

ECE 321 - Homework #2

Temperature and Calibration. Due Monday, November 15th

Please make the subject "ECE 321 HW#2" if submitting homework electronically to Jacob_Glower@yahoo.com (or on blackboard)

Temperature Sensors: Voltage Output

1) A B57891M0103J000 (Digikey 495-2157-ND) thermistor has a temperature - resistance relationship of

$$R = 10,000 \exp\left(\frac{3950}{T+273} - \frac{3950}{298}\right) \Omega$$

where T is the temperature in degrees Celsius.

1) Design a linearizing circuit (find R_a and R_b) so that the resistance is approximately linear from 0C to +30C. Plot the resulting resistance vs. temperature relationship.

$$Z = R_b \parallel (R_a + R)$$

2) Using the linearizing circuit from part 1, design a circuit which outputs

- -10V at 0C
- +10V at +30C
- Proportional in between.

Plot the resulting output voltage vs. temperature.

3) Determine a calibration function of the form

$$T = aV + b$$

to determine the temperature based upon the output voltage from your circuit in problem #2

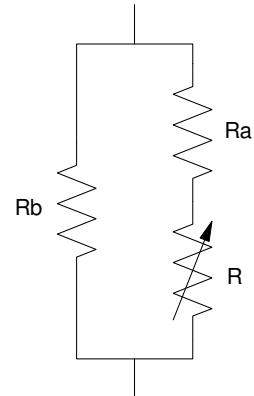
- What is the maximum calibration error?

4) Determine a calibration function of the form

$$T = aV^2 + bV + c$$

to determine the temperature based upon the output voltage from your circuit in problem #2

- What is the maximum calibration error?



Temperature Sensors: Frequency Output

5) Determine the frequency of the following 555 timer with R being the linearizing circuit from problem #2.

Note: For this 555 timer circuit

$$t_{on} = (R_1 + R_2) \cdot C \cdot \ln(2)$$

$$t_{off} = R_2 \cdot C \cdot \ln(2)$$

$$f = \left(\frac{1}{t_{on} + t_{off}} \right) \text{ Hz}$$

6) In CircuitLab, simulate the 555 timer at $T = 15\text{C}$.

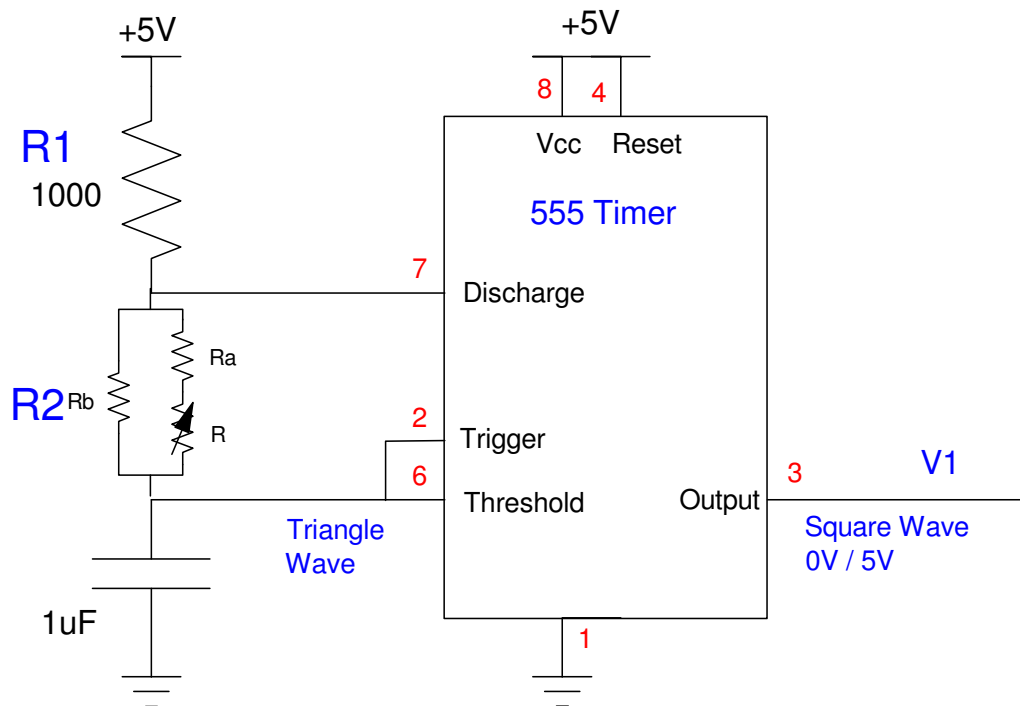
- Does the simulated frequency match your computed frequency?

7) Determine a calibration function of the form

$$T = a \cdot \text{Hz} + b$$

where Hz is the frequency of the oscillator over the temperature range of 0C to 30C

- What is the maximum calibration error for your temperature sensor?



5 point Bonus! Build this circuit replacing the linearizing circuit with the thermistor in your lab kit. Measure the frequency resulting from placing the thermistor in

- ice water
- room temperature
- hot water