High Stability Miniature Thermistor

ATH10KL2C

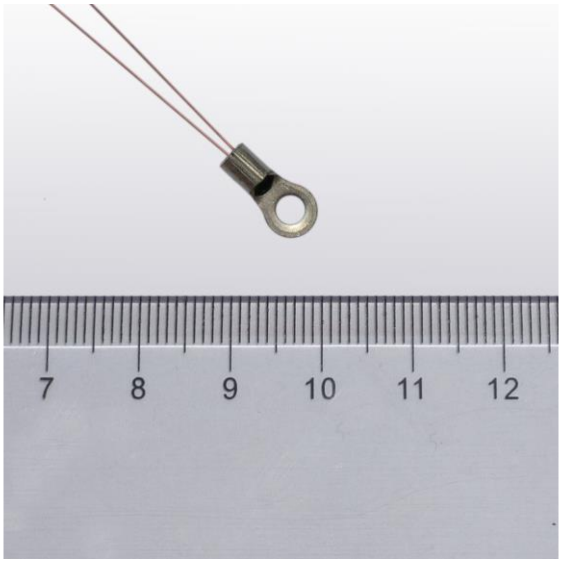

Figure 1.1. The physical photo of ATH10KL2C

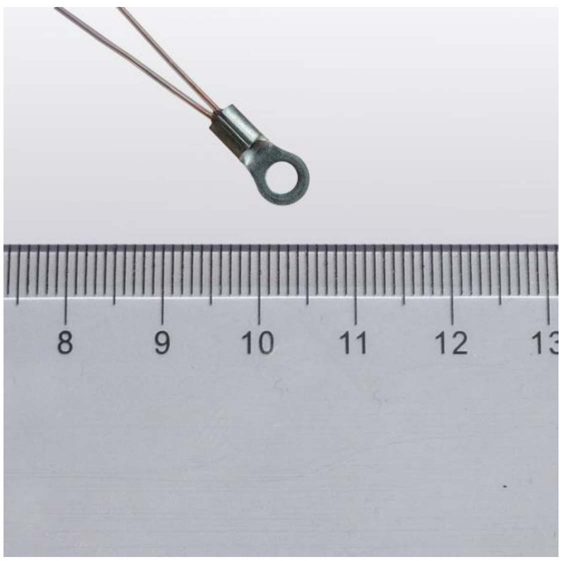

Figure 1.2. The physical photo of ATH10KL2CT70S

MAIN FEATURES

- Glass Encapsulated for Long Term Stability & Reliability
- High Resistance Accuracy: 1%
- Maximum Temp. Range: –40°C to 270°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 ATH10KL2C is a thermistor assembly with a glass encapsulated thermistor packaged in an extra compact ring lug. The ATH10KL2C series thermistor consists of three versions, ATH10KL2C, ATH10KL2CT70 and ATH10KL2CT70S. The ATH10KL2C has bear leads coated with copper, the ATH10KL2CT70S has the leads covered by high temperature plastic tubing and sealed by epoxy, while the ATH10KL2CT70 is the non-sealed version. Comparing with conventional assemblies containing epoxy encapsulated thermistors, ATH10KL2C 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 ATH10KL2C series thermistor can be used to measure the temperatures of laser diodes, optical components, etc., with high accuracy and long term stability.

There are some differences among ATH10KL2**A**, ATH10KL2**B** and ATH10KL2**C**. First, the ring sizes of them are different. Second, the thermistor head in ATH10KL2**A** is the same as ATH10KR8, while the heads in ATH10KL2**B** and ATH10KL2**C** are the same as ATH10K1R25. Last, the resistance temperature characteristics in ATH10KL2**B** and ATH10KL2**C** are the same, different from ATH10KL2**A**.

