

Sensors

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We reserve the right to make technical changes.

Techniques and applications

This catalog features the most important technical data required for selecting a given sensor. To date, the sensors listed have all been used in automotive applications, but their universal and highly versatile characteristics also make them ideally suitable for industrial applications. For instance in:

- Manufacturing engineering
- Mechanical engineering
- Automation
- Materials handling and conveying
- Heating and air-conditioning
- Chemical and process engineering
- Environmental and conservation technology
- Installation and plant engineering

Brief descriptions and examples of application are to be found in the Table below.

For the applications listed below, prior clarification of the technical suitability is imperative. This Catalog only lists those products which are available from series manufacture. If your problem cannot be solved with this range of products, please inform us of your requirements using the Enquiry Data Sheet.

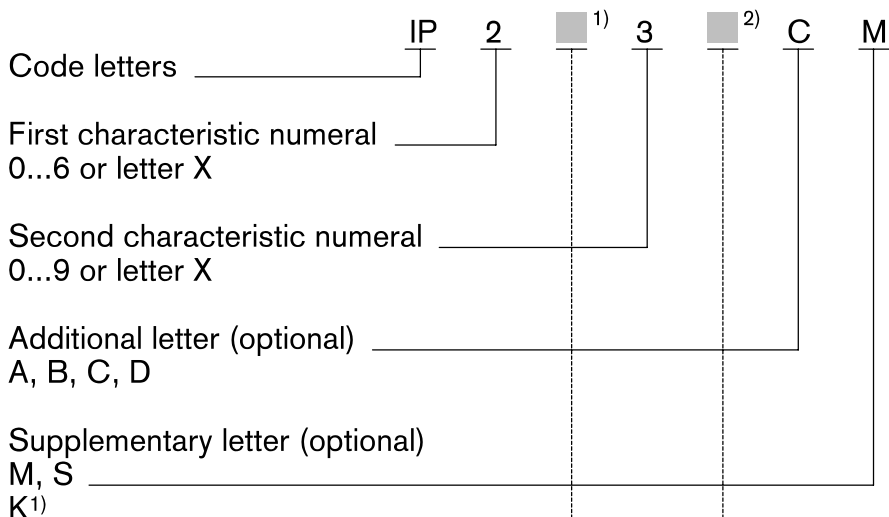
Sensors	Automotive application	Examples of non-automotive applications
Angular position sensors measure simple angular settings and changes in angle.	Throttle-valve-angle measurement for engine management on gasoline (SI) engines.	Door/window opening angle, setting-lever angles in monitoring and control installations.
Rotational-speed sensors measure rotational speeds, positions and angles in excess of 360°.	Wheel-speed measurement for ABS/TCS, engine speeds, positioning angle for engine management, measurement of steering-wheel angle, distance covered, and curves/bends for vehicle navigation systems.	Proximity or non-contact measurement of rotational speed, displacement and angular measurement, definition of end and limit settings for industrial machines, robots, and installations of all types.
Spring-mass acceleration sensors measure changes in speed, such as are common in road traffic.	Registration of vehicular acceleration and deceleration. Used for the Antilock Braking System (ABS) and the Traction Control System (TCS).	Acceleration and deceleration measurement for safety, control, protective systems in lifts, cable railways, fork-lift trucks, conveyor belts, machines, wind power stations.
Bending-beam acceleration sensors register shocks and vibration which are caused by impacts on rough/unpaved road surfaces or contact with kerbstones.	For engine management, detection of vibration on rough/unpaved road surfaces.	Forced switch-off for machines, industrial robots, manufacturing plant, and gaming machines in case of sudden acceleration or deceleration caused by shock or impact.
Piezoelectric acceleration sensors measure shocks and vibration which occur when vehicles and bodies impact against an obstacle.	Impact detection used for triggering airbags and belt tighteners.	Detection of impact in monitoring/surveillance installations, detection of foreign bodies in combine harvesters, filling machines, and sorting plants. Registration of score during rifleman competitions.
Yaw sensors measure skidding movements, such as occur in vehicles under road traffic conditions.	Used on the vehicle dynamics control (Electronic Stability Program, ESP) for measuring yaw rate and lateral acceleration, and for vehicle navigation sensors.	Stabilization of model vehicles and airplanes, safety circuits in carousels and other entertainment devices on fairgrounds etc.
Piezoelectric vibration sensors measure structure-borne vibrations which occur at engines, machines, and pivot bearings.	Engine-knock detection for anti-knock control in engine-management systems.	Machine-tool safety, cavitation detection, pivot-bearing monitoring, structure-borne-noise detection in measurement systems.
Absolute-pressure sensors measure the pressure ranges from about 50% to 500% of the earth's atmospheric pressure.	Manifold vacuum measurement for engine management. Charge-air-pressure measurement for charge-air pressure control, altitude-pressure-dependent fuel injection for diesel engines.	Pressure control in electronic vacuum cleaners, monitoring of pneumatic production lines, meters for air-pressure, altitude, blood pressure, manometers, storm-warning devices.
Differential-pressure sensors measure differential gas pressures, e.g. for pressure-compensation purposes.	Pressure measurement in the fuel tank, evaporative-emissions control systems.	Monitoring of over and underpressure. Pressure limiters, filled-level measurement.
Temperature sensors measure the temperature of gaseous materials and, inside a suitable housing, the temperatures of liquids in the temperature range of the earth's atmosphere and of water.	Display of outside and inside temperature, control of air conditioners and inside temperature, control of radiators and thermostats, measurement of lube-oil, coolant, and engine temperatures.	Thermometers, thermostats, thermal protection, frost detectors, air-conditioner control, temperature and central heating, refrigerant-temperature monitoring, regulation of hot-water and heat pumps.
Lambda oxygen sensors determine the residual oxygen content in the exhaust gas.	Control of A/F mixture for minimization of pollutant emissions on gasoline and gas engines.	Pollutants reduction during combustion, smoke measurement, gas analysis.
Air-mass meters measure the flow rate of gases.	Measurement of the mass of the air drawn in by the engine.	Flow-rate measurement for gases on test benches and in combustion plant.

IP degrees of protection

Valid for the electrical equipment of road vehicles as per DIN 40 050 (Part 9).

- Protection of the electrical equipment inside the enclosure against the effects of solid foreign objects including dust.
- Protection of the electrical equipment inside the enclosure against the ingress of water.
- Protection of persons against contact with dangerous parts, and rotating parts, inside the enclosure.

Structure of the IP code



If a characteristic numeral is not given, it must be superseded by the letter "X" (i.e. "XX" if both characteristic numerals are not given).

The supplementary and/or additional letters can be omitted at will, and need not be superseded by other letters.

¹⁾ The supplementary letter "K" is located either directly after the first characteristic numerals 5 and 6, or directly after the second characteristic numerals 4, 6 and 9.

²⁾ During the water test. Example: IP16KB protection against the ingress of solid foreign bodies with diameter ≥ 50 mm, protection against high-pressure hose water, protection against access with a finger.

Comments on IP code

1st characteristic numeral and supplementary letter K	Protection of electrical equipment against ingress of solid foreign objects	Persons	2nd characteristic numeral and supplementary letter K	Protection of electrical equipment against the ingress of water	Additional letter (optional)	Protection of persons against contact with hazardous parts	Additional letter (optional)
0	Non-protected	Non-protected	0	Non-protected	A	Protection against contact with back of hand	M
1	Protection against foreign bodies $\varnothing \geq 50$ mm	Protection against contact with back of hand	1	Protection against vertically dripping water	B	Protection against contact with finger	S
2	Protection against foreign bodies $\varnothing \geq 12.5$ mm	Protection against contact with finger	2	Protection against dripping water (at an angle of 15°)	C	Protection against contact with tool	K
3	Protection against foreign bodies $\varnothing \geq 2.5$ mm	Protection against contact with tool	3	Protection against splash water	D	Protection against contact with wire	
4	Protection against foreign bodies $\varnothing \geq 1.0$ mm	Protection against contact with wire	4	Protection against spray water			
5K	Dust-protected	Protection against contact with wire	4K	Protection against high-pressure spray water			
6K	Dust-proof	Protection against contact with wire	5	Protection against jets of water			
			6	Protection against powerful jets of water			
			6K	Protection against high-pressure jets of water			
			7	Protection against temporary immersion			
			8	Protection against continuous immersion			
			9K	Protection against high-pressure/steam-jet cleaners			

CAN-Bus

Controller Area Network

Present-day motor vehicles are equipped with a large number of electronic control units (ECUs) which have to exchange large volumes of data with one another in order to perform their various functions. The conventional method of

doing so by using dedicated data lines for each link is now reaching the limits of its capabilities. On the one hand, it makes the wiring harnesses so complex that they become unmanageable, and on the other the finite number of pins

on the connectors becomes the limiting factor for ECU development. The solution is to be found in the use of specialized, vehicle-compatible serial bus systems among which the CAN has established itself as the standard.

Applications

There are four areas of application for CAN in the motor vehicle, each with its own individual requirements:

Real-time applications

Real-time applications, in which electrical systems such as Motronic, transmission-shift control, electronic stability-control systems are networked with one another, are used to control vehicle dynamics. Typical data transmission rates range from 125 kbit/s to 1 Mbit/s (high-speed CAN) in order to be able to guarantee the real-time characteristics demanded.

Multiplex applications

Multiplex applications are suitable for situations requiring control and regulation of body-component and luxury/convenience systems such as air conditioning, central locking and seat adjustment. Typical data transmission rates are between 10 kbits and 125 kbit/s (low-speed CAN).

Mobile-communications applications

Mobile-communications applications connect components such as the navigation system, cellular phone or audio system with central displays and controls. The basic aim is to standardize control operations and to condense status information so as to minimize driver distraction. Data transmission rates are generally below 125 kbit/s; whereby direct transmission of audio or video data is not possible.

Diagnostic applications

Diagnostic applications for CAN aim to make use of existing networking for the diagnosis of the ECUs incorporated in the network. The use of the "K" line (ISO 9141), which is currently the normal practice, is then no longer necessary. The data rate envisaged is 500 kbit/s.

Bus configuration

CAN operates according to the multi-master principle, in which a linear bus structure connects several ECUs of equal priority rating (Fig. ①). The advantage of this type of structure lies in the fact that a malfunction at one node does not impair bus-system access for the remaining devices. Thus the probability of a total system failure is substantially lower than with other logical architectures (such as ring or active star structures). When a ring or active star structure is employed, failure at a single node or at the CPU is sufficient to cause a total failure.

Content-based addressing

Addressing is message-based when using CAN. This involves assigning a fixed identifier to each message. The identifier classifies the content of the message (e.g., engine speed). Each station processes only those messages whose identifiers are stored in its acceptance list (message filtering, Fig. ②). Thus CAN requires no station addresses for data transmission, and the nodes are not involved in administering system configuration. This facilitates adaptation to variations in equipment levels.

Logical bus states

The CAN protocol is based on two logical states: The bits are either "recessive" (logical 1) or "dominant" (logical 0). When at least one station transmits a dominant bit, then the recessive bits simultaneously sent from other stations are overwritten.

Priority assignments

The identifier labels both the data content and the priority of the message being sent. Identifiers corresponding to low binary numbers enjoy a high priority and vice versa.

Bus access

Each station can begin transmitting its most important data as soon as the bus is unoccupied. When several stations start to transmit simultaneously, the system responds by employing "Wired-AND" arbitration to sort out the resulting contentions over bus access. The message with the highest priority is assigned first access, without any bit loss or delay. Transmitters respond to failure to gain bus access by automatically switching to receive mode;

they then repeat the transmission attempt as soon as the bus is free again.

Message format

CAN supports two different data-frame formats, with the sole distinction being in the length of the identifier (ID). The standard-format ID is 11 bits, while the extended version consists of 29 bits. Thus the transmission data frame contains a maximum of 130 bits in standard format, or 150 bits in the extended format. This ensures minimal waiting time until the subsequent transmission (which could be urgent). The data frame consists of seven consecutive bit fields (Fig. ③):

"Start of frame"

indicates the beginning of a message and synchronizes all stations.

"Arbitration field"

consists of the message's identifier and an additional control bit. While this field is being transmitted, the transmitter accompanies the transmission of each bit with a check to ensure that no higher-priority message is being transmitted (which would cancel the access authorization). The control bit determines whether the message is classified under "data frame" or "remote frame".

"Control field"

contains the code indicating the number of data bytes in the data field.

"Data field's"

information content comprises between 0 and 8 bytes. A message of data length 0 can be used to synchronize distributed processes.

"CRC field"

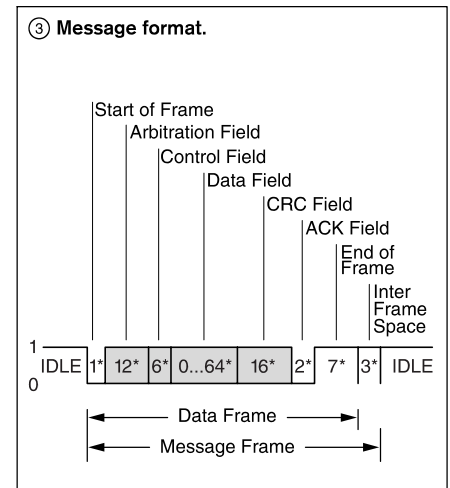
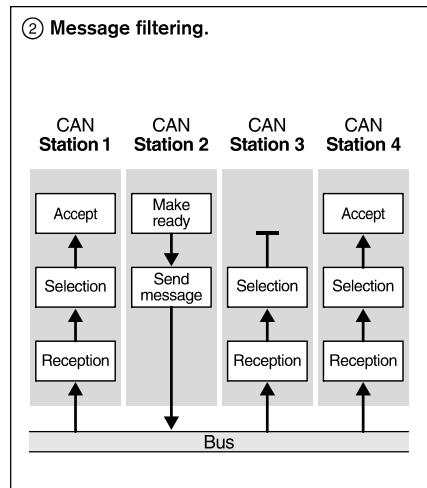
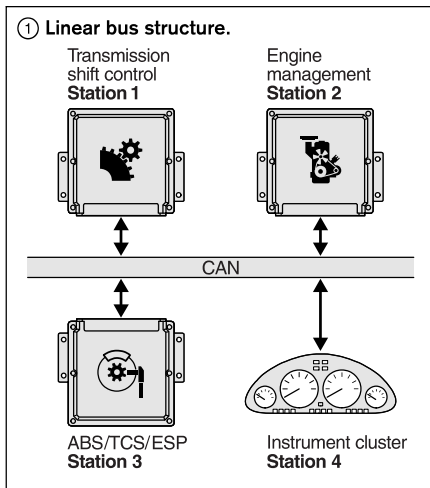
(Cyclic Redundancy Check) contains the check word for detecting possible transmission interference.

"Ack field"

contains the acknowledgement signals with which all receivers indicate receipt of non-corrupted messages.

"End of frame"

marks the end of the message.



Transmitter initiative

The transmitter will usually initiate a data transfer by sending a data frame. However, the receiver can also request data from the transmitter. This involves the receiver sending out a "remote frame". The "data frame" and the corresponding "remote frame" have the same identifier. They are distinguished from one another by means of the bit that follows the identifier.

Error detection

CAN incorporates a number of monitoring features for detecting errors. These include:

- 15 Bit CRC (Cyclic Redundancy Check): Each receiver compares the CRC sequence which it receives with the calculated sequence.
- Monitoring: Each transmitter compares transmitted and scanned bit.
- Bit stuffing: Between "start of frame" and the end of the "CRC field", each "data frame" or "remote frame" may contain a maximum of 5 consecutive bits of the same polarity. The transmitter follows up a sequence of 5 bits of the same polarity by inserting a bit of the opposite polarity in the bit stream; the receivers eliminate these bits as the messages arrive.
- Frame check: The CAN protocol contains several bit fields with a fixed format for verification by all stations.

Error handling

When a CAN controller detects an error, it aborts the current transmission by sending an "error flag". An error flag consists of 6 dominant bits; it functions by deliberately violating the conventions governing stuffing and/or formats.

Fault confinement with local failure

Defective stations can severely impair the ability to process bus traffic. Therefore, the CAN controllers incorporate mechanisms which can distinguish between intermittent and permanent errors and local station failures. This process is based on statistical evaluation of error conditions.

Implementations

In order to provide the proper CPU support for a wide range of different requirements, the semiconductor manufacturers have introduced implementations representing a broad range of performance levels. The various implementations differ neither in the message they produce, nor in their arrangements for responding to errors. The difference lies solely in the type of CPU support required for message administration.

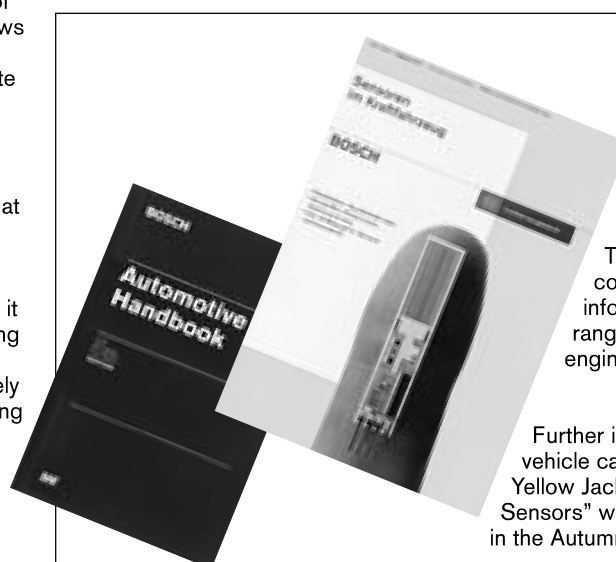
As the demands placed on the ECU's processing capacity are extensive, the interface controller should be able to ad-

minister a large number of messages and expedite data communications with, as far as possible, no demands on the CPU's computational resources. Powerful CAN controllers are generally used in this type of application.

