| BOSCH | Technische Kundenunterlage<br>Technical Customer Information | Y 261 K26 065 - 000 E<br>Seite/Page 1 von/of 13 |
|---|---|---|

**Produkt / Product:** **Pressure/Temperature Sensor for boost pressure applications**

**Typ / Type:** **DS-S2-TF (DS-LDF6T)**
**20 – 300 kPa**

**Bestellnummer / Part Number:**
0 281 002 437
0 281 002 680
0 281 002 845 [EGR]

**Angebotszeichnung / Offer Drawing:**
A 261 260 508 - ...
A 261 260 520 - ...
0 261 A04 331 - …

**Kenndaten / Characteristic Data:** - Seite/Page 3 bis/to 9

Prüfmethoden / Test Method: - Seite/Page 10 bis/to 13

Prüfdaten / Test Data: - Seite/Page - bis/to -

Gültig ab / Valid from: Start of production

**Bemerkung / Comment:**

| Nr.<br>Index | Seite<br>Page | Änderung<br>Revision | Datum<br>Date | GS-SI/ENS1 (dr) | GS-SI/ENS1 (ck) | GS-SI/ENS (app) | GS-SE/MKT | DS/EDS |
|---|---|---|---|---|---|---|---|---|
| — | — | **Erstausgabe / First Edition** | 13.07.98 | 04.08.98 Kuhnt | 04.08.98 Mast | 04.08.98 Lembke | 04.08.98 Smeets | 29.07.98 Berger |
| [1] | 1 | completion of new type | 05.10.98 | - | - | - | - | - |
| [2] | 1, 11-13 | released part no., replaces provisional TKU, 4.4 and 4.7 updated | 06.12.99 | 06.12.99 Kuhnt | 06.12.99 Mast | 07.12.99 Lembke | 21.12.99 Fischbach | 10.12.99 Berger |
| [3] | 9 | 2.7 R-table, values due to exact temperature | 02.02.00 | 02.02.00 Kuhnt | 02.02.00 Mast | 04.02.00 Lembke | 09.02.00 Fischbach | 02.03.00 Berger |
| [4] | 1 | No. of offer drawing | 12.07.01 | - | - | - | - | - |
| [5] | complete | updated, completion of 0 281 002 680 | 03.06.03 | - | - | - | - | - |
| [6] | 1,3,13 | Completion of new sensor type for EGR-applications, 5. and 6. new | 23.09.05 | 23.09.05 Kuhnt | 23.09.09 Mast | 23.09.05 Gleisberg | - | 26.09.05 Litzinger |
| | | | | | | | | |



26.09.05

# Contents:

# 1. Description

## 1.1 Application

The sensor described in this data sheet serves to measure the absolute intake-manifold pressure up to 300 kPa as well as the temperature of the intake air stream of internal-combustion engines operated with leaded or unleaded regular-grade or premium-grade gasoline, M15, E22 or diesel fuel.

## 1.2 Technical principle

The piezo-resistive pressure sensor element and a suitable circuitry for signal amplification and temperature compensation are integrated on a silicon chip. The measured pressure operates from above to the active side of the silicon diaphragm. Between the backside and a glass socket a reference vacuum is enclosed. The temperature sensor element is an NTC-resistor. The sensor is resistant against vapours and fluids existing in the intake-manifold. However, for applications in the air stream after inlet of exhaust gas recirculation only new sensor types marked with 'EGR' may be used. [6]

## 1.3 Installation instructions

The sensor is designed for attachment to a plane surface on the intake-manifold of motor vehicles. The pressure nozzle and the temperature sensor project into the intake-manifold and are sealed to atmosphere by an O-ring. By suitably fitting the sensor in the vehicle (place of tapping the pressure at the top of the intake-manifold, pressure port inclined downwards, etc.), it must be ensured that no condensate will accumulate in the pressure cell.
The bore in the intake-manifold and the clamping must be designed in accordance to the offer drawing so that a long-term, leakproof seat at the port and the resistance to the measured medium are guaranteed.
In the interest of good continuity on the connectors, it is essential that not only the connector on the component side is according to specification, but that the material quality and exact fit of the cable harness connector are also guaranteed. The cable harness connector should therefore be according to the BOSCH offer drawing specification.

