To quantify LED brightness value, the average voltage reading from the LED is analyzed as a proxy for brightness (Figure 4). The higher the brightness, the lower the measured voltage. The linear fit between applied voltage and LED 3 average voltage has an R^2 of 0.9944 (Figure 1). This value is very high and shows that there is a clear linear and direct relationship between voltage input and the LED3 brightness. An interesting observation is that the voltage like last time plateaus at 3 V. This is due to the ADC channel 0 not being able to convert anything higher than 3 V. This is due to the parameters set in the overlay file. ADC_REF_INTERNAL is 0.6 V and the closest gain to 3.3V is ADC_gain_1_5, which gets the voltage up to 3 V. If this plateau is taken into account and the last 3.3 V datapoint is removed, the R^2 value will be even higher.
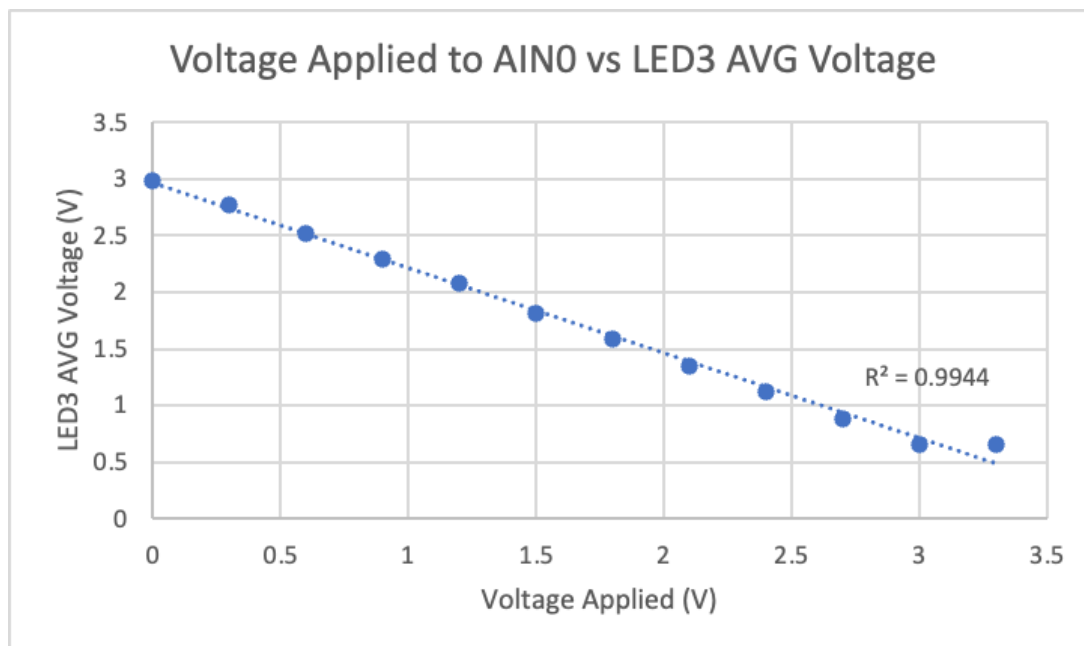

Figure 1: Voltage Applied vs LED3 "Brightness" (AVG Voltage Reading) Analysis

To measure the amplitude and frequency of the LED 2 brightness, the saw tooth function was obtained from the oscilloscope data using a low pass filter (Figure 5). The amplitude is analyzed through the use of the pk-pk voltage value.

