Thermistor Constant Conversions - Beta to Steinhart-Hart

TE CONTROL TECH NOTE

The non-linear resistance-temperature characteristics of negative-temperature coefficient (NTC) thermistors may be modeled to a high degree of accuracy using several modeling techniques. The most popular model is the Steinhart-Hart equation.

$$(1)\ 1/T = C1 + C2^*(\ln R) + C3^*(\ln R)^3$$

An early equation called the “Beta” formula proved to be useful over narrow temperature ranges. This equation requires a two-point calibration but, under the best conditions, is accurate to approximately ±1°C over the temperature range of 0°C to 100°C.

$$(2)\ R = R_0{}^*e^{\beta(1/T\ -\ 1/T_0)}$$

Where R_0 and T_0 are the “base” values for the thermistor. Temperature (T) is in Kelvin, and resistance (R) is in ohms.

If it is not possible to measure the temperature-resistance characteristics of a thermistor, this equation can be used to calculate the resistance-temperature characteristics. These resistance values can then be used in the Steinhart-Hart equation to calculate the C1, C2, and C3 constants.

Create a table of temperature-resistance values for a given Beta (ß). Table 1 (right) is for temperatures of 273.15, 298.15, and 323.15 K. The thermistor resistances in Ω were calculated using equation (2) at each temperature. The values for R_0, T_0, and ß were 10440, 298.15, and 4140, respectively. Once the resistance values are calculated, the Steinhart-Hart equation (1) can be used to calculate the constants C1, C2, and C3. ILX Lightwave’s Application Note #4 offers pre-programmed methods for calculating C1, C2, and C3 based on the Steinhart-Hart equation.

Temperature (K)	**R_{calc} (Ω)**
273.15	37208
298.15	10440
323.15	3565

Table 1. Calculated Resistance Values

This method is not as accurate as actual resistance-temperature measurements because the resistance-temperature characteristics are calculated and based on a two-point calibration used to generate values for a three-point model. The magnitude of the error depends on the temperature range over which the resistance measurement is made versus the given T_0. The measured thermistor resistance will be less accurate for temperatures further away from T_0.

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