Functional Requirement #3- Data Point Reliability

We are currently having issues getting accurate and precise measurements for our current and voltage readings. Entirely new codes have been created this semester in hopes of solving this issue. Additionally, we troubleshot this issue with the implementation of several different methods, which we will speak about in this document.

Voltage Readings:

One of the objectives this semester is to obtain more precise readings with the 12-bit ADC of the Arduino Nano RP2040. Since the old hardware used a regression based on experimental points, we want to do this again since the opto-coupler board we are using does not have good documentation to calculate input voltage. The following are our attempts to do so this semester.

5V Linear Regression

Our first approach was measuring the peak-to-peak voltage of the optocoupler when supplied with 5v. It gave us a linear regression, but the Nano works on a 3.3 V supply and we will only want one power source on the final PCB.

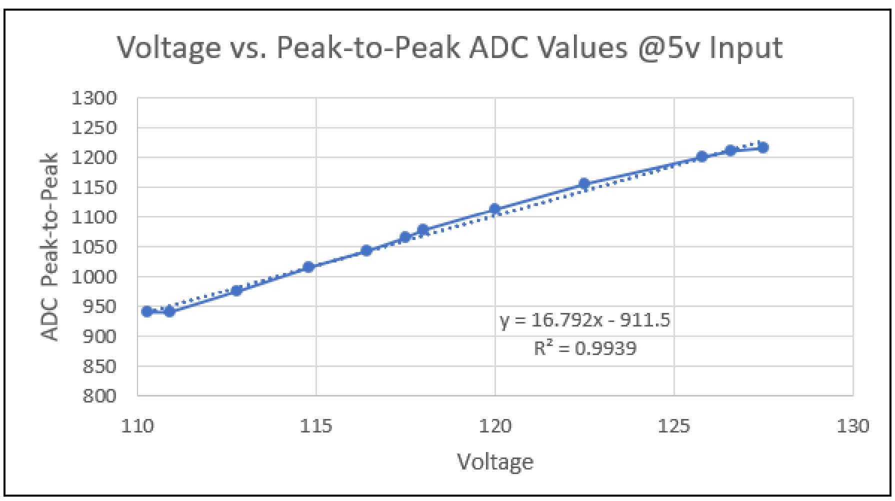

Figure 1: Voltage vs. Peak-to-Peak ADC Values using 5v Input

3.3V Attempted Regression

Then we powered the optocoupler with 3.3v and we tried the same thing but couldn't get a good regression for the window we were testing (110 - 130 V). The lowest polynomial we could fit to was a quartic and was not valid over the entire range.

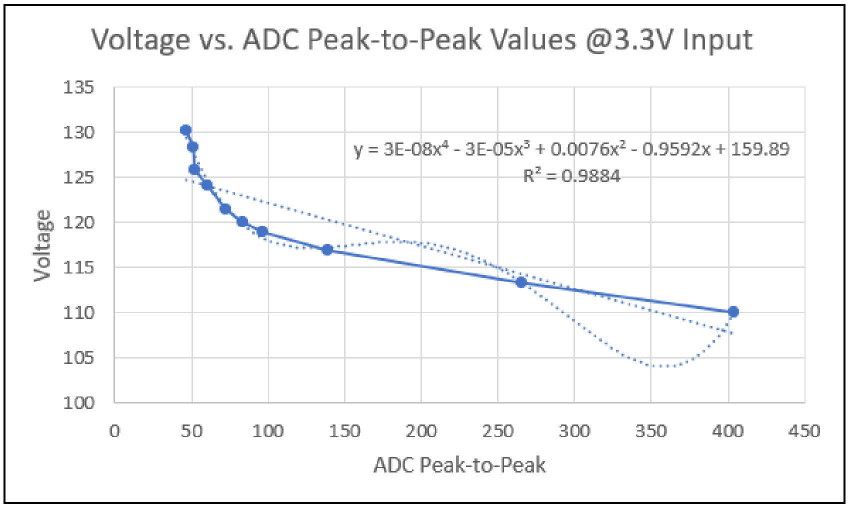

Figure 2: Voltage vs. Peak-to-Peak ADC Values using 3.3v Input

3.3 V Attempted Regression with resistor swap

Then we did a resistor swap for 47k to 33k to scale the output voltage to 3.3v, but there is no correlation between voltage of the variac and the output of the optocoupler. Any correlation is far too close to perform a regression. The difference between voltage values is only a couple ADC values so it would not be consistent enough to get reliable readings.

Wall Outlet	Optoisolater Readings		
Voltage (V)	Min (mV)	Max (mV)	Amplitude (mV)
129.7	45.8	131.6	13.5
120	50.6	135	13.6
109.9	65.2	127.1	13.4

Figure 3: Optocoupler Voltage Readings vs. Wall Outlet

<u>Current Readings:</u>

Last semester, the ACS712 (current sensor) provided readings that were accurate, but were unfortunately imprecise. For example, if there was an expectation for a current reading of 0.15A, the data points would read 0.11A to 0.17A. We believe that this imprecision is due to the length of the sampling window. It seems as if there are not enough points taken when the device is sampling and this causes some variance with the readings. Unfortunately, the code that was written is not easily mutable and we felt it would be best to redesign the reading libraries to have a sample frequency and variable sampling window.

Originally, the ACS712 (the current sensor) was integrated into the circuit design, as it has a 5v input for functionality, which was in accordance with the Arduino Uno. Since switching to the Arduino Nano, which has a 3.3v input and ADC reference, this was no longer applicable and we had to reevaluate our current design. These constraints informed our decision to replace the ACS712 with the ACS725 current sensor. This current sensor operates at 3.3V and, which is compatible with the new Arduino Nano and allows for an internal power supply.

Measurement Reliability:

Unfortunately, we are unsure as to whether our current data set is more reliable at this point in time. Since the PCB was a semester-long goal, we were unable to test the new current sensor with our code. This left us to test new code on our breadboard setup which caused some problems with the reliability of our measurements. The noise and voltage drops associated with using a breadboard left us with imprecise results, which inhibited us from fine tuning our conversions between ADC and real world values. Furthermore, our setup left us with some noise caused by the proximity to our high power lines. This is another issue that can be solved when the new hardware is implemented, because it isolates high and low currents from each other. Another setback is that the ACS725 component was not provided until recently, which left us minimal time to test its functionality. This will, however, lead us to more accurate and reliable measurements for the future.