ABSTRACT

TI advanced fuel-gauge battery-management ICs use a polynomial model to translate the voltage measured across the thermistor terminals into a temperature value. While the recommended Semitec AT103 is readily available, some customers prefer to use an alternate device. This report describes the use of a companion Excel® spreadsheet that automates coefficient calculation for a given thermistor. Project collateral discussed in this application report can be downloaded from the following URL: www.ti.com/lit/zip/SLUA398.

1 Introduction

The firmware algorithm in TI advanced fuel gauge battery management ICs uses a polynomial model to translate voltage measured across the thermistor terminals into temperature. While the recommended Semitec AT103 is readily available in various shapes, some customers prefer to use an alternate device. This report describes the use of a companion Excel spreadsheet that automates the calculation of coefficients for a given thermistor.

The Thermistor Coefficient Calculator is a Microsoft® Excel spreadsheet, which is available as a zip file in the same location as this report. It can be used for various advanced fuel gauge ICs such as the bq2084, bq20z70, bq20z80, bq20z90, etc.

2 Theory of Operation

Solver, an add-in tool for Excel, which is part of the standard installation, is used in this case to find a solution to a set of 3rd order polynomials. Given a few points on an unknown curve, it finds the coefficients of a cubic polynomial equation that best fits the available data. The fuel-gauge device firmware uses the cubic polynomial along with the dataflash-based coefficients at 1-s intervals when converting the A/D reading from the thermistor into a temperature value.

Solver’s job is to minimize the value in cell B33 (see Figure 1), which is the sum of the norms for each known data point. The norms are simply the square of the difference between what you want and what you get. Solver updates the polynomial coefficients in E25 ~ E28 for the best overall fit. You can, of course, change the coefficients manually to see what happens. The values in E31 ~ E36 should be programmed into the respective fuel gauge dataflash locations.
### Thermistor Tables

**Figure 1. Thermistor Coefficient Calculator Spreadsheet**

#### 3 Thermistor Tables

Enter the data for the desired thermistor into cells B2 ~ B22 which correspond to the temperatures in column A. Some vendors include resistance tables in their catalog; others provide a calculator for you to generate them. If a given vendor only supplies a small table with multiples of 10°C, then use it as-is in the spreadsheet, but include some of the degree-resistance pairs twice to fill up the table of 21 pairs.

#### 4 Circuit Modifications

For maximum accuracy, the voltage input voltage to the A/D converter in the fuel gauge should be limited to around 82% of the reference voltage, which is the same as V_{CC}. In this case. Looking at it another way, the A/D count should not exceed 27000 (82% of full scale 32767) counts for low temperature readings that must be accurate. Column C displays the expected A/D count for a given temperature. Measurements between 27000 and 32767 will be degraded somewhat, but still useful.

The recommended thermistor circuit, where R1 = 8.45 kΩ, R2 = 61.9 kΩ and Thermistor = 10 kΩ at 25°C, should satisfy the above requirement in most cases. However, if a 10-kΩ thermistor cannot be used, the fixed resistors should be modified in cells B24 and B25 to optimize the measurement. B25 is used to linearize the thermistor curve somewhat, enhancing the polynomial curve-fitting accuracy.
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