

Application Note

RTD Platinum Sensor



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1. General Information

In many sectors, temperature is one of the most important physically defined parameters to determine product quality, security and reliability. Temperature sensors are produced with different technologies to fit specific application requirements. IST AG has concentrated on the development and manufacturing of high-quality thin-film temperature sensors. This know-how, partially derived from the semiconductor industry, allows IST AG to manufacture sensors in very small dimensions. Thin-film temperature sensors exhibit a very short response time due to their low thermal mass. The technologies and processes of IST AG thin-film sensors combine the positive attributes of traditional sensors - accuracy, long-term stability, repeatability and interchangeability within a wide temperature range. The advantages of thin-film mass-production create an optimal price/performance ratio.

2. Construction

The temperature sensor consists of a high-purity platinum meander, structured on a ceramic substrate by the use of photolithography. The resistivity is laser-trimmed and precisely adjusted to the final value. The resistive structure is covered with a glass passivation layer protecting the sensor against mechanical and chemical damages. The welded lead wires are covered with an additional fixation layer.

3. Nominal Value and Temperature Coefficient

The nominal value of the sensor is the defined value of the sensor resistance at 0 °C. The temperature coefficient α (TCR) is defined as:

$$\alpha = \frac{R_{100} - R_0}{100 \times R_0} \quad [\text{K}^{-1}] \text{ according to the IEC60751, 2009-05 numerical value of } 0.00385 \text{ K}^{-1}.$$

Generally, the value is defined in ppm/K.

This example defines 3850 ppm/K¹⁾.

R_0 = resistance value in Ω at 0 °C

R_{100} = resistance value in Ω at +100 °C

1) Other TCRs available upon request

4. Long-Term Stability

For all sensor types up to 7W (+750 °C), the change in ohmic value after 1000 hrs is less than 0.04 % at maximum operating temperatures.

5. Temperature Characteristic Curve

The curve determines the relationship between the electrical resistance and the temperature.

$$\begin{aligned} R(T) &= R_0 (1 + A \times T + B \times T^2) && 0 \text{ }^\circ\text{C to } +850 \text{ }^\circ\text{C} \\ R(T) &= R_0 (1 + A \times T + B \times T^2 + C \times [T-100] \times T^3) && -200 \text{ }^\circ\text{C to } 0 \text{ }^\circ\text{C} \end{aligned}$$

Platinum (3850 ppm/K)	Platinum (3911 ppm/K)	Platinum (3750 ppm/K)	Platinum (3770 ppm/K)
$A = 3.9083 \times 10^{-3} \text{ [}^\circ\text{C}^{-1}\text{]}$	$A = 3.9692 \times 10^{-3} \text{ [}^\circ\text{C}^{-1}\text{]}$	$A = 3.8102 \times 10^{-3} \text{ [}^\circ\text{C}^{-1}\text{]}$	$A = 3.8285 \times 10^{-3} \text{ [}^\circ\text{C}^{-1}\text{]}$
$B = -5.775 \times 10^{-7} \text{ [}^\circ\text{C}^{-2}\text{]}$	$B = -5.829 \times 10^{-7} \text{ [}^\circ\text{C}^{-2}\text{]}$	$B = -6.01888 \times 10^{-7} \text{ [}^\circ\text{C}^{-2}\text{]}$	$B = -5.85 \times 10^{-7} \text{ [}^\circ\text{C}^{-2}\text{]}$
$C = -4.183 \times 10^{-12} \text{ [}^\circ\text{C}^{-4}\text{]}$	$C = -4.3303 \times 10^{-12} \text{ [}^\circ\text{C}^{-4}\text{]}$	$C = -6 \times 10^{-12} \text{ [}^\circ\text{C}^{-4}\text{]}$	

R_0 = resistance value in Ω at 0 °C

T = temperature in accordance with ITS 90



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6. Tolerance Classes IEC60751 Norm

Temperature sensors are classified according to IEC60751, 2009-05.

Class	± deviations in °C	Temperature range of validity in °C*	IST AG reference
IEC60751 F 0.1	$0.10 + 0.0017 \times T $	0 to +150	Y
IEC60751 F 0.15	$0.15 + 0.002 \times T $	-30 to +300	A
IEC60751 F 0.3	$0.30 + 0.005 \times T $	-50 to +500	B
IEC60751 F 0.6	$0.60 + 0.01 \times T $	-50 to +600	C
1/5 IEC60751 F 0.3	$0.06 + 0.001 \times T $	upon request	K
1/10 IEC60751 F 0.3	$0.03 + 0.0005 \times T $	upon request	K

* Customer specific temperature range available on request

|T| is the numerical value of the temperature in °C without taking leading signs into account.

The temperature curves refer to IEC60751 standards. The values in the table are for informative purposes only. Based on the assembly method and the different measurement conditions, accuracy, self-heating and response time may vary.

The measurement point is 5 mm from the wire end. For long wires (> 20 mm) the resistance is compensated (measured at room temperature) to ensure the correct resistance at the chip edge.

The resistance compensation of long wires (direct soldered or extended wires) has always to be taken into consideration for the end application. Exceptions are 3 or 4 wire solutions.

For 1/3 IEC60751, 1/5 IEC60751, 1/10 IEC60751 and 3- or 4-wire sensors please contact us.

7. Applied Current

The current applied is highly dependent on the application and leads to self-heating effects. In general, the applied current should be as low as possible in order to reduce self-heating effects. The following values are typically used as measurement current:

100 Ω	500 Ω	1000 Ω	2000 Ω	10000 Ω
1 mA	0.5 mA	0.3 mA	0.2 mA	0.1 mA

Higher measurement currents can be applied as long as self-heating does not change the measurement value more than the needed measurement accuracy. The maximum current for sensors between 750°C and 1000°C should not exceed 1mA.

