Analog Technologies

High Accuracy Miniature Thermistor

ATH1R80M0.1%200CL5R3

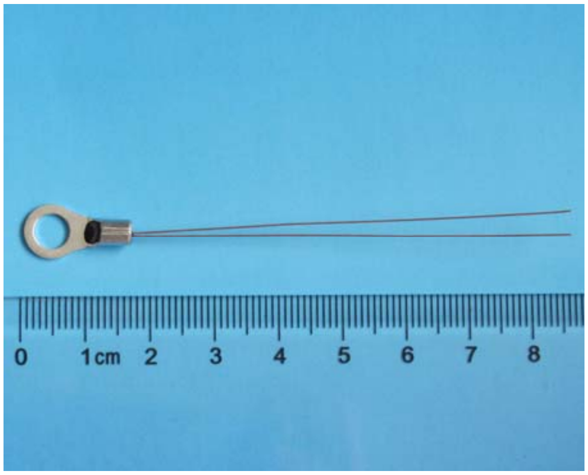

Figure 1. Physical Photo of ATH1R80M0.1%200CL5R3

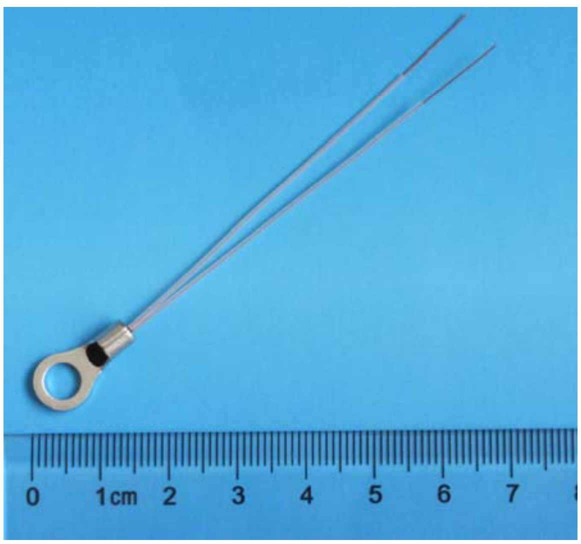

Figure 2. Physical Photo of ATH1R80M0.1%200CL5R3T70

MAIN FEATURES

- Glass Encapsulated for Long Term Stability & Reliability
- High Resistance Accuracy: 0.1%
- Temperature error: ±0.2°C
- Maximum Temp. Range: 0°C to 340°C
- Packaged in Extra Small Ring Lug
- 100 % Lead (Pb)-free and RoHS Compliant

APPLICATION AREAS

Temperature sensing for laser diodes, optical components, etc.

DESCRIPTIONS

The ATH1R80M0.1%200CL5R3 is a thermistor assembly with a glass encapsulated thermistor packaged in an extra compact ring lug. The ATH1R80M0.1%200CL5R3 series thermistor consists of three versions, ATH1R80M0.1%200CL5R3, ATH1R80M0.1%200CL5R3T70 and ATH1R80M0.1%200CL5R3T70S. The ATH1R80M0.1%200CL5R3 has bare leads coated with copper, the ATH1R80M0.1%200CL5R3T70S has the leads covered by high temperature plastic tubing and sealed by epoxy, while the ATH1R80M0.1%200CL5R3T70 is the non-sealed version with the plastic tubing. Comparing with conventional assemblies containing epoxy encapsulated thermistors, ATH1R80M0.1%200CL5R3 series thermistor presents higher long term stability, higher reliability and wider temperature range. In addition, it has a small size and short response time.

The ATH1R80M0.1%200CL5R3 series thermistor can be used to measure the temperatures of laser diodes, optical components, etc., with high accuracy and long term stability.

CUSTOMIZATION: We can customize the thermistor with different resistance and temperature errors:

A. The maximum resistance error is 0.1% when the object temperature is reached.

B. The most accurate temperature error is ±0.2°C when the object resistance is reached.

Please specify the requirements when you need a customized high stability thermistor.

