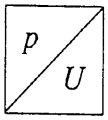
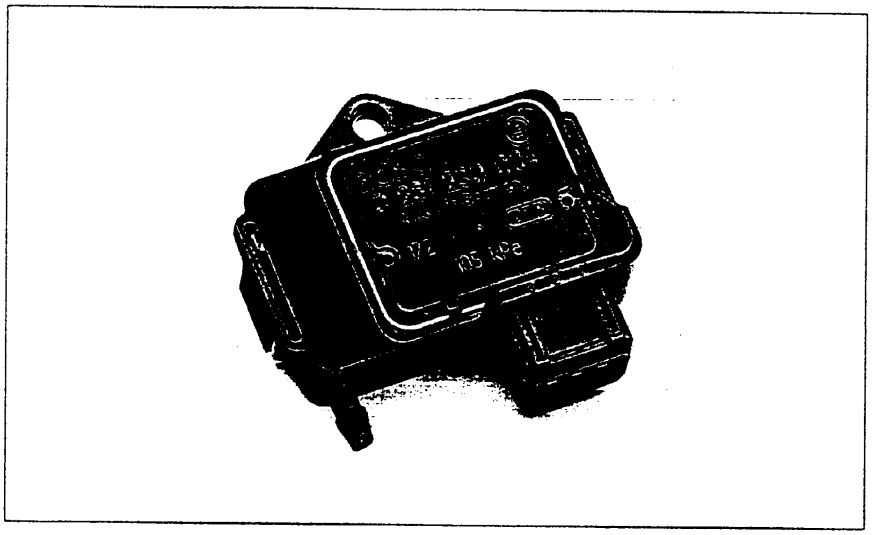
Piezoresistive absolute-pressure sensors (contd.)
Measurement of gas pressures up to 250 kPa



- 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

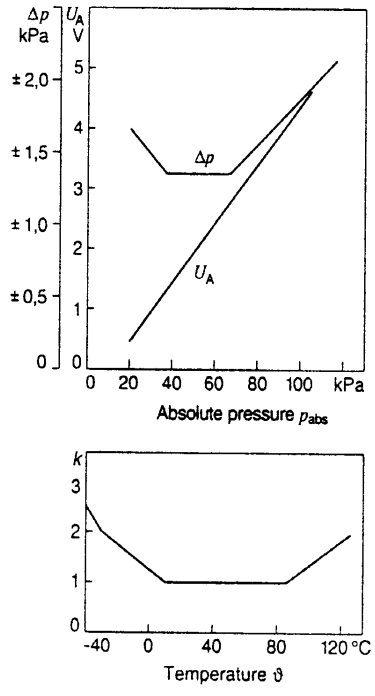
The heart of this sensor is the "sensor bubble" (pressure-measuring element) produced using 100% thick-film techniques. It is hermetically sealed on a ceramic substrate and contains a given volume of air at a reference pressure of approx. 20 kPa. Piezo-resistive thick-film strain gauges are printed onto 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 °C...+125 °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 °C...85 °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 °C...85 °C
k Tolerance multiplier
ϑ Temperature
p_{abs} Absolute pressure

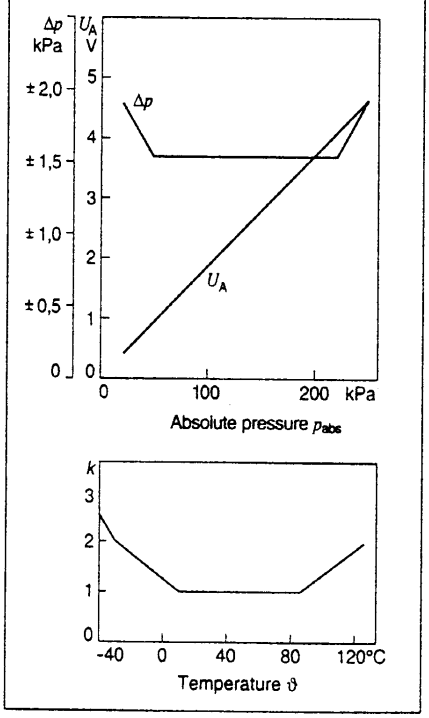
Characteristic curves 1 (U_V = 5 V).

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



Characteristic curves 2 (U_V = 5 V).

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



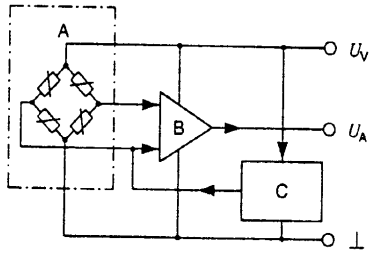
Technical data / Range

Part number		0 261 230 004	0 281 002 119
Characteristic curves		1	2
Measuring range	kPa	20...105	20...250
Pressure, max. (1 s, 30 °C)	kPa	600	500
Response time	ms	≤ 10	≤ 10
Supply voltage	V	4.75...5.25	4.75...5.25
Supply voltage, max.	V	16	16
Input current	mA	< 10	< 10
Load resistance	kΩ	> 50	> 50
Temperature range	°C	–40...+125	–40...+120
Degree of protection		IP 54 A	

