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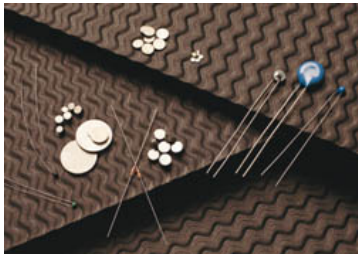
Temperature Measurement and Control Devices
DISC and CHIP **Style**

RoHS ✓

DISC & CHIP STYLE Features

- Wide Ohmic Value Range
- Accurate & Stable
- Fast Thermal Response Time
- Tight Tolerances
- High Sensitivity

NTC Thermistors
Negative Temperature Coefficient (NTC) thermistors are thermally sensitive semiconductor resistors which exhibit a decrease in resistance as absolute temperature increases. Change in the resistance of NTC thermistor can be brought about either by a change in the ambient temperature or internally by self-heating resulting from current flowing through the device. Most of the practical applications of NTC thermistors are based on these material characteristics.

NTC DISC & CHIP Style Devices
RTI manufactures **DISC & CHIP** style thermistors in resistance values ranging from 1.0 ohm to 500,000 ohms. These devices are suitable for a range of resistance values and temperature coefficients from relatively low resistance and temperature coefficients to very high values. Precision resistance tolerances are available to 1%. Standard resistance tolerances are from 5% to 20%. All tolerances are specified at 25°C or may be specified at any temperature within the operating temperature range of the thermistor.

Thermistor Terminology for Temperature Measurement & Control Devices

- **D.C.** - The dissipation constant is the ratio, normally expressed in milliwatts per degree C (mw/°C), at a specified ambient temperature, of a change in power dissipated in a thermistor to the resultant change in body temperature.
- **T.C.** - The thermal time constant is the time required for a thermistor to change 63.2% of the total difference between its initial and final body temperature when subjected to a step function change in temperature under zero-power conditions and is normally expressed in seconds (S).
- **Alpha (α) or Temperature Coefficient or Resistance** - The temperature coefficient of resistance is the ratio at a specified temperature, T, of the rate of change of zero-power resistance with temperature to the zero-power resistance of the thermistor. The temperature coefficient is commonly expressed in percent per degree C (%/°C).

$$\alpha_T = \Delta R_T / \Delta T$$

NTC DISC & CHIP Selection Considerations

- Select Req'd. Resistance Value & Temperature Coefficient
- Determine Accuracy Req'd.
- Review Power Dissipation

Applications
Time and temperature are two of the most frequently measured variables. There are numerous ways of the measuring temperature electronically, most commonly by thermocouples and negative temperature coefficient (NTC) thermistors. For general purpose temperature measurement, NTC temperature sensors can operate over a wide temperature range (-55 to +300°C). They are stable throughout a long lifetime,

and are small and comparatively inexpensive. Typically, they have negative temperature coefficients between -3.3 and -4.9%/°C at 25°C. This is more than ten (10) times the sensitivity of a platinum resistance thermometer of the same nominal resistance. RTI's **DISC & CHIP** style thermistors are used in many applications that require a high degree of accuracy and reliability.

Some of the most popular applications of NTC thermistors include:

- Temperature Compensation

- Determine Operating Temperature Range
- Review Thermal Time Constant

- Temperature Measurement & Control
- Fan Motor Control
- Fluid Level & Temperature Sensors

Selection considerations for NTC DISC & CHIP Devices

Power dissipation is a common problem in the use of thermistors as they can only dissipate a certain amount of power. If the power dissipated exceeds the dissipation constant (D.C.) rating of the sensor it is likely that it will exhibit self heating. Most thermistors dissipate from 1 to 25 mW/°C nominal. This means that the resistance changes by an equivalent of 1°C for each D.C. rating (mW/°C) for the selected device. To maintain a higher degree of accuracy, temperature error caused by self-heating should be an order of magnitude less than the required sensor accuracy. For many applications, this degree of accuracy is not required and a less stringent de-rating may be adequate. Several options to reduce the thermistor power are to increase the thermistor resistance, lower the source voltage and/or increase the series resistor in the divider circuit.