## 1.4 Assembly instructions

In order to avoid deterioration or pre-damage of the sensor at the user the following points have to be absolutely noticed: [5]

a) It has to be ensured that the O-ring will not be damaged at assembly. Only a thin film of 'Shell Ondina Oil 68' or light engine oil (5W20) may be applied as lubricant. Don't use silicone based lubricants.
b) The sensor must not be mounted with striking tools (e.g. hammer).
c) When the assembly unit is exposed to a leakage test, don't exceed maximum overpressure.
d) At immersion test plug connector and pressure port for protection against water ingress.
e) Avoid reverse voltage and overvoltage when electrical tests are applied to the sensor.

If the installation of the sensor takes place at the supplier e.g. of an assembly unit, the supplier has to be instructed accordingly.

## 1.5 Signal evaluation

The pressure sensor supplies an analogue output signal, which is ratiometric to the supply voltage. An RC low-pass filter with for instance $\tau$ = 2 ms is recommended as an input circuitry for the following electronics in order to suppress possibly disturbing harmonic vibrations. The temperature sensor should be operated by a series resistance i.e. 1 kΩ at 5 V.

## 1.6 Signal range check

The electric output of the sensor is designed in such a way, that failures in function by cable breaks or short circuits can be detected by a suitable input circuitry of the following electronics. For the signal range check the diagnosis ranges beyond the characteristic limits are provided. Example of circuitry for detection of all kinds of failures by signal out of characteristic limits:

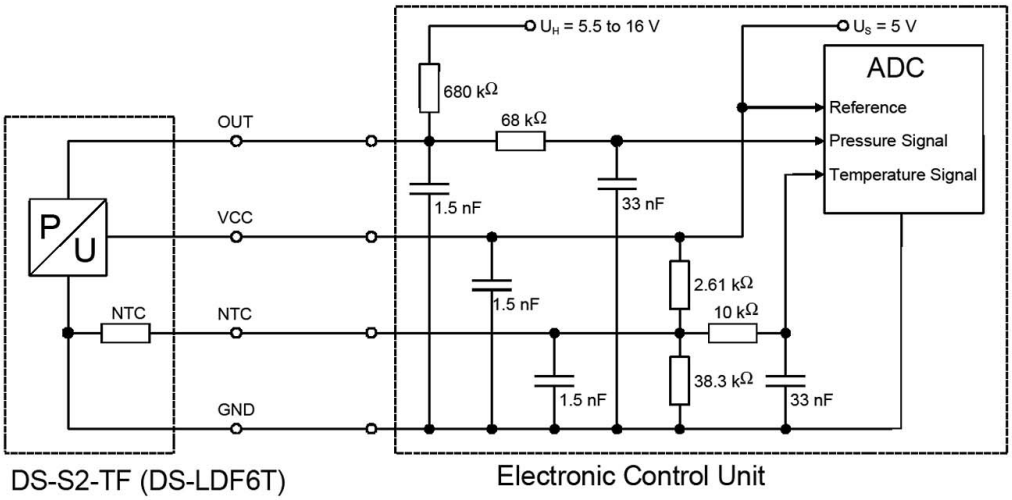



**Figure 1a. Signal evaluation with load resistor to $U_H$= 5.5 to 16 V**

Further possibility of circuitry for detection of failures (signal below characteristic limit or above plausible characteristic range):