An interesting observation is that the voltage reading seem to decrease in steps as voltage applied increased. This makes sense as the saw tooth function values lookup table passed in also exist in increments. To better account for this, 0.6 V increments was used for the linear fit instead of 0.3 V. The linear fit between applied voltage and LED 2 pk-pk voltage has an R^2 of 0.9682 (Figure 2). This value is relatively high and shows that there is a linear and direct relationship between voltage input and the amplitude of LED2 brightness. This is surprising as it was assumed that this pk-pk voltage will not change as more voltage is applied. A possibility that caused this decrease is that signal fidelity or stability decreased as voltage applied increase.
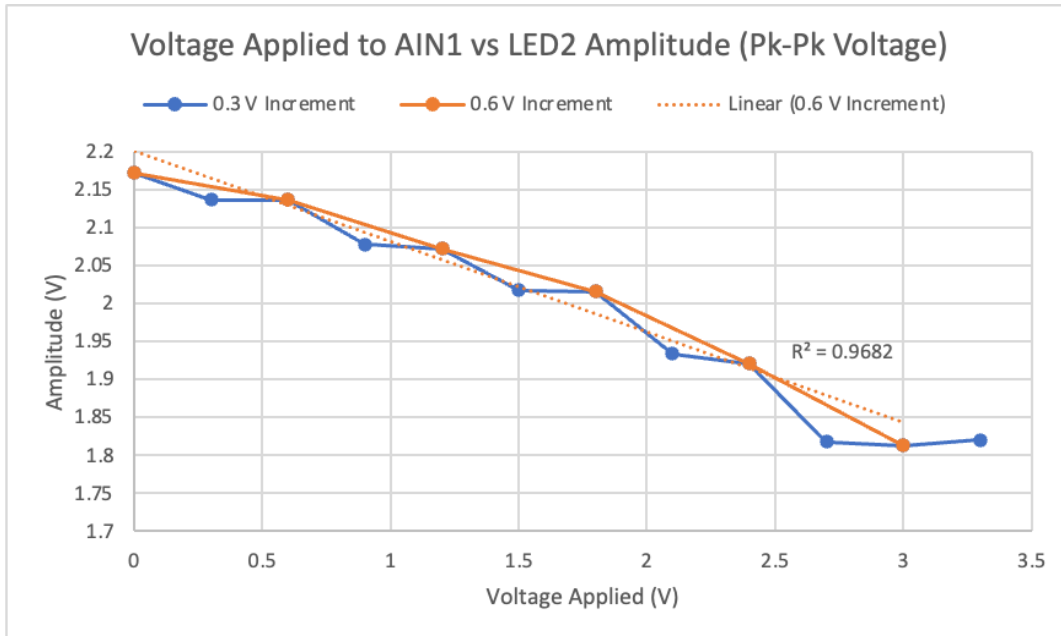
Figure 2: Voltage Applied vs LED2 Amplitude (Pk-Pk Voltage) Analysis

Like the amplitude analysis, the frequency reading seem to decrease in steps as voltage applied increased. This makes sense as the saw tooth function values lookup table passed in also exist in increments. To better account for this, 0.6 V increments was used for the linear fit instead of 0.3 V. The linear fit between applied voltage and LED 2 pk-pk voltage has an R^2 of 0.9608. This value is relatively high and shows that there is a linear and direct relationship between voltage input and the amplitude of LED2 brightness. This is expected and shows that the ADC input value modulates the LED brightness frequency linearly between the range 5-10 Hz.
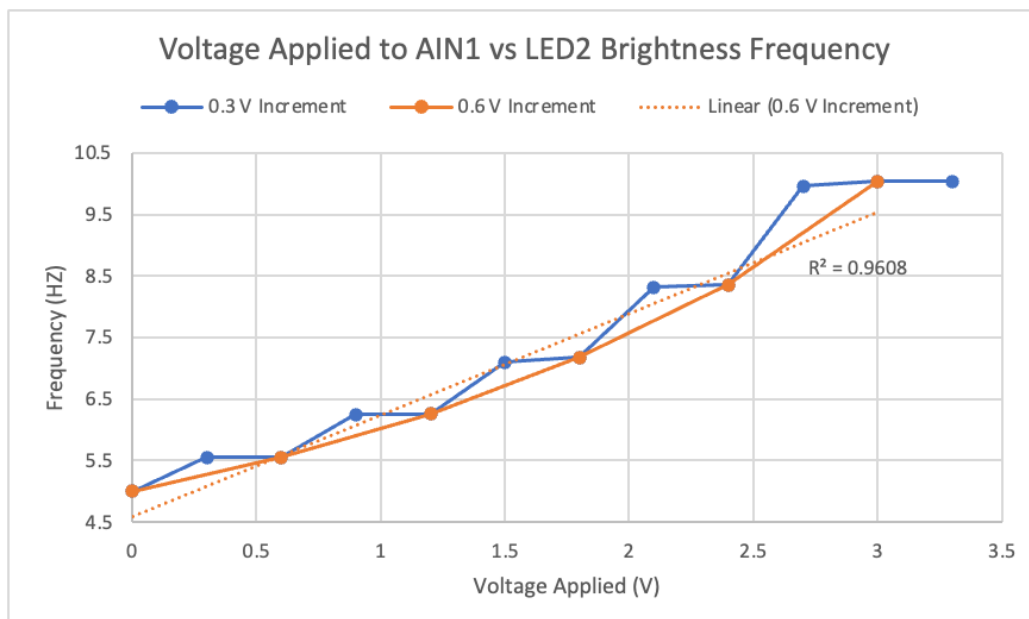
Figure 3: Voltage Applied vs LED2 Brightness Frequency (Hz) Analysis

