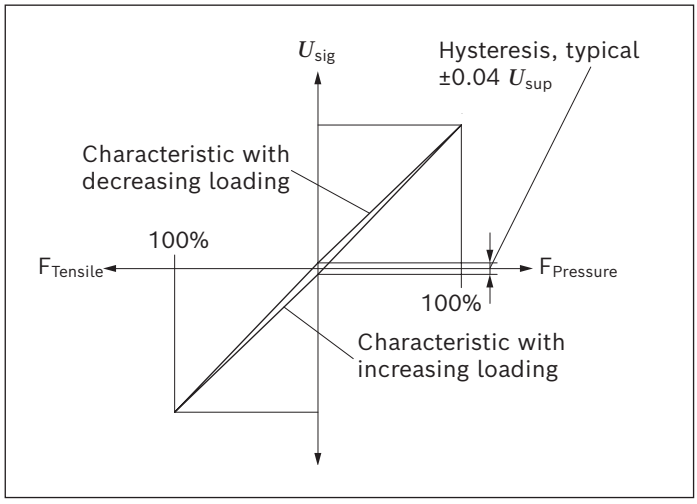
Type		**025**	**040**	**050**	**060**	**090**	**110**	**150**
Load range	F	±25 kN	±40 kN	±50 kN	±60 kN	±90 kN	±110 kN	±150 kN
Overload range: standard		±80 kN	±80 kN	±80 kN	±160 kN	±160 kN	±160 kN	±220 kN
Electrically measurable overload		+1.2 $F_{pressure}$ ... −1.5 $F_{tensile}$						
Supply voltage	U_{sup}	8 ... 10 V controlled voltage (no direct supply from the vehicle electrical system (battery)) or 5±0.5 V						
Supply current	I_{sup}	5±0.5 V: inrush current = 1A; operating current = 20 mA (pulsed between -20 and 40 mA) 8 ...10 V: inrush current = 3A; operating current = 40 mA (pulsed between -40 and 90 mA)						
Signal voltage	U_{sig}	25% ... 75% U_{sup} at 8 ... 10 V; 15% ... 85% U_{sup} at 5±0.5 V						
Lower clamping voltage	$U_{Clamp\ Low}$	8% U_{sup} at 8 ... 10 V; 12% U_{sup} at 5±0.5 V						
Upper clamping voltage	$U_{Clamp\ High}$	92% U_{sup} at 8 ... 10 V; 88% U_{sup} at 5±0.5 V						
Load resistance		≥ 10 kΩ (≥ 50 kΩ, if used in safety-related applications, where GND wire break shall be detected)						
Characteristic curve		1	1	1	2	2	2	2
Hysteresis		See offer drawings						
Operating temperature range		-35 ... +85 °C						
Maximum temperature for drying process for painting:		+130 °C at max. 2 hrs						
Type of protection with installed mating connector	AMP JPT	IP67 and IP69K						
	AMP Superseal 1.5	IP69K						
	DEUTSCH	IP66K						
Vibrational load		24 g						
Mating connector		3-pin connector with single-wire seal						
Electromagnetic compatibility	ISO 11452-5 2002-04; 1 MHz ... 2 GHz	150 V/m ≤ ±0.5% U_{sup}						
CE		ISO 14982:2009						
Storage time		5 years at an average relative humidity of 60 % and a temperature between -10 °C and +30 °C. For short periods of up to 100 hours a storage temperature of -20 °C to +40 °C is permissible						

Diagrams/characteristic curves

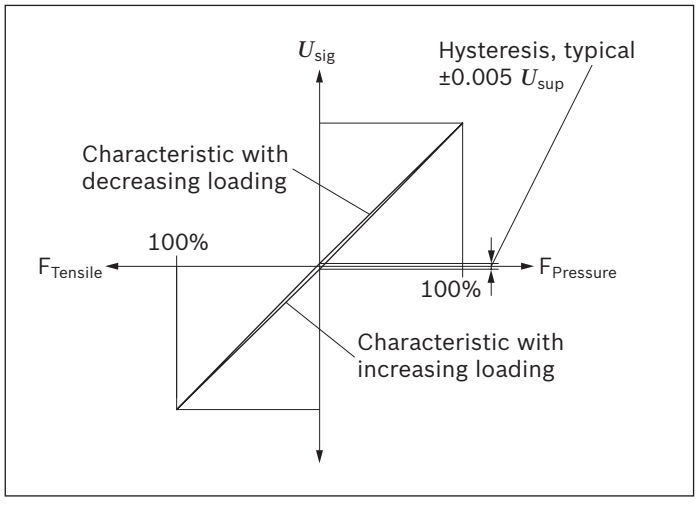
▼ **Characteristic curve 1 (load range up to 50 kN or 5 V versions)**



▼ **Characteristic curve 1 for AMP Superseal 1.5 (load range up to 50 kN)**



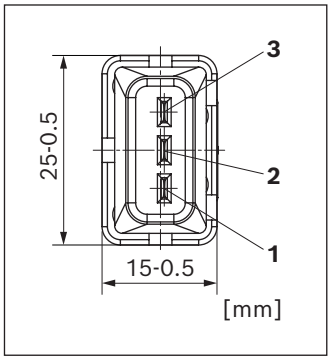
▼ **Characteristic curve 2 (load range from 60 kN)**



Electrical connection

Connector

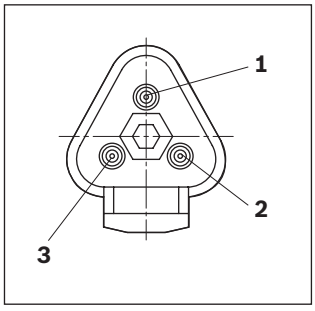
▼ **Pin Assignment AMP JPT**



Connecting U_{sup} with GND will cause a short-circuit. The short-circuit current must not exceed 1 A. Therefore, the current in the system must be limited.

Pin	Connection	
1	Weight	GND
2	Signal voltage	U_{sig}
3	Supply voltage	U_{sup}

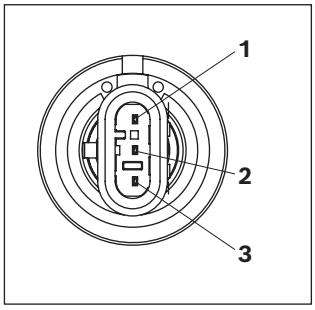
▼ **Pin assignment DEUTSCH**



Connecting U_{sup} with GND will cause a short-circuit. The short-circuit current must not exceed 1 A. Therefore, the current in the system must be limited.

Pin	Connection	
1	Supply voltage	U_{sup}
2	Signal voltage	U_{sig}
3	Weight	GND

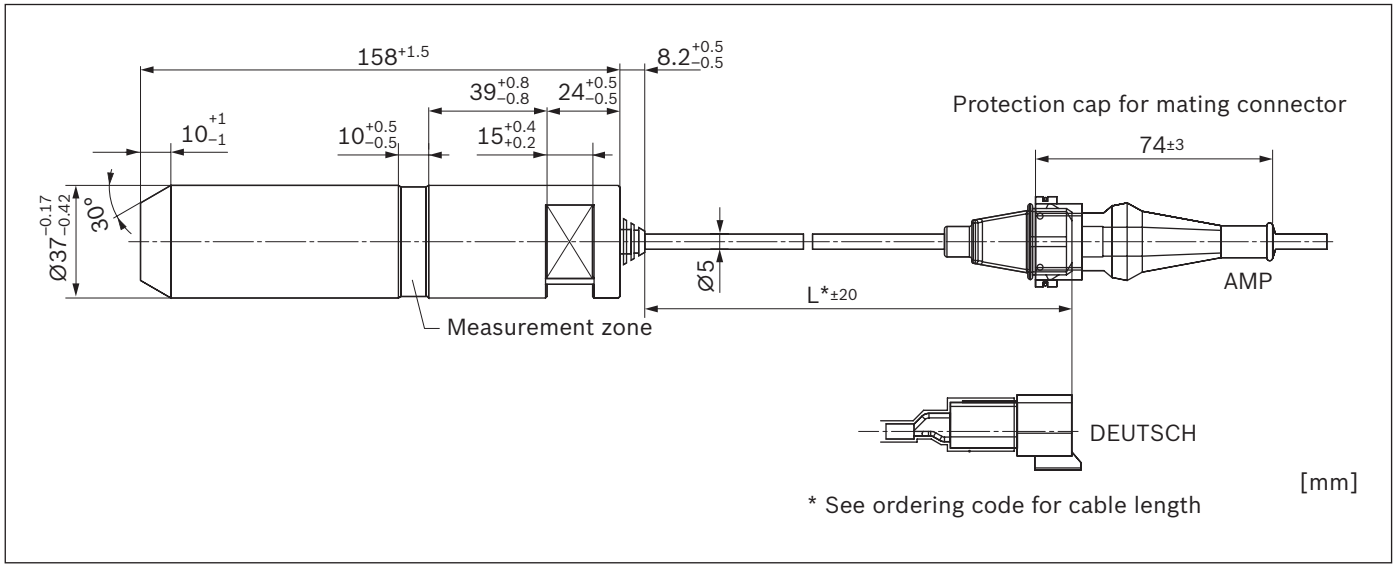
▼ **Pin assignment AMP Superseal 1.5**



Connecting U_{sup} with GND will cause a short-circuit. The short-circuit current must not exceed 1 A. Therefore, the current in the system must be limited.

Pin	Connection	
1	Weight	GND
2	Signal voltage	U_{sig}
3	Supply voltage	U_{sup}

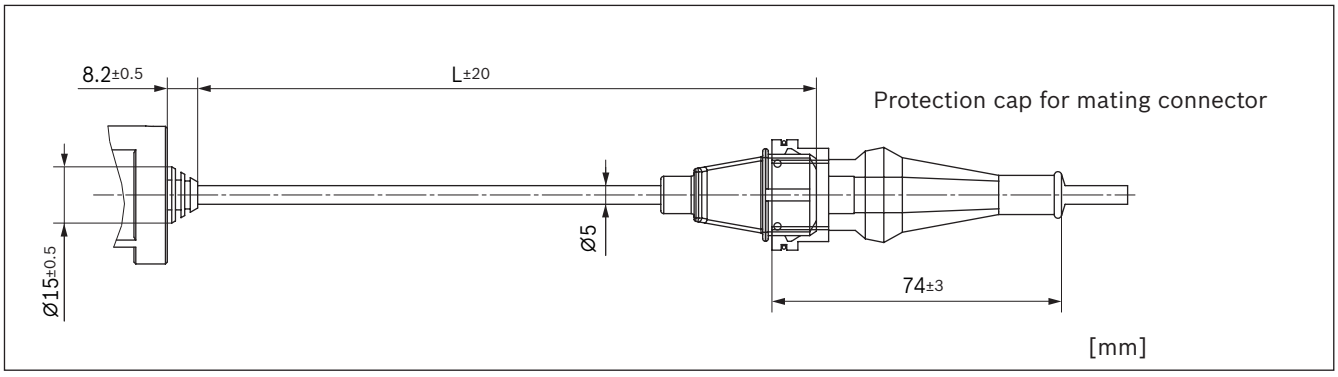
Dimensions


158+1.5
8.2+0.5 −0.5
39+0.8 −0.8
24+0.5 −0.5
10+1 −1
10+0.5 −0.5
15+0.4 +0.2
Protection cap for mating connector
74±3
Ø37−0.17 −0.42
30°
Ø5
L*±20
AMP
Measurement zone
DEUTSCH
[mm]
* See ordering code for cable length

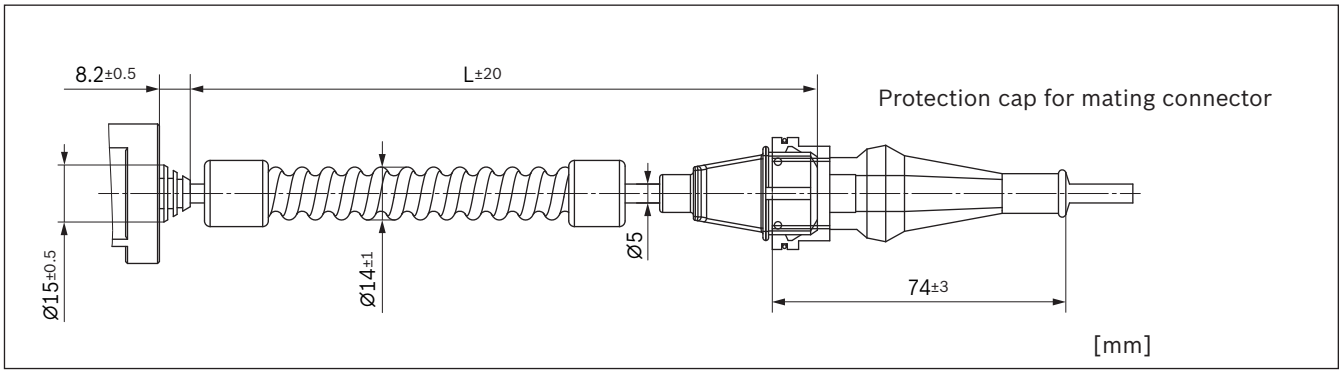
Project planning information

Cable versions

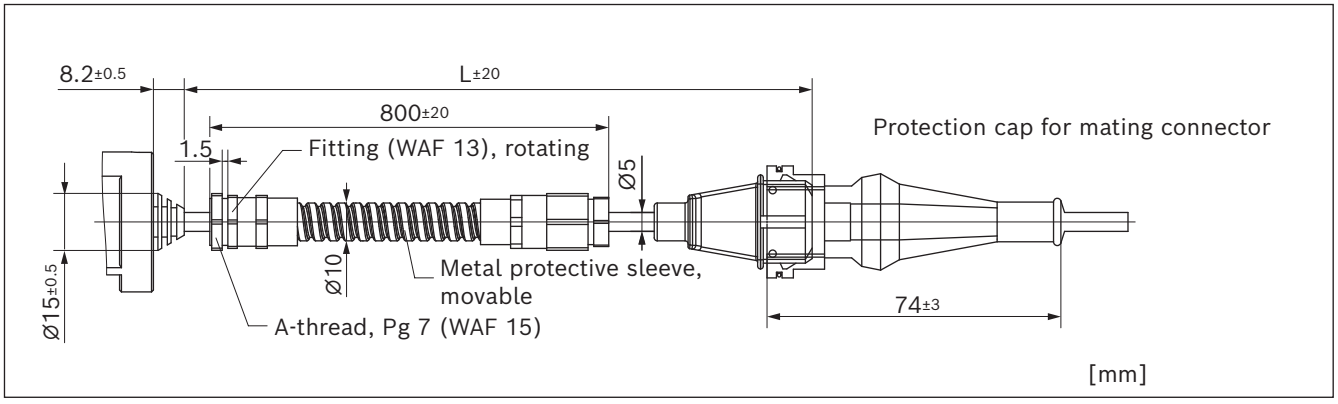
▼ Cable without protective sheath



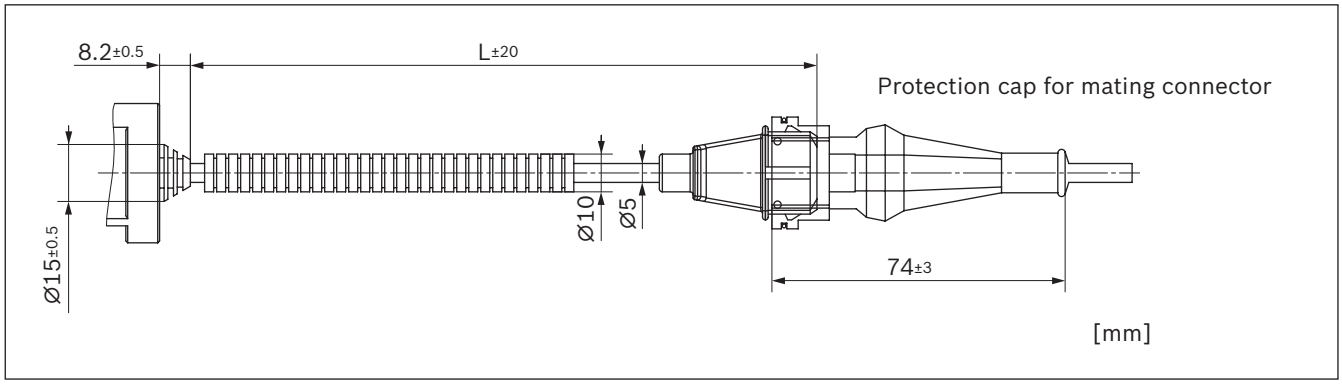
▼ Cable with protective spiral sheath



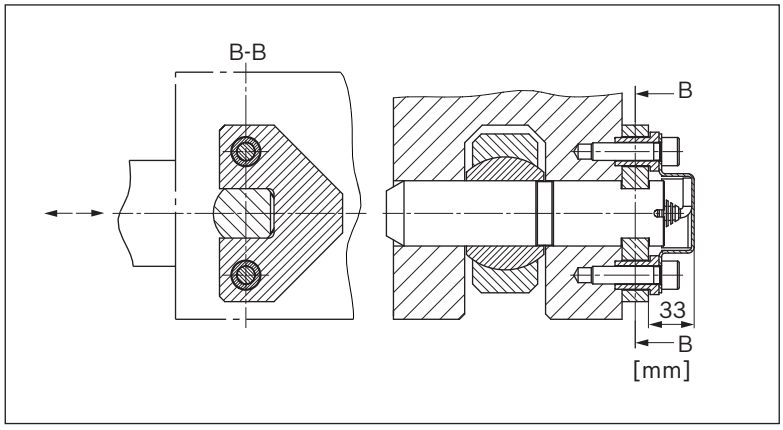
▼ Cable with protective metal sheath



▼ **Cable with protective plastic sheath**



Installation instructions



- ▶ See installation drawing Y 830 304 223 to avoid measurement uncertainties
- ▶ Defined force application, e.g. ball-type nipple
- ▶ Float mounting in radial direction with key plate

Information

Safety-related characteristics in accordance with ISO 25119:2018

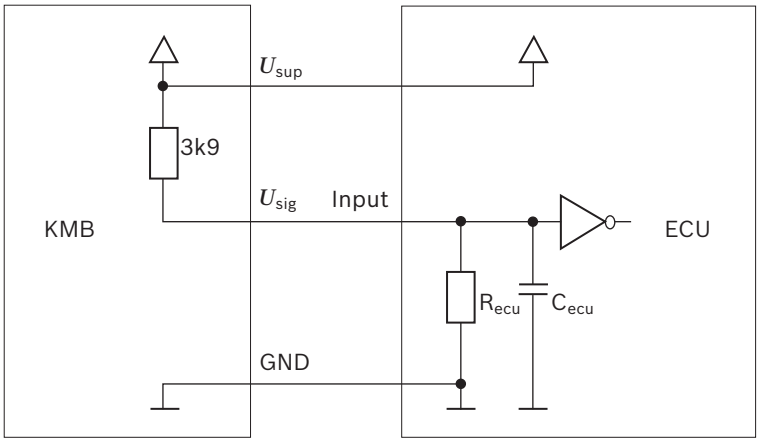
Safety function of the draft sensor KMB is defined as the system integrity, i.e. KMB should sense, calculate the force applied on it correctly and convert the force into corresponding analog voltage output without failure.

- The KMB possesses a Category B architecture (single channel)
- The KMB contains no safety-related software
- The KMB fulfills the requirements of basic and well-tried safety principles

Temperature profile and the corresponding $MTTF_D$ and DC_{avg}

Temperature (°C)	**Self heating** (°C)	**Working hours** (%)	**$MTTF_D$** (years)	**DC_{avg}**[1] (%)
10	5	2		
20	5	2		
30	5	12		
40	5	13		
50	5	17	738	35
60	5	18		
70	5	15		
80	5	15		
85	5	6		

1) It is assumed that the machine control unit will
   – monitor the sensor supply voltage, and switch off the sensor in case of over-current, over- and under-voltage.
   – react to the out of range sensor outputs, and bring the machine into machine safe state



Failure detection possibilities

The KMB contains an internal resistance of 3.9 kΩ between the U_{sup} and U_{sig}. At an open circuit failure of the KMB GND cable, the KMB internal resistance will work with the ECU internal input resistance R_{ECU} as a voltage divider and results in a U_{sig} that is dependent of the R_{ECU} but less than U_{sup}. During machine system integration, an open circuit failure of the KMB GND cable shall be simulated and the corresponding KMB output signal ($U_{OC\ GND}$) shall be measured. Please make sure (e.g. by adding additional resistors) that $U_{OC\ GND}$ > 92% U_{sup}.

Failures of the KMB that will cause out-of-range output signals and therefore detectable by the machine control system is listed in the following table:

Failure	Failure reaction	Failure response time
Connector/ wire break of U_{sig}, and/or KMB internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} < 8% U_{sup}	immediate
U_{sig} short circuit to U_{sup} and/or KMB internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} = U_{sup}	immediate
U_{sig} short circuit to GND and/or KMB internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} = 0 V	immediate
Connector/ wire break of U_{sup}, and/or KMB internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} < 8% U_{sup}	250 ms[1)]
Connector/ wire break of GND, and/or KMB internal failures that lead to the same effect	Sensor output out-of-range: U_{sig} > 92% U_{sup}	250 ms[1)]

1) Failure response time valid for control unit with R_{ECU} = 50 ... 200 kΩ and C_{ECU} = 100 nF

Accessories

AMP JPT mating connector R917000515[1)]

Designation	Number	Ordering details	
Housing	1	1928402579[2)]	
Protective cap	1	1280703022[2)]	
Contacts	3	929939[3)]	
Single-wire seal (wire size 0.5 ... 1 mm²)	3	828 905-1[3)]	at FLK cable type
	3	828 904-1[3)]	at FLKr, FLX cable

AMP Superseal 1.5 mating connector[4)]

Designation	Number	Ordering details
Housing	1	282 087-1[5)]
Contacts	3	183 035-1[5)]
Single-wire seal	3	281934-4 [5)]

DEUTSCH mating connector[6)]

Designation	Ordering details
Plug-in connection	DEUTSCH DT 04-3P[7)]
Wedge locking	DEUTSCH W 3P[7)]
Contacts	DEUTSCH 0460-202-16141[7)]

1) The mating connector is not included in the scope of delivery.
2) Available from Bosch
3) Available from AMP
4) The mating connector is not included in the scope of delivery.
5) Available from AMP
6) The mating connector is not included in the scope of delivery.
7) Available from DEUTSCH

Safety Instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modifications or repairs to the wiring could lead to dangerous malfunctions.
- The sensor may only be assembled/disassembled in a deenergized state.
- Only trained and experienced specialists who are adequately familiar with both the components used and the complete system should implement system developments or install and commission electronic systems for controlling hydraulic drives.
- When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- Do not use defective components or components not in proper working order. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to consider all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- The use of sensors by private users is not permitted, since these users do not typically have the required level of expertise.

Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g., exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- Cables/wires must be sealed individually to prevent water from entering the sensor.

Notes on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- If it is dropped, the sensor must not be used any longer, as invisible damage could have a negative impact on reliability.

Notes on wiring and circuitry

- Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The sensor mating connector must only be plugged and unplugged when it is in a deenergized state.
- The sensor lines are sensitive to spurious interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and approved in this data sheet, particularly with regard to voltage, current, temperature, vibration, shock and other described environmental influences.
- Use outside of the specified and approved boundary conditions may result in danger to life and/or cause damage to components which could result in sequential damage to the mobile working machine.
- Serious personal injury and/or damage to property may occur in case of non-compliance with the appropriate regulations.

Improper use

- Any use of the sensor other than that described in the chapter "Intended use" is considered to be improper.
- Use in explosive areas is not permitted.
- Damages which result from improper use and/or from unauthorized, unintended interventions in the device not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the machine and determining the possible machine safety functions.
- It is customer’s responsibility to evaluate the complete safety-related system and to determine the suitability of KMB for any machine safety functions.
  - KMB as a single component fulfills the requirements of ISO 25119:2018 AgPL b, restricted by DC. However, if used as part of a Category 2 machine safety-related system, where a better DC could be reached via monitoring by the logic subsystem and/or additional test concepts, it is capable to support a safety level up to AgPL c.
  - The KMB failure responses are listed in the table above. The KMB shall not be used if the failure responses including the response time is determined to be insufficient for the machine safety functions.
- The machine control system shall monitor the sensor supply voltage, and switch off the sensor in case of over-current, over- and under-voltage.
- The machine control system shall monitor the sensor output and react to the out-of-range outputs by bring the machine into the safe state.
- If the KMB is operated outside the mechanical specification, this can result in a zero shift of the sensor output or even the breakage of the KMB. Appropriate methods must be implemented by the machine manufacturer to prevent and detect these failures.
- An efficient field observation process shall be established by the customer. Any field failures involving the KMB should be immediately notified to Bosch Rexroth, even if it is not covered by warranty.

Disposal

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

Further information

- Further information about the sensor can be found at www.boschrexroth.de/mobilelektronik.

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RE 95155/2024-06-11
Replaces: 2024-03-06

rexroth
A Bosch Company

BODAS Pressure sensor PR3

- Measurement ranges to 25, 50, 160, 200, 250, 400, 600 bar
- Ratiometric output signal 0.5 to 4.5 V with 5 V supply voltage
- Fixed output signal 0.5 to 4.5 V with 8 to 36 V supply voltage
- Output signal 25% to 75% supply voltage with 8 to 12 V supply voltage
- Type of protection: IP67 and IP69K

Features

- Thin-film measurement principle
- Compact dimensions for all pressure ranges
- Shock and vibration resistant
- EMC characteristics to 100 V/m
- High resistance to pressure spikes
- Very good resistance to temperature shock
- CE conformity

Content

Ordering code

01	02	03	04	05		06
PR3					**/**	**10**

Type

01	Pressure sensor	**PR3**

Measurement range

02	0 ... 25 bar	**025**
	0 ... 50 bar	**050**
	0 ... 160 bar	**160**
	0 ... 200 bar	**200**
	0 ... 250 bar	**250**
	0 ... 400 bar	**400**
	0 ... 600 bar	**600**

Mechanical connection		**25, 50, 160, 200, 250, 400**	**600**	
03	G1/4 A in according to DIN EN ISO 1179-2	●	●	**G**
	M14 x 1.5 according to ISO 6149-2	–	●	**M**

Electrical connection		**25, 50**	**160**	**200**	**250, 400**	**600G**	**600M**	
04	AMP Superseal 1.5	●	●	–	●	●	–	**S**
	DEUTSCH DT04-3P	–	–	–	–	–	●	**D**
	Jet connector	–	●	●	–	–	–	**J**

Supply	**Output signal**		**25, 50**	**160GS**	**160GJ**	**200**	**250, 400**	**600GS**	**600MD**	
05	5 ±0.5 V	0.5 ... 4.5 V ratiometric	●	●	–	–	●	●	–	**05**
	8 ... 36 V	0.5 ... 4.5 V fixed	–	–	–	–	–	–	●	**36**
	8 ... 12 V	25 ... 75% U_{sup}	–	–	●	●	–	–	–	**12**

Series

06		**10**

● = Available – = Not available

Available variants

Type							Material number	Minimum torque	Maximum torque
PR3	025	G	S	05	/	10	R917008819	25 Nm	30 Nm
PR3	050	G	S	05	/	10	R917008821	25 Nm	30 Nm
PR3	160	G	S	05	/	10	R917008822	25 Nm	30 Nm
PR3	250	G	S	05	/	10	R917008823	25 Nm	30 Nm
PR3	400	G	S	05	/	10	R917008824	25 Nm	30 Nm
PR3	600	G	S	05	/	10	R917008825	30 Nm	45 Nm
PR3	160	G	J	12	/	10	R917008828	25 Nm	30 Nm
PR3	200	G	J	12	/	10	R917008829	25 Nm	30 Nm
PR3	600	M	D	36	/	10	R917008826	30 Nm	45 Nm

Description

This sensor is used for measuring pressure in hydraulic circuits, but is also suitable for measuring all kinds of gases of fluid group 2 according to the pressure vessel directive up to 200 bar (e.g. air). Due to its outstanding characteristics, it is also ideally suited for use in mobile hydraulics: shock and vibration resistance, type of protection, resistance to pressure spikes, resistance to temperature shock, EMC characteristics (up to 100 V/m), and much more. The measurement principle uses a hermetically welded thin-film measurement cell, which ensures long-term leak resistance. The sensor signal can be directly evaluated by a BODAS controller RC.

Technical data

Type PR3		**025 GS05**	**050 GS05**	**160 GS05**	**250 GS05**	**400 GS05**	**600 GS05**	**600 MD36**	**160 GJ12**	**200 GJ12**
Pressure Equipment Directive		–	–	–	–	–	2014/68/EU	2014/68/EU	–	–
Measurement range	bar	0 ... 25	0 ... 50	0 ... 160	0 ... 250	0 ... 400	0 ... 600	0 ... 600	0 ... 160	0 ... 200
Bursting pressure	bar	125	250	800	1200	1700	2400	2400	800	1000
Output signal		0.5 ... 4.5 V, ratiometric						0.5 ... 4.5 V, fixed	25 ... 75% U_{sup}	
Supply voltage U_{sup}		5 ± 0.5 V						8 ... 36 V	8 ... 12 V	
Connector		AMP Superseal 1.5						DEUTSCH DT04-3P	Jet connector	
Parts contacting measuring materials		CrNi steel, HNBR								
Housing material		PPS GF40/CrNi steel								
Load resistance		4.5 kΩ, for Jet connectors however > 1 kΩ (see circuit diagram of signal evaluation on page 4)								
Maximum current consumption										
For voltage interface		≤ 5 mA without load								
Jet connector variants		≤ 10 mA without load								
Response time (10 ... 90%)		≤ 2 ms						2 ms	≤ 2 ms	
Overall accuracy		≤ ±2%								
Reproducibility		≤ 0.2% of tensioning								
Stability per year		≤ 0.3% of tensioning (with reference conditions)								
Medium temperature range		–40 ... +125 °C								
Ambient temperature range		–40 ... +100 °C								
Storage temperature range		–40 ... +120 °C								
Compensated range		0 ... +80 °C								
Middle temperature coefficient zero point		≤ 0.15 % of tensioning / 10K in compensated range								
Middle temperature coefficient of tensioning		≤ 0.15 % of tensioning / 10K in compensated range								
Temperature error in the nominal temperature range		≤ 1 % of tensioning typ. ≤ 1.5% of tensioning								
Electromagnetic compatibility EMC		100 V/m; Irradiation: ISO 11452-2 intensity IV; Emissions: DIN EN ISO 14982:2009 (ESD according to ISO 10605:2023-06 functional state C, ISO 7637 pulse 1: functional state C, ISO 7637 pulse 5: functional state B)								
Electrostatic discharge (ESD)[1)]		According to ISO 10605:2023-06			Contact discharge ±8 kV (powered up and unpowered)					
					Air discharge ±15 kV (powered up and unpowered)					

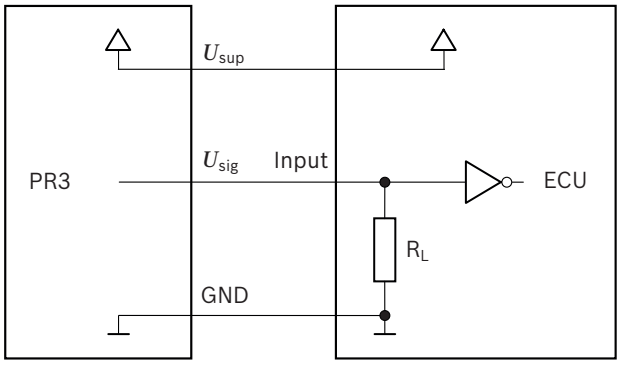
1) The control unit have to be insensitive to ESD pulses at the signal inputs, because the sensor does not actively suppress these pulses on the signal line.

Conformity according to	EMC directive 2014/30/EU with CE mark	Applied standards: DIN EN ISO 14982:2009 (ESD according to ISO 10605:2023-06 functional state C, ISO 7637 pulse 1: functional state C, ISO 7637 pulse 5: functional state B), ISO 13766-1:2019, EN 12895:2020
EU-RoHS	Compliance with RoHS substance restrictions using the exemptions according to RoHS directive 2011/65/EU	
E1 type approval	existing	
Pressure cycles over service life	20 million cycles (10% ... 90% of nominal pressure)	
Shock resistance	50 g (DIN EN 60068-2-27, 11 ms), 500 g (DIN EN 60068-2-27, 1 ms)	
Vibration resistance	20 g (DIN EN 60068-2-6, 5 ... 2000 Hz)	
Electrical protection	Protection from voltage reversal, short circuits and undervoltage; protection from overvoltage in the defined supply voltage range	
Type of protection with installed mating connector	AMP Superseal 1.5	IP67 and IP69K
	DEUTSCH DT04-3P	IP67
Weight	approx. 50 g	
Maximum storage period from manufacturing date	5 years at an average relative humidity of 60 % and a temperature between -10 °C and +30 °C. For short periods of up to 100 hours a storage temperature of -20 °C to +40 °C is permissible.	