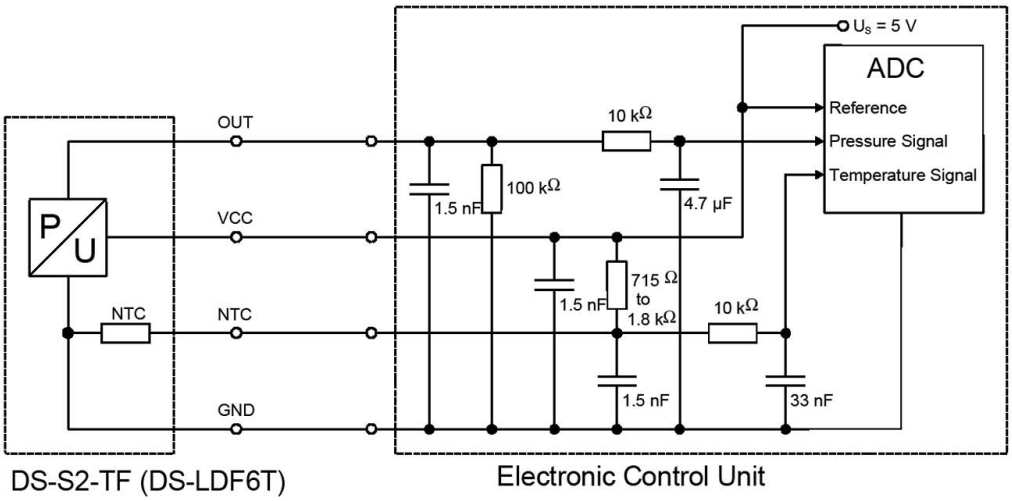



**Figure 1b. Signal evaluation with load resistor to ground**

# 2. Data

## 2.1 Maximum ratings of pressure sensor

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Supply voltage | $U_{S,max.}$ | 16 | V |
| Pressure | $p_{abs,max.}$ | 500 | kPa |
| Storage temperature | t | -40/+130 | °C |

The output is resistant against short circuit to 0 V respectively 5 V.
The sensor is resistant against reverse voltage for 5 min at room temperature, as the maximum current is limited to 0.3 A.

## 2.2 Operating characteristics of pressure sensor

| Parameter | Symbol | Value | | | Unit | |
|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | |
| Pressure range | $p_{abs}$ | 20 | | 300 | kPa | |
| Temperature range | t | -40 | | 130 | °C | |
| Supply voltage | $U_S$ | 4.75 | 5.0 | 5.25 | V | |
| Supply current at $U_S$ = 5 V | $I_S$ | 6.0 | 9.0 | 12.5 | mA | |
| Output load current | $I_L$ | -1.0 | | 0.5 | mA | [5] |
| Load resistance to $U_S$<br>or to ground | $R_{pull-up}$<br>$R_{pull-down}$ | 5<br>10 | 680<br>100 | | kΩ<br>kΩ | <br>[5] |
| Load capacitance | $C_L$ | | | 12 | nF | |
| Response time | $T_{10/90}$ | | | 1.0 | ms | |
| Lower limit at $U_S$ = 5 V | $U_{out,min.}$ | 0.25 | 0.3 | 0.35 | V | |
| Upper limit at $U_S$ = 5 V | $U_{out,max.}$ | 4.75 | 4.8 | 4.85 | V | |
| Output resistance [1)] to ground, $U_S$ open | $R_{lo}$ | 2.4 | 4.7 | 8.2 | kΩ | |
| Output resistance [1)] to $U_S$, ground open | $R_{hi}$ | 3.4 | 5.3 | 8.2 | kΩ | |

1) valid only for measuring voltage < 0.5 V [5]

## 2.3 Transfer function of pressure sensor

$$U_{out} = (c_1 \cdot p_{abs} + c_0) \cdot U_S$$

where $U_{out}$ = signal output voltage in V
$U_S$ = supply voltage in V
$p_{abs}$ = absolute pressure in kPa
$c_0$ = 5.4/280
$c_1$ = 0.85/280 $kPa^{-1}$

