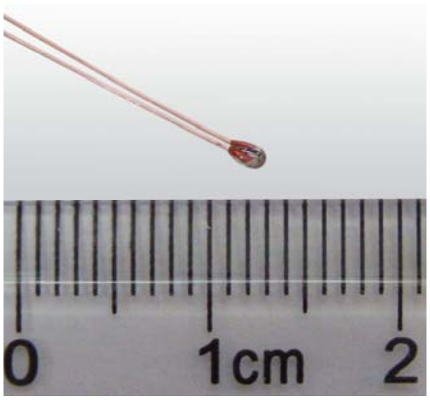
High Stability Miniature Thermistor

ATH10K1R25



MAIN FEATURES

- ➲ Glass Encapsulated for Long Term Stability & Reliability
- ➲ High Resistance Accuracy: 1%
- ➲ Small Size: ϕ1.25mm×2.0mm
- ➲ Maximum Temp. Range: –40°C to 270°C

APPLICATION AREAS

Temperature sensing for laser diodes, optical components, etc.

DESCRIPTIONS

The ATH10K1R25 is a high stability and high precision glass encapsulated thermistor. Comparing with conventional epoxy encapsulated thermistors, ATH10K1R25 features wider temperature range, much higher long term stability, smaller size, and shorter response time.

The ATH10K1R25 can be used to sense the temperatures for laser diodes, optical components, etc., with high accuracy and long term stability.

Figure 1 shows the mechanical dimensions of the ATH10K1R25. All dimension units are millimeters.

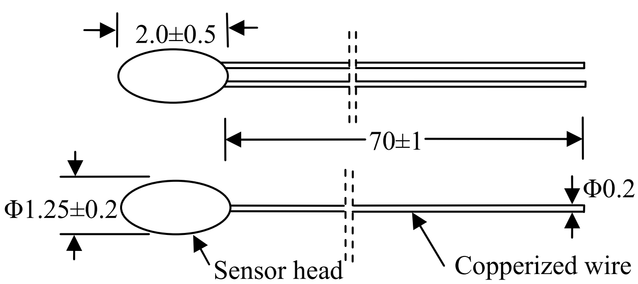


Figure 1. Side View of ATH10K1R25

SPECIFICATIONS

- ➲ Nominal Resistance @ 25°C: 10K ± 1%
- ➲ β Value @ 25°C/50°C: 3950K ± 1%
- ➲ β Value @ 25°C/85°C: 3990K ± 1%
- ➲ R@25˚C / R@50˚C: 2.771
- ➲ R@25˚C / R@85˚C: 9.271
- ➲ Thermistor Diameter: 1.25 ± 0.2mm
- ➲ Thermistor Length: 2.0 ± 0.5mm
- ➲ Lead Diameter: 0.2mm
- ➲ Lead Length: 70 ± 1mm
- ➲ Dissipation Factor: ≥ 1.0mW/°C
- ➲ Insulation Resistance: 50MΩ
- ➲ Thermal Time Constant: 6 Second (in still air)

APPLICATIONS

The thermistor ATH10K1R25 is designed to sense solid block temperature with high stability and accuracy. The best way to mount the thermistor is to drill a hole on the object for which the temperature needs to be measured and regulated, and use thermal conductive epoxy to pot the thermistor inside the hole. The hole diameter should be between 1.4 to 1.8mm and the depth should between 3 to 4mm. When a deeper hole is needed, drill a 2 stage hole to prevent epoxy bobbles trapped inside the deep hole which could cause temperature measurement errors. Figure 2 shows the section view of the 2 stage hole.

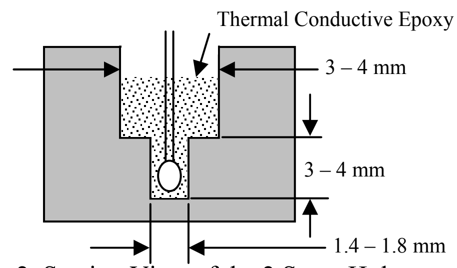


Figure 2. Section View of the 2 Stage Hole

The worst mounting result would be to have air bubbles trapped inside the thermistor mounting hole. These bubbles cause thermal sensing time delay and sensing temperature errors. To avoid the bubbles, in addition to drilling the 2 stage hole, use thin epoxy, vibrate the assembly before curing the epoxy, and cure the epoxy at high temperature, 80°C to 120°C, depending on the epoxy used and the maximum temperature the assembly components allow.

