GNG 1103 – Engineering Design

Project Deliverable H

Prototype III and Customer Feedback

Group#15

Lucas Siviero	St#300178151
Noah Aynalem	St#300166191
Rakshita Mathur	St#300215340
Riley de Gans	St#300170104
Timi Tella	St#300128051

Date: March 28, 2021

Presented to Justine Lucie Boudreau

Table of contents

1.0 Introduction

As the final phase of prototyping comes to an end in this project, the group has made steady and tangible progress in fulfilling its initial problem statement. During this entire prototyping process, an accelerometer has been added to the climate sensor, allowing the module to detect shaking. The case design has been refined several times, to more accurately follow the dimensions of the module. Several iterations of code have been written and rewritten to ensure the optimal output of all the components, and multiple different circuit diagrams have been tried and tested. This will now culminate in testing the module as a whole- the ultimate comprehensive test in a sense.

This iteration of prototyping aims to ensure that the design the group has created and refined over the past couple of weeks is a working product. The testing will seek to find any potential final flaws in the project as a whole, and by the end of this process, the group will have finalized the creation of a module that is ready to be used by JAMZ Delivery. This module will incorporate all of their major add-on requests, including the previously mentioned climate sensor and shake alarm and a newly added and prototyped anti-theft system and emergency beacon

2.0 General Prototyping Objectives

With the end of the testing period arriving, the goal of the prototyping this week was to ensure that the module was able to function properly as a single unit. With the major add-ons of the climate sensor and the shake alarm having been properly and thoroughly tested, the focus this past week has been to test the two remaining components, the anti-theft and the emergency beacon. Their testing was done individually, and given the fact that time is of the essence, their testing was wholly physical. Their circuits were properly tested and consolidated, and so was their code.

In addition to the extensive testing being done on the final two components, there will be quick testing of the dimensions for a third case. This case is for the protection of the step-down converter. This week, the group seeks to confirm the entire design of the module and present a finished product to JAMZ.

Finally, there will be in-depth numerical testing of the climate sensor, accelerometer, speaker and LEDs. These tests will act to calibrate any variable values in the code. All data from this testing can be found at this link.

3.0 Prototyping Objectives, Tests & Results

3.1 Climate Sensor Calibration Objective

This test will compare the temperature and humidity recorded by an accurate industrial sensor to the data collected by our module twice per second. These values will be used to make a residual plot, calculate the average difference and use the difference to calibrate the values up or down. The percent error calculated from the residual plot before an adjustment will be compared to the percent error calculated after adjustment. The objective of this test will be to measure the correct calibration value, the percent error after adjustment and whether or not the accuracy fits JAMZ's criteria of +- 0.5 degrees C.