SPECIFICATIONS

Parameters	Value
Nominal Resistance @ 25°C	1388.1K ± 0.1%
Nominal Resistance @ 200°C	4K ± 0.1%
B Value @ 200°C /300°C	5133K ± 0.1%
R@25°C / R@50°C	436.29K
R@25°C / R@85°C	107.66K
Ring Lug Length	16.5 ± 0.1mm
Ring Lug Width	8.5 ± 0.1mm
Ring Hole Diameter	5.3 ± 0.1mm
Lead Diameter	0.2mm
Lead Length	70 ± 1mm

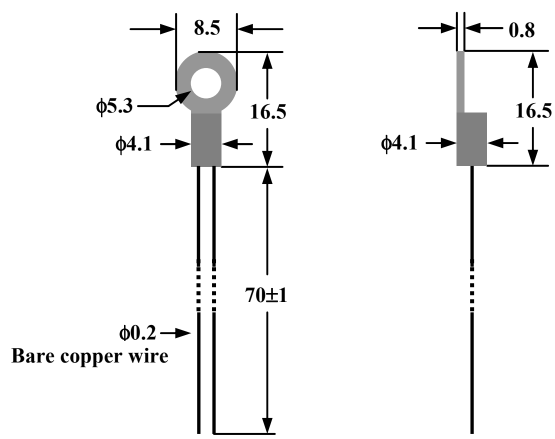

Figure 3. The Front and Side Views of ATH1R80M0.1%200CL5R3

APPLICATIONS

Use #2 imperial or M2.5 metric screw to mount the thermistor assembly onto a smooth metal surface of the object for which the temperature needs to be measured.

The thermistor lead wires are made of plain copper, make sure that they do not touch each other, nor any other electrically conductive objects.

For high precision applications, use a cover which is made of thermal isolation material to cover the thermistor area, see Figure 4. In this way, the air flow will not affect the temperature sensing accuracy.

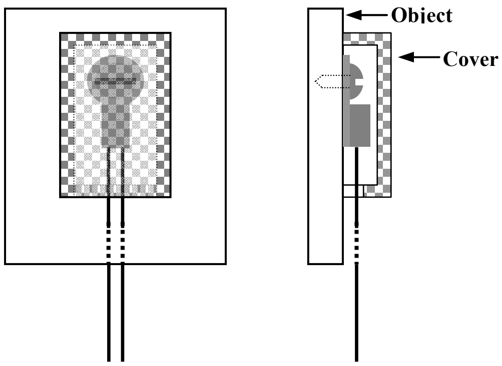

Figure 4. Using an Insulation Cover to Improve Accuracy

CAUTIONS

1. Do not apply a large DC voltage across the thermistor in the temperature sensing circuit. The thermistors self-heating temperature is about 1°C/mW. By injecting a 10μA current into the thermistor, it consumes 1mW and the self-heating temperature is about 1°C if the thermistor is placed in still air. Therefore, the sensing current needs to be much lower than 10μA when the thermistor is placed in the air for high accuracy applications. Injecting short current pulses into the thermistor is one of the ways to reduce the average current level on the thermistor in order to minimize the self-heating effect.
2. Handle the thermistor with care, do not use metal tools to hold the thermistor body with excessive force, otherwise, the glass body may crack, affecting its accuracy and stability.

Thermistor Resistance

Beta Value (β)

A simple approximation for the relationship between the resistance and temperature for ATH1R80M0.1%200CL5R3 is to use an exponential approximation. This approximation is based on simple curve fitting to experimental data and uses two points on a curve to determine the value of β. The equation relating resistance to temperature using β is:

$$R = Ae^{\frac{\beta}{T}};$$

Where:

R = thermistor resistance at temp T,
A = constant of equation,
β = beta, the material constant,
T = thermistor temperature in °K(Kelvin),

To calculate β for any given temperature range, the following formula applies:

$$\beta = \ln(R_{T1}/R_{T2})/(1/T1 - 1/T2);$$

Where β is measured in K, R_{T1} is the resistance at T1, while R_{t2} is the resistance at T2.