▼ **The following oils are suitable for the PR3:**

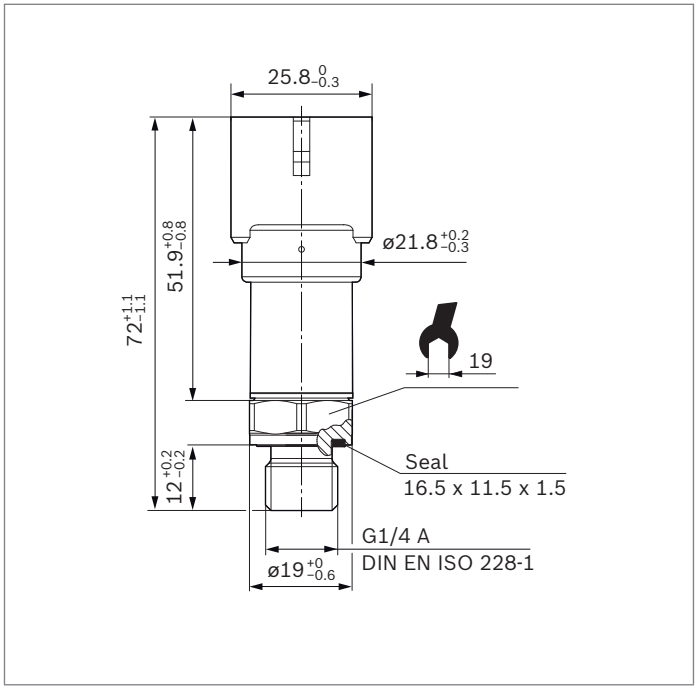
HETG, HEPG, HFE, HFB, HFC, HFA	
HEES:	Panolin HLP Synth 46
	Naturelle HF-E46
	Naturelle HFX 32
	Hydraulic HE 15
	Hydraulic HE 46
	Plantosyns Super S40
	Hydraulic oil based on mineral oils according to DIN 51524
	HLP according to DIN 51524
	Hydraulic oil HVLP 32/46/68 according to DIN 51524
	HD SAE 10 W 40
	HETG Fuchs Plantohyd 40/ Fragol TR46
	HEES Fuchs Plantosyns Super S40/ Fragol Hydraulic HE 15 + 46
	Motor oil according to API-C
	Motor oil according to API-CD
	Motor oil according to API-CF
	Colourant Renolin FST 101
HFD:	On request

Circuit diagram of signal evaluation

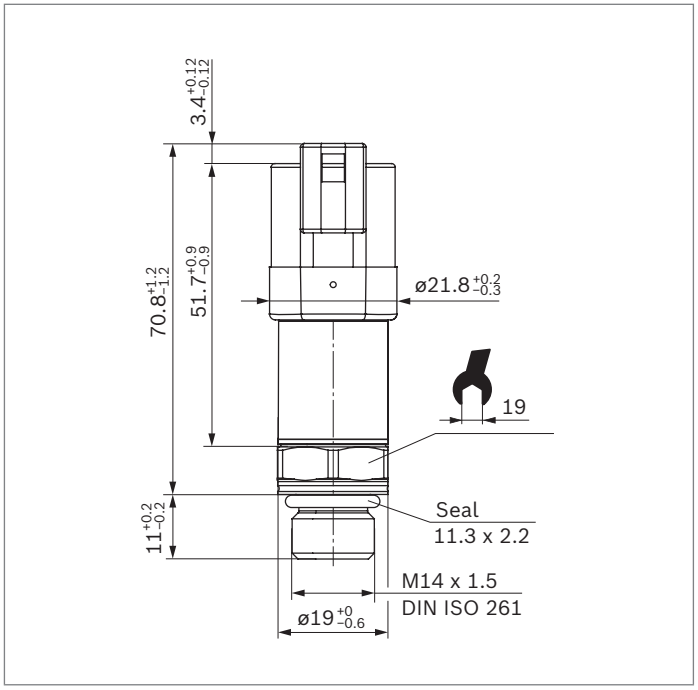


Dimensions

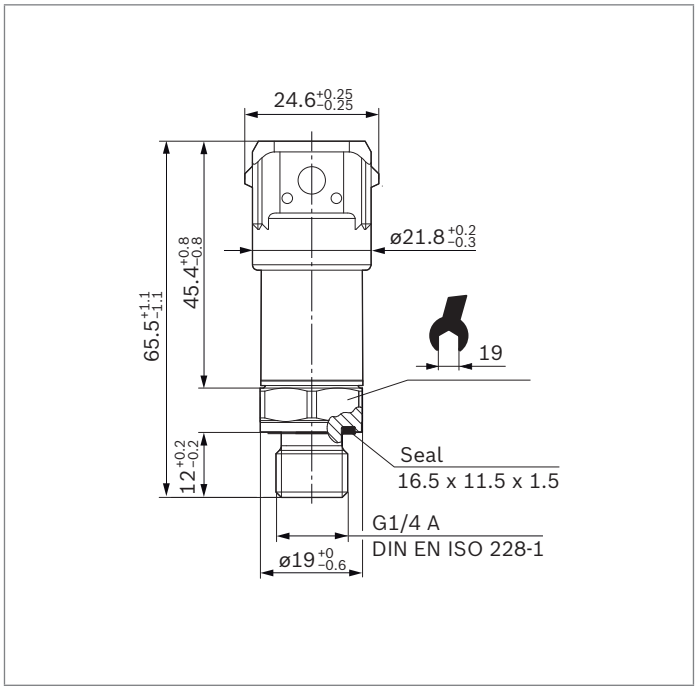
AMP Superseal



DEUTSCH DT04-3P



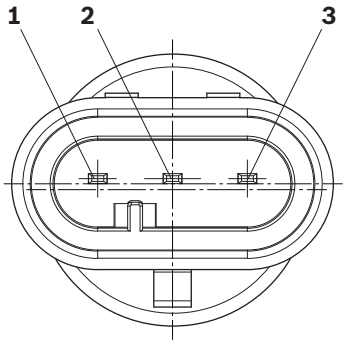
Jet connector



Connector

AMP Superseal

▼ **Pin assignment**



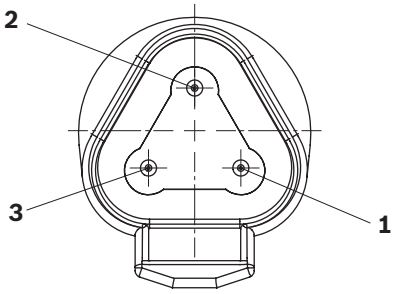
1 Ground GND
2 Signal voltage U_{sig}
3 Supply voltage U_{sup}

▼ **Mating connector** [1)]

Designation	Number	Material number
Mating connector set		R902602132[1)]
Socket housing 3-pin	1	282087-1[2)]
Single-wire seal, yellow	3	281934-2[2)]
Socket contact	3	183025-1[2)]

DEUTSCH DT04-3P

▼ **Pin assignment**



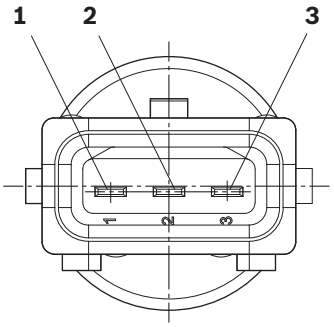
	Sensor DT04-3P	Connector DT06-3S-EP04
Ground GND	**1**	**B**
Signal voltage U_{sig}	**2**	**C**
Supply voltage U_{sup}	**3**	**A**

▼ **Mating connector** [1)]

Designation	Number	Material number
Mating connector set		R902603524[1)]
Housing 3-pin	1	DT06-3S-EP04[3)]
Wedge	1	W3S[3)]
Sockets	3	0462-201-16141[3)]

Jet connector

▼ **Pin assignment**



1 Ground GND
2 Signal voltage U_{sig}
3 Supply voltage U_{sup}

▼ **Mating connector** [1)]

Designation	Number	Material number
Bosch connector, 3-pin		R917000515[1)]
Connector housing with retention spring	1	1928402579[4)]
Contact for mini timer	3	929939[2)]
Protection cap	1	1280703022[4)]
Single seal	3	828904-1[2)]

1) The mating connectors are not included in the scope of supply. These are available from Bosch Rexroth under the corresponding material numbers.
2) Available from AMP
3) Available from DEUTSCH
4) Available from Bosch

Manufacturer confirmation of $MTTF_D$-values

The $MTTF_D$-values was determined in accordance with ISO 13849-1 Appendix D, Parts Count Method.

According to ISO 13849-2, the product meets the basic safety principles and the well-tried safety principles to the extent that they apply to the product.

The sensor is not a safety component in the sense of Directive on Machinery 2006/42/EC and has not been developed according to ISO 13849-1, respectively ISO 13849-2.

Note
The $MTTF_D$-values given are only valid for the sensor. For assessment of the functional safety for sensors according to ISO 13849-1, the entire signal chain has to be considered. For this reason, the corresponding kinematics (e.g. geared ring) are also to be taken into account for sensor application in hydraulic drive units.

PR3 DEUTSCH-Connector

Valid for PR3-600MD36

Calculated with IEC TR 62380:2004 with real stress of the components

Ambient temperatur Control unit [°C]	Self-heating [°C]	Temperature profile, Operating time share [%]					
		1	**2**	**3**	**4**	**5**	**6**
10	10	1	1	1	1	1	0
30	10	2	2	2	2	1	0
40	10	3	3	3	3	1	0
50	10	4	3	3	3	1	100
60	10	5	3	3	3	1	0
70	10	6	3	3	3	1	0
80	10	79	85	3	3	1	0
90	10	0	0	82	3	1	0
100	10	0	0	0	79	92	0
110	10	0	0	0	0	0	0
125	10	0	0	0	0	0	0
$MTTF_D$-value [years] with use	4h per day	845	841	756	685	872	3547
	8h per day	802	797	712	639	617	3211
	16h per day	721	715	632	562	536	2672
	24h per day	783	774	661	570	534	4673

Ambient temperatur Control unit [°C]	Self-heating [°C]	Temperature profile, Operating time share [%]					
		7	**8**	**9**	**10**	**11**	**12**
10	10	0	0	0	0	0	0
30	10	0	0	0	0	0	0
40	10	0	0	0	0	0	0
50	10	0	0	0	0	0	0
60	10	0	0	0	0	0	0
70	10	100	0	0	0	0	0
80	10	0	100	0	0	0	0
90	10	0	0	100	0	0	0
100	10	0	0	0	100	0	0
110	10	0	0	0	0	100	0
125	10	0	0	0	0	0	100
$MTTF_D$-value [years] with use	4h per day	3017	2743	2470	2205	1952	1605
	8h per day	2582	2273	1978	1705	1457	1139
	16h per day	1977	1666	1390	1150	947	704
	24h per day	2578	1938	1469	1124	868	599

PR3 AMP-Connector

Valid for PR3-025GS05, PR3-050GS05, PR3-160GS05, PR3-250GS05, PR3-400GS05, PR3-600GS05

Calculated with IEC TR 62380:2004 with real stress of the components

Ambient temperatur Control unit [°C]	**Self-heating [°C]**	**Temperature profile, Operating time share [%]**					
		1	**2**	**3**	**4**	**5**	**6**
10	10	1	1	1	1	1	0
30	10	2	2	2	2	1	0
40	10	3	3	3	3	1	0
50	10	4	3	3	3	1	100
60	10	5	3	3	3	1	0
70	10	6	3	3	3	1	0
80	10	79	85	3	3	1	0
90	10	0	0	82	3	1	0
100	10	0	0	0	79	92	0
110	10	0	0	0	0	0	0
125	10	0	0	0	0	0	0
$MTTF_D$-value [years] with use	4h per day	1077	1071	954	856	1048	4485
	8h per day	1007	999	882	784	751	3954
	16h per day	880	871	761	668	632	3159
	24h per day	1038	1038	880	752	702	4626

Ambient temperatur Control unit [°C]	**Self-heating [°C]**	**Temperature profile, Operating time share [%]**					
		7	**8**	**9**	**10**	**11**	**12**
10	10	0	0	0	0	0	0
30	10	0	0	0	0	0	0
40	10	0	0	0	0	0	0
50	10	0	0	0	0	0	0
60	10	0	0	0	0	0	0
70	10	100	0	0	0	0	0
80	10	0	100	0	0	0	0
90	10	0	0	100	0	0	0
100	10	0	0	0	100	0	0
110	10	0	0	0	0	100	0
125	10	0	0	0	0	0	100
$MTTF_D$-value [years] with use	4h per day	3662	3260	2876	2516	2186	1751
	8h per day	3031	2606	2218	1873	1572	1199
	16h per day	2219	1827	1493	1214	984	718
	24h per day	2537	1902	1439	1098	846	582

PR3 JET-Connector

Valid for PR3-160GJ12 and PR3-200GJ12

Calculated with IEC TR 62380:2004 with real stress of the components

Ambient temperatur Control unit [°C]	Self-heating [°C]	Temperature profile, Operating time share [%]					
		1	2	3	4	5	6
10	10	1	1	1	1	1	0
30	10	2	2	2	2	1	0
40	10	3	3	3	3	1	0
50	10	4	3	3	3	1	100
60	10	5	3	3	3	1	0
70	10	6	3	3	3	1	0
80	10	79	85	3	3	1	0
90	10	0	0	82	3	1	0
100	10	0	0	0	79	92	0
110	10	0	0	0	0	0	0
125	10	0	0	0	0	0	0
$MTTF_D$-value [years] with use	4h per day	843	838	751	678	821	3543
	8h per day	788	782	695	621	596	3120
	16h per day	690	683	599	528	501	2489
	24h per day	720	711	602	515	479	3721

Ambient temperatur Control unit [°C]	Self-heating [°C]	Temperature profile, Operating time share [%]					
		7	8	9	10	11	12
10	10	0	0	0	0	0	0
30	10	0	0	0	0	0	0
40	10	0	0	0	0	0	0
50	10	0	0	0	0	0	0
60	10	0	0	0	0	0	0
70	10	100	0	0	0	0	0
80	10	0	100	0	0	0	0
90	10	0	0	100	0	0	0
100	10	0	0	0	100	0	0
110	10	0	0	0	0	100	0
125	10	0	0	0	0	0	100
$MTTF_D$-value [years] with use	4h per day	2937	2631	2334	2051	1788	1437
	8h per day	2422	2093	1788	1514	1274	974
	16h per day	1765	1458	1195	973	971	578
	24h per day	2032	1522	1151	879	677	467

Assessment of Safety Principles

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

Basic safety principle A1	Remarks	Assessment
Application of the principle of energy separation	The safe state is achieved by connection of energy. Please check process for stopping in ISO 12100:2010, 6.2.11.3. Energy is supplied for actuation of movement of a mechanism. Please check process for movement in ISO 12100:2010, 6.2.11.3. Respect different operating categories, e.g. operating mode, maintenance mode. Important: This principle may not be applied if a dangerous situation can happen because of energy loss, e.g. release of a tool by loss of loading force.	Request has to be ensured by higher-level system.
Protection against unexpected movement	Consideration of unexpected movement caused by stored energy and after reestablishment of energy supply for different operation categories like operating mode, maintenance mode etc. A special device to let off stored energy may be is necessary. Special applications, e.g. for saving energy for clamping device or for ensuring of a position have to be considered separately.	Request has to be ensured by higher-level system.
Well-tried safety principle A2		
Application of components with defined breakdown	The predominant occurring breakdown behavior of a component is known in advance and always the same. Please check ISO 12100:2010, 6.2.12.3	Request has to be ensured by higher-level system.
Basic safety principle C1		
Application of principle energy separation	The safe state will be achieved by activating of energy at all relevant devices. Please check process for stopping in ISO 12100:2010, 6.2.11.3. Energy is supplied for actuation of movement of a mechanism.. Please check process for movement in ISO 12100:2010, 6.2.11.3. Respect different operating categories, e.g. operating mode, maintenance mode. This principle may not be applied for some applications, e.g.if because of loss of hydraulic pressure an additional endangering happens.	Request has to be ensured by higher-level system.
Protection against unexpected movement	Consideration of unexpected movement caused by stored energy and after reestablishment of energy supply for different operation categories like operating mode, maintenance mode etc. A special device to let off stored energy may be is necessary. Special applications, e.g. for saving energy for clamping device or for ensuring of a position have to be considered separately.	Request has to be ensured by higher-level system.

Basic safety principle D1	**Remarks**	**Assessment**
Application of energy separation principle	A safe state will be achieved by disconnecting all important devices from energy source, e.g. by application of a common closed contact (NC) for inputs (tactile and position switch) and common open contact (NO) for relay (see also ISO 12100:2010, 6.2.11.3). In some cases exceptions are possible, e.g. if the breakdown of energy source is an additional endangering. Time delayed functions can be necessary to achieve a safe state of the system (see IEC 60204-1:2005, 9.2.2).	Request has to be ensured by higher-level system.
Protection against unexpected movement	Protection of unexpected movement, e.g. recovering of energy supply (see ISO 12100:2010, 6.2.11.4, ISO 14118, IEC 60204-1).	Request has to be ensured by higher-level system.
Protection against steering current circuit	Steering current circuit shall be protected according to IEC 60204-1:2005, 7.2 und 9.1.1.	Request has to be ensured by higher-level system.
Well-tried safety principle D2		
Avoidance of errors in cables	In order to prevent short circuits between two lines: ▶ At every single line use a cable, which shield is connected to the protection system or ▶ In flat cables application of a protection conductor between all signal conductors.	Request has to be ensured by higher-level system.
Limiting of energy	For supply of a limited amount of energy a capacitor has to be used, e.g. for clock pulse steering.	Request has to be ensured by higher-level system.
State alignment of breakdowns	If possible in case of breakdown all devices/circuits shall switch to a safe state or safe conditions.	Request has to be ensured by higher-level system.
Directed breakdown	If realizable all components or systems shall be applied, where the case of breakdown is known ahead, (see ISO 12100:2010, 6.2.12.3).	Request has to be ensured by higher-level system.

Installation instructions

Electrical connection

- The device may only be installed by a trained electrician.
- The national and international specifications regarding the installation of electro-technical systems must be followed.
- Voltage supply according to SELV, PELV.
- De-energize the system.

Mechanical connection

- Before installing and removing the device, make certain that the system is not pressurized.

Safety instructions

Risk of injury!
Overload pressures that exceed the specified maximum permissible pressure are to be prevented through appropriate measures. The specified bursting pressure must not be exceeded. Even exceeding the bursting pressure for brief periods can destroy the device.

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- It is not permissible to open the BODAS pressure sensor PR3 or to modify or repair the BODAS pressure sensor PR3. Modifications or repairs to the wiring could result in dangerous malfunctions.
- Only allow pressure measurement devices to be installed by trained and specialist personnel who are authorized by the system owner.
- Connections must only be opened while in a depressurized state!
- The sensor may only be assembled/disassembled in a depressurized and deenergized state.
- In order to prevent damage at the sensor and to maintain its unobjectionable functioning, professional air bleed of the hydraulic system is required.
- System developments, installation and commissioning of electronic systems for controlling hydraulic drives must only be carried out by trained and experienced specialists who are sufficiently familiar with both the components used and with the complete system.
- While commissioning the BODAS pressure sensor PR3, the machine may pose unforeseen dangers. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- No defective or incorrectly functioning components may be used. If the BODAS pressure sensor PR3 should fail or demonstrate faulty operation, it must be replaced.
- Residual measurement materials in unmounted pressure measurement devices could endanger people, the environment and equipment. Take appropriate precautionary measures.
- In spite of taking great care in preparing this document, all conceivable application cases could not be taken into account. If information is lacking for your specific application, please contact Bosch Rexroth.
- The sensor may warm up at high liquid temperatures. Risk of burning!
  - Do not touch the device.
  - Protect the housing against contact with flammable substances and against unintentional contact secure.

Pressure vessel directive

- Devices with MEV (measurement range end value) 600 bar correspond to directive 2014/68/EU and are not designed for overheated fluids of fluid group 2. These devices are manufactured and inspected according to module A.
- Devices with MEV 25 to 400 bar correspond to article 3 paragraph (3) of directive 2014/68/EU and are not designed and manufactured for overheated fluids of fluid group 2, in accordance with good engineering practice.

Notes on the installation location and position

- Do not install the BODAS pressure sensor PR3 close to parts that generate considerable heat (e.g. exhaust).
- A sufficiently large distance to radio systems must be maintained.
- The connector of the BODAS pressure sensor PR3 is to be unplugged during electrical welding and painting operations.
- Cables/wires must be sealed individually to prevent water from entering the device.

Notes on transport and storage

- Please inspect the device for any damages which may have occurred during transport. If there are obvious signs of damage, please immediately inform the transport company and Bosch Rexroth.
- If it is dropped, the BODAS pressure sensor PR3 must not be used any longer as invisible damage could have a negative impact on reliability.

Notes on wiring and circuitry

- Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The BODAS pressure sensor PR3 should only be plugged and unplugged when it is in a de-energized state.
- Lines from the BODAS pressure sensor PR3 to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be fixated so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting points).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- The sensor lines are sensitive to radiation interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.

Intended use

- The BODAS pressure sensor PR3 is designed for use in mobile working machines provided no limitations/ restrictions are made to certain application areas in this data sheet.
- Prior to installation, commissioning and operation, make certain that the correct pressure measurement device was selected with respect to measurement range, design and – based on the specific measurement conditions – parts which are in contact with measuring materials (corrosion). Furthermore, the respective national safety regulations are to be observed.
- Operation of the BODAS pressure sensor PR3 must generally occur within the operating ranges specified and released in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.
- Use outside of the specified and released boundary conditions may result in danger to life and/or cause damage to components which could result in consequential damage to the mobile working machine.
- Failure to observe the respective specifications may result in serious bodily injury and/or property damage.

Improper use

- Any use of the BODAS pressure sensor PR3 other than that described in chapter “Intended use" is considered to be improper.
- Use in explosive areas is not permissible.
- Damages which result from improper use and/or from unauthorized, interference in the component not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and determining the possible safety-related functions.
- In safety-related applications, the customer is responsible for taking suitable measures for ensuring safety (sensor redundancy, plausibility check, emergency switch, etc.).
- Product data that is necessary to assess the safety ofthe machine are listed in this data sheet.

Disposal

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

Further information

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

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RE 95156/2024-03-18
Replaces: 2023-11-13

rexroth
A Bosch Company

BODAS Pressure sensor PR4

- Thin-film measurement principle
- Measuring ranges 0 to 50 bar, 0 to 100 bar, 0 to 280 bar, 0 to 400 bar, 0 to 420 bar, 0 to 480 bar, 0 to 600 bar
- Output signal 0.5 to 4.5 V ratiometric at supply voltage 5 V or SENT according to SAE J2716 JAN 2010
- Protection class IP67 / IP69K

Features

- Tightening torque up to 55 Nm
- High shock and vibration resistance
- High resistance to pressure peaks
- Very good temperature shock resistance
- High accuracy over the complete measuring range
- Compact robust construction
- Available electrical connections:
  - AMP Superseal 1.5
  - Bosch Compakt 1.1a
  - Deutsch DT04-3P
  - Trapez
- CE conformity

Contents

Type code

	01	02	03	04	05		06
BODAS	**PR4**					**/**	**10**

Type

01	Pressure sensor	**PR4**

Measuring range

02	0 ... 50 bar	**050**
	0 ... 100 bar	**100**
	0 ... 280 bar	**280**
	0 ... 400 bar	**400**
	0 ... 420 bar	**420**
	0 ... 480 bar	**480**
	0 ... 600 bar	**600**

Mechanical connection		**050**	**100**	**280**	**400**	**420**	**480**	**600**	
03	G 1/4 A in according to DIN EN ISO 1179-2	●	●	●	–	●	–	–	**G**
	M14 x 1.5 according to ISO 6149-2	–	–	–	●	–	●	●	**M**
	7/16-20 UNF according to SAE J 1926-1	–	–	●	–	●	–	●	**U7**
	9/16-18 UNF according to SAE J 1926-1	–	–	●	–	●	–	●	**U9**

Electrical connection		**050**	**100**	**280**	**400**	**420**	**480**	**600**	
04	AMP Superseal 1.5	●	–	●	–	●	–	●	**A**
	Bosch Compact 1.1a; **code 1**	●	●	●	●	●	●	●	**B**
	Bosch Compact 1.1a; **code 2** (potted connector base)	–	–	–	–	–	–	●	**SB**
	DEUTSCH DT04-3P	●	–	●	–	●	–	●	**D**
	Trapeze	–	–	–	–	–	–	●	**T**

Output signal		**050**	**100**	**280**	**400**	**420**	**480**	**600**	
05	0.5 ... 4.5 V ratiometric (at 5±0 V supply)	●	●	●	●	●	–	●	**05**
	SENT according to SAE J2716 JAN 2010	●	–	●	–	●	●	●	**SE**

Series

06		**10**

● = Available – = Not available

Available variants[1)]

Typ (with AMP Superseal 1.5 connection[2)])	Material number Bulk pack (136 pieces)	Single pack
PR4 050 G A 05/10	R917C13938	R917A13938
PR4 050 G A SE/10	R917C13939	R917A13939
PR4 280 G A 05/10	R917C13940	R917A13940
PR4 280 G A SE/10	R917C13941	R917A13941
PR4 420 G A 05/10	R917C13942	R917A13942
PR4 420 G A SE/10	R917C13943	R917A13943
PR4 600 M A 05/10	R917C13944	R917A13944
PR4 600 M A SE/10	R917C13945	R917A13945

Typ (with Bosch Compact 1.1a; code 1 connection)	Material number Bulk pack (136 pieces)	Single pack
PR4 050 G B 05/10	R917C11189	R917A11189
PR4 050 G B SE/10	R917C11574	R917A11574
PR4 100 G B 05/10	R917C12392	R917A12392
PR4 280 G B 05/10	R917C05562	R917A05562
PR4 280 G B SE/10	R917C10997	R917A10997
PR4 280 U7 B 05/10	R917C12991	R917A12991
PR4 280 U7 B SE/10	R917C12997	R917A12997
PR4 280 U9 B 05/10	R917C12990	R917A12990
PR4 280 U9 B SE/10	R917C12994	R917A12994
PR4 400 M B 05/10	R917C12355	R917A12355
PR4 420 G B 05/10	R917C09842	R917A09842
PR4 420 G B SE/10	R917C11558	R917A11558
PR4 420 U7 B 05/10	R917C12842	R917A12842
PR4 420 U7 B SE/10	R917C12996	R917A12996
PR4 420 U9 B 05/10	R917C12843	R917A12843
PR4 420 U9 B SE/10	R917C12993	R917A12993
PR4 480 M B SE/10	R917C11816	R917A11816
PR4 600 M B 05/10	R917C10105	R917A10105
PR4 600 M B SE/10	R917C11550	R917A11550
PR4 600 U7 B 05/10	R917C12844	R917A12844
PR4 600 U7 B SE/10	R917C12995	R917A12995
PR4 600 U9 B 05/10	R917C12845	R917A12845
PR4 600 U9 B SE/10	R917C12992	R917A12992

Typ (with Bosch Compact 1.1a; code 2 connection)	Material number Bulk pack (136 pieces)	Single pack
PR4 600 M SB 05/10	R917C11817	R917A11817

1) Further variants (incl. different electric connectors AK 3-pole code B, AK-Kostal 3-pole code A, Delphi Packard 3-pole code B, MLK 3-pole code B) on request.
2) SOP 04/2025

Typ (with DEUTSCH DT04-3P connection)	Material number Bulk pack (136 pieces)	Single pack
PR4 050 G D 05/10[1)]	R917C13930	R917A13930
PR4 050 G D SE/10[1)]	R917C13931	R917A13931
PR4 280 G D 05/10[2)]	R917C13932	R917A13932
PR4 280 G D SE/10[2)]	R917C13933	R917A13933
PR4 280 U7 D 05/10[2)]	R917C13917	R917A13917
PR4 280 U7 D SE/10[2)]	R917C13920	R917A13920
PR4 280 U9 D 05/10[2)]	R917C13923	R917A13923
PR4 280 U9 D SE/10[2)]	R917C13927	R917A13927
PR4 420 G D 05/10[2)]	R917C13934	R917A13934
PR4 420 G D SE/10[2)]	R917C13935	R917A13935
PR4 420 U7 D 05/10[2)]	R917C13918	R917A13918
PR4 420 U7 D SE/10[2)]	R917C13921	R917A13921
PR4 420 U9 D 05/10[2)]	R917C13924	R917A13924
PR4 420 U9 D SE/10[2)]	R917C13928	R917A13928
PR4 600 M D 05/10[2)]	R917C13936	R917A13936
PR4 600 M D SE/10[2)]	R917C13937	R917A13937
PR4 600 U7 D 05/10[2)]	R917C13919	R917A13919
PR4 600 U7 D SE/10[2)]	R917C13922	R917A13922
PR4 600 U9 D 05/10[2)]	R917C13925	R917A13925
PR4 600 U9 D SE/10[2)]	R917C13929	R917A13929

Typ (with trapeze connection)	Material number Bulk pack (136 pieces)	Single pack
PR4 600 M T 05/10	R917C12804	R917A12804

1) SOP 12/2024
2) SOP 07/2024

Product description PR4 xxx xx 05 / 10

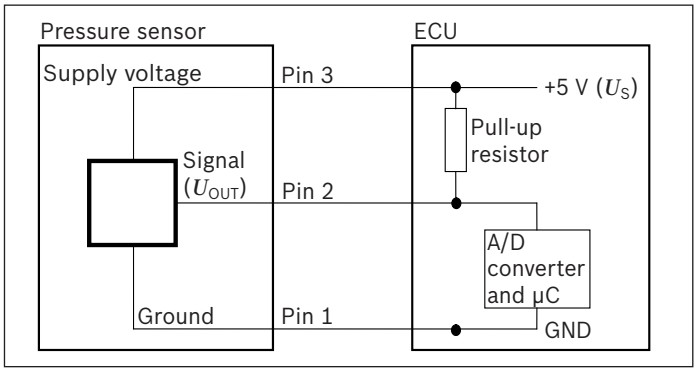
This sensor is used for measuring pressure in hydraulic circuits. Due to its outstanding characteristics, it is also ideally suited for use in mobile hydraulics:
Shock and vibration resistance, type of protection, resistance to pressure spikes, resistance to temperature shock, EMC characteristics better than 150 V / m.
A resistance bridge is applied on a steel membrane using thin-film technology. The measurement principle uses a hermetically welded thin-film measurement cell, which ensures long-term leak resistance. The sensor signal can be directly evaluated by a BODAS controller RC.

Wiring of the sensor PR4 xxx xx 05 / 10

Recommended wiring of the sensor

The sensor is to be connected to the ECU according to the following wiring diagram and provided with a supply voltage of 5 V.

▼ **Sensor wiring in the ECU**



The allocation of the pins of the high-pressure sensor can be found in the chapter “Pin assignment”.
The pressure sensor either delivers an analog output signal, which has a radiometric relation to the supply voltage, or a digital output signal.

Specification recommendation:
In the signal path of the control unit, a pull-up resistor of 4.64 kΩ± 5% against U_s as well as a low-pass filter with a time constant of max. 0.7 ms should be provided.
The electric output of the sensor is designed in such a way that any malfunction due to cable breaks or short-circuits in the displayed wiring can be detected.
Other circuitries are possible, the diagnosis function may, however, be limited

Resistor information

Designation		Value		
		Minimum	Typical	Maximum
Pull-up resistor to U_S	$R_{Pull-up}$	4.41 kΩ	4.64 kΩ	4.87 kΩ

Characteristics of the sensor PR4 xxx xx 05 / 10

Output voltage as function of the pressure

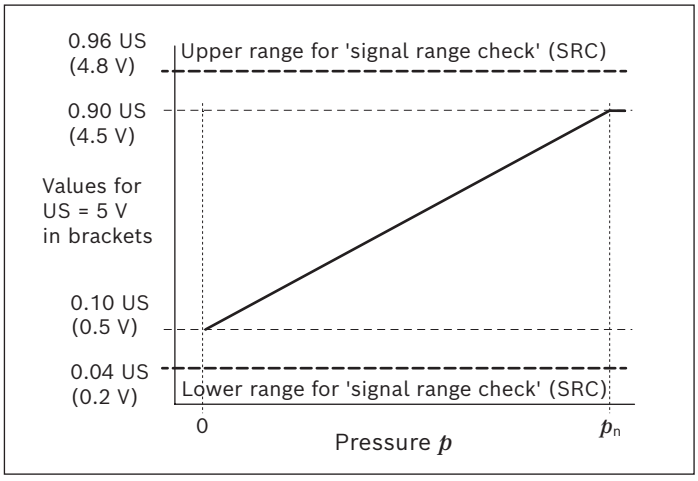
The signal output voltage is (up to the nominal pressure) calculated from the actual pressure as follows:

$$U_{OUT} = (c_1 \times p + c_0) \times U_S$$

Key

U_{OUT}	Signal output voltage
U_s	Supply voltage (typical 5 V)
p	Pressure [MPa]
c_0	= 0.1
c_1	= 0.8 / p_n
p_n	Nominal pressure [MPa]

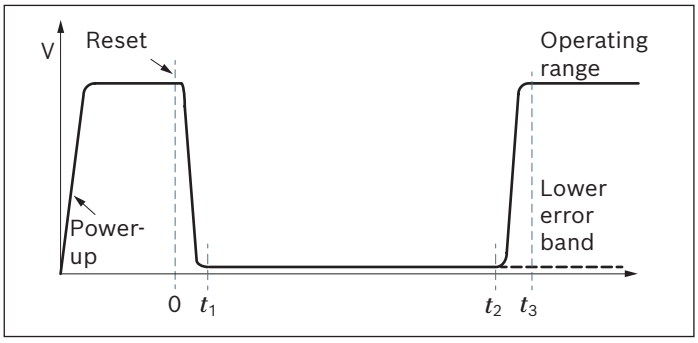
▼ **Signal output voltage U_{OUT}**



Behavior after reset and initialization for the sensor PR4 xxx xx 05 / 10

In case of certain errors, a reset is triggered in the sensor. These are then generated every 400 ms. After a reset, and during the subsequent initialization of the sensor, the output is pulled to ground. If the error is still present, the output signal remains in the lower error band. In case, the error is no longer present, the output signal controls its value into the applicable operating range. The course of the output signal and the related typical time at room temperature, after the reset, are shown in diagram below.

▼ **Representation of the time after reset and initialization**



Typical [ms]	t_1	t_2	t_3
CRC OK	0.03	0.9	1.1
CRC NOK	0.03	2.1	2.3

Behavior after undervoltage and overvoltage of the sensor PR4 xxx xx 05 / 10

In case of undervoltage or overvoltage detection, the output is drawn to ground.

Behaviour after connection failures PR4 xxx xx 05 / 10

Error description	Sensor output U_{out}
Short circuit of U_{out} and U_s	Upper error band[1)]
Short circuit of U_{out} and GND	Lower error band[1)]
Short circuit of U_s and GND	Upper error band[1)]
Connector/ wire break of U_s, GND or U_{out}	Upper error band[1)]

Error diagnosis for the sensor PR4 xxx xx 05 / 10

Since the sensor characteristic of the upper operating range is limited, overpressure conditions can be distinguished from errors.

The coding of the response to an error in the following table “Response of the sensor in case of error” is as follows:

0 = no error band and no reset
–1 = lower error band and no reset
–2 = lower error band and reset is triggered

1) Result with a pull up resistor as suggested in the circuit diagram “Sensor wiring in the ECU” page 2

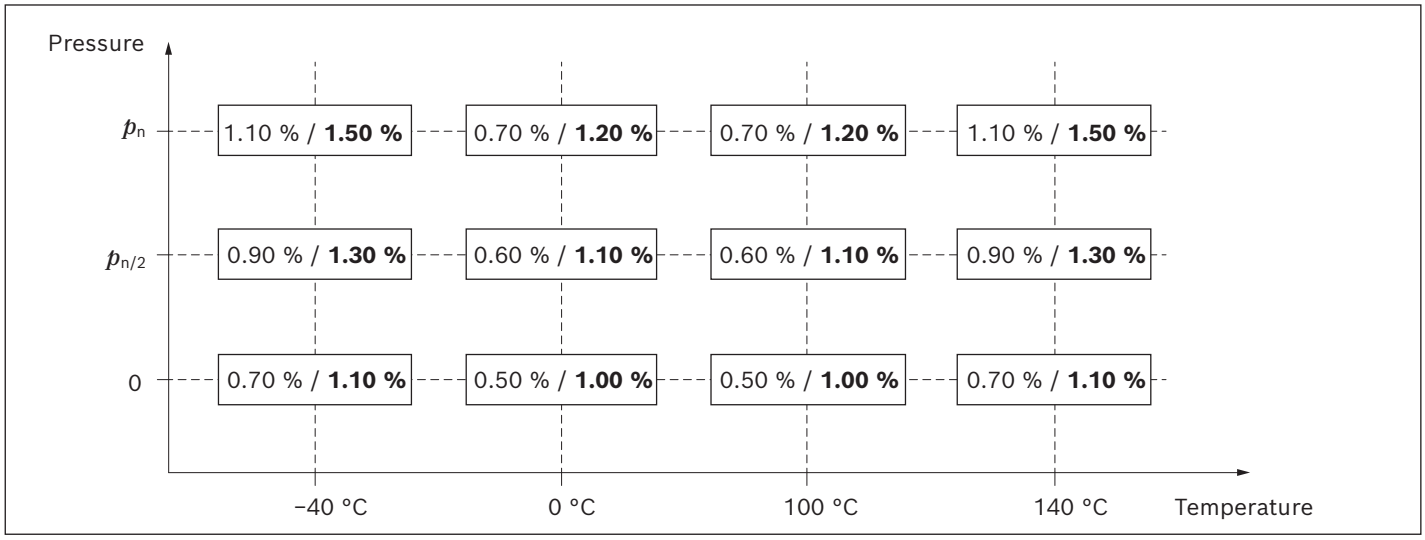
Response of the sensor in case of error

Error description	Debounce characteristics	Error mode
Initialization, p (pressure) and T (temperature) not yet available		–1
Indicates that OTP Bit for final programming at Bosch of OTP Master is not set (lock-bit not set)	Error is set immediately, No reset is triggered	–1
1) Power-on Complete RAM check (Read/Write) Beginning of continuous ROM check		
2) Normal operation Continuous ROM check Continuous RAM check RAM/ROM checks DSP by Parity during each Access HW-Check of Signal Processor (Question/Answer) Signature monitoring of program counter	Error is set immediately, Reset is triggered	–2
1) OTP CRC check of boot loading failed 4 times (consecutive)	1) Error is set immediately, Reset is triggered	–2
2) Sum-check on trim data. Test carried out during boot loading and continuous normal cycle	2) Error is set immediately, Reset is triggered	
Test on Aquisition Chain Pressure by injection of test signal before ADC on power-up Thresholds are defined during EoL programming at Bosch for each sensor individually.	Error is set immediately, Reset is triggered	–2
Decimation interval error (Only possible in case of severe hardware malfunction)	No reset, debouncing next frame	–1
Pressure Sensor element failure (Wiring Detection)		
1) Power-On Common Mode at Power-On	1) Error is set immediately, Reset is triggered	–2
2) Normal operation Common Mode Current Modulation	2) Reset, debouncing next frame	
Signal input ADC too high, also for Sensor Element Error	No reset, debouncing next frame	–1
Signal input ADC too low, also for Sensor Element Error	No reset, debouncing next frame	–1
Reference temperature input too high or low	No reset	–1
Failure of internal temperatur sensor --> HW Defects of ADC or PTAT itself	No reset	–1
Supply voltage too low Below the programmed threshold	No reset, debouncing next frame	–1
Supply voltage too high Above the programmed threshold	No reset, debouncing next frame	–1

Tolerances of the PR4 xxx xx 05 / 10 sensor

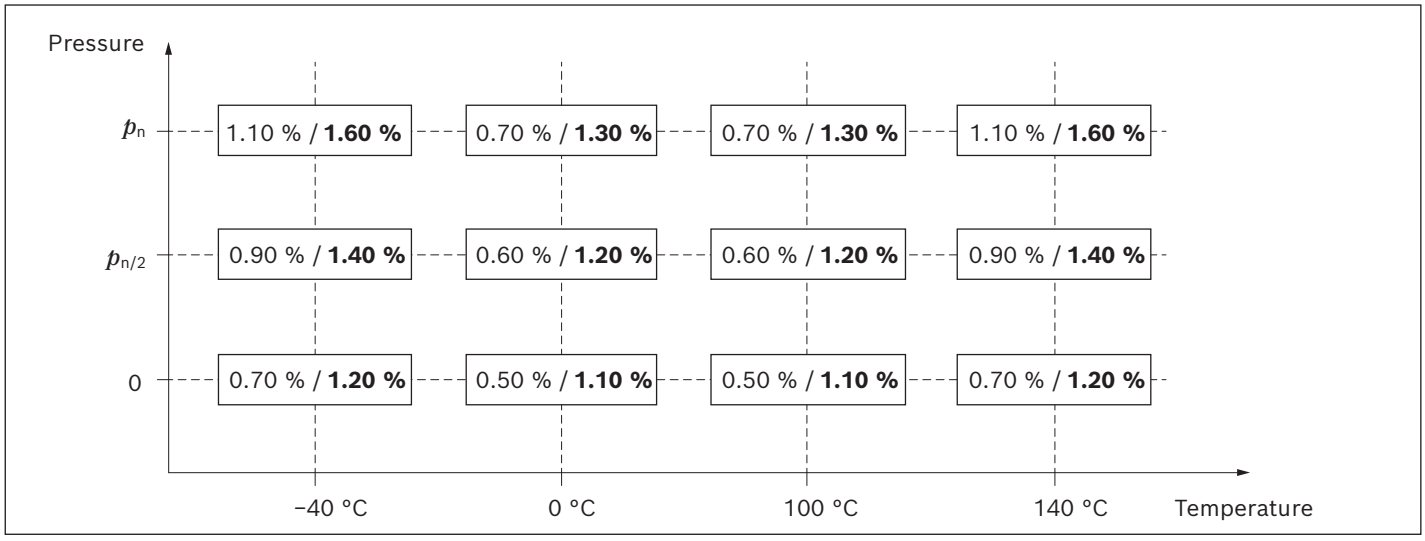
The tolerance of the pressure measurement is specified in % FS. FS = “full scale” refers to the nominal sensor pressure pn usable range (4 V). The relative tolerance is pressure- and temperature-dependent and increases over the service life. In this connection, the service life comprises the entire specified service life respectively all specified tests. Statistically, the tolerances for new parts are observed with ±3 s per production lot. 100% sorted products may be delivered. After the service life, the tolerance range of the new parts may expand to the values highlighted in the diagram; here, the 3 s limit is in turn located maximally at the indicated tolerance limit.