SPECIFICATIONS

Parameters	Value
Nominal Resistance @ 25°C	10K ± 1%
B Value @ 25°C /50°C	3950K ± 1%
B Value @ 25°C /85°C	3990K ± 1%
R@25˚C / R@50˚C	2.771
R@25˚C / R@85˚C	9.271
Ring Lug Length	11.2 ± 0.1mm
Ring Lug Width	5.5 ± 0.1mm
Ring Hole Diameter	3.02 ± 0.1mm
Lead Diameter	0.2mm
Lead Length	70 ± 1mm
Insulation Resistance	50MΩ
Time Constant	37.8s (in still air) 1.22s (in water)

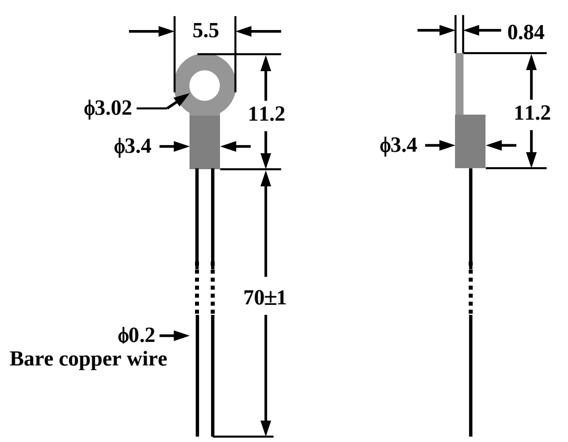

Figure 2. The Front and Side Views of ATH10KL2C

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, or 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 3. In this way, the air flow will not affect the temperature sensing accuracy.

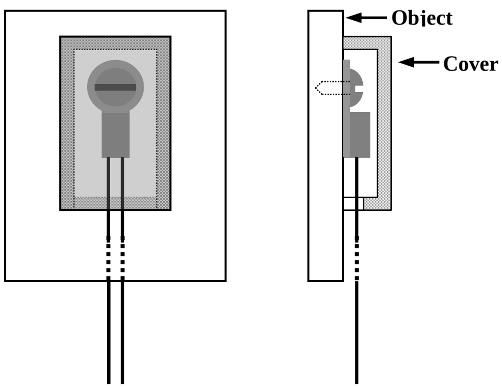

Figure 3. Using an Insulation Cover to Improve Accuracy

CAUTIONS

1. Do not apply a large DC voltage across the thermistor in the temperature sensing circuit. The thermistor 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 ATH10KL2C 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 ATH10KL2C 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 ATH10KL2C 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:

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

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

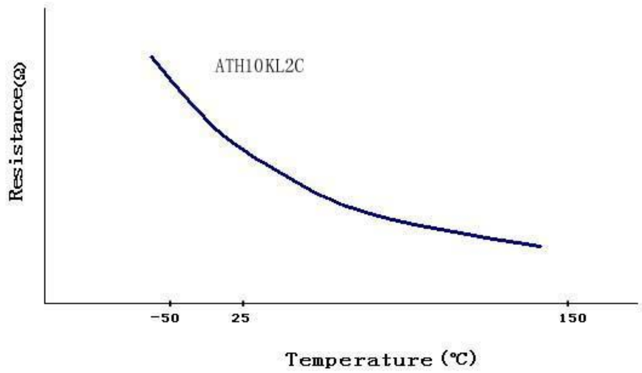

Figure 4. Resistance vs. Temperature for ATH10KL2C

As shown in Figure 4, the steepest position of the ATH10KL2C 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 ATH10KL2C, 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:

