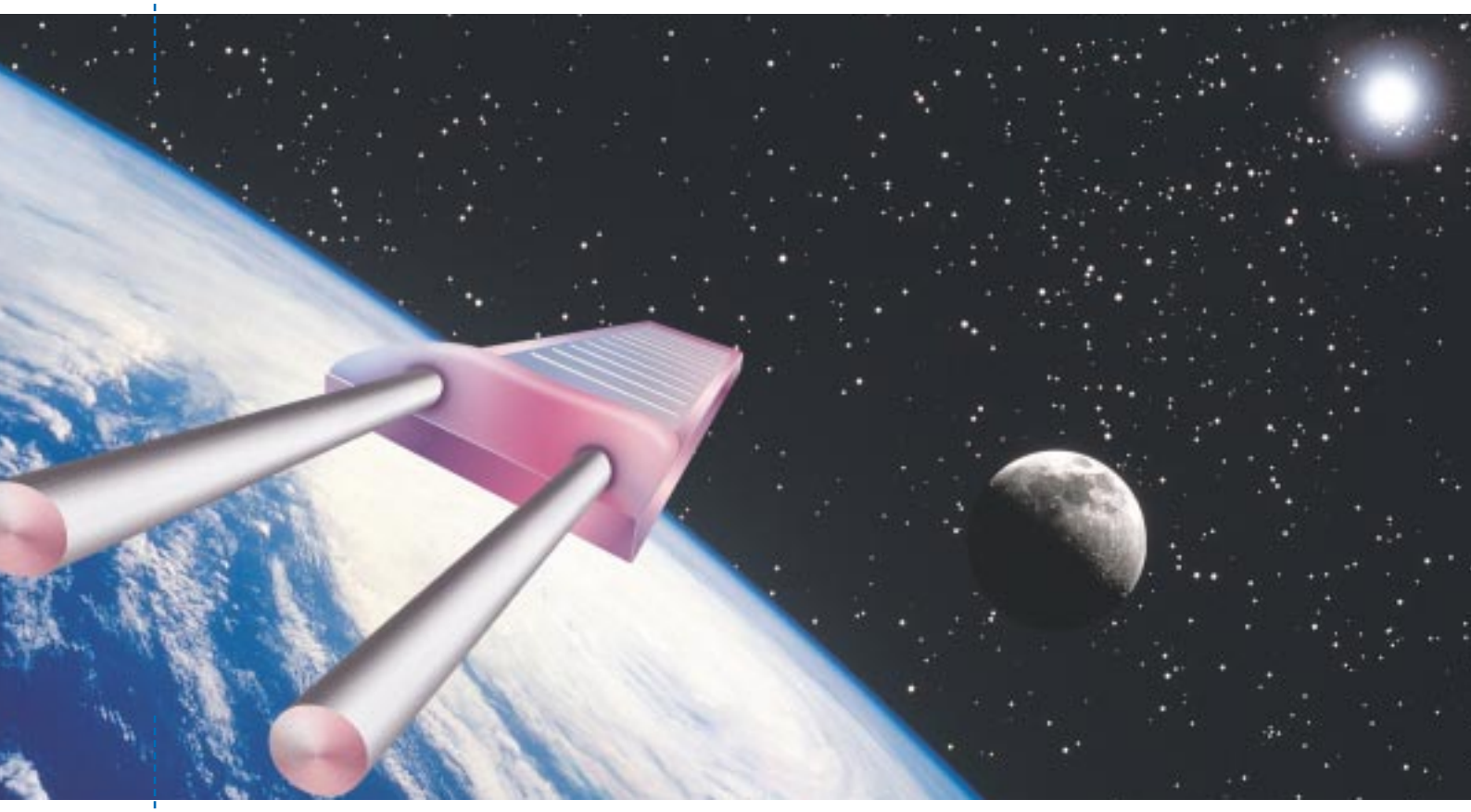
Nickel Temperature Sensors



INNOVATIVE SENSOR TECHNOLOGY

Data Sheet for
Nickel Temperature Sensors

General Information:

In many industrial sectors and fields of research, temperature is one of the most important parameters which decides about product quality, security, and reliability. Temperature sensors are manufactured by variable technologies, according to the field of application. In sense of a specified product policy, we concentrated in development and manufacturing on high-end thin film temperature sensors. These processes derived from the semiconductor industry allow to manufacture sensors in very small dimensions. Because of their low thermic mass thin film temperature sensors exhibit a very short response time. Furthermore, thin film sensors combine the good features of traditional wire wound nickel sensors such as accuracy, long-term stability, repeatability, interchangeability and wide temperature range, with the advantages of mass-production, which contributes to their 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 very precisely defined basic value of the 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:

- *brief response time*
- *excellent long-term stability*
- *low self-heating rate*
- *simple interchangeability*
- *small dimensions*
- *simple linearisation*
- *resistant against vibration and temperature shocks*

Response Time:

The response time $T_{0.63}$ is the time 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 = self-heating coefficient in mW/K
R = resistance in kΩ, I = measuring 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 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.

