RTD and Wheatstone Bridge

In this experiment, the behavior of a Resistive Temperature Detector (RTD) will be characterized. First the resistance of the RTD as a function of temperature will be measured. The RTD will then be placed in a Wheatstone bridge circuit and the performance of the system will be measured over the desired temperature range.

Simplified Instructions (NOT written as a full procedure)

Part I (RTD only)

Using a DMM, measure the terminal resistance of the RTD while it is submerged in a beaker of ice water. Fill the beaker ½ full of an ice water mixture. Place the beaker on a hot plate and obtain RTD resistance measurements as the water is heated to a temperature of about 50°C. Take readings at 5°C increments over the range from ~0° to ~50°C using a Fluke temperature probe as the reference. (Use Celsius for all temperature readings.)

Part II (RTD in Wheatstone Bridge)

Before connecting the power supply to the PCB and without removing the resistors from the terminals, measure and record the values of R1, R2, and R3 using an ohmmeter. (Just press the tips of the ohmmeter leads against the top of the appropriate pair of screw terminals to make the measurement)

Connect the RTD in the R4 position of a Wheatstone bridge circuit as shown in Figure 1. Use a nominal supply voltage, Vin, of 5V. Measure Vin with the DMM before and after making Vo measurements over temperature. Using a DMM, measure and record Vo as the RTD is again submerged in a half full beaker of ice water and heated to about 50°C. Take readings at 5°C increments over the range from ~0° to ~50°C using a Fluke temperature probe as the reference.

Results

Part 1 (RTD only):
Use the resistance versus temperature data for the RTD to graph a best-fit linear approximation. Determine the experimental static sensitivity and compare it to the expected (data sheet) value. On the same graph, plot the expected RTD resistance versus temperature using the data sheet values. The datasheet for the RTD is available on Canvas. Note that the resistance of the RTD is 100Ω at a temperature of 0°C.

Part 2 (RTD in Wheatstone Bridge):
Use the Vo/Vin versus temperature data for the RTD/Wheatstone bridge measurement system to plot a best-fit linear approximation. On the same graph, plot the expected values for Vo/Vin

using the measured values for R1, R2, R3, and Vin and the measured RTD resistance from Part 1 (RTD only).

From the second part of the experiment, one can determine the temperature (T_{NULL}) where the output of the Wheatstone bridge is nulled. You will probably need to interpolate to find this value, as your readings are every 5°C.

Next, you can determine the resistance of the RTD at T_{NULL} from your data in the first part of the experiment (the resistance versus temperature data for the RTD). Again, you will need to interpolate.

Finally, compare the RTD resistance at T_{NULL} to the measured value of R2 in the Wheatstone bridge. <u>Are they the same? Should they be? How different are they?</u>

The difference in the T_{NULL} values for the measured and expected plots of Vo/Vin in your graph is due to self-heating in the RTD. When the ohmmeter is used to measure the RTD resistance in Part 1, it supplies 1mA to the RTD. Calculate the power dissipated in the RTD at its nominal value of 110Ω. Now calculate the power dissipated in the RTD when it is in the Wheatstone bridge and it and R1, R2, and R3 all have a nominal value of 110Ω and Vin=5.0V. <u>How does the power dissipated in the RTD in Part 2 compare to the power dissipated in the RTD in Part 1?</u>

Now find an estimate for the RTD's Dissipation Constant (δ). You can find ΔT from the measured and expected plots of Vo/Vin, as the expected plot was made with RTD resistance values from Part 1 with a low power dissipation while the measured plot was from Part 2 with a high power dissipation. Use your calculated power dissipation for the RTD in the Wheatstone bridge along with ΔT to calculate δ.

<u>How could you modify the Wheatstone bridge circuit to reduce the power dissipated in the RTD?</u>

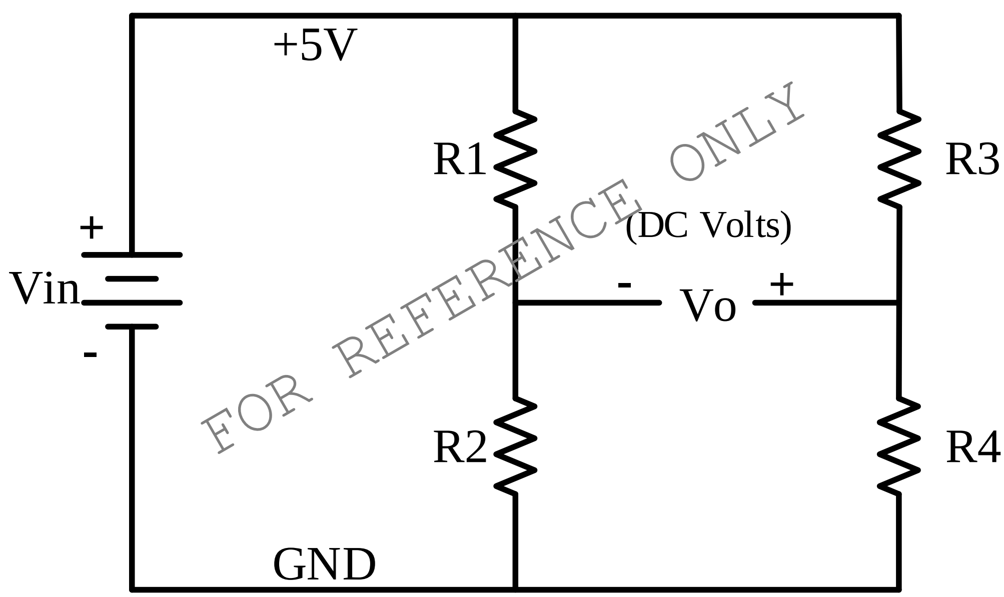

Figure 1. Wheatstone Bridge Circuit

Lab Report Tips

1. Read section 8.4 in the textbook BEFORE writing your report.
2. There are two separate experiments (RTD only and RTD in Wheatstone Bridge) that are performed in this lab. Therefore, you will need two separate apparatus diagrams.
3. If using Excel to obtain the "Trendlines," be sure to display the equation using scientific notation with at least 3 decimal places. (with the equation displayed, right click on it and select "Format Trendline Label…" to set the display format).
4. Be sure to answer the questions shown above in your report.