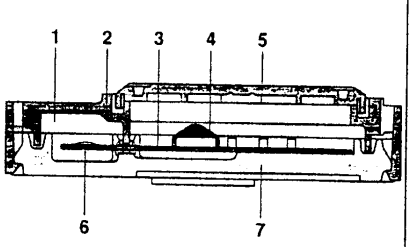
Accessories

Connector	1 237 000 039

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



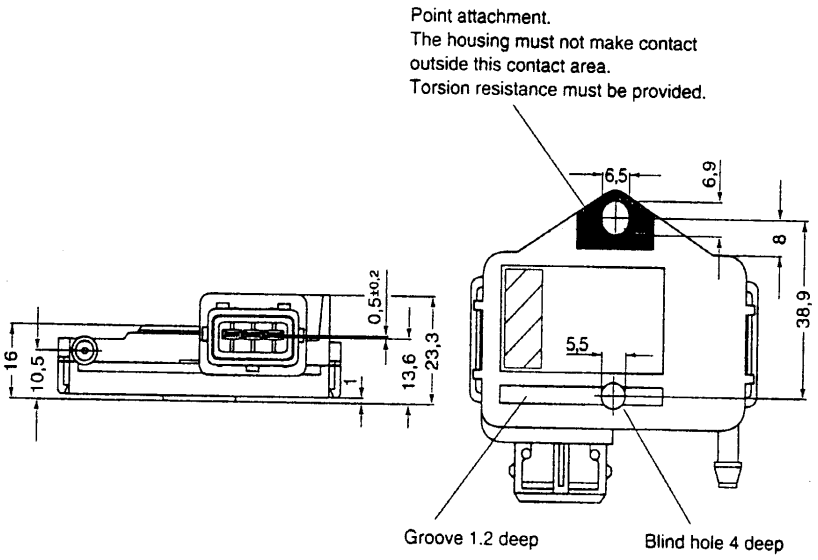
Design
1 Strain-gauge pressure-measuring cell, 2 Plastic housing, 3 Thick-film hybrid (sensor and evaluation circuit), 4 Operational amplifier, 5 Housing cover, 6 Thick-film sensor element (sensor bubble), 7 Aluminum base plate.



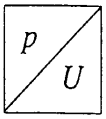
Installation instructions
A hose forms the connection between the sensor and the gas pressure to be measured. Upon installation, the sensor pressure connection should point downwards to prevent the ingress of moisture. The angular position referred to the vertical must be +20°...–85°, preferably 0°.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

Connector-pin assignment
Terminal 1 $+U_V$
Terminal 2 Ground
Terminal 3 U_A

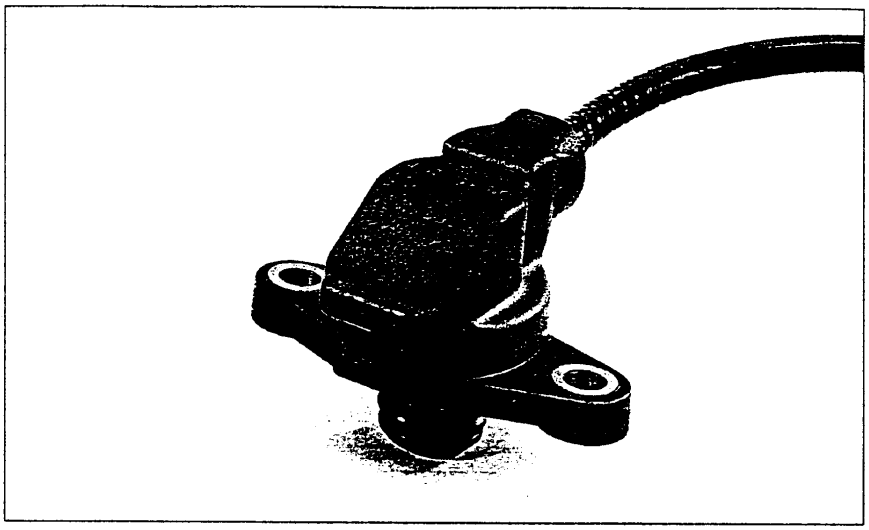
Dimension drawings



Piezoresistive absolute-pressure sensors (contd.)
Measurement of gas pressures up to 400 kPa



- Pressure-measuring element with silicon diaphragm ensures extremely high accuracy and long-term stability
- Integrated evaluation circuit for signal amplification and characteristic-curve adjustment
- Very robust construction



Applications
This type of absolute-pressure sensor is highly suitable for measuring the boost pressure in the intake manifold of turbo-charged diesel engines. They are needed in such engine assemblies for boost-pressure control and smoke limitation.

Design and function
The sensors are provided with a pressure-connection fitting with O-ring so that they can be fitted directly at the measurement point without the complication and costs of installing special hoses. They are extremely robust and insensitive to aggressive media such as oils, fuels, brake fluids, saline fog, and industrial climate.
In the measuring process, pressure is applied to a silicon diaphragm to which are attached piezoresistive resistors. Using their integrated electronic circuitry, the sensors provide an output signal the voltage of which is proportional to the applied pressure.

Installation information
The metal bushings at the fastening holes are designed for tightening torques of maximum 10 N · m.
When installed, the pressure fitting must point downwards. The pressure fitting's angle referred to the vertical must not exceed 60°.

Tolerances
In the basic temperature range, the maximum pressure-measuring error Δp (referred to the excursion: 400 kPa–50 kPa = 350 kPa) is as follows:
Pressure range 70...360 kPa
As-new state ±1.0 %
After endurance test ±1.2 %
Pressure range < 70 and > 360 kPa (linear increase)
As-new state ±1.8 %
After endurance test ±2.0 %

Technical data / Range

Part number	**0 281 002 257**
Measuring range	50...400 kPa
Basic measuring range with enhanced accuracy	70...360 kPa
Resistance to overpressure	600 kPa
Ambient temperature range/sustained temperature range	–40...+120 °C
Basic range with enhanced accuracy	+20...+110 °C
Limit-temperature range, short-time	≤ 140 °C
Supply voltage U_V	5 V ±10 %
Current input I_V	≤ 12 mA
Polarity-reversal strength at I_V ≤ 100 mA	$-U_V$
Short-circuit strength, output	To ground and U_V
Permissible loading	
Pull down	≥ 100 kΩ
	≤ 100 nF
Response time $t_{10/90}$	≤ 5 ms
Vibration loading, max.	20 g
Protection against water	
Strong hose water at increased pressure	IPX6K
High-pressure and steam-jet cleaning	IPX9K
Protection against dust	IP6KX

Throughout the complete temperature range, the permissible temperature error results from multiplying the maximum permissible pressure measuring error by the temperature-error multiplier corresponding to the temperature in question.

