Negative temperature coefficient (NTC) thermistors

Introduction

HOW NTC TEMPERATURE SENSORS FUNCTION

NTC temperature sensors are made from pure metal oxides. They respond quickly to temperature changes, even small temperature increases cause their resistance to decrease significantly, as shown in Fig.6.

So, by placing an NTC temperature sensor into one arm of a bridge circuit, accurate temperature measurement is possible.

The main characteristics of an NTC temperature sensor are expressed by three parameters:

- The resistance at 25 °C (R_{25}). Tolerances on the R_{25}-value are mainly caused by manufacturing and material tolerances. By using very precise sawing, tolerances on R_{25} lower than 1% (or 0.25 °C) can be achieved.
- The material constant (B). This constant relates the rate of change of resistance with temperature, and therefore affects the slope of the R/T-characteristic.

  $R = A \times e^{B/T}$

  where R is the resistance at absolute temperature T (in Kelvin) and A is a first-approximation constant. In practice, B is defined between two selected temperatures. The B-value is very useful for comparing sensors, but in making this comparison, care must be taken to ensure that the same two temperatures are used (normally 25 and 85 °C).

- The temperature coefficient of resistance (α), expressed in %/K. This coefficient indicates the sensitivity of the sensor to a change in temperature.

  For calculation purposes $\alpha = \frac{\Delta R}{\Delta T}$, where ΔR is the percentage change in resistance at the required temperature and ΔT is the temperature deviation (T in Kelvin). So, when ΔR and α are known for any temperature, ΔT (the temperature deviation in °C) can be calculated.

Two other parameters which are important in specifying NTC temperature sensors are the thermal time constant and the response time:

- The thermal time constant is the time required for the temperature of the sensor to change **in air** by $\left(1 - \frac{1}{e}\right) = 63.2\%$ of the difference between its initial and final body temperatures, when subjected to a step function temperature change (85 °C to 25 °C in accordance with *"IEC 539"*).
- The response time is the time the sensor needs to reach 63.2% of the total temperature difference when subjected to a temperature change from 25 °C **in air** to 85 °C **in silicone oil** (MS 200/50).

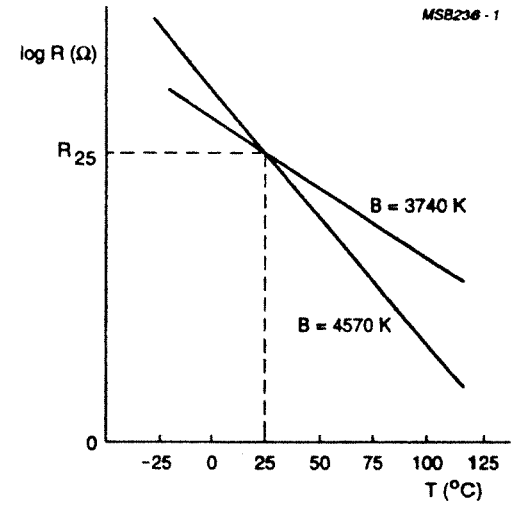

Fig.6 Typical plot of resistance as a function of temperature for an NTC temperature sensor.

Data

The thermistor available on the IDP is a Philips 2322 640 63333.

Electrical Characteristics:

R_{25} value	33kΩ
R_{25} tolerance	+/-5%
Maximum dissipation	500mW
Dissipation factor	1.2mW/°K
Response time	1.2s
Thermal time constant	11sec

The resistance of the thermistor at intermediate temperatures is shown in the table below:

T_{amb} (°C)	R_T/R_{25}	α (%/°K)
-5	3.5881	4.64
0	2.8550	4.51
5	2.2860	4.38
10	1.8425	4.25
15	1.4941	4.13
20	1.2189	4.01
25	1.0000	3.90
30	0.8250	3.80
35	0.6841	3.69
40	0.5703	3.59
45	0.4777	3.50
50	0.4020	3.40