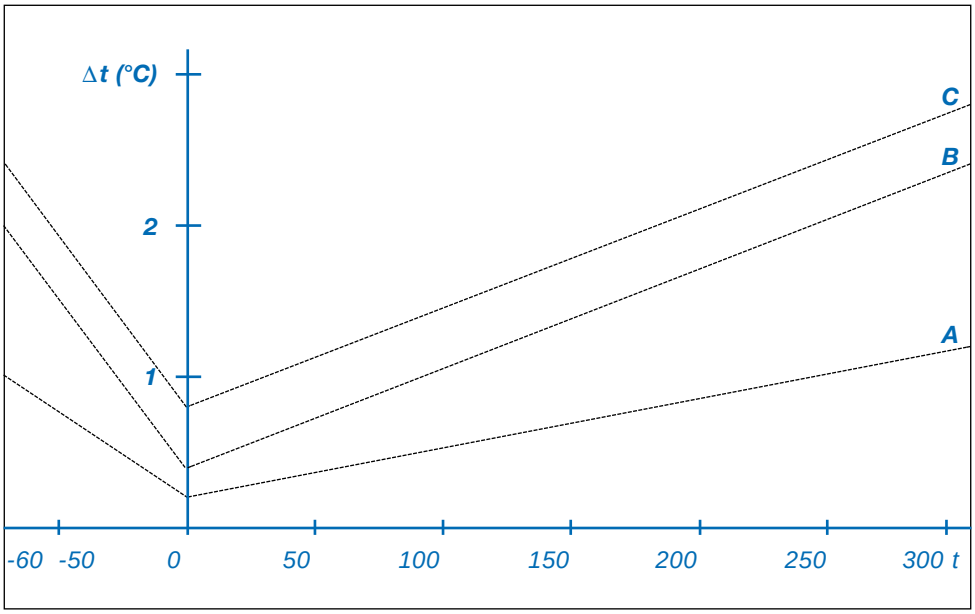
Tolerance classes:

The temperature sensors are divided into classes according to their limit deviations:

Class	± limit deviations in ºC (K)		Diagram designation
	t < 0ºC	t > 0ºC	
1/2 DIN	0.2 + 0.014 |t|	0.2 + 0.0035 |t|	A
DIN 43760	0.4 + 0.028 |t|	0.4 + 0.007 |t|	B
2 x DIN	0.8 + 0.028 |t|	0.8 + 0.007 |t|	C

|t| is the numerical value of the temperature in °C without taking into account either negative or positive signs. Special selection of sensors upon request (e.g. pairings, grouping, special tolerances).

Tolerance field:



Characteristic Temperature Curve:

The characteristic temperature curve determines the dependence of the electrical resistivity on the temperature: $R\,|t| = R_0\,(1 + A \cdot t + B \cdot t^2 + C \cdot t^3 + D \cdot t^4 + E \cdot t^5 + F \cdot t^6)$

with:
$A = 5.485 \cdot 10^{-3} \cdot °C^{-1}$; $B = 6.65 \cdot 10^{-6} \cdot °C^{-2}$; $C = 0$
$D = 2.805 \cdot 10^{-11} \cdot °C^{-4}$; $E = O$; $F = -2 \cdot 10^{-17} \cdot °C^{-6}$
R_0 = resistance value in ohm at 0°C
t = temperature in °C (IPTS - 68)

In addition, the following polynomials are available from IST AG:

TCR 5000: $A = 4.427 \cdot 10^{-3}\,°C^{-1}$; $B = 5.172 \cdot 10^{-6}\,°C^{-2}$; $C \cdot 5.585 \cdot 10^{-9}\,°C^{-3}$;
$D = E = F = O$

TCR 6370: $A = 5.6547 \cdot 10^{-3}\,°C^{-1}$; $B = 6.814 \cdot 10^{-6}\,°C^{-2}$; $C = 1.49 \cdot 10^{-9}\,°C^{-3}$;
$D = 2 \cdot 10^{-11}\,°C^{-4}$; $E = O$; $F = O$

