Calibration of your thermistor

Remember that a thermistor’s resistance rises almost exponentially with decreasing temperature. Any power of polynomial interpolation will fail, so we first straighten the curve out by looking at the natural log of the resistance, then using a polynomial:

The usual fit to a plot of thermistor resistance vs. absolute temperature is of the form

,

which is known as the Steinhart-Hart equation.

Let’s see how well it works with our nominal resistance table, taken from Vishay, the manufacturer:

|  |  |  |
| --- | --- | --- |
| T celsius | T(K) | Rnominal |
| -5 | 268.15 | 42268 |
| 0 | 273.15 | 32624 |
| 5 | 278.15 | 25381 |
| 10 | 283.15 | 19897 |
| 15 | 288.15 | 15711 |
| 20 | 293.15 | 12493 |
| 25 | 298.15 | 10000 |
| 30 | 303.15 | 8056 |
| 35 | 308.15 | 6529.7 |
| 40 | 313.15 | 5323.9 |
| 45 | 318.15 | 4365.3 |
| 50 | 323.15 | 3598.7 |
| 55 | 328.15 | 2982.3 |
| 60 | 333.15 | 2483.8 |
| 65 | 338.15 | 2078.7 |
| 70 | 343.15 | 1747.7 |
| 75 | 348.15 | 1475.9 |
| 80 | 353.15 | 1251.8 |
| 85 | 358.15 | 1066.1 |
| 90 | 363.15 | 911.59 |
| 95 | 368.15 | 782.46 |
| 100 | 373.15 | 674.11 |
| 105 | 378.15 | 582.84 |

I plucked out values at 10, 50, and 90 degrees and solved the simultaneous equations to get:

a 1.142841E-03

b 2.318728E-04

c 9.662130E-08

And here’s the full spreadsheet, showing the nominal resistance and the difference in temperature between nominal and the three-parameter Steinhart-Hart fit:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| T celsius | T(K) | Rnominal |  |  | 1/T | T(K) | T(celsius) | deltaT |
| -5 | 268.15 | 42268 | a | 1.142841E-03 | 0.003729 | 268.1344 | -5.016 | -0.016 |
| 0 | 273.15 | 32624 | b | 2.318728E-04 | 0.003661 | 273.1412 | -0.009 | -0.009 |
| 5 | 278.15 | 25381 | c | 9.662130E-08 | 0.003595 | 278.1465 | 4.997 | -0.003 |
| 10 | 283.15 | 19897 |  |  | 0.003532 | 283.15 | 10.000 | 0.000 |
| 15 | 288.15 | 15711 |  |  | 0.00347 | 288.1531 | 15.003 | 0.003 |
| 20 | 293.15 | 12493 |  |  | 0.003411 | 293.1539 | 20.004 | 0.004 |
| 25 | 298.15 | 10000 |  |  | 0.003354 | 298.155 | 25.005 | 0.005 |
| 30 | 303.15 | 8056 |  |  | 0.003299 | 303.1548 | 30.005 | 0.005 |
| 35 | 308.15 | 6529.7 |  |  | 0.003245 | 308.1543 | 35.004 | 0.004 |
| 40 | 313.15 | 5323.9 |  |  | 0.003193 | 313.1529 | 40.003 | 0.003 |
| 45 | 318.15 | 4365.3 |  |  | 0.003143 | 318.1513 | 45.001 | 0.001 |
| 50 | 323.15 | 3598.7 |  |  | 0.003095 | 323.15 | 50.000 | 0.000 |
| 55 | 328.15 | 2982.3 |  |  | 0.003047 | 328.1479 | 54.998 | -0.002 |
| 60 | 333.15 | 2483.8 |  |  | 0.003002 | 333.1469 | 59.997 | -0.003 |
| 65 | 338.15 | 2078.7 |  |  | 0.002957 | 338.1449 | 64.995 | -0.005 |
| 70 | 343.15 | 1747.7 |  |  | 0.002914 | 343.1441 | 69.994 | -0.006 |
| 75 | 348.15 | 1475.9 |  |  | 0.002872 | 348.1454 | 74.995 | -0.005 |
| 80 | 353.15 | 1251.8 |  |  | 0.002832 | 353.1457 | 79.996 | -0.004 |
| 85 | 358.15 | 1066.1 |  |  | 0.002792 | 358.1476 | 84.998 | -0.002 |
| 90 | 363.15 | 911.59 |  |  | 0.002754 | 363.15 | 90.000 | 0.000 |
| 95 | 368.15 | 782.46 |  |  | 0.002716 | 368.154 | 95.004 | 0.004 |
| 100 | 373.15 | 674.11 |  |  | 0.00268 | 373.1596 | 100.010 | 0.010 |
| 105 | 378.15 | 582.84 |  |  | 0.002644 | 378.1667 | 105.017 | 0.017 |

The error never exceeds 0.02 degrees, and then only at the extreme ends of the temperature range. Your values will be different, but you can determine the coefficients by measuring the resistance at 3 widely-spaced temperatures across the 0-100 C range, and then solving the following matrix equations to get a, b, and c:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1 | ln(19897) | [ln(19897)]^3 | a |  | 1/(10+273.15) |
| 1 | ln(3598.7) | [ln(3598.7)]^3 | b | "=" | 1/(50+273.15) |
| 1 | ln(911.59) | [ln(911.59)]^3 | c |  | 1/(90+273.15) |