The demands placed on the controllers by multiplex systems and present-day mobile communications are more modest. For that reason, more basic and less expensive chips are preferred for such uses.

Standardization

CANs for data exchange in automotive applications have been standardized both by the ISO and the SAE – in ISO 11519-2 for low-speed applications ≤ 125 kbit/s and in ISO 11898 and SAE J 22584 (cars) and SAE J 1939 (trucks and busses) for high-speed applications >125 kbit/s. There is also an ISO standard for diagnosis via CAN (ISO 15765 – Draft) in the course of preparation.



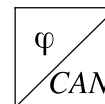
Source: Texts and illustrations on the subject of CAN-Bus are taken from the Bosch Automotive Handbook, 5th Edition, 2000.

The Automotive Handbook contains a very wide variety of information covering the whole range of modern-day automotive engineering.

Further information on sensors in the vehicle can be taken from the Bosch Yellow Jacket publication "Automotive Sensors" which is scheduled to appear in the Autumn.

Steering-wheel-angle sensor

Measurement of angles from -780° to $+780^\circ$



- "True-Power-On" function.
- Multiple-rotation function.
- CAN interface.



Application

The steering-wheel-angle sensor was developed for use with vehicle dynamics systems (ESP*).

Due to integral plausibility tests, and special self-diagnosis functions, this steering-wheel-angle sensor is highly suitable for application in safety systems.

Design and function

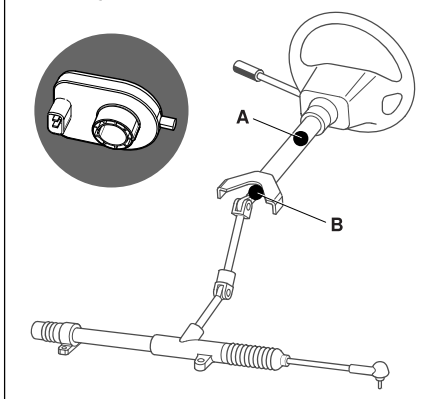
When the steering wheel is turned it rotates a gearwheel which in turn drives two other special measuring gears which incorporate magnets. AMR elements which change their resistance as a function of the direction of magnetic field register the angular position of the magnets. These analog measured values are then inputted to the microprocessor via an A/D converter. The number of teeth on one measuring gear differs to that on the other, which means that they therefore change their rotational position at different speeds. By combining both the actual angles of rotation, it is possible to calculate the total angle of rotation. After a number of rotations of the steering wheel, each of the measuring gears has returned to its initial position. Using this principle, it becomes possible to cover a measurement range of several steering-wheel rotations without the need to use a revolution counter.

The steering-wheel angle is outputted in the form of an absolute angle across the total steering-column rotation range. One of this sensor's special features is the fact that the (correct) angle-of-rotation is available immediately the ignition is switched on, without the steering wheel having been moved ("True-Power-On"). The steering-wheel angle and the steering-wheel speed are outputted via CAN.

* ESP = Electronic Stability Program

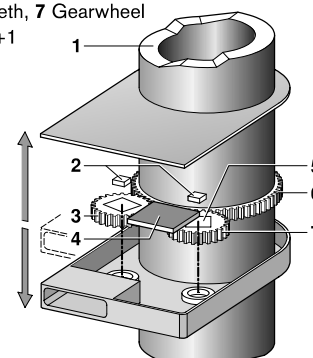
Installation possibilities.

- A** Steering-column switch,
B Steering column



Design and function.

- 1** Steering column, **2** AMR sensor element,
3 Measuring gear with m teeth, **4** Evaluation electronics, **5** Magnets, **6** Measuring gear with n>m teeth, **7** Gearwheel with m+1 teeth



Technical data / Range

Order No.	0 265 005 411 ¹⁾
Steering-wheel-angle sensor/Type	LWS 3
Measuring range, angle	$-780^\circ \dots +779.9^\circ$
Measuring range, acceleration	$0 \dots 1016^\circ/\text{s}$
Sensitivity and resolution throughout the measuring range, angle	0.1°
Sensitivity and resolution throughout the measuring range, acceleration	$4^\circ/\text{s}$
Non-linearity throughout measuring range	$-2.5^\circ \dots +2.5^\circ$
Hysteresis throughout measuring range	$0^\circ \dots 5^\circ$
Rate of steering-wheel-angle change, max.	$-2000^\circ \dots +2000^\circ/\text{s}$
Rate of steering-wheel-angle change, displayed	$0^\circ \dots 1016^\circ/\text{s}$

General data

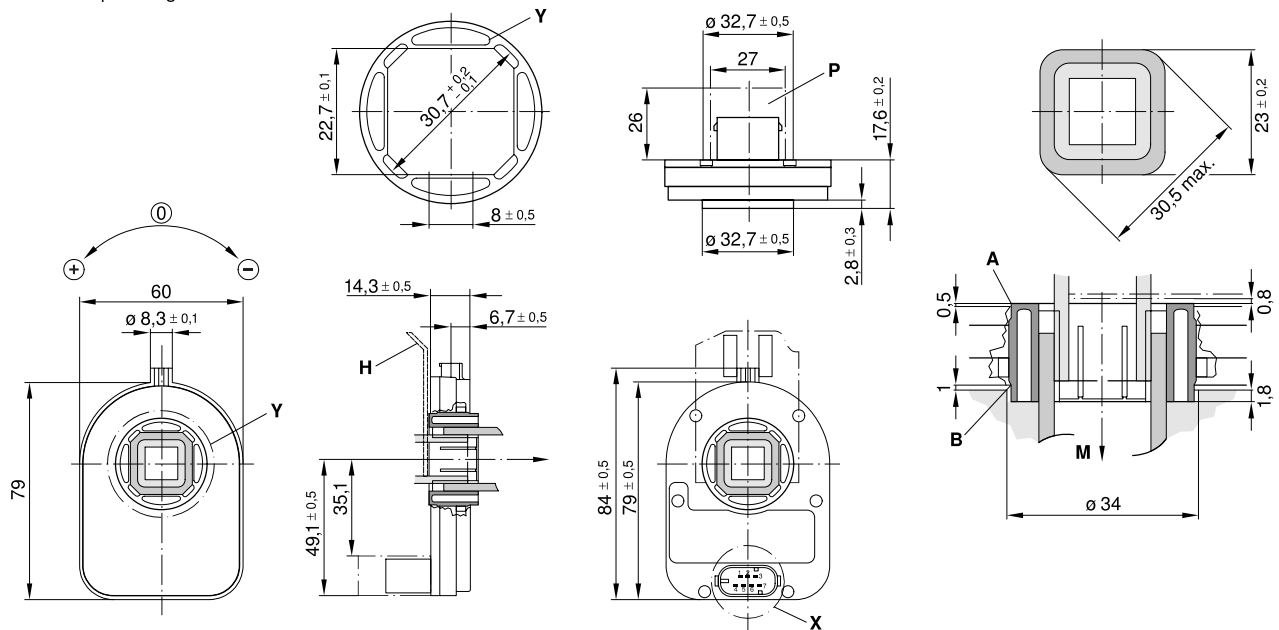
Operating temperature	$-40 \dots +85^\circ\text{C}$
Storage temperature	$-40 \dots +50^\circ\text{C}$
Supply voltage	12 V nominal
Supply-voltage range U_v	$8 \dots 16\text{ V}$
Current consumption at 12 V	$< 150\text{ mA}$

¹⁾ Details of further designs upon request

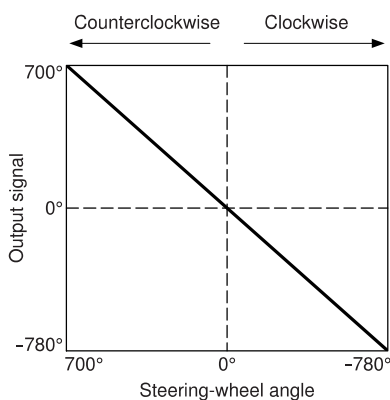
Dimension drawings.

- A** Distance hub to mount
- B** Distance LWS (steering-wheel-angle sensor) to steering-column mounting flange
- H** Mounting bracket
- M** Mounting direction
- P** Space for mating connector and wiring harness
- X** Connector-pin assignment

Steering-column installation dimensions

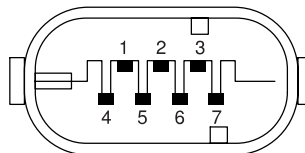


Characteristic curve.



Connector-pin assignment.

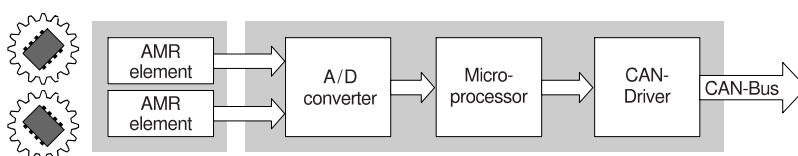
- Pin 1 Ground
- Pin 2 12 V
- Pin 3 CAN high
- Pin 4 CAN low
- Pin 5 -
- Pin 6 -
- Pin 7 -



Further application possibilities

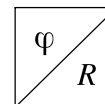
Using the standardized CAN-Bus, the steering-wheel angle information can be used for such systems as electronic stability program (ESP), navigation and electric power steering. Details of mechanical connection variants, as well as of the electrical interface are available on request.

Block diagram.



Throttle-valve angular-position sensor

Measurement of angles up to 88°



- Potentiometric angular-position sensor with linear characteristic curve.
- Sturdy construction for extreme loading.
- Very compact.



Application

These sensors are used in automotive applications for measuring the angle of rotation of the throttle valve. Since these sensors are directly attached to the throttle-valve housing at the end of the throttle-shaft extension, they are subject to extremely hostile underhood operating conditions. To remain fully operational, they must be resistant to fuels, oils, saline fog, and industrial climate.

Design and function

The throttle-valve angular-position sensor is a potentiometric sensor with a linear characteristic curve. In electronic fuel injection (EFI) engines it generates a voltage ratio which is proportional to the throttle valve's angle of rotation. The sensor's rotor is attached to the throttle-valve shaft, and when the throttle valve moves, the sensor's special wipers move over their resistance tracks so that the throttle's angular position is transformed into a voltage ratio. The throttle-valve angular-position sensor's are not provided with return springs.

Design

The position sensor 0 280 122 001 has one linear characteristic curve. The position sensor 0 280 122 201 has two linear characteristic curves. This permits particularly good resolution in the angular range 0°...23°.

Explanation of symbols

U_A Output voltage
 U_V Supply voltage
 φ Angle of rotation
 U_{A2} Output voltage, characteristic curve 2
 U_{A3} Output voltage, characteristic curve 3

Accessories for 0 280 122 001

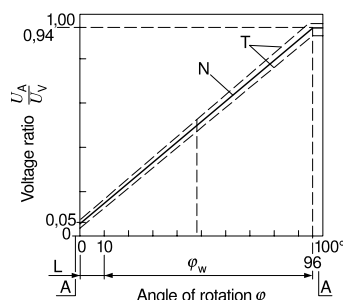
Connector 1 237 000 039

Accessories for 0 280 122 201

Plug housing 1 284 485 118
 Receptacles, 5 per pack,
 Qty. required: 4 1 284 477 121
 Protective cap, 5 per pack,
 Qty. required: 1 1 280 703 023

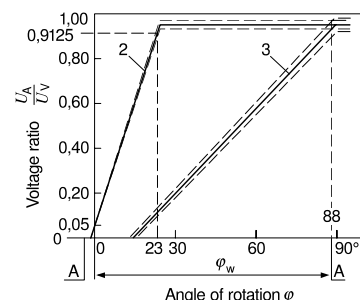
Characteristic curve 1.

A Internal stop, L Positional tolerance of the wiper when fitted, N Nominal characteristic curve, T Tolerance limit, φ_w Electrically usable angular range.



Characteristic curves 2 and 3.

A Internal stop, φ_w Electrically usable angular range.



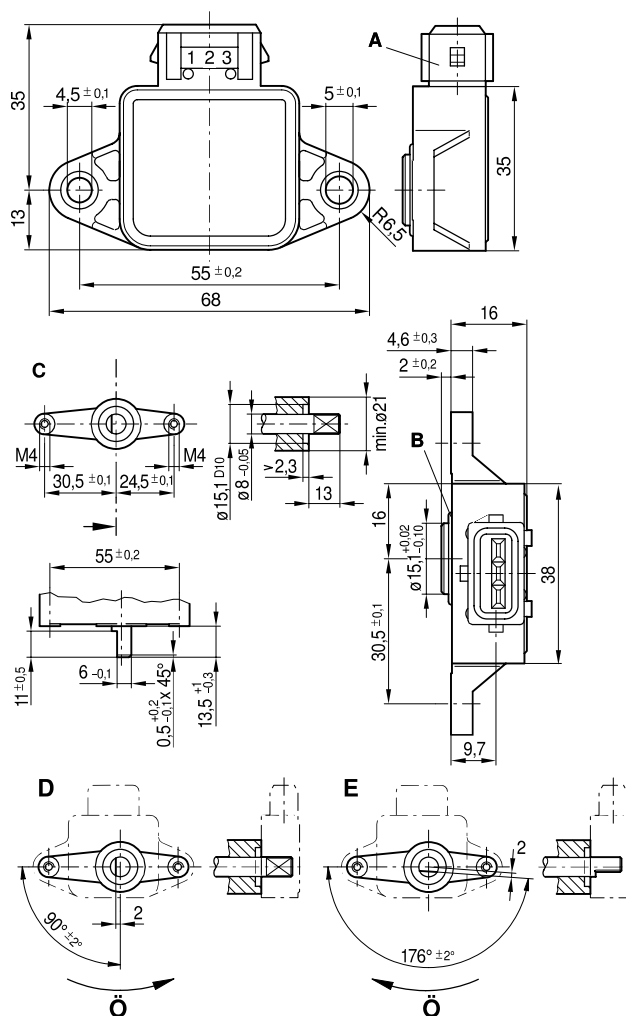
Technical data / Range

Part number	0 280 122 001	0 280 122 201
Diagram	1; 2	3
Useful electrical angular range	Degree ≤ 86	≤ 88
Useful mechanical angular range	Degree ≤ 86	≤ 92
Angle between the internal stops (must not be contacted when sensor installed)	Degree ≥ 95	–
Direction of rotation	Optional	Counterclockwise
Total resistance (Terms. 1–2)	kΩ 2 ± 20 %	–
Wiper protective resistor (wiper in zero setting, Terms. 2–3)	Ω 710...1380	–
Operating voltage U_V	V 5	5
Electrical loading	Ohmic resistance	Ohmic resistance
Permissible wiper current	μA ≤ 18	≤ 20
Voltage ratio from stop to stop Chara. curve 1	0.04 ≤ U_A/U_V ≤ 0.96 –	
Voltage ratio in area 0...88 °C		
Chara. curve 2	–	0.05 ≤ U_{A2}/U_V ≤ 0.985
Chara. curve 3	–	0.05 ≤ U_{A3}/U_V ≤ 0.970
Slope of the nominal characteristic curve	deg ⁻¹ 0.00927	–
Operating temperature	°C –40...+130	–40...+85
Guide value for permissible vibration acceleration	m · s ⁻² ≤ 700	≤ 300
Service life (operating cycles)	Mio 2	1.2

Dimension drawings.

A Plug-in connection,
B O-ring 14.65 x 2 mm,
C Fixing dimensions for throttle-valve housing, **D** Clockwise rotation ¹⁾,
E Counterclockwise rotation ¹⁾, **Ö** Direction of throttle-valve opening.
¹⁾ Throttle valve in idle setting.

0 280 122 001



F O-ring 16.5 x 2.5 mm, **G** 2 ribs, 2.5 mm thick,
H Plug-in connection, **I** Blade terminal,
K This mounting position is only permissible when the throttle-valve shaft is sealed against oil, gasoline, etc., **Ö** Direction of throttle-valve opening,
L Fixing dimensions for throttle-valve potentiometer.

0 280 122 201

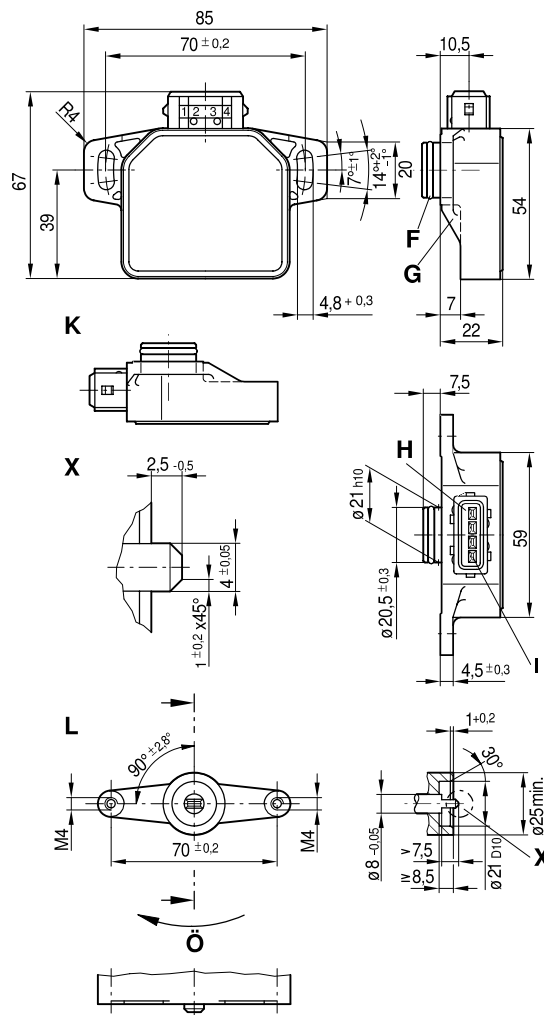


Diagram 1.

