Press Release

Our technology makes the difference

Quality improvement of monolithic and flush mounted piezo resistive ceramic pressure sensors through increased long term stability and moisture resistance

Korb, Germany, 2009-08-05

Through innovative measures, long term stability and moisture resistance of pressure sensors can be increased. The new improved generation of pressure sensors benefits on the one side from results of modern measurements- and calculation tools as well as through marked improvements in the screen print technology and better algorithm during the laser trimming process. Metallux AG, a leading manufacturer of piezo resistive pressure sensors was thus able to improve the quality of their pressure sensors considerably.

Current situation:

Conventional manufacturing process of piezo resistive ceramic pressure sensors

Piezo resistive pressure sensors are manufactured through a screen print process. A Wheatstone bridge is printed onto a thin membrane and burned in at 850°C. After the firing process the offset of the bridge needs to be compensated. For this resistors are integrated in the bridge, which are aligned through laser trimming.
These laser trimmed resistors are however a reason for instabilities. At the edge of the laser trims, micro cracks are forming, which under thermal- and / or mechanical stress are expanding, thereby leading to a change of the resistance value. Also the compensating resistors are integrated on the Wheatstone bridge. Even small deviations of the resistance values lead to a noticeable measurable change of the signal. Generally the compensation of the temperature alignment of the bridge (TC-0) is achieved with laser trimmed PCT resistors. Noticeable measurable instabilities are the results.

1. Objective: Long term stability to be improved significantly

Picture 1: Metallux Piezoresistive ceramic pressure sensor CPS 2184 with flush mounted membrane.

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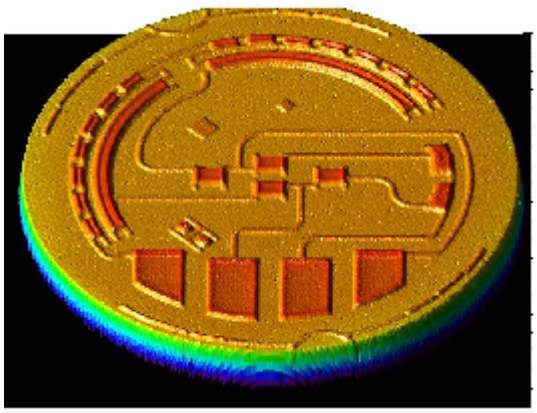
Action: redesign of layout

With the redesigned layout, resistor compensation network is no longer trimmed with long analog cuts, as generally done. The network instead consists of a digital part, which through cutting of conductive tracks resistors are switched to the bridge. Only a small rest of the bridge is compensated by a short analog trim. This results in a network which, after laser compensation, consists of untrimmed –therefore very stable- resistors and only a small part of trimmed resistors. Therefore the number of micro cracks which occur over time and contribute to instability, are significantly reduced.

Optimise space requirement

A radial alignment of the resistors coupled with a reduction of the structural width, equalises the increased space requirement of the digital/analog resistor network. The thickness of the printed layers is continuously checked by optical thickness measurements, ensuring immediate pro-active action during a change of print-parameters. This enables the optimisation of the screen print process, resulting in markedly less variation of the untrimmed offset and the temperature coefficient. As an additional benefit, the number of trim-cuts decreases significantly.



Picture 2: 3d-scan of the printed layers of a monolithic Metallux AG ceramic Sensor taken with an optical thickness measuring device.

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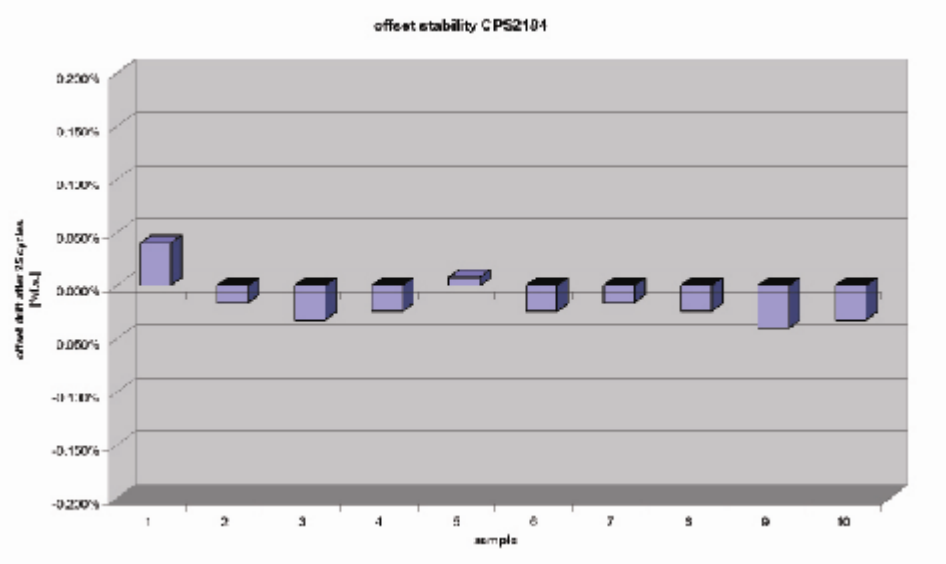
2. Objective: optimise moisture resistance