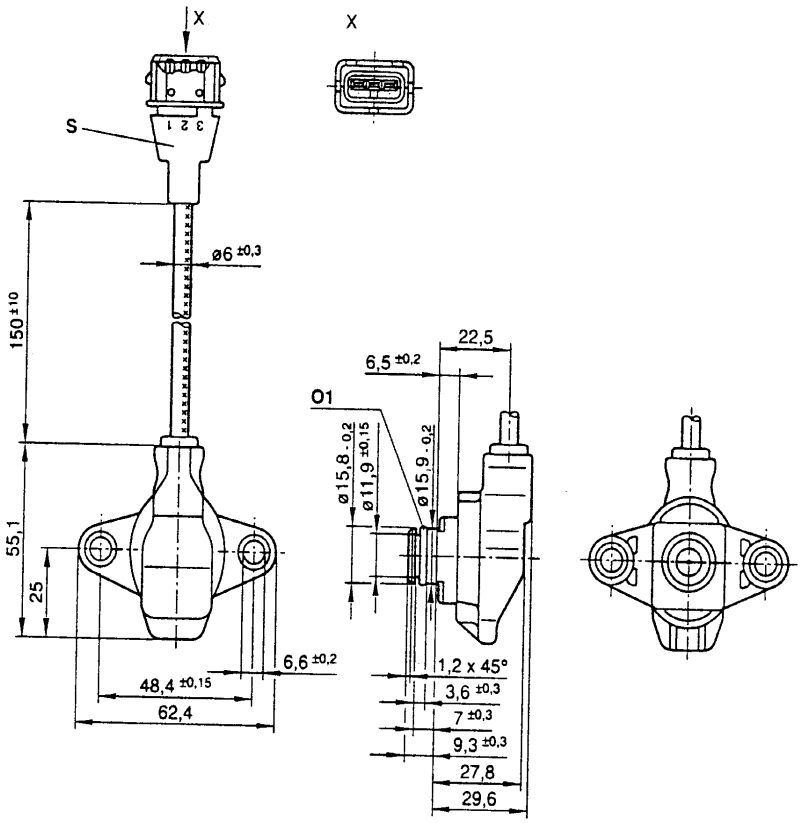
Basic temperature range	+20...+110 °C	1.0 [1]
	+20... – 40 °C	3.0 [1]
	+110...+120 °C	1.6 [1]
	+120...+140 °C	2.0 [1]

Accessories

Connector	**1 237 000 039**

[1] In each case, increasing linearly to the given value.

Dimension drawings
S 3-pole plug
O1 O-ring dia. 11.5x2.5 mm HNBR-75-ShA



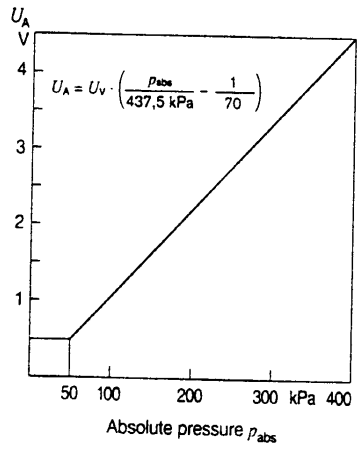
Explanation of symbols

U_V	Supply voltage
U_A	Output voltage (signal voltage)
k	Temperature-error multiplier
p_{abs}	Absolute pressure
g	Acceleration due to gravity 9.81 m · s^{-2}
D	After endurance test
N	As-new state

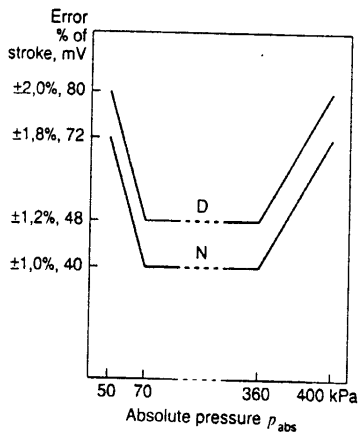
Connector-pin assignment

Pin 1	U_A
Pin 2	+5 V
Pin 3	Ground

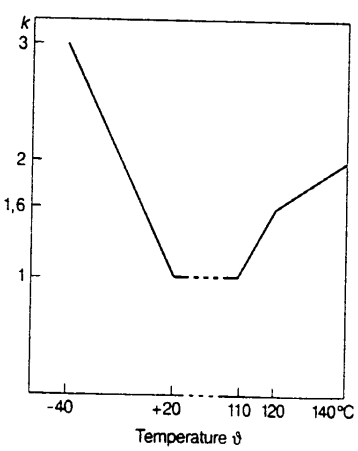
Characteristic curve (U_V = 5 V).



