



Precision Temperature Measurement and Control Devices

Interchangeables

NTC Thermistors

ACCU-CURVE™

Features

- **Wide Ohmic Value Range**
- **Accurate & Stable**
- **D.C. 1mW/°C**
- **Fast Thermal Response Time**
- **T.C. 10 Sec. in Air**
- **Compact Epoxy Package Style**
- **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 the 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.

Interchangeable Thermistors

RTI manufactures precision resistance-temperature matched **ACCU-CURVE™** thermistors. These devices offer interchangeability over a broad temperature range and eliminate the need to individually calibrate or provide circuit compensation for part variability. Accurate temperature measurement to $\pm 0.2^\circ\text{C}$ is available over the 0°C to 70°C temperature range. Standard ohmic values at 25°C range from 2,252 to 100,000 ohms.

Thermistor Terminology for Temperature Measurement & Control Devices

- **D.C.** - The dissipation constant is the ratio, normally expressed in milliwatts per degree C ($\text{mw}/^\circ\text{C}$), 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 of 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 ($\%/^\circ\text{C}$).

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



Applications

There are numerous ways of measuring temperature electronically. Improvements in thermistor technology, coupled with the introduction of integrated circuitry, have made precision temperature measurement systems very cost effective. Microprocessors, A/D converters, interface electronics and displays are readily available. Circuit designs with built-in thermistor resistance-temperature algorithms have gained wide spread acceptance in precision temperature metrology. RTI's **ACCU-CURVE™** style thermistors are used in many applications that require a high degree of accuracy and reliability.

Some of the most popular applications of NTC **ACCU-CURVE™** thermistors include:

- Temperature Measurement & Control
- Temperature Sensors

ACCU-CURVE™ Selection Considerations

- **Determine Resistance Value & Temperature Coefficient**
- **Determine Accuracy Req'd.**
- **Review Power Dissipation**
- **Select Temperature Range**
- **Review Thermal Time Constant**

Selection Considerations for NTC **ACCU-CURVE™** Devices

Interchangeable **ACCU-CURVE™** NTC thermistors are usually selected when a high degree of measurement accuracy is required over a wide temperature range. By modifying the **Alpha** equation the resistance and temperature tolerances can be calculated for various temperature intervals. ($\Delta T = \Delta R / (\alpha * R)$ and $\Delta R = \alpha * R * \Delta T$) Because thermistors are non-linear with respect to their resistance-temperature characteristics, **Alpha** therefore is non-linear across their resistance-temperature range. As an example, a thermistor material curve with an **Alpha** of -4.4%/°C @ 25°C will have an **Alpha** of -3.8%/°C @ 50°C. For practical applications we recommend that the standardized R/T curves be used.

RTI **ACCU-CURVE™** thermistors can dissipate 1mW/°C. As a result, the possibility of error induced by excessive current flow, which would defeat the level of accuracy these devices are capable of representing, may exist in some circuits. To prevent this type of error, RTI recommends that circuit design engineers select the highest R value their circuit will tolerate for applications > 5 Volts to minimize any self-heating of the thermistor device. Refer to the **ACCU-CURVE™ Specifications** table for resistance values and temperature tolerances.

RTI offers two standard R/T curves, "C" & "W", with temperature coefficients of resistance (α) of -4.4%/°C and -4.7%/°C, and Beta (β) values of 3965°K and 4250°K. To determine the nominal resistance value of a thermistor at a specified temperature, multiply its resistance at 25°C value by the corresponding R_T/R_{25} value for the desired temperature and applicable R-T curve from the **ACCU-CURVE™ Resistance/Temperature Conversion Table**.



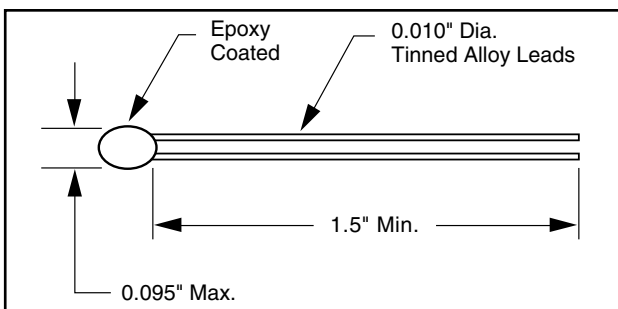
ACCU-CURVE™ Specifications

Resistance @ 25° C (Ω)	Temperature Tolerance from 0° C to 70° C			Color Code
	±0.2° C	±0.5° C	±1.0° C	
	Part Number	Part Number	Part Number	
2,252	ACCX-001	ACCX-011	ACCX-021	Brown
3,000	ACCX-002	ACCX-012	ACCX-022	Red
5,000	ACCX-003	ACCX-013	ACCX-023	Orange
10,000	ACCX-004	ACCX-014	ACCX-024	Yellow
30,000	ACCX-005	ACWX-015	ACWX-025	Green
50,000	ACCX-006	ACWX-016	ACWX-026	Blue
100,000	ACCX-007	ACWX-017	ACWX-027	Violet

ACCU-CURVE™ Resistance/Temperature Table

RESISTANCE (Ω)