3.2 Climate Sensor Result

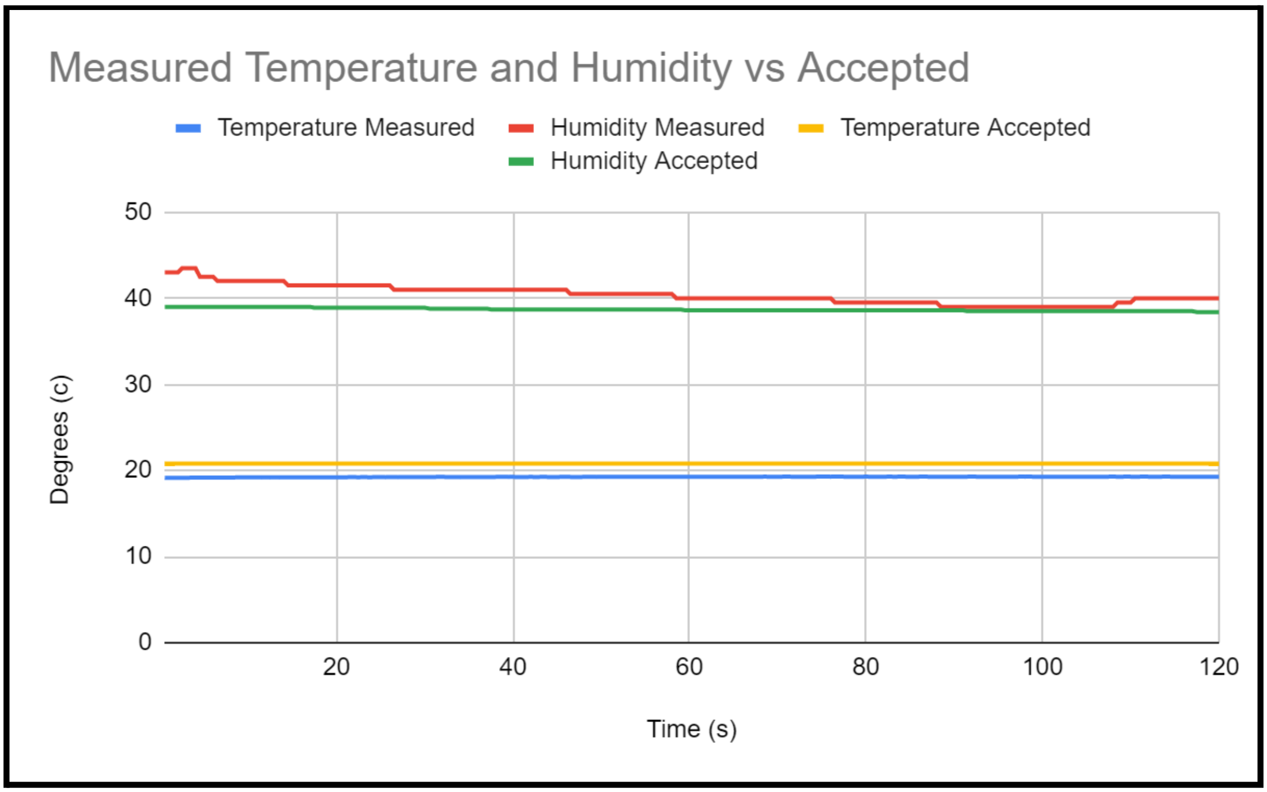

Figure 1 - Measured Temperature and Humidity vs Accepted Plotted Over 120 Seconds

