Hall-effect rotational-speed sensors

Digital measurement of rotational speeds

n, φ, s / U

- Precise and reliable digital measurement of rotational speed, angle, and distance travelled.
- Non-contacting (proximity) measurement.
- Hall-IC in sensor with open-collector output.
- Insensitive to dirt and contamination.
- Resistant to mineral-oil products (fuel, engine lubricant).

Design
Hall sensors comprise a semiconductor wafer with integrated driver circuits (e.g. Schmitt-Trigger) for signal conditioning, a transistor functioning as the output driver, and a permanent magnet. These are all hermetically sealed inside a plastic plug-type housing.

Application
Hall-effect rotational-speed sensors are used for the non-contacting (proximity), and therefore wear-free, measurement of rotational speeds, angles, and travelled distances. Compared to inductive-type sensors, they have an advantage in their output signal being independent of the rotational speed or relative speed of the rotating trigger-wheel vane. The position of the tooth is the decisive factor for the output signal.
Adaptation to almost every conceivable application requirement is possible by appropriate tooth design. In automotive engineering, Hall-effect sensors are used for information on the momentary wheel speed and wheel position as needed for braking and drive systems (ABS/TCS), for measuring the steering-wheel angle as required for the vehicle dynamics control system (Electronic Stability Program, ESP), and for cylinder identification.

Operating principle
Measurement is based upon the Hall effect which states that when a current is passed through a semiconductor wafer the so-called Hall voltage is generated at right angles to the direction of current. The magnitude of this voltage is proportional to the magnetic field through the semiconductor. Protective circuits, signal conditioning circuits, and output drivers are assembled directly on this semiconductor. If a magnetically conductive tooth (e.g. of soft iron) is moved in front of the sensor, the magnetic field is influenced arbitrarily as a function of the trigger-wheel vane shape. In other words, the output signals are practically freely selectable.

Technical Data 1) / Range

Part number		**0 232 103 021**	**0 232 103 022**
Minimum rotational speed of trigger wheel n_{min}		0 min⁻¹	10 min⁻¹
Maximum rotational-speed of trigger wheel $n_{max.}$		4000 min⁻¹	4500 min⁻¹
Minimum working air gap		0.1 mm	0.1 mm
Maximum working air gap		1.8 mm	1.5 mm
Supply voltage U_N		5 V	12 V
Supply-voltage range U_V		4.75...5.25 V 2)	4.5...24 V
Supply current I_V	Typical	5.5 mA	10 mA
Output current I_A		0...20 mA	0...20 mA
Output voltage U_A		0... U_V	0... U_V
Output saturation voltage U_S		≤ 0.5 V	≤ 0.5 V
Switching time t_f 3) at $U_A = U_N$, I_A = 20 mA (ohmic load)		≤ 1 µs	≤ 1 µs
Switching time t_r 4) at $U_A = U_N$, I_A = 20 mA (ohmic load)		≤ 15 µs	≤ 15 µs
Sustained temperature in the sensor and transition region		–40...+150 °C	–30...+130 °C 5)
Sustained temperature in the plug area		–40...+130 °C	–30...+120 °C 6)

1) At ambient temperature 23 ±5 °C. 2) Maximum supply voltage for 1 hour: 16.5 V
3) Time from HIGH to LOW, measured between the connections (0) and (–) from 90% to 10%
4) Time from LOW to HIGH, measured between the connections (0) and (–) from 10% to 90%
5) Short-time –40...+150 °C permissible. 6) Short-time –40...+130 °C permissible.

Accessories for connector

Plug housing	Contact pins	Individual gaskets	For cable cross section
1 928 403 110	**1 987 280 103**	**1 987 280 106**	0.5...1 mm²
	1 987 280 105	**1 987 280 107**	1.5...2.5 mm²

Note: For a 3-pin plug, 1 plug housing, 3 contact pins, and 3 individual gaskets are required.
For automotive applications, original AMP crimping tools must be used.

Installation information
– Standard installation conditions guarantee full sensor functioning.
– Route the connecting cables in parallel in order to prevent incoming interference.
– Protect the sensor against destruction by static discharge (CMOS components).
– The information on the right of this page must be observed in the design of the trigger wheel.

Symbol explanation
n_{min} = 0: Static operation possible.
n_{min} > 0: Only dynamic operation possible.
U_S: Max. output voltage at LOW with
I_A: Output current = 20 mA.
I_V: Supply current for the Hall sensor.
t_f: Fall time (trailing signal edge).
t_r: Rise time (leading signal edge).

Trigger-wheel design
0 232 103 021
The trigger wheel must be designed as a 2-track wheel. The phase sensor must be installed dead center. Permissible center offset: ±0.5 mm.
Segment shape:

Mean diameter	≥ 45 mm
Segment width	≥ 5 mm
Segment length	≥ 10 mm
Segment height	≥ 3.5 mm

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The trigger wheel is scanned radially.
Segment shape:

Diameter	≥ 30 mm
Tooth depth	≥ 4.5 mm
Tooth width	≥ 10 mm
Material thickness	≥ 3.5 mm

Dimension drawings.

