Pressure sensors

AEA xx.xx C32/2 F04 G08 N

Series/Type: Absolute pressure sensor die for wet media
Ordering code:
Date: 2017-12-04
Version: 5

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EPCOS AG is a TDK Group Company.
Applications

- Medical devices
- Automotive
- Automation

Features

- Piezoresistive MEMS technology
- Small dimensions: $1.65 \times 1.65$ mm
- Square diaphragm
- Reference pressure chamber on topside
- Measured media (back side):
  - Non-aggressive gases and fluids.
    - Unsuitable for substances which react with glass or silicon.
- Whetstone bridge with mV output, ratiometric to supply voltage
- Rated pressure ranges 1.6 up to 25 bar
- Outstanding long-term stability

Delivery mode

- Tape, Tray

Dimensional drawings
Technical data

Absolute maximum ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum supply voltage</td>
<td>(V_{DD})</td>
<td>Without damage (^1)</td>
<td></td>
<td></td>
<td>10</td>
<td>V</td>
</tr>
<tr>
<td>Temperature ranges</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>(T_a)</td>
<td>(^2)</td>
<td>-40</td>
<td>135</td>
<td>140</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For (t &lt; 15) min</td>
<td>-40</td>
<td></td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>(T_{st})</td>
<td>(^3)</td>
<td>-40</td>
<td>150</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Pressure ranges</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating pressure range</td>
<td>(p_r)</td>
<td>Absolute pressure (^4)</td>
<td>1.6</td>
<td>25</td>
<td>25</td>
<td>bar</td>
</tr>
<tr>
<td>Over pressure</td>
<td>(p_{ov})</td>
<td>Absolute pressure (^5)</td>
<td>2.5</td>
<td>5</td>
<td></td>
<td>(p_r)</td>
</tr>
<tr>
<td>Burst pressure</td>
<td>(p_{burst})</td>
<td>Absolute pressure (^6)</td>
<td>3</td>
<td>10</td>
<td></td>
<td>(p_r)</td>
</tr>
</tbody>
</table>

Electrical specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrostatic discharge</td>
<td></td>
<td>(HBM (AEC-Q100-002-REV-D))</td>
<td>1000</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Supply voltage / bridge resistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating supply voltage</td>
<td>(V_{DD})</td>
<td>(^7)</td>
<td>1.0</td>
<td>5.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Total bridge resistance</td>
<td>(R_s)</td>
<td>@ 25 °C (^8)</td>
<td>2.6</td>
<td>4.0</td>
<td></td>
<td>kΩ</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>(\alpha_{R_s})</td>
<td>at 25 °C (^9)</td>
<td>2.0</td>
<td>2.7</td>
<td></td>
<td>(10^{-3}/K)</td>
</tr>
<tr>
<td>of total bridge resistance</td>
<td>(\beta_{R_s})</td>
<td>@ 25 °C (^9)</td>
<td>0</td>
<td>8</td>
<td></td>
<td>(10^{-6}/K^2)</td>
</tr>
<tr>
<td>Output signal @ (V_{DD} = 5) V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offset</td>
<td>(V_o)</td>
<td>@ 25 °C (^10)</td>
<td>See next table</td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>(S)</td>
<td>@ 25 °C (^13)</td>
<td>See next table</td>
<td>mV/bar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>(\alpha_{T_{Vo+}})</td>
<td>Unglued (^11)</td>
<td>See next table</td>
<td>µV/V/K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of offset</td>
<td>(\alpha_{T_{Vo-}})</td>
<td></td>
<td>See next table</td>
<td>µV/K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>(\alpha_{S})</td>
<td>@ 25 °C (^15)</td>
<td>-2.5</td>
<td>-2.2</td>
<td>-1.9</td>
<td>(10^{3}/K)</td>
</tr>
<tr>
<td>of the sensitivity</td>
<td>(\beta_{S})</td>
<td></td>
<td>0</td>
<td>5</td>
<td>8</td>
<td>(10^{6}/K^2)</td>
</tr>
<tr>
<td>Pressure hysteresis</td>
<td>(p_{Hys})</td>
<td>(^{16})</td>
<td>-0.1</td>
<td></td>
<td>0.1</td>
<td>% FS (^{12})</td>
</tr>
<tr>
<td>Long-term stability (Full scale normal output FSON = 120 mV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature hysteresis of offset</td>
<td>(THV_{0})</td>
<td>(^{17})</td>
<td>-0.2</td>
<td>(\pm 0.1)</td>
<td>0.2</td>
<td>% FSON</td>
</tr>
<tr>
<td>Temperature cycle drift of offset</td>
<td>(TCDV_{0})</td>
<td>(^{17})</td>
<td>-0.1</td>
<td>(\pm 0.05)</td>
<td>0.1</td>
<td>% FSON</td>
</tr>
<tr>
<td>High temperature drift of offset</td>
<td>(HTDV_{0})</td>
<td>(^{17})</td>
<td>-0.25</td>
<td>(\pm 0.05)</td>
<td>0.25</td>
<td>% FSON</td>
</tr>
<tr>
<td>Long term stability of offset</td>
<td>(LT_{SV_{0}})</td>
<td>(^{17})</td>
<td>-0.3</td>
<td>(\pm 0.1)</td>
<td>0.3</td>
<td>% FSON</td>
</tr>
</tbody>
</table>
**Operating pressures and ordering codes**