As an example, if the D.C. of the thermistor selected is 5 mW/°C and the power dissipated by the device is 20 mW/°C, then a 4°C error is induced due to the effect of self-heating. To minimize this effect, a factor can be derived simply by taking the DC rating times 10^{-1} (one order of magnitude lower) and use it in the power equation to produce a good approximation of the maximum allowable power. For instance, if the desired accuracy is 1°C, and the rated D.C. of the device selected is 5 mW/°C, adjusting the specified D.C. rating in the power equation to 0.5 mW/°C compensates for self-heating error and effectively predicts the maximum power the device can dissipate without significantly affecting the desired accuracy. The resulting maximum power that should be applied would be calculated as 1°C*0.5mW/°C = 0.5mW.

NTC DISC & CHIP - Selection Process

- Select R Value
- Determine R @ T
- Calculate DEV for R @ T
- Evaluate Power Rating (D.C.)
- Review T.C. Requirements

NTC Standard Chip Thermistor Specifications

Part Number	Resistance @25°C (Ohms) ±10%	R-T Curve	THK (in.)	D.C.	T.C.
05CA101K	100	A	0.020	2	2
05CA151K	150	A	0.025	2	2
05CA201K	200	A	0.030	2	2
05CA251K	250	A	0.040	2	2
05CA301K	300	A	0.050	2	3
05CA401K	400	A	0.070	2	3
05CA501K	500	A	0.080	2	3
05CB102K	1,000	B	0.020	2	2
05CB152K	1,500	B	0.025	2	2
05CB202K	2,000	B	0.030	2	2
05CB302K	3,000	B	0.050	2	3
05CB402K	4,000	B	0.070	2	3
05CB502K	5,000	B	0.080	2	3
05CC802K	8,000	C	0.020	2	2
05CC103K	10,000	C	0.025	2	2
05CC153K	15,000	C	0.035	2	2
05CC203K	20,000	C	0.050	2	3
05CC253K	25,000	C	0.060	2	3
05CC303K	30,000	C	0.075	2	3
05CE104K	100,000	E	0.030	2	2
05CE154K	150,000	E	0.045	2	2
05CE204K	200,000	E	0.060	2	2
05CE304K	300,000	E	0.090	2	3
05CE404K	400,000	E	0.120	2	3
05CE504K	500,000	E	0.150	2	3
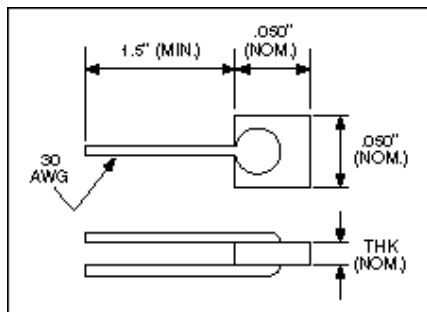
Maximum Temperature rating: 150°C