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

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 ±0.001˚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	7	23.041	54	3.1061	101	0.6639	148	0.1957
-39	320.26	8	21.935	55	2.9940	102	0.6463	149	0.1912
-38	299.57	9	20.908	56	2.8858	103	0.6280	150	0.1869
-37	280.36	10	19.921	57	2.7816	104	0.6102	151	0.1786
-36	262.51	11	18.984	58	2.6834	105	0.5932	152	0.1745
-35	245.92	12	18.100	59	2.5871	106	0.5766	153	0.1706
-34	230.49	13	17.264	60	2.4969	107	0.5605	154	0.1667
-33	216.13	14	16.471	61	2.4086	108	0.5449	155	0.1629
-32	202.77	15	15.717	62	2.3244	109	0.5229	156	0.1593
-31	190.31	16	15.004	63	2.2441	110	0.5153	157	0.1557
-30	178.71	17	14.327	64	2.1658	111	0.5013	158	0.1523
-29	167.89	18	13.683	65	2.0915	112	0.4877	159	0.1489
-28	157.80	19	13.073	66	2.0202	113	0.4745	160	0.1456
-27	148.37	20	12.494	67	1.9515	114	0.4617	161	0.1424
-26	139.58	21	11.943	68	1.8854	115	0.4493	162	0.1393
-25	131.36	22	11.419	69	1.8219	116	0.4371	163	0.1363
-24	123.68	23	10.923	70	1.7610	117	0.4256	164	0.1333
-23	116.49	24	10.449	71	1.7022	118	0.4141	165	0.1304
-22	109.78	25	10.000	72	1.6457	119	0.4032	166	0.1276
-21	103.49	26	9.5730	73	1.5916	120	0.3927	167	0.1249
-20	97.597	27	9.1658	74	1.5393	121	0.3823	168	0.1222
-19	92.091	28	8.7783	75	1.4891	122	0.3724	169	0.1196
-18	86.912	29	8.4085	76	1.4406	123	0.3628	170	0.1171
-17	82.063	30	8.0586	77	1.3941	124	0.3535	171	0.1146
-16	77.525	31	7.7224	78	1.3494	125	0.3445	172	0.1122
-15	73.259	32	7.4041	79	1.3063	126	0.3356	173	0.1099
-14	69.245	33	7.0995	80	1.2648	127	0.3271	174	0.1076
-13	65.485	34	6.8109	81	1.2246	128	0.3189	175	0.1054
-12	61.958	35	6.5341	82	1.1861	129	0.3109	176	0.1032
-11	58.626	36	6.2711	83	1.1488	130	0.3031	177	0.1011
-10	55.508	37	6.0180	84	1.1131	131	0.2955	178	0.0990
-9	530.5	38	5.7788	85	1.0786	132	0.2882	179	0.0970
-8	502.4	39	5.5496	86	1.0453	133	0.2811	180	0.0950
-7	476.2	40	5.3302	87	1.0132	134	0.2742	181	0.0931
-6	451.3	41	5.1207	88	0.9823	135	0.2675	182	0.0912
-5	428.0	42	4.9211	89	0.9524	136	0.2609	183	0.0894
-4	405.8	43	4.7315	90	0.9236	137	0.2546	184	0.0876
-3	385.1	44	4.5478	91	0.8957	138	0.2484	185	0.0859
-2	36.281	45	4.3740	92	0.8690	139	0.2425	186	0.0842
-1	34.407	46	4.2082	93	0.8431	140	0.2367	187	0.0825
0	32.738	47	4.0484	94	0.8181	141	0.2311	188	0.0809
1	31.104	48	3.8944	95	0.7938	142	0.2256	189	0.0793
2	29.568	49	3.7485	96	0.7705	143	0.2203	190	0.0778
3	28.109	50	3.6085	97	0.7481	144	0.2151	191	0.0763
4	26.729	51	3.4764	98	0.7262	145	0.2100	192	0.0748
5	25.428	52	3.3464	99	0.7051	146	0.2052	193	0.0733
6	24.205	53	3.2243	100	0.6825	147	0.2004	194	0.0719

Temp	Resistance	Temp	Resistance	Temp	Resistance	Temp	Resistance	Temp	Resistance
℃	KΩ	℃	KΩ	℃	KΩ	℃	KΩ	℃	KΩ
195	0.0706	211	0.0524	226	0.0402	241	0.0314	256	0.0248
196	0.0692	212	0.0514	227	0.0396	242	0.0309	257	0.0244
197	0.0679	213	0.0505	228	0.0389	243	0.0304	258	0.0241
198	0.0666	214	0.0496	229	0.0382	244	0.0299	259	0.0237
199	0.0654	215	0.0487	230	0.0376	245	0.0294	260	0.0234
200	0.0641	216	0.0479	231	0.0370	246	0.0290	261	0.0230
201	0.0630	217	0.0470	232	0.0364	247	0.0285	262	0.0227
202	0.0618	218	0.0462	233	0.0358	248	0.0280	263	0.0223
203	0.0606	219	0.0454	234	0.0352	249	0.0276	264	0.0220
204	0.0595	220	0.0446	235	0.0346	250	0.0272	265	0.0217
205	0.0584	221	0.0439	236	0.0340	251	0.0268	266	0.0214
206	0.0574	222	0.0431	237	0.0335	252	0.0264	267	0.0210
207	0.0563	223	0.0424	238	0.0329	253	0.0260	268	0.0207
208	0.0553	224	0.0416	239	0.0324	254	0.0256	269	0.0204
209	0.0543	225	0.0409	240	0.0319	255	0.0252	270	0.0201
210	0.0533								

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