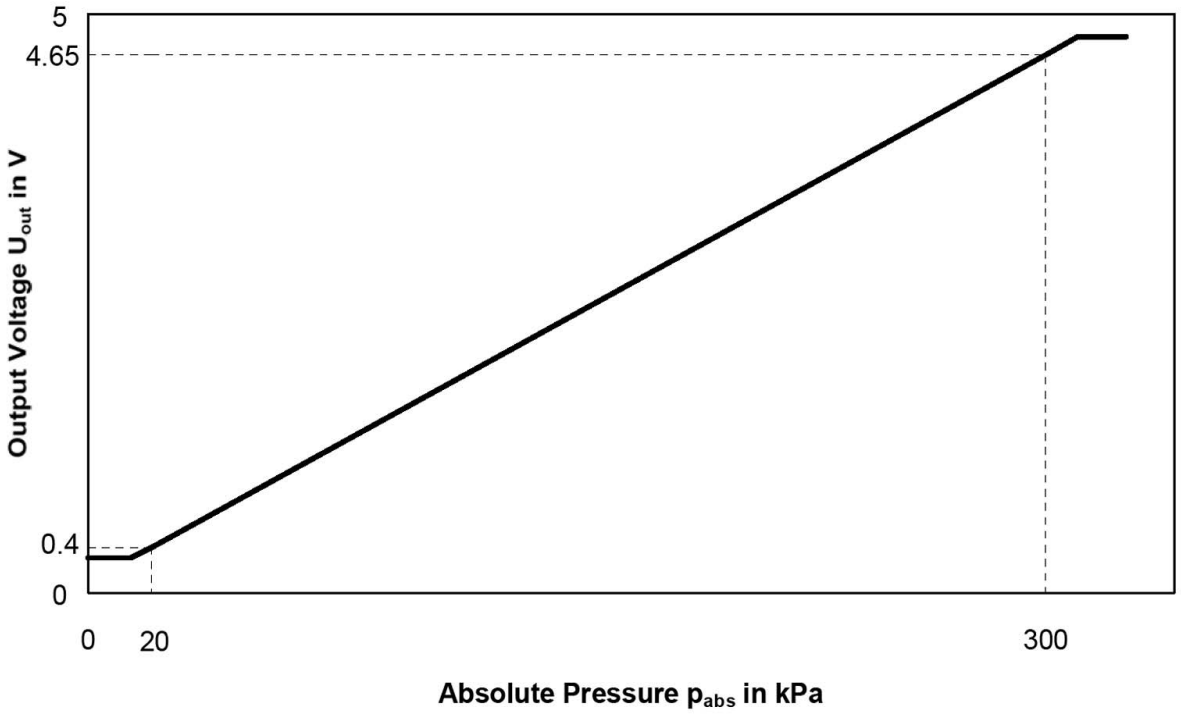
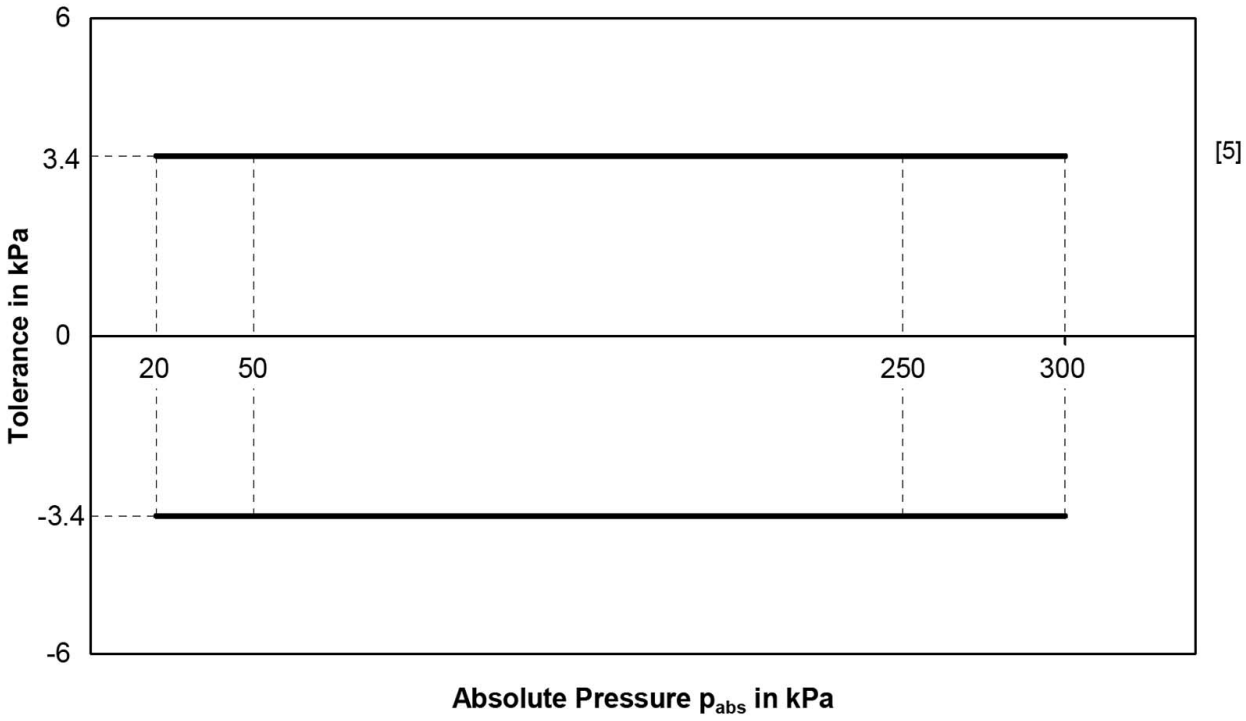