▼ **Version 050 bar / 280 bar / 420 bar / 480 bar / 600 bar**



New condition unmounted / after life time

▼ **Version 100 bar / 400 bar**



New condition unmounted / after life time

Product description PR4 xxx xx SE / 10

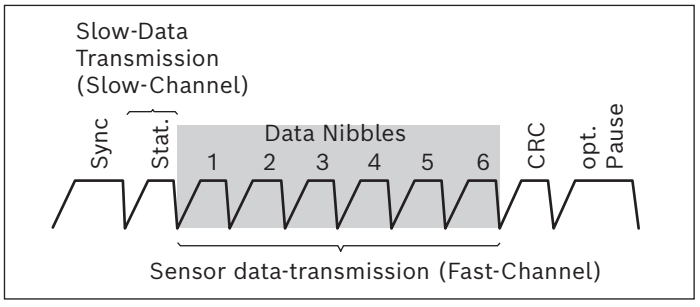
Wiring of sensor PR4 xxx xx SE / 10

The sensor is to be switched by the control unit according to the SENT specification SAE J2716 JAN 2010 and supplied with a supply voltage of 5 V.
The assignment of the sensor connector pins of the high-pressure sensor deviates from the SENT standard as described in chapter “Pin Assignment”.

Sensor characteristics PR4 xxx xx SE / 10 and SENT protocol description

SENT configuration for PR4 sensor

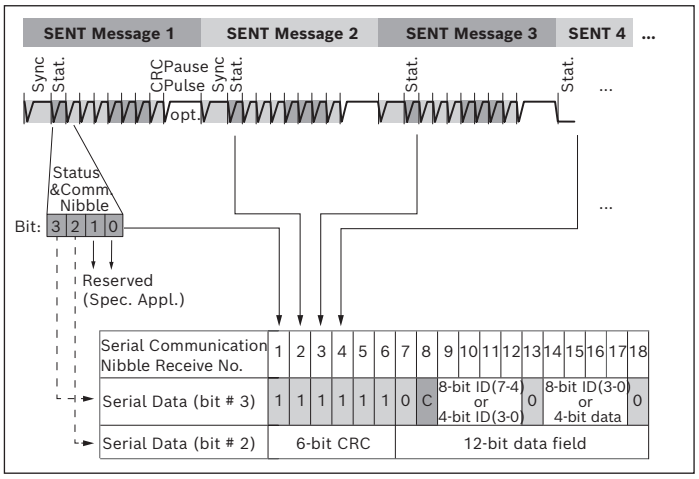
The PR4 xxx xx SE / 10 output setting, according the SAE J2716 JAN 2010 standard is: p / T.
With the data nibbles 1-3 the SENT signal transmits a 12-bit data value “Fast-Channel 1” (pressure).
With the data nibbles 4-6 the SENT signal transmits a 12-bit data value “Fast-Channel 2” (temperature).



Serial communication / Slow-Channel / Slow-Data

PR4 uses the “Enhanced Serial Message” format with 8-bit MsgID and 12-bit Data (config bit C=0).
In order to compose serial messages in enhanced format, two bit of each SENT message are beeing used. 18 consecutive error-free SENT messages are required to compose one serial message.

▼ **Set-up of the extended serial message from 18 sent messages**



In the “slow-channel / slow-data”, characteristic sensor data like coefficients, parameters, error information messages, OEM data, and so on are transmitted.

The sensor is delivered with the following settings:
("Configuration Shorthand" according to J2716 JAN 2010)

	050 PR4 xxx xx SE/10	**280 PR4 xxx xx SE/10**	**420 PR4 xxx xx SE/10**	**480 PR4 xxx xx SE/10**	**600 PR4 xxx xx SE/10**
Pressure offset (P2) / Nominal pressure (P3)[1)]	0 bar in the mode relative pressure / 050 bar	0 bar in the mode relative pressure / 280 bar	0 bar in the mode relative pressure / 420 bar	0 bar in the mode relative pressure / 480 bar	0 bar in the mode relative pressure / 600 bar
Maximal pressure for error - flag	62.5 bar±5%	350 bar±5%	525 bar±5%	600 bar±5 %	750bar±5%
Sensor type	p/T				
Tick length	3 µs				
Bandwidth	Minimum: 470 Hz Nominal: 523 Hz Maximum: 575 Hz				
Latency	Minimum: 1.13 ms Nominal: 1.25 ms Maximum: 1.4 ms				
Variable frame length	No				
Maximal temperature for error - flag	160 °C typically ±20 Kelvin (full functionality only guaranteed up to 140 °C)				
Number of data nibbles	6				
Pause pulse	Yes ("constant frame length")				
Serial protocol	"Enhanced Serial Protocol" with 8 bit ID and 12 bit data				
Fast-Channel 1	Pressure 12 bit				
Fast-Channel 2	Temperature 12 bit				
Length of one Fast-Data Message	0.846 ms±10%				
Length of one Slow-Data Message (18 Fast-Data Messages)	15.2 ms±10%				
8 Slow-Data Messages (Diag)	121.6 ms±10%				
All 32 Slow-Data Messages	486.4 ms±10%				

Transfer function of the signals of the sensor PR4 xxx xx SE/10

Transfer function pressure measurement signal

The measured pressure is transmitted as a digital value according to the SENT specification SAE J2716 JAN 2010 according to the following function in Fast-Channel 1 (measured values are contained in the Fast-Channel). The coefficients and other values are transmitted in the Slow-Channel, refer to the see "SENT-Slow-Channel Messages Order, meaning and values" chapter.

▼ **Measured pressure**

$$p_{ist} = \frac{p_{OUT,code} - c_0}{k}$$

▼ **Transfer function pressure**

$$p_{OUT,code} = k \times p + c_0$$

$$k = \frac{(Y2 - Y1)}{(X2 - X1)} = \frac{(C3 - C2)}{(P3 - P2)}$$

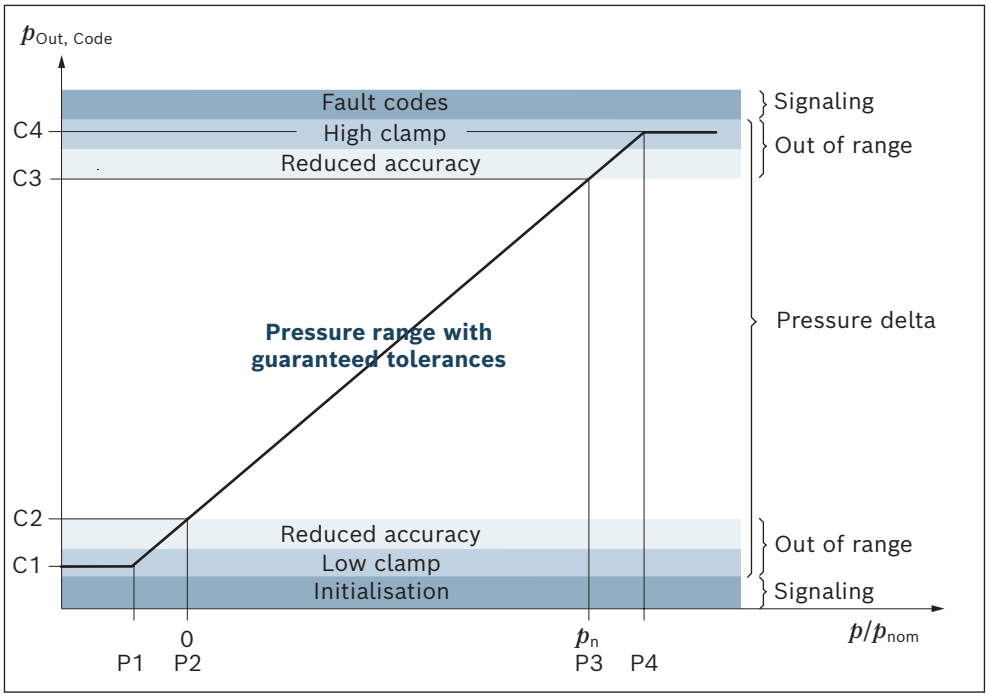
$$c_0 = Y1 - \frac{(Y2 - Y1)}{(X2 - X1)} \times X1 = C2 - \frac{(C3 - C2)}{(P3 - P2)} \times P2 = C2$$

Key

$p_{OUT.code}$	Digital 12 bit data value
p	Pressure [kPa] (Hinweis: 1 kPa = 0.01 bar)
k	Slope
c_0	Offset

1) The specific calculation rule for the nominal pressure P3 results from the 12-bit value X2 from the Slow-Channel data as follows: The least significant 3 bits as power of ten, the higher-order (9) bits as the mantissa.
Example for X2 = 0x156: The nominal pressure corresponds to 42e6 Pa = 420 bar.

▼ **Transfer characteristic for the pressure as 12-bit data values**



The assignment of digital value to pressure is shown in table “Characteristic parameters pressure”, the accuracy of the sensor is defined in the section Tolerances on temperature, pressure and life of the sensor PR4 xxx xx SE/10.

Characteristic parameters pressure

Parameter	050 HPS5 50 bar	280 HPS5 280 bar	420 HPS5 420 bar	480 HPS5 480 bar	600 HPS5 600 bar
P1	-259249 Pa	-1451796 Pa	-2177694 Pa	-2488793 Pa	-3110991 Pa
P2 (X1)	0 Pa (0x0)	0 Pa (0x0)	0 Pa (0x0)	0 Pa (0x0)	0 Pa (0x0)
P3 (X2)	5000000 Pa (0x195)	28000000 Pa (0xE6)	42000000 Pa (0x156)	48000000 Pa (0x186)	60000000 Pa (0x1E6)
P4	5259249 Pa	29451796 Pa	44177694 Pa	50488793 Pa	63110991 Pa
C1 (Low clamp)	1 LSB	1 LSB	1 LSB	1 LSB	1 LSB
C2 (Y1, c_0)	193 LSB	193 LSB	193 LSB	193 LSB	193 LSB
C3 (Y2)	3896 LSB	3896 LSB	3896 LSB	3896 LSB	3896 LSB
C4 (High clamp)	4088 LSB	4088 LSB	4088 LSB	4088 LSB	4088 LSB
k	74.06 LSB/bar	13.225 LSB/bar	8.8167 LSB/bar	7.7146 LSB/bar	6.1717 LSB/bar
c_0	193 LSB	193 LSB	193 LSB	193 LSB	193 LSB

Temperature measurement transfer function

The sensor measures the temperature in the ASIC (application-specific integrated circuit). According to the SENT specification SAE J2716 JAN 2010, the temperature characteristic is encoded as a 12-bit signal for Slow- and Fast-Channel:

▼ **Measured temperature**

$$T^{*}_{ist} = \frac{T_{OUT,\,code}}{8}\,K + 200\,K$$

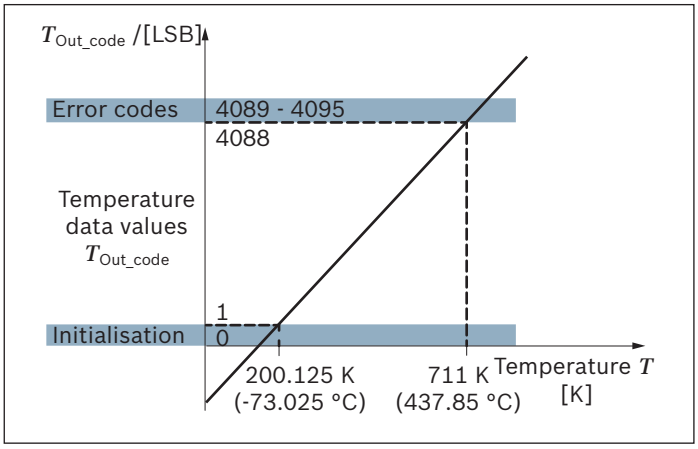
▼ **Transfer function temperature**

$$T_{OUT,\,code} = round\left(8 \times \frac{T_{ist} - 200\,K}{K}\right)$$

Key

$T_{OUT.code}$	Digital 12 bit data value
T_{ist}	Measurand in Kelvin [K]
T^{*}_{ist}	Measured value in Kelvin [K]

▼ **Transfer characteristic of the temperature values [K] into 12-bit data values**



Maximum temperature until sending an error message:
160 °C typical ±20 Kelvin

Supply voltage measurement transfer function

According to the SENT specification SAE J2716 JAN 2010, the supply voltage is encoded as a 12-bit signal for Slow-Channel:

▼ **Measured supply voltage**

$$U^{*}_{ist} = \frac{U_{Val}}{100}\,V$$

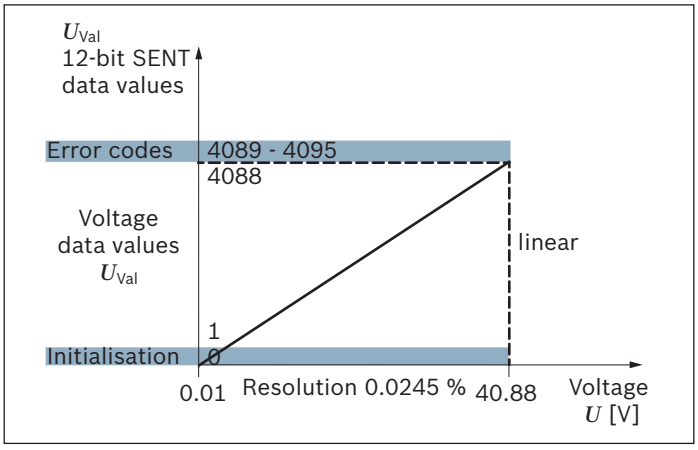
▼ **Supply voltage**

$$U_{Val} = round\left(100 \times \frac{U_{ist}}{V}\right)$$

Key

U_{Val}	Digital 12 bit data value
U_{ist}	Measurand in Volt [V]
U^{*}_{ist}	Measured value in Volt [V]

▼ **Transmission characteristics of voltage supply [V] to 12-bit data values**



Threshold for the overvoltage error message:
5.65±0.15 V
Threshold for the undervoltage error message:
4.35±0.15 V

SENT-Slow-Channel Messages Order, meaning and values

In the Slow-Channel, this information is submitted in the order given as a continous (repeating) sequence.

Message ID	Message order	Meaning	Hexadecimal value (decimal value)
0x01	1	Diagnostic Error Codes / Error and Status Codes	See table “Error Codes”[1]
0x03	2	Channel 1 / 2 Sensor type Data values for the sensor types are defined in Table D.4 in SAE J2716 JAN 2010	0x7 (7)
0x04	3	Configuration Code Detailed specification of sensor type defined in Message 03 (Material number)	[2]
0x05	4	Manufacturer Code Specific codes are assigned by the SAE SENT Task Force (B for Bosch)	0x42 (66)
0x06	5	SENT Standard Revision SENT SAE J2716 JAN 2010	0x3 (3)
0x23	6	Supplementary Data-Channel Bosch Codes: Internal Reference Temperature (PTAT / Diode) (TIC)	[1]
0x1C	7	Supplementary Data-Channel Supply Voltage	[1]
0x82	8	Bosch-specific Information	[1]
0x01	9	Diagnostic Error Codes / Error and Status Codes	See table “Error Codes”[1]
0x07	10	Fast-Channel 1 Characteristic X1 [Pa] Physical unit and encoding defined in application-specific appendices: Pressure transfer characteristic function (Channel 1)	0x0 (0)
0x08	11	Fast-Channel 1 Characteristic X2 [Pa] (Exponent + Mantisse = nominal measurement range)	[2]
0x09	12	Fast-Channel 1 Characteristic Y1 [LSB]	193 LSB
0x0A	13	Fast-Channel 1 Characteristic Y2 [LSB]	3896 LSB
0x83	14	Configurable Message 1	0x1 (1)
0x84	15	Configurable Message 2	0x2 (2)
0x85	16	Configurable Message 3	0x3 (3)
0x01	17	Diagnostic Error Codes / Error and Status Codes	See table “Error Codes”[1]
0x29	18	Sensor ID #1 12-bit for 48-Bit Serial Number	[3]
0x2A	19	Sensor ID #2 12-bit for 48-Bit Serial Number	[3]
0x2B	20	Sensor ID #3 12-bit for 48-Bit Serial Number	[3]
0x2C	21	Sensor ID #4 12-bit for 48-Bit Serial Number	[3]
0x80	22	IIR Lowpass Filter Setting	(0)
0x81	23	Supplier Info #2 Bosch Rexroth part number, coded (part1)	[3]
0x90	24	Bosch Rexroth-specific Information	0x0 (0)
0x01	25	Diagnostic Error Codes / Error and Status Codes	See table “Error Codes”[1]
0x91	26	Bosch Rexroth-specific Information	0x0 (0)
0x92	27	Bosch Rexroth-specific Information	0x0 (0)
0x93	28	Bosch Rexroth-specific Information	0x0 (0)
0x94	29	Bosch Rexroth-specific Information	0x0 (0)
0x95	30	Bosch Rexroth-specific Information	0x0 (0)
0x96	31	Bosch Rexroth-specific Information	0x0 (0)
0x97	32	Bosch Rexroth-specific Information	0x0 (0)

Default = 0

1) Variable values

2) Depending on the pressure range and sensor type, this means the data changes for each material number.

3) Changes for each sensor

Response after a reset and following initialization of the Sensor PR4 xxx xx SE/10

For certain faults (see “Fault diagnosis for sensor PR4 xxx xx SE/10”) a reset is triggered in the sensor. After a reset and during the subsequent initialization of the sensor, the SENT message “Initialization 0” is sent exactly once as soon as the transmission is possible. As soon as pressure values and temperature values are available, they are sent.

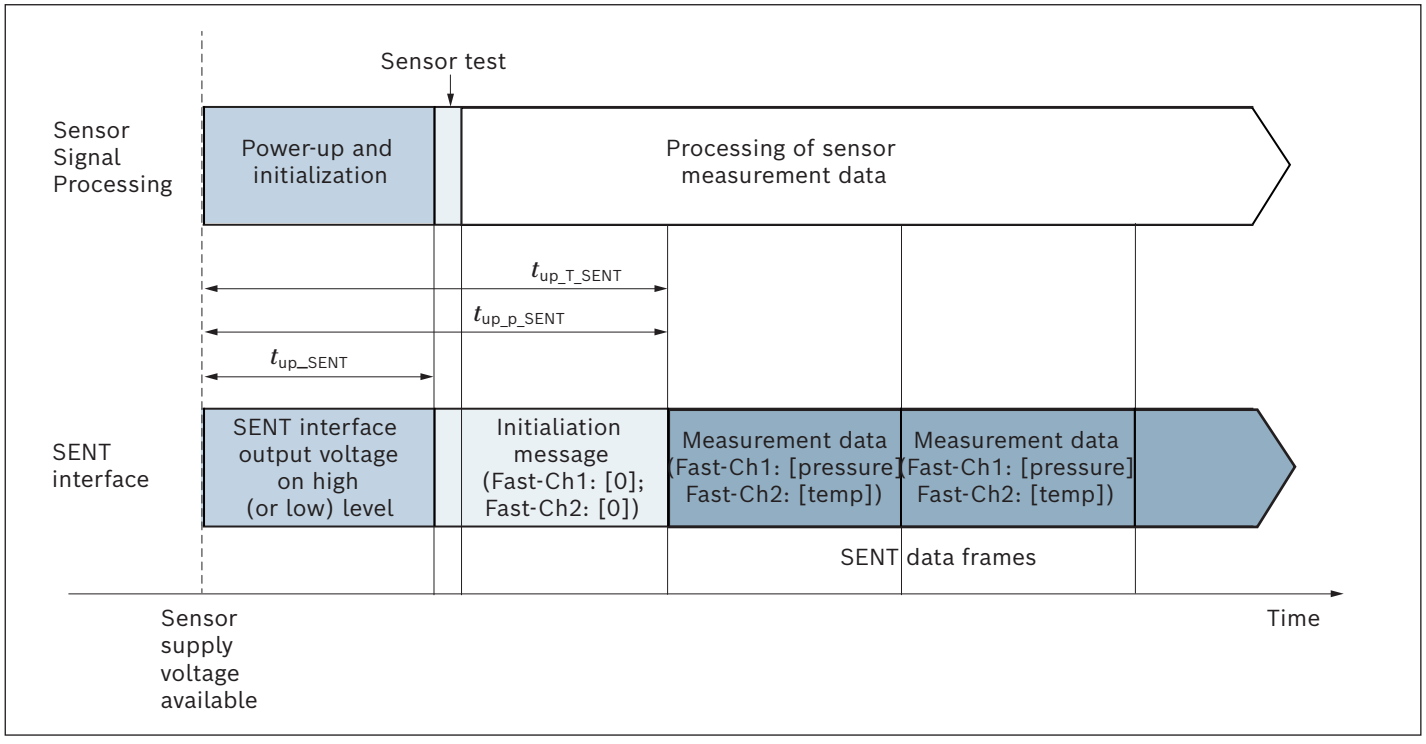
There are two types of resets:

Hard-Resets: are executed immediately on request.

Soft-Resets: are not executed until error conditions are still present after approx. 400 ms after power-on and the cause of the error could be reported under ID1 in the Slow-Channel.

The attempt to initiate a reset within 400 ms after power-on results in a continuous transmission of ID1 until the error condition is omitted or the reset is triggered after 400 ms.

▼ **Response after a reset of the Sensor PR4 xxx xx SE/10**



Values for the indicated times are available on request and are made available by Bosch Rexroth

Behavior after undervoltage and overvoltage of the sensor PR4 xxx xx SE / 10

The sensor PR4 xxx xx SE / 10 can detect an undervoltage or overvoltage in the supply line. An undervoltage is detected when the supply voltage drops below a measured voltage threshold (U_{mess} under). Overvoltage is detected when the supply voltage is above a voltage threshold (U_{mess} over).

The undervoltage / overvoltage detection is designed in such a way that continuous undervoltage / overvoltage (e.g. due to damaged cables or plug-in connections) and temporary undervoltage / overvoltage are detected.

Behaviour after connection failures PR4 xxx xx SE/10

Error description	Sensor output U_{out}
Short circuit of U_{out} and U_s	SENT signal not available
Short circuit of U_{out} and GND	SENT signal not available
Short circuit of U_s and GND	SENT signal not available
Connector/ wire break of U_s, GND, or U_{out}	SENT signal not available

Error diagnosis for Sensor PR4 xxx xx SE / 10

For fault diagnosis, fault codes are transmitted in the Fast-Channel instead of data values (pressure or temperature), these are shown in the “Transmitted error codes on the Fast-Channel” table.

Transmitted error codes on the Fast-Channel

Transmission	Description PR4 xxx xx SE / 10
4095	Used for the production stage (e.g. if errors occurred during the manufacturing process)
4094	Unused
4093	Unused
4092	Unused
4091	Error indication sensor element and front-end pressure measuring of sensor element and front-end error
4090	Error signal processing and signal perimeter
4089	Error message is sent due to reduced accuracy or reliability of the pressure signal
0	The initialization message is transmitted during the sensor initialization phase until valid measurement values are available (minimum one time after reset)

Note
Error indicator bits and serial message data (Massage ID 01) carry additional information.

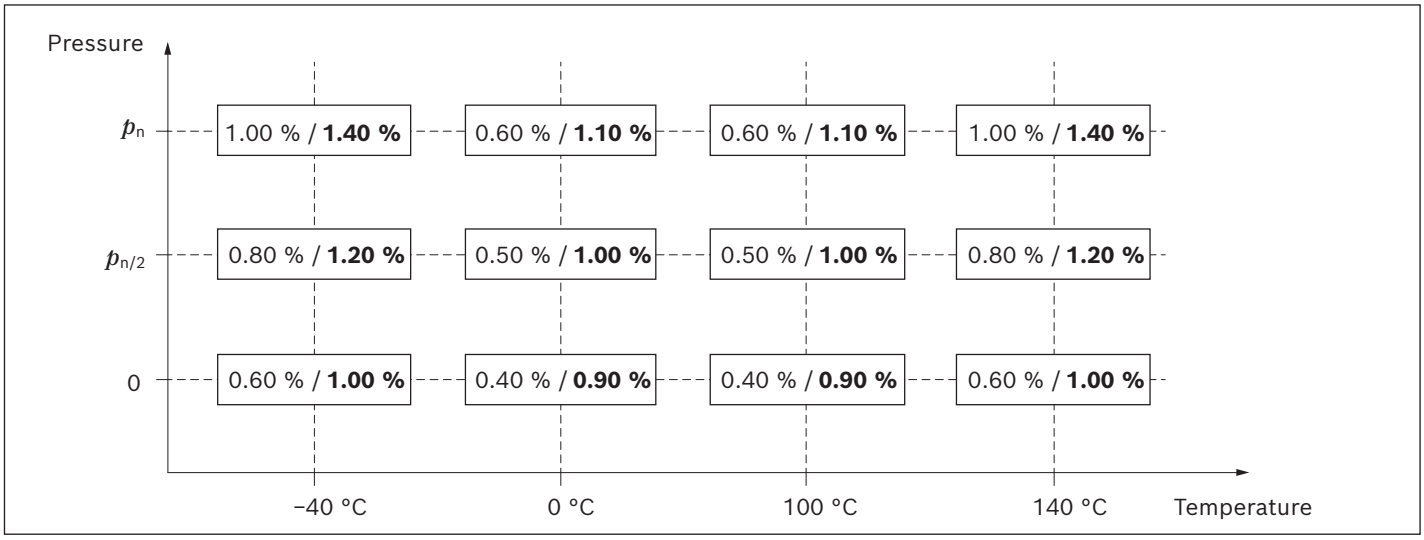
A further error detailing is described via information sent in the Slow-Channel. The assignment of the errors between Fast-Channel and Slow-Channel as well as the associated priorities are shown in the “Error codes” table.

Error codes

Error description	Slow-Channel error codes [dec]	SENT Fast-Channel 1 error codes [dec]	SENT Fast-Channel 2 error codes [dec]	Channel 1 error bit 0 of status nibble	Channel 2 error bit 0 of status nibble	Internal reference temperature (PTAT/Diode) Supplementary Data-Channel #4.1 error codes	Sensor supply voltage Supplementary Data-Channel #3.1 error codes [dec]	Reset after Slow-Channel error message if set to 1 [bin]	Fast-Channel 1 measurement data priority (measured value is transmitted at FC rather than error)	Fast-Channel 2 measurement data priority (measured value is transmitted at FC rather than error)
Initialization (p and T not yet available)	0	0	0	0				0		
Factory use only (OTP bits not set)	0	4095	4095	1	1	4095	4095	0		
Error during initial or cycling HW check (RAM/ROM)	2070	4090	4090	1	1	4090	4090	1		
Error during initial CRC or cyclic trim data check	3	4090	4090	1	1	4090	4090	1		
Error during injection self test on power-up	2049	4091		1	0			1		
Internal timing error (buffer overflow)	2076	4089		1	0			0		
Sensor element error (FC1, pressure)	2064	4091		1	0			1		
Signal input ADC too high (FC1, pressure)	1	4091		1	0			1		
Signal input ADC too low (FC1, pressure)	2	4091		1	0			1		
Reference temperature input to high or low	2067	4091	4091	1	1	4091		0		
Failure of internal temperature sensor	2067	4091		1	0	4091		0		
Low voltage supply (threshold exceeded)	32	4089	4089	1	1	4089		0	1	1
High voltage supply (threshold exceeded)	33	4089	4089	1	1	4089		0	1	1
ASIC temperature high (threshold exceeded)	34	4089	4089	1	1		4089	0	1	1
Pressure above or below limit for error flag	2056			1	0			0		
Overflows or saturation in supply voltage path (measurement possibly unreliable or wrong)	2079			0	0		4089	0		
Overflows or saturation in signal paths (pressure, temperature, supply voltage)	2075			1	1			0		

Tolerances of the PR4 xxx xx SE / 10 sensor

The tolerance of the pressure measurement is specified in % FS. FS = “full scale” refers to the nominal sensor pressure pn. The relative tolerance is pressure- and temperature-dependent and increases over the service life. Here, the service life comprises the entire specified service life. Statistically, the tolerances for new parts are observed with ±3 s per production lot. 100% sorted products may be delivered. After the service life, the tolerance range of the new parts may expand to the values highlighted in the diagram; here, the 3 s limit is in turn located maximally at the indicated tolerance limit.



New condition unmounted / after service life

Tolerances of the PR4 xxx xx SE / 10 temperature measurement

The relative tolerance is temperature-dependent. Statistically, the tolerances are observed with ±3 s per production lot. 100% sorted products may be delivered.

The following tolerances apply to SENT 280 bar, SENT 420 bar, SENT 480 bar and SENT 600 bar

Temperature	Tolerance
< 25 °C	±12 K over service life ±10 K for new parts
25 ... 90 °C	±7 K over service life ±5 K for new parts
> 90 °C	±12 K over service life ±10 K for new parts

The following tolerances apply for all other pressures

Temperature	Tolerance
−40 °C	±12 K
30 °C	±12 K
140 °C	±12 K

Tolerances of the supply voltage measurement PR4 xxx xx SE / 10

The high-pressure sensor transmits the level of the power supply with a tolerance of ±150 mV.

Technical data

Type PR4	**050**	**100**	**280**	**400**	**420**	**480**	**600**
Measuring range p_n	0 ... 50 bar	0 ... 100 bar	0 ... 280 bar	0 ... 400 bar	0 ... 420 bar	0 ... 480 bar	0 ... 600 bar
Maximum overpressure[1] p_{max}	100 bar	200 bar	400 bar	840 bar	560 bar	840 bar	840 bar
Burst pressure (static)[2][3] p_{Burst}	500 bar	2000 bar	2500 bar	4500 bar	3750 bar	4500 bar	4500 bar
Output signal	PR4 xxx xx 05/10: 0.5 ... 4.5 V, ratiometric (at 5 V supply) PR4 xxx xx SE/10: SENT according to SAE J2716 JAN 2010						
Supply voltage U_s	5±0.25 V						
Maximum supply voltage	18 V (max. 1 h)						
Short circuit signal output to GND or supply voltage	$U_{S,\ short}$ = 0 ... 18 V, (max. 8 h) in case of simultaneous supply of U_S with $U_{S,\ short}$						
Sensor output impedance $R_{differntial}$ at 0.1 U_s < U_{out} < 0.9 U_s	Typical: 5 Ω Maximum: 10 Ω						
Current consumption typical	12 mA (at 5 V supply voltage)						
Maximum current consumption	≤ 15 mA (at 5 V supply voltage)						
Reverse polarity protection of the supply voltage	yes (U_S≤ 11 V)						
Maximum current consumption in case of reverse polarity	260 mA						
Sensor connector	AMP Superseal 1.5 Bosch Compact 1.1a, 3 pin, code 1 Bosch Compact 1.1a, 3 pin, code 2 DEUTSCH DT04-3P Trapeze						
Parts contacting with measuring medium	X5CrNiCuNb16-4						
Housing material	PBT-GF30/CrNi steel						
PR4 xxx xx 05/10: Response time (10 ... 90 %)	≤ 1 ms						
PR4 xxx xx SE/10: SENT data transfer	Time till the first SENT Data transmission min.: 1.8 ms, max.: 2.2 ms						
Overall accuracy	≤1.5%, refer to table “tolerance of the sensor PR4 xxx xx 05/10” or “PR4 xxx xx SE/10”						
Ambient temperature range	−40 ... +125 °C for AMP Superseal 1.5, DEUTSCH DT04-3P and UNF variants −40 ... +140 °C for others						
	The sensor is designed for use in engine compartment (direct motor attachment) and the corresponding ambient temperatures with a typical temperature Distribution:						
	Temperature Distribution						
	−40 °C 6%						
	23 °C 20%						
	85 °C 65%						
	135 °C 8%						
	140 °C 1%						
Storage time and storage temperature	Maximum storage period from manufacturing date: 5 years at −30 ... +60 °C and 0 ... 80% relative humidity						
Transportation conditions	−40 ... +80 °C at 0 ...80% relative humidity, for the duration of max. 48h						
Service life	10000 operating hours or 15 years. Different values, depending on operational conditions on request						
Pressure cycles against service life	10 million cycles						
Shock resistance	50 g (DIN EN 60068-2-27, 11 ms)						

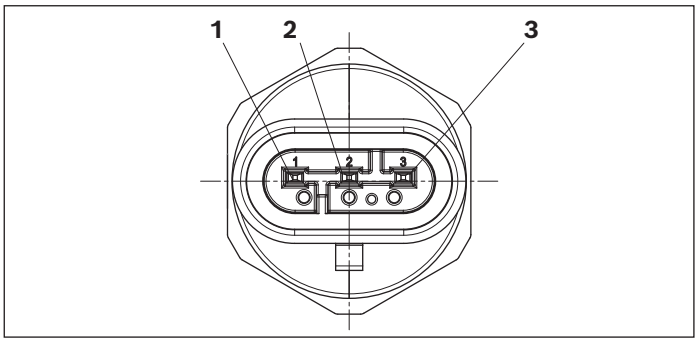
1) Maximum 15 minutes at p_{max}
2) Maximum 15 minutes at p_{Berst}
3) The specifield bursting pressure is valid for the device only. This value does not include the mechanical interface - the thread between the sensor and the hydraulic component.

Vibration resistance	Amplitude of the deflection	For Connectors: Bosch Compact 1.1a; code 1, Bosch Compact 1.1a; code 2, trapeze	s = 0.25 mm in the range 70 ... 147 Hz
		For Connectors: AMP Superseal 1.5, DEUTSCH DT04-3P	s = 1.4 mm in the range 5 ... 70 Hz
	Amplitude of the acceleration	For Connectors: AMP Superseal 1.5, Bosch Compact 1.1a; code 1, Bosch Compact 1.1a; code 2, DEUTSCH DT04-3P	a = 210 m/s^2 in the range 147 ... 1350 Hz
			a = 175 m/s^2 in the range 1350 ... 2000 Hz
		For Connector: Trapeze	a = 140 m/s2 at 100 Hz
			a = 420 m/s2 in the range 300 ... 1200 Hz
			a = 290 m/s2 in the range 1200 ... 2000 Hz
	Frequency change		1 octave/min
	Duration of excitation		100 h in each spatial direction with the same test specimen
Drop test	Controlled drop from 1 m height onto concrete in accordance with ISO 16750-3: 2023-07 One drop event per axial direction. The component must then be fully functional or visually damaged		
Salt spray test	According to DIN EN 60068-2-11 (Feb. 2000)		Test duration 240 h, without electrical operation
Electromagnetic compatibility (EMC)			ISO 11452-2, -4, -5 as well as according to IEC 61000-4-2
	BCI 100 mA		According to ISO 11452-4; 2 ... 400 MHz (closed loop; CBCI)
	Antenna > 150 V/m		According to ISO 11452-2 from 200 MHz... 3.2 GHz
Electrostatic discharge (ESD)	According to ISO 10605: 2023-06	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: EN ISO 14982:2009, ISO 13766-1, EN 12895
	RoHS directive 2011/65/EU		RoHS 2 with the exception of 7(c)-I and RoHS 3 with the exception of 7(c)-I
E1 type approval	UN ECE 10 - Rev. 4		
Electrical protection	Protection against reverse voltage, short circuit and undervoltage; protection against overvoltage in the defined supply voltage range		
Type of protection with installed mating connector	AMP Superseal 1.5		IP67, IPX6K, IPX9K according to ISO 20653:2013
	Bosch Compact 1.1a; code 1		IP67 and IPX9K according to ISO 20653:2006-08-15
	Bosch Compact 1.1a; code 2		IP67 und IPX9K nach ISO 20653:2006-08-15
	DEUTSCH DT04-3P		IP67 according to ISO 20653:2013
	Trapeze		IP67 and IPX9K according to ISO 20653:2006-08-15
Weight approximately	G 1/4 A		48 g
	M14 × 1.5 mm		52 g
Permissible hydraulic fluids	Mineral oil, HETG, HEPG, HEES, HFE, HFB, HFD (other hydraulic fluids on request)		
Cable length	The maximum cable length with SENT has been defined according to SAE J2716 JAN 2010. Under certain conditions, this length may also be extended to up to 20 m. If cable lengths which exceed the applicable SENT standard SAE J2716 JAN 2010 are required, please contact the product management.		

