

# Temperature



INNOVATIVE SENSOR TECHNOLOGY

# Focus on temperature and customized sensors

Temperature measurement is one of the most important physical parameters when determining quality, accuracy and reliability of processes not only in industrial use, but also in almost all human activities. Temperature sensors are produced with different technologies to fit specific application requirements.

IST AG has concentrated one part of the development and manufacturing on high-end thin-film temperature sensors. This know-how is partially derived from the semiconductor industry and allows us to manufacture sensors with high accuracy, excellent long-term stability, high reliability and repeatability within a wide temperature range from -200 °C up to 1000 °C. Because of very small dimensions and low thermal mass, the thin-film temperature sensors exhibit a very short response time.

It is no secret that customers over time require a better long-term stability with increasing accuracy in a wider and wider temperature range. Due to the excellent long-term stability of the IST AG thin film temperature sensors it is possible not only to guarantee the standard class B (DIN EN 60751; F 0,3), class A (DIN EN 60751; F 0,15) or class 1/3DIN EN 60751; F 0,1, but also even more precise accuracy classes such as 1/5 DIN or 1/10 DIN. IST AG manufactures and supplies various sensor elements in accuracies measured in class 1/5 DIN, 1/6 DIN or even 1/10DIN over a wide temperature range.

Additionally, IST AG also offers the customers a special nominal resistance at e.g. 0

°C or to measure the sensors in shifted tolerance bands such as (0 mK to 300 mK) at 0 °C instead of e.g. (-300 mK to +300 mK) at 0 °C to compensate a shift of Ohmic values during the assembly process by the customer.

The IST AG characteristic curve is based on more than 20 years of measuring experience and exactly describes the behavior of the IST AG platinum temperature sensors. With this knowledge it is possible within a specific temperature range to measure individual sensor elements and extract individual polynomial values  $R(0)$ ,  $A$  and  $B$  from a polynomial of second order of type  $R(T) = R_0 (1 + A \times T + B \times T^2)$  to achieve the highest achievable accuracy.

Furthermore, we also offer sensor elements in pairs with custom specific deviations (max.) or sensors in groups based on temperature coefficient and custom specific deviation (max.).

Every year, we manufacture more than 10 million sensors from a portfolio covering more than 4000 different products.

## The Process of CSPAB (Custom-Specific Product Approval Board)

Customer specific enquiries usually start by taking contact to one of the IST AG sales specialists. The sales specialist discusses the specific requirements and application together with the customer. Subsequently the project is discussed internally with relevant R&D engineers and submitted to the CSPAB board. The CSPAB board



1. MiniSens temperature sensor (1 mm x 1.6 mm)



2. Temperature sensor with PTFE insulated wires



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consists of IST AG production and quality engineers, developers and sales specialists contributing with specific product knowledge and expertise. The feasibility of the submitted solution and its product requirements are evaluated by the board to either approve or determine if further clarification is needed. Only when the customer is satisfied with the proposed solution, samples are produced for customer validation. When successful, IST AG will commence production and deliver the parts in a short time.

Each year more than 200 new sensor solutions, approved by the CSPA board, are manufactured and added to the portfolio based on specific customer requests and applications.

## As easy as 1 – 2 – 3: Production of a Customized Temperature Sensor

**Step 1:** The production of a customized sensor starts by deposition of a thin film metallic layer onto a ceramic substrate. This process is done in our modern clean rooms classified as ISO5 (meaning a maximum of 3520 particles per m<sup>3</sup>). During deposition, various possibilities of customization such as deposition material (Pt, Ni, Ti, Cr or Au) and substrate thicknesses (from 0.1 mm to 0.6 mm) are available.



3. Ceramic substrate

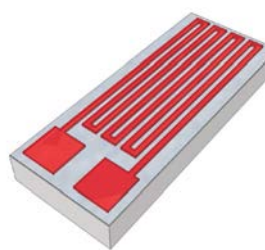


4. Ceramic substrate with thin film metallic layer

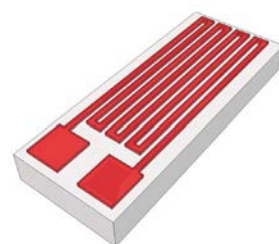
To ensure high quality and long term stable sensors wet chemical cleaning processes and high temperature annealing steps are performed after the deposition.