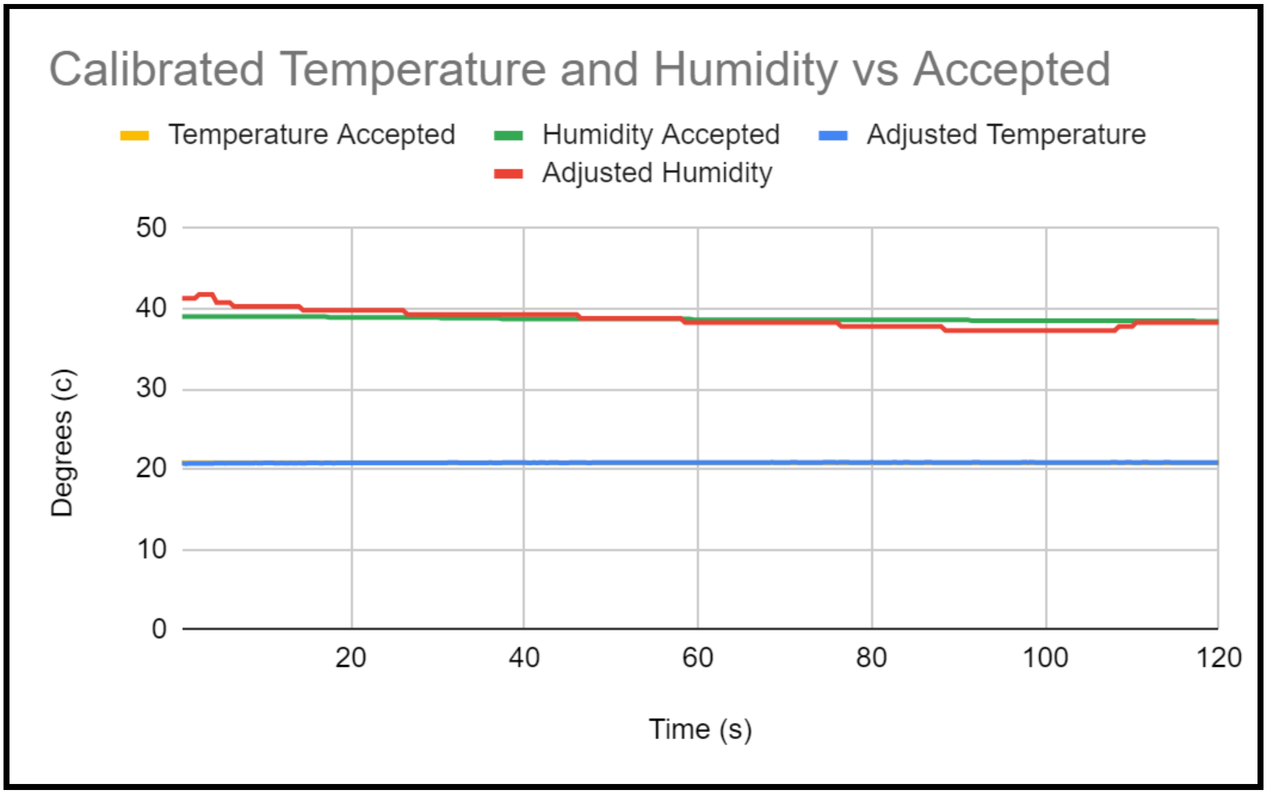

Figure 2 - Calibrated Temperature and Humidity vs Accepted Plotted Over 120 Seconds

