TEMPERATURE
HUMIDITY
FLOW

Nickel Temperature Sensors

General Information

In many industrial sectors and fields of research, temperature measurement is one of the most important parameters to determine product quality, security, and reliability. Temperature sensors are available in several types, all of which have a unique performance characteristic. The performance capability of the various sensors are a result of the manufacturing process and component materials associated with their technologies and intended application. IST sensors exceed the industry standard of temperature measurement and have the capability to directly replace older traditional methods and provide the maximum performance. To this end, IST has concentrated its development and manufacturing on the process and materials of high-end thin-film temperature sensors. Additionally, these processes, partially derived from the semiconductor industry, allow IST to manufacture sensors in very small dimensions. Because of their low thermic mass, thin-film temperature sensors exhibit a very short response time. IST core technology and processes result in thin-film sensors that combine the positive attributes of traditional wire-wound nickel sensors - accuracy, long-term stability, repeatability, interchangeability, and wide temperature range, with the advantages of mass-production, which ultimately creates an optimal price/performance ratio.

Sensor Construction

The temperature sensor consists of a photo-lithographically structured, high-purity nickel coating arranged in the shape of a meander. The nickel thin-film structures are laser trimmed to form resistive paths with a precisely-defined basic value of resistivity. The sensors are covered with a dielectric layer to protect the sensor against mechanical and chemical damage. The bonded leads, which are additionally fixed with a sealing compound, provide the electrical contact to the resistive path.

Typical Features

– short response time
– excellent long-term stability
– low self-heating rate
– simple interchangeability
– small dimensions
– excellent linearity
– resistant against vibration and temperature shocks

Response Time

The response time $T_{0.63}$ is the time in seconds the sensors need to respond to 63% of the change in temperature. The response time depends on the sensor dimensions.

Long-Term Stability

The change of ohmage after 1,000 hrs at maximum operating temperature amounts to less than 0.1%.

Self Heating

To measure the resistance, an electric current has to flow through the element, which will generate heat energy resulting in errors of measurement. To minimize the error, the testing current should be kept low (approximately 1 mA for Ni-1000). Temperature error $\Delta T = RI^2 / E$, with E being equal to self-heating coefficient in mW/K, R equal to resistance in kΩ, and I being the measured current in mA.

Nominal Values

The nominal value of the sensor is the target value of the sensor resistance at 0° C. The temperature coefficient α is defined as $\alpha = \frac{R_{100} - R_0}{100 \cdot R_0}$ [K^{-1}] and has the numerical value of 0.00618 K^{-1} for the sensors which comply with the old norm DIN 43760.

In practice, a value multiplied by 10^6 is often entered: $TCR = 10^6 * \frac{R_{100} - R_0}{100 \cdot R_0}$ [ppm/K].
In this case, the numerical value is 6180 ppm/K.

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Applied Current

Electric current heats the nickel thin-film sensor. The resulting temperature error is given by: $\Delta T = P/E$ with P, the power loss = I^2R and E, the self heating coefficient in mW/K.

The amount of thermal transfer from the sensor determines how much current can be applied. There is no bottom limit of the applied current with nickel thin-film. The current depends highly on the application in use.

We recommend at:

100 Ω:	typ. 1 mA	max. 5 mA
500 Ω:	typ. 0.5 mA	max. 3 mA
1000 Ω:	typ. 0.3 mA	max. 2 mA
2000 Ω:	typ. 0.2 mA	max. 1 mA
10000 Ω:	typ. 0.1 mA	max. 0.3 mA

Temperature Characteristic Curve

After DIN 43760, the Temperature Characteristic Curve is defined with a polynomal of the 6th order:

$R(t) = R_0 (1 + A * t + B * t^2 + C * t^3 + D * t^4 + E * t^5 + F * t^6)$

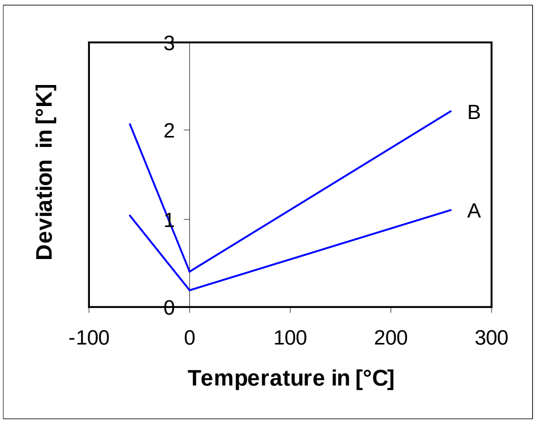
Coefficient for
Nickel NL (5000 ppm/K):
$A = 4.427 * 10^{-3}$ [°C^{-1}]; $B = 5.172 * 10^{-6}$ [°C^{-2}];
$C = 5.585 * 10^{-9}$ [°C^{-3}]; D = E = F = O

Nickel ND (6180 ppm/K):
$A = 5.485 * 10^{-3}$ [°C^{-1}]; $B = 6.65 * 10^{-6}$ [°C^{-2}]; C = 0;
$D = 2.805 * 10^{-11}$ [°C^{-4}]; E = O ; $F = -2 * 10^{-17}$ [°C^{-6}]

Nickel NJ (6370)
$A = 5.64742 * 10^{-3}$ [°C^{-1}]; $B = 6.69504 * 10^{-6}$ [°C^{-2}];
$C = 5.68816 * 10^{-9}$ [°C^{-3}]; D = E = F = 0

