Project SIT-C

"Soldering Iron Temperature Control"

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Model:

- ***Voltage to Celsius Temperature Formulas:***
  - **Based On The Formula In The Thermocouple Handout:**
    - Type-J Thermocouple (Iron Constantan) = $51.7\mu v/°C$
  - **Based On The Chart In The Thermocouple Handout:**
    - $15.771mV/290°C \approx .0544mV/°C \rightarrow$

      $.0544mV * 1000\mu v/mV = 54.4\mu v/°C$
- ***Average of Temperature Conversion Formula:***
  - $(54.4\mu v/°C + 51.7\mu v/°C)/2 = 53.05\mu v/°C$
- ***Theoretical Values of Voltage to Celsius (based on handout):***

Temperature (C)	Chart Voltage	Formula Voltage
290°	15.771 mV	14.993mv
300°	16.325 mV	15.51mv
310°	16.879 mV	16.027mv

- ***Temp Conversion from*** μv **to** mV ***:***
  - **F1.** $51.7 * 10^{-6} v/°C$
  - **F2.** $54.4 * 10^{-6} v/°C$
  - **F3.** $53.05 * 10^{-6} v/°C$
- ***Circuit Design:***

  (See Attached sheet for model in Agilent VEE)

Manipulate:

In this lab, we applied an Agilent VEE model created to control a "Weller" Soldering iron's temperature. We began by connecting the two thermocouple leads on the soldering iron to a HP 34401A DMM (digital multi meter). We then plugged the iron's power plug into a normally open solid state relay, and connected the leads of the relay to an E3631A DC power supply. Finally, we connected the plug of the relay into the wall outlet for AC power. This setup allowed us to measure the thermocouple voltage, and it also allowed us to control when the AC power would be applied.

We determined a start point of around 12mV would be the best initial voltage for gathering 100 samples of data. Our initial data set used an Agilent VEE model that first measured the thermocouple voltage, and if it was greater than or equal to 15.771 mV or less than or equal 16.979mV, the DC power supply would output 0 volts. If the voltage was less than 15.771 mV, a 5V DC voltage would be applied to the relay in order for the relay to close. This would trigger the relay to allow AC power to the soldering iron when a higher temperature was needed, and otherwise the relay would cut the AC power until the iron was cooled down.

After viewing our first results, we realized that the second part of the control statement wasn't necessary to control the iron and was being be ignored by the process. Based on the chart data, we also realized that the temperature was staying lower then it should have been, since the 290° voltage of 15.771 mV triggered the relay to open. By adjusting the control statement to open the relay if the thermocouple measured greater than or equal to the 300° chart voltage of 16.325 mV, we hoped to rectify the issue. We ran measurements for the second data set, and after noticing only one on-off cycle, we decided to run an extra 50 samples starting at 15mV in order to have more accurate results.

After the testing phase, a problem arose in determining an accurate conversion formula for converting thermocouple voltage readings to a Celsius temperature. During the second testing phase (lab #2, soldering iron temperature measurement), our samples ended before the soldering iron reached 300° Celsius, and so our team did not have a accurate voltage for our Agilent VEE temperature control program to run with. After consulting the project manager, we were advised to use values from the chart within our thermocouple handout, and so we used these values with the final testing phase. It was later realized the values on the chart from the handout do not coincide with the values found using the conversion formula on the reverse side.

We found that our results were skewed by the fact that the Agilent VEE Model was based on only one of these conversion formulas. To receive the best results, a second conversion formula was devised based upon the values on the handout chart, and we applied both of our formulas to our measured values in a new column on excel. Finally, we found the average of the formulas creating a third formula, and added a third column to the excel data with the new formula applied.

Measured:

- ***Time Constant (sample rate):***
    - (8s/ 20 samples) + 3s delay = 3.4s/count
- ***Total Time For Each Data Set:***
    - 3.4s/count * 100counts = 340s

- ➢ ***(See Attached sheets for measured values and graphs)***

Mine and Conclusion:

With all of the voltage to temperature conversion formulas applied, our team was able to get the most out of the measured data sets. Since the model included the second formula's 300° Celsius voltage value (16.325 mV) in Agilent VEE, the team found that using the first formula would not produce the best results for our needs, and so we based our findings on the second and third formulas. Though the first data set collected did not meet the customer's needs applying either of these formulas, it seems as though our second data set with the revised Agilent VEE model produced good results, for the measured values mostly did not stray from the requested range of 300°+-10° Celsius.

To conclude the testing phase of this project, it is clear that the best results for the customers needs were produced using our second model which was used with our second data set. The Agilent VEE model applied to our temperature control design meets all of the customers needs, including: the range of 300°+-10° Celsius, DC control of an AC powered circuit, and remote access and management of the soldering irons temperature. It is also clear that due to limited testing time, and the need for more accurate voltage to temperature conversion formulas, it would be best for the project to not move on to the production phase. It is our findings that it would be best to conduct further research and the appropriate testing to gather more accurate voltage to temperature conversion formulas for the thermocouples used is our design. The testing should most likely be based on a system of measuring the voltages of our thermocouples at different measured temperatures. After this testing phase, an appropriate voltage value can be applied to our second model, and then the project will be complete.