1) When used in an oil environment, the subsection „Note for use in oil environment“ in the section „Notices on the installation location and position“ (see page 30) must be observed.

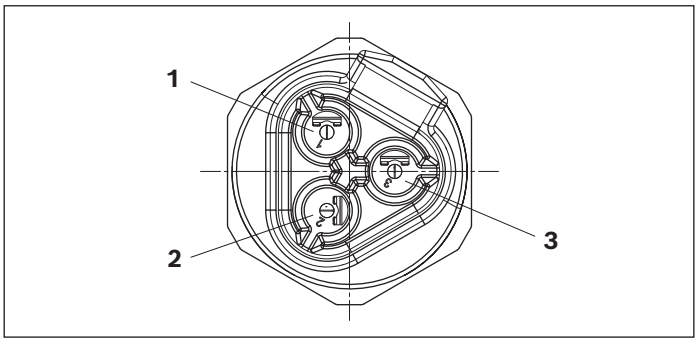
Electrical connection (Pin assignment)

▼ Sensor connector: AMP Superseal 1.5



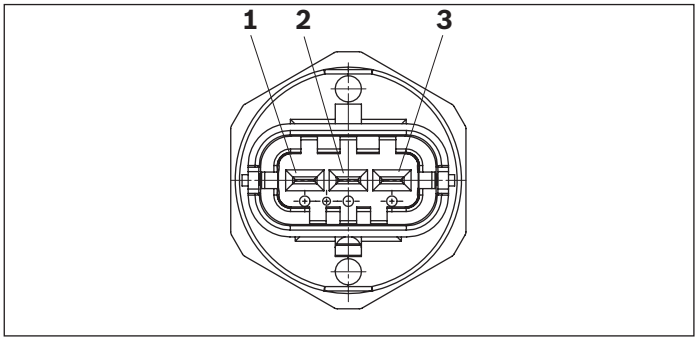
Pin	Connection	
1	Ground	GND
2	Output signal	U_{sig}
3	Supply voltage	U_s

▼ Sensor connector: DEUTSCH DT04-3P



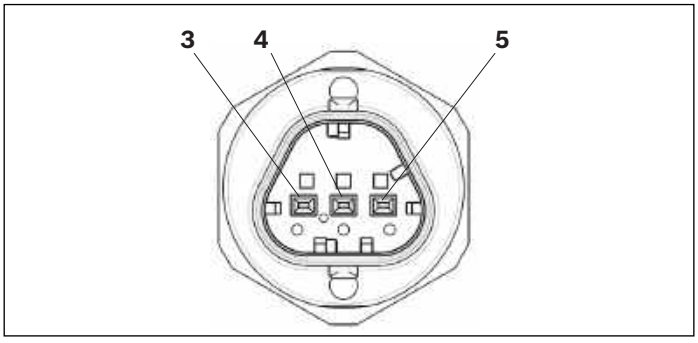
Pin	Connection	
1	Ground	GND
2	Output signal	U_{sig}
3	Supply voltage	U_s

▼ Sensor connector: Bosch Compact 1.1a; code 1



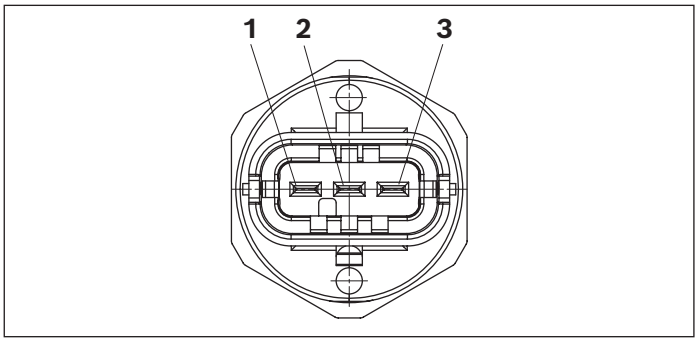
Pin	Connection	
1	Ground	GND
2	Output signal	U_{sig}
3	Supply voltage	U_s

▼ Sensor connector: Trapeze



Pin	Connection	
3	Ground	GND
4	Output signal	U_{sig}
5	Supply voltage	U_s

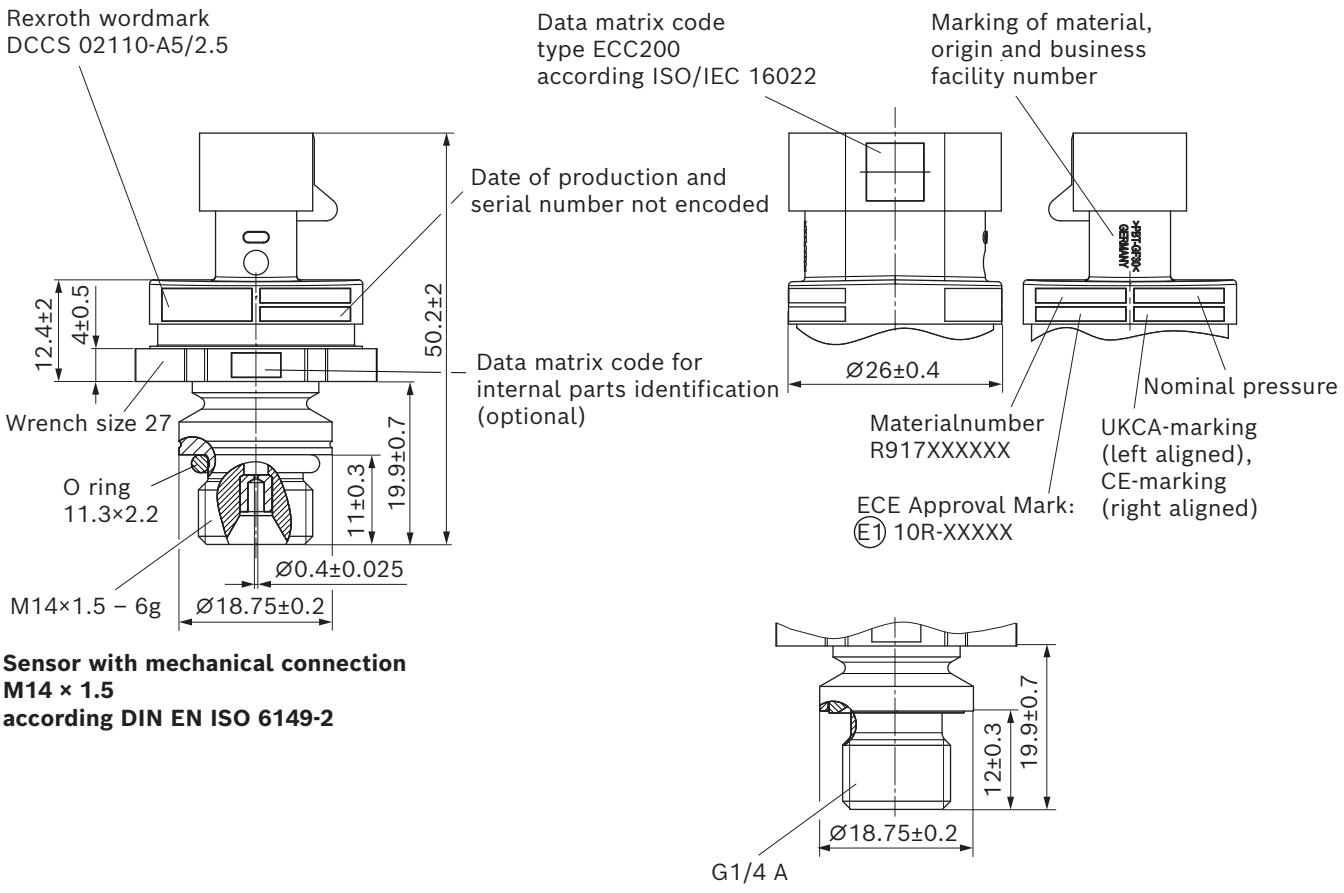
▼ Sensor connector: Bosch Compact 1.1a; code 2



Pin	Connection	
1	Ground	GND
2	Output signal	U_{sig}
3	Supply voltage	U_s

Dimensions

▼ **Sensor connector AMP Superseal 1.5 dimensions and labeling**



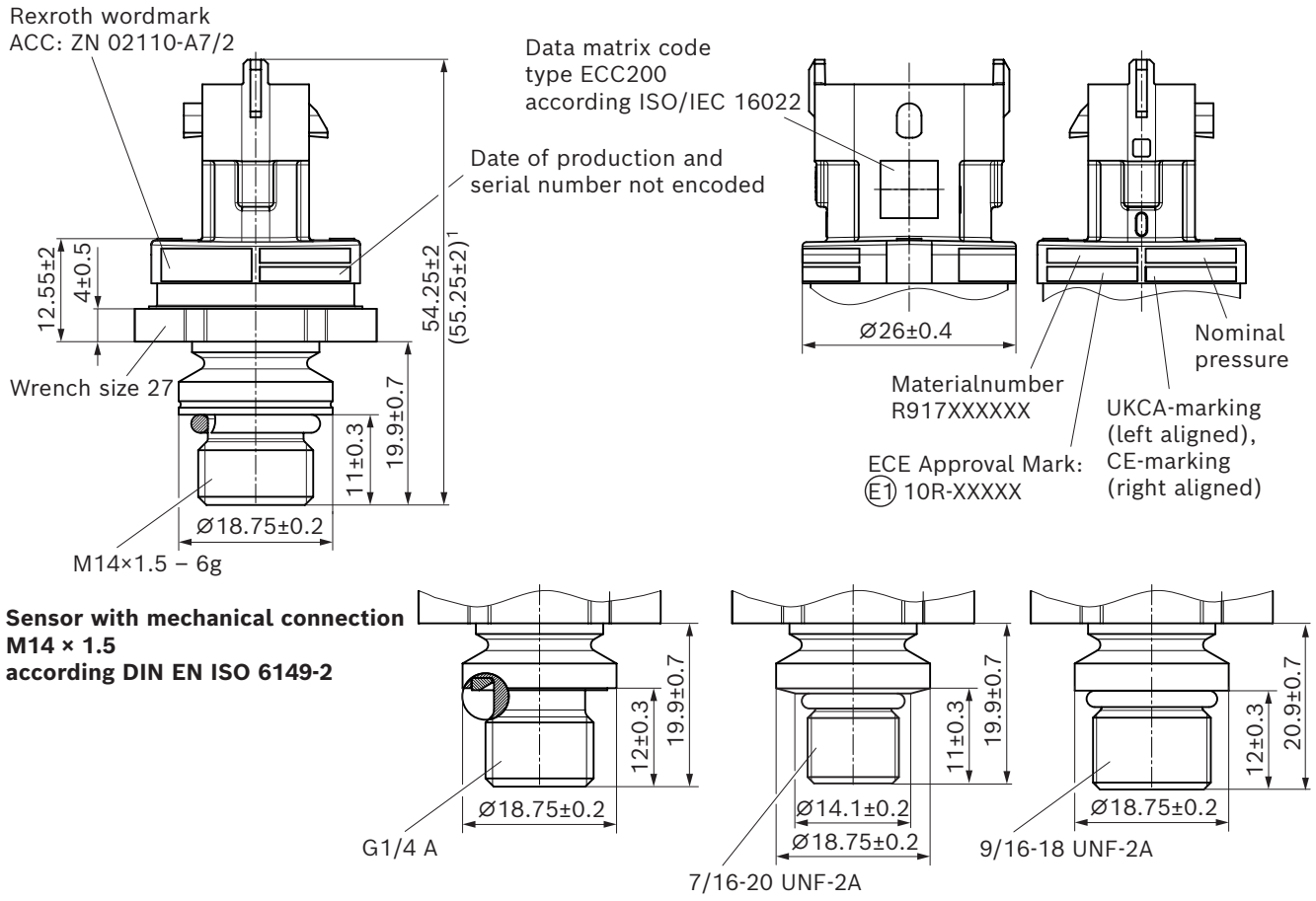
Sensor with mechanical connection M14 × 1.5 according DIN EN ISO 6149-2

Sensor with mechanical connection G 1/4 A according DIN EN ISO 1179-2

Data matrix code content

Content	Digits	Number
Material type: finished product	1	1
Material number R917XXXXXX	2 ... 11	10
Year of production	12 ... 13	2
Production day related to production year	14 ... 16	3
Serial number related to production day	17 ... 21	5
Number of production-line	22	1
Number of the manufacturing plant	23 ... 25	3
Internal Bosch Rexroth number	26 ... 30	5
Bosch Rexroth change index	31 ... 32	2
Bosch Rexroth drawing index	33 ... 35	3
Empty place for CD-free sensor	36	1

▼ **Sensor connector Bosch Compact 1.1a; code 1 and Bosch Compact 1.1a; code 2 dimensions and labelings**

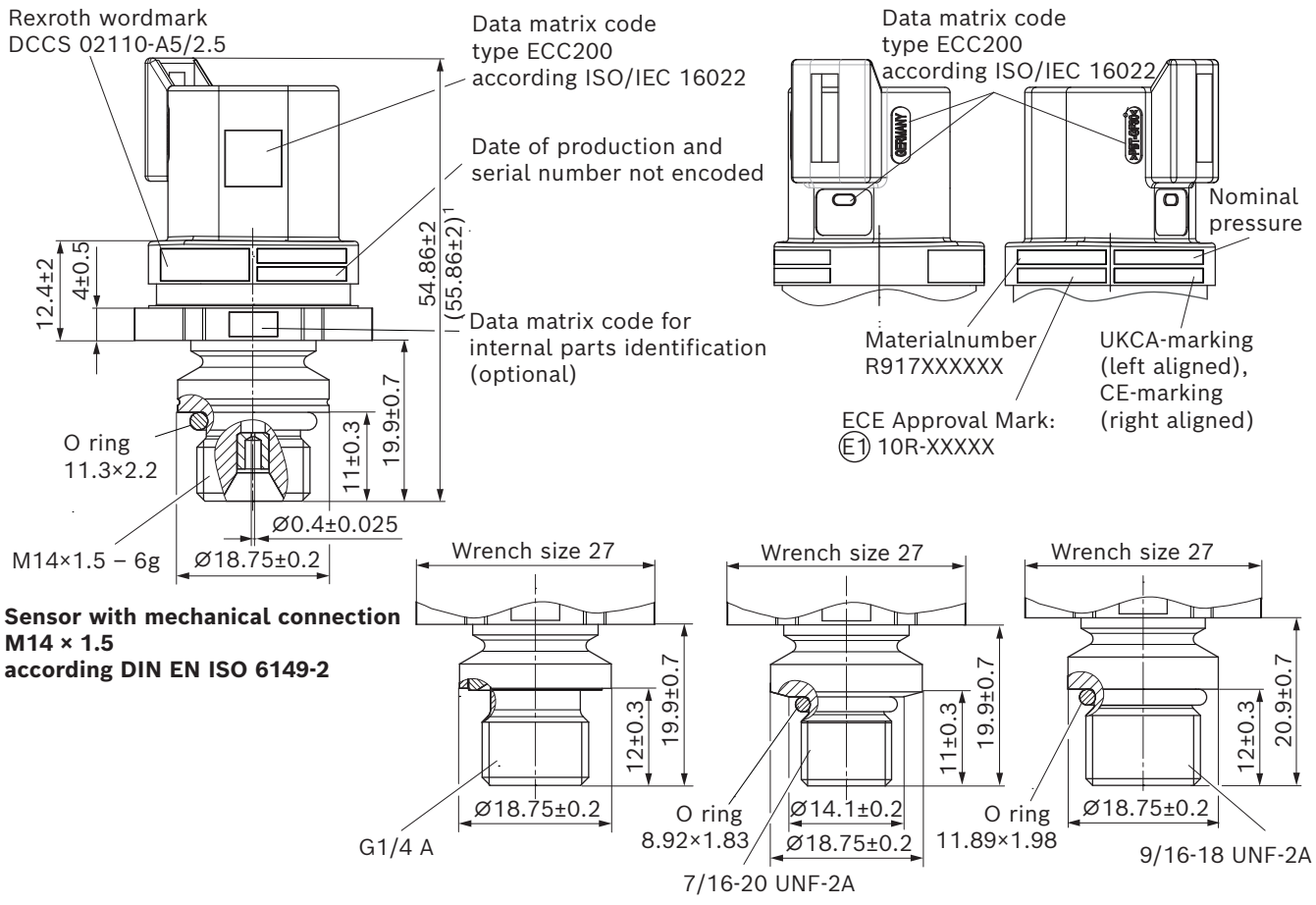


Data matrix code content

Content	Digits	Number
Material type: finished product	1	1
Material number R917XXXXXX	2 ... 11	10
Year of production	12 ... 13	2
Production day related to production year	14 ... 16	3
Serial number related to production day	17 ... 21	5
Number of production-line	22	1
Number of the manufacturing plant	23 ... 25	3
Internal Bosch Rexroth number	26 ... 30	5
Bosch Rexroth change index	31 ... 32	2
Bosch Rexroth drawing index	33 ... 35	3
Empty place for CD-free sensor	36	1

1) Clamp value valid for sensor version with mechanical connection 9/16-20 UNF

▼ **Sensor connector DEUTSCH DT04-3P dimensions and labelings**

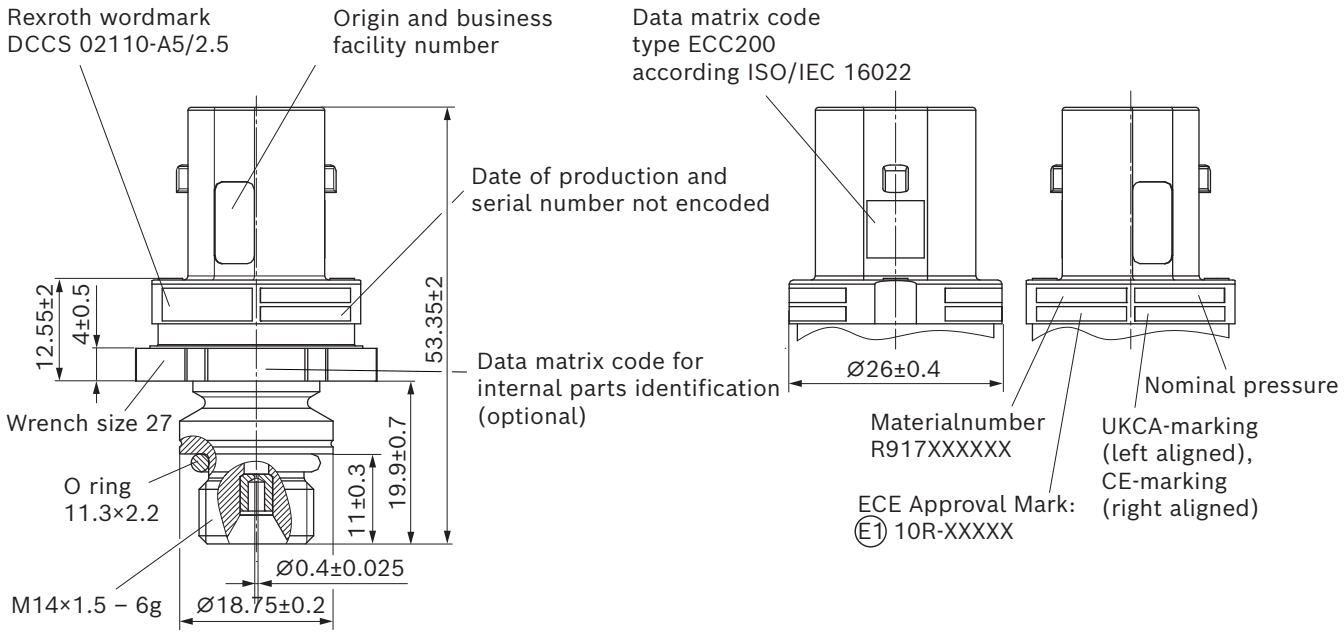


Data matrix code content

Content	Digits	Number
Material type: finished product	1	1
Material number R917XXXXXX	2 ... 11	10
Year of production	12 ... 13	2
Production day related to production year	14 ... 16	3
Serial number related to production day	17 ... 21	5
Number of production-line	22	1
Number of the manufacturing plant	23 ... 25	3
Internal Bosch Rexroth number	26 ... 30	5
Bosch Rexroth change index	31 ... 32	2
Bosch Rexroth drawing index	33 ... 35	3
Empty place for CD-free sensor	36	1

1) Clamp value valid for sensor version with mechanical connection 9/16-20 UNF

▼ **Sensor connector trapeze dimensions and labelings**



Sensor with mechanical connection M14 × 1.5 according DIN EN ISO 6149-2

Data matrix code content

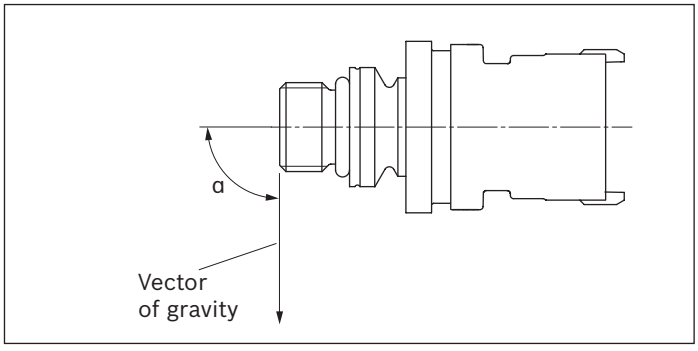
Content	Digits	Number
Material type: finished product	1	1
Material number R917XXXXXX	2 ... 11	10
Year of production	12 ... 13	2
Production day related to production year	14 ... 16	3
Serial number related to production day	17 ... 21	5
Number of production-line	22	1
Number of the manufacturing plant	23 ... 25	3
Internal Bosch Rexroth number	26 ... 30	5
Bosch Rexroth change index	31 ... 32	2
Bosch Rexroth drawing index	33 ... 35	3
Empty place for CD-free sensor	36	1

Mounting

Mounting process of sensor must be ensured by customer by adequate validation.
Bosch Rexroth recommends to wet the surface of thread and tightening plane of pressure sensor completely with Oil or Molykote WI5 prior to mounting.

To prevent accumulation of lubricant in the pressure port application of lubricant by spraying while pressure port facing downwards is recommended.
Recommended installation position α = ± (0 ... 90°) to the acceleration due to gravity in order to prevent fluid from entering when the mating connector is not plugged in.

▼ **Installation position**



Mechanical connection

Before installing and removing the sensor, make certain that the system is not pressurized.

Tightening torque

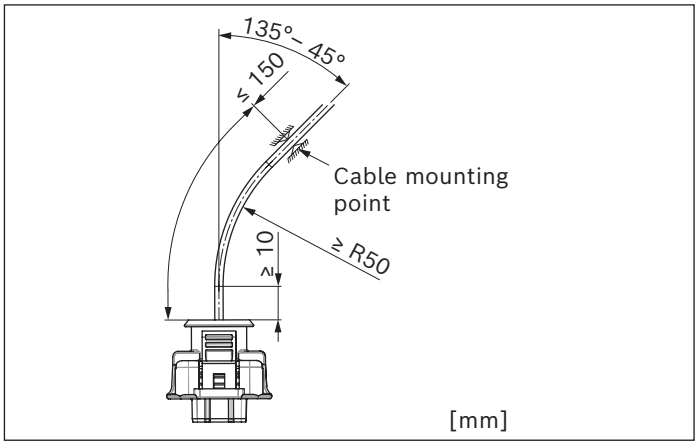
Before mounting the PR4 pressure sensor, check the specifield tightening torque of the hydraulic pump, motor or valve block.
If the torque for mounting the sensor in the respective hydraulic component is not specified, the following torques apply.

Mechanical connection	Torque [Nm]
G 1/4 A	50+5
7/16 UNF-2A	35+3.5
9/16 UNF-2A	45+4.5
M14 × 1.5 mm	45±4.5

The maximum tightening torque must not exceed the following values.

Mechanical connection	Torque [Nm]
G 1/4 A	55
7/16 UNF-2A	40
9/16 UNF-2A	50
M14 × 1.5 mm	55

▼ **Instruction for cable guide**



Required tooling[1)]

Designation	Number	Ordering No.
Bosch crimping pliers for BDK 2.8 terminal 0.5, 0.75, 1.0 mm² wire	1	1928498161
Bosch terminal dismantling tool for BDK 2.8 terminals	1	1928498167

1) The tools may be purchased from Bosch dealers or Bosch Service (www.bosch-service.com).

Assembly information

For assembly of connectors, please observe the assembly instructions for plug-in connections (Y 928 P00 222) and BDK 2.8 contacts (1 928 F00 025).
These assembly instructions are available on request from Bosch Rexroth.

Attention:

For assembly of the sensor connector in the vehicle, the following must be observed:

- The wiring harness must be mechanically fastened within a distance of ≤ 150 mm from the sensor connector.
- The wiring harness has to be secured in such a way that in-phase excitation with the sensor occurs.
- Use wiring harness connectors to protect the sensor against ingress of water.
- The sensor has an air bleed bore and is leaky if the mating connector is not plugged in! During processing and / or assembly, you must therefore use suitable protection against the ingress of humidity.

Electrical connection

- The sensor may only be installed by qualified 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 assembly.
- When connecting the mating connector, “hot plugging” must be prevented (= connection of the mating connector with live voltage).

Safety-related characteristics in accordance with ISO 13849, ISO 25119, ISO 19014-3, ISO 19014-4

Safety function of the PR4 pressure sensor is defined as the system integrity, i.e., it shall sense and process the pressure correctly and convert it into the corresponding output signals with a deviation of less than ± 5 bar.

The supply voltage measurement of the PR4 xxx xx SE/10 sensor is NOT safety-related.

- The PR4 pressure sensor possesses a single channel architecture
- The PR4 pressure sensor fulfills the requirements of basic and well-tried safety principles
- The PR4 pressure sensor meets the requirements on common cause failures and well-tried components
- The PR4 software meets the requirements of ISO 26262 ASIL B, which can support up to PL d according to ISO 13849, AgPL d according to ISO 25119 and MPL c according to ISO 19014-4

$MTTF_D$ and diagnostic coverage (DC_{avg}) of the PR4 pressure sensor with analog output signals[1)]

Ambient temperature [°C]	Operating time [%]	$MTTF_D$ [years]				DC_{avg} [%]
		24h/day	16h/day	8h/day	4h/day	
–40	6	1160	1657	2900	4640	65.4
23	20					
85	65					
135	8					
140	1					

$MTTF_D$ and diagnostic coverage (DC_{avg}) of the PR4 pressure sensor with SENT output signals[2)]

Ambient temperature [°C]	Operating time [%]	$MTTF_D$ [years]				DC_{avg} [%]
		24h/day	16h/day	8h/day	4h/day	
–40	6	1181	1687	2952	4724	66.5
23	20					
85	65					
135	8					
140	1					

1) It is assumed that the machine control unit will
   – Monitor the sensor operating conditions, among others the supply voltage and applied pressure, and make sure the sensor only works within the specified boundary conditions
   – React to the abnormal sensor output signals (see chapter “Behavior after undervoltage and overvoltage of the sensor PR4 xxx xx 05/10”, “Behaviour after connection failures PR4 xxx xx 05/10” and “Error diagnosis for Sensor PR4 xxx xx 05/10”), and bring the machine into machine safe state.

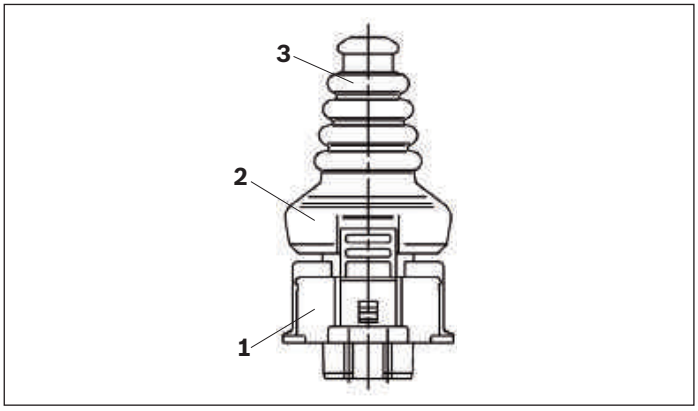
2) It is assumed that the machine control unit will
   – Monitor the sensor operating conditions, among others the supply voltage and applied pressure, and make sure the sensor only works within the specified boundary conditions
   – React to the abnormal sensor output signals (see chapter “Behavior after undervoltage and overvoltage of the sensor PR4 xxx xx SE/10”, “Behaviour after connection failures PR4 xxx xx SE/10” and “Error diagnosis for Sensor PR4 xxx xx SE/10”), and bring the machine into machine safe state.

Accessories

AMP connector set R902602132[1)]

Designation	Number	Ordering No.
Socket housing 3-pin	1	282087-1[2)]
Single-wire seal, yellow	3	281934-2[2)]
Socket contact	3	183025-1[2)]

Mating connector Bosch Compact 1.1a; code 1



Position	Designation
1	Compact 1.1a / Plug 3P / Code 1
2	End clip
3	Cap straight

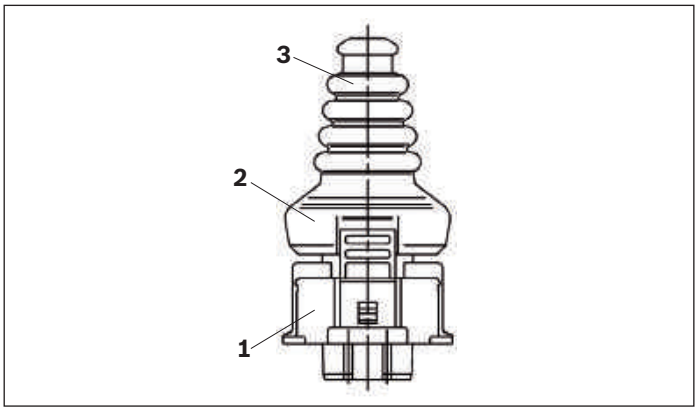
The suitable connector set is available under Rexroth material number R917009890 for manual assembly of wiring harness connectors for laboratory or small series requirements with the following contents:

Mating connector set Bosch Compact 1.1a; code 1 R917009890[1)]

Designation	Number	Ordering No.
Bosch Compact 1.1a connector	1	1928403966
BDK 2.8 Terminal Gold for 18 ... 20 AWG, 0.5 ... 1.0 mm^2	3	1928498054
Bosch compact cap straight	1	1928300527
BDK 2.8 / Single seal / Ø1.2 ... 2.1 mm / blue for insulation diameter 1.2 ... 2.1 mm	3	1928300599
End clip	1	1928403423

Further variants of the mating connector are available from Robert Bosch GmbH as well as via distribution.
See also the list in the drawing:
A 928 000 453 - Offer drawing compact plug 1.1[3)]

Mating connector Bosch Compact 1.1a; code 2



Position	Designation
1	Compact 1.1a / Plug 3P / Code 2
2	End clip
3	Cap straight

Mating connector set Bosch Compact 1.1a; code 2

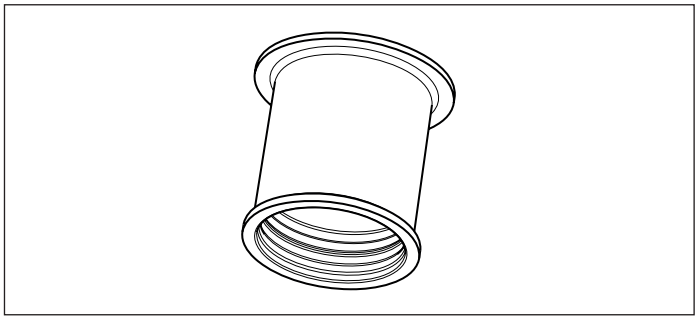
Designation	Number	Ordering No.
Bosch Compact 1.1a connector	1	1928403968
BDK 2.8 Terminal Gold for 18 ... 20 AWG, 0.5 ... 1.0 mm^2	3	1928498054
Bosch compact cap straight	1	1928300527
BDK 2.8 / Single seal / Ø1.2 ... 2.1 mm / blue for insulation diameter 1.2 ... 2.1 mm	3	1928300599
End clip	1	1928403423

Further variants of the mating connector are available from Robert Bosch GmbH as well as via distribution.
See also the list in the drawing:
A 928 000 453 - Offer drawing compact plug 1.1[3)]

1) The mating connector is not included in the scope of delivery. This can be supplied by Bosch Rexroth on request.
2) Available from AMP
3) Drawings and further information about Bosch connectors and tools can be found on the internet: www.bosch-connectors.com

Trapeze connector set R917012805[1)]

Protective cap (for PR4 with sensor connector AMP, Bosch Compact 1.1a; code 1, Bosch Compact 1.1a; code 2 or trapeze)



The protective cap is used to protect against moisture or fluids which can enter the sensor via the sensor connector as long as the cable wiring harness connector / mating connector is not plugged in.
In addition, it can also be used as transport protection for the sensor connector.
The protective cap can be ordered at Bosch Rexroth Elchingen.

Designation	Material number
Protective cap	R913078779

DEUTSCH DT04-3P connector set R902603524[1)]

Designation	Number	Ordering No.
Housing 3-pin	1	DT06-3S-EP04[2)]
Wedge	1	W3S[2)]
Sockets	3	0462-201-16141[2)]

1) The mating connector is not included in the scope of delivery. This can be supplied by Bosch Rexroth on request.
2) Available from DEUTSCH

Safety Instructions

General instructions

- Request a binding installation drawing before completing your design.
- The proposed circuits do not imply any technical liability for the system or the machine on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modifications to or repairs on the wiring can lead to dangerous malfunctions.
- Pressure gages may only be installed by trained personnel authorized by the system operator.
- Ports may only be opened in a depressurized state.
- The sensor may only be assembled / disassembled in a depressurized and de-energized state.
- When reassembling a sensor, the O-ring must be replaced.
- In order to prevent damage to the sensor and maintain its impeccable function, a professional air bleed of the hydraulic system is required.
- 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 dangers. 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.
- Residual measurement media in dismantled pressure gages may cause hazards to people, the environment and equipment. Adequate precautions must be taken.
- Despite the greatest care being taken when compiling this document, it is not possible to consider all feasible applications. If notices for your specific application are missing, please contact Bosch Rexroth.

Notices on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g., exhaust).
- The connection lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- Painting the sensor with electrostatic charge is not permitted (danger: ESD damage).
- Suitable measures, e.g. individual wire sealing of the cables/wires, must be taken to ensure that no liquids can enter the sensor.
- Notice for use in oil environment
  - If it cannot be ruled out that oil can get into the connector chamber, a sensor with a "Bosch Compact 1.1a; code 2" connector to be used. Only the following non-electrically conductive oils[1)] may be used with this sensor:
    - Petronas Akcela Hy Tran Ultra
    - Shell Spirax S4TXM
    - Total Dynatrans MPV
    - John Deere Hy-Gard
  - When used in safety functions, suitable measures must be taken to ensure that no oil can get into the sensor.
- With a suitable installation in the vehicle, it is to be ensured that there is no water accumulation in the diaphragm (danger: measuring bridge detuning or diaphragm fracture in case of frost).

Notices on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- If the sensor is dropped, it is not permissible to use it any longer, as invisible damage could have a negative impact on reliability.
- Store the sensor in a dry and dust-free place. Ensure that any contamination with fluid or solid media in the area of the connector or on the thread can be excluded.
- Atmospheres containing sulfur are to be avoided in silver-plated connector pinning. For this application, we recommend using gold-plated contacts.
- The storage conditions described in the chapter "Technical data" do not lead to any change in the characteristics and the function of the high-pressure sensor.
- Upon exceedance of the maximum storage duration, the sensors must be returned to Bosch Rexroth AG for examination.

1) Further oils will only be released after a positive test at Bosch Rexroth.

Notices on wiring and circuitry

- Use twisted lines for the connection of the sensor.
- To minimize voltage drop in the line, the lines used must be as short as possible and, if applicable, have a larger cross section between the sensor and the electronic control unit.
- We recommend using twisted and shielded lines as well as connecting one side of the shield to the vehicle ground or the housing ground of the electronics.
- The sensor mating connector must only be plugged and unplugged when it is in a deenergized state.
- The sensor lines are sensitive to spurious interference. For this reason, the following measure 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 in the near of other power-conducting lines in the device or vehicle.
- The wiring harness should be fixated mechanically 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.
- The Bosch Rexroth warranty only covers the function of the plug-in system in combination with wiring harness connector system parts according to this data sheet.
- Only use appropriate tools for crimping and installing the mating connector.
- Bending of the cable (deviation from the straight line) between cable outlet at the sensor and first assembly point, 20 ... 90°.
- Permissible bending radius of the cable until the first cable diameter: R ≥ 50 mm.