TCR 6720: $A = 5.88539 \cdot 10^{-3}\,°C^{-1}$; $B = 7.872 \cdot 10^{-6}\,°C^{-2}$;
$C = 4.71 \cdot 10^{-9}\,°C^{-3}$; $D = E = F = O$

Response Times and Self-Heating:

	Response Time						Self-Heating	
	water 0.4m/s			air 1m/s			water	air
Sensor size	$T_{0.5}$	$T_{0.63}$	$T_{0.9}$	$T_{0.5}$	$T_{0.63}$	$T_{0.9}$	mW/°C	mW/°C
2.3 x 2.0 x 0.25	0.09	0.12	0.33	2.7	3.6	7.5	40	4
2.3 x 2.0 x 0.63	0.15	0.2	0.55	4.5	6	12	40	4
3.0 x 2.5 x 0.63	0.25	0.3	0.7	5.5	7.5	16	90	8
5.0 x 1.6 x 0.63	0.25	0.3	0.7	5.5	7.5	16	80	7
5.0 x 2.0 x 0.63	0.25	0.3	0.75	6	8.5	18	80	7
5.0 x 2.5 x 0.63	0.33	0.4	0.85	6.5	9	19	90	8
10. x 2.0 x 0.63	0.33	0.4	0.85	7.5	10.5	20	140	10
5.0 x 3.8 x 0.63	0.35	0.4	0.9	7.5	10	20	140	10
5.0 x 5.0 x 0.63	0.4	0.5	1.1	8	11	21	150	11

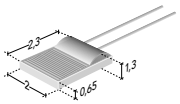
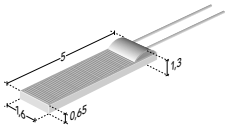
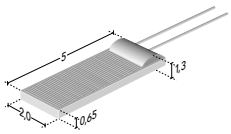
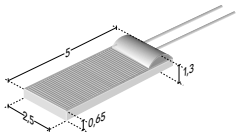
Tolerances of dimensions:

Sensor width	± 0.2 mm	Sensor thickness	± 0.1 mm
Sensor length	± 0.2 mm	Wire length	± 1.0 mm

Standard Versions

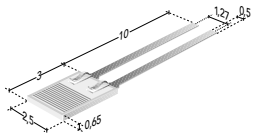
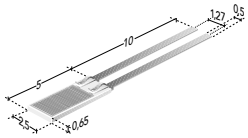
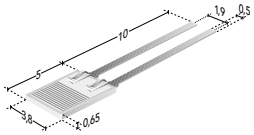
Temperature sensors with Wire Terminations:

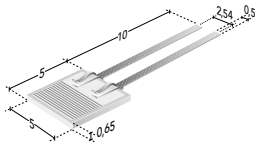
Product series Nx.xxx.xxx.2W.x.010 –60 .. 200°C (silver-wire termination 0.25 x 10 mm)

Dimensions	Nominal resistance at 0°C (Ohm)	Part number
	100	Nx.0k1.232.2W.x.010
	500	Nx.0k5.232.2W.x.010
	1 000	Nx.1k0.232.2W.x.010
	100	Nx.0k1.516.2W.x.010
	500	Nx.0k5.516.2W.x.010
	1 000	Nx.1k0.516.2W.x.010
	100	Nx.0k1.520.2W.x.010
	500	Nx.0k5.520.2W.x.010
	1 000	Nx.1k0.520.2W.x.010
	500	Nx.0k5.525.2W.x.010
	1 000	Nx.1k0.525.2W.x.010
	2 000	Nx.2k0.525.2W.x.010
	5 000	Nx.5k0.525.xW.x.010
	10 000	Nx.10k.525.xW.x.010
	20 000	Nx.20k.525.xW.x.010

Temperature sensors with SIL lead frames:

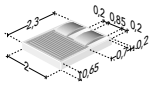
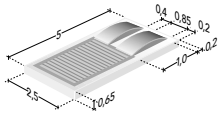
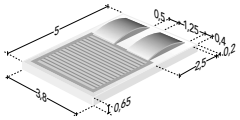
Product series Nx.xxx.xxx.2S.x –60 .. 200°C

