THERMISTOR EQUATION

Steinhart-Hart equation

In practice, the linear approximation (above) works only over a small temperature range. For accurate temperature measurements, the resistance/temperature curve of the device must be described in more detail. The Steinhart-Hart equation is a widely used third-order approximation:

$$\frac{1}{T} = a + b\,\ln(R) + c\,\ln^3(R)$$

where a, b and c are called the Steinhart-Hart parameters, and must be specified for each device. T is the temperature in kelvins and R is the resistance in ohms. To give resistance as a function of temperature, the above can be rearranged into:

$$R = e^{\left(\beta-\frac{\alpha}{2}\right)^{\frac{1}{3}}-\left(\beta+\frac{\alpha}{2}\right)^{\frac{1}{3}}}$$

where

$$\alpha = \frac{a-\frac{1}{T}}{c}$$ and $$\beta = \sqrt{\left(\frac{b}{3c}\right)^3+\frac{\alpha^2}{4}}$$

The error in the Steinhart-Hart equation is generally less than 0.02°C in the measurement of temperature. As an example, typical values for a thermistor with a resistance of 3000 Ω at room temperature (25°C = 298.15 K) are:

$$a = 1.40 \times 10^{-3}$$

$$b = 2.37 \times 10^{-4}$$

$$c = 9.90 \times 10^{-8}$$

B parameter equation

NTC thermistors can also be characterised with the B parameter equation, which is essentially the Steinhart Hart equation with c=0.

$$\frac{1}{T} = \frac{1}{T_0} + \frac{1}{B} \ln\left(\frac{R}{R_0}\right)$$

where the temperatures are in kelvin. Using the expansion only to the first order yields:

$$R = R_0 e^{B \cdot (1/T - 1/T_0)}$$

or

$$R = r_\infty e^{B/T}$$

or

$$T = \frac{B}{\ln\left(R/r_\infty\right)}$$

where

R0 is the resistance at temperature T0 (usually 25 °C=298.15 K)

$$r_\infty = R_0 \cdot e^{-B/T_0}$$

Source: http://www.juliantrubin.com/encyclopedia/electronics/thermistor.html