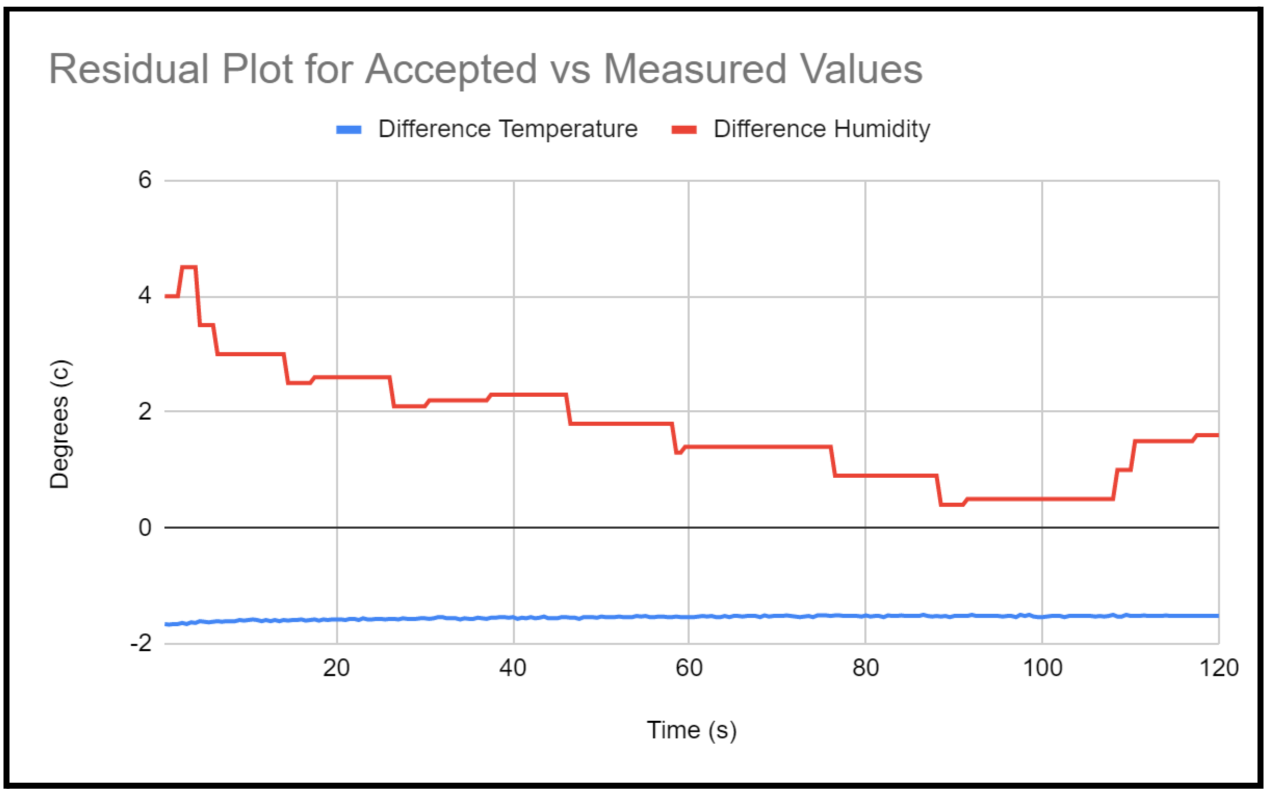

Figure 3 - Residual Plot for Measured Temperature and Humidity vs Accepted Plotted Over 120 Seconds