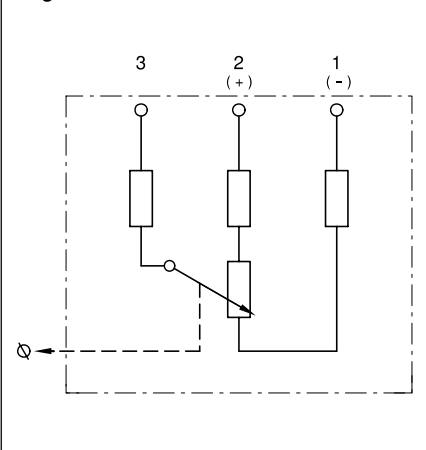


Diagram 2.

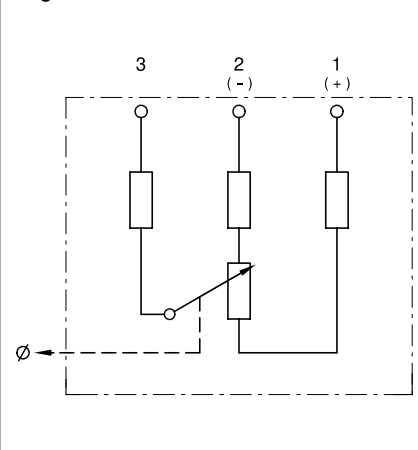
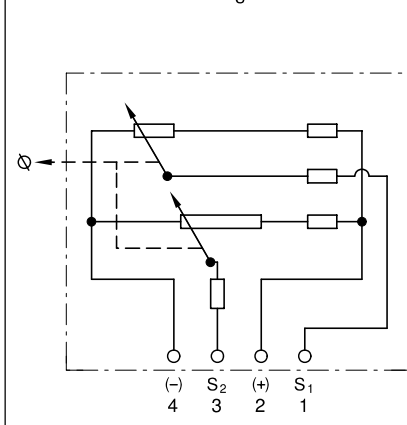


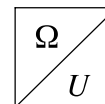
Diagram 3.

Throttle valve in idle setting.



Yaw sensor (gyrometer)

with micromechanical acceleration sensor



- Compact system design with highly integrated electronics.
- Insensitive to mechanical or electrical interference.
- Simultaneous measurement of yaw rate and acceleration vertical to the rotary axis.
- Extensive yaw-rate measuring range from 0.2...100 degrees per second (corresponds to 2...1,000 rotations per hour).
- Capacitive measuring concept.



Design

The complete unit is comprised of a yaw sensor and an acceleration sensor, together with evaluation electronics. These components are all mounted on a hybrid and hermetically sealed in a metal housing.

Application

This sensor is used in automotive engineering for the vehicle dynamics control (Electronic Stability Program, ESP) and measures the vehicle's rotation around its vertical axis, while at the same time measuring the acceleration at right angles to the driving direction. By electronically evaluating the measured values, the sensor is able to differentiate between normal cornering and vehicle skidding movements.

Operating principle

Two oscillatory masses each have a conductor attached through which alternating current (AC) flows. Since both of the masses are located in a constant magnetic field, they are each subjected to an electrodynamic force which causes them to oscillate. If the masses are also subjected to a rotational movement, Coriolis forces are also generated. The resulting Coriolis acceleration is a measure for the yaw rate. The linear acceleration values are registered by a separate sensor element.

Installation information

- Installation near to the vehicle's center of gravity
- Max. reference-axis deviation transverse to the direction of movement $\pm 3^\circ$
- Refer to sketch on Page 9
- Tightening torque for fastening screws: 6 +2/-1 Nm.

Explanation of symbols

- Ω Yaw rate
 g Acceleration due to gravity
 $9.8065 \text{ m} \cdot \text{s}^{-2}$
 a_q Linear (transverse) acceleration

Technical data / Range

Part number	0 265 005 258
Yaw sensor	DRS-MM1.0R
Maximum yaw rate Ω_{max} about the rotary axis (Z-axis)	$\pm 100^\circ/\text{s}$
Minimum resolution $\Delta\Omega$	$\pm 0.2^\circ/\text{s}$
Sensitivity	$18 \text{ mV}/^\circ/\text{s}$
Change of sensitivity	$\leq 5\%$
Offset yaw rate	$2^\circ/\text{s}^1)$
Change of offset	$\leq 4^\circ/\text{s}$
Non-linearity, max. deviation from best linear approximation	$\leq 1\% \text{ FSO}$
Ready time	$\leq 1 \text{ s}$
Dynamic response	$\geq 30 \text{ Hz}$
Electrical noise (measured with 100 Hz bandwidth)	$\leq 5 \text{ mV}_{\text{rms}}$

Linear acceleration sensor

Maximum acceleration $a_{q\text{max}}$	$\pm 1.8 g$
Sensitivity	$1000 \text{ mV}/g$
Change of sensitivity	$\leq 5\%$
Offset	$0 g^1)$
Change of offset	$\leq 0.06 g$
Non-linearity, max. deviation from best linear approximation	$\leq 3\% \text{ FSO}$
Ready time	$\leq 1.0 \text{ s}$
Dynamic response	$\geq 30 \text{ Hz}$
Electrical noise (measured with 100 Hz bandwidth)	$\leq 5 \text{ mV}_{\text{rms}}$

General data

Operating-temperature range	$-30...+85^\circ\text{C}$
Storage-temperature range	$-20...+50^\circ\text{C}$
Supply voltage	12 V nominal
Supply-voltage range	$8.2...16 \text{ V}$
Current consumption at 12 V	$< 70 \text{ mA}$
Reference voltage	$2.5 \text{ V} \pm 50 \text{ mV}^1)$

¹⁾ Zero point is 2.5 V (reference).

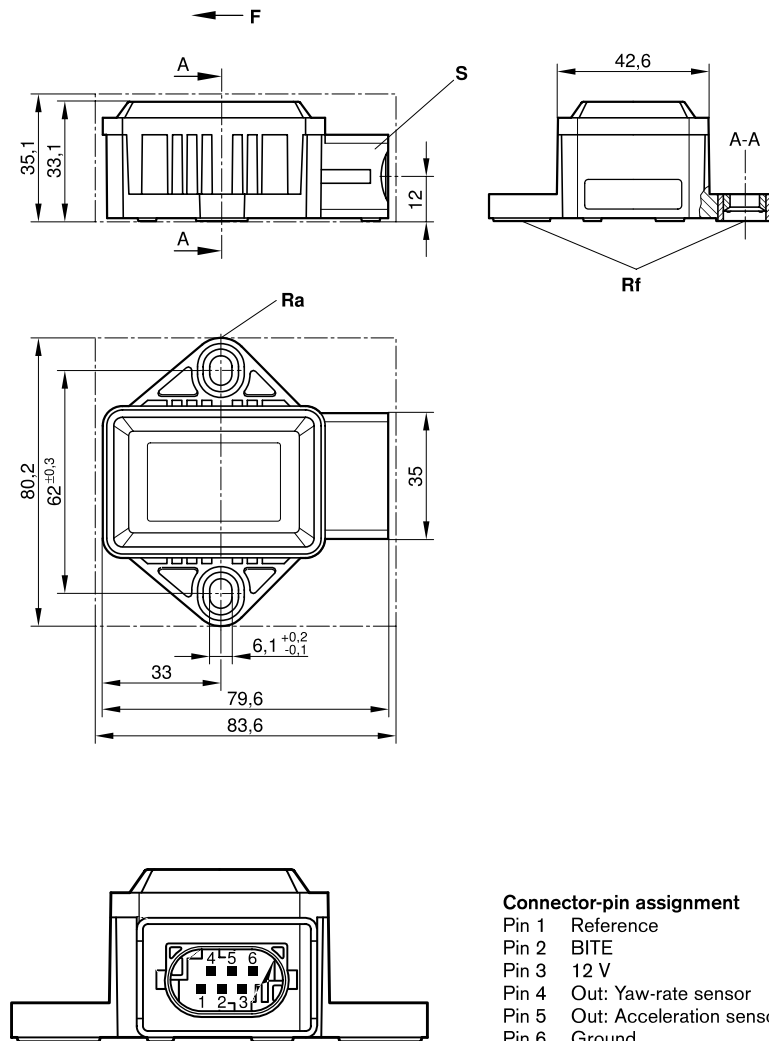
Accessories ²⁾

Plug housing	–	Qty. required: 1	AMP-No: 1-967 616-1
Contact pins	for 0.75 mm^2	Qty. required: 6	AMP-No: 965 907-1
Gaskets	for $\varnothing 1.4...1.9 \text{ mm}^2$	Qty. required: 6	AMP-No: 967 067-1

²⁾ To be obtained from AMP Deutschland GmbH, D-63225 Langen,
 Tel. 0 61 03/7 09-0, Fax 0 61 03/7 09-12 23, E-Mail: AMP.Kontakt@tycoelectronics.com

Dimension drawings.

- F** Forward driving direction
S 6-pole plug
Ra Reference axis
Rf Reference surface
a_c Acceleration direction

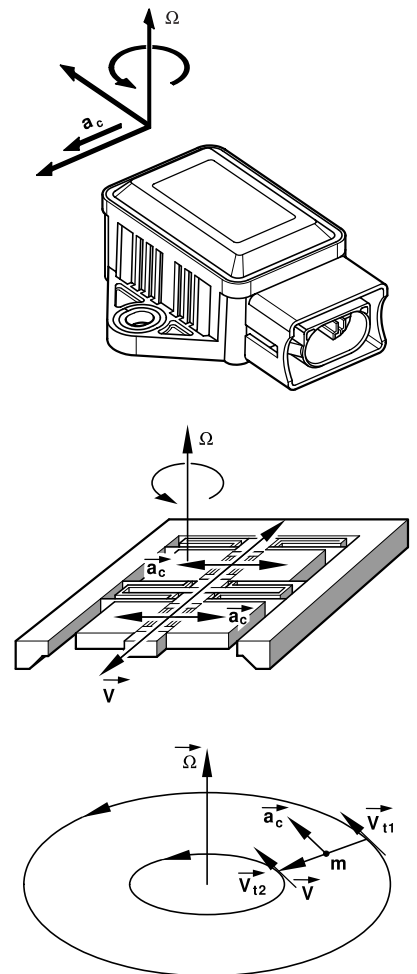


Operating principle.

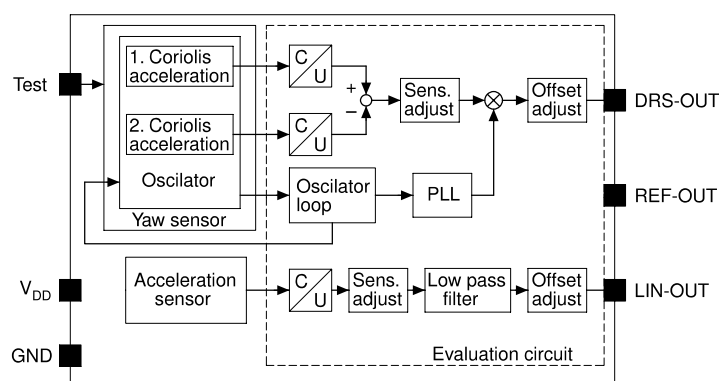
- a_c** Coriolis acceleration
V Speed of oscillation
Ω Angular velocity

$$\vec{a}_c = 2\vec{V} \times \vec{\Omega}$$

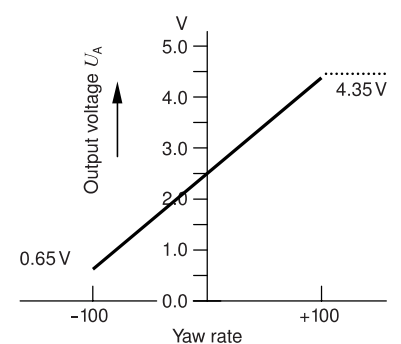
Deviation of $\vec{\Omega}$ -axis to reference surface $\pm 3^\circ$



Block diagram.

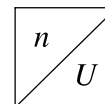


Characteristic curve.



Inductive rotational-speed sensors

Incremental* measurement of angles and rotational speeds



- Non-contacting (proximity) and thus wear-free, rotational-speed measurement.
- Sturdy design for exacting demands.
- Powerful output signal.
- Measurement dependent on direction of rotation.

Application

Inductive rotational-speed sensors of this type are suitable for numerous applications involving the registration of rotational speeds. Depending on design, they measure engine speeds and wheel speeds for ABS systems, and convert these speeds into electric signals.

Design and function

The soft-iron core of the sensor is surrounded by a winding, and located directly opposite a rotating toothed pulse ring with only a narrow air gap separating the two. The soft-iron core is connected to a permanent magnet, the magnetic field of which extends into the ferromagnetic pulse ring and is influenced by it. A tooth located directly opposite the sensor concentrates the magnetic field and amplifies the magnetic flux in the coil, whereas the magnetic flux is attenuated by a tooth space. These two conditions constantly follow on from one another due to the pulse ring rotating with the wheel. Changes in magnetic flux are generated at the transitions between the tooth space and tooth (leading tooth edge) and at the transitions between tooth and tooth space (trailing tooth edge). In line with Faraday's Law, these changes in magnetic flux induce an AC voltage in the coil, the frequency of which is suitable for determining the rotational speed.



Wheel-speed sensor (principle).
 1 Shielded cable, 2 Permanent magnet, 3 Sensor housing, 4 Housing block, 5 Soft-iron core, 6 Coil, 7 Air gap, 8 Toothed pulse ring with reference mark.

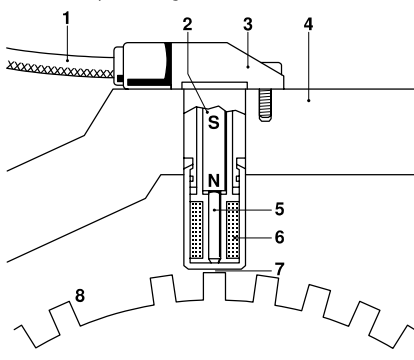
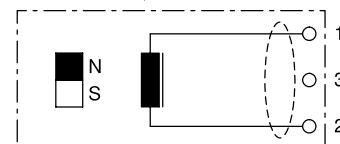


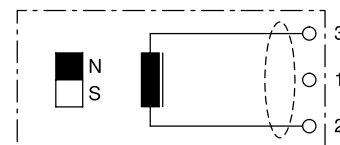
Diagram.

Connections:
 1 Output voltage,
 2 Ground, 3 Shield.

0 281 002 214, ...104



0 261 210 147



Range

Cable length with plug	Fig./ Dimension drawing	Order No.
360 ± 15	1	0 261 210 104
553 ± 10	2	0 261 210 147
450 ± 15	3	0 281 002 214

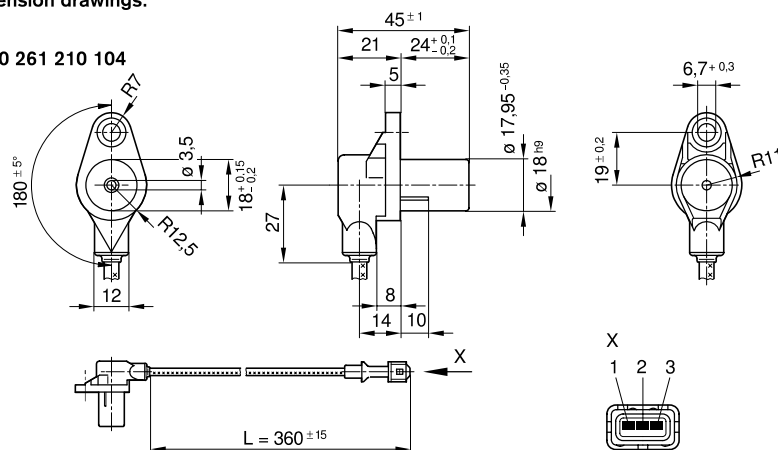
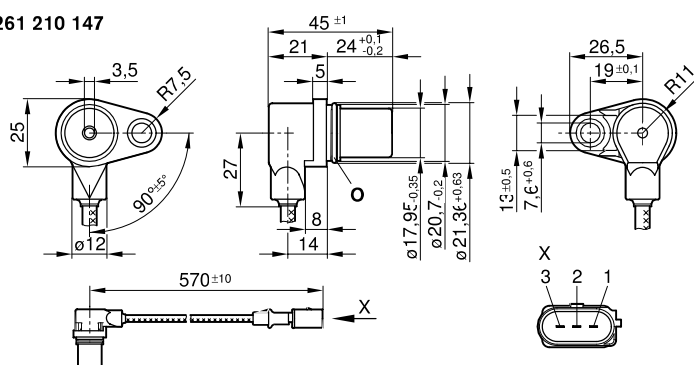
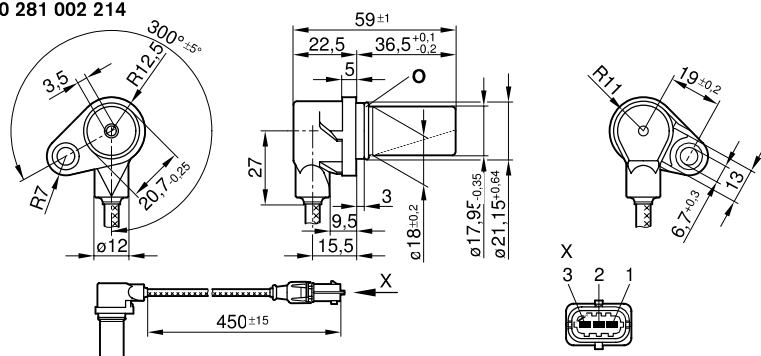
Technical Data

Rotational-speed range n ¹⁾	min ⁻¹	≈ 20...7000
Permanent ambient temperature in the cable area	°C	-40...+120
For 0 261 210 104, 0 281 002 214	°C	-40...+130
For 0 261 210 147	°C	-40...+150
Permanent ambient temperature in the coil area	°C	-40...+150
Vibration stress max.	m · s ⁻²	1200
Number of turns		4300 ± 10
Winding resistance at 20 °C ²⁾	Ω	860 ± 10 %
Inductance at 1 kHz	mH	370 ± 15 %
Degree of protection		IP 67
Output voltage U_A ¹⁾	V	0...200

* A continuously changing variable is replaced by a frequency proportional to it.

