



## Pressure sensors

Pressure transmitters with casing (voltage output)

**Series/Type:** CAU-T series  
**Ordering code:**  
Date: 2009-08-03  
Version: 3

### Description

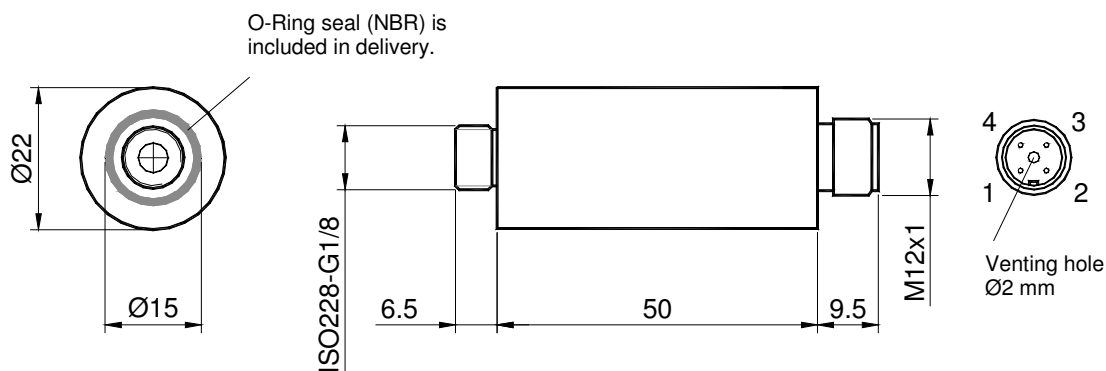
- The transmitters are based on piezoresistive silicon pressure sensors from our own clean room.
- The T-series electronic compensates nonlinearity and temperature errors and supplies a precise calibrated output signal with a high immunity against electromagnetic influences (EMI).

### Features

- Piezoresistive MEMS technology
- Measured media (absolute pressure):  
Air, non-aggressive gases (gas humidity 0 ... 85% r.h., without dew)  
Unsuitable for substances which react with glass, silicon, gold, aluminum, stainless steel, NBR, silicone glue or silicone gel.
- Measured media (gauge pressure):  
Air, non-aggressive gases (gas humidity 0 ... 100% r.h.) and non-aggressive fluids.  
Unsuitable for substances which react with glass, silicon, stainless steel, NBR, silicone glue ( $p_r \leq 10$  bar) or epoxy glue ( $p_r > 10$  bar).
- Voltage output proportional to pressure: 0.5 ... 4.5 V
- Reverse supply voltage protection
- RoHS-compatible, halogen-free
- Compact stainless steel casing (protection IP65) with G1/8" thread



### Dimensional drawings



All dimensions in mm

A shielded 4-pole cable (2 m) with a modified (pressure equalization) female M12 locking plug is included in delivery.

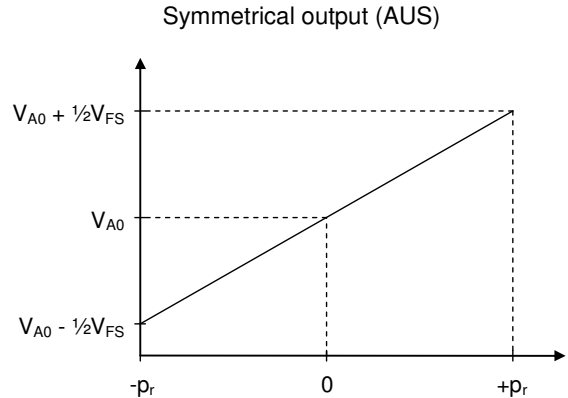
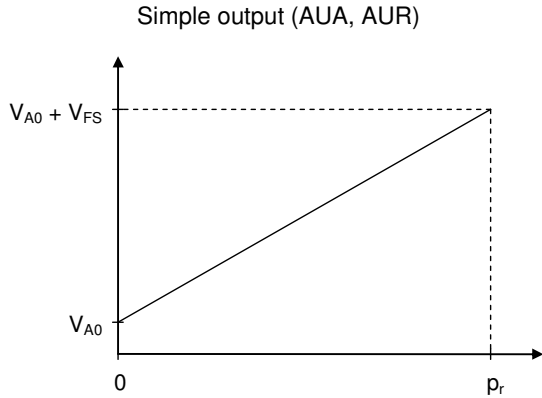
**Technical data**
**Absolute maximum ratings**