Maximum permissible pressure-measuring error

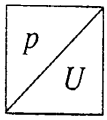


Temperature-error multiplier

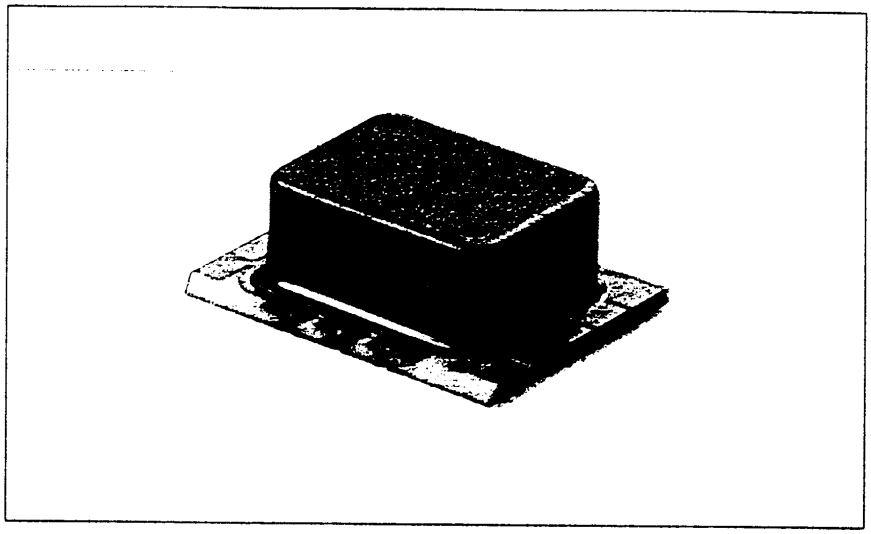


Absolute-pressure sensor for measuring atmospheric pressure

Measurement of temperatures from 60 kPa to 115 kPa



- SMD assembly
- Compact form
- Temperature-compensated
- Integral signal amplification



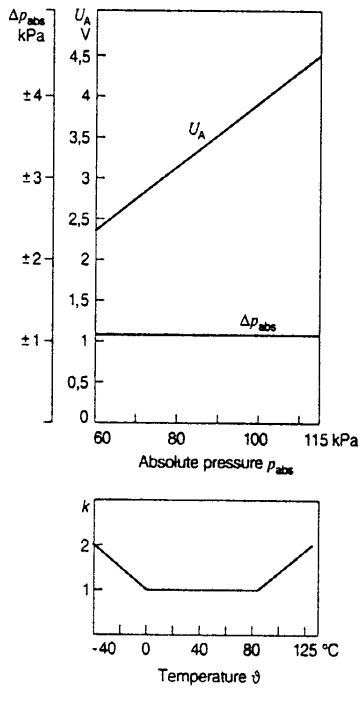
Design and function

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

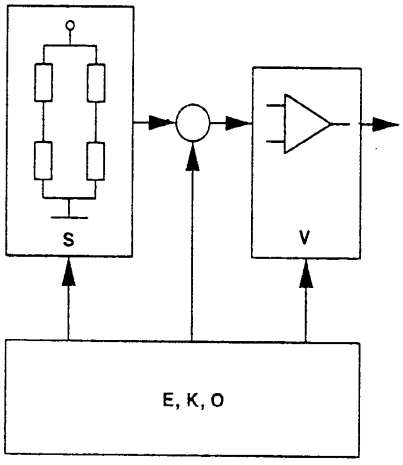
U_V Supply voltage
U_A Output voltage (signal voltage)
k Temperature-error multiplier
p_{abs} Absolute pressure

Characteristic curves



Block diagram

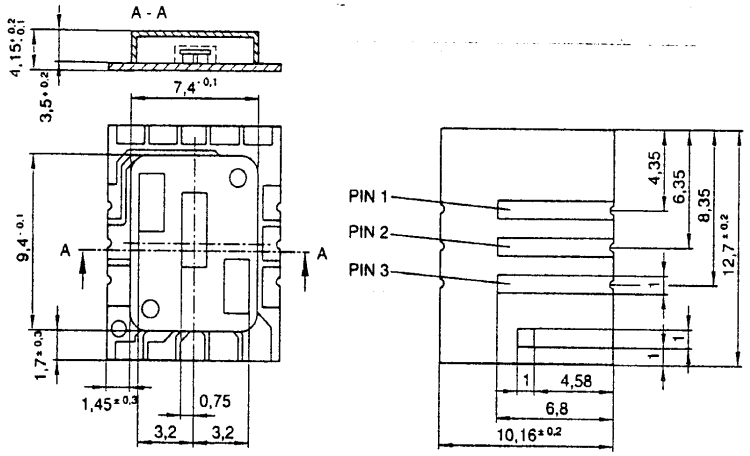
E sensitivity, O Offset, K Compensation circuit, S Sensor bridge, V Amplifier.



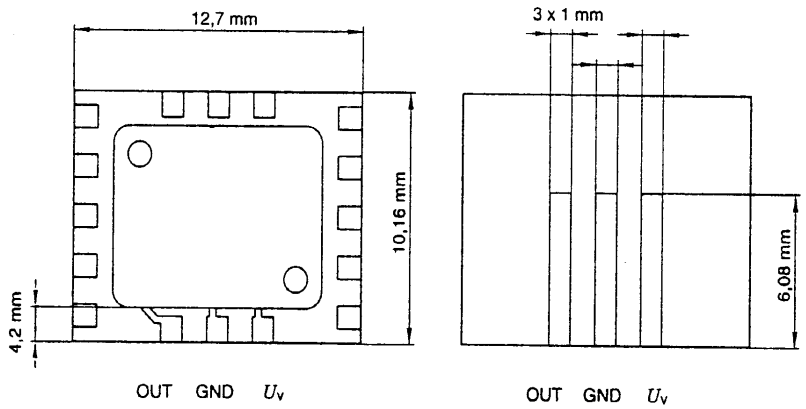
Technical data / Range

Part number			0 273 300 005		
			min.	typ.	max.
Pressure-measuring range	p_{abs}	kPa	60	–	115
Supply voltage	U_V	V	4.75	5.0	5.25
Supply current at U_V = 5 V	I_V	mA	–	9	13
Signal voltage	U_A	V	2.37	–	4.54
Operating temperature range	ϑ_B	°C	–40	–	+125
Recommendations for signal evaluation					
Output load, ohmic resistance		kΩ	50	–	–
Output load, capacitive resistance		nF	–	–	10
Limit data					
Supply voltage, 1 min		V	–	–	16
Operating temperature		°C	–40	–	+125
Storage temperature		°C			