The thermistor lead wires are made of copperized alloy and there is no insulation coating on them, make sure that they do not touch each other after mounting the thermistor.

Some thermal conductive epoxies are also electrically conductive and such epoxies should not be used for mounting the thermistors, since the lead wires are conductive and the epoxy would change the thermistor's resistance, thus causing temperature sensing errors.

CAUTIONS

1. Do not bend the thermistor leads on the location that is too close to the thermistor, to avoid breaking the glass coating as shown in Figure 3 below on the leads near the thermistor's body. Only bend the leads at the location that is at least 2mm away from the thermistor body.

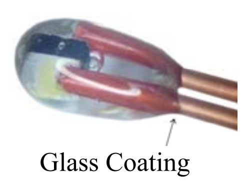


Figure 3. Glass Coating on the Leads

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2. Do not apply a large DC voltage across the thermistor in the temperature sensing circuit. The thermistor's 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.
3. 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 ATH10K1R25 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:

$$R = \mathrm{A}e^{\frac{\beta}{\mathrm{T}}};$$

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 ATH10K1R25 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 ATH10K1R25 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.

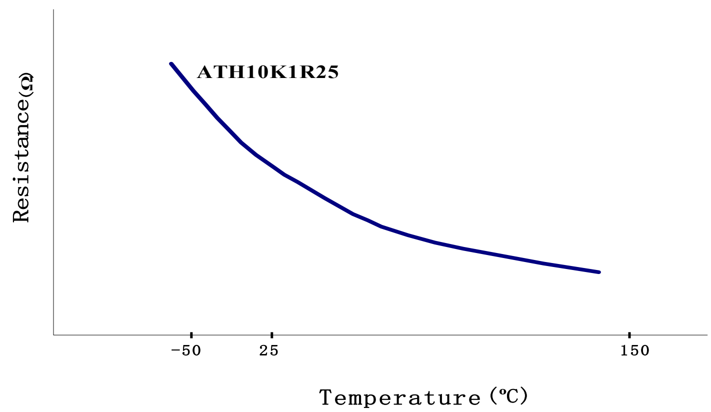

Figure 4. Resistance vs. Temperature for ATH10K1R25

As shown in Figure 4, the steepest position of the ATH10K1R25 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 recommoned 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 temperature 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 ATH10K1R25, which is much accurater 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 an accuracy as good as ±0.001˚C over a 100˚C temperature span.

Resistance Temperature Characteristics

Temp	Resistance	Temp	Resistance	Temp	Resistance	Temp	Resistance	Temp	Resistance
℃	KΩ	℃	KΩ	℃	KΩ	℃	KΩ	℃	KΩ
-40	342.55	-9	530.5	22	11.419	53	3.2243	84	1.1131
-39	320.26	-8	502.4	23	10.923	54	3.1061	85	1.0786
-38	299.57	-7	476.2	24	10.449	55	2.9940	86	1.0453
-37	280.36	-6	451.3	25	10.000	56	2.8858	87	1.0132
-36	262.51	-5	428.0	26	9.5730	57	2.7816	88	0.9823
-35	245.92	-4	405.8	27	9.1658	58	2.6834	89	0.9524
-34	230.49	-3	385.1	28	8.7783	59	2.5871	90	0.9236
-33	216.13	-2	36.281	29	8.4085	60	2.4969	91	0.8957
-32	202.77	-1	34.407	30	8.0586	61	2.4086	92	0.8690
-31	190.31	0	32.738	31	7.7224	62	2.3244	93	0.8431
-30	178.71	1	31.104	32	7.4041	63	2.2441	94	0.8181
-29	167.89	2	29.568	33	7.0995	64	2.1658	95	0.7938
-28	157.80	3	28.109	34	6.8109	65	2.0915	96	0.7705
-27	148.37	4	26.729	35	6.5341	66	2.0202	97	0.7481
-26	139.58	5	25.428	36	6.2711	67	1.9515	98	0.7262
-25	131.36	6	24.205	37	6.0180	68	1.8854	99	0.7051
-24	123.68	7	23.041	38	5.7788	69	1.8219	100	0.6825
-23	116.49	8	21.935	39	5.5496	70	1.7610	101	0.6639
-22	109.78	9	20.908	40	5.3302	71	1.7022	102	0.6463
-21	103.49	10	19.921	41	5.1207	72	1.6457	103	0.6280
-20	97.597	11	18.984	42	4.9211	73	1.5916	104	0.6102
-19	92.091	12	18.100	43	4.7315	74	1.5393	105	0.5932
-18	86.912	13	17.264	44	4.5478	75	1.4891	106	0.5766
-17	82.063	14	16.471	45	4.3740	76	1.4406	107	0.5605
-16	77.525	15	15.717	46	4.2082	77	1.3941	108	0.5449
-15	73.259	16	15.004	47	4.0484	78	1.3494	109	0.5229
-14	69.245	17	14.327	48	3.8944	79	1.3063	110	0.5153
-13	65.485	18	13.683	49	3.7485	80	1.2648	111	0.5013
-12	61.958	19	13.073	50	3.6085	81	1.2246	112	0.4877
-11	58.626	20	12.494	51	3.4764	82	1.1861	113	0.4745
-10	55.508	21	11.943	52	3.3464	83	1.1488	114	0.4617

