

Figure 1. The physical photo of ATH10KHN6

### FEATURES

- Glass Encapsulated for Long Term Stability & Reliability
- High Resistance Accuracy: 1%
- Maximum Temp. Range:  $-40^{\circ}\text{C}$  to  $270^{\circ}\text{C}$
- Packaged in Extra Threaded Hex Nut
- 100 % Lead (Pb)-free and RoHS Compliant

### APPLICATION

Temperature Sensing  
 Temperature Detection  
 Transformers  
 Electric Motors  
 Air Sensors

### DESCRIPTIONS

The ATH10KHN6 is a thermistor assembly with threaded hex nut. The ATH10KHN6 has bare leads coated with copper. ATH10KHN6 thermistor assembly presents long term stability, high reliability and wide temperature range, compact size and short response time.

The ATH10KHN6 thermistor assembly can be used for temperature sensing and detection, transformers, and air sensors, etc..

### SPECIFICATIONS

Parameters	Value
Nominal Resistance @ $25^{\circ}\text{C}$	$10\text{K} \pm 1\%$
B Value @ $25^{\circ}\text{C} / 50^{\circ}\text{C}$	$3950\text{K} \pm 1\%$
B Value @ $25^{\circ}\text{C} / 85^{\circ}\text{C}$	$3990\text{K} \pm 1\%$
$R@25^{\circ}\text{C} / R@50^{\circ}\text{C}$	2.771
$R@25^{\circ}\text{C} / R@85^{\circ}\text{C}$	9.271
Threaded Hex Nut Length	6mm+6mm
Threaded Hex Nut Inner Dia.	4mm
Lead Dia.	0.2mm
Lead Length	$70 \pm 1\text{mm}$
Insulation Resistance	50M $\Omega$
Time Constant	37.8s (in still air)
	1.22s (in water)

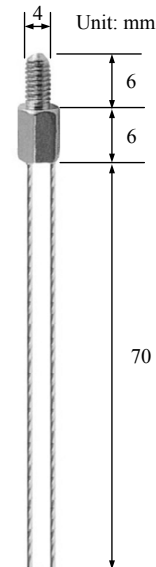


Figure 2. The Front and Side Views of ATH10KHN6



#### 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 ATH10KHN6 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<sub>T1</sub> is the resistance at T1, while R<sub>T2</sub> is the resistance at T2.

β can be used to compare the relative steepness of ATH10KHN6 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:

$$\begin{aligned} T1 &= (25 + 273.15)^\circ\text{K} = 298.15^\circ\text{K}, \\ T2 &= (50 + 273.15)^\circ\text{K} = 323.15^\circ\text{K}, \\ R_{T1} &= 10\text{k}\Omega, \\ R_{T2} &= 3.6085\text{k}\Omega; \end{aligned}$$

This value of β would be referenced as β<sub>25°C/50°C</sub>, and calculated as:

$$\beta_{25^\circ\text{C}/50^\circ\text{C}} = \ln(10/3.6085) / (1/298.15 - 1/323.15) = 3950\text{K};$$

By using the same formula, β<sub>25°C/85°C</sub>, will be:

$$\beta_{25^\circ\text{C}/85^\circ\text{C}} = \ln(10/1.0786) / (1/298.15 - 1/358.15) = 3990\text{K}.$$

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 ATH10KHN6 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.

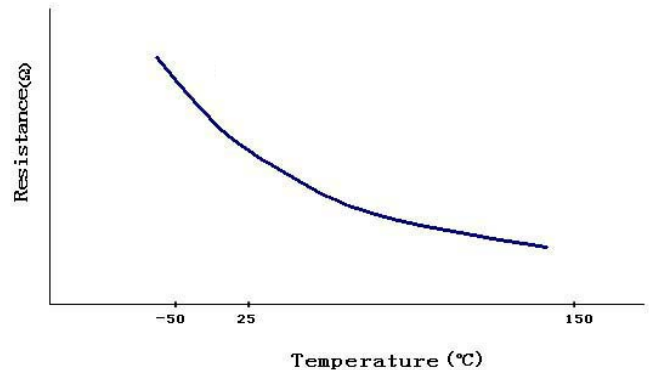


Figure 3. Resistance vs. Temperature for ATH10KHN6

As shown in Figure 3, the steepest position of the ATH10KHN6 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:

$$R@25^\circ\text{C} / R@50^\circ\text{C} = 10/3.6085 = 2.771;$$

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

$$R@25^\circ\text{C} / R@85^\circ\text{C} = 10/1.0786 = 9.271.$$



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 ATH10KHN6, which is much more accurate than β method. 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^([(-x/2 + (x^2/4 + psi^3/27)^1/2)^1/3 + (-x/2 - (x^2/4 + psi^3/27)^1/2)^1/3];

Where:

x = (a - 1/T) / c, psi = 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

Table with 10 columns: Temp, Resistance, Temp, Resistance, Temp, Resistance, Temp, Resistance, Temp, Resistance. Rows range from -40 to 194 degrees Celsius.



Temp	Resistance	Temp	Resistance	Temp	Resistance	Temp	Resistance	Temp	Resistance
°C	kΩ	°C	kΩ	°C	kΩ	°C	kΩ	°C	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								



ORDERING INFORMATION

Quantity (pcs)	1 – 9	10 – 49	50 – 199	200 – 499	≥500
ATH10KHN6	\$2.5	\$2.2	\$1.9	\$1.6	\$1.3

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