¹⁾ Referred to the associated pulse ring.

²⁾ Change factor $k = 1 + 0.004 (\vartheta_W - 20 \text{ °C})$; ϑ_W winding temperature

Dimension drawings.
① 0 261 210 104

② 0 261 210 147

③ 0 281 002 214


The sensor generates one output pulse per tooth. The pulse amplitude is a function of the air gap, together with the toothed ring's rotational speed, the shape of its teeth, and the materials used in its manufacture. Not only the output-signal amplitude increases with speed, but also its frequency. This means that a minimum rotational speed is required for reliable evaluation of even the smallest voltages.

A reference mark on the pulse ring in the form of a large "tooth space" makes it possible not only to perform rotational-speed measurement, but also to determine the pulse ring's position. Since the toothed pulse ring is an important component of the rotational-speed measuring system, exacting technical demands are made upon it to ensure that reliable, precise information is obtained. Pulse-ring specifications are available on request.

Explanation of symbols

U_A Output voltage
 n Rotational speed
 s Air gap

Accessories

For rot-speed sensor	From offer drawing	Plug part number
0 261 210 104	A 928 000 019	1 928 402 412
0 261 210 147	A 928 000 012	1 928 402 579
0 261 002 214	A 928 000 453	Enquire at AMP
		1 928 402 966

Hall-effect rotational-speed sensors

Digital measurement of rotational speeds

$$\frac{n, \varphi, s}{U}$$

- 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 mm ²
	1 987 280 105	1 987 280 107	1.5...2.5 mm ²

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

0 232 103 022

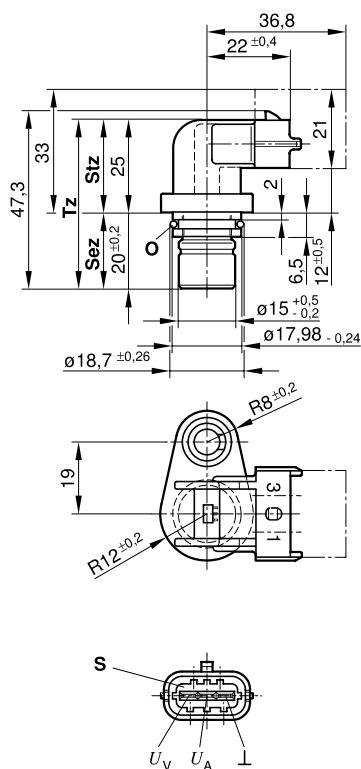
The trigger wheel is scanned radially.

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

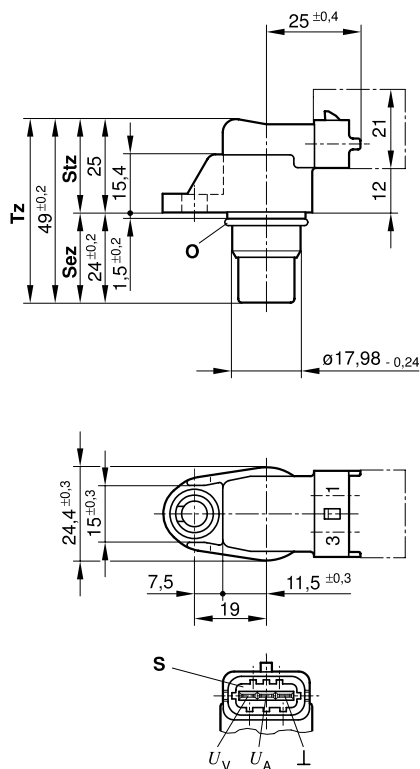
Dimension drawings.

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

0 232 103 021

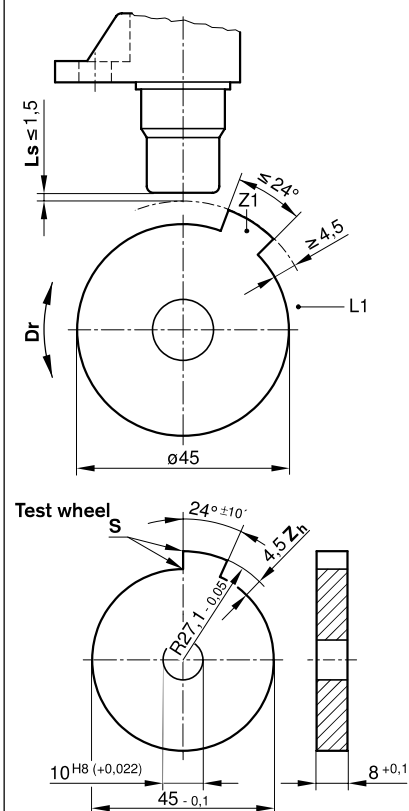


0 232 103 022

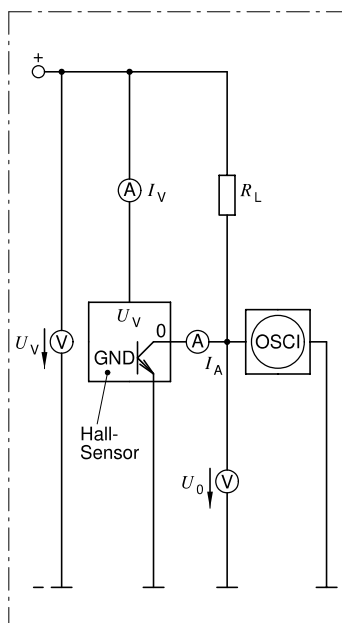


Installation stipulation 0 232 103 022.

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



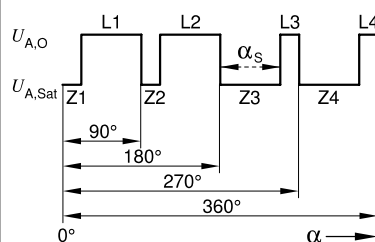
Block diagram.



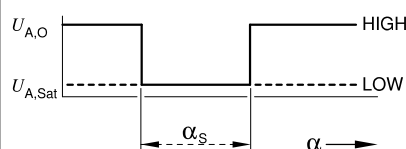
Output-signal shape.

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

0 232 103 021

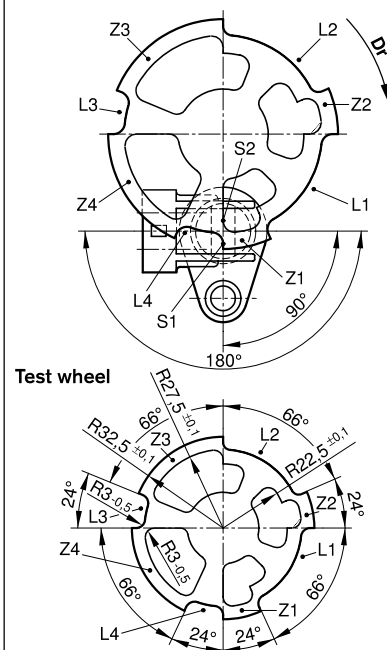


0 232 103 022



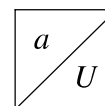
Installation stipulation 0 232 103 021.

Dr Direction of rotation



Acceleration sensor

Measurement of acceleration up to $\pm 5 g$



- Ratiometric output signal.
- Temperature-compensated.
- Low pyroelectric sensitivity.
- Hermetically sealed housing.
- High-level EMC.
- Overvoltage protection.
- Short-circuit proof.
- Protected against reverse polarity.



Applications

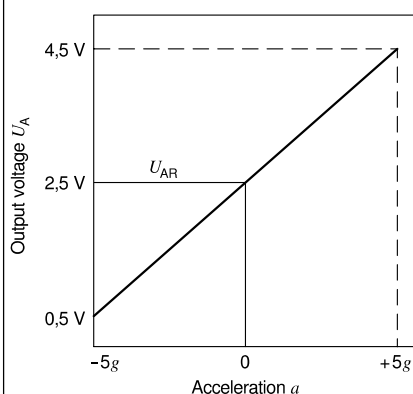
In automotive engineering, this sensor is used to rule out the chance of false diagnosis in the engine electronics. It registers the vehicle accelerations which are the direct result of fluctuations in crankshaft speed. In order to ascertain whether these crankshaft-speed fluctuations result from ignition misfire or a poor road surface, the latest engine-management systems also register the ignition misfires of the individual cylinders.

Design and function

The sensor element comprises a "bending element" consisting of two anti-parallel polarized piezoelectric layers. If acceleration forces are applied to this bending element, mechanical tension is caused which in turn results in a charge of electricity at the bending-element surfaces. This charge is evaluated by a hybrid circuit. The sensor can measure in the horizontal and in the vertical measurement directions when mounted appropriately, whereby the measurement direction is usually vertical to the clamping surface.

An output signal $U_A > U_0$ is generated for vertical upwards acceleration of the clamping surface, whereas the corresponding downward acceleration generates a signal $U_A < U_0$. The output voltage U_A has a cosine relationship to the angle between the sensor measurement direction and the direction of acceleration. Taking an angle of 15° , this produces a (calculated) signal reduction of 3.4%.

Characteristic curve.



U_{AR} Open-circuit output voltage

$$U_A = U_0 \pm U_D$$

Output-voltage excursion for measuring range

$$U_D = \pm 2 V$$

Output voltage U_A

For acceleration $> +5 g$ 4.5 V

For acceleration $< -5 g$ 0.5 V

Technical Data / Range

Part number	0 273 101 021
Measuring range	$\pm 5 g$
Limit of operating load	
Sustained operation in the sensor's dynamic core-frequency range without damage	$\pm 10 g$
Overload protection	
Peak amplitude: 20 times without damage	100 g
Lateral sensitivity	$< 10 \%$
Nominal sensitivity at $f = 15.8 \text{ Hz}$	2 V / 5 g
Operating temperature range	$-40 \dots +105^\circ \text{C}$
Storage-temperature range	$-40 \dots +95^\circ \text{C}$
Service life (ageing)	
In operating temperature range $-40 \dots +105^\circ \text{C}$	4000 h
Weight	75 g

Electrical specifications for $U_v = 5 V \pm 3 \%$

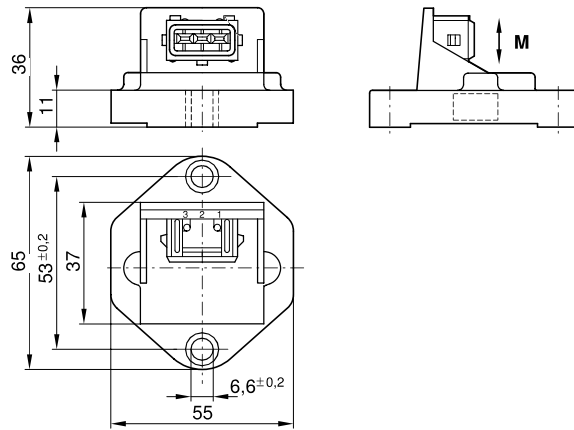
Input current I_v	$< 20 \text{ mA}$
Output-voltage zero point U_0	$U_v / 2 = 2.5 V \pm 100 \text{ mV}$
Sensitivity	400 mV / g $\pm 12 \%$
Dynamic output resistance R_{AO} in the range 0...100 Hz	< 300
Load resistance R_L (pullup above +5 V)	$> 7.5 \text{ k}\Omega$
Load capacity C_L	$< 15 \text{ nF}$
Lower critical frequency f_u (-3 dB)	0 Hz $< f_u < 5 \text{ Hz}$
Upper critical frequency f_o (-3 dB)	50 Hz $< f_o < 100 \text{ Hz}$

Accessories

Connector	1 237 000 039
-----------	---------------

Dimension drawings.

M Direction of measurement.



Installation instructions

The sensor must be securely screwed to the base. We recommend two M6 screws with collar or washer. Screw tightening torque: 2.5 N · m.

Explanation of symbols

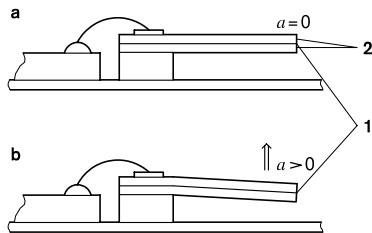
U_A Output voltage
 U_0 Output-voltage zero point (ratiometric to U_V)
 U_D Dynamic portion of the output signal
 U_V Supply voltage
 g Acceleration due to gravity
 $= 9.81 \text{ m} \cdot \text{s}^{-2}$

Pin assignment

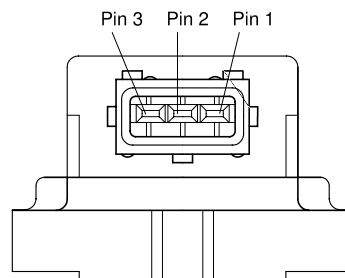
Pin 1 +5 V (U_V)
 Pin 2 Ground
 Pin 3 OUT

Sensor principle.

- a** Without effect of acceleration
- b** With effect of acceleration
- 1** Piezo-ceramic bending element "measuring beam"
- 2** Opposed-polarity layers

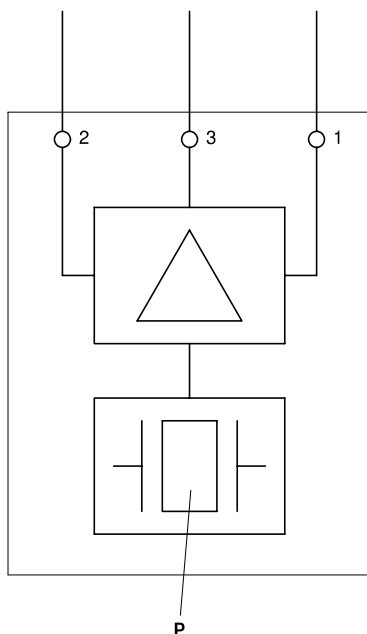


Pin assignment.



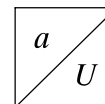
Block diagram.

P Piezo-ceramic element

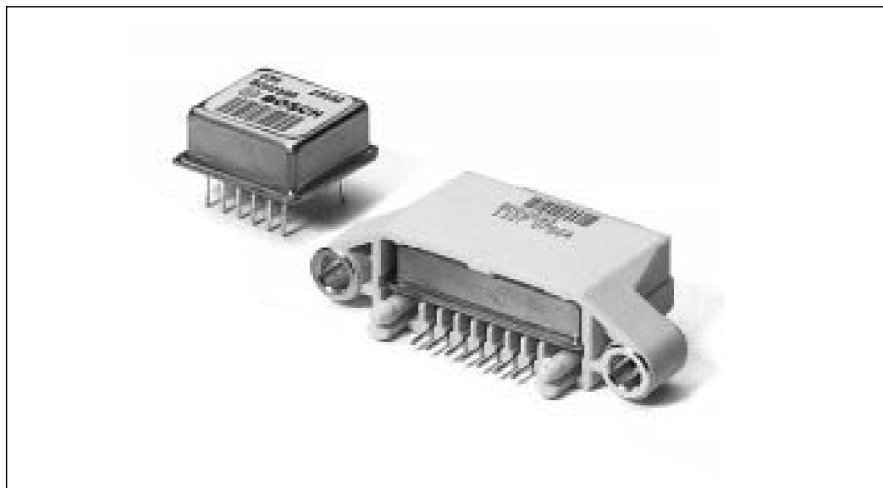


Piezoelectric acceleration sensors

Measurement of acceleration up to 35 g



- Acceleration measurement using piezoelectric bending elements (bimorphous strips).
- Micromechanical acceleration sensor (please enquire).
- Low temperature-dependence.
- High sensitivity.
- Wide measuring range.