**Figure 2. Characteristic at $U_S$= 5.000 V**

## 2.4 Accuracy of pressure sensor




[5]

**Figure 3. Characteristic tolerance**

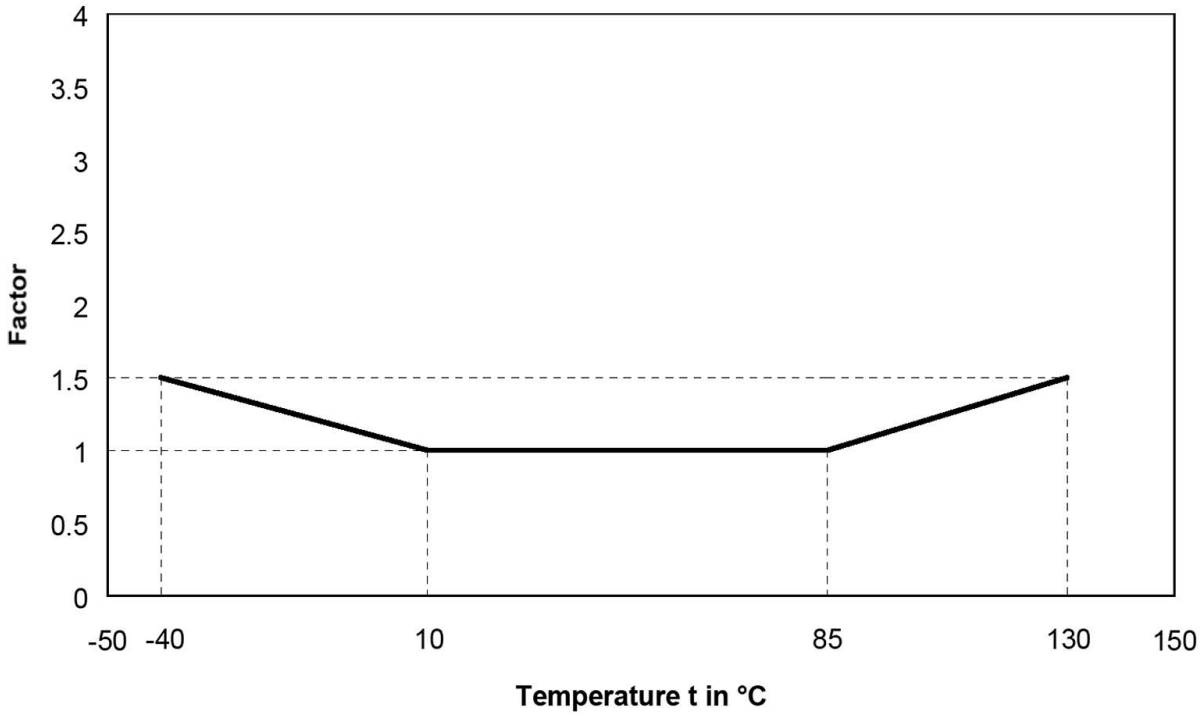



**Figure 4. Tolerance broadening as a function of temperature**

## 2.5 Maximum ratings of temperature sensor

Storage temperature: -40/130°C
Power rating at 25°C: 100 mW

## 2.6 Data of temperature sensor

Temperature range: -40/130°C
Rated voltage: Operation by series resistance 1 kΩ at 5 V in the control unit or by constant current ≤ 1 mA for measuring purposes
Nominal resistance at 20 °C: 2.5 kΩ ± 5 %
Temperature response time $\tau_{63}$ in air, v = 6 m/s: ≤ 10 s