Dimension drawings



Top view and through view (from above)



Connector-pin assignment

For operation, only the following pins are needed:

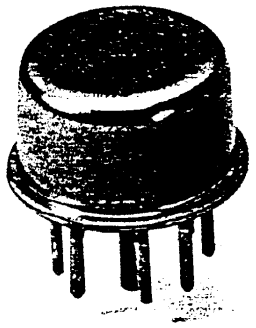
Pin 1 OUT output signal
Pin 2 GND (ground)
Pin 3 U_V supply voltage, positive

Micromechanical absolute-pressure sensors

Measurement of pressure in gases and liquid media up to 600 kPa

p/U

- Delivery possible either without housing or inside rugged housing
- EMC protection up to 100 V · m^{-1}
- Temperature-compensated
- Ratiometric output signal
- Version also available with additional, integrated temperature sensor
- All sensors and sensor cells are resistive to fuels (incl. diesel), and oils such as engine lube oils.



Accessories

For 0 261 230 009, .. 020; 0 281 002 137

Plug housing	**1 928 403 110**
Contact pin	**1 987 280 104**
Individual gasket	**1 987 280 106**

For 0 261 230 013, .. 022; 0 281 002 205, ..244, ..246

Plug housing	**1 928 403 112**
Contact pin	**1 987 280 104**
Individual gasket	**1 987 280 106**

Note

Each 3-pole plug requires 1 plug housing, 3 contact pins, and 3 individual gaskets.
4-pole plugs required 1 plug housing, 4 contact pins, and 4 individual gaskets.

Range

Pressure sensor integrated in rugged, media-resistant housing

Pressure range kPa (p1...p2)	Chara. curve [1]	Features	Dimension drawing [2]	Part number
10...115	1	Hose connection	1	**0 261 230 009**
10...115	1	Integrated temperature sensor	2	**0 261 230 022**
15...380	2	Clip-type module with connection cable	3	**1 267 030 835** [3]
20...115	1	O-ring connection	4	**0 261 230 020**
20...115	1	Integrated temperature sensor	2	**0 261 230 013**
20...250	1	O-ring connection	4	**0 281 002 137**
20...250	1	Integrated temperature sensor	2	**0 281 002 205**
50...350	2	Integrated temperature sensor	5	**0 281 002 244**
50...400	2	Integrated temperature sensor	–	**B 261 260 259** [4]
50...600	2	Integrated temperature sensor	6	**0 281 002 246**

Pressure-sensor cells in housings similar to transistors
Suitable for installation inside devices

Pressure range kPa (p1...p2)	Chara. curve [1]	Features	Dimension drawing [2]	Part number
10...115	1	–	7	**0 273 300 006**
15...380	2	–	7	**0 273 300 017**
20...105	1	–	7	**0 273 300 001**
20...115	1	–	7	**0 273 300 002**
20...250	1	–	7	**0 273 300 004**
50...350	2	–	7	**0 273 300 010**
50...400	2	–	7	**0 273 300 019**
50...600	2	–	7	**0 273 300 012**

[1] The characteristic-curve tolerance and the tolerance extension factor apply to all versions, refer to Page 40.
[2] See Page 41/42
[3] Details of accessories upon request
[4] Provisional draft number, part number available upon request, delivery as from about mid-1998

Technical data

		Min.	Typical	Max.
Supply voltage U_V	V	4.5	5	5.5
Current input I_V at U_V = 5 V	mA	6	9	12.5
Load current at output	mA	–0.1	–	0.1
Load resistance to ground or U_V	kΩ	50	–	–
Lower limit at U_V = 5 V	V	0.25	0.30	0.35
Upper limit at U_V = 5 V	V	4.75	4.80	4.85
Output resistance to ground U_V open	kΩ	2.4	4.7	8.2
Output resistance to U_V, Ground open	kΩ	3.4	5.3	8.2
Response time $t_{10/90}$	ms	–	0.2	–
Operating temperature	°C	–40	–	+125
Limit data				
Supply voltage U_V	V	–	–	16
Operating temperature	°C	–40	–	+130
Recommendation for signal evaluation				
Load resistance to U_H = 5.5...16 V	kΩ	–	680	–
Load resistance to ground	kΩ	–	100	–
Low-pass resistance	kΩ	–	21.5	–
Low-pass capacitance	nF	–	100	–
Temperature sensor				
Measuring range	°C	–40	–	+120
Nominal voltage	V	–	5 [1]	–
Nominal resistance at +20 °C	kΩ	–	2.5 ±5%	–
Temperature time constant t_{63} [2]	s	–	–	45

[1]) Operation with series resistor 1 kΩ, measured current ≤1 mA. [2]) In air with airflow speed 6 m · s^{-1}.