Range

Dual-channel sensor

With two identical, but independent, piezo-ceramic bending strips. These are connected so that the output voltages of each channel are phase-opposed. Suitable for pcb mounting.

0 273 101 141

With two sensing directions offset to each other by 90°. Suitable for pcb mounting.

0 273 101 150

With one sensing direction only. In this direction, acceleration leads to a 180° phase shift of channel A, whereas the channel B phase shift is 0°.

Suitable for pcb mounting.

0 273 101 131

Applications

Used in automotive occupant-protection systems for triggering the airbag, the seat-belt tightener, the roll-over bar, or the seat-belt locking systems. Used for instance as the impact sensor for monitoring impact loads during transportation. Since the lower frequency limit is 0.9 Hz, this sensor can only be used to register acceleration changes.

Design and function

The heart of this acceleration sensor is a piezo-ceramic strip of polycrystalline sintered material. When electrically polarized, this material displays a piezoelectrical effect: That is, when pressure is applied, the mechanical loading results in charge separation, or a voltage which can then be picked-off by electrodes.

The piezo bending element comprises a bonded structure containing two inversely polarized piezo strips, the so-called bimorphous strips. These have electrodes, and are bonded to a center electrode. This configuration has the advantage that the pyroelectrical signals caused by temperature fluctuations compensate each other.

Technical data / Range

Part number	0 273 101 141			0 273 101 150			0 273 101 131			
Block diagram	X			–			–			
	min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	
Measuring range at $U_V = 5\text{ V}$	g^{-1}	–35	–	+35	–35	–	+35	–35	–	+35
Frequency range (–3dB)	Hz	0.9	–	250	0.9	–	340	0.9	–	340
Supply voltage U_V	V	4.75	5.00	5.25	4.0	5.0	5.25	4.0	5.0	5.25
Supply current I_V	mA	–	–	12	–	–	15	–	–	15
Open-circuit voltage at zero acceleration	mV	–45	–	+45	$U_V/2 \pm 60\text{ mV}$			$U_V/2 \pm 60\text{ mV}$		
Calibrated sensitivity at room temperature	$\text{mV} \cdot g^{-1}$	57.5	60	62.5	57.5	60	62.5	57.5	60	62.5
Calibrated sensitivity at operating temperature	%	–	–	4	–	–	–	–	–	–
Operating-temperature range	°C	–45	–	+95	–45	–	+95	–45	–	+95
Electrical output										
Current-carrying capacity	mA	0.9	–	–	–	–	–	–	–	–
Capacitive loadability	pF	1200	–	–	–	–	–	–	–	–
Pin assignment										
Pin 1	$U_V = +5\text{ V}$			Output B			Output B			
Pin 2	Output B			$U_V = +5\text{ V}$			$U_V = +5\text{ V}$			
Pin 3	$U_V = +5\text{ V}$			Data			Data			
Pin 4	Test input			Test input			Test input			
Pin 5	Ground			Output A			Output A			
Pin 6	Output A			Housing, ground			Housing, ground			
Pin 7	Housing, ground			–			–			

¹⁾ Acceleration due to gravity $g = 9.81\text{ m} \cdot \text{s}^{-2}$.

When subjected to acceleration, the piezo-ceramic bends by as much as 10^{-7} m . For signal processing, the sensor is provided with a hybrid circuit which is comprised of an impedance converter, a filter, and an amplifier. These serve to define the sensitivity and effective frequency range. The filter removes the HF signal components.

The lower frequency limit of 0.6 Hz is defined by the piezo element itself. Using a supplementary test input, the sensor's electronic functions can be monitored as well as piezo-strip integrity.

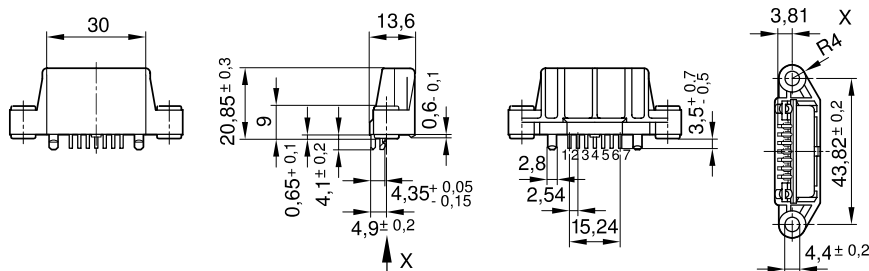
Test signal

A fully operational sensor generates a positive output pulse when +5V are briefly applied across its test input. If there is an open-circuit in the signal path, this output pulse will be missing, and if the bimorphous strip is broken the signal will exceed +5V.

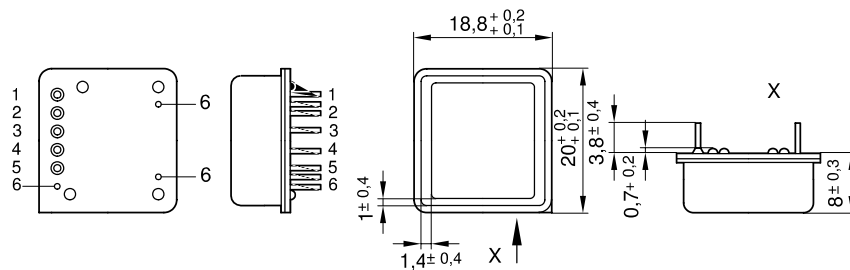
For the versions with two bimorphous strips, the output pulse must appear at each output.

Dimension drawings.

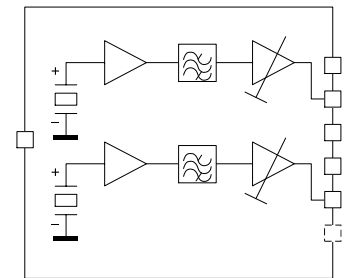
0 273 101 141



0 273 101 131/150



Block diagram of dual-channel sensor.



Installation instructions

The acceleration sensors must be installed so that the baseplate is either vertical or horizontal referred to the direction of acceleration or deceleration.

Installation position.

A, B, M Directions of measurement

Baseplate vertical referred to direction of measurement.
0 273 101 141
Deceleration in direction of measurement
Channel A output voltage

$$U_{AA} < \frac{U_V}{2},$$

Channel B output voltage

$$U_{AB} > \frac{U_V}{2}.$$

Baseplate parallel to direction of measurement.
0 273 101 150
Acceleration in A direction
Channel A output voltage

$$U_{AA} > \frac{U_V}{2}.$$

Acceleration in B direction
Channel B output voltage

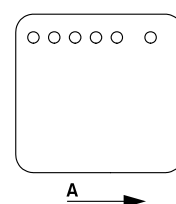
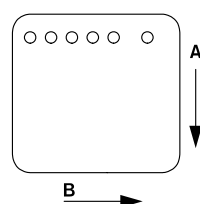
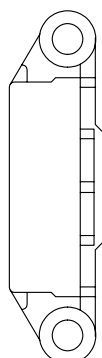
$$U_{AB} > \frac{U_V}{2}.$$

0 273 101 131
Acceleration in A direction
Channel A output voltage

$$U_{AA} < \frac{U_V}{2},$$

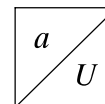
Channel B output voltage

$$U_{AB} > \frac{U_V}{2}.$$



Surface-type micromechanical acceleration sensors

Measurement of accelerations of $\pm 35\text{ g}$ or $\pm 50\text{ g}$



- Complete measuring range of $\pm 35\text{ g}$ or $\pm 50\text{ g}$.
- Low number of external components required.
- Integrated self-diagnosis.
- Integrated offset calibration.
- Integrated 2nd-order Bessel filter.
- Ratiometric output signal.
- Standard SMD PLCC28 housing.
- Temperature range suitable for commercial-vehicle applications.



Applications

This acceleration sensor is used in vehicles as one of the components for the front air-bag. Depending upon installation position in the passenger compartment, it can be used to measure longitudinal or transverse acceleration (referred to the vehicle's direction of travel).

Design and function

These acceleration sensors rely on a capacitive measuring principle.

Lateral sensing direction (in the component level).

Acceleration causes the seismic mass to deflect in the x-direction. This seismic mass is suspended on wave-shaped bending springs.

One electrode set is connected to the seismic mass (comb-like structure) and moves along with the particular acceleration.

These movable electrodes are designed as capacitor plates and are also provided with immovable counter-electrodes which are separated from each other by a narrow air gap. The application of a capacitive differential circuit with two capacitors results in a reduction of the non-linearity of the signal evaluation. Overload stops are provided as a protection against over-acceleration.

These prevent direct contact between the electrodes (combs). Mechanical sensitivity is defined by the geometrical shape of the springs.

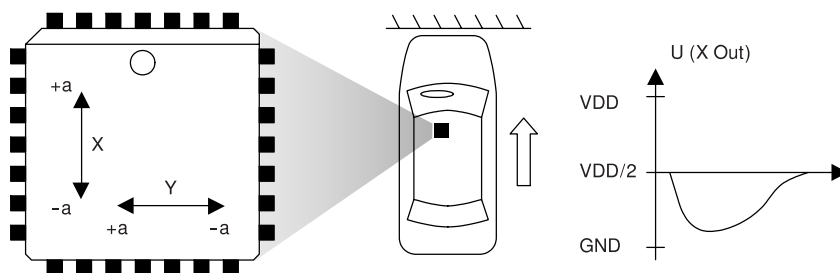
Changes in C1 and C2 are registered and changed to a corresponding voltage by a capacity/voltage converter.

Range

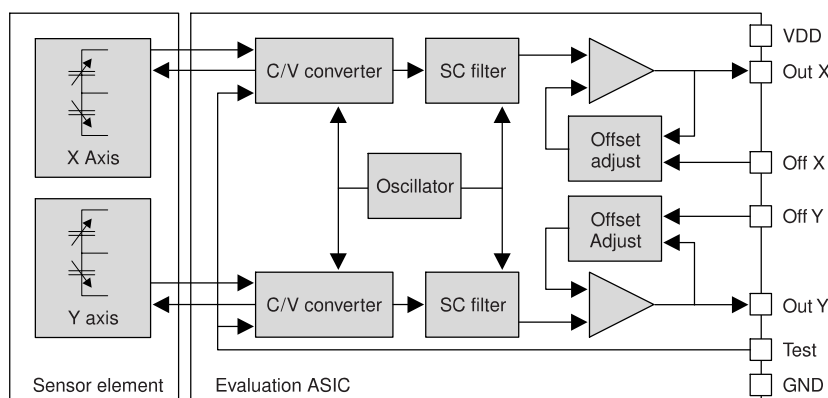
Acceleration 1)	Sensing axis	Sensor type	Order No.
$\pm 35\text{ g}$	X	SMB 050	0 273 101 138
	X/Y	SMB 060	0 273 101 143
	X/-X	SMB 065	0 273 101 144
$\pm 50\text{ g}$	X	SMB 052	0 273 101 155
	X/Y	SMB 062	0 273 101 154
	X/-X	SMB 067	0 273 101 157

1) Measuring range for full-load deflection is guaranteed after setting the offset to VDD/2.

Sensing direction.



Design and function.



Technical Data

Limit values

Parameter		min.	normal	max.
Supply voltage U_V	V	-0.3		6
Storage temperature	°C	-55		+105
Mechanical impact ¹⁾				
Not energized	g			2000
Energized	g			1000
ESD (each pin)	kV	1.5		
Temperature gradient	K/min			20

Operating conditions

Parameter		min.	normal	max.
Supply voltage U_V	V	4.75	5	5.25
Supply current I_V				
Single-channel unit	mA		6	7
Two-channel unit	mA		10	14
Operating temperature	°C	-40		+85

Measuring and function characteristics

Parameter		min.	normal	max.
Sensitivity	mV/g		55	
	mV/g		38.5	
Sensitivity tolerance ²⁾	%		5	9
Non-linearity of the sensitivity	%		0.8	2
Transverse-axis sensitivity ³⁾	%			5
Zero-acceleration output			VDD/2	
Offset at zero acceleration				
After offset adjustment	mV			±150
Without offset adjustment	V			±Vdd/4
Offset-adjustment time	s			1.65
Offset/Test-voltage input (X/Y)				
Low	V			0.25 x VDD
High	V	0.75 x VDD		
Self-test				
±35g g type at 5 V	mV	250	385	866
±50g g type at 5 V	mV	200	336	610
Output-voltage range U_A				
$I_{out} = \pm 50 \mu A$	V	0.25		VDD - 0.25
Output current I_A	μA	±50		
Capacitive output load	pF			1000
3 dB corner frequency				
2nd order Bessel filter	Hz	320	400	480
Output noise ⁴⁾				
10 to 1000 Hz	mg/√Hz		2.5	4.5

¹⁾ The effects of excessive shock can permanently damage the unit.

Maloperation of the sensor due to mechanical impact, and excessive g figures, are detected by on-chip self-test.

²⁾ In percentage of nominal sensitivity, as a function of service life and temperature range.

³⁾ Output signal resulting from acceleration in any axis vertical to the sensing axis.

⁴⁾ Output noise with the offset adjustment out of operation. With offset adjustment in operation, the output noise is approx. double the figure.

Explanation of symbols

a	Acceleration ($g_n = 9.81 \text{ m/s}^2$)
V_{out}	Output voltage
V_{DD}	Supply voltage
V_{off}	Offset voltage
S	Sensitivity

$$V_{out} = \frac{V_{DD}}{2} + (V_{off} + S \cdot a) \cdot \frac{V_{DD}}{5V}$$

Installation information

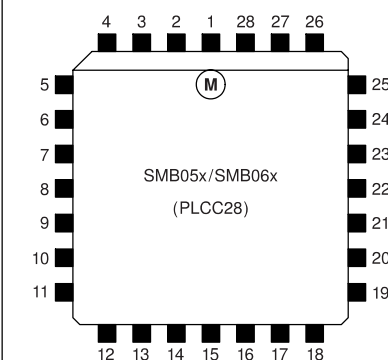
A deviation in the installation by $\pm 1^\circ$ from the horizontal results in a measuring error of 0.02 g. The sensor is protected against polarity reversal.

Connector-pin assignment.

M marking pin 1

Pin	Order No. 1 273 101...	Order No. 1 273 101...	Order No. 1 273 101...
	.. 138	.. 143	.. 144
	.. 155	.. 154	.. 157
1-11	N.C. (*)	N.C. (*)	N.C. (*)
12	Offset X	Offset X	Offset X
13	Out X	Out X	Out X
14	Test	Test	Test
15	GND	GND	GND
16	VDD	VDD	VDD
17	N.C.	Offset Y	Offset X
18	N.C.	Out Y	Out X
19-28	N.C.	N.C.	N.C.

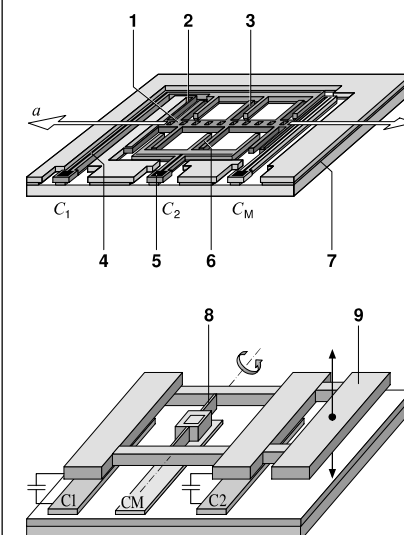
* Pin has no bond connection



Operating principle.

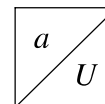
1 Horizontal sprung seismic mass with springs, 2 Spring, 3 Fixed electrodes with capacitance C_1 , 4 Al conductor, 5 Bond pad, 6 Fixed electrodes with capacity C_2 , 7 Silicon oxide, 8 Torsion spring, 9 Vertical sprung seismic mass with electrodes. A Acceleration in sensing direction, C_M measuring capacity.

$$a \sim \frac{C_1 - C_2}{C_1 + C_2}$$



Piezoelectric vibration sensors

Measurement of structure-borne noise/acceleration



- Reliable detection of structure-borne noise for protecting machines and engines.
- Piezo-ceramic with high degree of measurement sensitivity.
- Sturdy compact design.



Applications

Vibration sensors of this type are suitable for the detection of structure-borne acoustic oscillations as can occur for example in case of irregular combustion in engines and on machines. Thanks to their ruggedness, these vibration sensors can be used even under the most severe operating conditions.

Areas of application

- Knock control for internal-combustion engines
- Protection of machine tools
- Detection of cavitation
- Monitoring of bearings
- Theft-deterrent systems

Design and function

On account of its inertia, a mass exerts compressive forces on a ring-shaped piezo-ceramic element in time with the oscillation which generates the excitation. Within the ceramic element, these forces result in charge transfer within the ceramic and a voltage is generated between the top and bottom of the ceramic element. This voltage is picked-off using contact discs – in many cases it is filtered and integrated – and made available as a measuring signal. In order to route the vibration directly into the sensor, vibration sensors are securely bolted to the object on which measurements take place.

Measurement sensitivity

Every vibration sensor has its own individual response characteristic which is closely linked to its measurement sensitivity. The measurement sensitivity is defined as the output voltage per unit of acceleration due to gravity (see characteristic curve). The production-related sensitivity scatter is acceptable for applications where the primary task is to record that vibration is occurring, and not so much to measure its severity.

The low voltages generated by the sensor can be evaluated using a high-impedance AC amplifier.