Implementation: Double layered protective coating consisting of glass and polymer

Materials used in screen printing technique (Ag, AgPd, Au, etc.) tend to migrate with existing moisture and voltage potential. Should water be released (e.g. condensation), onto the structure, high ohmic connections, can establish themselves on the printed boards. Such shortcuts are resulting in unavoidable offset shifts.
A double layered protection coating improves the moisture protection of the sensor substantially. This is made up of a dense glass layer and an additional polymer coating
By treating the glass layer before application of the polymer coating, a sealing effect of the glass layer is achieved. Thus the resulting diffusion barrier against moisture is considerable higher than the sum of moisture barrier effects of the two single layers. In combination with a lead-free, noclean solder a moisture- temperature test according to DIN EN 60068-2-30 shows only negligible chances.



Upper temperature	+ 85°C
Lower temperature	+ 5°C
Temperature gradient	2 K/ min
Time frame at temperature	60 min
Relative air humidity	85%
No. of cycles	25

Abb.3: Metallux AG Offsetstability after temperature change at 85% relative moisture

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Optimise glass solder and joining process

With flush mounted pressure sensors a thin membrane is glass-soldered to the massive ceramic main body. Adhesion of the membranes on the baseplate often presents a weak point. Many of the glass solders under thermal and / or mechanical stress tend to form cracks. The membranes remain firmly and reliably connected to the baseplate, however those tiniest cracks cause often more or less strong characteristically formed offset drifts which, especially with absolute pressure sensors are very noticeable.

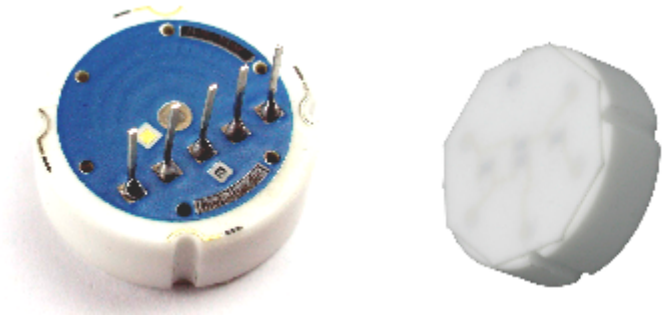

Abb. 4: Metallux CPS2184 with flush mounted membrane (front-and rear view)

Extensive investigations and series of measurements were required to determine a suitable glass solder as well as the appropriate optimal soldering parameters. Apart from the selection of the correct glass solder and an optimised temperature profile during the soldering process, also the distribution of tension on the joining area is responsible for the linearity and hysteresis. Finite-element-calculations (FEM) are ensuring to optimise the geometry of the base body especially in this area.

