EPCOS Product Brief 2018

Miniaturized Pressure Sensor Dies

C33 and C39 for Automotive, Industrial and Consumer Applications

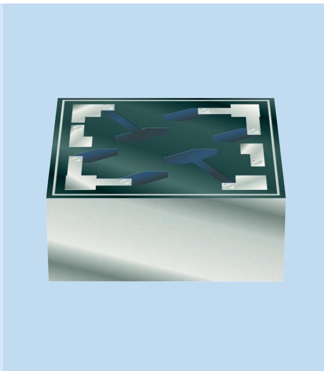
The C33/C39 pressure dies with their small footprint of 1 × 1 mm or even 0.65 × 0.65 mm fulfill requirements of various automotive, industrial and consumer applications.

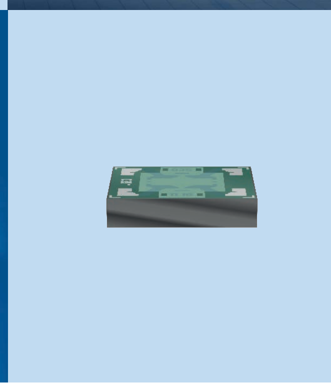
Their flat bulk silicon designs facilitate tight packaging requirements.

The dies are available in absolute sensing and with bond pads on all four sides. Its robust design ensures high signal stability over lifetime.

Features

- Piezoresistive MEMS technology
- Rated pressure ranges of 1.2 to 10 bar
- Bulk silicon design
- Automotive validation (acc. to AECQ-101)
- Wheatstone bridge with mV output, ratiometric to supply voltage
- Outstanding high long-term stability
- Absolute measurement



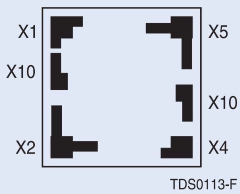


Pressure Sensor Dies
C33 Series

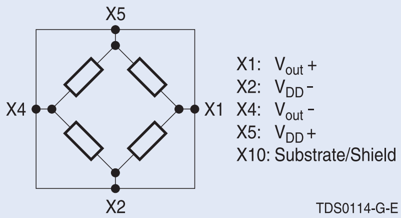
Characteristics

- Pressure measurement: absolute
- Operating pressure: 1 to 10 bar
- Size: 1 × 1 × 0.4 mm^3
- High signal stability
- Outstanding long-term stability
- Measured media: dry non-aggressive gases and fluids
- Narrow tolerance of sensitivity

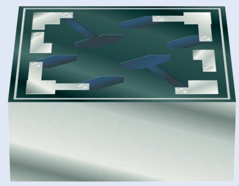
Layout



Circuit diagram



Cross-section



Technical data

	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Temperature maximum ratings						
Operating temperature	T_a	1)	–40	–	135	°C
		For t < 15 min	–40	–	140	°C
Electrical specifications						
Total bridge resistance	R_b	@ 25 °C 3)	2.6	3.3	4.0	kΩ
Temperature coefficient of total bridge resistance	α_{Rb}	@ 25 °C 4)	2.1	2.4	2.7	10^{-3}/K
	β_{Rb}		0	5.0	8.0	$10^{-6}/K^2$
Temperature coefficient of the sensitivity	α_S	@ 25 °C 5)	–2.5	–2.2	–1.9	10^{-3}/K
	β_S		0	5.0	8.0	$10^{-6}/K^2$
Pressure hysteresis	pHys	6)	–0.1	–	0.1	% FS
Long-term stability of offset	$LTSV_0$	7)	–0.35	0.15	0.35	% FSON

Rated pressure @ 25 °C, V_{DD} = 5 V

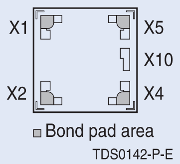
Ordering codes	Operating pressure p_r 2) bar		Nonlinearity L 8) % FS (typ./ max.)		Sensitivity S 9) mV/V/bar
B58600E3314B518	1.2		±0.2/ ±0.4		12/16/20
B58600E3344B090	2.5	4.0	±0.1/ ±0.2	±0.15/ ±0.3	8/10/12
B58600E3394B091	7.0	10.0	±0.15/ ±0.3	±0.15/ ±0.3	2.4/2/3.6

Pressure Sensor Dies
C39 Series

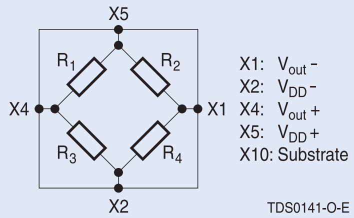
Characteristics

- Pressure measurement: absolute
- Operating pressure: 1.2 bar
- Size: 0.65 × 0.65 × 0.24 mm^3
- High signal stability
- Outstanding long-term stability
- Measured media: dry non-aggressive gases and fluids
- Narrow tolerance of sensitivity