Technical data

Frequency range	1...20 kHz
Measuring range	≈ 0.1...400 g ¹⁾
Sensitivity at 5 kHz	26 ±8 mV/g
Linearity between 5...15 kHz at resonances	+20/-10 % of 5 kHz-value (15...41 mV/g)
Dominant resonant frequency	> 25 kHz
Self-impedance	> 1 MΩ
Capacitance range	800...1400 pF
Temperature dependence of the sensitivity	≤ 0.06 mV/(g · °C)
Operating-temperature range:	
Type 0 261 231 118	-40...+150 °C
Type 0 261 231 148	-40...+150 °C
Type 0 261 231 153	-40...+130 °C
Permissible oscillations	
Sustained	≤ 80 g
Short-term	≤ 400 g

Installation

Fastening screw	Grey cast iron	M 8 x 25; quality 8.8
	Aluminum	M 8 x 30; quality 8.8
Tightening torque (oiled permitted)	20 ±5 N · m	
Mounting position	Arbitrary	

¹⁾ Acceleration due to gravity $g = 9.81 \text{ m} \cdot \text{s}^{-2}$.

Resistant to saline fog and industrial climate.

Range

Vibration sensor

2-pole without cable	0 261 231 148
2-pole, with cable, length 480 mm, up to +130 °C	0 261 231 153
3-pole, with cable, length 410 mm, up to +150 °C	0 261 231 118

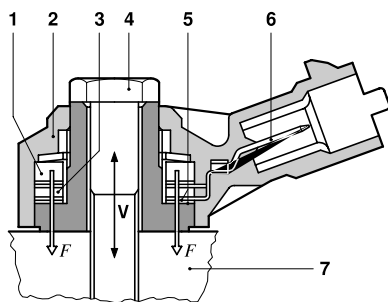
Accessories

Sensor	Plug housing	Contact pins	Individual gasket	For cable cross section
0 261 231 148	1 928 403 137	1 987 280 103	1 987 280 106	0.5...1.0 mm ²
		1 987 280 105	1 987 280 107	1.5...2.5 mm ²
0 261 231 153	1 928 403 826	1 928 498 060	1 928 300 599	0.5...1.0 mm ²
		1 928 498 061	1 928 300 600	1.5...2.5 mm ²
0 261 231 118	1 928 403 110	1 987 280 103	1 987 280 106	0.5...1.0 mm ²
		1 987 280 105	1 987 280 107	1.5...2.5 mm ²

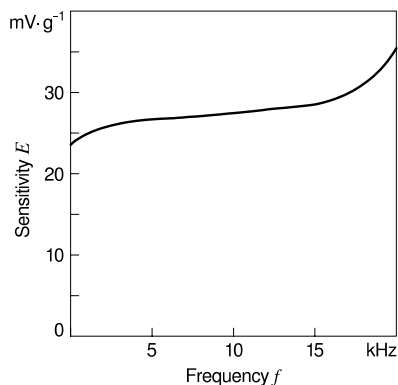
Note: A 3-pole plug requires 1 plug housing, 3 contact pins, and 3 individual gaskets. In automotive applications, original AMP crimping tools must be used.

Vibration sensor (design).

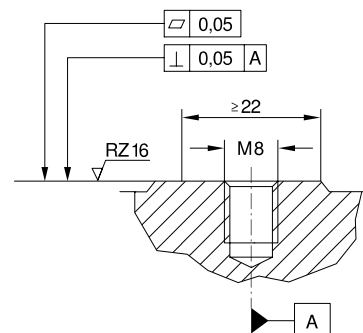
1 Seismic mass with compressive forces F ,
2 Housing, 3 Piezo-ceramic,
4 Screw, 5 Contact, 6 Electrical connection,
7 Machine block, V Vibration.



Response characteristic as a function of frequency.



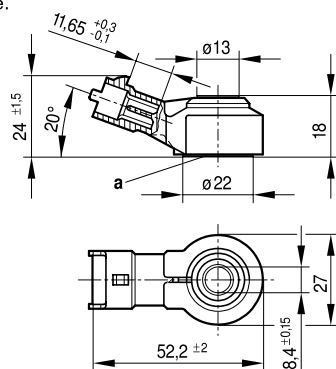
Mounting hole.



Dimension drawings.

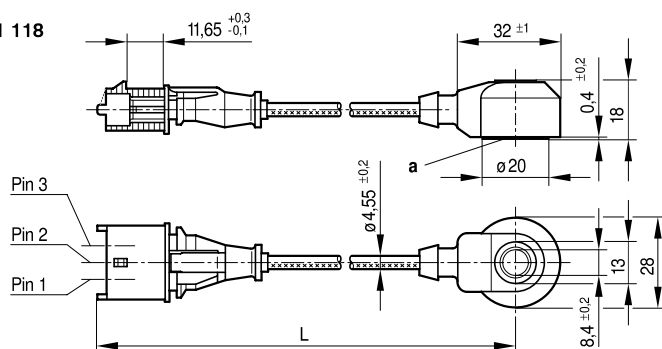
a Contact surface.

0 261 231 148

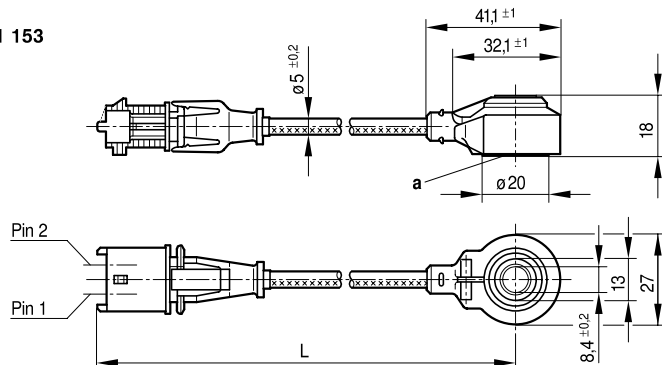


Part number	L mm
.. 118	410 ± 10
.. 153	430 ± 10

0 261 231 118



0 261 231 153



Evaluation

The sensor's signals can be evaluated using an electronic module. This is described on Pages 26/27.

Installation instructions

The sensor's metal surfaces must make direct contact. No washers of any type are to be used when fastening the sensors. The mounting-hole contact surface should be of high quality to ensure low-resonance sensor coupling at the measuring point. The sensor cable is to be laid such that there is no possibility of sympathetic oscillations being generated. The sensor must not come into contact with liquids for longer periods.

Explanation of symbols

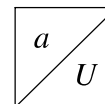
E Sensitivity
 f Frequency
 g Acceleration due to gravity

Connector-pin assignments

Pin 1, 2 Measuring signal
Pin 3 Shield, dummy

Piezoelectric vibration sensors

Signal-evaluation module



- Choice of 4 selectable sensor inputs or 2 symmetrical inputs.
- Programmable amplification.
- Programmable bandpass filter.
- External calibration unnecessary.
- Integral programmable frequency divider.
- Analog stage with signal test.
- Suitable for a wide variety of microcomputers.
- PLCC28 housing.



Applications

Evaluation of the analog signals from piezoelectric sensors (vibration sensors).

Design and function

The analog signals are evaluated by a circuit integrated in the module. The circuit contains a programmable amplifier, a band-pass filter, a rectifier, an integrator, and control logic circuitry. The use of "SC" circuit engineering ensures that operation remains insensitive to interference, and that there is no necessity for external calibration. It is an easy matter to use this fully programmable circuit for a variety of applications.

The start and end of the integration are controlled through the "measuring window" input. For a variety of different pulse frequencies applied from outside (8 steps of 1...16 MHz), a frequency divider which is programmed through 3 inputs, generates the system clock for the analog stage, and the test frequencies (9 mid-frequencies from 5...16 kHz) depending upon the setting of the filter. The internal pulse frequency can be changed from nominal 100 kHz to values between 50 kHz and 150 kHz by changing the quartz frequency. At the same time, a shift of the band-filter mid-frequencies, the test frequencies, and the integration time constants also takes place.

Note

Due to its having MOS inputs, this module is to be handled very carefully. It is not to be touched directly and a MOS workstation is to be used. Operating-voltage switch-on is only to take place with a voltage gradient $< 1 \text{ V} \cdot \mu\text{s}^{-1}$.

Technical data / Range

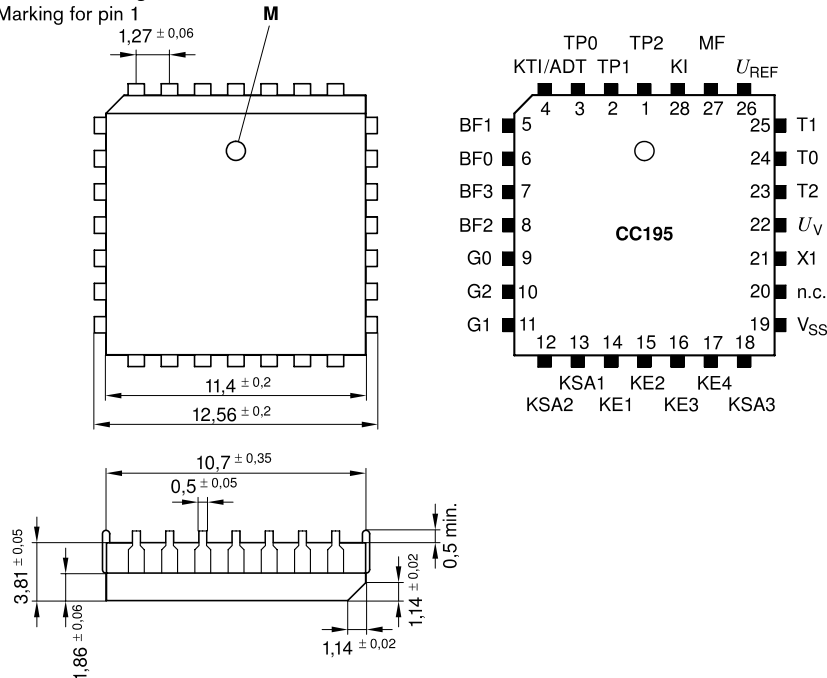
Part number		0 272 230 424		
		Condition	min.	max.
Supply voltage	U_V V	–	4.75	5.25
Supply current	I_V mA	$U_V/2$	–	30
Input voltage,				
Analog	U_{KE} V	–	0	2
Input current,				
Analog	I_{KE} μA	$U_{KE} = 2 \text{ V}$	–	10
Signal amplification	V	–	2	128
Signal amplification,				
Tolerance	d_V %	–	–3	+3
Clock frequency	f_x MHz	–	0,5	27
Input-signal frequency	f_{KE} kHz	–	–	30
Bandpass-filter mid-frequency	f_M kHz	–	5	16
Filter quality	Q	–	3	–
Filter quality, tolerance	d_Q	–	–0.5	+0.3
Integrator voltage excursion,				
effective	d_{VKU} V	–	3.8	+4.5
Integrator offset		$t_{MF} = 10 \text{ ms}$		
	mV	$> 0 \text{ }^\circ\text{C}$	–300	+300
	mV	$\leq 0 \text{ }^\circ\text{C}$	–400	+400
Integrator time constant	t_I μs	–	148	152
Integrator output impedance	Z_{KL} k Ω	–	–	2
Operating temperature	ϑ $^\circ\text{C}$	–	–40	+125

Limit values

		min.	typ.	max.
Max. supply voltage	V	–0.5	–	6.7
Max. rate of rise of the supply voltage	μs	–	1	–
Max. current in all inputs and outputs	mA	–2.5	–	+2.5
Protection of the inputs and outputs against destruction due to electrostatic charge				
	kV	–2	–	2
Storage temperature	$^\circ\text{C}$	–55	–	+135
Ambient temperature during operation	$^\circ\text{C}$	–40	–	+125

Dimension drawings.

M Marking for pin 1



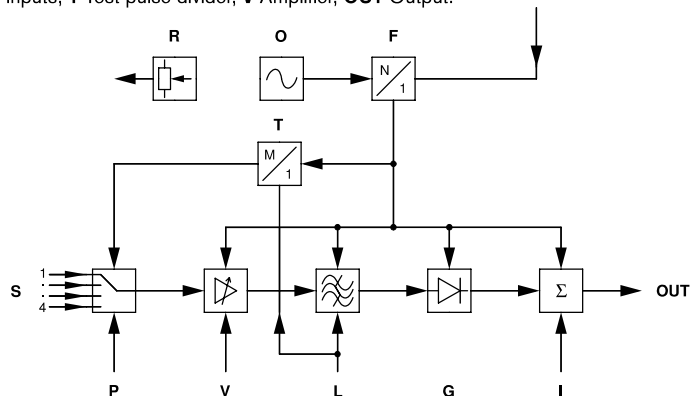
Connector-pin assignment.

U_{REF} Reference voltage
 $U_V/2$ (Output loadable with ± 0.5 mA)
 U_V Supply voltage 5 V
 V_{SS} Ground
 BF0/BF1/BF2/BF3*) Setting of the bandpass mid-frequency
 G0/G1/G2*) Setting of the amplification factor
 KE1/2/3/4 Sensor inputs
 KI Signal-integral output
 KSA1/2/3*) Sensor selection
 KT1/ADT Controlled input/test output
 MF*) Measuring window
 N.C. Not connected
 T0/T1/T2 Clock-frequency selection
 TP0/TP1/TP2 For test purposes
 X1 Clock input

*) TTL-compatible inputs from the microcomputer port driver

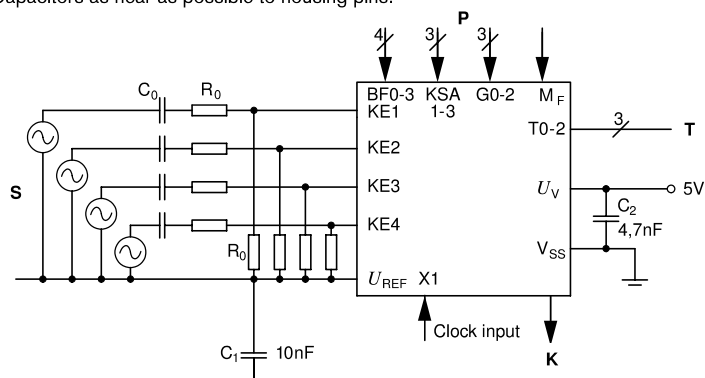
Design and function.

F Frequency divider, G Rectifier, L Filter, I Integrator, O Oscillator, P Multiplexer, R Reference signals, S Sensor inputs, T Test-pulse divider, V Amplifier, OUT Output.



Application circuit (Example).

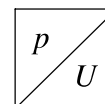
K Signal-integral output, P From microcomputer port driver, S Sensors, T Quartz clock, C_1/C_2 Capacitors as near as possible to housing pins.



Micromechanical differential-pressure sensors

Hybrid design

Measurement of pressure in gases from –100 kPa to 5 kPa



- High accuracy.
- EMC protection better than 100 V m⁻¹.
- Temperature-compensated.



Applications

On internal-combustion engines, this sensor is used to measure the differential pressure between the intake-manifold pressure of the drawn-in air and a reference pressure which is inputted through a hose.

Design and function

The piezoresistive pressure-sensor element and suitable electronic circuitry for signal amplification and temperature compensation are mounted on a silicon chip. The measured pressure is applied to the rear side of the silicon diaphragm. The reference pressure is applied from above to the diaphragm's active surface. Thanks to a special coating, both sides of the diaphragm are insensitive to the gases and liquids which are present in the intake manifold.

Installation information

The sensor is designed for mounting on a horizontal surface of the vehicle's intake manifold. The pressure fitting extends into the manifold and is sealed-off to atmosphere by an O-ring. Care must be taken, by ensuring appropriate mounting, that condensate does not form in the pressure cell or in the reference opening. Generally speaking, installation is to be such that liquids cannot accumulate in either the sensor or the pressure hose. Water in the sensor leads to malfunctions when it freezes.

Range

Pressure range kPa (p ₁ ...p ₂)	Order No.
–80...5	B 261 260 314 ¹⁾
–100...0	B 261 260 318 ¹⁾

¹⁾ Provisional draft number, order number available upon enquiry. Deliverable as from about the end of 2001.