8. Self-Heating

The electric current generates self-heating resulting in errors of measurement. To minimize the error, the testing current should be kept as low as possible. The measurement error caused by self-heating is dependent on temperature error $\Delta T = R \times I^2 / E$.

E = self-heating coefficient in mW/K, R = resistance in kΩ, I = measuring current in mA



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9. Response Time

The response time is defined as the time in seconds the sensor needs to detect the change in temperature. $t_{0.63}$ describes the time in seconds the sensor needs to measure 63 % of the temperature change. The response time depends on the sensor dimensions, the thermal contact resistance and the surrounding medium.

Dimensions number	Response time in seconds						Self-heating			
	Water (v = 0.4 m/s)			Air (v = 1 m/s)			Water (v = 0 m/s)		Air (v = 0 m/s)	
	$t_{0.5}$	$t_{0.63}$	$t_{0.9}$	$t_{0.5}$	$t_{0.63}$	$t_{0.9}$	E in mW/K	ΔT in [mK] ¹⁾	E in mW/K	ΔT in [mK] ¹⁾
161	0.05	0.08	0.18	1	1.2	2.5	12	8.3	1.8	56
308	0.08	0.1	0.25	1.2	1.5	3.5	15	6.7	2.2	46
232	0.09	0.12	0.33	2.7	3.6	7.5	40	2.5	4	25
202	0.11	0.16	0.38	3.6	4.9	10.2	32	3.1	3.2	31
216	0.12	0.18	0.42	4	5.4	11	36	2.8	3.6	28
232	0.15	0.2	0.55	4.5	6	12	40	2.5	4	25
325	0.25	0.3	0.7	5.5	7.5	16	90	1.1	8	13
516	0.25	0.3	0.7	5.5	7.5	16	80	1.3	7	14
520	0.25	0.3	0.75	6	8.5	18	80	1.3	7	14
525	0.33	0.4	0.85	6.5	9	19	90	1.1	8	13
538	0.35	0.4	0.90	7.5	10	20	140	0.7	10	10
505	0.4	0.5	1.1	8	11	21	150	0.7	11	9
102	0.33	0.4	0.85	7.5	10.5	20	140	0.7	10	10
281	2.5	4.5	8	10	15	28	60	1.7	5.5	18
281*	2	2.5	5.5	10	12	22	45	2.2	4	25
451	8	10	22	12	22	40	85	1.2	8	13
451*	5	6	14	16	18	37	60	1.7	6.5	15
SMD 1206	0.15	0.25	0.45	3.5	4.2	10	55	1.8	7	14
SMD 0805	0.1	0.12	0.33	2.5	3	8	38	2.6	4	25
FC 0603	0.08	0.1	0.25	1.8	2.2	5.5	25	4	2.5	40

1) Self-heating ΔT [mK] measured with Pt100 at 1 mA applied current at 0 °C

* Two sensing elements in the same round ceramic housing

L: Sensor length (without connections)

H: Sensor height (without connections)

W: Sensor width

H2: Sensor height (incl. connections and strain relief)

10. Dimensions Tolerances

Sensor width (W) ± 0.2 mm
 Sensor length (L) ± 0.2 mm
 Sensor height (H2) ± 0.3 mm
 Sensor height (H) ± 0.1 mm

Wire length ± 1 mm (up to 30 mm)
 Wire length > 30 mm, tolerances according ISO 2768-1, tolerance class V (very coarse): see table below

Wire length in mm	31-120	121-400	401-1000	1001-2000	2001-4000
ISO 2768-1, tolerance class V (very coarse):	± 1.5 mm	± 2.5 mm	± 4 mm	± 6 mm	± 8 mm



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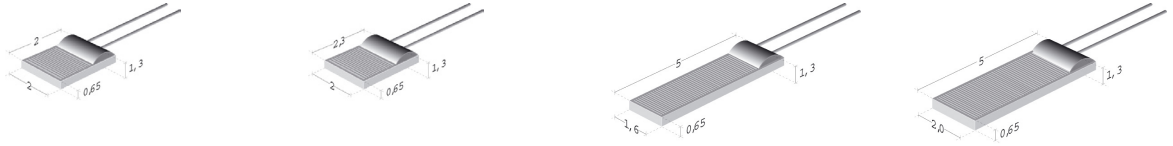


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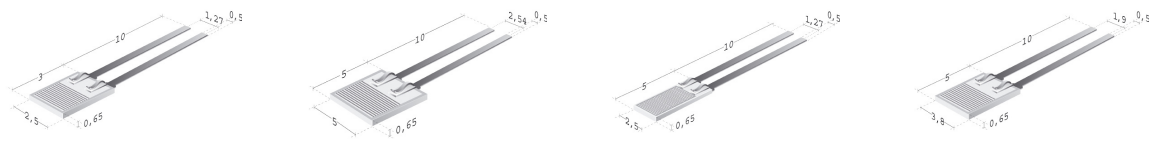


11. Sensor Construction Examples

Wire



SIL



FlipChip and SMD



Minisens and Slimsens



Long wire, insulated wire and insulated stranded wire



Inverted wire and perpendicular wire



Round ceramic housing





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12. Additional Documents

Data Sheets:

Document name:

DTP150_E	DTP150_D
DTP200_E	DTP200_D
DTP300_E	DTP300_D
DTP400_E	DTP400_D
DTP600_E	DTP600_D
DTP750_E	DTP750_D
DTP850_E	DTP850_D
DTP1000_E	DTP1000_D
DTPPW_E	DTPPW_D
DTPPG_E	DTPPG_D
DTPSMD_E	DTPSMD_D
DTPFC_E	DTPFC_D
DTPBondSens_E	DTPBondSens_D
DTPRPT_E	DTPRPT_D



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