Applications

These monolithic integrated silicon pressure sensors are high-precision measuring elements for measuring the absolute pressure. They are particularly suitable for operations in hostile environments, for instance for measuring the absolute manifold pressure in internal-combustion engines.

Design and function

The sensor contains a silicon chip with etched pressure diaphragm. When a change in pressure takes place, the diaphragm is stretched and and the resulting change in resistance is registered by an evaluation circuit. This evaluation circuit is integrated on the silicon chip together with the electronic calibration elements. During production of the silicon chip, a silicon wafer on which there are a number of sensor elements, is bonded to a glass plate. After sawing the plate into chips, the individual chips are soldered onto a metal base complete with pressure connection fitting. When pressure is applied, this is directed through the fitting and the base to the rear side of the pressure diaphragm. There is a reference vacuum trapped underneath the cap welded to the base. This permits the absolute pressure to be measured as well as protecting the front side of the pressure diaphragm. The programming logic integrated on the chip performs a calibration whereby the calibration parameters are paths. The calibrated and tested sensors are mounted in a special housing for attachment to the intake manifold.

Signal evaluation

The pressure sensor delivers an analog output signal which is ratiometric referred to the supply voltage. In the input stage of the downstream elecronics, we recommend the use of an RC low-pass filter with, for instance, t = 2 ms, in order to suppress any disturbance harmonics which may occur. In the version with integrated temperature sensor, the sensor is in the form of an NTC resistor (to be operated with series resistor) for measuring the ambient temperature.

Construction

Sensors with housing: This enclosed version is provided with a rugged housing. In the temperature-sensor version, the temperature sensor is also enclosed in the housing.
Sensors without housing: This version is provided with a protective cover similar to that of a transistor. Pressure application is through a central pressure connector fitting.
Of the available solder pins, only the following pins are needed:

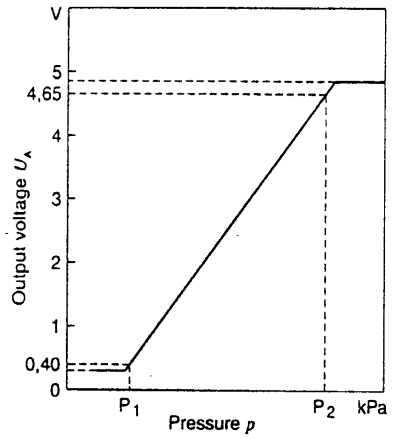
Pin 6 Output voltage U_A
Pin 7 Ground
Pin 8 +5 V

Installation information

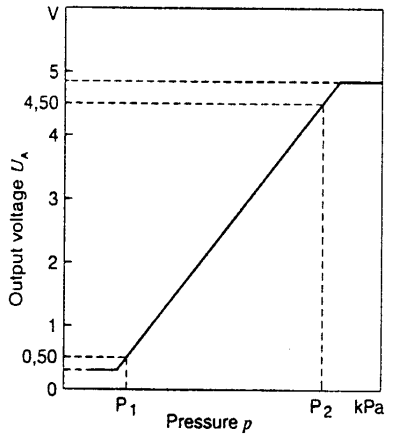
When installed, the pressure connection fitting must point downwards in order that condensate cannot form in the pressure cell.

Micromechanical absolute-pressure sensors (contd.)

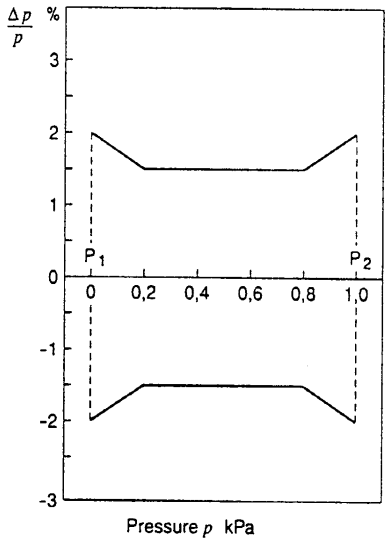
Characteristic curve 1 (U_V = 5.0 V).



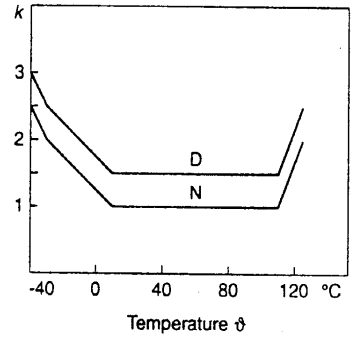
Characteristic curve 2 (U_V = 5.0 V).



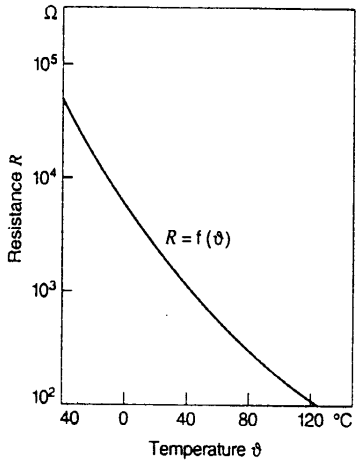
Characteristic-curve tolerance



Tolerance extension factor



Temperature-sensor characteristic curve

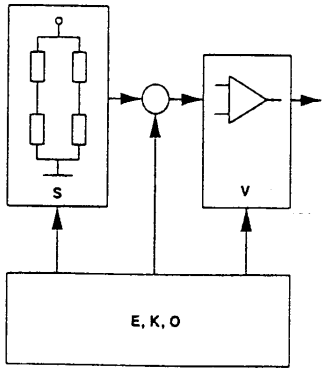


Explanation of symbols

U_A	Output voltage
U_V	Supply voltage
k	Tolerance multiplication factor
D	Following endurance test
N	As-new state