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>Temperature ranges</b>						
Storage temperature range	$T_{st}$	1)	-30		+85	°C
Operating temperature range	$T_a$	2)	-25		+85	°C
Compensated temperature range	$T_c$	3)	0		+70	°C
Soldering temperature (cable)	$T_{solder}$	<5 s (no reflow soldering)			+240	°C
<b>Pressure ranges</b>						
Overpressure	$p_{ov}$	4), 5)	1.5			$p_r$
<b>Supply voltage /-current</b>						
Supply voltage	$V_{CC}$	6)	7.5		30	V
Supply current	$I_{CC}$	$I_A = 0$			7	mA
Signal output current	$I_A$	7)			2	mA
Output signal at sensor failure	$V_{ERR}$				0.01	V
DC break down voltage	$V_{is}$	8)	500			V

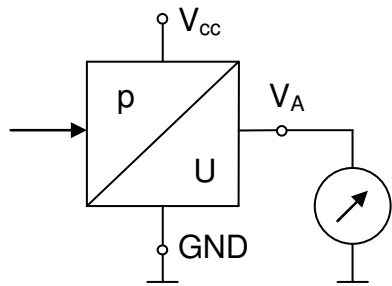
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>Output signal @ <math>T_a = 25\text{ °C}</math>, <math>V_{CC} = 15\text{ V}</math>, <math>I_A &lt; 0.1\text{ mA}</math></b>						
Offset	$V_{A0}$	Simple output AUA, AUR <sup>9)</sup>	0.485	0.5	0.515	V
		Symmetrical output AUS <sup>9)</sup>	2.485	2.5	2.515	V
Signal span (Full Scale)	$V_{FS}$	10)	3.985	4.0	4.015	V
Nonlinearity	L	Simple output <sup>10), 11)</sup>		±0.1	±0.25	% FS
		Symmetrical output <sup>10), 11)</sup>		±0.25	±0.5	% FS
Response time	$t_{10-90}$	12)		1		ms
Supply voltage rejection	SVR	10), 13)			±0.01	% FS/V

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>Data in temperature range @ <math>T_a = -25 \dots 85\text{ °C}</math>, <math>V_{CC} = 15\text{ V}</math>, <math>I_A &lt; 0.1\text{ mA}</math></b>						
Temperature hysteresis		14)		±0.1	±0.5	% FS
<b>Data in temperature range @ <math>T_a = 0 \dots 70\text{ °C}</math>, <math>V_{CC} = 15\text{ V}</math>, <math>I_A &lt; 0.1\text{ mA}</math></b>						
Temperature coefficient of offset	$TCV_{A0}$	$p_r < 0.25\text{ bar}$ <sup>15)</sup>		±0.015	±0.05	% FS/K
		$p_r \geq 0.25\text{ bar}$ <sup>15)</sup>		±0.015	±0.03	% FS/K
Temperature coefficient of span	$TCV_{FS}$	16)		±0.015	±0.03	% FS/K

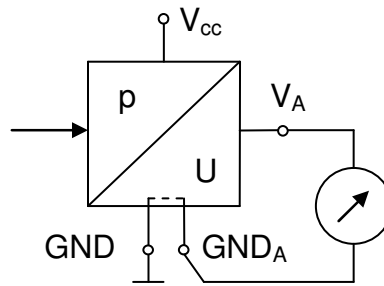
Characteristics



Connection diagram



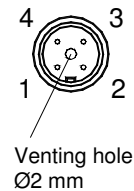
3-wire connection (standard)



4-wire connection (option for long cable)  
 GND and GND<sub>A</sub> are internally connected.  
 To avoid ground loops, it is not allowed to connect GND and GND<sub>A</sub> at the end of the cable.