Dimensions	Nominal resistance at 0°C (Ohm)	Part number
	100	Nx.0k1.325.2S.x
	500	Nx.0k5.325.2S.x
	1 000	Nx.1k0.325.2S.x
	2 000	Nx.2k0.325.2S.x
	100	Nx.0k1.525.2S.x
	500	Nx.0k5.525.2S.x
	1 000	Nx.1k0.525.2S.x
	2 000	Nx.2k0.525.2S.x
	5 000	Nx.5k0.525.2S.x
	10 000	Nx.10k.525.2S.x
	20 000	Nx.20k.525.2S.x
	100	Nx.0k1.538.2S.x
	500	Nx.0k5.538.2S.x
	1 000	Nx.1k0.538.2S.x
	2 000	Nx.2k0.538.2S.x

Dimensions	Nominal resistance at 0°C (Ohm)	Part number
	100	Nx.0k1.505.2S.x
	500	Nx.0k5.505.2S.x
	1 000	Nx.1k0.505.2S.x

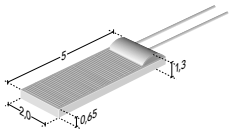
Leadless Chip Temperatur sensors:

Product series Nx.xxx.xxx.1P.x –60 .. 150°C (with low melting point solder bumps)
Product series Nx.xxx.xxx.2P.x –60 .. 200°C (with high melting point solder bumps)

Dimensions	Nominal resistance at 0°C (Ohm)	Part number
	100	Nx.0k1.232.xP.x
	500	Nx.0k5.232.xP.x
	1 000	Nx.1k0.232.xP.x
	100	Nx.0k1.525.xP.x
	500	Nx.0k5.525.xP.x
	1 000	Nx.1k0.525.xP.x
	100	Nx.0k1.538.xP.x
	500	Nx.0k5.538.xP.x
	1 000	Nx.1k0.538.xP.x
	2 000	Nx.2k0.538.xP.x

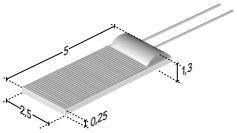
Temperature sensors with higher temperature range:

Product series Nx.xxx.xxx.3W.x.010 –60 .. 300°C
(with nickel-wire terminations 0.20 x 10 mm)

	100	Nx.0k1.520.3W.x.010
	500	Nx.0k5.520.3W.x.010
	1 000	Nx.1k0.520.3W.x.010

Temperature sensors on a Thin Substrate:

Product series Nx.xxx.525.xT.x.010

	100	Nx.0k1.525.xT.x.010
	500	Nx.0k5.525.xT.x.010
	1 000	Nx.1k0.525.xT.x.010

Tighter/looser tolerances or special selections on request.

Resistor Table: relative values of resistivity in steps of 1°C

in accordance with DIN 43760
TCR = 6180 ppm/K

°C	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
-60	695.20	699.87	704.56	709.26	713.97	718.70	723.44	728.20	732.97	737.75
-50	742.55	747.36	752.19	757.03	761.89	766.76	771.64	776.54	781.45	786.37
-40	791.31	796.26	801.23	806.21	811.21	816.21	821.23	826.27	831.32	836.38
-30	841.46	846.55	851.65	856.77	861.90	867.04	872.20	877.37	882.56	887.75
-20	892.96	898.19	903.43	908.68	913.94	919.22	924.51	929.82	935.14	940.47
-10	945.82	951.17	956.55	961.93	967.33	972.74	978.17	983.60	989.06	994.52