<table>
<thead>
<tr>
<th>Parameter @ 25 °C, $V_{DD} = 5$ V</th>
<th>Symbol</th>
<th>Typ.</th>
<th>Typ.</th>
<th>Typ.</th>
<th>Typ.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating pressure 6)</td>
<td>$p_1$</td>
<td>1.6</td>
<td>4</td>
<td>10</td>
<td>25</td>
<td>bar</td>
</tr>
<tr>
<td>Offset voltage 10) [min/typ/max]</td>
<td>$V_0$</td>
<td>$-50/-15/25$</td>
<td>$-40/-5/25$</td>
<td>$-35/-3/25$</td>
<td>$-30/0/25$</td>
<td>mV</td>
</tr>
<tr>
<td>Temperature coefficient of offset voltage (unglued) 11) [min/typ/max]</td>
<td>$TCV_0^-$</td>
<td>$-27/-15/-5$</td>
<td>$-18/-9/-1$</td>
<td>$-13/-6/2$</td>
<td>$-13/-5/2$</td>
<td>$\mu$V/V/K</td>
</tr>
<tr>
<td></td>
<td>$TCV_0^+$</td>
<td>$-14/-6/1$</td>
<td>$-9/-3/2$</td>
<td>$-7/-2/3$</td>
<td>$-7/-1/3$</td>
<td>$\mu$V/V/K</td>
</tr>
<tr>
<td>Sensitivity 13) [min/typ/max]</td>
<td>$S$</td>
<td>$45/70/95$</td>
<td>$23/30/38$</td>
<td>$9/12/15$</td>
<td>$3.6/4.8/6$</td>
<td>mV/bar</td>
</tr>
<tr>
<td>Nonlinearity 14) [typ/max]</td>
<td>$L$</td>
<td>$\pm0.2/\pm0.3$</td>
<td>$\pm0.2/\pm0.3$</td>
<td>$\pm0.2/\pm0.3$</td>
<td>$\pm0.2/\pm0.3$</td>
<td>% FS 12)</td>
</tr>
<tr>
<td>Burst pressure 6) [min]</td>
<td>$p_{\text{burst}}$</td>
<td>4.8</td>
<td>12</td>
<td>30</td>
<td>75</td>
<td>bar</td>
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</table>

**Product type**

<table>
<thead>
<tr>
<th></th>
<th>AEA 1.600 C32/2 F04 G08 N</th>
<th>AEA 4.000 C32/2 F04 G08 N</th>
<th>AEA 10.00 C32/2 F04 G08 N</th>
<th>AEA 25.00 C32/2 F04 G08 N</th>
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<td>Ordering code Delivery form on tape</td>
<td>B5860E5224B604</td>
<td>B5860E5223B604</td>
<td>B5860E5221B604</td>
<td>B5860E5226B604</td>
</tr>
</tbody>
</table>

**Ordering code Delivery in tray**

|                          | B5860H840A037 | B5860H840A039 | B5860H840A038 | B5860H840A040 |

Other operating pressures upon request.
Symbols and Terms

1) Maximum power supply $V_{DD}$
   This is the maximal allowed voltage, which may be applied to the piezoresistive bridge circuit without damage.