Intended use

- The sensor is designed for use in mobile working machines provided that no limitations / restrictions are made to certain application areas in this data sheet.
- Before installation, commissioning and operation, you must always ensure that the correct pressure gage has been selected with regard to measurement range, version and specific measurement conditions, and that the gage is suitable for wetted material (corrosion). National safety regulations must also be observed.
- Generally, the sensor must be operated within the operating ranges specified and approved in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.
- If necessary, a throttle in the hydraulic system which limits possible pressure peaks and pulses must be installed. Please also observe any specific operating conditions which could cause cavitation, for example. Make sure to avoid any stress exceeding the specified values. Cavitation must be prevented in any operation or standby mode.
- 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.
- Severe personal injury and / or damage to property may occur in case of non-compliance with the corresponding specifications.

Improper use

- Any use of the sensor other than that described in the 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 PR4 pressure sensor for any machine safety functions.
  - Limited by its low DC_{avg}, the PR4 pressure sensor can support a safety level up to PL b/ AgPL b when integrated properly into machine safety-related system following all relevant requirements in this document.
  - If higher PL or AgPL is required, additional failure detection methods need to be implemented by the machine control system.
  - The failure detection possibilities and reactions of the PR4 pressure sensor are listed in this datasheet. The sensor shall not be used if the failure reaction is

determined to be insufficient for the machine safety functions.

- The customer is responsible for protecting the PR4 pressure sensor against out-of-boundary operating conditions specified in this datasheet, e.g., overpressure, overvoltage, undervoltage, overcurrent, overtemperature, etc.
- The machine control shall monitor the PR4 pressure sensor output signals and respond to the abnormal output signals by bringing the machine into a safe state.
- An efficient field observation process shall be established by the customer. Any field failures involving the PR4 pressure 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.

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RE 95181/2023-03-23
Replaces: 2020-03-27

rexroth
A Bosch Company

Temperature sensor for air TSA

- Typical use in fan controls
- Measuring range -30 °C to 130 °C
- Resistor 800 to 1550 Ω temperature dependent
- Protection class IP64

Contents

Product description

The sensor element comprises a PTC nickel thin-film resistor, which is vapor-deposited onto a ceramic carrier substrate. This small plate is mounted in a plastic housing to protect it from damage. The lattice structure and hydrodynamic design of the inlet and outlet limit the sensor time constant and/or the delay.

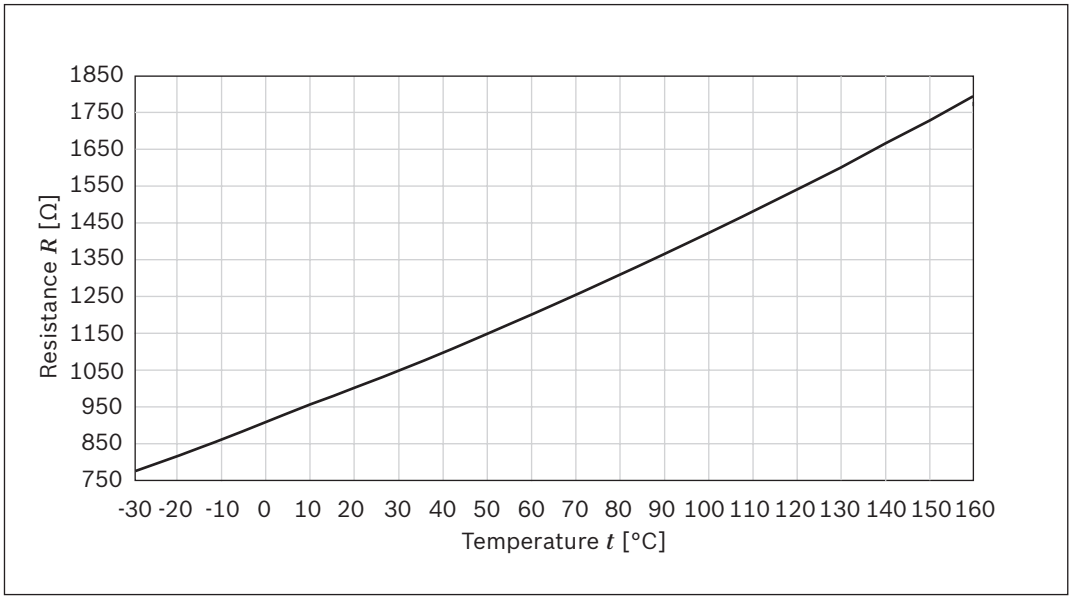
Type code

Designation	Ordering No.
Sensor (without connector set)	0 538 009 203

The mating connector is not included in the scope of delivery. This can be supplied by Bosch Rexroth on request (see Chapter “Accessories”)

Technical data

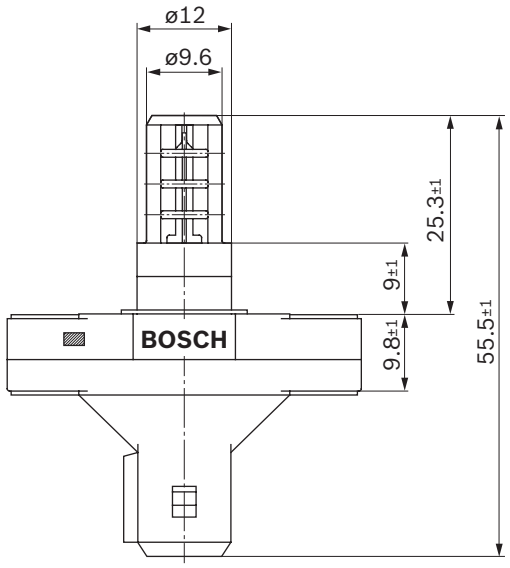
Type		**TSA**
Measuring range		-30 °C ... +130 °C
Measurement accuracy	at 20 °C	±0.5 K
	at 100 °C	±1.1 K
Resistor		1000 Ω
Tolerance	at 20 °C	±0.3 %
	at 100 °C	±0.5 %
Maximum permissible current		5 mA
Time constant (in standing water)		→ 0
Type of protection		IP 64 with the connector plugged in
Plug connection		Jet connector, 2-pin
Mounting type		2 x M6
ROHS		EU-RoHS2-compliant
Storage time		5 years at an average relative humidity of 60 % and a temperature between -10 °C and +30 °C. For short periods of up to 100 hours a storage temperature of -20 °C to +40 °C is permissible.

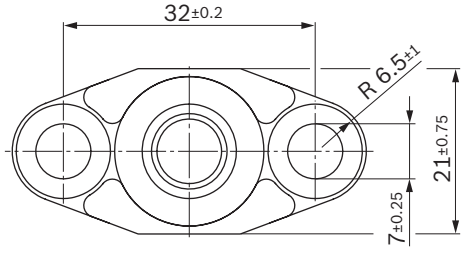


Temperature / resistance data

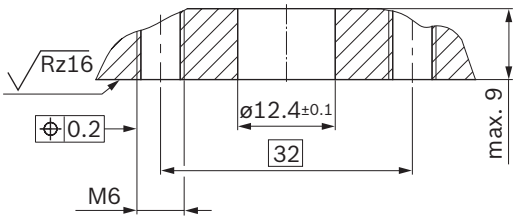
Temperature t	**°C**	**-30**	**-25**	**-20**	**-15**	**-10**	**-5**	**0**	**5**	**10**	**15**
Resistor R	Ω	775.2	796.3	817.7	839.5	861.5	883.8	906.4	929.4	952.6	976.2
Temperature t	**°C**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**50**	**60**	**65**
Resistor R	Ω	1000.0	1024.1	1048.6	1073.4	1098.4	1123.8	1149.4	1175.4	1201.7	1228.3
Temperature t	**°C**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**105**	**110**	**115**
Resistor R	Ω	1255.1	1282.3	1309.8	1337.6	1365.7	1394.1	1422.8	1451.8	1481.1	1510.7
Temperature t	**°C**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	
Resistor R	Ω	1540.6	1570.8	1601.3	1632.2	1663.3	1694.7	1726.5	1758.5	1790.8	

Dimensions





Temperature sensor support



Tightening torque:
2.6 - 3.5 Nm

[mm]

Accessories

Mating connector (connector set)

Material number	Connector set
R917000516	comprising: 1 x connector housing (Bosch-Material number 1284485110) 2 x contact spring (Bosch-Material number 1284477176, AMP- Material number: 925590-3) 1 x protective cap (Bosch-Material number 1280703026)

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

Safety Instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modifications or repairs to the wiring could lead to dangerous malfunctions.
- The sensor may only be assembled/disassembled in a deenergized state.
- Only trained and experienced specialists who are adequately familiar with both the components used and the complete system should implement system developments or install and commission electronic systems for controlling hydraulic drives.
- When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- Do not use defective components or components not in proper working order. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to consider all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- The use of sensors by private users is not permitted, since these users do not typically have the required level of expertise.

Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- Cables/wires must be sealed individually to prevent water from entering the sensor.

Notes on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- If it is dropped, the sensor must not be used any longer, as invisible damage could have a negative impact on reliability.

Notes on wiring and circuitry

- Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The sensor mating connector must only be plugged and unplugged when it is in a deenergized state.
- The sensor lines are sensitive to spurious interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and approved in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.
- Use outside of the specified and approved boundary conditions may result in danger to life and/or cause damage to components which could result in sequential damage to the mobile working machine.
- Serious personal injury and/or damage to property may occur in case of non-compliance with the appropriate regulations.

Improper use

- Any use of the sensor other than that described in the chapter "Intended use" is considered to be improper.
- Use in explosive areas is not permitted.
- Damages which result from improper use and/or from unauthorized, unintended interventions in the device not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and determining the possible safety-related functions.
- In safety-related applications, the customer is responsible for taking proper measures to ensure safety (sensor redundancy, plausibility check, emergency switch, etc.).

Disposal

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

Further information

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

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RE 95182/2024-01-08
Replaces: 2023-06-12

Temperature sensor for fluids TFW

- NTC Sensor
- Measuring range −40 to +140 °C
- Resistor 45 kΩ to 71 Ω temperature-dependent
- Protection class IP5K9K, IPX6K, IPX7

Contents

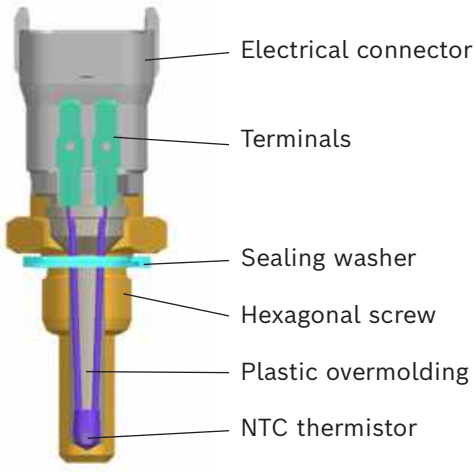
Product description

The main function of the temperature sensor (TFW) is to measure temperature and convert it into an electrical signal. The temperature sensor houses an NTC thermistor, the resistance of which decreases with an increase in temperature. The TFW is suitable for the measurement of liquid media, e.g., coolant, fuel, oil etc.
The sensor is a passive sensor. The product does not store or process digital data.

Available variants[1)]

Type	Order number
TFW	0 281 002 209

Design



1) This sensor is a non-customer-specific standard product. Bosch Rexroth may implement changes to the product over the course of the time which do not influence the products' s characteristics and/or functions as described in this datasheet.

Technical data

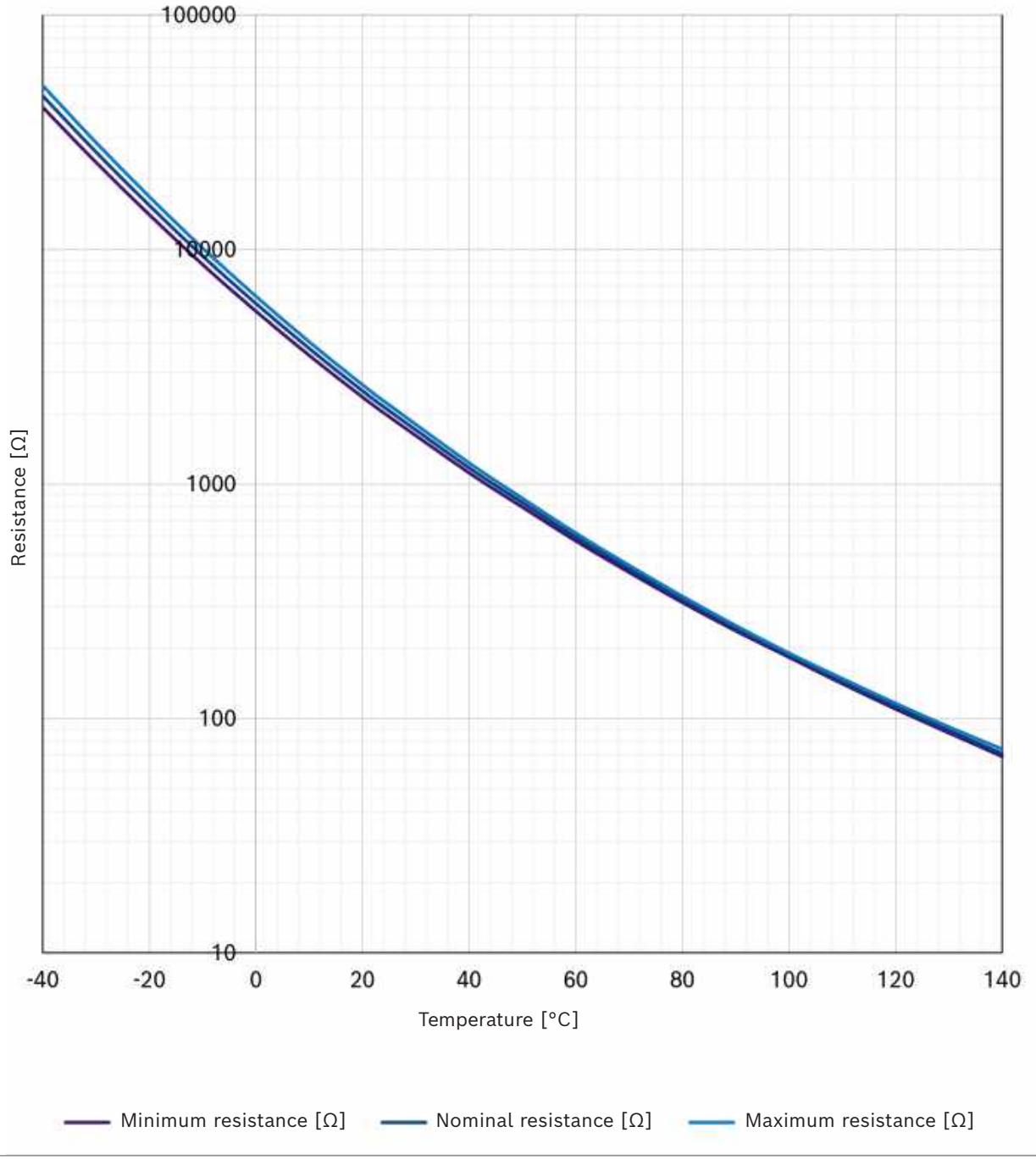
Type		**TFW**
Permissible fluids		Liquid media, e.g., coolant, fuel, and oil
Supply voltage		5 V±150 mV
Power consumption / power output		TFW is a passive sensor with very minimal power dissipation. The power consumption is dependent on the temperature and the series resistor. With a series resistor of 1 kΩ, the typical power consumption at a temperature of 25 °C is approximately 5 mW.
Response time		τ63 ≤ 15 seconds (measured in oil from +20 ... +100°C)
Maximum permissible pressure		5 bar
Nominal resistance at +100 °C		0.1866 kΩ±2%
Necessary series resistor		1 kΩ
Type of protection		IP5K9K, IPX6K, IPX7
Operating temperature range	Connector zone	-40 ... +130 °C
	Sensor zone	-40 °C ... +140 °C
	Short term (100 h cumulative)	+150 °C
Electrical connection		Bosch Kompakt variant A, 2 way, code 1
Weight		~30 g
Chemical tests (The sensor is tested against listed chemical agents. Complete sensor was subjected to the test.)		Super gasoline according to DIN EN 228, diesel according to DIN EN 590, motor oil SAE 10 W 50, oil of hydraulic system (commercial), transmission fluid (commercial), antifreeze, battery fluid (37% sulphuric acid), headlight/ windscreen cleaner (undiluted), brake fluid, engine cleaning agent, denatured alcohol (spirit)
Shelf life		12 years (After a storage time of 8 years, a test at Bosch Rexroth is necessary at the expense of the customer. After a total storage time of 12 years, sensor must be scrapped.)
Storage time and storage temperature		The sensor must be stored in dry and dust-free condition, within the permissible storage temperature range between -30 ... +60 °C and at an average relative humidity of 20 ... 60%. Direct sunlight must be avoided.
Lifetime (valid under the conditions described in this data sheet)		Maximum 6000 hours of operational time, but no longer than 15 years (whichever occurs first).

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]**
-40	40481	45303	50124	60	573	595	618
-30	23575	26108	28640	70	421	436	450
-20	14093	15458	16824	80	313	323	332
-10	8640	9395	10149	90	237	243	249
0	5465	5895	6324	100	183	187	190
10	3541	3791	4042	110	141	144	148
20	2351	2499	2648	120	110	113	116
25	1940	2056	2173	130	87	89	92
40	1118	1174	1231	140	69	71	74
50	798	834	869				

The values mentioned in table are valid only for new parts. After ageing, a variation of ±5% relative to the measured resistance value in new condition is permissible.

▼ **Transmission characteristic**



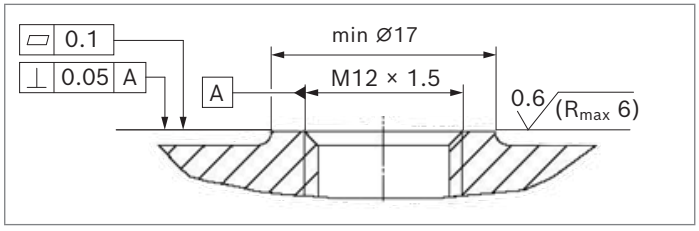
Time constant τ63 ≤ 15 seconds (measured in oil from +20 to +100 °C)

Installation instructions

General instructions

The TFW sensor is a negative temperature coefficient (NTC) thermistor which is used to measure the media temperature. The sensor tip must always be in continuous contact with the fluid for accurate and consistent results.

Mechanical interface

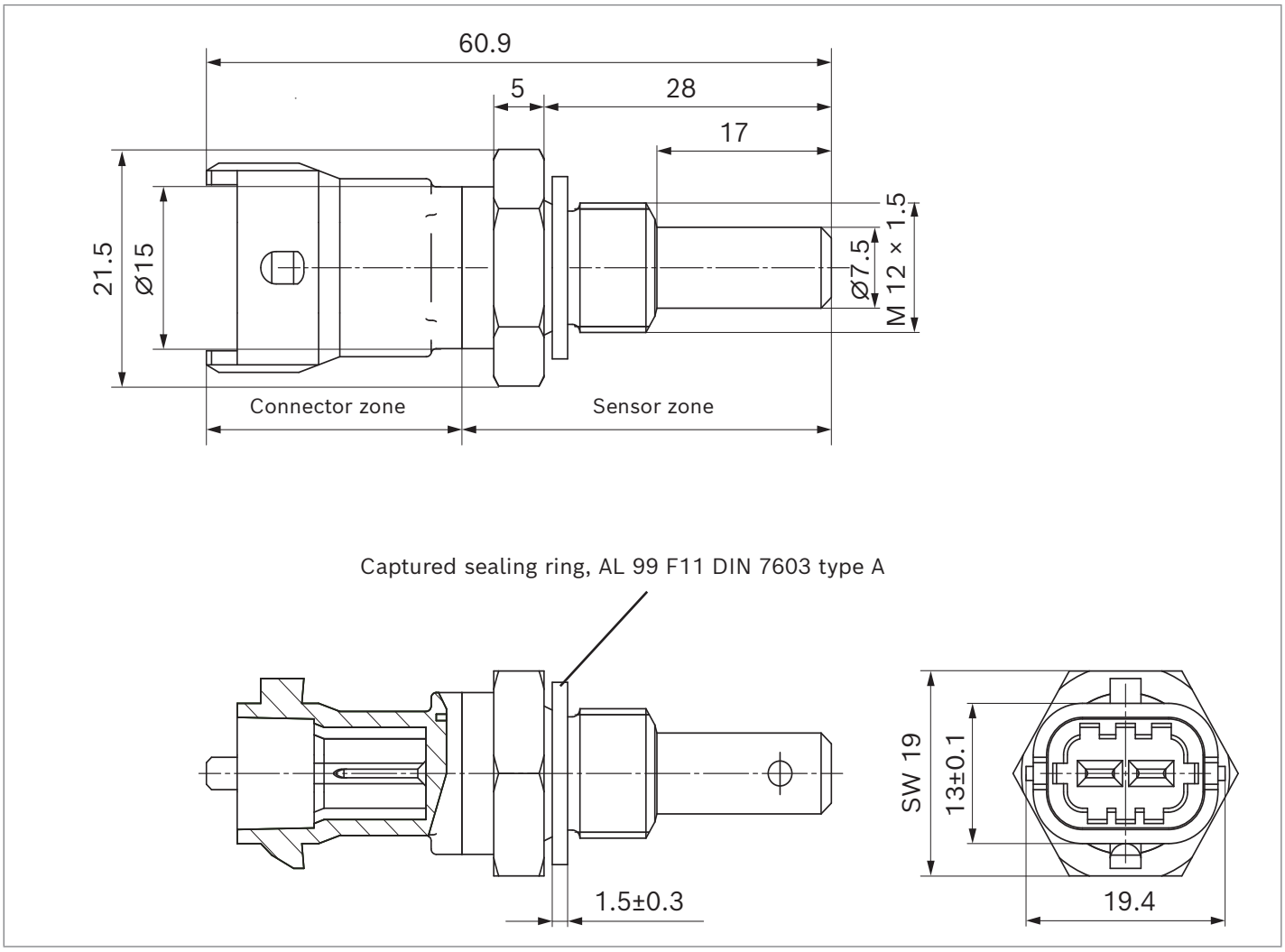


Screw plug M12 x 1.5 according to DIN 3852-1 form Z, but with thread length of min. 11 mm.
Permissible tightening torque: 20±5 Nm

Electrical interface

The coating on the mating connector terminals must match the coating on the terminals of the Temperature sensor to ensure a reliable electrical connection.
The first fixation point of the wiring harness must be on the same vibration level as the sensor’s mounting position, with a maximum distance of 150 mm from the connector. More than one fixation point is recommended for a wiring harness of length greater than 200 mm.

Dimension



Service, repair, and maintenance

Repair of the product is not possible. Service and repair or replacement of the product may only be performed by technically qualified personnel.

Accessories

Mating connector (connector set)

Material number	Connector set
R917015681	comprising: 1 x connector housing (Bosch-Material number 1928403874) 2 x contact (Bosch-Material number 1928498056) 2 x single-wire seal (Bosch-Material number 1928300599)

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

Safety Instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modifications or repairs to the wiring could lead to dangerous malfunctions.
- The sensor may only be assembled/disassembled in a deenergized state.
- Only trained and experienced specialists who are adequately familiar with both the components used and the complete system should implement system developments or install and commission electronic systems for controlling hydraulic drives.
- When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- Do not use defective components or components not in proper working order. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to consider all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- The use of sensors by private users is not permitted, since these users do not typically have the required level of expertise.
- Class III component with QM classification
  - Bosch Rexroth points out that the system/product does not implement any ASIL-classified requirements (in the sense of ISO 26262:2018). It is therefore not approved by Bosch Rexroth for applications in which one or more requirements with an ASIL classification (above QM) are assigned to the Bosch Rexroth scope of supply.
- Bosch Rexroth liability for defects in the function of the plug connection only if the plug connection system parts specified in this datasheet or in the corresponding plug connection offer drawing are used and if the connector is used within the limits (electrical/mechanical /thermal) described in the plug connection specification.
- Customer is responsible to verify that the product is fit for its intended purpose and is responsible for the proper application/calibration of the product

Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- Cables/wires must be sealed individually to prevent water from entering the sensor.

Notes on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- If it is dropped, the sensor must not be used any longer, as invisible damage could have a negative impact on reliability.
- During transport or mounting of the component, the connector must not be contaminated by chemically reactive liquids or water.

Notes on wiring and circuitry

- Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The sensor mating connector must only be plugged and unplugged when it is in a deenergized state.
- The sensor lines are sensitive to spurious interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.

- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and approved in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.
- Use outside of the specified and approved boundary conditions may result in danger to life and/or cause damage to components which could result in sequential damage to the mobile working machine.
- Serious personal injury and/or damage to property may occur in case of non-compliance with the appropriate regulations.

Improper use

- Any use of the sensor other than that described in the chapter "Intended use" is considered to be improper.
- Use in explosive areas is not permitted.
- Damages which result from improper use and/or from unauthorized, unintended interventions in the device not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and determining the possible safety-related functions.
- In safety-related applications, the customer is responsible for taking proper measures to ensure safety (sensor redundancy, plausibility check, emergency switch, etc.).

Lifetime

The lifetime statement must be differentiated from the applicable warranty period which expires independently from the duration of this lifetime statement.
Bosch Rexroth trusts that the customer will assess if the Bosch Rexroth-product's lifetime specified in this datasheet is in line with the relevant legal lifetime requirements applicable to the customers system in the specific target country and whether any particular measures need to be taken in order to comply with relevant legal lifetime requirements (e.g. if the Bosch Rexroth-product needs to be replaced after the Bosch Rexroth-product's lifetime period).
The behavior of Bosch Rexroth-product after its lifetime as stated above is not validated. A safety risk when used beyond the stipulated component's lifetime cannot be ruled out. Therefore, customer has to evaluate what measures to implement when reaching the end of Bosch Rexroth-product's lifetime in order to avoid such risk (e.g. after customer's evaluation, information to end-customer or other more far-reaching measures).

Disposal

- The sensor is an electronic component. During disposal the sensor shall not be mixed with municipal waste. The sensor being an e-waste needs to be disposed of and recycled respecting the local laws and applicable regulations.

Further information

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

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RE 95180/2024-04-09
Replaces: 2023-03-23

rexroth
A Bosch Company

BODAS Temperature sensor for fluids TSF

- Typical use in fan controls
- Measuring range −40 to +150 °C
- Resistor 800 to 2000 Ω temperature dependent
- Protection class IP65

Contents

Product description

The sensor comprises a PTC nickel thin-film resistor, which is evaporated onto a ceramic carrier substrate in a meandering pattern. Installed in a metallic radiator housing, it is used to measure the temperature of fluids. Its resistance behavior is almost linear.

Type code

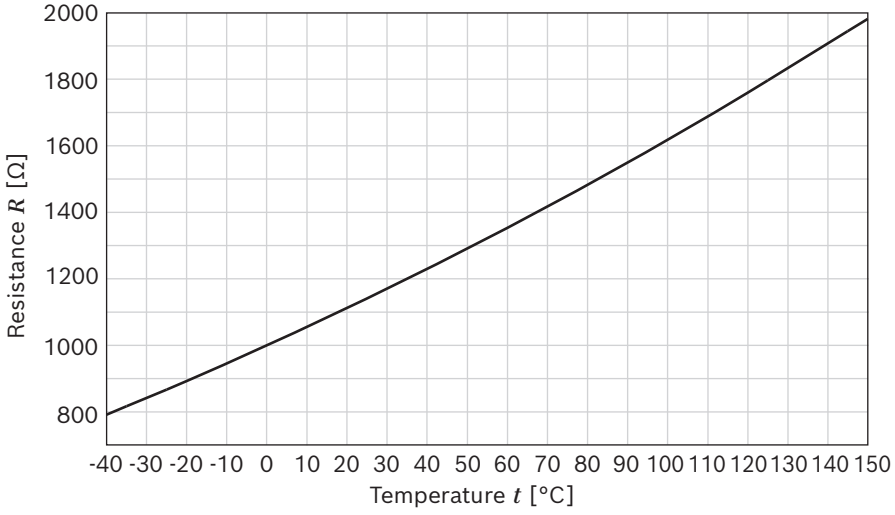
Designation	Ordering No.
TEMPERATURE SENSOR[1)]	0 538 009 252

The mating connector is not included in the scope of delivery. This can be supplied by Bosch Rexroth on request (see page 10 “Accessories”)

1) Without connector set

Technical data

Type		**TSF**
Measuring range		–40 ... 150 °C
Maximum pressure		150 bar
Resistor	at 0 °C	1000 Ω
Tolerance[1)]	at 20 °C	±0.5 K corresponds to ±0.3% of R20
	at 100 °C	±1.1 K corresponds to ±0.5% of R100
Supply voltage		5±0.5 V
Maximum permissible current		5 mA
Time constant (in standing water)		11 s
Delay		1 s
Vibration resistance		40 g
Type of protection		IP 65 with the connector plugged in
Plug connection		Jet connector, 2-pin
Screw thread		M14 × 1.5
Material		Brass and plastic
RoHS		EU-RoHS2-compliant
Maximum storage period from manufacturing date		2 years at relative humidity 40 ... 70 % and storage temperature –20 ... +50 °C, no storage with substances that emit aggressive steams or dusts

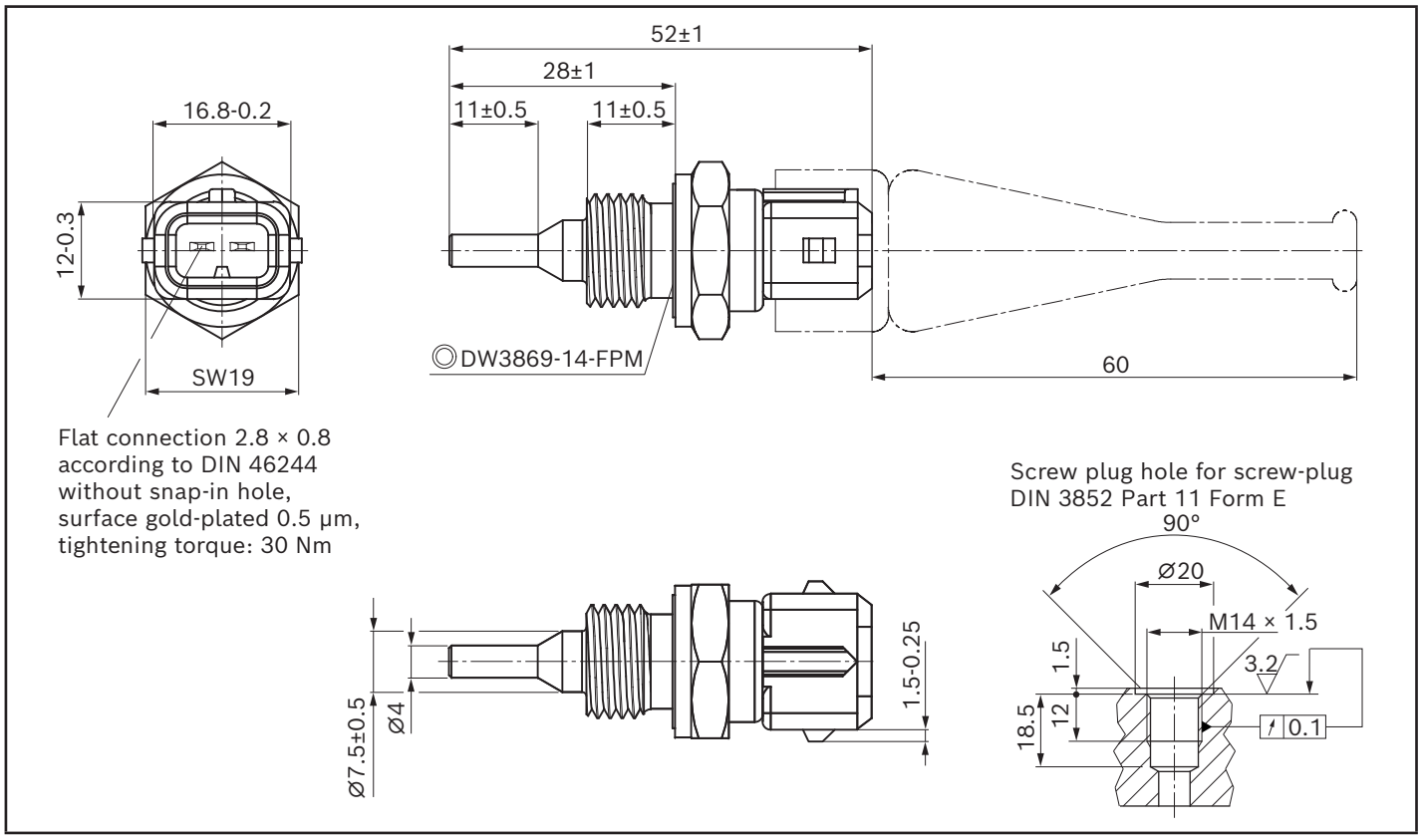


Temperature / resistance data

Temperature t	**°C**	**–40**	**–30**	**–25**	**–20**	**–15**	**–10**	**–5**	**0**	**5**	**10**
Resistor R	Ω	791.0	841.5	867.0	893.0	919.2	945.8	972.7	1000.0	1027.6	1055.5
Temperature t	**°C**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
Resistor R	Ω	1083.8	1112.4	1141.3	1170.6	1200.2	1230.1	1260.4	1291.1	1322.0	1353.4
Temperature t	**°C**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**105**	**110**
Resistor R	Ω	1385.1	1417.2	1449.7	1482.5	1515.7	1549.4	1583.4	1617.8	1652.7	1687.9
Temperature t	**°C**	**115**	**120**	**125**	**130**	**135**	**140**	**145**			
Resistor R	Ω	1723.6	1759.8	1796.4	1833.4	1871.0	1909.0	1947.5			

1) To determine tolerances at other temperatures, the formula applies:
Tolerance = 0.4 + 0.007 × temperature

Dimensions


52±1
28±1
11±0.5
11±0.5
16.8-0.2
12-0.3
SW19
DW3869-14-FPM
60
Flat connection 2.8 × 0.8
according to DIN 46244
without snap-in hole,
surface gold-plated 0.5 µm,
tightening torque: 30 Nm
Screw plug hole for screw-plug
DIN 3852 Part 11 Form E
90°
Ø20
M14 × 1.5
3.2
1.5
18.5
12
0.1
Ø7.5±0.5
Ø4
1.5-0.25

Information

Manufacturer confirmation of $MTTF_D$ values

The component was developed and series produced before the validity of the currently applicable machinery directive 2006/42/EC and the harmonized EN ISO 13849 standard.

The component is not a safety component in the sense of machinery directive 2006/42/EC and has not been developed according to ISO 13849.

The $MTTF_D$ value was determined according to field experience.

The $MTTF_D$ value of 455.58 is determined for 8760 hours of continuous operation in a temperature range of −40 ... 150 °C.

Rating of the safety principles based on DIN EN ISO 13849-2

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

General safety principles	Comment A1	Methods applied for development
Use of suitable materials and appropriate manufacturing processes	Selection of the materials, manufacturing and treatment processes taking into consideration, e.g. tension, durability, elasticity, friction, wear, corrosion, temperature.	Materials used are specified in the data sheet. The system operator must ensure correct selection.
Correct sizing and configuration	Accounting for e.g. tension, expansion, fatigue, surface roughness, tolerances, snagging, manufacturing processes.	Selected dimensions and configuration are specified in the data sheet. The system operator must ensure correct selection.
Suitable selection, combination, arrangement, assembly and installation of the components/system	Consideration of the manufacturer's application instructions, e.g. catalog sheets, installation instructions, specifications, as well as application of proven technical experience with similar components/ systems.	The components of the sensor are matched to one another with regard to geometry and materials.
Application of the principle of energy separation	Safe state is achieved by disconnecting from energy. See authoritative shutdown procedure in ISO 12100:2010, 6.2.11.3. Energy is required to initiate movement in a mechanism. See authoritative start-up procedure in ISO 12100:2010, 6.2.11.3. Accounting for various operating states, e.g. operating mode, maintenance mode. IMPORTANT - This principle should not be applied if a loss of power would cause a hazard, e.g. loss of clamping force releases tool.	Since the sensor is a passive component, it is supplied with current from the higher-level electronics.
Adequate mounting	Manufacturer's application instructions must be observed when using screw locks. An appropriate torque limitation method can be used to prevent excessive stress and to achieve adequate resistance to prevent the connection from loosening.	The correct mounting is specified in the data sheet (max. 30 Nm) and must be ensured by the system operator.
Limitation of the generation and/or transmission of force and like parameters	Examples include shear pin, shear plate, torque limiting coupler. IMPORTANT - This principle should not be applied if the continued integrity of the components is essential for maintaining the necessary level of control.	Not applicable to the temperature sensor (N/A).