Technical data

			min.	typ.	max.
Pressure-measuring range	p_e	kPa	–100	–	0
Operating temperature	ϑ_B	°C	–40	–	+130
Supply voltage	U_V	V	4.5	5.0	5.5
Current consumption at $U_V = 5$ V	I_V	mA	6.0	9.0	12.5
Load current at output	I_L	mA	–1.0	–	0.1
Load resistance to U_V or ground	$R_{pull-up}$	kΩ	5	680	–
	$R_{pull-down}$	kΩ	50.0	100	–
Response time	$t_{10/90}$	ms	–	1.0	–
Voltage limitation at $U_V = 5$ V					
Lower limit	$U_{A min}$	V	0.25	0.3	0.35
Upper limit	$U_{A max}$	V	4.75	4.8	4.85

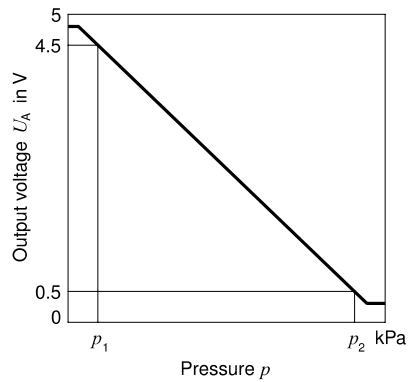
Limit data

Supply voltage	$U_{V max}$	V	–	–	+16
Pressure	p_e	kPa	–500	–	+500
Storage temperature	ϑ_L	°C	–40	–	+130

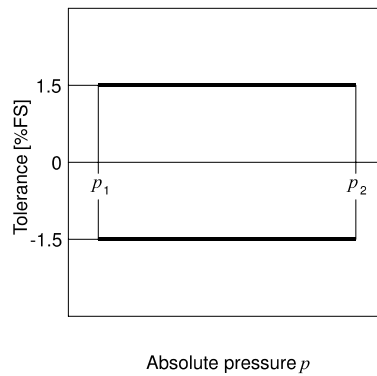
Accessories

Plug housing	Qty. required: 1	1 928 403 966
Contact pins	Qty. required: 3	1 928 498 060
Individual gaskets	Qty. required: 3	1 928 300 599

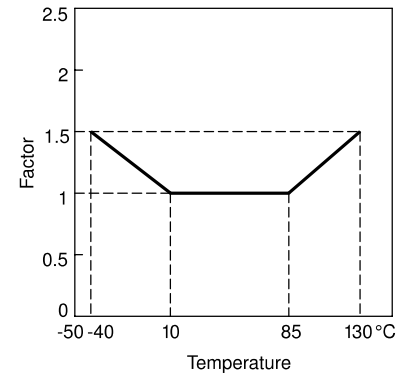
Characteristic curve.



Characteristic-curve tolerance.

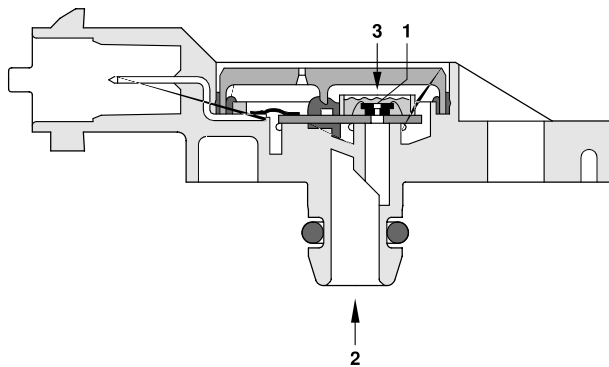


Tolerance-extension factor.



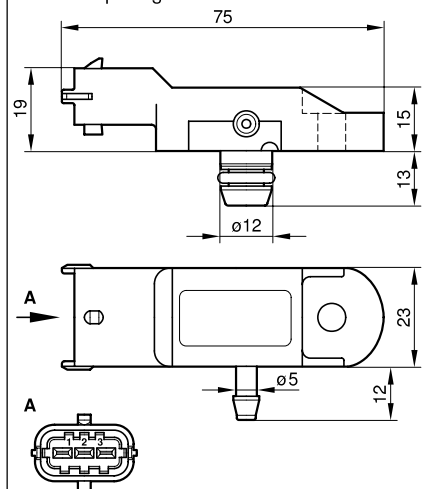
Section drawing (overall system).

1 Sensor cell, 2 Measured pressure, 3 Reference pressure



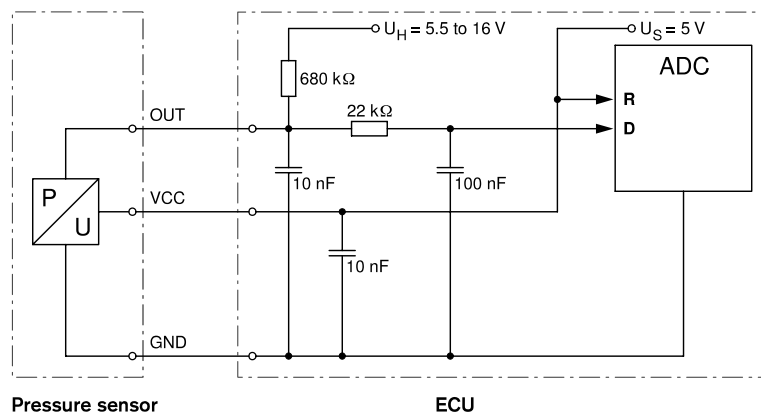
Dimension drawings.

Pin assignment
Pin 1 +5 V
Pin 2 Ground
Pin 3 Output signal



Signal evaluation: Recommendation.

D Pressure signal, R Reference

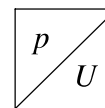


Signal evaluation: Recommendation

The pressure sensor's electrical output is so designed that malfunctions caused by cable open-circuits or short circuits can be detected by a suitable circuit in the following electronic circuitry. The diagnosis areas situated outside the characteristic-curve limits are provided for fault diagnosis. The circuit diagram shows an example for detection of all malfunctions via signal outside the characteristic-curve limitation.

Differential-pressure sensors

Measurement of pressures in gases and liquid mediums from -2.5 kPa to $+3.75$ kPa



- Resistant to the monitored medium.
- Piezoresistive sensor element.
- Integrated protection against humidity.



Application

In automotive applications, this type of pressure sensor is used for measuring fuel-tank pressure. In the process, a differential pressure is established referred to the ambient pressure.

Design and function

A micromechanical pressure element with diaphragm and connector fitting is the most important component in this differential-pressure sensor.

The diaphragm is resistant to the effects of the monitored medium. The measurement is carried out by routing the monitored medium through the pressure connector and applying the prevailing pressure to the piezoresistive sensor element. This sensor element is integrated on a silicon chip together with electronic circuitry for signal amplification and temperature compensation. The silicon chip is surrounded by a TO-type housing which forms the inner sensor cell. The surrounding pressure is applied to the active surface through an opening in the cap and a reference fitting. The active surface is protected against moisture by Silicagel. The pressure sensor generates an analog signal which is ratio-metric referred to the supply voltage.

Installation instructions

The sensor is designed for horizontal mounting on a horizontal surface. In case of non-horizontal mounting, each case must be considered individually. Generally speaking, installation is to be such that liquids cannot accumulate in the sensor or in the pressure hose. Water in the sensor leads to malfunctions when it freezes.

Range

Pressure range kPa ($p_1...p_2$)	Characteristics	Dimension drawing	Part No.
$-2.50...2.50$	–	①	0 261 230 015
$-2.50...2.50$	with protective cover	②	0 261 230 026
$-3.75...1.25$	–	①	B 261 260 317 ¹⁾

Technical data

			min	typ	max
Pressure-measuring range	p_e	kPa	-2.5	–	$+2.5$
Operating temperature	ϑ_B	°C	-40	–	$+80$
Supply voltage U_V	U_V	V	4.75	5.0	5.25
Input current at $U_V = 5$ V	I_V	mA	–	9.0	12.5
Load current at output	I_L	mA	-0.1	–	$+0.1$
Load resistance to ground or U_V	R_L	kΩ	50	–	–
Response time	$t_{10/90}$	ms	–	0.2	–
Voltage limitation at $U_V = 5$ V					
Lower limit	$U_{A\ min}$	V	0.25	0.3	0.35
Upper limit	$U_{A\ max}$	V	4.75	4.8	4.85

Recommendation for signal evaluation

Load resistance to $U_H = 5.5...16$ V	$R_{L,H}$	kΩ	–	680	–
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Limit data

Supply voltage (1 min)	$U_{V\ max}$	V	–	–	16
Pressure measurement	$P_{e,\ max}$	kPa	-30	–	$+30$
Storage temperature	ϑ_L	°C	-40	–	$+80$

Accessories

Plug housing	Qty. required: 1	1 928 403 110
Contact pins	Qty. required: 3 ³⁾	AMP-Nummer 929 939-3 ²⁾
Contact pins	Qty. required: 3 ⁴⁾	AMP-Nummer 2-929 939-1 ²⁾
Individual gaskets	Qty. required: 3	AMP-Nummer 828 904 ²⁾

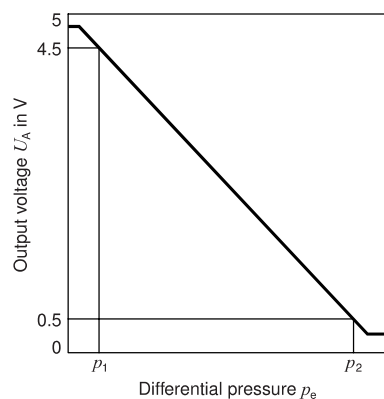
¹⁾ Provisional draft number, Order No. available upon request. Available as from the end of 2001.

²⁾ To be obtained from AMP Deutschland GmbH, Amperestr. 7–11, D-63225 Langen, Tel. 0 61 03/7 09-0, Fax 0 61 03/7 09 12 23, E-Mail: AMP.Kontakt@tycoelectronics.com

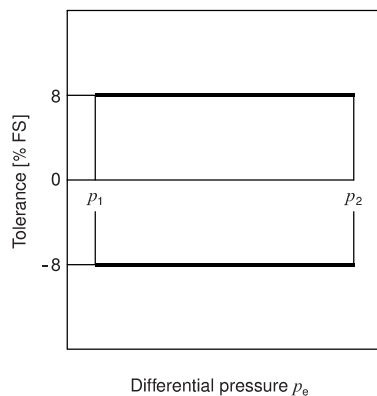
³⁾ Contacts for 0 261 230 026

⁴⁾ Contacts for 0 261 230 015, B 261 260 317

Characteristic-curve.

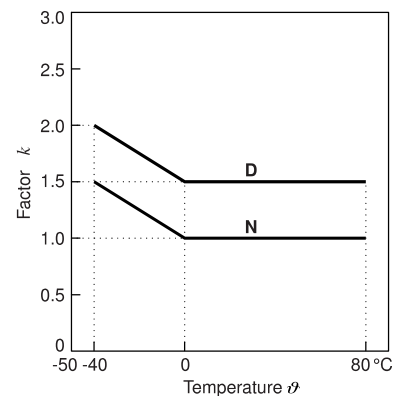


Characteristic-curve tolerance.



Temperature-error multiplier.

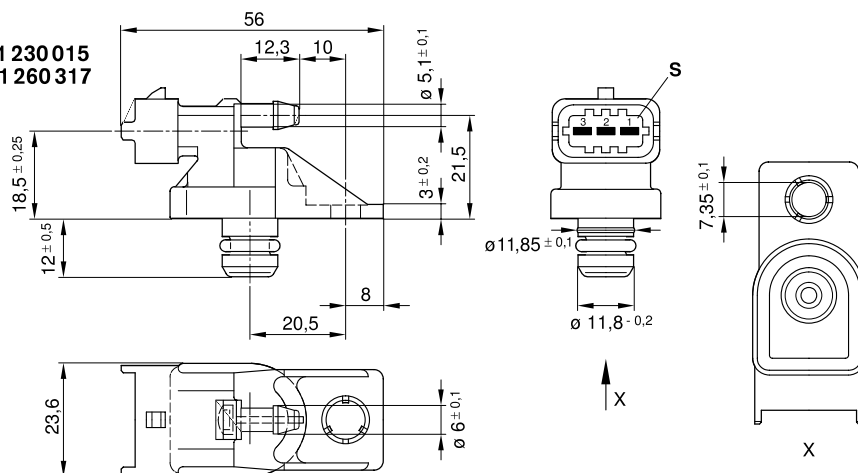
D After endurance test
N In as-new state



Dimension drawings.

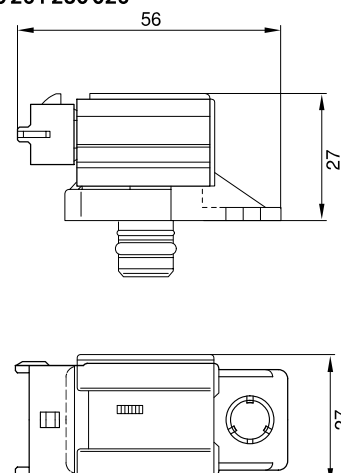
S 3-pole plug

①
0261 230 015
B261 260 317



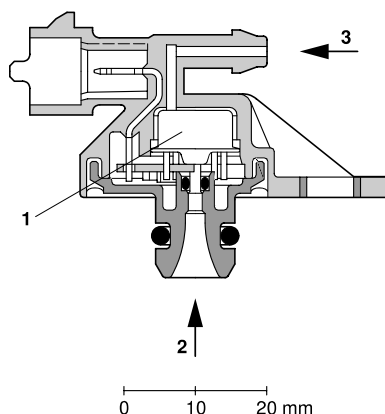
②

0261 230 026



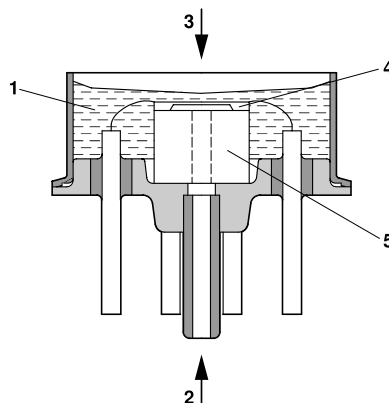
Sectional drawing of pressure sensor (overall system).

1 Sensor cell, **2** Applied pressure, **3** Reference pressure.



Sectional drawing of sensor cell.

1 Silicagel, **2** Applied pressure, **3** Reference pressure, **4** Sensor chip, **5** Glass base.



Explanation of symbols

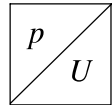
p_e Differential pressure
 U_A Output voltage (signal voltage)
 U_V Supply voltage
 k Tolerance multiplier
D Following endurance test
N As-new state

Connector-pin assignment

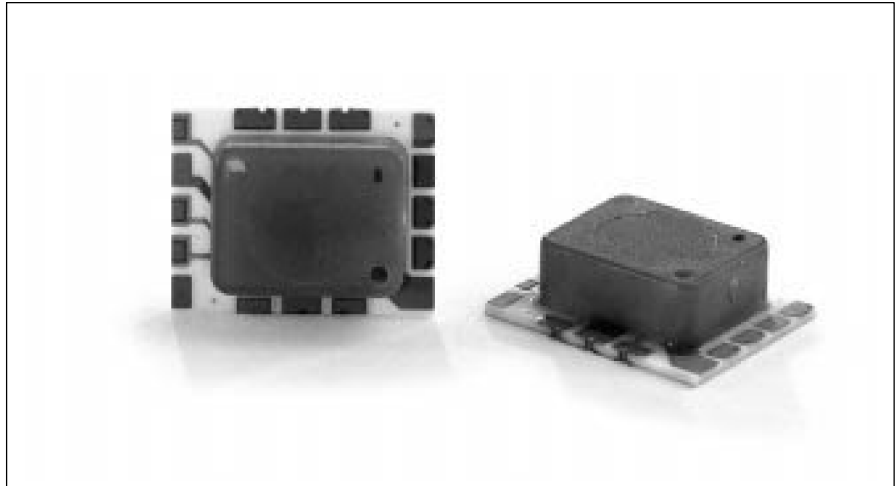
Pin 1 +5 V (U_V)
Pin 2 Ground
Pin 3 Output signal

Absolute-pressure sensor for measuring atmospheric pressure

Measurement of temperatures from 60 kPa to 115 kPa



- SMD assembly.
- Low-profile micromechanics.
- Temperature-compensation.
- Integral signal amplification.



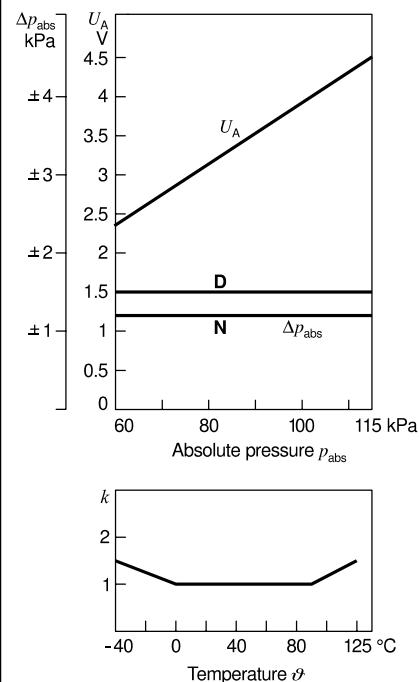
Design and function

This sensor comprises a temperature-compensated measuring element for determining the barometric absolute pressure. In this monolithic integrated silicon pressure sensor, the sensor element, and the respective evaluation circuitry with calibration elements are all united on a single silicon chip. The silicon chip is glued onto a hybrid substrate to facilitate automatic SMD assembly.

Explanation of symbols

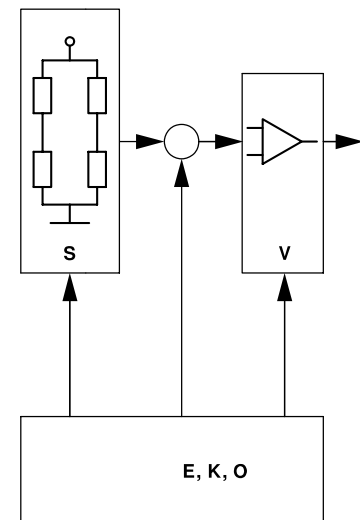
U_V Supply voltage
 U_A Output voltage (signal voltage)
 k Temperature-error multiplier
 ϑ Temperature
 p_{abs} Absolute pressure
D Following endurance test
N Nominal status

Characteristic curves.



Block diagram.

E sensitivity, **O** Offset, **K** Compensation circuit, **S** Sensor bridge, **V** Amplifier.



