A Simple Thermistor Interface to an ADC

This article describes a simple and cost effective method of measuring temperature using a thermistor connected in a half-bridge configuration. The goal is to perform a ratiometric measurement such that the V_{REF} source voltage to the divider is the same as the reference to the analog-to-digital converter (ADC) used to measure the voltage at VT.

There are many circuits and measurement methods that can be used with a thermistor to determine the temperature. The simplest approach is to use a half-bridge circuit also known as a resistor divider, shown in Figure 1. The goal is to perform a ratiometric measurement such that the V_{REF} source voltage to the divider is the same as the reference to the ADC used to measure the voltage at V_T. The R1 resistance is known.

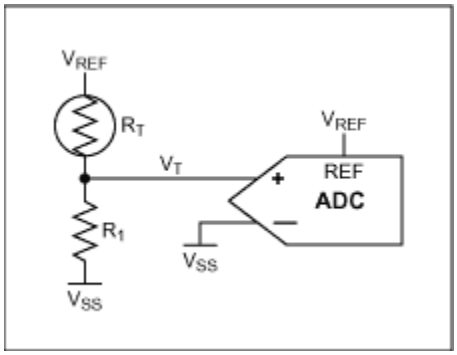

Figure 1.

The equation for V_T is shown in Equation 1.

$$V_T = \frac{R_1}{R_1 + R_T} \bullet V_{REF} \qquad \text{Eq. 01}$$

The equation for the ADC result is shown in Equation 2.

$$ADC = \frac{V_T}{V_{REF}} \bullet 2^N \qquad \text{Eq. 02}$$

where ADC is the ADC result and N = the ADC resolution.

Substituting Equation 1 into Equation 2 yields Equation 3 and the V_{REF} term is cancelled out. This leaves the R_1 value, which is known, and the ADC result, which is measured. The R_1 resistor should be a temperature stable resistor otherwise it will affect the accuracy of the temperature measurement.

$$ADC = \frac{R_1}{R_1 + R_T} \bullet 2^N \qquad \text{Eq. 03}$$

Rearranging Equation 3 and solving for R_T yields Equation 4.

$$R_T = \left(\frac{2^N}{ADC} - 1\right) \bullet R_1 \qquad \text{Eq. 04}$$

After the value for R_T is calculated, the temperature can then be calculated by using the equation provided by the thermistor vendor. An example of an equation is shown in Equation 5, which is for a NTC thermistor.

$$T(^oC) = [\, b_0 + b_1(\ln R_T) + b_3(\ln R_T)^3]^{-1} - 273.25 \qquad \text{Eq. 05}$$

The thermistor vendor would provide the value for the coefficients b0, b1, and b3. The equation can be solved for directly or a lookup table can be used if easier. Simple linear interpolation between the table data points is required to gain the proper resolution. A plot of the NTC thermistor is shown below in Figure 2.

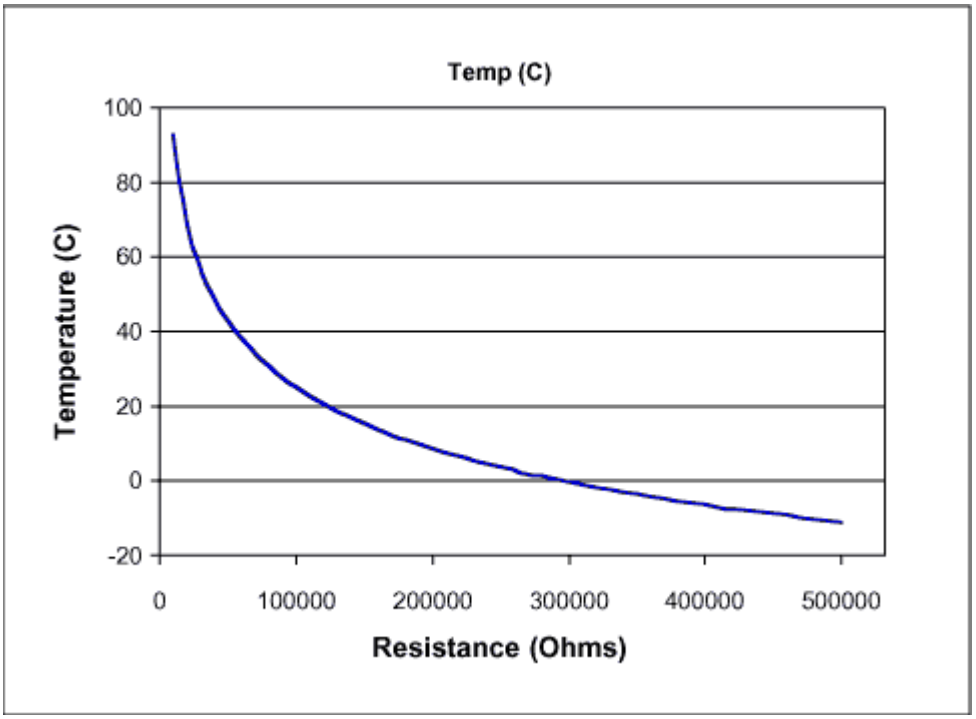

Figure 2.

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