Block diagram

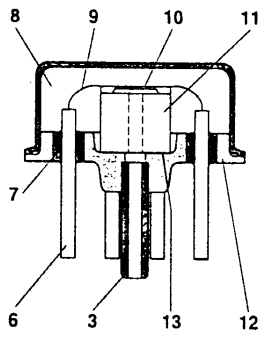
E Characteristic curve: Sensitivity,
K Compensation circuit
O Characteristic curve: Offset,
S Sensor bridge, V Amplifier



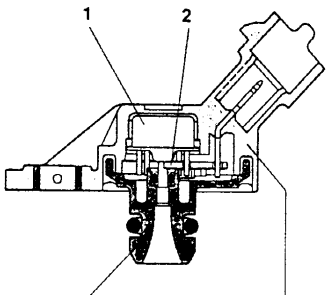
Sectional views

Pressure sensor in housing

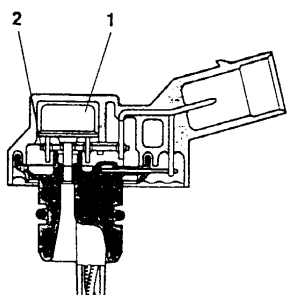
1 Pressure sensor, 2 pcb, 3 Pressure fitting,
4 Housing, 5 Temperature sensor, 6 Electrical bushing,
7 Glass insulation, 8 Reference vacuum,
9 Aluminum connection (bonding wire), 10 Sensor chip,
11 Glass base, 12 Welded connection,
13 Soldered connection.