°C	0	1	2	3	4	5	6	7	8	9
0	1000.00	1005.49	1011.00	1016.51	1022.05	1027.59	1033.15	1038.72	1044.31	1049.90
10	1055.52	1061.14	1066.78	1072.43	1078.09	1083.77	1089.46	1095.17	1100.89	1106.62
20	1112.36	1118.12	1123.90	1129.68	1135.48	1141.29	1147.12	1152.96	1158.81	1164.68
30	1170.56	1176.45	1182.36	1188.28	1194.21	1200.16	1206.13	1212.10	1218.09	1224.09
40	1230.11	1236.14	1242.19	1248.25	1254.32	1260.41	1266.51	1272.62	1278.75	1284.89
50	1291.05	1297.22	1303.41	1309.61	1315.82	1322.05	1328.29	1334.55	1340.82	1347.10
60	1353.40	1359.72	1366.05	1372.39	1378.75	1385.12	1391.51	1397.91	1404.33	1410.76
70	1417.21	1423.67	1430.14	1436.64	1443.14	1449.67	1456.20	1462.75	1469.32	1475.91
80	1482.50	1489.12	1495.75	1502.39	1509.05	1515.73	1522.42	1529.13	1535.85	1542.59
90	1549.34	1556.12	1562.90	1569.71	1576.53	1583.36	1590.21	1597.08	1603.97	1610.87
100	1617.79	1624.72	1631.67	1638.64	1645.62	1652.62	1659.64	1666.68	1673.73	1680.80
110	1687.89	1694.99	1702.11	1709.25	1716.41	1723.58	1730.77	1737.98	1745.21	1752.45
120	1759.72	1767.00	1774.30	1781.61	1788.95	1796.30	1803.68	1811.07	1818.48	1825.90
130	1833.35	1840.82	1848.30	1855.80	1863.33	1870.87	1878.43	1886.01	1893.61	1901.23
140	1908.87	1916.52	1924.20	1931.90	1939.62	1947.35	1955.11	1962.89	1970.69	1978.51
150	1986.35	1994.21	2002.09	2009.99	2017.91	2025.85	2033.82	2041.80	2049.81	2057.84
160	2065.89	2073.96	2082.05	2090.16	2098.30	2106.46	2114.64	2122.84	2131.06	2139.31
170	2147.58	2155.87	2164.19	2172.52	2180.88	2189.26	2197.67	2206.10	2214.55	2223.03
180	2231.53	2240.05	2248.59	2257.16	2265.76	2274.38	2283.02	2291.68	2300.37	2309.09
190	2317.83	2326.59	2335.38	2344.20	2353.04	2361.90	2370.79	2379.70	2388.64	2397.61
200	2406.60	2415.62	2424.66	2433.73	2442.82	2451.95	2461.09	2470.27	2479.47	2488.70
210	2497.95	2507.23	2516.54	2525.88	2535.24	2544.63	2554.05	2563.50	2572.97	2582.47
220	2592.00	2601.56	2611.15	2620.76	2630.40	2640.08	2649.78	2659.51	2669.26	2679.05
230	2688.87	2698.72	2708.59	2718.50	2728.43	2738.40	2748.40	2758.42	2768.48	2778.56
240	2788.68	2798.83	2809.01	2819.22	2829.46	2839.73	2850.03	2860.37	2870.73	2881.13
250	2891.56	2902.02	2912.52	2923.04	2933.60	2944.19	2954.82	2965.48	2976.16	2986.89
260	2997.64	3008.43	3019.26	3030.11	3041.00	3051.92	3062.88	3073.87	3084.90	3095.96
270	3107.06	3118.19	3129.35	3140.55	3151.78	3163.05	3174.36	3185.70	3197.07	3208.49
280	3219.93	3231.42	3242.94	3254.49	3266.08	3277.71	3289.38	3301.08	3312.82	3324.60
290	3336.41	3348.26	3360.15	3372.08	3384.04	3396.04	3408.08	3420.16	3432.28	3444.43
300	3456.63									

Resistor Table:
relative values
of resistivity
in steps of 1°C

TCR = 5000 ppm/K

°C	-0.00	-1.00	-2.00	-3.00	-4.00	-5.00	-6.00	-7.00	-8.00	-9.00
-60.00	751.79	755.66	759.54	763.43	767.33	771.23	775.14	779.07	783.00	786.93
-50.00	790.88	794.84	798.80	802.78	806.76	810.75	814.75	818.76	822.78	826.80
-40.00	830.84	834.88	838.94	843.00	847.07	851.15	855.24	859.34	863.45	867.57
-30.00	871.69	875.83	879.98	884.13	888.30	892.47	896.65	900.85	905.05	909.26
-20.00	913.48	917.72	921.96	926.21	930.47	934.74	939.02	943.31	947.61	951.92
-10.00	956.24	960.57	964.91	969.26	973.62	977.99	982.37	986.77	991.17	995.58