2) Operating temperature range $T_a$
   This is the operating Temperature range $T_{a,\min}$ to $T_{a,\max}$. Because most of the sensor parameters depend on assembling conditions like gluing, wire bonding etc., the die has to be tested over the operating temperature range by the customer fully assembled. For design verification and process control samples, mounted in AK transducer package (AK2 series) are tested over the temperature range of $T_{\min}$ to $T_{\max}$.

3) Storage temperature range $T_{st}$
   If the pressure sensor dies are stored in the temperature range $T_{st,\min}$ to $T_{st,\max}$ without applied voltage power supply, this will not affect the performance of the pressure sensor dies.

4) Operating pressure range $p_r$
   In the operating pressure range 0 to $p_{r,\max}$ the pressure sensor die output characteristic is as defined in this specification.

5) Over pressure $p_{ov}$
   Pressure cycles in the pressure range 0 to $p_{ov}$ do not affect the performance of the pressure sensor dies.

6) Burst pressure $p_{burst}$
   Up to the burst pressure $p_{burst}$ the diaphragm of the sensor die will not be destroyed mechanically. This parameter is tested at room temperature on samples mounted on an aluminium socket by applying the specified burst pressure for 30 seconds. The evaluation of this test is done by optical inspection of the diaphragm. However the maximum value of the burst pressure is limited to 90 bar due to the stability of the bonding between bulk and backside glass.

7) Operating power supply $V_{DD}$
   The pressure sensor parameters are defined for a power supply voltage of $V_{DD} = 5$ V. In the operating power supply voltage range $V_{DD,\min}$ to $V_{DD,\max}$ the ratiometric parameters $r(V_{DD})$ like sensitivity, offset voltage and the temperature coefficient of the offset voltage are defined by:

$$r(V_{DD}) = r(5[V]) \frac{V_{DD}}{5[V]}$$

8) Total bridge resistance $R_b$
   The total bridge resistance is defined between pad X5 and X2, (see the dimensional drawing in this data sheet) of the closed piezoresistive bridge circuit. The total bridge resistance is in a good approximation the output impedance of the piezoresistive bridge circuit. This parameter is tested completely on a wafer (wafer level test measurement).

9) Temperature coefficients of resistance $\alpha_{rb}$ and $\beta_{rb}$:
   The temperature coefficients of resistance are tested for design verification on samples, mounted on AK transducer package (AK2 series) over the temperature range $T_{\min}$ to $T_{\max}$ with $T_R = 25 \, ^\circ C$.
   The temperature coefficients of first and second order are defined with the polynomial:

$$R_b(T) = R_b(T = 25 ^\circ C)[1 + \alpha_{rb}(T - 25 ^\circ C) + \beta_{rb}(T - 25 ^\circ C)^2]$$

The coefficients $\alpha_{rb}$ and $\beta_{rb}$ are calculated using the three measurement points of $R_b(T)$ at $T_{\text{meas, min}}$, $T_R$ and $T_{\text{meas, max}}$.

10) Offset voltage $V_O$
   The offset voltage $V_O$ is the output voltage $V_{out}(p = 0 \text{ bar absolute})$ at zero absolute pressure and for a bridge voltage power supply $V_{DD} = 5$ V. The high range of the allowed offset voltage is due to the reference pressure in the glass cap from 0 to 0.3 bar and to the tolerance of the sensitivity. The typical value of the reference pressure is 0.2 bar.
   Before anodic glass bonding the offset voltage is tested completely on a wafer (wafer level test measurement) with limits $-25 \text{ mV} < V_O < 25 \text{ mV}$. For design verification $V_O$ is measured on samples, mounted in AK transducer package (AK2 series) by extrapolating the output characteristic to zero bar.
   It should be noted that this parameter may be influenced by assembly. This parameter has to be verified by the customer with his assembling possibilities.

11) Temperature coefficients of offset voltage $TCV_O$
   The temperature coefficients of offset voltage are defined for a bridge voltage power supply $V_{DD} = 5$ V. These parameters strongly depend on assembly conditions like gluing, wire bonding etc.
   The temperature coefficients of offset voltage are tested for design verification on samples, mounted on AK transducer package (AK2 series) over the temperature range $T_{\min}$ to $T_{\max}$.
   Therefore $TCV_O$, and $TCV_O$ are defined for the measurement temperature range by:
Pressure sensors

Important notes

Please read Cautions and warnings and Important notes at the end of this document.