Technical data / Range

Part number		0 273 300 030			
			min.	typ.	max.
Pressure-measuring range	p_{abs}	kPa	60	–	115
Operating temperature range	ϑ_B	°C	–40	–	+125
Supply voltage	U_V	V	4.75	5.0	5.25
Supply current at $U_V = 5\text{ V}$	I_V	mA	6.0	9.0	12.5
Load current at output	I_L	mA	–1.0	–	0.5
Signal voltage	U_A	V	2.37	–	4.54
Voltage limitation at $U_V = 5\text{ V}$					
Lower limit	$U_{A\min}$	V	0.25	0.3	0.35
Upper limit	$U_{A\max}$	V	4.75	4.8	4.85
Response time	$t_{10/90}$	ms	–	–	1
Load capacity	C_L	nF	–	–	12

Signal evaluation: Recommendation

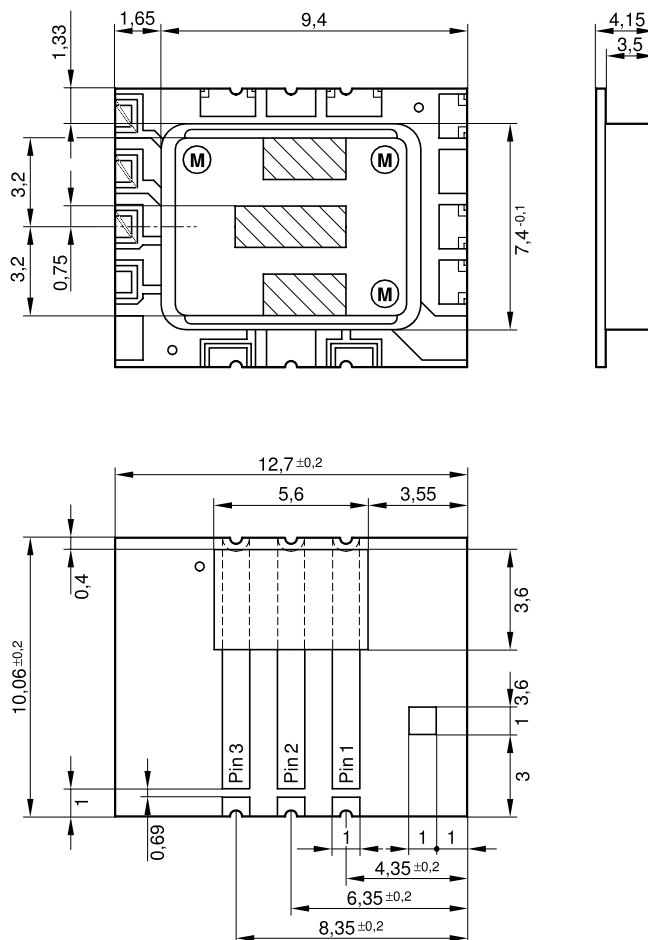
Load resistance to U_V or ground	$R_{pull-up}$	k Ω	5	680
	$R_{pull-down}$	k Ω	10.0	100

Limit data

Supply voltage, 1 min	$U_{V\max}$	V	–	–	16
Pressure	$p_{\max}$	kPa	–	–	160
Storage temperature	ϑ_L	°C	–40	–	130

Dimension drawings.

M Pin marking



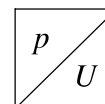
Connector-pin assignment

For operation, only the following pins are needed:

- Pin 1 OUT output signal
- Pin 2 GND (ground)
- Pin 3 U_V supply voltage

Piezoresistive absolute-pressure sensors in thick-film technology

Measurement of pressures in gases up to 250 kPa



- Thick-film pressure-measuring element ensures a high degree of measurement sensitivity.
- Thick-film sensor element and IC on the same substrate guarantee problem-free signal transmission.
- Integrated evaluation circuit for signal amplification, temperature compensation, and characteristic-curve adjustment
- Sensor enclosed by robust housing.



Design and function

The heart of this sensor is the "sensor bubble" (pressure-measuring element) produced using 100% thick-film techniques. It is hermetically sealed on a ceramic substrate and contains a given volume of air at a reference pressure of approx. 20 kPa. Piezo-resistive thick-film strain gauges are printed onto the bubble and protected with glass against aggressive media. The strain gauges are characterized by high measurement sensitivity (gauge factor approx. 12), as well as by linear and hysteresis-free behavior. When pressure is applied, they convert mechanical strain into an electric signal. A full-wave bridge circuit provides a measurement signal which is proportional to the applied pressure, and this is amplified by a hybrid circuit on the same substrate. It is therefore impossible for interference to have any effect through the leads to the ECU. DC amplification and individual temperature compensation in the $-40^{\circ}\text{C} \dots +125^{\circ}\text{C}$ range, produce an analog, ratiometric (i.e. proportional to the supply voltage U_V) output voltage U_A . The pressure sensors are resistant to gauge pressures up to 600 kPa.

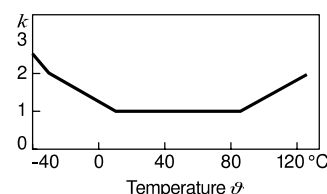
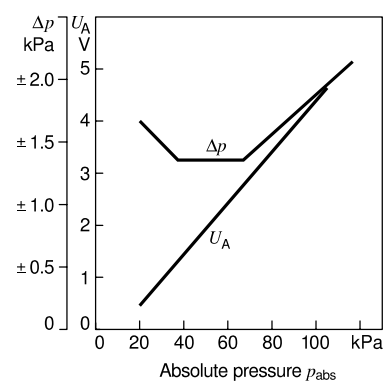
Outside the temperature range $10^{\circ}\text{C} \dots 85^{\circ}\text{C}$ the permissible tolerance increases by the tolerance multiplier. To protect the sensors, the stipulated maximum values for supply voltage, operating temperature, and maximum pressure are not to be exceeded.

Explanation of symbols

U_V	Supply voltage
U_A	Output voltage
Δp	Permissible accuracy in the range $10^{\circ}\text{C} \dots 85^{\circ}\text{C}$
k	Tolerance multiplier
ϑ	Temperature
p_{abs}	Absolute pressure

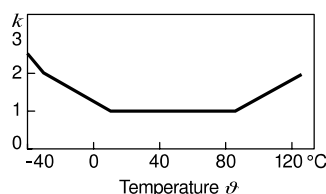
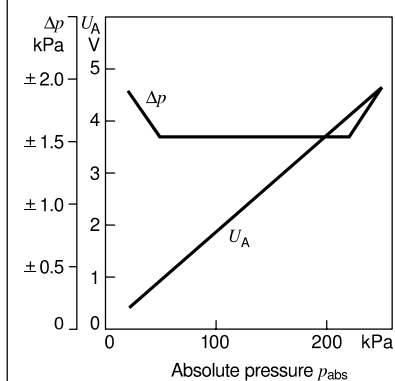
Characteristic curves 1 ($U_V = 5 \text{ V}$).

$$U_A = U_V \cdot \left(0,01 \frac{p_{\text{abs}}}{\text{kPa}} - 0,12 \right)$$



Characteristic curves 2 ($U_V = 5 \text{ V}$).

$$U_A = U_V \cdot \left(\frac{0,85}{230} \cdot \frac{p_{\text{abs}}}{\text{kPa}} + 0,0061 \right)$$



Technical data / Range

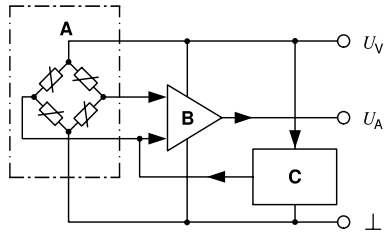
Part number	0 261 230 004	0 281 002 119
Characteristic curve	1	2
Measuring range	kPa 20...105	20...250
Max. pressure (1 s, 30 °C)	kPa 600	500
Pressure-change time	ms ≤ 10	≤ 10
Supply voltage U_V	V 4.75...5.25	4.75...5.25
Max. supply voltage	V 16	16
Input current I_V	mA < 10	< 10
Load impedance R_L	kΩ > 50	> 50
Operating temperature range	°C -40...+125	-40...+120
Degree of protection	IP 54 A	-

Accessories

Connector	1 237 000 039
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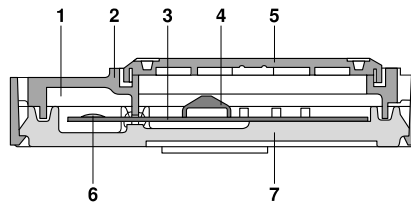
Block diagram.

- A** Strain-gauge pressure-measuring cell,
B Amplifier,
C Temperature-compensation circuit



Design.

- 1** Strain-gauge pressure-measuring cell,
2 Plastic housing, **3** Thick-film hybrid
(sensor and evaluation circuit), **4** Operational
amplifier, **5** Housing cover, **6** Thick-film sensor
element (sensor bubble), **7** Aluminum base
plate.



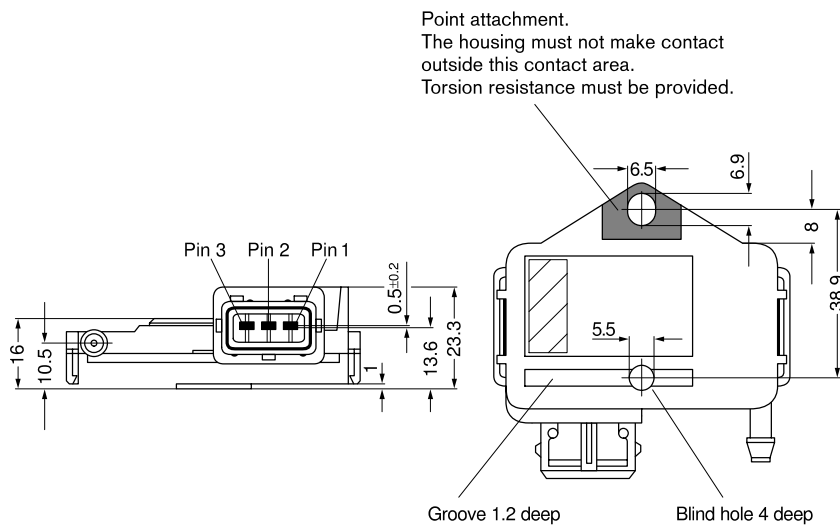
Installation instructions

A hose forms the connection between the sensor and the gas pressure to be measured. Upon installation, the sensor pressure connection should point downwards to prevent the ingress of moisture. The angular position referred to the vertical must be $+20^\circ \dots -85^\circ$, preferably 0° . Suggested fastening: M6 screw with spring washer.

Connector-pin assignment

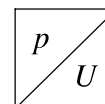
- Terminal 1 $+U_V$
Terminal 2 Ground
Terminal 3 U_A

Dimension drawings.



Absolute-pressure sensors in micromechanical hybrid design

Measurement of pressures in gases up to 400 kPa



- High accuracy.
- EMC protection better than 100 V m⁻¹.
- Temperature-compensated.
- Version with additional integral temperature sensor.



Applications

This sensor is used to measure the absolute intake-manifold pressure. On the version with integral temperature sensor, the temperature of the drawn-in air flow is also measured.

Design and function

The piezoresistive pressure-sensor element and suitable electronic circuitry for signal-amplification and temperature compensation are mounted on a silicon chip. The measured pressure is applied from above to the diaphragm's active surface. A reference vacuum is enclosed between the rear side and the glass base. Thanks to a special coating, both pressure sensor and temperature sensor are insensitive to the gases and liquids which are present in the intake manifold.

Installation information

The sensor is designed for mounting on a horizontal surface of the vehicle's intake manifold. The pressure fitting together with the temperature sensor extend into the manifold and are sealed-off to atmosphere by O-rings. By correct mounting in the vehicle (pressure-monitoring point on the top at the intake manifold, pressure fitting pointing downwards etc.) it is to be ensured that condensate does not collect in the pressure cell.

Range

Pressure range kPa (p ₁ ...p ₂)	Characteristic curve ¹⁾	Features	Dimension drawing ²⁾	Order No.
10...115	1		1	B 261 260 136³⁾
10...115	1		2	0 261 230 052
20...250	1		1	0 281 002 487
10...115	1	Integral temperature sensor	3	0 261 230 030
20...250	1	Integral temperature sensor	3	0 261 230 042
20...300	1	Integral temperature sensor	3	0 281 002 437
50...350	2	Integral temperature sensor	3	0 281 002 456
50...400	2	Integral temperature sensor	3	B 261 260 508³⁾

¹⁾ The characteristic-curve tolerance and the tolerance expansion factor apply for all versions, see Page 36

²⁾ See Page 37

³⁾ Provisional draft number, order number available upon enquiry. Available as from about the end of 2001

Accessories

Plug housing	Qty. required: 1 ⁴⁾	1 928 403 966
Plug housing	Qty. required: 1 ⁵⁾	1 928 403 736
Contact pin	Qty. required: 3 or 4 ⁶⁾	1 928 498 060
Individual gasket	Qty. required: 3 or 4 ⁶⁾	1 928 300 599

⁴⁾ Plug housing for sensors without integral temperature sensor

⁵⁾ Plug housing for sensors with integral temperature sensor

⁶⁾ Sensors without temperature sensor each need 3 contacts and gaskets. Sensors with integral temperature sensor each need 4 contacts and gaskets

Technical data

			min.	typ.	max.
Operating temperature	ϑ_B	°C	-40	–	+130
Supply voltage	U_V	V	4.5	5.0	5.5
Current consumption at $U_V = 5$ V	I_V	mA	6.0	9.0	12.5
Load current at output	I_L	mA	-1.0	–	0.5
Load resistance to U_V or ground	$R_{pull-up}$	k Ω	5	680	–
	$R_{pull-down}$	k Ω	10.0	100	–
Response time	$t_{10/90}$	ms	–	1.0	–
Voltage limitation at $U_V = 5$ V					
Lower limit	$U_{A min}$	V	0.25	0.3	0.35
Upper limit	$U_{A max}$	V	4.75	4.8	4.85

Limit data

Supply voltage	$U_{V max}$	V	–	–	+16
Storage temperature	ϑ_L	°C	-40	–	+130

Temperature sensor

Measuring range	ϑ_M	°C	-40	–	+130
Measured current	I_M	mA	–	–	1 ¹⁾
Nominal resistance at +20 °C		k Ω	–	2.5±5%	–
Thermal time constant	t_{63}	s	–	–	10 ²⁾

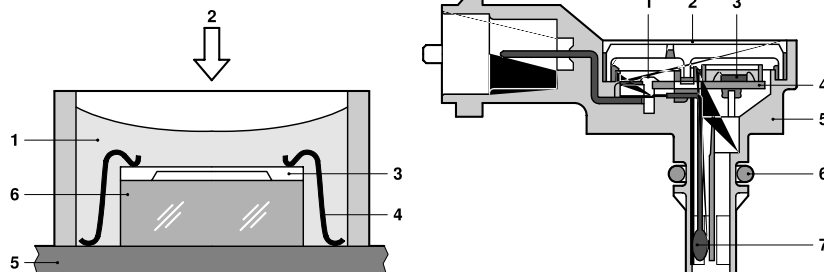
1) Operation at 5 V with 1 k Ω series resistor

2) In air with a flow rate of 6 m · s⁻¹

Sectional view.

Section through the sensor cell

Section through the DS-S2 pressure sensor



Section through the sensor cell.

1 Protective gel, 2 Pressure, 3 Sensor chip, 4 Bonded connection, 5 Ceramic substrate, 6 Glass base.

Section through the pressure sensor.

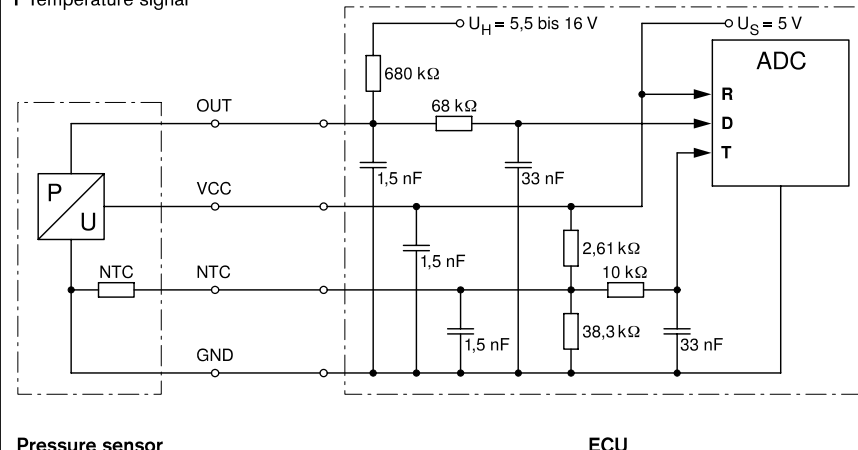
1 Bonded connection, 2 Cover, 3 Sensor chip, 4 Ceramic substrate, 5 Housing with pressure-sensor fitting, 6 Gasket, 7 NTC element.

Signal evaluation: Recommendation.

R Reference

D Pressure signal

T Temperature signal



Signal evaluation: Recommendation.

The pressure sensor's electrical output is so designed that malfunctions caused by cable open-circuits or short circuits can be detected by a suitable circuit in the following electronic circuitry. The diagnosis areas situated outside the characteristic-curve limits are provided for fault diagnosis. The circuit diagram shows an example for detection of all malfunctions via signal outside the characteristic-curve limitation.