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Temp	Resistance	Temp	Resistance	Temp	Resistance	Temp	Resistance	Temp	Resistance
℃	KΩ	℃	KΩ	℃	KΩ	℃	KΩ	℃	KΩ
115	0.4493	147	0.2004	179	0.0970	211	0.0524	243	0.0304
116	0.4371	148	0.1957	180	0.0950	212	0.0514	244	0.0299
117	0.4256	149	0.1912	181	0.0931	213	0.0505	245	0.0294
118	0.4141	150	0.1869	182	0.0912	214	0.0496	246	0.0290
119	0.4032	151	0.1786	183	0.0894	215	0.0487	247	0.0285
120	0.3927	152	0.1745	184	0.0876	216	0.0479	248	0.0280
121	0.3823	153	0.1706	185	0.0859	217	0.0470	249	0.0276
122	0.3724	154	0.1667	186	0.0842	218	0.0462	250	0.0272
123	0.3628	155	0.1629	187	0.0825	219	0.0454	251	0.0268
124	0.3535	156	0.1593	188	0.0809	220	0.0446	252	0.0264
125	0.3445	157	0.1557	189	0.0793	221	0.0439	253	0.0260
126	0.3356	158	0.1523	190	0.0778	222	0.0431	254	0.0256
127	0.3271	159	0.1489	191	0.0763	223	0.0424	255	0.0252
128	0.3189	160	0.1456	192	0.0748	224	0.0416	256	0.0248
129	0.3109	161	0.1424	193	0.0733	225	0.0409	257	0.0244
130	0.3031	162	0.1393	194	0.0719	226	0.0402	258	0.0241
131	0.2955	163	0.1363	195	0.0706	227	0.0396	259	0.0237
132	0.2882	164	0.1333	196	0.0692	228	0.0389	260	0.0234
133	0.2811	165	0.1304	197	0.0679	229	0.0382	261	0.0230
134	0.2742	166	0.1276	198	0.0666	230	0.0376	262	0.0227
135	0.2675	167	0.1249	199	0.0654	231	0.0370	263	0.0223
136	0.2609	168	0.1222	200	0.0641	232	0.0364	264	0.0220
137	0.2546	169	0.1196	201	0.0630	233	0.0358	265	0.0217
138	0.2484	170	0.1171	202	0.0618	234	0.0352	266	0.0214
139	0.2425	171	0.1146	203	0.0606	235	0.0346	267	0.0210
140	0.2367	172	0.1122	204	0.0595	236	0.0340	268	0.0207
141	0.2311	173	0.1099	205	0.0584	237	0.0335	269	0.0204
142	0.2256	174	0.1076	206	0.0574	238	0.0329	270	0.0201
143	0.2203	175	0.1054	207	0.0563	239	0.0324		
144	0.2151	176	0.1032	208	0.0553	240	0.0319		
145	0.2100	177	0.1011	209	0.0543	241	0.0314		
146	0.2052	178	0.0990	210	0.0533	242	0.0309		

ORDERING INFORMATIONS

Part number: ATH10K1R25

Quantity	1 – 9	10 – 49	50 – 199	200 – 499	≥500
Price	$2.4	$2.1	$1.8	$1.5	$1.2

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