Appendix:

V	LED3 AVG V (V)	LED2 pk-pk (V)	LED2 freq (Hz)
0	2.99	2.1719	4.9973
0.3	2.7707	2.1367	5.5536
0.6	2.5145	2.1367	5.5528
0.9	2.2949	2.0781	6.2527
1.2	2.0845	2.072	6.2552
1.5	1.8102	2.0176	7.0961
1.8	1.5903	2.0156	7.1807
2.1	1.3509	1.9336	8.3174
2.4	1.124	1.9209	8.361
2.7	0.88463	1.8174	9.9622
3	0.65627	1.8125	10.041
3.3	0.6569	1.8203	10.04

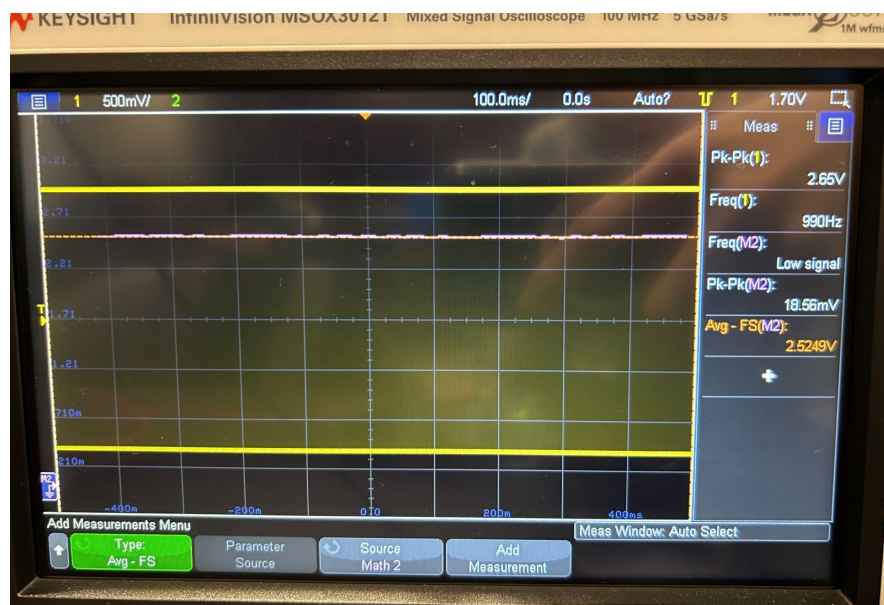Table 1: Voltage Applied vs LED Blink Frequency Raw Data

Figure 4: Data Collection for LED 3

Figure 5: Data Collection for LED 2