## 2.7 Characteristic of temperature sensor

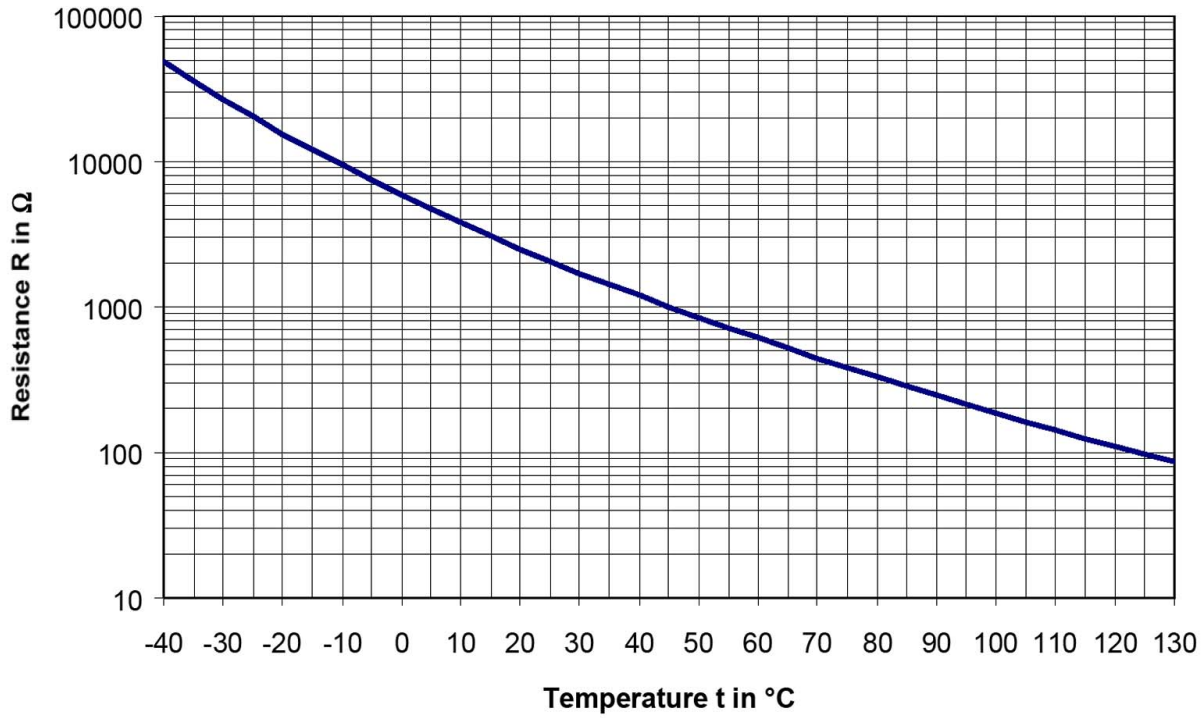



**Figure 5. Characteristic R= f(t)**

Resistance with measuring current ≤ 1 mA and after assimilation time ≥ 10 min: [3]