°C	0.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
0.00	1000.00	1004.43	1008.87	1013.33	1017.79	1022.26	1026.75	1031.24	1035.75	1040.27
10.00	1044.79	1049.33	1053.88	1058.44	1063.01	1067.59	1072.18	1076.78	1081.39	1086.02
20.00	1090.65	1095.30	1099.96	1104.62	1109.30	1113.99	1118.70	1123.41	1128.13	1132.87
30.00	1137.62	1142.37	1147.14	1151.92	1156.72	1161.52	1166.34	1171.16	1176.00	1180.85
40.00	1185.71	1190.59	1195.47	1200.37	1205.28	1210.20	1215.13	1220.07	1225.03	1230.00
50.00	1234.98	1239.97	1244.97	1249.99	1255.02	1260.06	1265.11	1270.18	1275.25	1280.34
60.00	1285.45	1290.56	1295.69	1300.83	1305.98	1311.14	1316.32	1321.51	1326.71	1331.92
70.00	1337.15	1342.39	1347.64	1352.91	1358.18	1363.47	1368.78	1374.09	1379.42	1384.77
80.00	1390.12	1395.49	1400.87	1406.26	1411.67	1417.09	1422.53	1427.97	1433.43	1438.91
90.00	1444.39	1449.90	1455.41	1460.94	1466.48	1472.03	1477.60	1483.18	1488.77	1494.38
100.00	1500.00	1505.64	1511.29	1516.95	1522.63	1528.32	1534.03	1539.75	1545.48	1551.22
110.00	1556.98	1562.76	1568.55	1574.35	1580.17	1586.00	1591.84	1597.70	1603.58	1609.47
120.00	1615.37	1621.28	1627.22	1633.16	1639.12	1645.10	1651.08	1657.09	1663.11	1669.14
130.00	1675.19	1681.25	1687.33	1693.42	1699.52	1705.65	1711.78	1717.93	1724.10	1730.28
140.00	1736.48	1742.69	1748.91	1755.15	1761.41	1767.68	1773.97	1780.27	1786.59	1792.92
150.00	1799.27	1805.63	1812.01	1818.41	1824.82	1831.24	1837.68	1844.14	1850.61	1857.10
160.00	1863.60	1870.12	1876.65	1883.20	1889.77	1896.35	1902.95	1909.56	1916.19	1922.84
170.00	1929.50	1936.18	1942.87	1949.58	1956.31	1963.05	1969.81	1976.58	1983.37	1990.18
180.00	1997.00	2003.84	2010.70	2017.57	2024.46	2031.37	2038.29	2045.23	2052.19	2059.16
190.00	2066.15	2073.15	2080.17	2087.21	2094.27	2101.34	2108.43	2115.54	2122.66	2129.80
200.00	2136.96	2144.13	2151.33	2158.53	2165.76	2173.00	2180.26	2187.54	2194.84	2202.15
210.00	2209.48	2216.82	2224.19	2231.57	2238.97	2246.39	2253.82	2261.27	2268.74	2276.23
220.00	2283.73	2291.26	2298.80	2306.35	2313.93	2321.52	2329.14	2336.77	2344.41	2352.08
230.00	2359.76	2367.46	2375.18	2382.92	2390.68	2398.45	2406.24	2414.05	2421.88	2429.73
240.00	2437.59	2445.48	2453.38	2461.30	2469.24	2477.20	2485.17	2493.17	2501.18	2509.21
250.00	2517.27									

Special Versions:

We offer many special designs.
We shall be pleased to inform you about the various available solutions such as e.g.:

- *special chip dimensions*
- *special nominal values*
- *substrate thickness: 0.25 mm, 0.38 mm*
- *wire material: Pd, Ni, AgPd, insulated wire materials*
- *wire diameters: 0.1 – 0.4 mm*
- *wire length: may be freely selected*
- *metal-coated backside: –NiCr/Ni/Au*

Part numbering

N	x	x	x	x	x	x	x	x	x	x	x	x	x	x

wire length

Class	
A	1/2 DIN 43760
B	DIN 43760
C	2 DIN
K	custom specified

Contact version	
S	SIL (Comatel)
P	pad
W	wire
I	insulated connection
T	thin substrate
C	customized

Temperature range	
1	.. 150°C
2	.. 200°C
3	.. 300°C

Dimension number (see possible dimensions)

Resistor (Ohm)

Characteristic curve
D DIN 6180 ppm/K
L 5000 ppm/K
J 6370 ppm/K
A 6720 ppm/K
S special

Sensor-material identifikation

Order example: **ND.1k0.520.2W.B.010**

1 2 3 4 5 6 7 8

1: Identification of material = nickel temperature sensor
2: Characteristic curve = DIN 6180 ppm/K
3: Resistance value in ohm = 1 000 Ω / 0°C
4: Chip size = 5 x 2 mm
5: Temperature range = + 250°C
6: Termination = wire terminations (Ag, Ø 0,25 x 10 mm)
7: Tolerance class = DIN 43760
8: Length of termination = 10 mm

Subject to technical changes.

Sensor Data bv Postbus 1111 2280 CC Rijswijk tel +31 (0)70 3070736 / fax -938 www.sensordata.nl info@sensordata.nl