Terminal assignment

Electrical connection	Symbol	Pin (color)
Supply voltage	V <sub>cc</sub>	1 (brown)
Ground	GND	3 (blue)
Output signal (referenced to GND)	V <sub>A</sub>	2 (white)
Ground (Kelvin guidance)	GND <sub>A</sub>	4 (black)





**Rated pressures and ordering codes**

Pressure measurement	Absolute		Gauge					Gauge, symmetrical			
	Rated pressure p <sub>r</sub> bar	Product type	Rated pressure p <sub>r</sub> bar	Product type	Rated pressure p <sub>r</sub> bar	Product type	Rated pressure p <sub>r</sub> bar	Product type	Rated pressure p <sub>r</sub> bar	Product type	
	1.000	AUA 1.000 F V4 TN H S2.0	0.100	AUR 0.100 F V4 TN H S2.0	0.100	AUS 0.100 F V4 TN H S2.0	0.250	AUR 0.250 F V4 TN H S2.0	0.250	AUS 0.250 F V4 TN H S2.0	
	2.500	AUA 2.500 F V4 TN H S2.0	0.250	AUR 0.250 F V4 TN H S2.0	0.400	AUR 0.400 F V4 TN H S2.0	0.400	AUR 0.400 F V4 TN H S2.0	0.400	AUS 0.400 F V4 TN H S2.0	
	6.000	AUA 6.000 F V4 TN H S2.0	1.000	AUR 1.000 F V4 TN H S2.0	6.000	AUR 6.000 F V4 TN H S2.0	1.000	AUR 1.000 F V4 TN H S2.0	1.000	AUS 1.000 F V4 TN H S2.0	
	10.00	AUA 10.00 F V4 TN H S2.0	2.500	AUR 2.500 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	2.500	AUR 2.500 F V4 TN H S2.0	2.500	AUS 2.500 F V4 TN H S2.0	
	25.00	AUA 25.00 F V4 TN H S2.0	6.000	AUR 6.000 F V4 TN H S2.0	25.00	AUR 25.00 F V4 TN H S2.0	6.000	AUR 6.000 F V4 TN H S2.0	6.000	AUS 6.000 F V4 TN H S2.0	
	0.100	AUR 0.100 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	25.00	AUR 25.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	0.250	AUR 0.250 F V4 TN H S2.0	25.00	AUR 25.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	25.00	AUR 25.00 F V4 TN H S2.0	25.00	AUS 25.00 F V4 TN H S2.0	
	0.400	AUR 0.400 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	1.000	AUR 1.000 F V4 TN H S2.0	25.00	AUR 25.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	2.500	AUR 2.500 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	6.000	AUR 6.000 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	25.00	AUR 25.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	0.100	AUS 0.100 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	0.250	AUS 0.250 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	0.400	AUS 0.400 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	
	1.000	AUS 1.000 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUR 10.00 F V4 TN H S2.0	10.00	AUS 10.00 F V4 TN H S2.0	

Other rated pressures upon request.