| Temperature | Resistance R in Ω | | | Tolerance | |
|---|---|---|---|---|---|
| in °C | minimum | nominal | maximum | in % | in K |
| -40 | 45301 | 48153 | 51006 | ± 5.92 | ± 0.98 |
| -35 | 33703 | 35763 | 37823 | ± 5.76 | ± 0.99 |
| -30 | 25350 | 26854 | 28359 | ± 5.60 | ± 1.00 |
| -25 | 19265 | 20376 | 21487 | ± 5.45 | ± 1.01 |
| -20 | 14785 | 15614 | 16443 | ± 5.31 | ± 1.02 |
| -15 | 11453 | 12078 | 12702 | ± 5.17 | ± 1.02 |
| -10 | 8951 | 9426 | 9901 | ± 5.04 | ± 1.03 |
| -5 | 7055 | 7419 | 7783 | ± 4.91 | ± 1.04 |
| 0 | 5605 | 5887 | 6168 | ± 4.78 | ± 1.05 |
| 5 | 4487 | 4707 | 4926 | ± 4.66 | ± 1.06 |
| 10 | 3618.7 | 3791.1 | 3963.5 | ± 4.55 | ± 1.07 |
| 15 | 2938.5 | 3074.9 | 3211.3 | ± 4.44 | ± 1.08 |
| 20 | 2401.9 | 2510.6 | 2619.3 | ± 4.33 | ± 1.08 |
| 25 | 1975.8 | 2062.9 | 2150.1 | ± 4.22 | ± 1.09 |
| 30 | 1644.7 | 1715.4 | 1786.2 | ± 4.12 | ± 1.10 |
| 35 | 1374.2 | 1431.8 | 1489.5 | ± 4.03 | ± 1.11 |
| 40 | 1152.4 | 1199.6 | 1246.7 | ± 3.93 | ± 1.12 |
| 45 | 969.9 | 1008.6 | 1047.4 | ± 3.84 | ± 1.12 |
| 50 | 819.1 | 851.1 | 883.0 | ± 3.75 | ± 1.13 |
| 55 | 694.2 | 720.7 | 747.1 | ± 3.67 | ± 1.14 |
| 60 | 590.3 | 612.3 | 634.2 | ± 3.58 | ± 1.14 |
| 65 | 503.6 | 521.9 | 540.2 | ± 3.50 | ± 1.15 |
| 70 | 431.0 | 446.3 | 461.6 | ± 3.43 | ± 1.15 |
| 75 | 370.1 | 382.89 | 395.7 | ± 3.35 | ± 1.16 |
| 80 | 318.68 | 329.48 | 340.27 | ± 3.28 | ± 1.17 |
| 85 | 275.25 | 284.37 | 293.48 | ± 3.20 | ± 1.17 |
| 90 | 238.43 | 246.15 | 253.86 | ± 3.13 | ± 1.18 |
| 95 | 207.12 | 213.67 | 220.23 | ± 3.07 | ± 1.18 |
| 100 | 180.42 | 186.00 | 191.58 | ± 3.00 | ± 1.19 |
| 105 | 157.37 | 162.35 | 167.32 | ± 3.06 | ± 1.24 |
| 110 | 137.63 | 142.08 | 146.52 | ± 3.13 | ± 1.30 |
| 115 | 120.68 | 124.66 | 128.63 | ± 3.19 | ± 1.36 |
| 120 | 106.09 | 109.65 | 113.21 | ± 3.25 | ± 1.42 |
| 125 | 93.48 | 96.68 | 99.88 | ± 3.31 | ± 1.48 |
| 130 | 82.58 | 85.45 | 88.32 | ± 3.36 | ± 1.54 |

**Table 1. R(t)-table**

# 3. Functional test

## 3.1 Pressure sensor

Ambient temperature: (23 ± 5) °C

Supply voltage: $U_S$= (5.000 ± 0.250) V
If the supply voltage $U_S$ differs from the nominal value 5.000 V, the measured output voltage $U_{out}$ must be converted to the nominal value with factor 5.000 V/$U_S$.

Output voltage at: $p_{abs}$ = 50.0 kPa: $U_{out}$ = (0.855 ± 0.052) V [5]
$p_{abs}$ = 250.0 kPa: $U_{out}$ = (3.891 ± 0.052) V

Leakage: Test pressure: Δp = (25.0 ± 5.0) kPa
Leakage rate: < 20 ml/min

Electromagnetic compatibility:

a. Interference pick-up in accordance with ISO 11452-5: [5]
Test specimen with electrical connection, hereof 1.5 m cable under the stripline.
Voltage supply and output signal are led through filters.
Effective field strength in the frequency range 1 to 400 MHz: 100 V/m
Maximum deviation by the interference pick-up: ± 0.150 V

b. Test pulses a) -60 V and b) 40 V in accordance with ISO 7637-3: [5]
Input of the control unit simulated by RC network (21.5 kΩ, 100 nF).
Maximum deviation by pulse test: ± 0.150 V

## 3.2 Temperature sensor

Values of NTC-resistor at 20°C and 85°C according to section 2.7 table 1.

# 4. Endurance tests

The tests will depend upon the mechanical and climatic stresses applicable to the engine compartment. Experience has shown that these cover the requirements expected during the vehicles life cycle. For critical requirements the conditions have to be investigated by vehicle measurements.

New parts must be used for each test.

Assessment:
After the tests have been conducted, the output voltage of the pressure sensor must be within the limits given in section 3.1. The characteristic of the temperature sensor may exceed the test limits according to section 3.2 by at most 5 %.

## 4.1 Temperature cycling

500 temperature shocks between -40°C and +130°C.
Dwell time at the final temperatures 1 h in each case.
No electrical operation.

## 4.2 High-temperature storage

100 h of storage at 130°C.
No electrical operation.