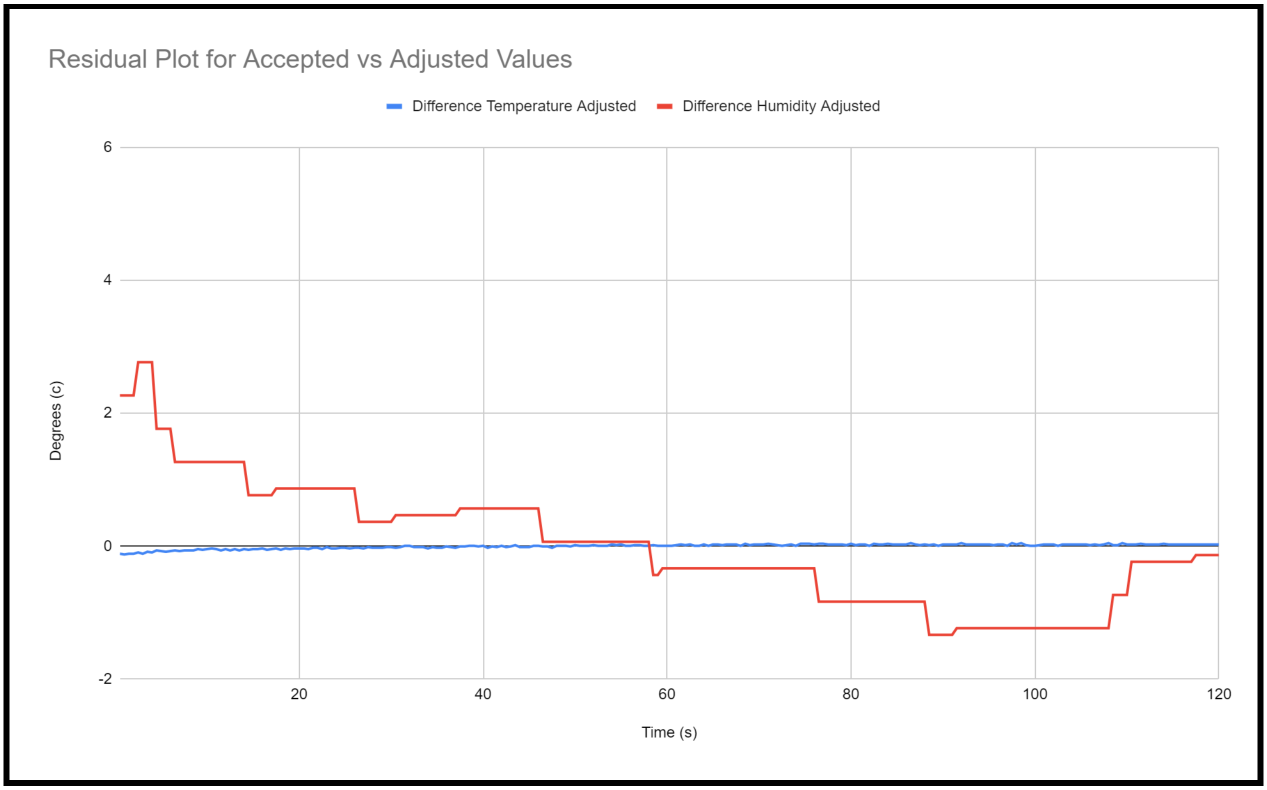

Figure 4 - Residual Plot for Calibrated Temperature and Humidity vs Accepted Plotted Over 120 Seconds

Table 1 - Measured and Calibrated Humidity and Temperature Value Analysis

	Measured		Calibrated	
	Temperature (c)	Humidity (%)	Temperature (c)	Humidity (%)
Percent Error (%)	7.44	4.47	0.13	1.92
Accuracy (Absolute Max Difference)	1.67	4.50	0.12	2.77
Calibration Value	-1.55	1.73	N/A	N/A

As shown in the table above the calibration values calculated from the average difference greatly increased the accuracy. The non-linear residual plot for humidity suggests that data-smoothing is also necessary and this will be implemented in the code

3.3 Accelerometer Calibration Objective

This test will consist of moving the accelerometer back and forth and in circles at different frequencies and different count values in the code. The distance moved by the accelerometer will be 15 cm in the linear test and around the circumference of a circle with a diameter of 15 cm in the circular test. The count variable represents the number of times there has been a non-zero change in acceleration out of 10 readings over 0.5 seconds. The objective of this test will be to measure the frequency at which each count value detects a violent shake and choose the correct count value for calibration. A good count value will not trigger from low frequency shakes that would occur from normal activity (80-100 bpm) but would trigger at higher frequencies (120-160 bpm).