Layout



Circuit diagram



Cross-section

Technical data

	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Temperature maximum ratings						
Operating temperature	T_a	[1]	–40	–	135	°C
		For t < 15 min	–40	–	140	°C
Electrical specifications						
Total bridge resistance	R_b	@ 25 °C [3]	4.8	5.7	7.2	kΩ
Temperature coefficient of total bridge resistance	α_{Rb}	@ 25 °C [4]	1.2	1.5	1.8	10^{-3}/K
	β_{Rb}		4.0	7.0	10.0	$10^{-6}/K^2$
Temperature coefficient of the sensitivity	α_S	@ 25 °C [5]	–1.8	–2.0	–2.4	10^{-3}/K
	β_S		0	4.0	8.0	$10^{-6}/K^2$
Pressure hysteresis	pHys	[6]	–0.1	–	0.1	% FS
Long-term stability of offset	$LTSV_0$	[7]	–0.35	±0.1	0.35	% FSON

Rated pressure @ 25 °C, V_{DD} = 5 V

Ordering codes	Operating pressure p_r [2] bar	Nonlinearity L [8] % FS (typ./ max.)	Sensitivity S [9] mV/V/bar
B58600E3914B637	1.2	±0.2/ ±0.4	12/15/18

Other operating pressures upon requests

Symbols and Terms

1) 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 on TO39 base are tested over the temperature range of T_{min} to T_{max}.

2) 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.

3) Total bridge resistance R_b
The total bridge resistance is defined between pad X5 and X2 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 100% on a wafer (wafer level test measurement).

4) Temperature coefficients of resistance α_{Rb} and β_{Rb}:
The temperature coefficients of resistance are tested for design verification on samples, mounted on a TO39 base package (AT2 series) over the temperature range T_{min} to T_{max} with T_R = 25 °C. The temperature coefficients of first and second order are defined with the polynomial:

$$R_b(T) = R_b(T = 25\ °C)\left[1 + \alpha_{Rb}(T - 25\ °C) + \beta_{Rb}(T - 25\ °C)^2\right]$$

The coefficients α_{Rb} and β_{Rb} are calculated using the three measurement points of $R_b(T)$ at $T_{meas,min}$, T_R and $T_{meas,max}$.

5) Temperature coefficients of sensitivity α_S and β_S:
These parameters may be influenced by assembly. The temperature coefficients of sensitivity are tested for design verification on samples mounted on a TO39 base package (AT2 series) over the temperature range T_{min} to T_{max} with T_R = 25 °C. The temperature coefficients of first and second order are defined with the polynomial:

$$S(T) = S(T = 25\ °C)\left[1 + \alpha_S(T - 25\ °C) + \beta_S(T - 25\ °C)^2\right]$$

The coefficients α_S and β_S are calculated using the three measurement points of S(T) at $T_{meas,min}$, T_R and $T_{meas,max}$.

6) Pressure hysteresis pHys
The pressure hysteresis is the difference between output voltages at constant pressure and constant temperature while applying a pressure cycle with pressure steps of $p_{r,min}$, p_1, p_2, p_3, $p_{r,max}$, p_3, p_2, p_1, $p_{r,min}$:

$$pHys = \frac{V_{out,2}(p_k) - V_{out,1}(p_k)}{FS}$$

With k = min, 1, 2, 3, max. The pressure steps are: $p_{r,min} = 0$, $p_1 = 0.25 \cdot p_{r,max}$, $p_2 = 0.5 \cdot p_{r,max}$, $p_3 = 0.75 \cdot p_{r,max}$, $p_{r,max}$. This parameter is tested for design verification on samples mounted on a TO39 base package (AT2 series). Since the pHys depends on several assembling conditions, this parameter has to be verified by the customer with his assembling possibilities.

7) Reliability data
For long-term stability of offset voltage $LTSV_0$ please refer to the defined TDK standard AS100001 in chapter “Reliability data” available on the internet.

8) Nonlinearity L
This parameter may be influenced by assembly. The nonlinearity is measured using the endpoint method. Assuming a characteristic, this can be approximated by a polynomial of second order, where the maximum is at $p_x = p_{r,max}/2$. The nonlinearity is defined at $p_x = p_{r,max}/2$, using the equation:

$$L = \frac{V_{out}(p_x) - V_0}{V_{out}(p_{r,max}) - V_0} - \frac{p_x}{p_{r,max}}$$

This parameter is tested for process control on samples mounted on a TO39 base.

9) Sensitivity S
The sensitivity is defined for a bridge voltage power supply V_{DD} = 5 V. It can be determined by the formula:

$$S = \frac{V_{out}(p_{r,max}) - V_0}{p_{r,max}}$$

This parameter is tested for process control on samples mounted on a TO39 base package (AT2 series).

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