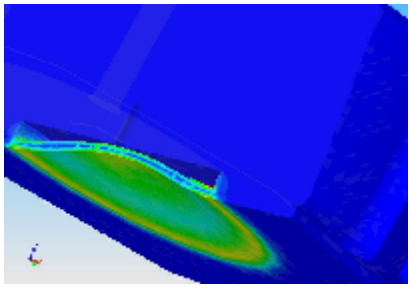

Abb.5: Metallux FEM simulation of optimising base plate geometry

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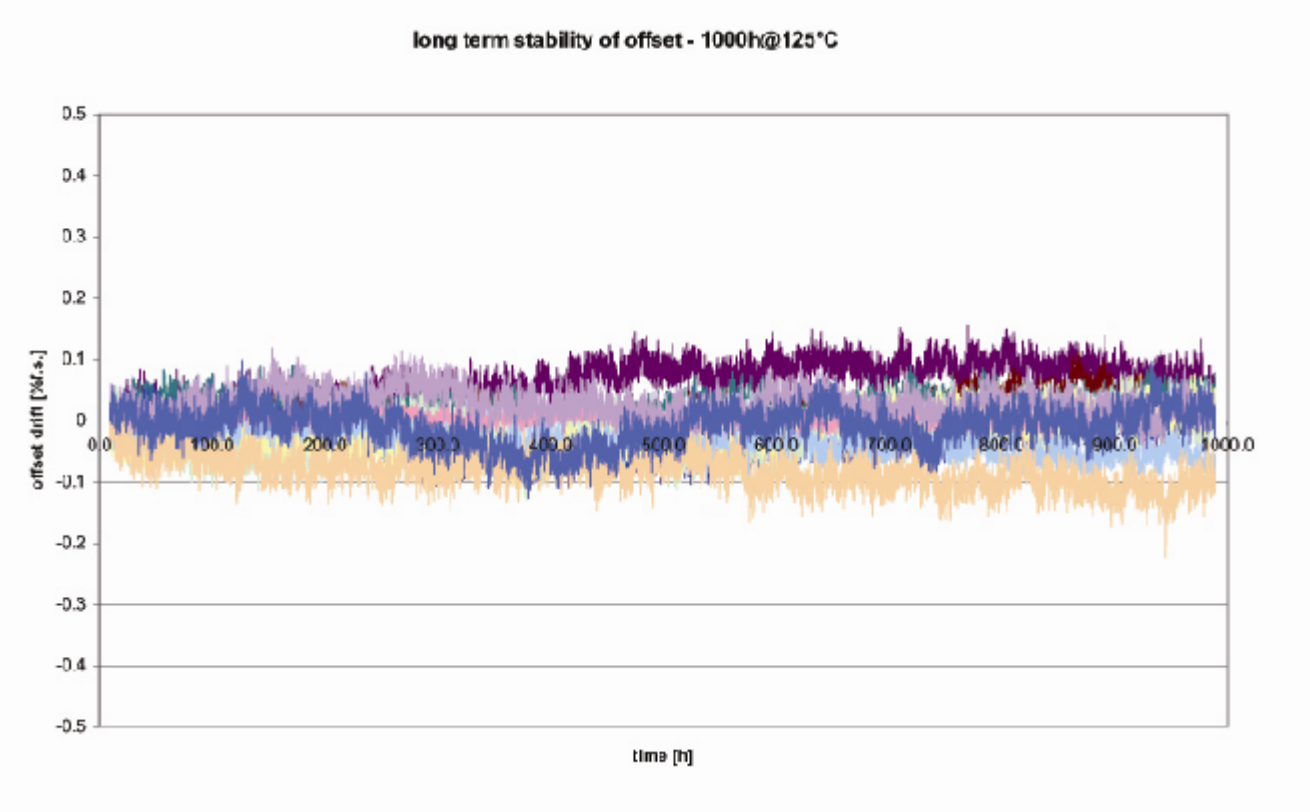
Result: quality improvement through better long term stability and moisture resistance

Extensive layout improvements reduce instabilities significantly. Well thought out sealing processes improve the moisture resistance. The sum of all described exercises together with the vast screen printing experience of our Metallux AG team members enabled us to considerably improve the quality of the new generation pressure sensors. The marginal offsetchanges during the 1.000 hr. test at 125°C underline the improved quality impressively.



Picture 6: Long term stability of the offset-signal of monolithic and flush mounted ceramic pressure sensors manufactured by Metallux AG

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About Metallux:
Metallux AG is a high-capacity manufacturer of electronic thick-film components. Metallux provides a broad spectrum of services and in addition to the standard program of pressure, position, angle and foil sensors, high-tension and power resistors also offers complete customer-specific solutions including customization of potentiometers and joysticks. Proven customer orientation providing suitable ideas and solutions ensures satisfied customers.

Innovative products and many years of experience – numerous well-known customers from the automobile industry, electrostatics, medical and industrial electronics and sensor systems have relied on the company headquartered in the vicinity of Stuttgart for more than 22 years.

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