Nickel NA (6720)
$A = 5.88025 * 10^{-3}$ [°C^{-1}]; $B = 8.28385 * 10^{-6}$ [°C^{-2}]; C = 0;
$D = 7.67175 * 10^{-12}$ [°C^{-4}]; E = O ; $F = -1.5 * 10^{-16}$ [°C^{-6}]

R_0 = Nominal Resistance in Ohm at 0°C;
t = Temperature at ITS 90



Tolerance field

Tolerance classes

Class	+/- limit deviations in ºC (K)		IST AG designation
	t<0°C	t>0°C	
DIN 43760	0.4 + 0.028 x |t|	0.4 + 0.007 x |t|	B
½ DIN 43760	0.2 + 0.014 x |t|	0.2 + 0.0035 x |t|	A

The tolerances are only garanteed to 260°C

Nickel Temperature Sensors

Response Time and Self Heating

Dimension Number	Sensor Size	Response Time in seconds						Self Heating			
	L x W x T / H (mm)	Water v=0.4 m/s			Air v=1m/s			Water v=0 m/s		Air v=0 m/s	
		$T_{0.5}$	$T_{0.63}$	$T_{0.9}$	$T_{0.5}$	$T_{0.63}$	$T_{0.9}$	mW/K	ΔT[mK]*	mW/K	ΔT[mK]*
232	2.3 x 2.0 x 0.25 / 0.8	0.09	0.12	0.33	2.7	3.6	7.5	40	2.3	4	22.5
232	2.3 x 2.0 x 0.65 / 1.3	0.15	0.2	0.55	4.5	6	12	40	2.3	4	22.5
325	3.0 x 2.5 x 0.65 / 1.3	0.25	0.3	0.7	5.5	7.5	16	90	1	8	11.3
516	5.0 x 1.6 x 0.65 / 1.3	0.25	0.3	0.7	5.5	7.5	16	80	1.1	7	12.9
520	5.0 x 2.0 x 0.65 / 1.3	0.25	0.3	0.75	6	8.5	18	80	1.1	7	12.9
525	5.0 x 2.5 x 0.65 / 1.3	0.33	0.4	0.85	6.5	9	19	90	1	8	11.3
102	10.0 x 2.0 x 0.65 / 1.3	0.33	0.4	0.85	7.5	10.5	20	140	0.6	10	9
538	5.0 x 3.8 x 0.65 / 1.3	0.35	0.4	0.9	7.5	10	20	140	0.6	10	9
505	5.0 x 5.0 x 0.65 / 1.3	0.4	0.5	1.1	8	11	21	150	0.6	11	0.6
SMD 1206	3.2 x 1.6 x 0.4	0.15	0.25	0.45	3.5	4.2	10	55	1.8	7	14.3
SMD 0805	2.0 x 1.2 x 0.4	0.10	0.12	0.33	2.5	3	8	38	2.6	4	25

*self heating ΔT[mK] measured for Ni1000 at 0.3mA measurement current at 0°C

Tolerances of Dimensions

Sensor width (W) ± 0.2 mm
Sensor length (L) ± 0.2 mm
Sensor height (H) ± 0.2 mm
Sensor thickness (T) ± 0.1 mm

Wire length ± 1.0 mm
Tube length ± 0.2 mm
Tube diameter ± 0.1 mm

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Order Information

N | D | 1 K 0 | 5 2 0 | 2 | W | B | 0 1 0 | x **Example**

Specials

T	Substrate thickness 0.25 mm
W	Sintered powder
M	Metallised backside
U	Inverted welding
S	Special*

Connection Length in mm

Tolerance classes

A	½ DIN 43760
B	DIN 43760
C	2 DIN 43760
K	Customer specific*

Extension Type

S	SIL (Single in line)
P	Tin solder overall (SMD) →
FC	Flip Chip →
W	Wire
FW	Flat wire
FK	Flat wire customized
I	Insulated contacts
E	Enameled copper wire
K	Customer specific*

1P = Contacts tin-coated, LMP lead-contained
2P = Contacts tin-coated, LMP lead-free, RoHS compliant

Contacts tin-coated lead-contained
2P = Contacts tin-coated, LMP lead-free, RoHS compliant1FC = Contacts tin-coated, LMP lead free
2FC = Contacts tin-coated, HMP
3FC = Au-Pads (bonding Pads)

Temperature range

1	-60°C to	150°C
2	-60°C to	200°C
3	-60°C to	300°C

Dimension number (see various dimensions) in mm

Resistance value in Ohm at 0°C

Characteristic curve

A	6720 ppm/K
B	Balco*
D	DIN 6180 ppm/K
L	5000 ppm/K
J	6370 ppm/K
M	5696 ppm/K
C	4280 ppm/K (Copper)
S	Special*

Material Identification

N	Nickel
S	Special sensors

*** Additional details, specifications required from the customer.**

Order Example:
N D. 1K0. 520. 2 W. B. 010
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

1: Material Identification	= Nickel temp. Sensor	5: Temperature range	= -60°C to +200°C
2: Characteristic curve	= DIN 6180 ppm/K	6: Extension	= Wire connections
3: Resistance value in ohm	= 1000 Ω / 0°C	7: Tolerance Class	= DIN 43760
4: Chip dimension	= 5 mm x 2 mm	8: Connection Length	= 10 mm

Specifications are subject to change without notice

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ISO 9001

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