β can be used to compare the relative steepness of ATH1R80M0.1%200CL5R3 curves. However, the value of β will vary depending on the temperatures used for calculating the value. For example, to calculate β for the temperature range of 25°C to 50°C:

T1 = (25 + 273.15)°K = 298.15°K,
T2 = (50 + 273.15)°K = 323.15°K,
R_{T1} = 10KΩ,
R_{T2}= 3.6085KΩ;

This value of β would be referenced as β25°C/50°C, and calculated as:

β25°C/50°C = ln(10/3.6085) / (1/298.15 – 1/323.15) = 3950K;

By using the same formula, β25°C/85°C, will be:

β25°C/85°C= ln(10/1.0786) / (1/298.15 – 1/358.15) = 3990K.

When using the β value to compare 2 thermistors, make sure that the β values are calculated based on the same 2 temperature points.

Temperature Coefficient of Resistance (α)

Another way to characterize the R-T curve of the ATH1R80M0.1%200CL5R3 is to use the slope of the resistance versus temperature (R/T) curve at one temperature. By definition, the resistance slope vs. temperature is given by:

$$\alpha = (1/R)\times(dR/dT);$$

Where T is the temperature in °C or ° K, R is the resistance at temperature T.

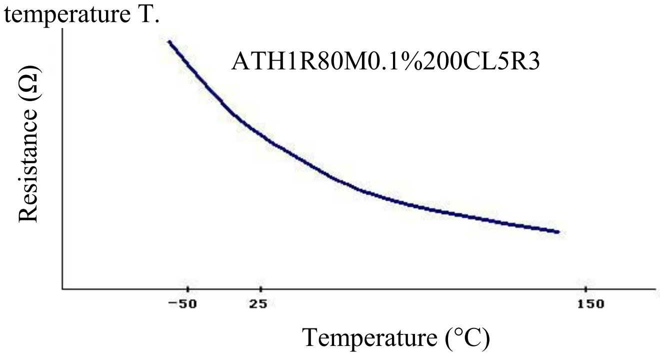

Figure 5. Resistance vs. Temperature

As shown in Figure 5, the steepest position of the ATH1R80M0.1%200CL5R3 curve is at colder temperatures.

The temperature coefficient is one method that can be used for comparing the relative steepness of the curves. It is highly recommended to compare the temperature coefficient at the same temperature because α varies widely over the operating temperature range.

Resistance Ratio (Slope)

The resistance ratio, or slope, for thermistors is defined as the ratio of the resistance at one temperature to the resistance at a higher temperature. As with resistance ratios, this method will vary depending on the temperatures used for calculating the value. This method can also be used to compare the relative steepness of two curves. There is no industry standard for the two temperatures that are used to calculate the ratio, we can select two common temperatures from the table below, for example, 25°C and 50°C, then the result of this calculation: R@25°C / R@50°C, will be:

R@25°C / R@50°C = 10/3.6085 = 2.771;

And this calculation: R@25°C/R@85°C, will be:

R@25°C / R@85°C = 10/1.0786 = 9.271.

Steinhart-Hart Thermistor Equation

The Steinhart-Hart Equation is an empirically derived polynomial formula which does best in describing the relationship between the resistance and the temperature of ATH1R80M0.1%200CL5R3, which is much more accurate than β mathod. To solve for temperature when resistance is known, yields the following equation:

$$1/T = a + b(\ln R) + C(\ln R)^3;$$

Where:

T = temperature in °K (Kelvin),
a, b and c are equation constants,
R = resistance in Ω at temp T;