TEMP (°C)	"C" CURVES				"W" CURVES		
	2,252Ω @ 25°C	3,000Ω @ 25°C	5,000Ω @ 25°C	10,000Ω @ 25°C	30,000Ω @ 25°C	50,000Ω @ 25°C	100,000Ω @ 25°C
-40	75,780	100,950	168,250	336,500	1,204,600	2,007,700	4,015,500
-30	39,860	53,100	88,500	177,000	619,200	1,032,000	2,064,000
-20	21,860	29,121	48,535	97,070	331,030	551,720	1,103,400
-10	12,460	16,599	27,665	55,330	183,560	305,940	611,870
0	7,352.8	9,795.0	16,325	32,650	105,310	175,510	351,020
10	4,481.5	5,970.0	9,950.0	19,900	62,354	103,920	207,850
20	2,812.8	3,747.0	6,245.0	12,490	38,022	63,370	126,740
25	2,252.0	3,000.0	5,000.0	10,000	30,000	50,000	100,000
30	1,814.4	2,417.1	4,028.5	8,057.0	23,827	39,711	79,422
40	1,199.6	1,598.1	2,663.3	5,327.0	15,314	25,524	51,048
50	811.40	1,080.9	1,801.5	3,603.0	10,077	16,795	33,591
60	560.30	746.40	1,244.0	2,488.0	6,777.1	11,295	22,590
70	394.55	525.60	876.00	1,752.0	4,650.5	7,750.9	15,502
80	282.63	376.50	627.50	1,255.0	3,251.2	5,418.7	10,837
90	206.13	274.59	457.65	915.30	2,312.3	3,853.9	7,707.7
100	152.75	203.49	339.15	678.30	1,670.8	2,784.6	5,569.3
110	114.92	153.09	255.15	510.30	1,224.9	2,041.5	4,082.9
120	87.671	116.79	194.65	389.30	909.99	1,516.7	3,033.3
130	67.770	90.279	150.47	300.93	684.31	1,140.5	2,281.0
140	52.983	70.581	117.64	235.27	520.30	867.16	1,734.3
150	41.881	55.791	92.985	185.97	399.56	665.94	1,331.9



The **ACCU-CURVE™** device can also be supplied with 30 AWG solid Teflon insulated leads of 3, 6, 9 and 12 inches in length. contact RTI applications engineering for additional information.

WARNING: USE HEAT SINKS WHEN SOLDERING TO THERMISTOR LEADS.



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ACCU-CURVE™ Resistance/Temperature Conversion Tables

ACCX-0XX “C” CURVE

TEMP. °C	R _T /R ₂₅
0	3.2650
1	3.1030
2	2.9500
3	2.8050
4	2.6690
5	2.5390
6	2.4170
7	2.3010
8	2.1920
9	2.0880
10	1.9900
11	1.8970
12	1.8090
13	1.7250
14	1.6460
15	1.5710
16	1.5000
17	1.4320
18	1.3680
19	1.3070
20	1.2490
21	1.1940
22	1.1420
23	1.0920
24	1.0450
25	1.0000
26	0.9573
27	0.9167
28	0.8777
29	0.8407
30	0.8057
31	0.7723
32	0.7403
33	0.7097
34	0.6807
35	0.6530

TEMP. °C	R _T /R ₂₅
36	0.6267
37	0.6017
38	0.5777
39	0.5547
40	0.5327
41	0.5117
42	0.4917
43	0.4727
44	0.4543
45	0.4370
46	0.4200
47	0.4040
48	0.3890
49	0.3743
50	0.3603
51	0.3467
52	0.3340
53	0.3217
54	0.3099
55	0.2986
56	0.2878
57	0.2774
58	0.2675
59	0.2579
60	0.2488
61	0.2400
62	0.2316
63	0.2235
64	0.2157
65	0.2083
66	0.2011
67	0.1942
68	0.1876
69	0.1813
70	0.1752

ACWX-0XX “W” CURVE

TEMP. °C	R _T /R ₂₅
0	3.5102
1	3.3264
2	3.1532
3	2.9899
4	2.8360
5	2.6908
6	2.5539
7	2.4246
8	2.3026
9	2.1873
10	2.0785
11	1.9756
12	1.8784
13	1.7865
14	1.6995
15	1.6173
16	1.5395
17	1.4658
18	1.3961
19	1.3300
20	1.2674
21	1.2081
22	1.1519
23	1.0985
24	1.0480
25	1.0000
26	0.9545
27	0.9113
28	0.8702
29	0.8313
30	0.7942
31	0.7590
32	0.7256
33	0.6938
34	0.6636
35	0.6348

TEMP. °C	R _T /R ₂₅
36	0.6074
37	0.5814
38	0.5566
39	0.5330
40	0.5105
41	0.4891
42	0.4686
43	0.4492
44	0.4306
45	0.4129
46	0.3961
47	0.3800
48	0.3646
49	0.3499
50	0.3359
51	0.3225
52	0.3098
53	0.2976
54	0.2859
55	0.2748
56	0.2641
57	0.2539
58	0.2442
59	0.2348
60	0.2259
61	0.2174
62	0.2092
63	0.2014
64	0.1939
65	0.1867
66	0.1798
67	0.1732
68	0.1669
69	0.1608
70	0.1550

To determine the nominal resistance value of a thermistor at a specified temperature, multiply its R_T/R₂₅ value for the desired temperature and R-T curve from the table above by its nominal resistance at 25°C.