The NTC Thermistors

NTC Thermistors is a negative temperature coefficient resistor that significantly reduces its resistance value as the heat/ambient temperature rises. Thermistors is sintered in high-temperature (1200 °C to 1500 °C), and manufactured in various shapes. It’s comprised of 2 to 4 kinds of metal oxides: iron, nickel, cobalt, manganese and copper.

Features

● Temperature Coefficient of Resistance is negative, and it’s extremely large (–2.8 to –5.1 [%/°C]).
● Various shapes, especially compact size components are available.
● Selection of resistance value is comparatively free, it’s available from several 10 Ω to 100 kΩ.

Recommended Applications

● For temperature measurement or temperature detection: Thermometer, temperature controller
● For temperature compensation: Transistor, transistor circuit, quartz oscillation circuit, and measuring instruments

Physical Characteristics of NTC Thermistors

Thermistor is a resistor sensitive to temperature that is utilizing the characteristic of metal oxide semiconductor having large temperature coefficient. And its temperature dependency of resistance value is indicated by the following equation:

\[ R = R_0 \exp \left[ B \left( \frac{1}{T} - \frac{1}{T_0} \right) \right] \quad \text{(1)} \]

\[ T_0 : \text{Standard Temperature 298.15 K (25 °C)} \]
\[ R_0 : \text{Resistance at } T_0 [K], B : \text{Thermistor Constant [K]} \]

Temperature coefficient (\( \alpha \)) in general meaning is indicated as follows:

\[ \alpha = -B \frac{1}{T_2} \quad \text{(2)} \]

Since the change by temperature is considerably large, \( \alpha \) is not appropriate as a constant. Therefore, B value (constant) is generally used as a coefficient of thermistors.

Major Characteristics of NTC Thermistors

The relation between resistance and temperature of a thermistor is linear as shown in Fig. 2. The resistance value is shown in vertical direction in a logarithmic scale and reciprocal of absolute temperature (adding 273.15 to centigrade) is shown in horizontal direction. The B value (constant) determines the gradient of these straight lines. The B value (constant) is calculated by using following equation.

\[ B = \frac{\ln R_1 - \ln R_2}{\frac{1}{T_1} - \frac{1}{T_2}} \quad \text{(3)} \]

\[ R_1 : \text{Resistance at } T_1 K, \quad R_2 : \text{Resistance at } T_2 K \]

When you calculate this equation, you’ll find that B value is not exactly constant. The resistance is expressed by the following equation:

\[ R = AT^{-C} \exp \left[ \frac{D}{T} \right] \quad \text{(4)} \]

In (4), \( C \) is a small positive or negative constant and quite negligible except for use in precision temperature-measuring device, therefore, the B value can be considered as constant number.

In Fig. 1, the relation between the resistance ratio \( R_T/R_{25} \) (\( R_{25} : \text{Resistance at 25 °C. } RT : \text{Resistance at } T \degree \text{C} \)) and B Value is shown.