To solve for resistance when the temperature is known, the form of the equation is:

$$R = e^{\left[\left(-\frac{x}{2}+\left(\frac{x^2}{4}+\frac{\psi^3}{27}\right)^{\frac{1}{2}}\right)^{\frac{1}{3}}+\left(-\frac{x}{2}-\left(\frac{x^2}{4}+\frac{\psi^3}{27}\right)^{\frac{1}{2}}\right)^{\frac{1}{3}}\right]};$$

Where:

$$x = \frac{a - 1/T}{c},\ \psi = \frac{b}{c}.$$

The a, b and c constants can be calculated for either a thermistor material or for individual values of the thermistors within a material type. To solve for the constants, three sets of data must be used. Normally, for a temperature range, the low end, middle end and high end values are used to calculate the constants, resulting in the best fit for the equation over the range. Using the Steinhart-Hart equation allows for accuracy as good as ±0.001ºC over a 100ºC temperature span.

Resistance Temperature Characteristics

Temp ºC	Resistance KΩ	Temp ºC	Resistance KΩ	Temp ºC	Resistance KΩ	Temp ºC	Resistance KΩ	Temp ºC	Resistance KΩ
0	5163.2	46	520.06	92	83.609	138	19.172	184	5.768
1	4882.7	47	497.56	93	80.698	139	18.629	185	5.634
2	4618.8	48	476.13	94	77.901	140	18.103	186	5.503
3	4370.3	49	455.73	95	75.213	141	17.595	187	5.376
4	4136.5	50	436.29	96	72.629	142	17.103	188	5.252
5	3916.2	51	417.77	97	70.146	143	16.627	189	5.131
6	3708.8	52	400.13	98	67.759	144	16.166	190	5.014
7	3513.3	53	383.31	99	65.464	145	15.719	191	4.900
8	3329.0	54	367.27	100	63.256	146	15.287	192	4.789
9	3155.3	55	351.98	101	61.133	147	14.869	193	4.681
10	2991.5	56	337.39	102	59.090	148	14.464	194	4.576
11	2836.9	57	323.48	103	57.124	149	14.072	195	4.473
12	2691.1	58	310.20	104	55.233	150	13.691	196	4.374
13	2553.5	59	297.53	105	53.412	151	13.323	197	4.276
14	2423.5	60	285.44	106	51.659	152	12.966	198	4.182
15	2300.8	61	273.89	107	49.972	153	12.621	199	4.090
16	2184.9	62	262.86	108	48.347	154	12.285	200	4.000
17	2075.3	63	252.33	109	46.782	155	11.961	201	3.913
18	1971.8	64	242.26	110	45.274	156	11.646	202	3.827
19	1873.9	65	232.65	111	43.822	157	11.340	203	3.745
20	1781.4	66	223.45	112	42.423	158	11.044	204	3.664
21	1693.8	67	214.67	113	41.074	159	10.757	205	3.585
22	1611.0	68	206.27	114	39.774	160	10.479	206	3.508
23	1532.6	69	198.23	115	38.521	161	10.209	207	3.433
24	1458.4	70	190.55	116	37.313	162	9.947	208	3.360
25	1388.1	71	183.19	117	36.148	163	9.693	209	3.289
26	1321.5	72	176.16	118	35.024	164	9.446	210	3.220
27	1258.5	73	169.43	119	33.940	165	9.207	211	3.152
28	1198.7	74	162.98	120	32.894	166	8.974	212	3.086
29	1142.1	75	156.81	121	31.885	167	8.749	213	3.022
30	1088.4	76	150.90	122	30.912	168	8.530	214	2.959
31	1037.5	77	145.24	123	29.972	169	8.317	215	2.898
32	989.20	78	139.82	124	29.065	170	8.111	216	2.839
33	943.38	79	134.62	125	28.189	171	7.911	217	2.780
34	899.89	80	129.64	126	27.344	172	7.716	218	2.724
35	858.61	81	124.87	127	26.527	173	7.527	219	2.668
36	819.42	82	120.29	128	25.738	174	7.343	220	2.614
37	782.20	83	115.91	129	24.976	175	7.165	221	2.561
38	746.84	84	111.70	130	24.240	176	6.991	222	2.510
39	713.24	85	107.66	131	23.529	177	6.823	223	2.460
40	681.31	86	103.79	132	22.842	178	6.659	224	2.411
41	650.96	87	100.07	133	22.177	179	6.500	225	2.363
42	622.10	88	96.506	134	21.535	180	6.345	226	2.316
43	594.65	89	93.083	135	20.914	181	6.195	227	2.270
44	568.55	90	89.796	136	20.314	182	6.049	228	2.226
45	543.71	91	86.640	137	19.733	183	5.906	229	2.182