3.4 Accelerometer Calibration Result

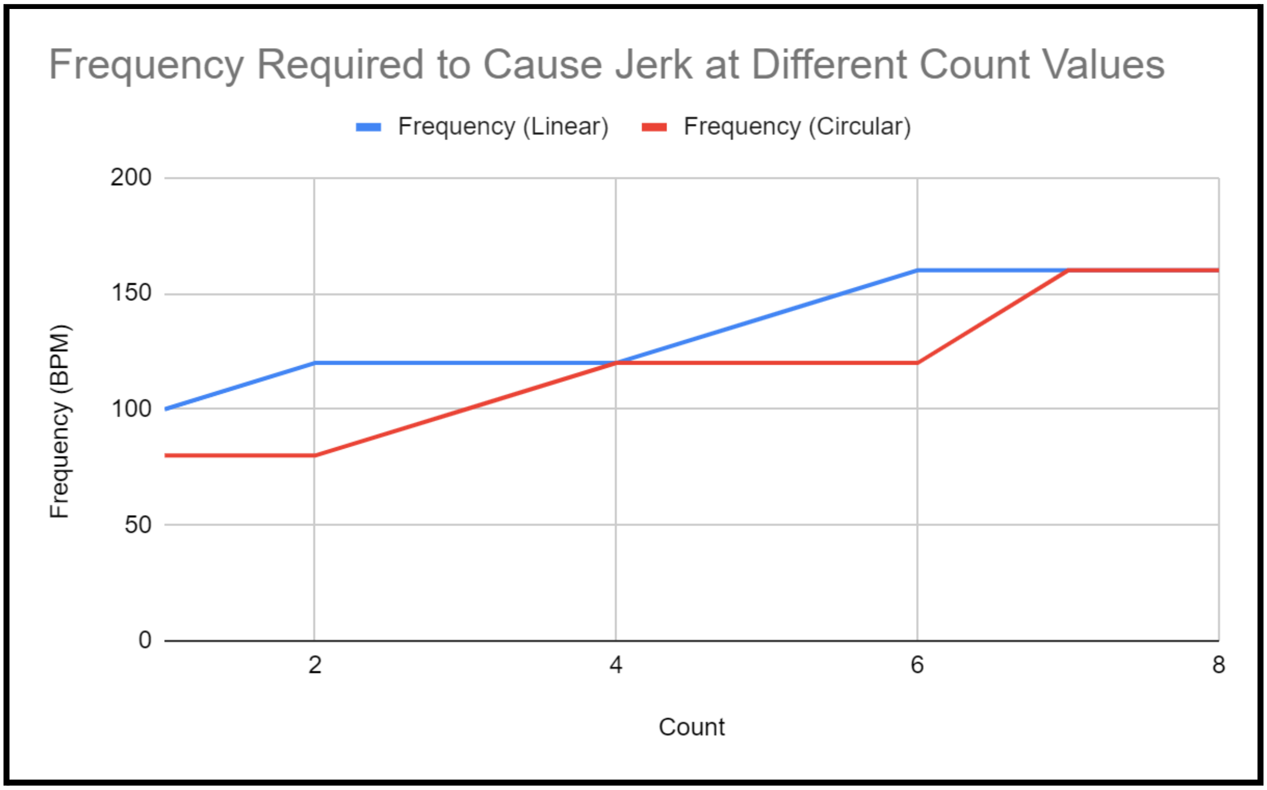

Figure 5 - Frequency Required to Cause a Violent Shake (Jerk) at Different Count Variable Values

As shown in the graph above, both the linear and circular movement patterns trigger a violent shake at 120 bpm with a count value of 4, so this was implemented in the code.

3.5 Speaker Configuration Objective

This test will consist of measuring the volume of the speaker in decibels with a sound meter application at distances of 0, 1, 2, 3, 4 and 5 feet away. This test will be repeated with the speaker attached to 3.3 V, 3.3 V with an NPN transistor and 5V with an NPN transistor. All configurations are risk-free, but sound quality can be lost with higher voltage and transistors. The objective of the test will be to plot the volume measured for each situation and use this to select the loudest configurations. As well, sound quality will be considered, but cannot be measured.