NTC Standard Disc Thermistor Specifications

Part Number	Resis. @25°C (Ohms) ±10%	R-T Curve	D (in.)	THK (in.)	D.C.	T.C.	Leads AWG#	S (in.)
5DA4R0K	4	A	0.50	0.065	14	60	22	0.330
5DA5R0K	5	A	0.50	0.080	15	70	22	0.330
2DA100K	10	A	0.20	0.025	7	18	24	0.100
3DA100K	10	A	0.30	0.060	8	48	24	0.100
5DA100K	10	A	0.50	0.150	17	120	22	0.330
3DA150K	15	A	0.30	0.090	8	55	24	0.100
2DA200K	20	A	0.20	0.050	7	20	24	0.100
1DA300K	30	A	0.10	0.020	3	5	28	0.070
2DA300K	30	A	0.20	0.075	7	25	24	0.100
1DA500K	50	A	0.10	0.030	3	6	28	0.070
2DA500K	50	A	0.20	0.120	7	30	24	0.100
3DB500K	50	B	0.30	0.025	8	35	24	0.100
4DB500K	50	B	0.40	0.045	9	50	22	0.330
1DA101K	100	A	0.10	0.060	3	10	28	0.070
2DB101K	100	B	0.20	0.025	7	18	24	0.100
2DB151K	150	B	0.20	0.035	7	19	24	0.100
2DB201K	200	B	0.20	0.050	7	20	24	0.100
2DB301K	300	B	0.20	0.070	7	25	24	0.100
3DB301K	300	B	0.30	0.150	9	75	24	0.100
1DB501K	500	B	0.10	0.030	3	6	28	0.070
2DB501K	500	B	0.20	0.120	7	30	24	0.100
4DC501K	500	C	0.40	0.070	9	65	22	0.330
1DB102K	1,000	B	0.10	0.060	3	10	28	0.070
2DC102K	1,000	C	0.20	0.035	7	18	24	0.100
3DC102K	1,000	C	0.30	0.080	8	48	24	0.100
1DB202K	2,000	B	0.10	0.120	4	14	28	0.070
2DC202K	2,000	C	0.20	0.070	7	25	24	0.100
2DC302K	3,000	C	0.20	0.100	7	30	24	0.100
3DC302K	3,000	C	0.30	0.210	10	90	24	0.100
2DC402K	4,000	C	0.20	0.125	7	32	24	0.100
1DC502K	5,000	C	0.10	0.040	3	8	28	0.070
2DC502K	5,000	C	0.20	0.160	8	36	24	0.100
1DC103K	10,000	C	0.10	0.080	4	12	28	0.070
2DE103K	10,000	E	0.20	0.040	7	17	24	0.100
3DE103K	10,000	E	0.30	0.085	8	48	24	0.100
2DE203K	20,000	E	0.20	0.075	7	20	24	0.100
2DE303K	30,000	E	0.20	0.115	7	25	24	0.100
1DE503K	50,000	E	0.10	0.050	3	6	28	0.070
2DE503K	50,000	E	0.20	0.190	7	30	24	0.100
1DE104K	100,000	E	0.10	0.095	3	9	28	0.070
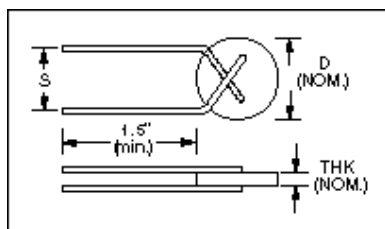
Maximum temperature rating: 150° C
Standard resistance tolerances:
J=5%, K=10%, L=15%, M=20%
Other resistance tolerances available.