Temp °C	Resistance KΩ	Temp °C	Resistance KΩ	Temp °C	Resistance KΩ	Temp °C	Resistance KΩ	Temp °C	Resistance KΩ
230	2.140	253	1.389	276	0.9341	299	0.6487	322	0.4636
231	2.098	254	1.364	277	0.9188	300	0.6390	323	0.4571
232	2.057	255	1.340	278	0.9038	301	0.6294	324	0.4508
233	2.018	256	1.316	279	0.8892	302	0.6200	325	0.4445
234	1.979	257	1.293	280	0.8748	303	0.6107	326	0.4384
235	1.941	258	1.270	281	0.8607	304	0.6016	327	0.4324
236	1.904	259	1.248	282	0.8469	305	0.5927	328	0.4265
237	1.868	260	1.226	283	0.8333	306	0.5840	329	0.4207
238	1.833	261	1.205	284	0.8200	307	0.5754	330	0.4149
239	1.798	262	1.184	285	0.8070	308	0.5670	331	0.4093
240	1.765	263	1.164	286	0.7942	309	0.5587	332	0.4038
241	1.732	264	1.144	287	0.7817	310	0.5506	333	0.3984
242	1.699	265	1.124	288	0.7694	311	0.5426	334	0.3930
243	1.668	266	1.105	289	0.7574	312	0.5347	335	0.3878
244	1.637	267	1.086	290	0.7455	313	0.5270	336	0.3826
245	1.607	268	1.068	291	0.7339	314	0.5195	337	0.3775
246	1.577	269	1.050	292	0.7226	315	0.5120	338	0.3725
247	1.549	270	1.033	293	0.7114	316	0.5047	339	0.3676
248	1.520	271	1.015	294	0.7005	317	0.4976	340	0.3628
249	1.493	272	0.9984	295	0.6897	318	0.4905		
250	1.466	273	0.9818	296	0.6792	319	0.4836		
251	1.440	274	0.9656	297	0.6689	320	0.4768		
252	1.414	275	0.9497	298	0.6587	321	0.4701		

NAMING

A TH 1R38M 0.1% 200C L5R3 T70 S

- S — Sealed
- T70 — Tubing and its length
- L5R3 — Length
- 200C — Temperature at test point
- 0.1% — Accuracy
- 1R38M — Nominal Resistance @ 25°C
- TH — Thermistor
- A — Company code: Analog Technologies, Inc.

ORDERING INFORMATIONS

Quantity	1 – 9	10 – 49	50 – 199	200 – 499	≥500
ATH1R80M0.1%200CL5R3	$6.75	$6.00	$5.25	$4.50	$3.75
ATH1R80M0.1%200CL5R3T70	$7.00	$6.25	$5.50	$4.75	$4.00
ATH1R80M0.1%200CL5R3T70S	$7.25	$6.50	$5.75	$5.00	$4.25

CUSTOMIZATION: We can customize the thermistor with different resistance and temperature errors:

A. The maximum resistance error is 0.1% when the object temperature is reached.

B. The most accurate temperature error is ±0.2°C when the object resistance is reached.

Please specify the requirements when you need a customized high stability thermistor.

NOTICE

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