S 3-pin plug-in connection
Sez Sensor area
Stz Plug area
Tz Temperature area
O O-ring

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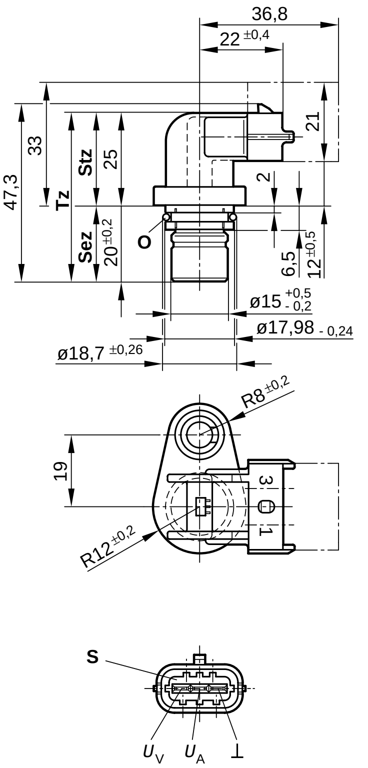

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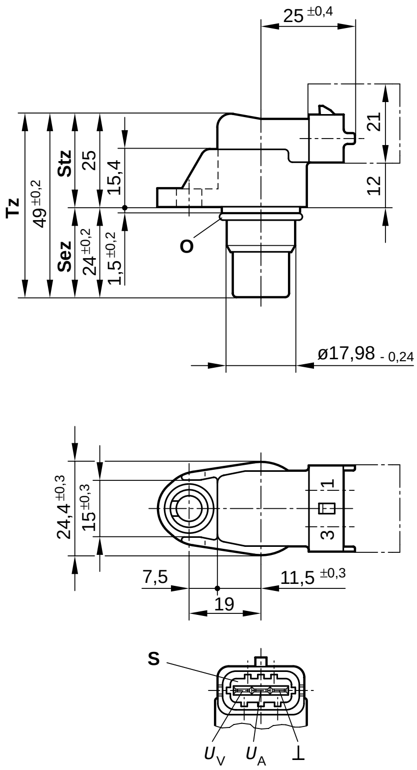
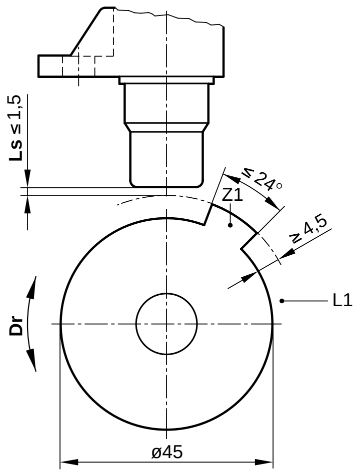
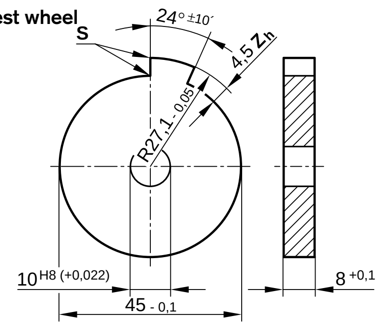


Installation stipulation 0 232 103 022.

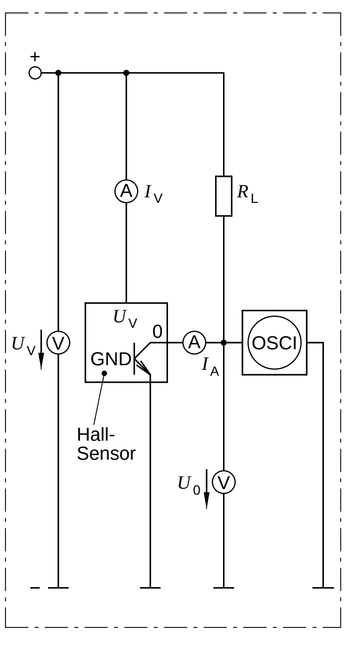
Dr Direction of rotation
Ls Air gap
S Sharp-edged
Zh Tooth height



Test wheel



Block diagram.



Output-signal shape.

$U_{A,O}$ Output voltage
$U_{A,SAT}$ Output saturation voltage
α Angle of rotation
α_S Signal width

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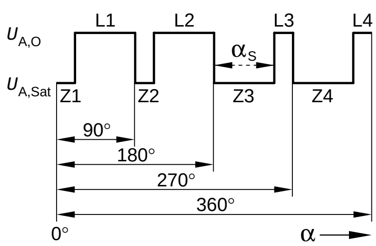

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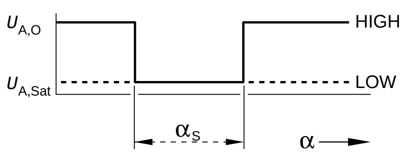
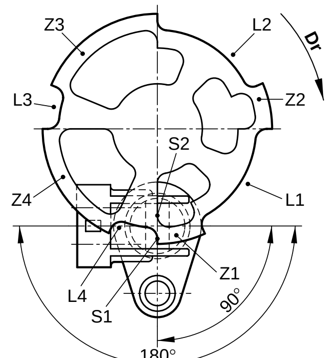


Installation stipulation 0 232 103 021.

Dr Direction of rotation



Test wheel