General safety principles	Comment A1	Methods applied for development
Limitation of the range of environmental parameters	Temperature, air humidity and contamination at the installation location are examples of these parameters. See ISO 13849-2, Section 10 and the manufacturer's application instructions.	The operating temperature / ambient temperature is specified in the data sheet and is –40 ... 150 °C.
Limitation of speed and similar parameters	Observe the speed, acceleration and deceleration that are required by the application.	Not applicable to the temperature sensor (N/A).
Adequate reaction time	Observance of, e.g. reduction of spring force, friction, lubrication, temperature, inertia during acceleration and deceleration, combination of tolerances.	Response times are specified in the data sheet. Response times in water t05 = 1.2 sec / t09 = 3.2 sec.
Protection against unexpected start-up	Accounting for unexpected start-up caused by stored energy and after reestablishment of energy supply for different operating states, such as operating mode, maintenance mode, etc. A special mechanism for discharging stored energy may be necessary. Special applications, e.g., for saving energy for clamping device or for ensuring of a position have to be considered separately.	Not applicable to the temperature sensor (N/A).
Simplification	Avoidance of unnecessary components in safety-related systems.	Not applicable to the temperature sensor (N/A).
Isolation	Isolation of safety-related functions from other functions.	The temperature sensor only has one function (Temperature measurement).
Adequate lubrication	Observance of the necessity of lubrication mechanisms, specifications on lubricants and lubrication intervals.	Not applicable to the temperature sensor (N/A).
Adequate protection to keep out fluids and dust	Observance of IP type of protection (see IEC 60529).	Qualification with identical versions.

Well-tried safety principles	Comment A2	Methods applied for development
Use of carefully selected materials and manufacturing processes	Selection of suitable materials for the application, as well as appropriate manufacturing and treatment processes.	The selected material is indicated in the customer drawing; the system operator must make sure that the material is suitable.
Use of components with defined failure behavior	The predominant failure behavior of a component is known in advance and is consistent. See ISO 12100:2010, 6.2.12.3.	Not applicable to the temperature sensor (N/A).
Oversizing/ safety factor	The safety factors specified in the standards or based on experience with safety-related applications should be applied.	Not applicable to the temperature sensor (N/A).
Secured position	The mobile element of the component is mechanically held in a secure position (friction alone is insufficient). The application of force is required for movement out of the secured position.	Not applicable to the temperature sensor (N/A).
Increased OUT force	A safe position/safe state is achieved by increasing the OUT force in relation to the IN force.	Not applicable to the temperature sensor (N/A).
Careful selection, combination, arrangement, assembly and installation of the components/systems for the relevant application	-	The components of the sensor are matched to one another with regard to geometry and materials.
Careful selection of the mounting type for each application	Avoidance of mounting by friction only.	Mounting the sensor with M14 x 1.5 screw thread (friction) (see customer drawing).
Positive mechanical action	In order to achieve positive mechanical action, all mechanical moving parts necessary for performing the safety function must also move connected components, e.g. a trip that directly opens the contacts of an electric switch instead of a spring-based connection (see SO 12100:2010, 6.2.5).	Not applicable to the temperature sensor (N/A).
Multiplication of parts	Reduction in the impact of failures by using several parts of the same type that act in parallel, e.g., the failure of one of many springs does not result in a hazardous state.	Not applicable to the temperature sensor (N/A).
Use of proven springs	A proven spring requires: the use of carefully selected materials, manufacturing processes (e. g. static and dynamic setting before use) and treatment processes (e. g. rolling and shot-blasting) a sufficient guide for the spring a sufficient safety factor for continuous use (i. e. high probability of no breakage) Proven compression springs can also be designed with: the use of carefully selected materials, manufacturing processes (e. g. static and dynamic setting before use) and treatment processes (e. g. rolling and shot-blasting) a sufficient guide for the spring a distance between the coils for unloaded springs that is smaller than the wire diameter sufficient force maintained after breakage or after several breakages (i. e. breakage/ breakages does/do not result in a hazardous state). NOTE: Compression springs are preferred.	Not applicable to the temperature sensor (N/A).

Well-tried safety principles	Comment A2	Methods applied for development
Reduced range of speed and similar parameters	Setting the required limitation depending on experience and the respective application. Examples include shear pin, shear plate and torque limiting coupler. IMPORTANT - This principle should not be applied if the continued integrity of the components is essential for maintaining the necessary level of control.	Not applicable to the temperature sensor (N/A).
Reduced speed range and similar parameters	Set the required limitation depending according to experience and the respective application. Examples include centrifugal governor, secure monitoring of speed and travel limitation.	Not applicable to the temperature sensor (N/A).
Reduced environmental parameters range	Determining the necessary limitations. Examples are temperature, air humidity and contamination during installation. ISO 13849-2, observe section 10 and the manufacturer's application instructions.	The operating temperature / ambient temperature is specified in the data sheet and is –40 ... 150 °C.
Reduced reaction time range, hysteresis limitation	Determination of the necessary limitations. Observance of, e. g. reduction of spring force, friction, lubrication, temperature, inertia during acceleration and deceleration, combination of tolerances.	Not applicable to the temperature sensor (N/A).

Service and maintenance works

The following inspections and tests are recommended in certain time intervals:

- Every 12 months, the isolation resistance of the measuring circuit to the protection fitting has to be measured (in case of several measuring circuits, the insulation test is also to be carried out between the individual measuring circuits). The minimum isolation resistance at room temperature should be 100 MΩ at 100 V.
- Damage and corrosion at thermometer protective pipes
- Corrosion and correct seat at contacts and terminals of line connections
- Seals of connection heads at line ducts
- Interruptions by “knocking” at the thermometer/measuring insert

Accessories

Mating connector (connector set)

Material number	Connector set
R917000516	comprising: 1 x connector housing (Bosch-Material number 1928402571) 2 x contact (Tyco Electronics number 929 939-3) 1 x protective cap (Bosch-Material number 1280703031) 2 x single-wire seal (Tyco Electronics number 828904-1)

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

Safety Instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modifications or repairs to the wiring could lead to dangerous malfunctions.
- The sensor may only be assembled/disassembled in a deenergized state.
- Only trained and experienced specialists who are adequately familiar with both the components used and the complete system should implement system developments or install and commission electronic systems for controlling hydraulic drives.
- When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- Do not use defective components or components not in proper working order. If the sensor should fail or demonstrate faulty operation, it must be replaced.
- Despite every care being taken when compiling this document, it is not possible to consider all feasible applications. If instructions for your specific application are missing, you can contact Bosch Rexroth.
- The use of sensors by private users is not permitted, since these users do not typically have the required level of expertise.

Notes on the installation location and position

- Do not install the sensor close to parts that generate considerable heat (e.g. exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- Cables/wires must be sealed individually to prevent water from entering the sensor.

Notes on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- If it is dropped, the sensor must not be used any longer, as invisible damage could have a negative impact on reliability.

Notes on wiring and circuitry

- Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- The sensor mating connector must only be plugged and unplugged when it is in a deenergized state.
- The sensor lines are sensitive to spurious interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.
- Lines from the sensor to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- Operation of the sensor must generally occur within the operating ranges specified and approved in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.
- Use outside of the specified and approved boundary conditions may result in danger to life and/or cause damage to components which could result in sequential damage to the mobile working machine.

- Serious personal injury and/or damage to property may occur in case of non-compliance with the appropriate regulations.

Improper use

- Any use of the sensor other than that described in the chapter "Intended use" is considered to be improper.
- Use in explosive areas is not permitted.
- Damages which result from improper use and/or from unauthorized, unintended interventions in the device not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and determining the possible safety-related functions.
- In safety-related applications, the customer is responsible for taking proper measures to ensure safety (sensor redundancy, plausibility check, emergency switch, etc.).

Disposal

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

Further information

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

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RE 95178/2024-02-22
Replaces: 2023-11-13

rexroth
A Bosch Company

BODAS Inertial sensor MM7.10 / MM7.10AC

- MEMS inertial sensor
- 3 acceleration and 3 rotation rate signals
- Output signal CAN (ISO 11898)
- Supply voltage 8 to 16 V
- Protection class IPX6K, IPX7K, IPX9k
- CE conformity

The inertial sensor is available as MM7.10 and MM7.10AC.

Contents

Product description

The inertial sensor is available as MM7.10 and MM7.10AC.

Description MM7.10 and MM7.1AC
The purpose of the inertial sensor is to measure the physical effects of the yaw rate, rate of roll, and of transverse, longitudinal and vertical acceleration. When mounted appropriately (i.e. according to the offer drawing), the sensor measures the yaw and roll rates as well as the lateral, longitudinal and vertical acceleration of the vehicle.
In order to prevent signal interference or negative power supply impacts on the sensor, we recommend the supply of the sensor via the control unit or terminal 15 with separate ground connection.

Description Address Claiming
Address claiming is a method defined by SAE J1939 communications network. The product with Address Claiming functionality does not have predefined CAN-IDs. Instead, the product checks the CAN network for CAN-IDs that are occupied by other devices and chooses available CAN-IDs. This claiming procedure is conducted at every launch of the product. The claimed CAN-IDs are stored in the NVM (non volatile memory) of the product. Hence, speeding up the claiming procedure if no changes to the CAN-network were implemented in the meantime.

An identification routine is required to determine where a sensor with a specific CAN ID is in the system. The development of such a routine depends on the system. The identification routine must also be performed again when replacing a sensor with a Address Claiming functionality.
Please also consider "Technical Customer Documentation" 95179_TCD_MM7.10_Address_Claiming.

Vibration
Due to the sensor's sensitivity to acceleration across the entire frequency range, it is necessary to test the inertial sensor during the application approval process. Please also consider the data shown in the offer drawing.

Ordering code

01	02		03		04		05		06		07		08
		–		–		–	N	–		–		–	15

Type

01	Inertial sensor	**MM7.10**

Address Claiming

02	Without Address Claiming (without code)	
	With Address Claiming	**AC**

Baud rate

03	250 kBaud	**250**
	500 kBaud	**500**

CAN ID

04	**MM7.10**	
	TX1: 18FF2330h TX2: 18FF2430h TX3: 18FF2530h	**1**
	TX1: 174h TX2: 178h TX3: 17Ch	**2**
	TX1: 130h TX2: 131h TX3: 140h	**3**
	TX1: 274h TX2: 278h TX3: 27Ch	**4**
	TX1: 374h TX2: 378h TX3: 37Ch	**5**
	Adress Claiming	
	TX1: 18FF26 TX2: 18FF27 TX3: 18FF28	**6**

CAN message deactivation

05	No	**N**

CAN update rate

06	5 ms	**5**
	10 ms	**10**
	20 ms	**20**

Identifier length

07	11 bit	**11**
	29 bit	**29**

Bandwidth signal filter (frequency limit)

08	15 Hz	**15**

Available variants MM7.10

Type	Material number
MM7.10-250-1-N-20-29-15	R917013321
MM7.10-250-2-N-5-11-15	R917013372
MM7.10-250-3-N-20-11-15	R917013363
MM7.10-250-4-N-5-11-15	R917013373
MM7.10-250-5-N-5-11-15	R917014192
MM7.10-500-2-N-10-11-15	R917013362
MM7.10-500-4-N-10-11-15	R917014617
MM7.10-500-5-N-10-11-15	R917014618

Available variants MM7.10 Adress Claiming

Type	Material number
MM7.10AC-250-6-N-10-29-15	R917014591
MM7.10AC-500-6-N-10-29-15	R917014590

Other variants on request.
Configurable parameters:
Baud rate, CAN ID, CAN message deactivation, CAN update rate, Big/Little Endianess format, Identifier Length, Bandwidth signal filter (frequency limit), No_Ack timing and Bus_Off timing.

Technical data

Ambient conditions

Parameters			
Storage time	At −40 ... +85 °C and 60% relative humidity		5 years
Service life			15 years
Operation time (UZ on) with the following temperature distribution	Temperature	Distribution	20000 h
	−40 °C	6 %	
	23 °C	20 %	
	40 °C	65 %	
	75 °C	8 %	
	80 °C	1 %	
Operating temperature range			−40 ... 85 °C
Temperature gradient			5 K/min
Room temperature			18 ... 28 °C (typically 23 °C)
Protection class	According to EN 60529		IPX7, IP6K, IPX9K
Functional safety	Environmental requirements and test requirements for earth-moving machinery		According to DIN EN ISO 19014- 3:2018

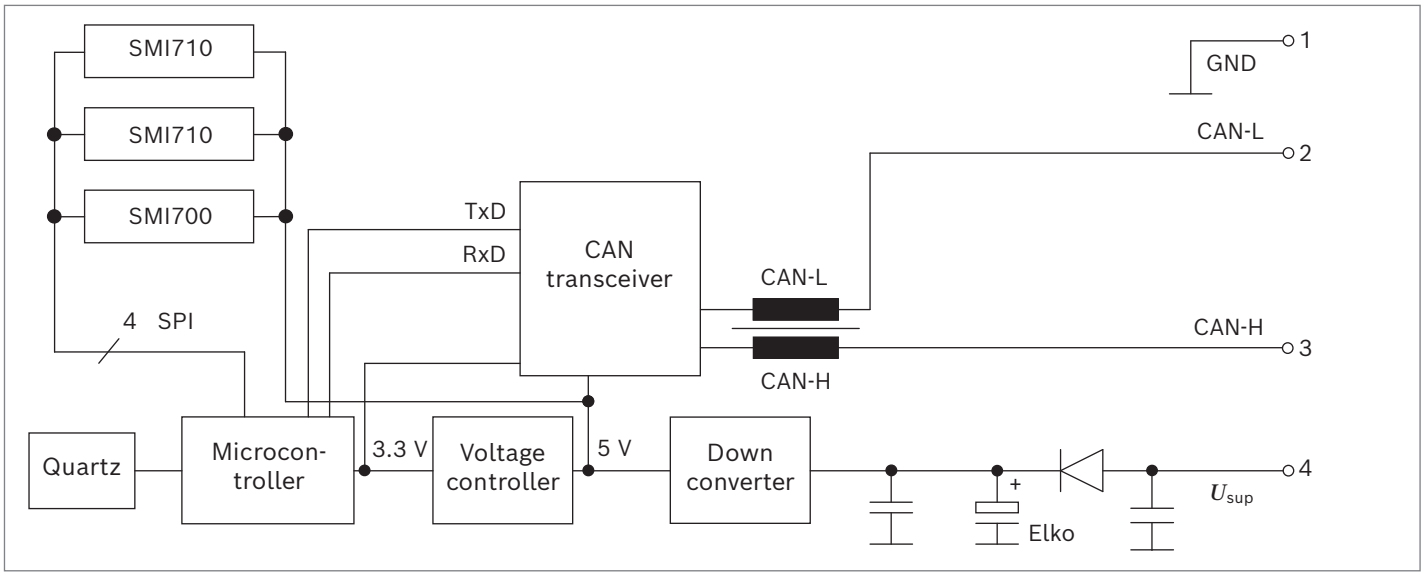
Electrical data

Parameters			
Typical nominal voltage			14 V
Supply voltage			8 ... 16 V
Fault-free supply voltage	(within t_{life}, δ_{op})		−16 ... +16 V
	(within t_{life}, δ_{op}); t < 5 min		−18 ... +18 V
Maximum supply current at 7 V			100 mA
Maximum supply current at 14 V			50 mA
Short-circuit protection output			0 ... 18 V
Signal output (CAN)			ISO 11898-2 and ISO 11898-5
Electrostatic discharge (ESD)	According to ISO 10605: 2023-06	Direct contact discharge	±8 kV (powered up and unpowered)
		Direct air discharge	±15 kV (powered up and unpowered)
	According to IEC 61000-4-2	Contact discharge	±8 kV (powered)
		Air discharge	±15 kV (powered)
Conformity according to	EMC directive 2014/30/EU with CE mark		Applied standards: EN ISO 14982:2009, EN 12895:2015, ISO 13766-1:2018, ISO 13766-2:2018
	RoHS directive 2011/65/EU		
	EU REACH		Annex XIV, Annex XVII, SVHC

Electrical data (CAN interface)

Parameters		
EMI filter	L	51 µH
Microcontroller		Renesas RL78
CAN transceiver		NXP TJA1042T
Down converter		TI LM53600
Voltage controller		TI TLV70033
Microcontroller memory		Flash

▼ **Block circuit diagram**



For compliance with Load Dump 5a according to ISO 16750-2, it is required to install a load dump diode in the vehicle electrical system of the higher-level system (machine).

Yaw and roll rate output

Parameters		Minimum	Typical	Maximum
Nominal measurement range	°/s	−163		163
Overload limit	°/s	−1000		1000
Sensitivity error at ϑ_{op} within t_{life}	%	−4.0	±2.0	4.0
Non-linearity	°/s	−1	±0.5	1
$\Omega_{x,y,z}$: Offset, absolute within t_{life}, measured with ϑ_{op}	°/s	−2.0	±1.0	2.0
Rate of change, offset t < 3 min after U_{sup} on	°/s/min	−0.6	±0.2	0.6
Rate of change, offset t > 3 min after U_{sup} on	°/s/min	−0.2		0.2
Time until availability	s		0.5	1
Sensitivity of the transverse axis	%	−4.0	±1.5	4.0
Cut-off frequency -3 db	Hz		15	
Output noise	$°/s_{RMS}$			0.2
Resolution, absolute	°/s			0.1

Acceleration output (lateral (y), longitudinal (x) and vertical (z))

Parameters		Minimum	Typical	Maximum
Nominal measurement range	m/s^2	−41		41
Overload limit	m/s^2	−200		200
Sensitivity error at ϑ_{op} within t_{life}	%	−3.0	±2.0	3.0
Non-linearity	m/s^2	−0.4		0.4
Offset X, Y, Z, absolute within t_{life}, measured with ϑ_{op}	m/s^2	−0.5		0.5
Rate of change, offset	m/s^2/min	−0.3		0.3
Time until availability	s		0.5	1
Sensitivity of the transverse axis	%	−4.0	±1.5	4.0
Cut-off frequency -3 db	Hz		15	
Output noise	$m/s^2{}_{RMS}$		0.04	0.05
Resolution, absolute	m/s^2			0.1

Radiated susceptibility to interference (interference immunity)

Parameters
Conductor track test according to ISO 11452-5
BCI test according to ISO 11452-4
Absorber chamber test according to ISO 11452-2
Mobile phone test according to ISO 11452-9

Radiated susceptibility to interference (radiation)

Parameters
Antenna measurement according to CISPR 25-13

There is further technical data in the TCD
("Technical Customer Documentation" 95178_TCD_MM7.10/95179_TCD_MM7.10_Address_Claiming).

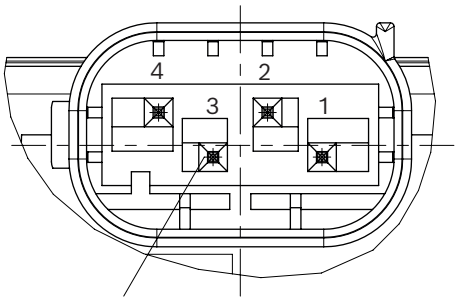
Angle output

The inertial sensor – in combination with the software library ASlib-IMU and a control unit – can realize an angle output in Euler format. The ASlib-IMU must be integrated into the control unit. The sensor signals are read in via the control unit, offset to angle values by the software library and made available on the CAN-BUS. Further information available in document 95380-01-B.
The ASlib-IMU can be downloaded on the Bosch Rexroth website in the MyRexroth area under ME Partner Download Space.

Electrical connection

AMP-MQS Superseal connector

▼ **Pin assignment**

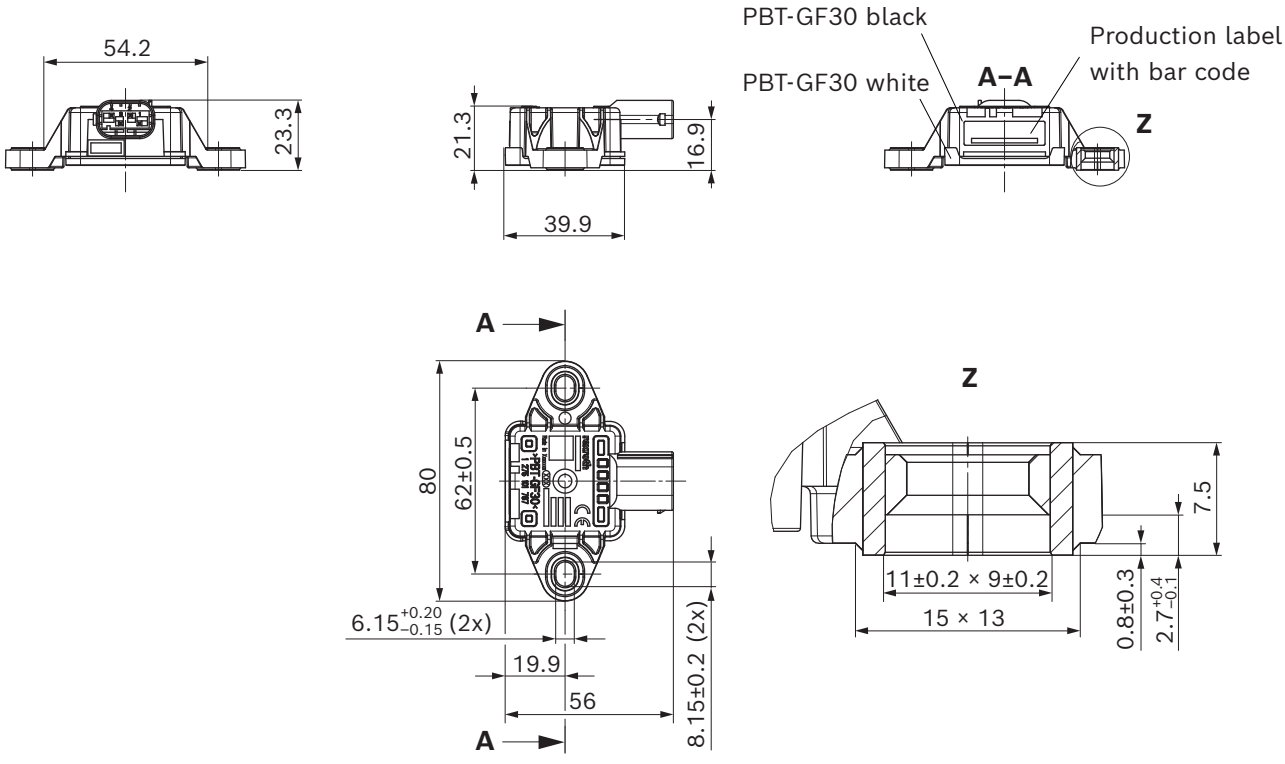


CuSn6
Pin surface 3 ... 6 µm Ag (galvanic)
over 1.3 ... 3 µm Ni

Pin	Port	
1	Signal ground	GND
2	CAN-L	
3	CAN-H	
4	Supply voltage	U_{sup}

The mating connector is not included in the scope of delivery.
This can be supplied by Bosch Rexroth on request (see chapter "Accessories" page 11).

Dimensions



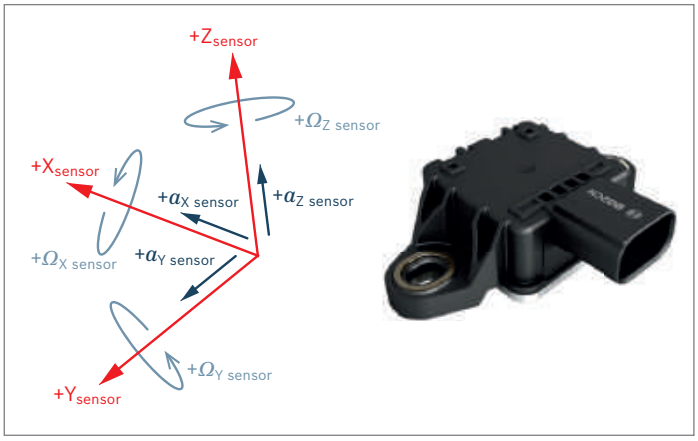
Project planning notes

Installation position

Normal position of the inertial sensor:

- connector facing away from direction of travel
- For a definition of the axes, see chapter - Assembly (vehicle axis system)

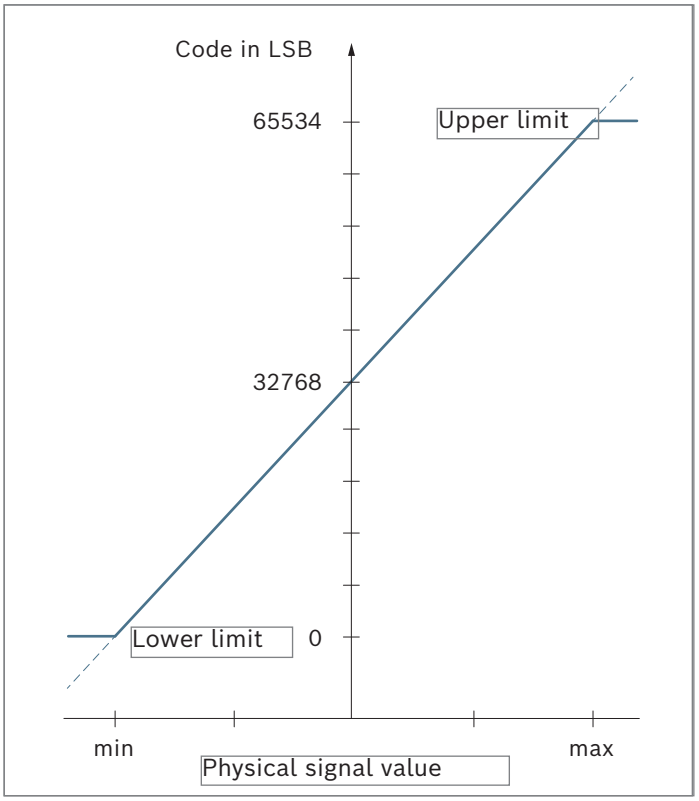
Vehicle axis system



Vehicle axis system according to DIN 70000 or ISO 8855:
+ $X_{vehicle}$ is aligned with the front of the vehicle
+ $Y_{vehicle}$ is aligned with the left side of the vehicle
+ $Z_{vehicle}$ is aligned with the vehicle roof

If the sensor is installed in the vehicle as shown in the offer drawing, the sensor axis and the vehicle axis are identical, i.e.:
+ $X_{vehicle}$ = + X_{sensor}
+ $Y_{vehicle}$ = + Y_{sensor}
+ $Z_{vehicle}$ = + Z_{sensor}

Acceleration and rotation rate



Installation in the vehicle

The inertial sensor must be fastened with two screws prior to operation. The appropriate size can be found in the offer drawing.
The tightening torque for the M6 nut is defined in the offer drawing.

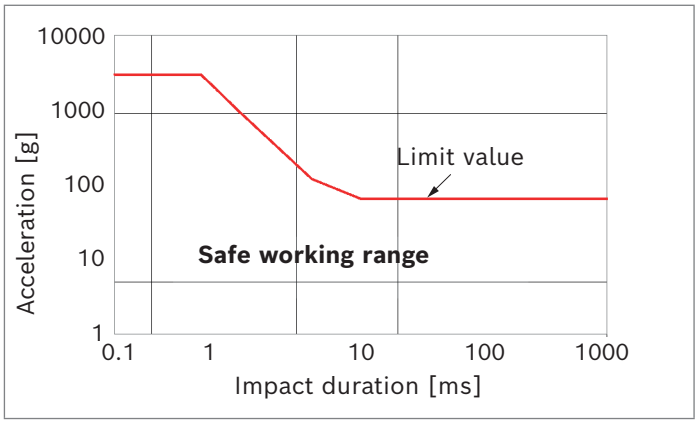
Fixing the bolts with impact wrenches is not allowed as the high impact force of the wrench and resulting acceleration may damage the silicon micro machines inside the inertial sensor. Bosch Rexroth recommends the use of electronically controlled screwdrivers (torque and angle of rotation) for fixing.

It is also not permitted to subject the area near the mounted inertial sensor to excessive shock loads, as this would result in accelerations outside the safe operating range. High accelerations can be caused, for example, by hammer blows, the stopping of workpiece carriers, and the use of automatic screwdrivers for screwing, etc. There may be exceptions during maintenance work, e.g. in service.
The inertial sensor must be mounted without exerting force on the inertial sensor housing or deforming the mounting location.
The use of tools such as a hammer or crowbar may cause tension and damage on the inertial sensor. An inertial sensor that has been damaged during installation on the vehicle is detected by a specific inertial sensor internal function and communicated to the ECU by the CAN.

The inertial sensor connector must not be connected / disconnected while supply voltage is applied to the wiring harness.
Do not install or use the inertial sensor if the housing is deformed or damaged.

Before installation, read the "Mounting guideline" (95178_MG_MM7.10) thoroughly and completely.

Spectrum during fixing
During the fixing on the vehicle, the housing of the inertial sensor is exposed to various influences, e.g. due to the fixing and the tools. These values, which are determined by a triaxial accelerometer mounted on the PCB of the inertial sensor, must not exceed the specified range.



Safety-related characteristics according to ISO 25119 and ISO 13849

The safety function of the inertial sensor is defined as system integrity, i.e. the inertial sensor shall measure the physical effects (roll rate, pitch rate, rotation rate, transverse acceleration, longitudinal acceleration and vertical acceleration) and send the corresponding CAN messages without error. If a critical error is detected, an error message or no CAN message shall be sent.

- The inertial sensor has a category 2 architecture (one single channel with external monitoring unit)
- The inertial sensor meets the requirements of the basic and well-tried safety principles
- The inertial sensor meets the requirements of the common cause failures and well-tried components
- The inertial sensor software meets the requirements of ISO 26262 ASIL B, which can support up to AgPL d according to ISO 25119 and PL d according to ISO 13849

▼ **Temperature profile of the inertial sensor with corresponding $MTTF_D$ values and the diagnostic coverage (DC).**

Ambient temperature [°C]	Operating time [%]	$MTTF_D$ [years]				DC[1] [%]
		24h/day	16h/day	8h/day	4h/day	
–40	6	179	256	447	716	94
23	20					
40	65					
75	8					
80	1					

▼ **Error reactions**

Error type	Error reaction	Error reaction time in the worst case
Error detected at start-up	No transmission of CAN messages	–
Error inertial sensor module (sensor unit, bus, etc.)	Transmission of CAN messages with error signal status	100 ms
µC error (memory, program execution, etc.)	No transmission of CAN messages	100 ms
CAN error	See chapter 4.1.3 of the "Technical customer documentation" (95178_TCD_MM7.10/95179_TCD_MM7.10_Address_Claiming)	

1) It is assumed that the control unit of the machine monitors the CAN messages and reacts to error messages and loss of messages by bringing the system into a safe state.

Use in safety-related functions

- The customer is responsible for the preparation of a risk analysis of the machine and for the definition of possible safety functions of the machine.
- The customer is responsible for evaluating the entire safety-relevant machine system and for determining the suitability of the inertial sensor for safety functions of the machine:
  - The inertial sensor meets the requirements of ISO 25119:2018 AgPL d and ISO 13849 PL d when properly integrated into the machine's safety system in accordance with all relevant instructions in this document and the "Technical customer documentation" (95178_TCD_MM7.10/ 95179_TCD MM7.10_Address_Claiming).
  - The error reactions of the inertial sensor are listed in detail in the top table "Error reactions" page 10. The inertial sensor must not be used if it becomes apparent that the error reactions including the reaction time are not sufficient for the safety functions of the machine.
- The customer is responsible for protecting the inertial sensor against overcurrent, overvoltage and undervoltage.
- The machine control must monitor the CAN messages and respond to the error messages and loss of messages by bringing the machine into a safe state.
- An efficient field monitoring process must be defined by the customer. All field errors with involvement of the inertial sensor should be reported to Bosch Rexroth without delay, even if they are not subject to warranty.

Application guidelines

General instructions

Due to the sensor's sensitivity to acceleration across the entire frequency range, it is necessary to test the inertial sensor inertial sensor during the application approval process.

Additional tests

It shall be tested whether vehicle components in the vicinity of the inertial sensor inertial sensor generate signal interference. This can be caused as follows:

- Full engine speed range, minimum speed up to maximum speed with 3500 rpm
- Actuation of the gear lever

Accessories

▼ **Mating connector**[1)]

Designation	Number	AMP-MQS Material number
Housing	1	1-967640-1
Contacts (DGB 0.75 mm^2)	4	965906-1
Single conductor seals (for Ø1.4 ... 1.9 mm)	4	967067-1

1) The mating connector can be supplied by Bosch Rexroth on request (Bosch Rexroth mat. no. R917009162).

Safety instructions

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modification or repairs to the wiring could result in dangerous malfunctions.
- The sensor may only be assembled/disassembled in a deenergized state.
- System developments, installations and commissioning of electronic systems for controlling hydraulic drives must only be carried out by trained and experienced specialists who are sufficiently familiar with both the components used and the complete system.
- When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- 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 not possible to consider all feasible applications. If notes for your specific application are 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.

Information on installation location and position

- Do not assemble the sensor close to parts that generate considerable heat (e.g., exhaust).
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- A sufficient distance to radio systems must be maintained.
- Before electric welding and painting operations, the sensor must be diskonnected from the power supply and the sensor connector must be removed.
- Cables/wires must be sealed individually to prevent water from entering the sensor.

Notices on transport and storage

- Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- If 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 measure 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 in the near of other power-conducting lines in the device or vehicle.
- The cable harness should be mechanically secured in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside 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.
- Serious personal injury and/or damage to property may occur in case of non-compliance with the appropriate regulations.
- Improper use
- Any use of the sensor other than that described in chapter "Intended use" is considered to be improper use.
- Its use in explosive areas is not permitted.
- Damage resulting from improper use and/or from unauthorized interference in the component not described in this data sheet render all warranty and liability claims void with respect to the manufacturer.

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.

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Replaces: 2023-09-19

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.