5. Substrate with photo-sensitive resist



6. Substrate after exposition



7. Photo-sensitive resist structured by exposition



8. Structure after removal of photo-sensitive resist

**Step 2:** The pattern of the sensor structure is defined by multiple steps. First, spin coating of a photo-sensitive resist onto the substrate. Afterwards, the photo-sensitive resist is structured by exposition. Finally, the photo resist is removed leaving only the sensor structure on the chip.

During this step, a specific mask must be chosen. The mask determines the final chip dimension, layout and the resistive structure of the sensor element. Various standard chip dimensions with different resistive values and layouts based on specific customer requests are offered by IST AG. Resistive values between 50  $\Omega$  and 100'000  $\Omega$  and multiple resistances on one chip are also possible.

Afterwards, screen printing is applied to the sensor pads to increase the strength between the pads and wires significantly improving vibration and thermal cycling robustness. The resistive structure of each sensor element is individually laser-

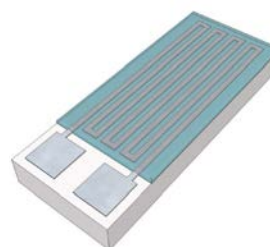


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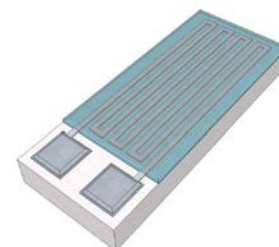
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trimmed to achieve the required resistive accuracy. As a final process step in the clean room an additional passivation layer is screen printed onto the element for further mechanical and chemical protection.

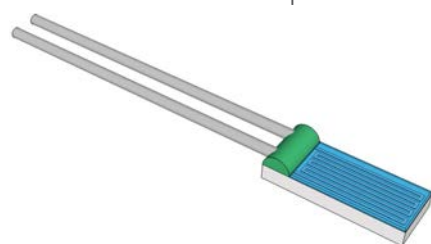
**Step 3:** Reading the resistance values requires contact with the element. For SMD and Flip-Chip sensor elements, LMP or HMP solder are directly deposited on contact pads instead of wires. Specific contact layers for bonding are also part of the IST AG portfolio. For wired sensor elements different configurations are welded directly on the chip on automated welding machines. IST AG offers a wide range of wire material e.g. Ag, Ni, Cu, Pt, Pt/Ni, Cu, Au/Ni, Ag/Cu etc. configured as both single core and stranded wire. In many applications insulation of the wires is required and IST AG is capable of directly welding insulated wires on the sensor element. When direct welding is not an option, extension of the lead wires with brazing or laser welding is offered. The length and diameter of the wire are customizable as well as the design of the wire configuration e.g. standard, inverted or perpendicular welding. Furthermore, configurations with 3 or 4 wires in various colors are also possible.



9. Sensor with passivation layer



10. Sensor with passivation layer and strengthened pads



11. Sensor with welded wires and welding area covered with fixation paste to increase robustness

After welding the contact area is covered with fixation paste to increase robustness. Furthermore, aging and thermal cycling the sensor elements are now ready for visual and electrical quality inspection before shipping.

A very sought after option is our metalized back side feature. This allows our customers to achieve excellent thermal coupling by soldering directly to a metal surface or cap (Cu, stainless steel, titanium etc.). Further options could be sensor elements inserted in round ceramic cases, injection molded housings, fitting of connectors onto wires and sensor elements assembled in stainless steel probes.

Due to the outstanding accuracy and stability, our temperature sensors are used in all volumes – small and large – in industries ranging from heating-ventilation, medical, process control over aerospace and satellite applications (see insight article). With the excellent accuracy and stability of our sensors, the flexibility in our production and competence of our employees, the IST AG sensors, whether it is a standard or a customized solution, offer the optimal price to performance ratio with a short production time.

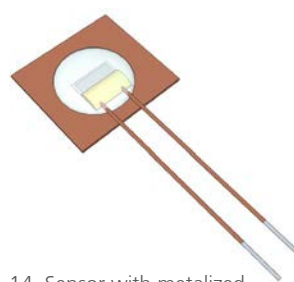
*Your sensor is our competence*



12. Temperature sensor with



13. Sensor assembled in



14. Sensor with metalized back side feature and soldering directly to a Cu surface



15. Sensor inserted in round ceramic case



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