

COMPUTER INTERFACING TO AN NTC THERMISTOR



Using a precision NTC thermistor as a sensor for a uC or computer based instrument can be accomplished in a fairly straightforward manner. A thermistor/resistor voltage divider bridge can supply a strong signal to an A-D converter, which can then be interfaced to the desired instrument (Figure 1). Using the entire range of the thermistor (-55°C to 125°C), a 12 bit A-D can give a resolution of 0.04°C, a 10 bit 0.175°C and an 8 bit 0.70°C. Since an NTC thermistor exhibits a nonlinear change in resistance with a linear change in temperature, the voltage output of the bridge must be interpreted for the actual temperature. This can be accomplished with an R-T look up table, or through the use of an equation which characterizes the thermistor response.

APPLICATION USING AN R-T LOOK UP TABLE

Using this method, the A-D count is simply used as an offset to correlate to the temperature recorded in the table. The table is created by calculating or measuring the A-D count when the thermistor is at a given temperature or resistance value, and recording this in the table. This method has the advantage of the ability to manipulate the table to fit a particular thermistor's R-T characteristic very closely.

The following example uses a 10K ohm thermistor/10K ohm fixed resistor bridge network, and an 8 bit A-D converter.

R-T multiplier @ -55°C = 96.4	Bridge voltage @ 125°C = 0.00048V
Thermistor R @ -55°C = 964K ohm	R-T multiplier @ 25°C = 1
Bridge voltage @ -55°C = 4.948V	Thermistor R @ 25°C = 10K ohm
R-T multiplier @ 125°C = .03461	Bridge voltage @ 25°C = 2.5V
Thermistor R @ 125°C = 346.1 ohm	

Using these values, the A-D high ref would be set at 4.984V, and the low ref at 0.00048V, yielding (4.984V-0.00048V)/256 count or ~0.0194V per A-D count, giving the following:

A-D count at 125°C = 00000000, table element 0 = 125
 A-D count at -55°C = 11111111, table element 255 = -55
 A-D count at 25°C = 2.5V/0.0194V = 128.8dec = 10000001bin, table element 129 = 25

The in-between values are calculated in the same manner. The number of values in the table can be any power of 2 up to the resolution of the A-D converter. By dividing the A-D count by the appropriate number and using linear interpolation between the table entry numbers, required table memory space can be reduced with a minimum decrease in accuracy.

```

DIM TABLE (255) AS SINGLE 'this is the lookup table
TABLE (0) = 125
.
.
.
TABLE (129) = 25
.
.
.
TABLE (255) = -55
OPEN "A-D" FOR INPUT AS #1 'open A-D
INPUT #1, ADCOUNT 'and get count
TEMP = TABLE (ADCOUNT) 'get temperature at pointer
PRINT TEMP 'and the final output in degrees Celsius
  
```

The following is an example in BASIC how to implement this using a 64 element lookup table and 8 bit A-D converter.

```

DIM TABLE (64) AS SINGLE      'this is the lookup table
  TABLE (0) = 125
  .
  .
  TABLE (32) = 25             'this is ~129/4
  .
  .
  TABLE (63) = -55
  .
  .

OPEN "A-D" FOR INPUT AS #1     'open A-D
INPUT #1, ADCOUNT              'and get count
TABLEOFFSET = INT(ADCOUNT/4)   'divide by 4 for lookup table of 64 elements. Round result to next lowest
                                integer value.

TEMP = TABLE (TABLEOFFSET)    'get temperature at pointer
NEXTTEMP = TABLE (TABLEOFFSET+1) 'get temperature above pointer (next 'pointer location). Actual temperature
                                is between these two.

DIFFTEMP = ABS (ADCOUNT-(TEMP*4)) 'this is the distance from TEMP between TEMP and NEXTTEMP. This is the
                                interpolated temperature. Remember that values in table decrease as the
                                A-D count increases. Note that this assumes that a table point lies on 0. If
                                there is no 0 entry separating positive and negative table entries, some
                                additional conditions must be added to correctly interpolate.

INTERPTEMP = TEMP +
  (((TEMP-NEXTTEMP)/4)*DIFFTEMP)
PRINT INTERPTEMP              'and the final output in degrees Celsius.

```

APPLICATION USING THERMISTOR CHARACTERIZATION EQUATION

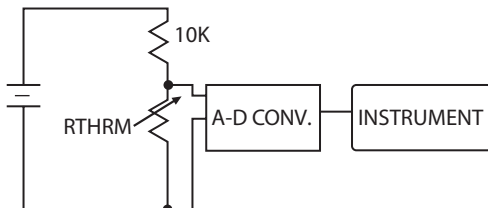


Figure 1. (Left) A thermistor/resistor voltage divider bridge can supply a strong signal to an A-D converter, which can then be interfaced to the desired instrument.

```

a = ?                          'these constants need to be entered
b = ?
c = ?
d = ?

resolution = 256                'for 8 bit A-D
vref = 5                        'bridge voltage
rfix = 10000                    'fixed bridge resistor

OPEN "A-D" FOR INPUT AS #1     'open A-D
INPUT #1, ADCOUNT              'and get count
VBRIDGE = ADCOUNT*(vref/resolution) 'convert to voltage across thermistor
R THERM = VBRIDGE/((vref-VBRIDGE)/rfix) 'find thermistor resistance. Convert to temperature using given
                                        coefficients and equation. This is the standard Steinhart-Hart
                                        equation, with the 273.15 added to yield degrees Celsius.

TEMP = (1/(a + b*(LnR THERM) + c*(LnR THERM)^2 +
  d*(LnR THERM)^3)) - 273.15
PRINT TEMP                      'and the final output in deg C

```

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