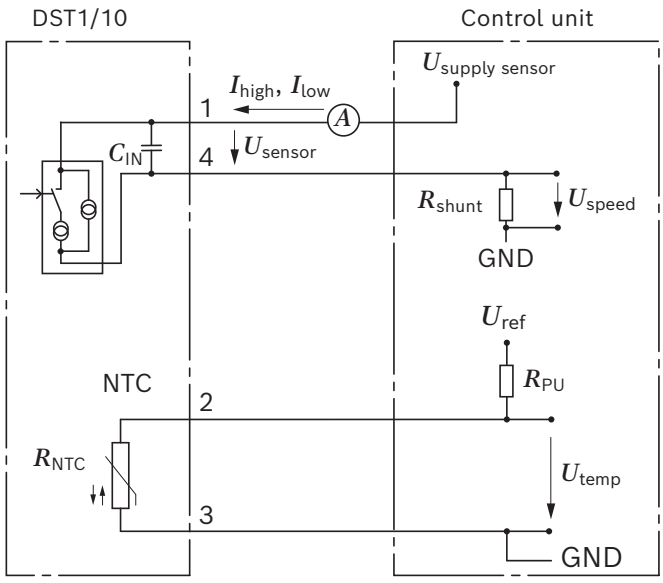
Application examples

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

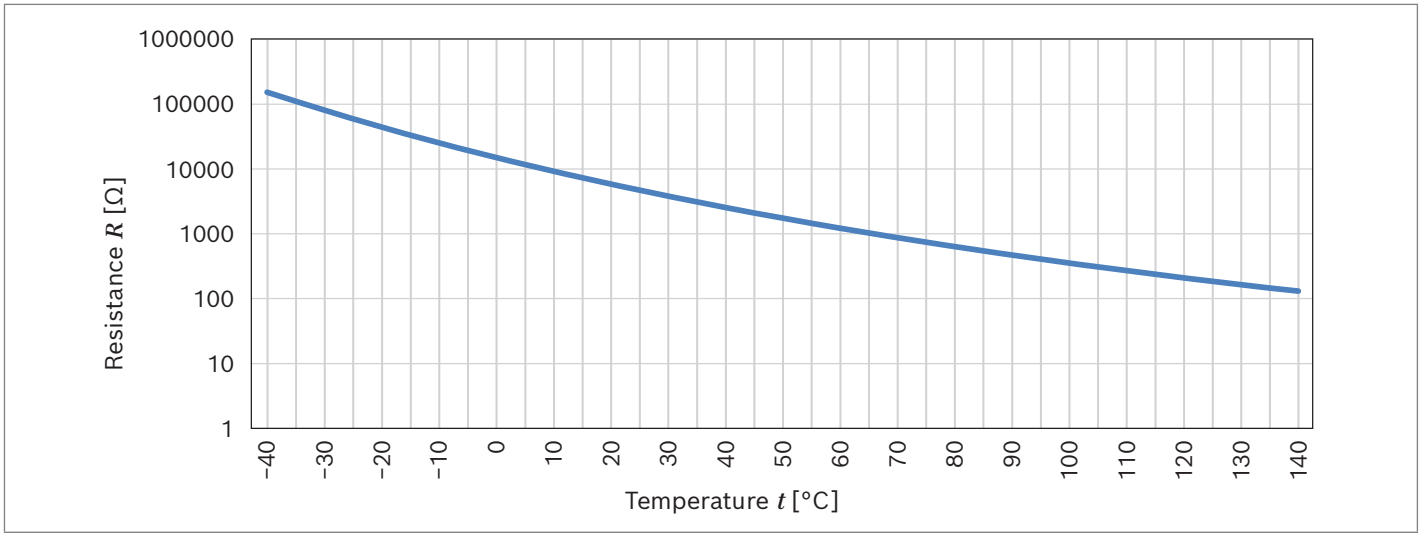
General			
Electromagnetic compatibility (EMC)	BCI (ISO 11452-4)	1 ... 400 MHz	100 mA
	Free field (ISO 11452-2)	20 ... 80 MHz	60 V/m
		80 ... 2700 MHz	150 V/m
Electrostatic discharge ESD	According to ISO 10605: 2008	Contact discharge	±8 kV
		Air discharge	±15 kV
	According to IEC 61000-4-2:2008	Direct 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)

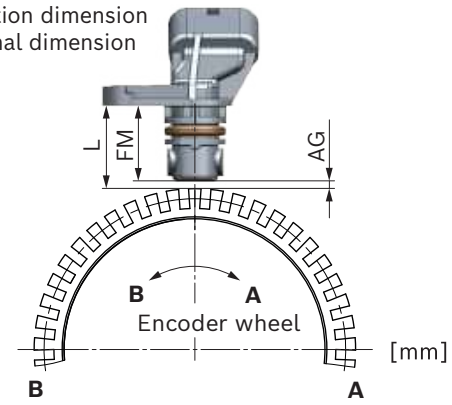
Electrical characteristics

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

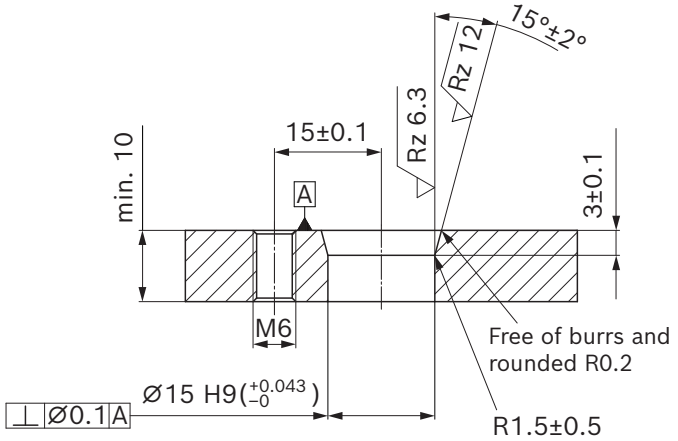
L = installation dimension
FM = functional dimension
AG = air gap



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

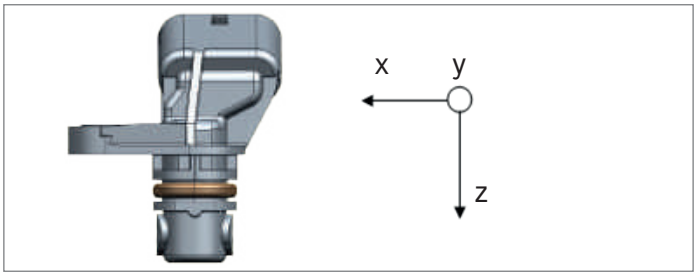
Encoder wheel direction of rotation clockwise (CW)
45 µs output signal

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

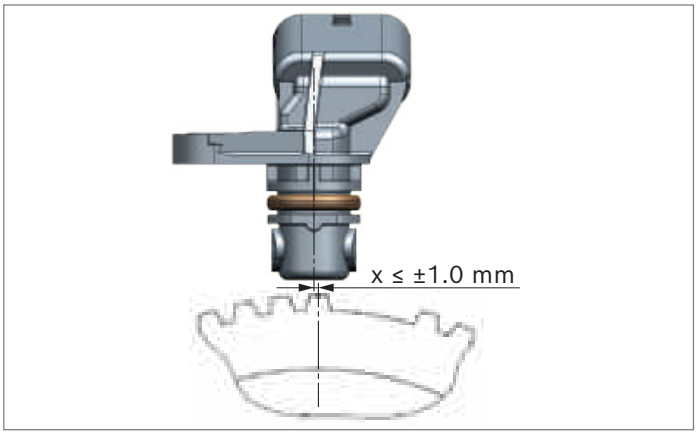
The installation dimension (L) is dependent on the air gap (AG) and the tolerance of the functional dimension (FM). It must be within the following limits:

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

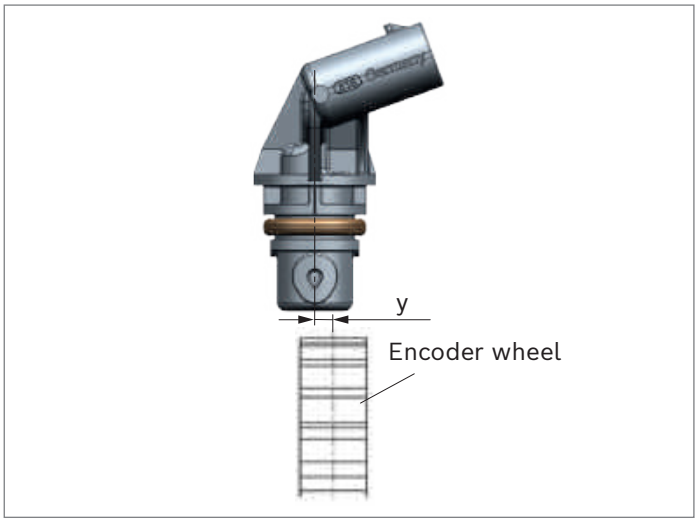
The fluctuations (jitter) of the period length output of speed sensors are dependent on the tangential position "x" of the sensor referring to the encoder wheel center. In this document, the switching accuracy ranges are specified for an ideally set sensor, i.e. for x = 0.0 mm. The position of the recording 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

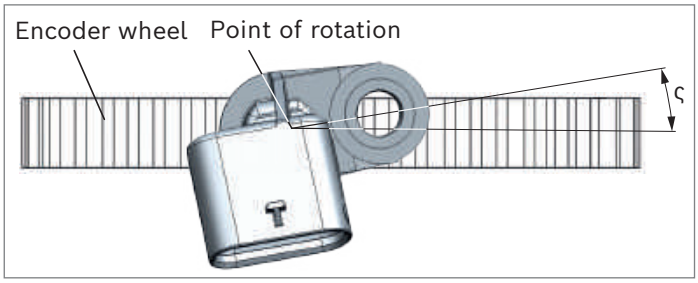
The fluctuation (jitter) of the period length output of the sensor is influenced by the axial "y" position of the sensor referring to the scanning track of the encoder wheel (see figure). To achieve the specified accuracy, the sensor has to be mounted as follows:

- 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

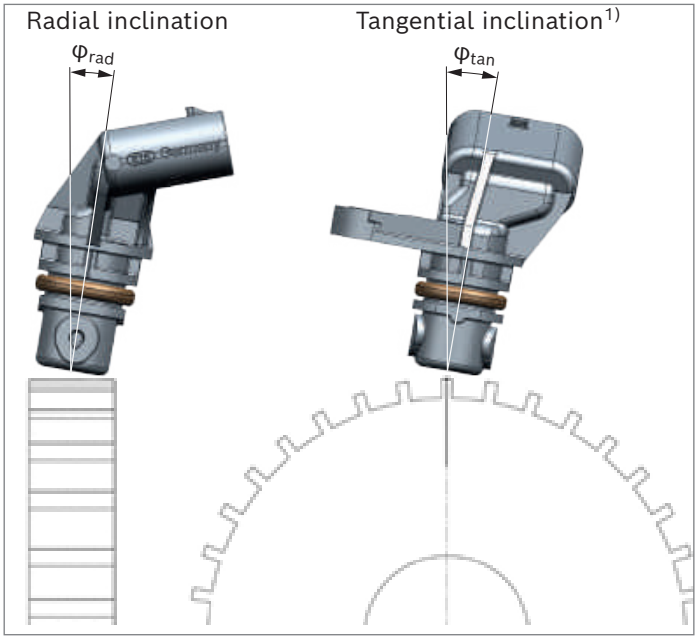
Due to the position of the Hall plates in the sensor, the fluctuation (jitter) of the period length output of the sensor is dependent on the angle of rotation ς around the z-axis. The rotation must not exceed ς_{max} = ±5.0°.
This specification is valid for a standard encoder wheel (see chapter "Gear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

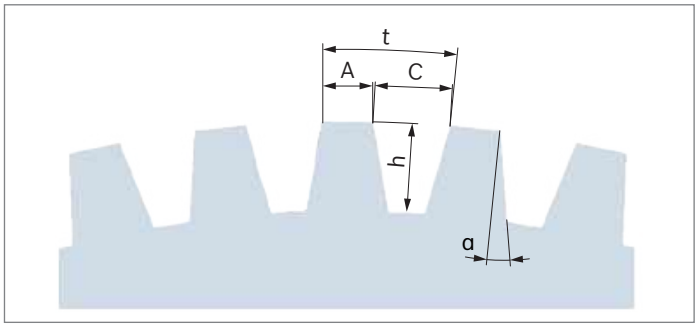
Material

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).

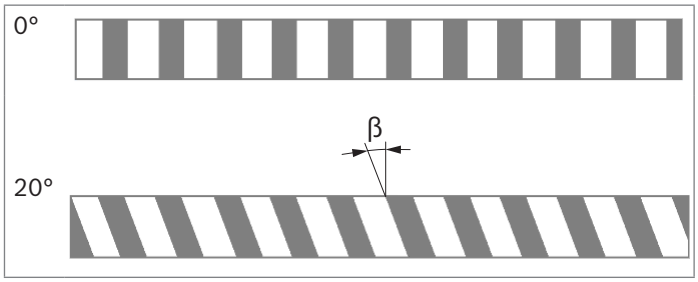
Notice

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

▼ **Definition of gear wheel parameters**



▼ **Helix angle**

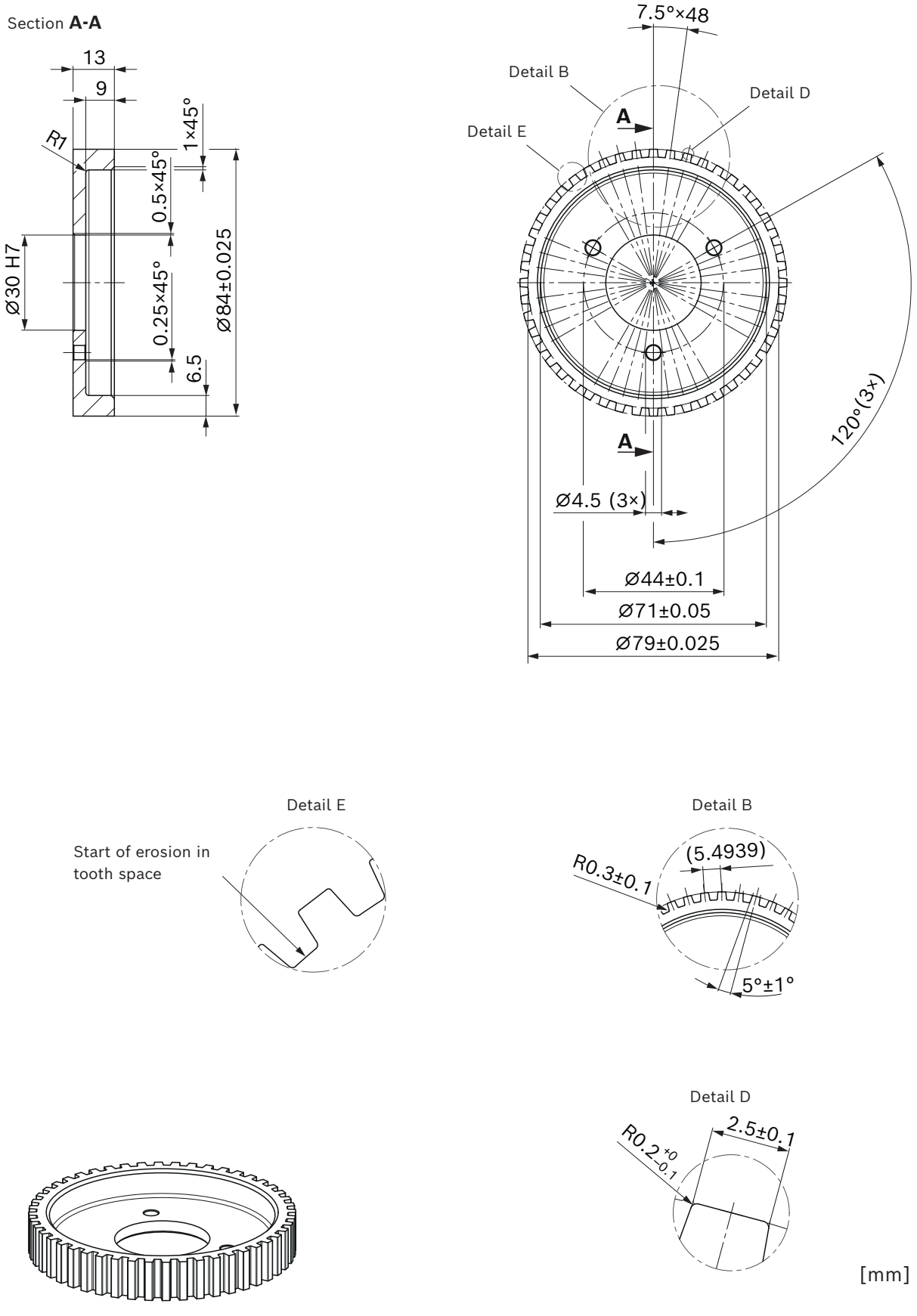


▼ **Spline specifications valid for basic number of teeth 48**

			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			

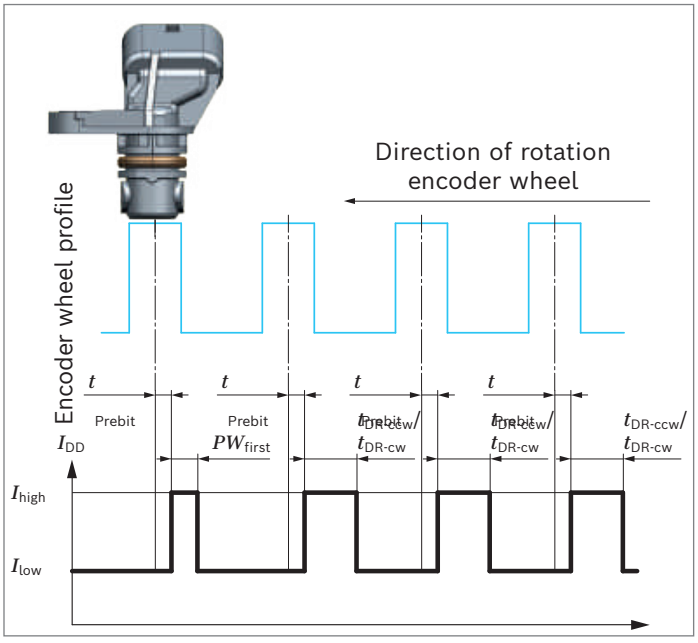
The information given here is a recommendation.
Other geometries are possible after consultation with your Bosch Rexroth contact person.

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:

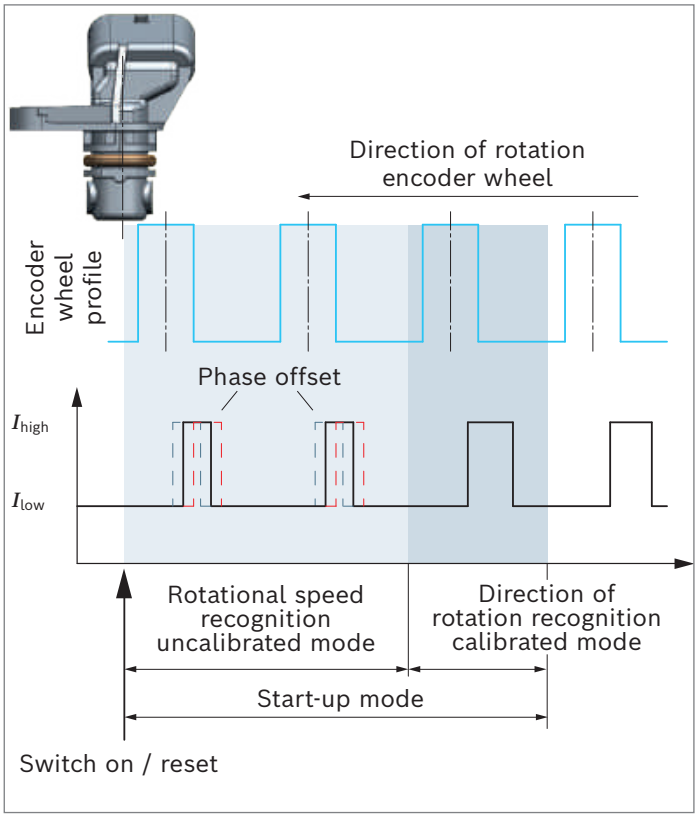
Pulse designation			Pulse width t_{Pulse}		
			min	nom	max
Prebit (low)	t_{Prebit}	µs	13.12	15	16.87
Length of the first pulse after switch-on	PW_{first}	µs	26.25	30	33.75
Counter-clockwise rotation	t_{DR-ccw}	µs	78.75	90	101.25
Clockwise rotation	t_{DR-cw}	µs	39.37	45	50.62
Frequency including direction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

Vibrations

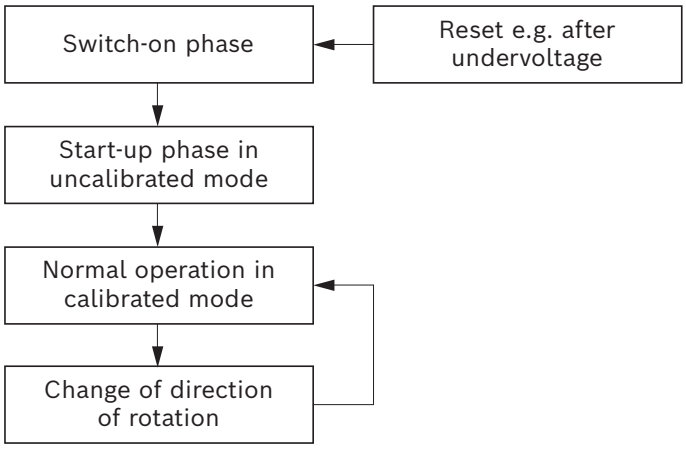
Vibrations of the standing encoder wheel may lead to incorrect sensor signals.

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**

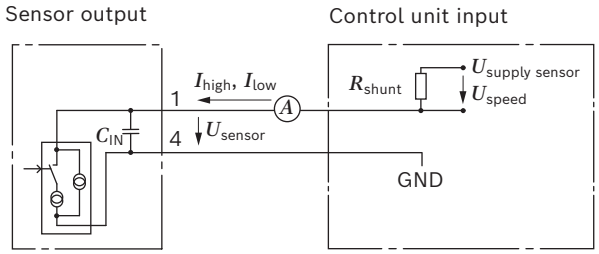


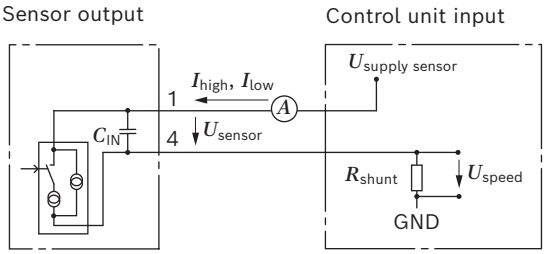
Description of the start sequence	Number of teeth
Number of teeth until transmission of the first rotational speed signal	≤2 (uncalibrated mode)
Number of teeth until transmission of the direction of rotation signal	≤ 3 (calibrated mode)
Maximum number of teeth that are required until transmission of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

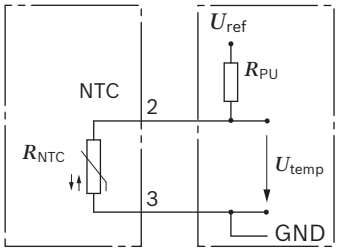
Please note in the dimensioning of the switching thresholds in the control unit that also the combination $I_{high\ minimum}$ with $I_{low\ maximum}$ may occur.

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.

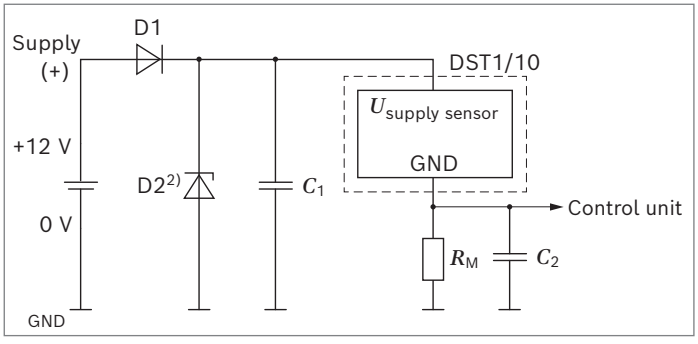
Notice
The current data sheet of the control unit used must be considered.

▼ **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**



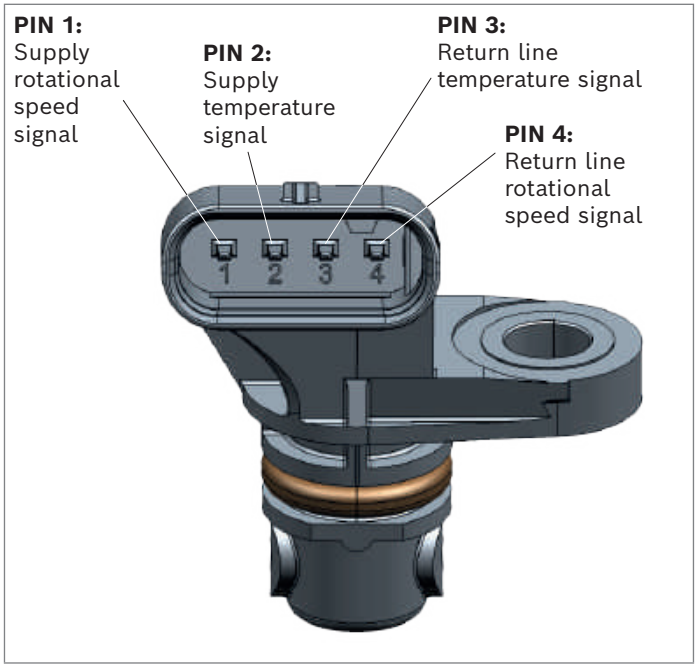
Key

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

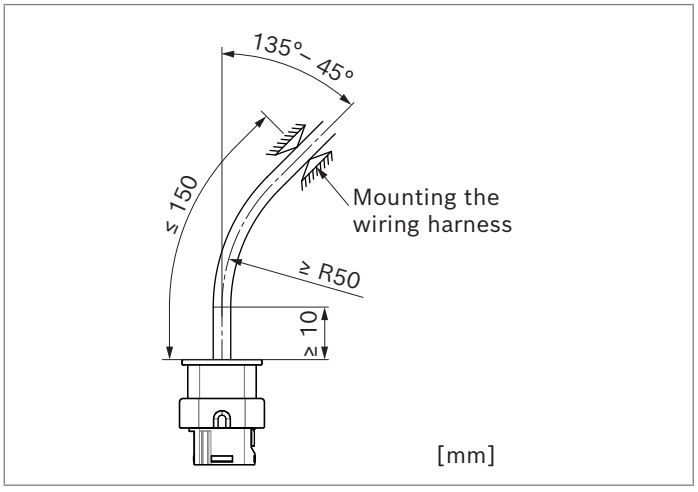


Installation

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**

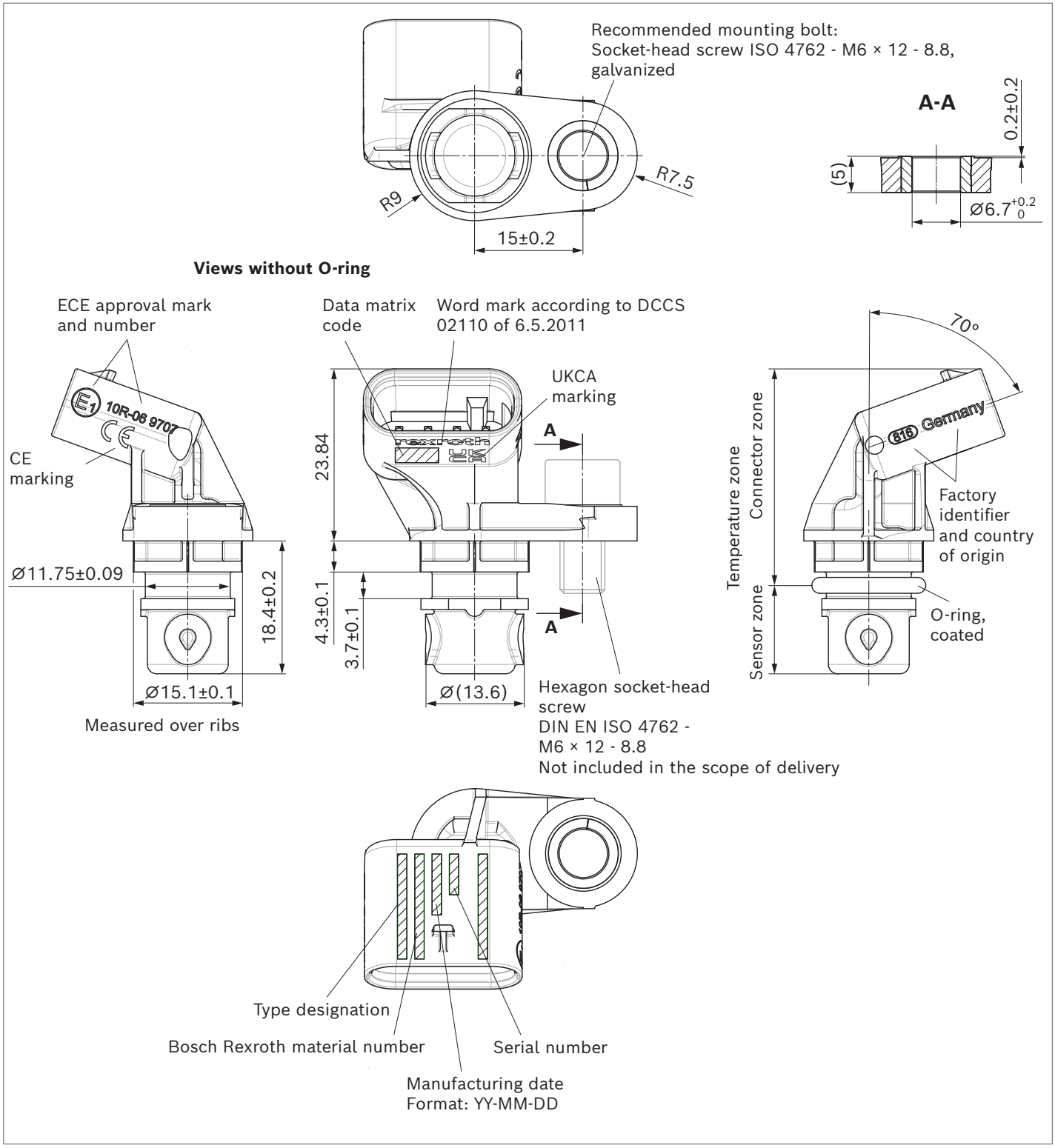


Notice
- Installation of the quick connectors:
  - Observe the assembly instructions for plug-in connections.
  - For information on the mating connector, see chapter "Accessories".
- Installation of the connector in the vehicle:
  - Fasten the wiring harness at a distance ≤ 150 mm from the connector.
  - 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.

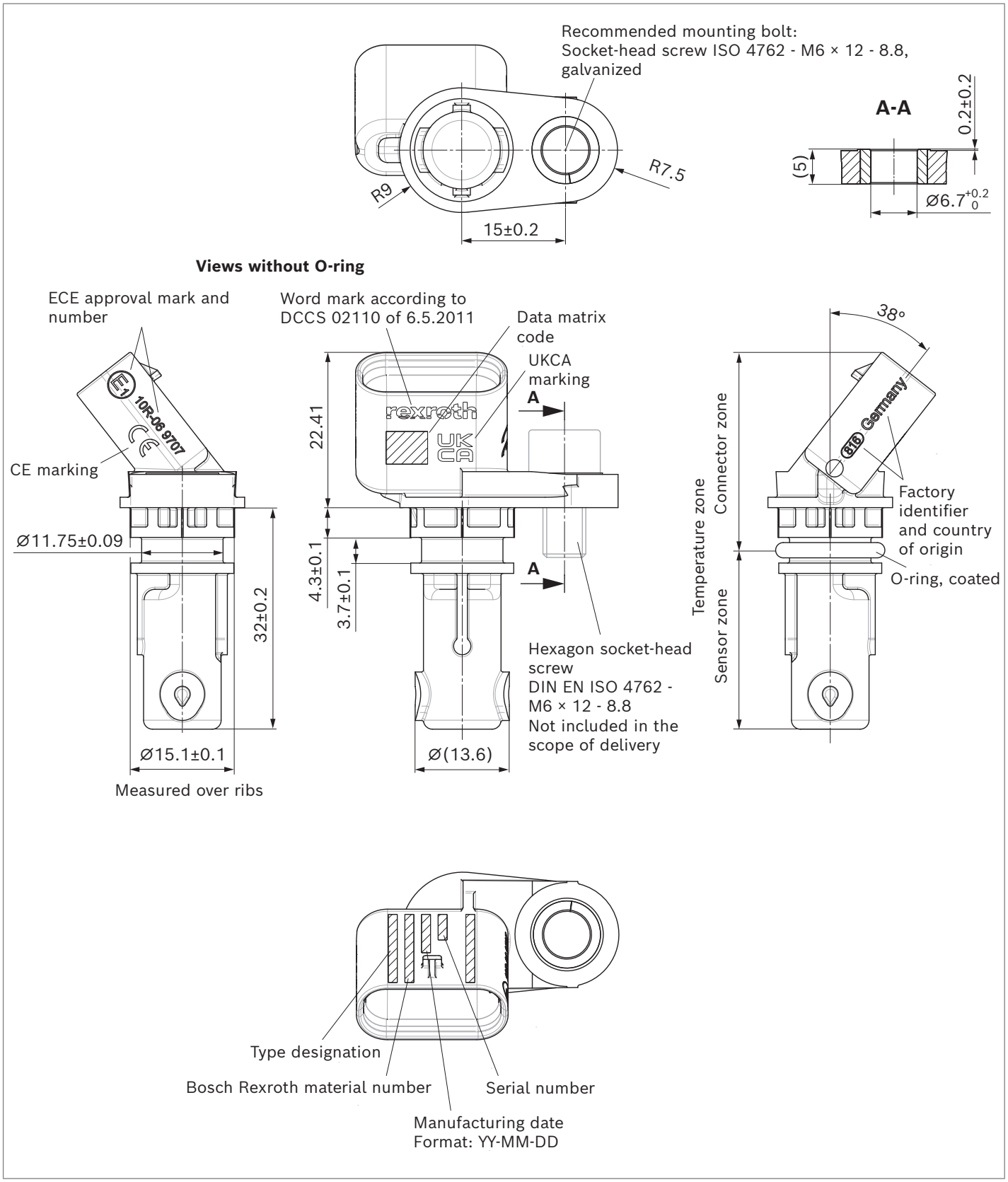
Electrical connection
- The sensor may only be installed by skilled personnel (electrician).
- National and international specifications for installation of electrotechnical systems must be observed.
- Voltage supply according to SELV, PELV.
- The contacts in the connector of the sensor must not be touched 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

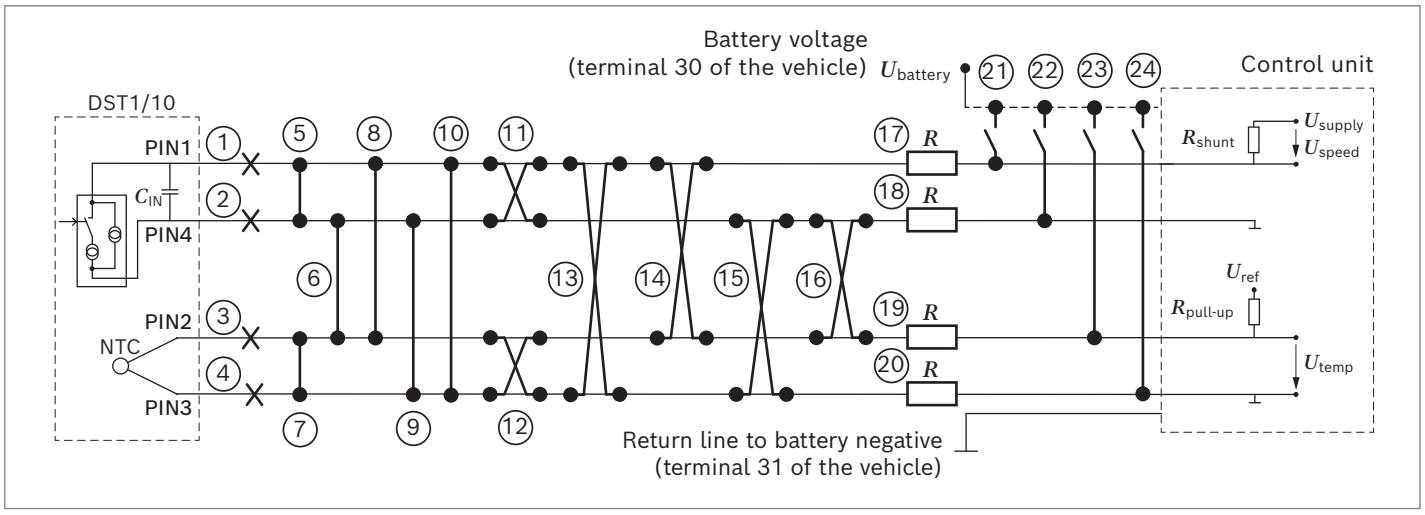


DST 1 S32

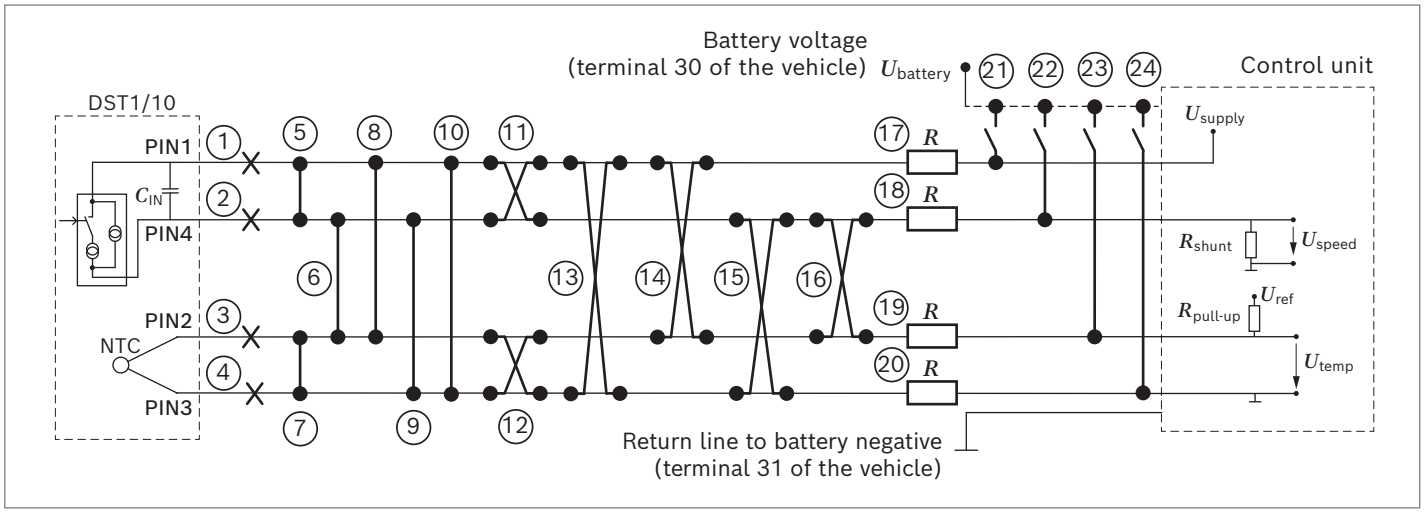

Recommended mounting bolt:
Socket-head screw ISO 4762 - M6 × 12 - 8.8, galvanized
R7.5
R9
15±0.2
A-A
0.2±0.2
(5)
Ø6.7 +0.2 0
Views without O-ring
ECE approval mark and number
E1 10R-06 9707
CE marking
Ø11.75±0.09
32±0.2
Ø15.1±0.1
Measured over ribs
Word mark according to DCCS 02110 of 6.5.2011
Data matrix code
UKCA marking
rexroth
UK CA
22.41
A
4.3±0.1
3.7±0.1
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
BIB Germany
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

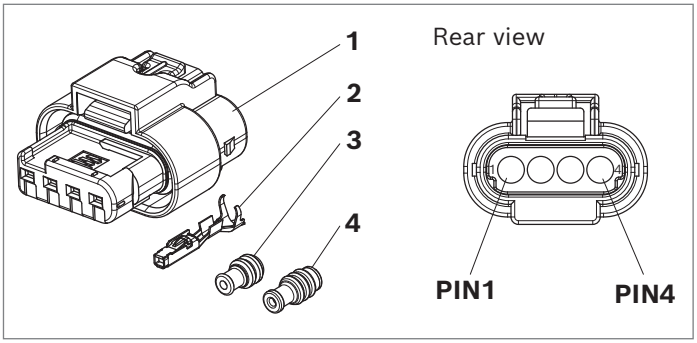
The DC is based on ISO 13849 1:2023 Table E.1 and ISO 25119 2:2019 Table C.6 given. For this purpose, the diagnostic functions described in the table can be implemented.