NTC DISC & CHIP - Configuration Options

DISC

- Leaded Insulated/Non-insulated
- Without Leads
- Pre-formed Leads

CHIP

- Standard size 0.050" x 0.050" x "T"
- Leaded
- Epoxy Coated
- Un-coated

NTC Resistance/Temperature Conversion Tables

Temp. °C	R-T Curve A		R-T Curve B		R-T Curve C		R-T Curve E	
	RT/R25	DEV	RT/R25	DEV	RT/R25	DEV	RT/R25	DEV
-60	43.0		75.0	6.6	140.5	6.6		
-55	31.9		54.1	6.1	96.4	6.1	131.0	
-50	24.3		39.7	5.6	67.0	5.6	97.5	
-45	18.6		29.2	5.2	47.2	5.2	66.6	
-40	14.4	7.6	21.7	4.7	33.7	4.7	45.5	7.6
-35	11.3	6.9	16.4	4.3	24.3	4.3	32.3	6.9
-30	8.93	6.2	12.5	3.8	17.7	3.8	23.0	6.2
-25	7.10	5.6	9.58	3.4	13.0	3.4	16.5	5.6
-20	5.69	5.0	7.42	3.0	9.71	3.0	12.0	5.0
-15	4.56	4.4	5.75	2.6	7.30	2.6	8.79	4.4
-10	3.68	3.7	4.50	2.2	5.53	2.2	6.51	3.7
-5	2.99	3.1	3.55	1.9	4.23	1.9	4.86	3.1
0	2.45	2.5	2.82	1.5	3.27	1.5	3.71	2.5
5	2.02	2.0	2.26	1.2	2.54	1.2	2.79	2.0
10	1.68	1.6	1.83	0.8	1.99	0.8	2.13	1.6
15	1.42	1.1	1.48	0.5	1.57	0.5	1.65	1.1
20	1.18	0.6	1.22	0.2	1.25	0.2	1.28	0.6
25	1.00	0.0	1.00	0.0	1.00	0.0	1.00	0.0
30	0.854	0.6	0.828	0.4	0.806	0.4	0.787	0.6
35	0.732	1.1	0.689	0.7	0.653	0.7	0.623	1.1
40	0.628	1.6	0.576	1.0	0.533	1.0	0.496	1.6
45	0.537	2.0	0.482	1.3	0.437	1.3	0.398	2.0
50	0.464	2.5	0.406	1.5	0.360	1.5	0.320	2.5
55	0.403	3.0	0.343	1.8	0.299	1.8	0.259	3.0
60	0.350	3.4	0.292	2.0	0.249	2.0	0.211	3.4
65	0.305	3.8	0.247	2.3	0.208	2.3	0.172	3.6
70	0.267	4.2	0.212	2.5	0.175	2.5	0.141	4.2
75	0.236	4.6	0.182	2.8	0.148	2.8	0.114	4.6
80	0.208	4.9	0.157	3.0	0.126	3.0	0.0962	4.9
85	0.183	5.3	0.137	3.2	0.107	3.2	0.0799	5.3
90	0.163	5.6	0.120	3.4	0.0916	3.4	0.0666	5.6
95	0.145	6.0	0.105	3.6	0.0787	3.6	0.0588	6.0
100	0.130	6.3	0.0920	3.8	0.0679	3.8	0.0468	6.3
105	0.117	6.7	0.0812	4.0	0.0588	4.0	0.0395	6.7
110	0.105	7.0	0.0723	4.2	0.0511	4.2	0.0333	7.0
115	0.0943	7.3	0.0641	4.4	0.0445	4.4	0.0283	7.3
120	0.0852	7.6	0.0569	4.6	0.0389	4.6	0.0241	7.6
125	0.0771	7.9	0.0508	4.8	0.0342	4.8	0.0205	7.9
130	0.0700	8.2	0.0455	4.9	0.0301	4.9	0.0176	8.2
135	0.0636	8.4	0.0408	5.1	0.0265	5.1	0.0151	8.4
140	0.0579	8.6	0.0368	5.3	0.0235	5.3	0.0130	8.6
145	0.0529	9.0	0.0332	5.4	0.0208	5.4	0.0112	9.0
150	0.0483	9.3	0.0300	5.5	0.0185	5.5	0.0101	9.3

NTC Resistance/Temperature Curve Characteristics

R-T Curve	A	B	C	E
Temp. Coeff. (ɑ @ 25°C)	-3.3%/°C	-3.9%/°C	-4.4%/°C	-4.9%/°C
Beta, ß	3000°K	3530°K	3965°K	4500°K

R@0°C/R@50°C	5.3±5%	6.9±3%	9.1±3%	11.6±5%
R@25°C/R@125°C	13.0	19.8	29.4	48.7

Resistance at Temperature:

To determine the nominal resistance value of a thermistor at a specified temperature, multiply its R_T/R_{25} value for the desired temperature and R-T curve from the table above by its nominal resistance value at 25°C. For instance, the nominal resistance value at 80°C for a thermistor with part number 1DC103K is 10,000 times 0.126, the R_T/R_{25} value in R-T Curve C table above, or 1,260 ohms.

Resistance Tolerances:

The standard resistance tolerance at 25°C for RTI's NTC thermistors is ±10% and is indicated in its part number by the addition of the suffix K. However, RTI's thermistors may also be supplied with other resistance tolerances. To determine a thermistor's resistance tolerance at a temperature other than 25°C, add the appropriate DEV value from the R-T Curve table above to its resistance tolerance at 25°C. For instance, the resistance tolerance at 80°C for a thermistor with part number 1DC103K is ±10% ±3.0%, the DEV value from the R-T Curve C table above or ±13%.

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