3.6 Speaker Configuration Result

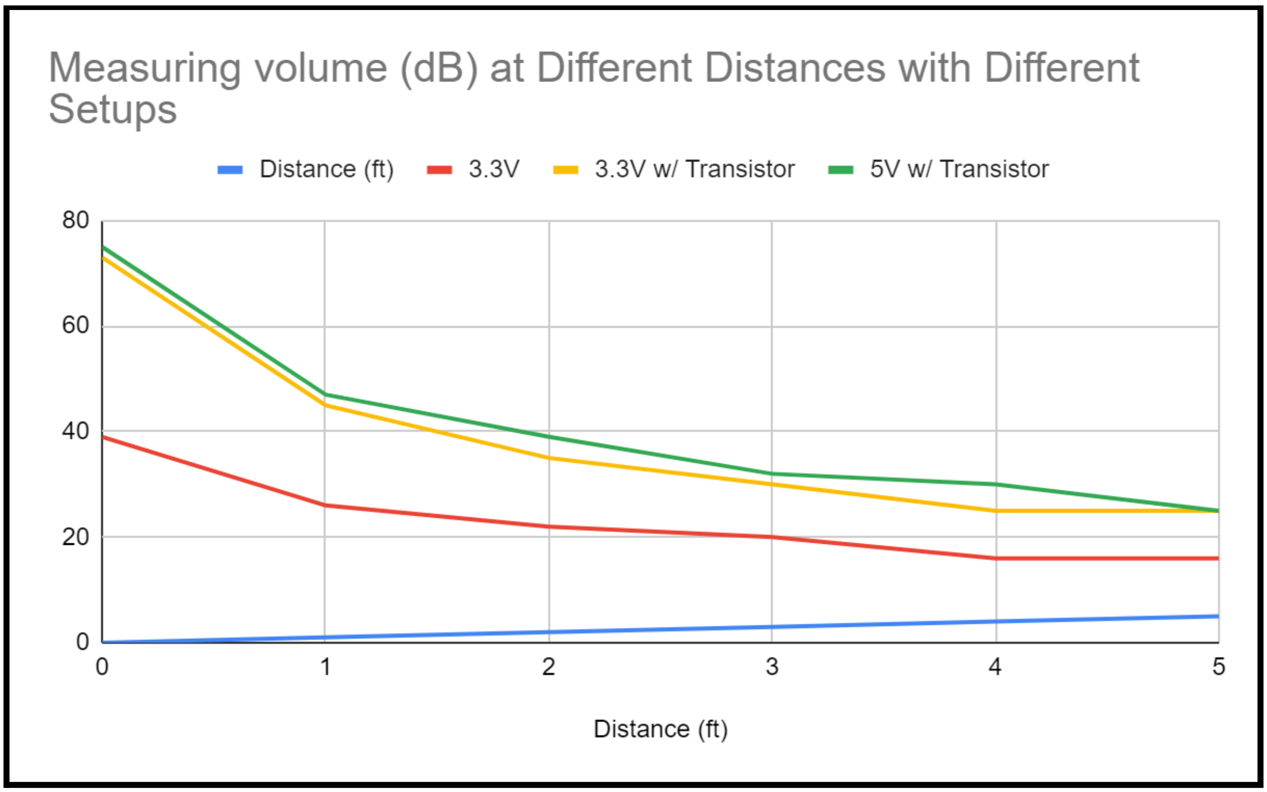

Figure 6 - Measuring Volume of Speaker at Different Distances with Different Setups

As shown in the graph above the 5V with transistor configuration was the loudest in every scenario and there was no loss in sound quality heard.

3.7 RGB LED Calibration Objective

This test will consist of testing the RGB values for each colour required (Red, Green, Blue, Yellow, Orange, Purple and White). The resultant colour will be photographed and labelled with names from a colour wheel, then the incorrect value will be changed. This will be repeated until the desired colours are produced. The objective of this test is to measure the correct RGB values for each colour through trial and error and subjective observation.

3.8 RGB LED Calibration Result

Table 2 - RGB Value Inputs and Colour Outputs

Desired Colour	Red Value	Green Value	Blue Value	Output
	255	0	255	Blue
	255	0	240	Blue
	255	0	220	Lilac
	255	0	200	Lilac
	255	0	190	Lavender
	255	0	160	Lavender
	255	0	120	Red
Purple	255	0	130	Purple
Red	255	0	0	Red
Green	0	255	0	Green
Blue	0	0	255	Blue
	255	255	0	Green
	255	230	0	Lime
	255	200	0	Chartreuse
Yellow	255	180	0	Yellow
	255	153	51	Green
	255	130	51	Chartreuse
Orange	255	110	51	Orange
	255	255	255	Blue
	255	255	200	Blue
White	255	255	180	White

As shown in the table above the values for red, green and blue were all correct. The purple, yellow, orange and white values were all changed slightly as shown and implemented in the code.

4.0 Conclusion

With the final prototyping stage coming to an end, the group feels confident in the module that has been produced from the cycles of iteration. Results from the calibration and configuration tests are positive, and mark the end of the group's design process. In presenting the finished module design to JAMZ, the client can be assured that they will receive the highest quality that this group has to offer them. Having successfully done analytical, physical, comprehensive and focused testing throughout all stages of the prototyping process, the client can be assured the module that has been designed is of the highest quality.