Section through the installed pressure sensor

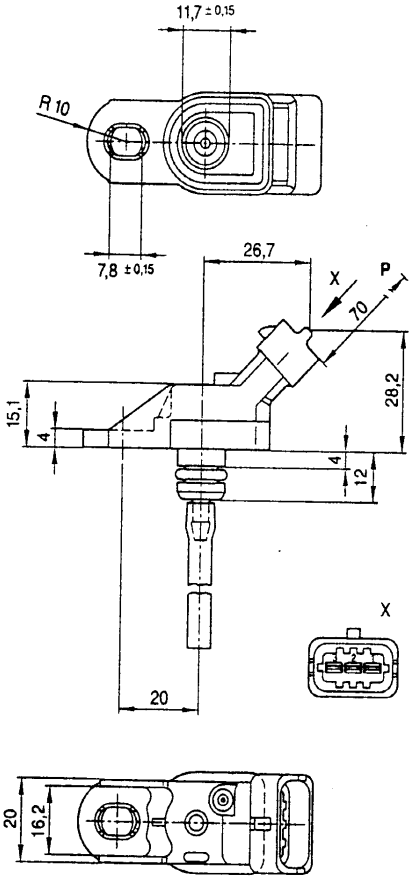


Installed pressure sensor. Version with temperature sensor

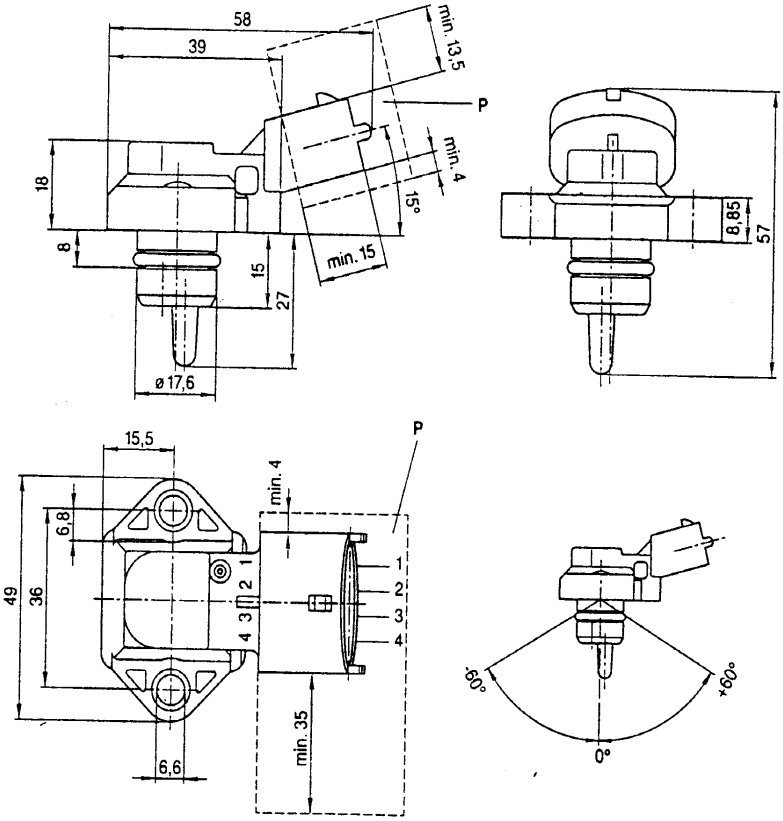


Dimension drawings P Space required by plug and cable

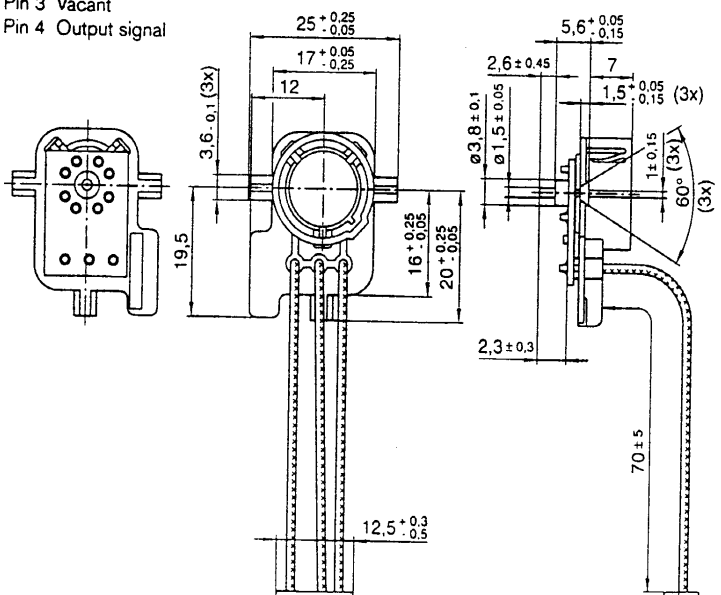
① **0 261 230 009**
Connector-pin assignment
Pin 1 +5 V
Pin 2 Ground
Pin 3 Output signal



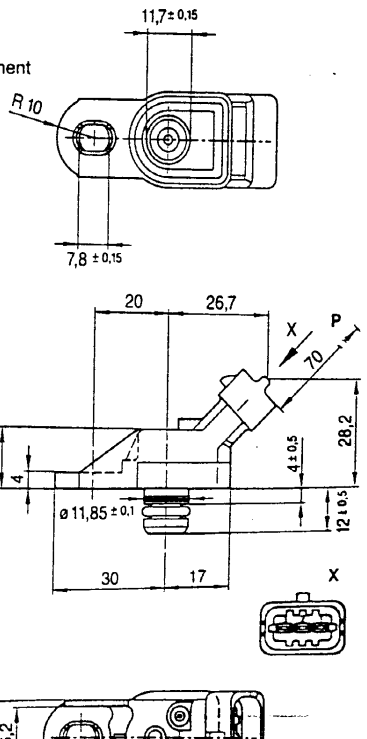
② **0 261 230 013, 0 261 230 022, 0 281 002 205**
Connector-pin assignment
Pin 1 Ground
Pin 2 NTC resistor
Pin 3 +5 V
Pin 4 Output signal



③ **1 267 030 835**
Connector-pin assignment
Pin 1 Ground
Pin 2 +5 V
Pin 3 Vacant
Pin 4 Output signal



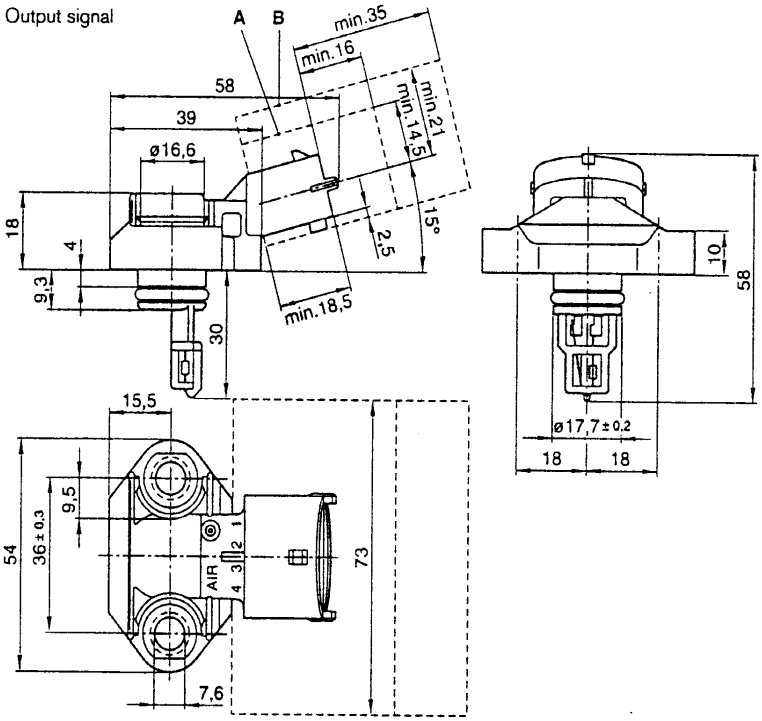
④ **0 261 230 020;**
0 281 002 137
Connector-pin assignment
Pin 1 +5 V
Pin 2 Ground
Pin 3 Output signal



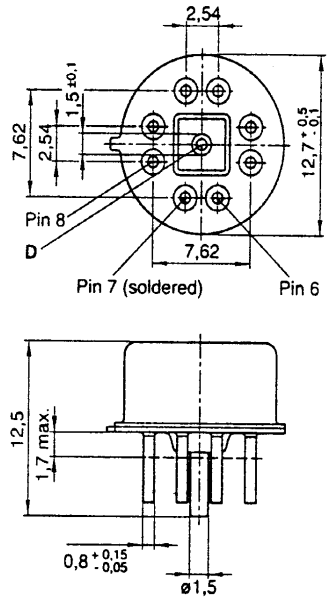
Micromechanical absolute-pressure sensors (contd.)

Dimension drawings A Space required by plug and cable
B Space required when plugging in/unplugging

⑤ **0 281 002 244**
Connector-pin assignment
Pin 1 Ground
Pin 2 NTC resistor
Pin 3 +5 V
Pin 4 Output signal



⑦ **0 273 300 ..**
Sensor without housing
D Pressure-connection fitting
Pin 6 Output signal



⑥ **0 281 002 246**
Connector-pin assignment
Pin 1 Ground
Pin 2 NTC resistor
Pin 3 +5 V
Pin 4 Output signal