The implementation of the following diagnostic functions in the higher-level control is a way to achieve the specified DC of 60% according to ISO 25119 and to achieve 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	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.

1) Alternatively, a connector housing (order number: 2203773-1) or a connector housing with the option of mounting a cover (order number: 1-2203773-1) is available.
Corresponding connector covers:
With an angle of 180° (order number: 2272162-1)
With an angle of 90° (order number: 2272163-1)

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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rexroth
A Bosch Company

BODAS 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 12895:2020 (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.

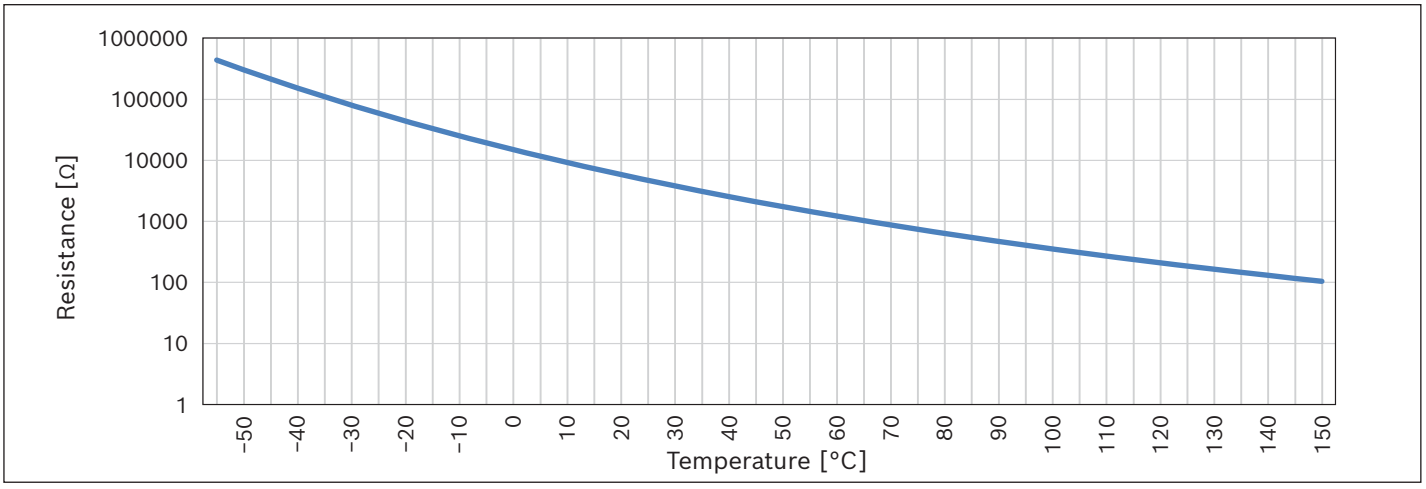
3) Only suitable for HNBR seal

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**



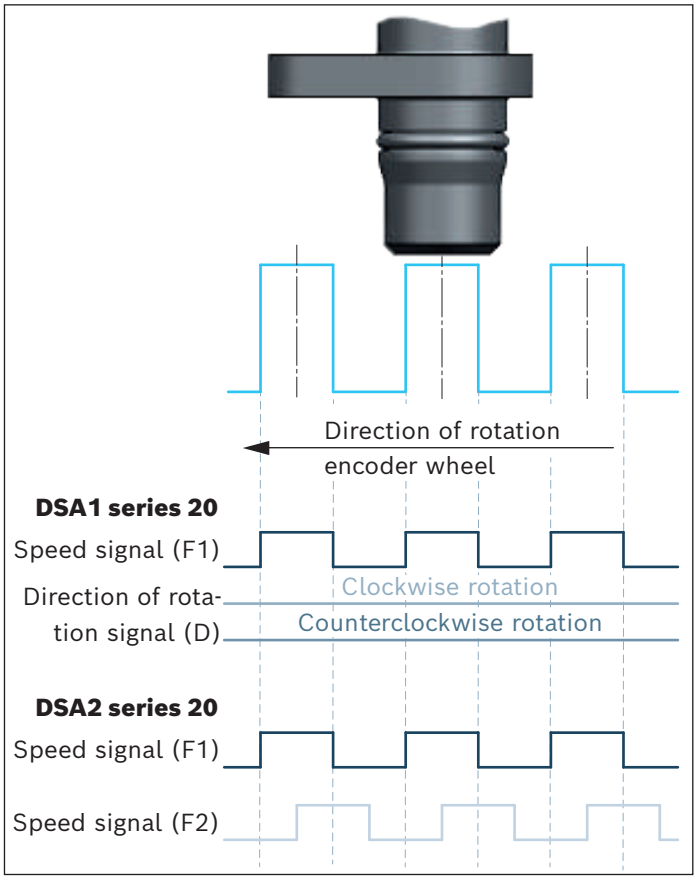
Electrical characteristics

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

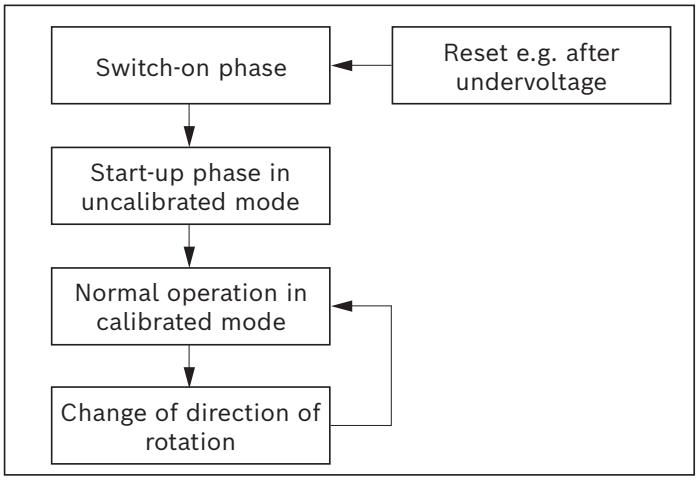
1) Additional temperature increase (temperature offset) due to the power dissipation in the thermistor (NTC)

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.

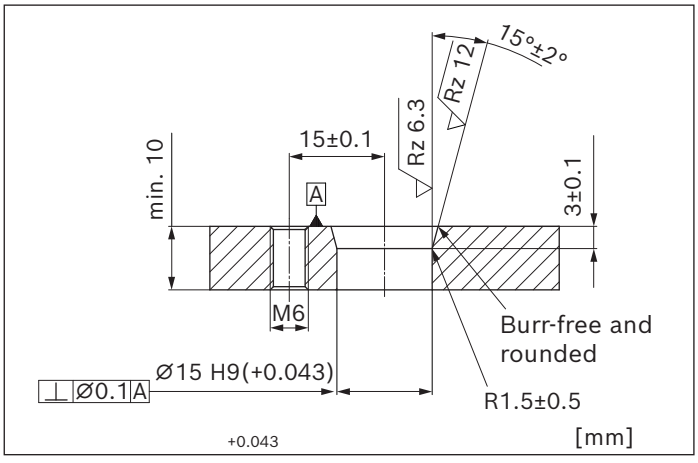
Installation instructions

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.

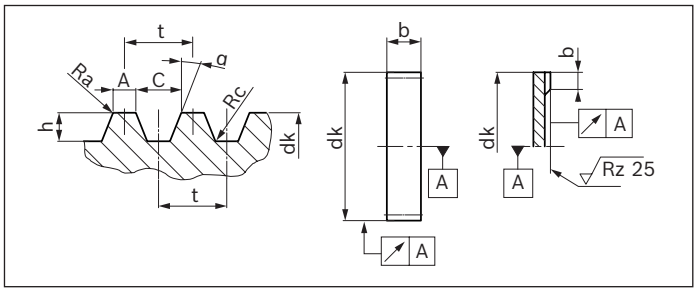
▼ **Installation bore**



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

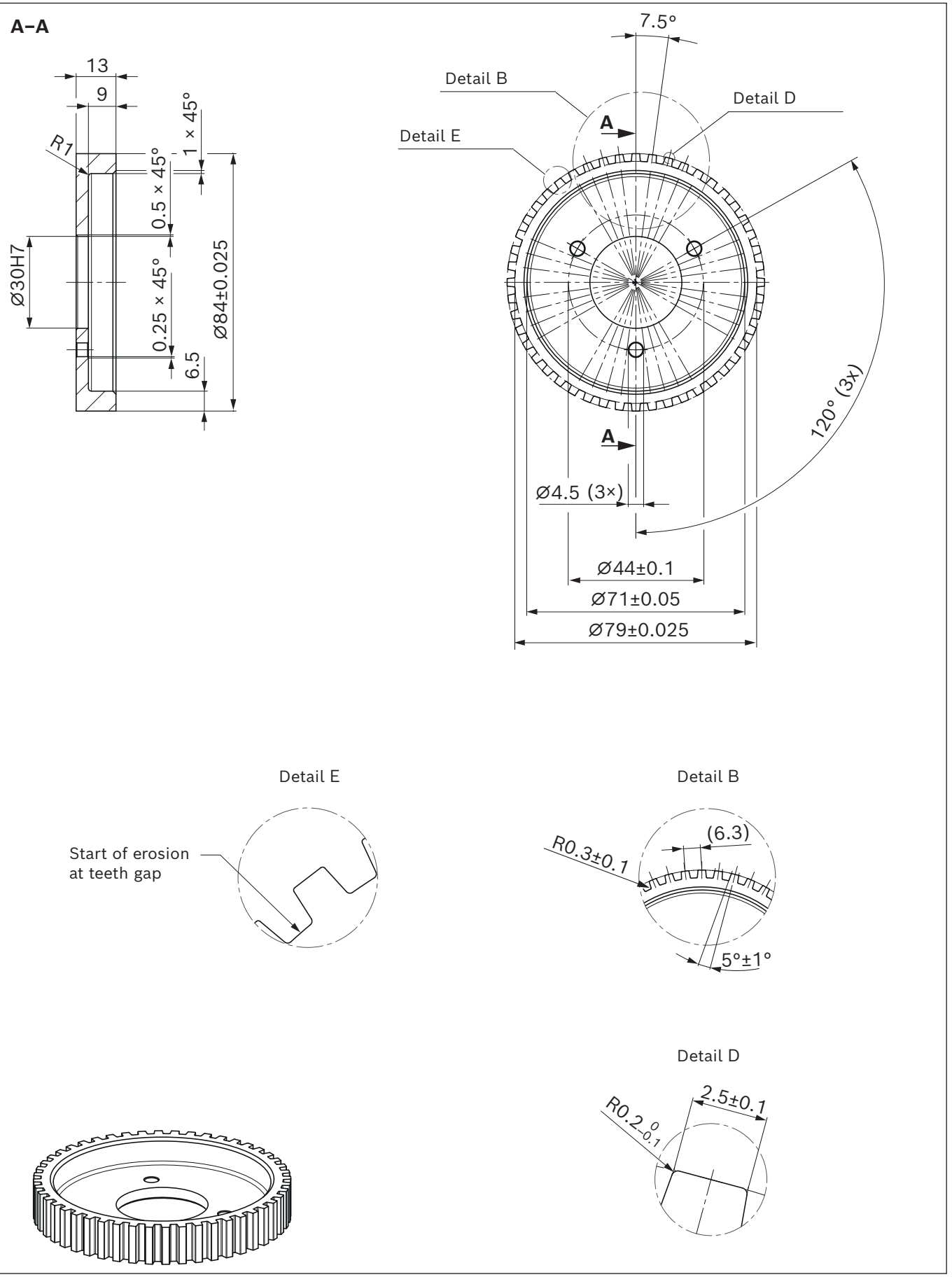
Distance of the gear wheel to the sensor

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

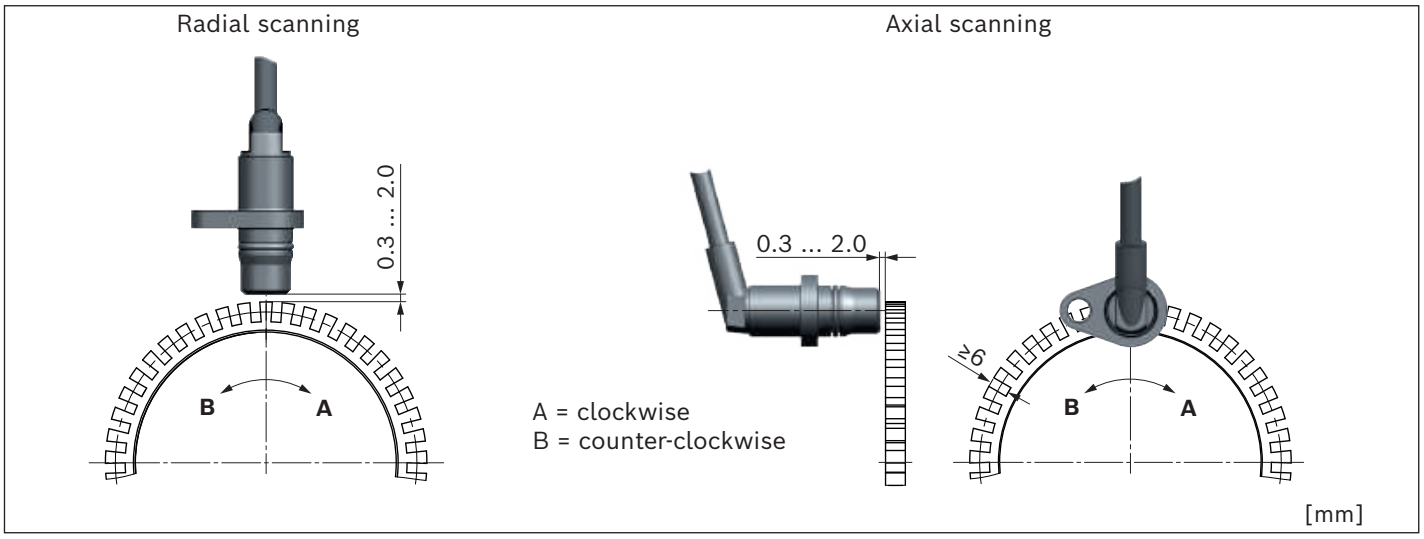
		Size	Permissible deviation
A/t	Ratio of tooth tip width to spacing	0.5	±10%
h	Tooth height	> 6 mm	
b	Pulse wheel width	> 2 mm	
α	Pressure angle	0	±1

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

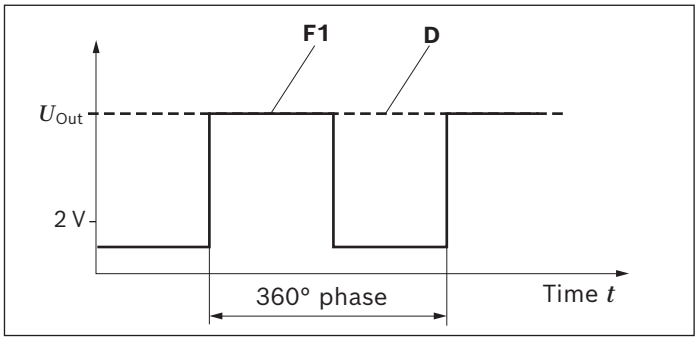
▼ **Assigning the direction of rotation to the sensor**



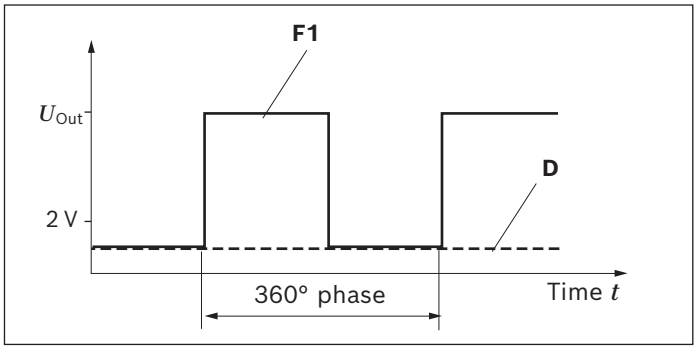
Signal output DSA1 series 20

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

▼ **Clockwise**



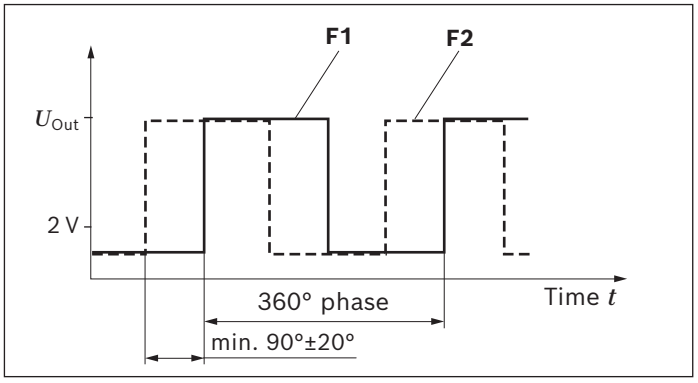
▼ **Counter-clockwise**



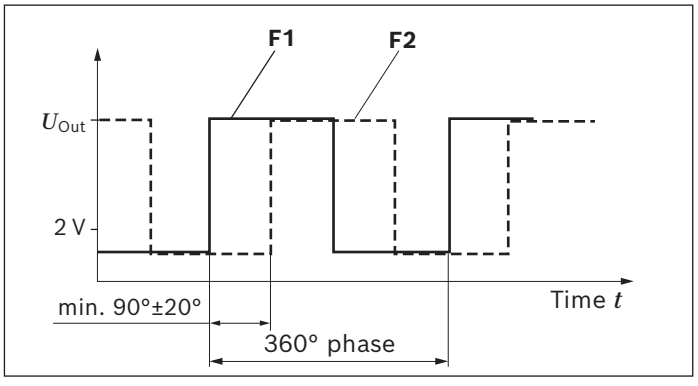
Signal output DSA2 series 20

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

▼ **Clockwise**

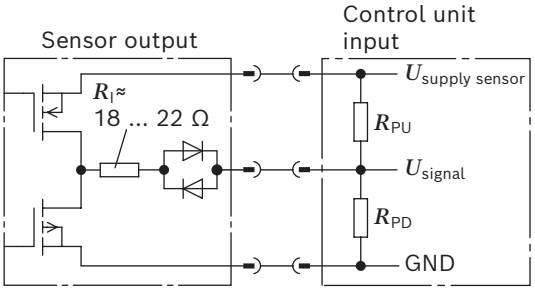
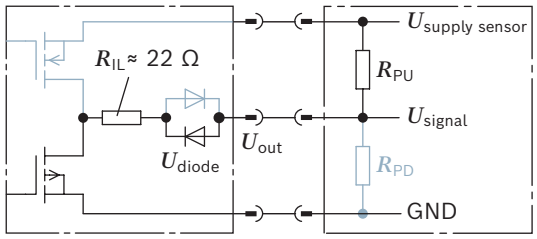
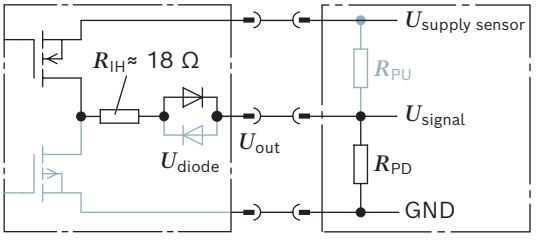


▼ **Counter-clockwise**



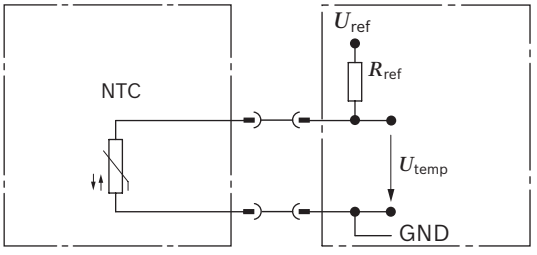
Calculation of the output voltage of the speed signal in dependence of the evaluating control unit

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

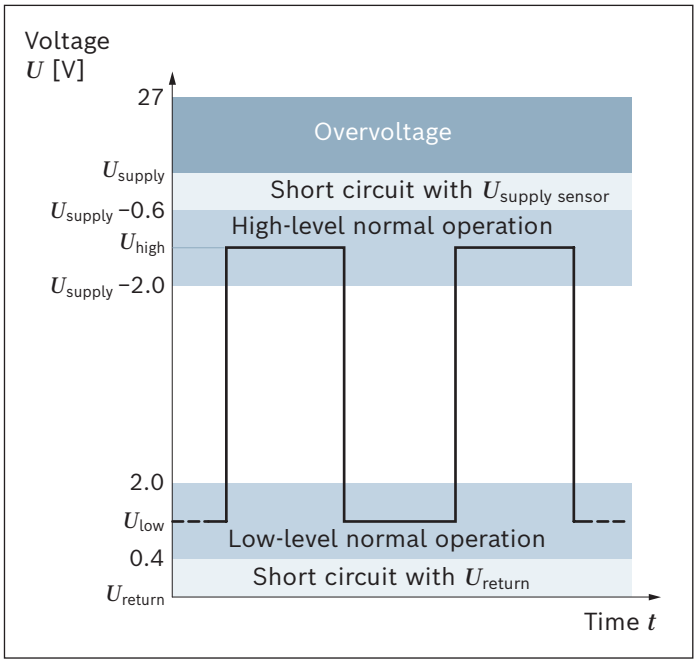
Key

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.

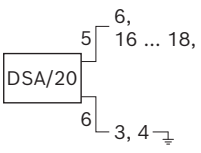
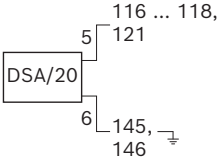
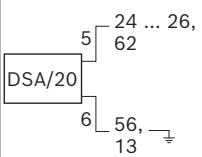
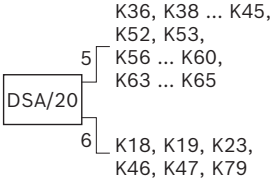
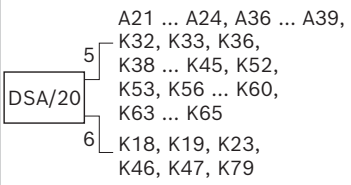
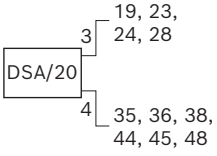
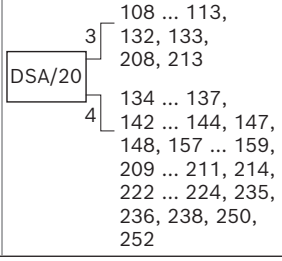
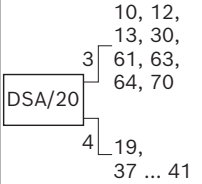
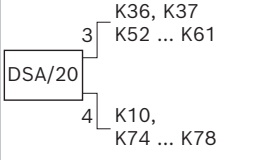
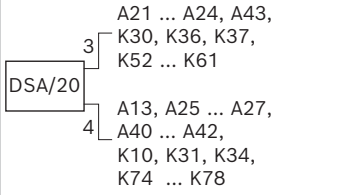
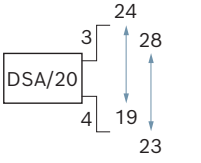
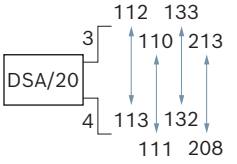
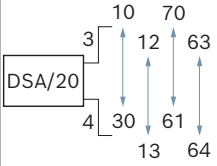
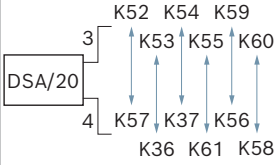
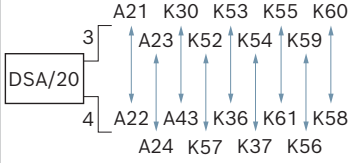
1) See also “Error detection” see page 18

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] ▼

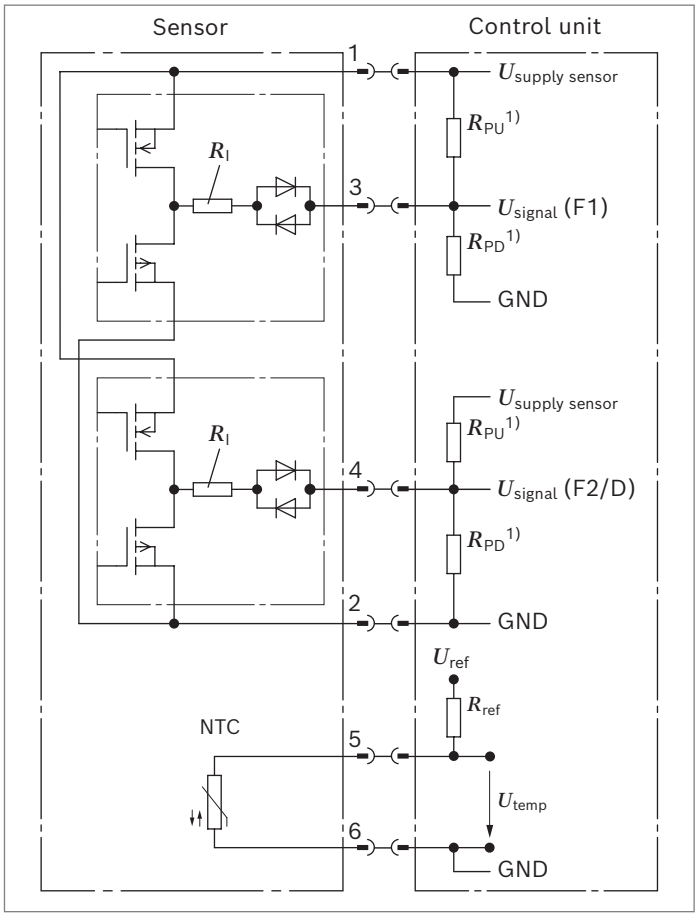
RC4-5/30 (Data sheet 95205)	**RC12-10/30, RC20-10/30 RC28-14/30,** (Datenblatt 95204)	**RC10-10/31** (Datenblatt 95206)	**RC5-6/40** (Datenblatt 95207)	**RC18-12/40, RC27-18/40** (Datenblatt 95208)
Temperature signals				
				
Frequency signals, DSA1 series 20				
				
Frequency signals, DSA2 series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

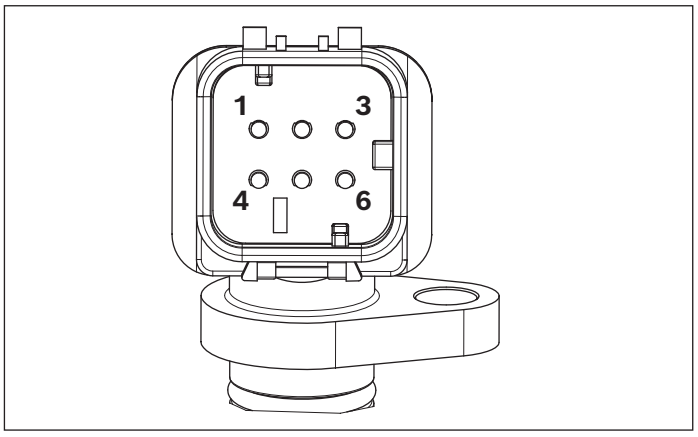


Key

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

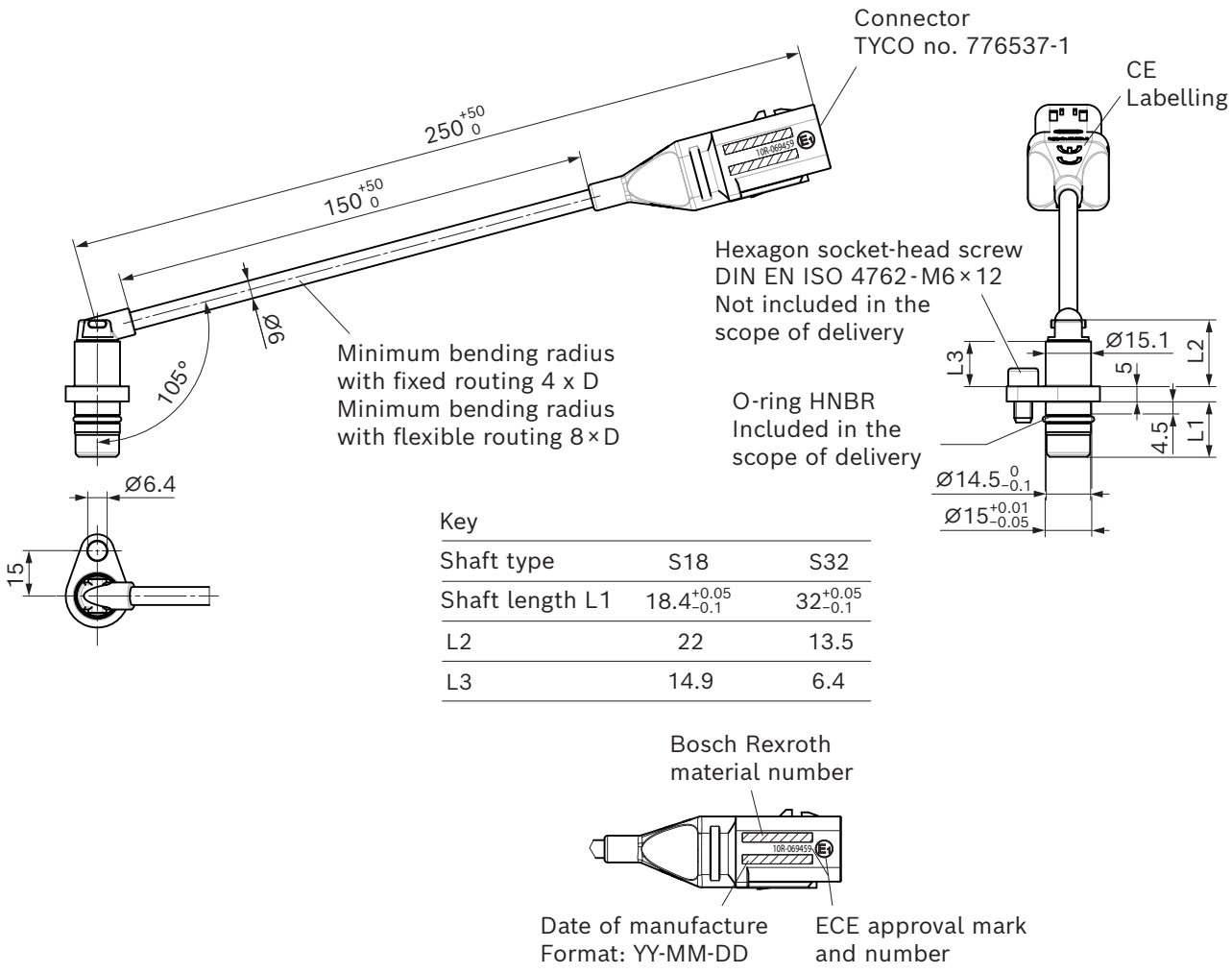
▼ **Pin assignment**



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.

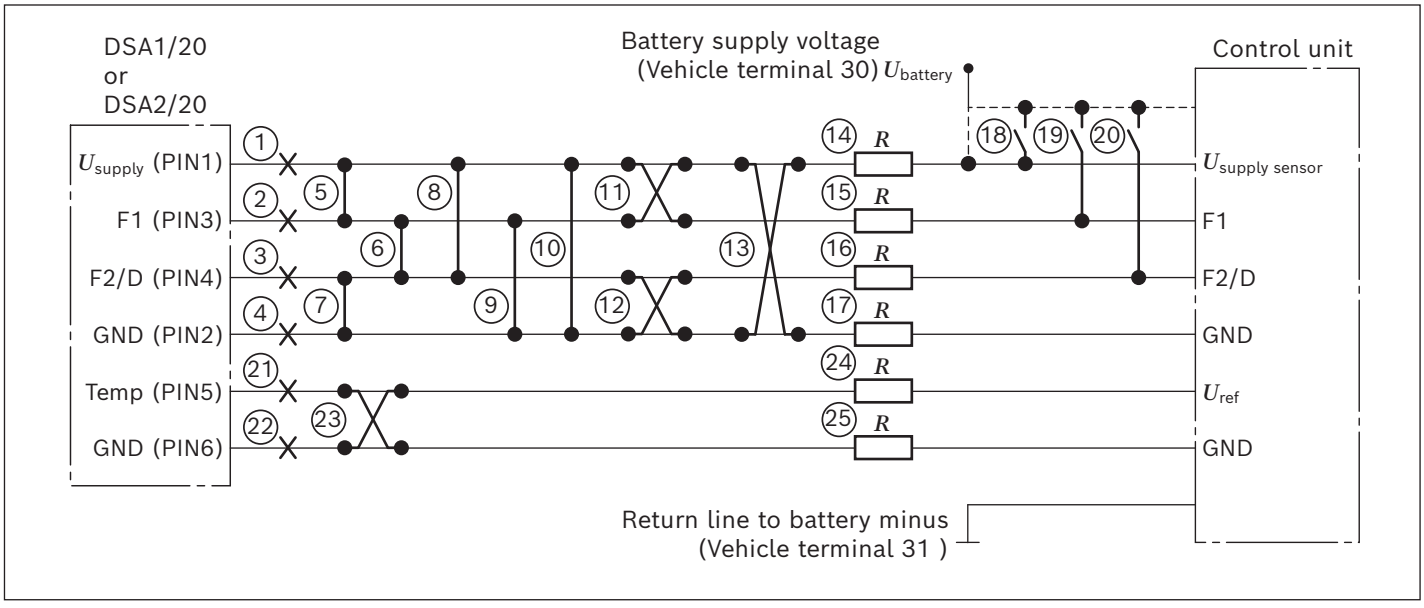
The temperature signal of the DSA series 20 speed sensor is not safety-related.

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

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.

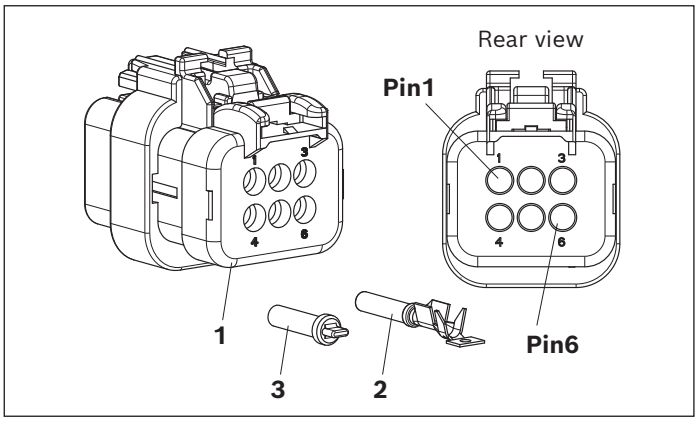
Notice

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.
The following document must be observed when assembling the connector.
AMPSEAL 16 Connector System 408-8623 Instruction Sheet

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

Pos.	Designation		Quantity	Order number	Manufacturer	Remarks
1	AS 16, 6P PLUG ASSY, KEY 1		1	776531-1	TE Connectivity	
2	Nickel pin coating	tape and reel	6	1924464-2	TE Connectivity	Contact coating: Nickel Suitable for wire thicknesses: 20-18AWG, 0.51 ... 0.82 mm²
				776493-2	TE Connectivity	Contact coating: Nickel Suitable for wire thicknesses: 20-18AWG, 0.5 ... 0.75 mm²
3	Sealing plug		2	776364-1	TE Connectivity	Use sealing plugs if pins are not connected

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**

Pos.	Designation		Quantity	Order number	Manufacturer	Remarks
1	AS 16, 6P PLUG ASSY, KEY 1		1	776433-1	TE Connectivity	
2	Nickel pin coating	bush	6	776299-2	TE Connectivity	Contact coating: Nickel Suitable for wire thicknesses: 14-18AWG, 0.8 ... 2 mm²
		tape and reel	6	776492-2	TE Connectivity	Contact coating: Nickel Suitable for wire thicknesses: 14-18AWG, 0.8 ... 2 mm²
3	Sealing plug		2	776363-1	TE Connectivity	Use sealing plugs if pins are not connected

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

▼ **Retaining clip**

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

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

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

Version	Quantity per bag	Type of packaging
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.

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