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Cautions and warnings

Storage (general)
All pressure sensors should be stored in their original packaging. They should not be placed in harmful environments such as corrosive gases nor exposed to heat or direct sunlight, which may cause deformations. Similar effects may result from extreme storage temperatures and climatic conditions. Avoid storing the sensor dies in an environment where condensation may form or in a location exposed to corrosive gases, which will adversely affect their performance. Plastic materials should not be used for wrapping/packing when storing or transporting these dies, as they may become charged. Pressure sensor dies should be used soon after opening their seal and packaging.

Operation (general)
Media compatibility with the pressure sensors must be ensured to prevent their failure. The use of other media can cause damage and malfunction. Never use pressure sensors in atmospheres containing explosive liquids or gases. Ensure pressure equalization to the environment, if gauge pressure sensors are used. Avoid operating the pressure sensors in an environment where condensation may form or in a location exposed to corrosive gases. These environments adversely affect their performance. If the operating pressure is above the rated overpressure range, it may change the output characteristics. This may also happen with pressure sensor dies if an incorrect mounting method is used. Be sure that the applicable pressure does not exceed the overpressure, as it may damage the pressure sensor.

Do not exceed the maximum rated supply voltage nor the rated storage temperature range, as it may damage the pressure sensor.

Temperature variations in both the ambient conditions and the media (liquid or gas) can affect the accuracy of the output signal from the pressure sensors. Be sure to check the operating temperature range and thermal error specification of the pressure sensors to determine their suitability for the application.

Connections must be wired in accordance with the terminal assignment specified in the data sheets. Care should be taken as reversed pin connections can damage the pressure transmitters or degrade their performance. Contact between the pressure sensor terminals and metals or other materials may cause errors in the output characteristics.

Design notes (dies)
This specification describes the mechanical, electrical and physical requirements of a piezoresistive sensor die for measuring pressure. The specified parameters are valid for the pressure sensor die with pressure application either to the front or back side of the diaphragm as described in the data sheet. Pressure application to the other side may result in differing data. Most of the parameters are influenced by assembly conditions. Hence these parameters and the reliability have to be specified for each specific application and tested over its temperature range by the customer.

Handling/Mounting (dies)
Pressure sensor dies should be handled appropriately and not be touched with bare hands. They should only be picked up manually by the sides using tweezers. Their top surface should never be touched with tweezers. Latex gloves should not be used for handling them, as this will inhibit the curing of the adhesive used to bond the die to the carrier. When handling, be careful to avoid cuts caused by the sharp-edged terminals. The sensor die must not be contaminated during manufacturing processes (gluing, soldering, silk-screen process).

The package of pressure sensor dies should not be opened until the die is mounted and should be closed after use. The sensor die must not be cleaned. The sensor die must not be damaged during the assembly process (especially scratches on the diaphragm).
Storage conditions
Used materials for storage should be ESD protective according JESD625, non-outgassing, and chemically stable.
Furthermore the following storage conditions should be preserved:

1. Storage in cabinets (if shipment package is opened):
   a. Atmosphere: inert gas, dry air or dry nitrogen
   b. Temperature range (in cabinet): 20 ± 3 °C
   c. Relative humidity range (in cabinet): < 40 %
   d. Particle count (in cabinet): Class 6 per ISO 14644:1999 (equivalent FED STD 209E Class 1000)
   e. Shelf life under these conditions: 24 months for deliveries in trays
   f. Shelf life under these conditions: 12 months for deliveries on tape

2. Storage in containers (if shipment package is sealed):
   a. Sealed as delivered or backfilled with inert gas, dry air or dry nitrogen and re-sealed
   b. Temperature range: 20 ± 3 °C
   c. Relative humidity range: < 50 %
   d. Particle count (during backfill): Class 6 per ISO 14644:1999 (equivalent FED STD 209E Class 1000)
   e. Shelf life under these conditions: 12 months for deliveries in trays
   f. Shelf life under these conditions: 6 months for deliveries on tape

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3. The warnings, cautions and product-specific notes must be observed.

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