**Symbols and terms**

- 1) **Storage temperature range  $T_{st}$**   
A storage of the pressure sensor within the temperature range  $T_{st,min}$  up to  $T_{st,max}$  and without applied pressure and supply voltage will not affect the performance of the pressure sensor.
- 2) **Operating temperature range  $T_a$**   
An operation of the pressure sensor within the temperature range  $T_{a,min}$  up to  $T_{a,max}$  will not affect the performance of the pressure sensor.
- 3) **Compensated temperature range  $T_c$**   
While operating the pressure sensor within the temperature range  $T_{c,min}$  up to  $T_{c,max}$ , the deviation of the output signal from the values at 25 °C will not exceed the temperature coefficients. Out of the compensated temperature range, the deviations may increase.
- 4) **Rated pressure  $p_r$**   
Within the rated pressure range 0 up to  $p_r$  (symmetrical output:  $-p_r$  up to  $+p_r$ ) the signal output characteristic corresponds to this specification.
- 5) **Overpressure  $p_{ov}$**   
Pressure cycles within the pressure range 0 up to  $p_{ov}$  will not affect the performance of the pressure sensor.
- 6) **Supply voltage  $V_{CC}$**   
 $V_{CC,max}$  is the maximum permissible supply voltage, which can be applied without damages.  
 $V_{CC,min}$  is the minimum required supply voltage, which has to be applied for normal operation.
- 7) **Signal output current  $I_A$**   
 $I_{A,max}$  is the maximum permissible sink current of the signal output.  
Exceeding (e.g. short circuit) may cause irreparable damages.
- 8) **DC break down voltage  $V_{is}$**   
The pressure sensor withstands a high voltage between the stainless steel casing and the electrical connection  $V_{CC}$ ,  $V_A$  and GND (all short circuited) without damage.
- 9) **Offset  $V_{A0}$**   
The offset  $V_{A0}$  is the signal output  $V_A(p = 0)$  at zero pressure.
- 10) **Signal span (Full Scale)**  
Simple output:  $V_{FS} = FS = V_A(p_r) - V_{A0}$   
Symmetrical output:  $V_{FS} = FS = V_A(+p_r) - V_A(-p_r)$
- 11) **Nonlinearity L (including pressure hysteresis)**  
The nonlinearity is the deviation of the real sensor characteristic  $V_A = f(p)$  from the ideal straight line. It can be approximated by a polynomial of second order, with the maximum at  $p_x = p_r / 2$ .  
The equation to calculate the nonlinearity is:  
$$L = \frac{V_A(p_x) - V_{A0}}{V_A(p_r) - V_{A0}} - \frac{p_x}{p_r}$$
- 12) **Response time  $t_{10-90}$**   
Delay between a pressure change (10 ... 90%  $p_r$ ) and the corresponding signal output change (10 ... 90% FS).
- 13) **Supply voltage rejection SVR**  
While varying the supply voltage within the range  $V_{CC,min}$  up to  $V_{CC,max}$  at constant pressure and temperature, the signal output change will not exceed  $SVR_{max}$ .
- 14) **Temperature hysteresis**  
The temperature hysteresis is the change of offset, starting from the value at 25 °C after a temperature change and return to 25 °C. Determined during temperature cycles in operating temperature range (cycles with 1 K/min).
- 15) **Temperature coefficient of offset  $TCV_{A0}$**   
Offset at temperature  $T_x$ :  $V_{A0}(T_x) = V_{A0}(25\text{ °C}) + V_{FS}(25\text{ °C}) \cdot (T_x - 25\text{ °C}) \cdot TCV_{A0}$   
Values are valid within the compensated temperature range  $T_{c,min}$  up to  $T_{c,max}$   
Out of the compensated temperature range, the deviation may increase.
- 16) **Temperature coefficient of span  $TCV_{FS}$**   
Span at temperature  $T_x$ :  $V_{FS}(T_x) = V_{FS}(25\text{ °C}) \cdot [1 + (T_x - 25\text{ °C}) \cdot TCV_{FS}]$   
Values are valid within the compensated temperature range  $T_{c,min}$  up to  $T_{c,max}$   
Out of the compensated temperature range, the deviation may increase.

## 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 not within the rated pressure 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 to 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).

### Soldering (transducers, transmitters)

The thermal capacity of pressure sensors is normally low, so steps should be taken to minimize the effects of external heat. High temperatures may lead to damage or changes in characteristics.

A non-corrosive type of flux resin should normally be used and complete removal of the flux is recommended. Avoid rapid cooling due to dipping in solvent. Note that the output signal may change if pressure is applied to the terminals during soldering.

This listing does not claim to be complete, but merely reflects the experience of EPCOS AG.

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