## 4.3 Functional endurance run

Electrical operation.
Ambient temperature: (110 ± 5) °C
Pressure cycling: $p_{min.}$ = 20 kPa to $p_{max.}$ = 300 kPa, frequency approx. 0.5 Hz
Duration: $2 \cdot 10^6$ pressure cycles

## 4.4 Vibration

Electrical operation at standard electrical interface.
Sine vibration, wideband random vibration and temperature cycles superposed
(Sine on random in accordance with FAKRA standard proposal revision 07/99):
a) Sine vibration, sweep rate: 1 octave/min; logarithmic
- amplitude of shifting from 100 Hz to 200 Hz: 0.177 mm
- amplitude of acceleration at 200 Hz: 280 $m/s^2$
- amplitude of acceleration at 220 Hz: 280 $m/s^2$
- amplitude of acceleration at 240 Hz: 160 $m/s^2$
- amplitude of acceleration at 320 Hz: 160 $m/s^2$
- amplitude of acceleration at 340 Hz: 125 $m/s^2$
- amplitude of acceleration at 440 Hz: 125 $m/s^2$

b) Wideband random vibration, effective acceleration $a_{rms}$(10 – 1500 Hz):120 $m/s^2$
- acceleration density at 10 Hz: 10.00 $(m/s^2)^2/Hz$
- acceleration density at 100 Hz: 10.00 $(m/s^2)^2/Hz$
- acceleration density at 300 Hz: 0.51 $(m/s^2)^2/Hz$
- acceleration density at 500 Hz: 12.08 $(m/s^2)^2/Hz$
- acceleration density at 1500 Hz: 12.08 $(m/s^2)^2/Hz$

c) Temperature cycle
- ramp to -40°C within 1 h
- dwell time at -40°C: 1.5 h
- ramp to 90°C within 2.5 h
- dwell time at 90°C: 1 h
- ramp to 25°C in 2 h

Duration of stressing per principle axis: 22 h
Total duration in 3 axis: 66 h

## 4.5 Humidity cycle

Pressure port open.
Fit the connector to standard electrical interface.
Electrical operation under daytime tropical conditions.
Humidity cycling test: 21 cycles in accordance with FW24 DIN 50 016

## 4.6 Salt spray

Test specimens mounted on carrier as in the vehicle.
Close off the pressure port.
Fit the connector to standard electrical interface.
No electrical operation.
Salt spray test: 144 h in accordance with DIN 50 021 - SS
Assessment: Characteristic, see above; surface may not become cracked.

### 4.7 Resistance to vehicle climate

Follow-up test with the same test specimens:

1. Pressure port open.
   No electrical operation.
   Test specimens approximately 200 mm away from the fuel surface in the heatable test tank. Test fuel: unleaded premium-grade gasoline.
   Test cycle: Heating in 3 h from room temperature to (70 ± 3) °C
   Test 5 h at (70 ± 3) °C
   Cooling in 16 h (70 ± 3) °C to room temperature
   Duration: 4 cycles
2. Close off the pressure port.
   Fit the connector to standard electrical interface.
   No electrical operation.
   Test cycle: wet with diesel fuel for 5 s, 24 h storage at +80°C
   Duration: 4 cycles
3. Test cycle: wet with engine oil (SAE10W40) for 5 s, 24 h storage at +80°C
   Duration: 4 cycles
4. Test cycle: 1 h storage at +80°C, wet for 5 s with cold cleaning agent (P3 of Henkel)
   Duration: 4 cycles
5. Splashwater test in accordance with DIN 40 050, part 9
   Degree of protection IP X4K

Assessment: Characteristic, see above; surface may not become cracked.

## 5. Maximum Storage Time

[6]

Maximum Storage Time: 3 years
Storage Temperature: 0°C / 40°C
Relative Humidity: 40% - 60%
Short-term exceeding of storage conditions are possible ( see maximum ratings).
Sensor protected against external effect (i.e. precipitation, vapour).
After the end of maximum storage time an inspection of the sensor at manufacturer with costs by the customer is required.

## 6. Evaluation of field returns

Complaint products are judged as good if the following characteristics are fulfilled: [6]

- For zero km complaints: Functional test according to chapter 3.1 and 3.2
- For field return: Same Functional check as for 0-km parts, however assessment of characteristic according to the tolerance defined for endurance tests, see chapter 4.

If no concurrence with cause of complaint is found, further common actions may be defined in order to reproduce customer results.