UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

# Climate Control Grow Box

## Electrical & Computer Engineering

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Group 73

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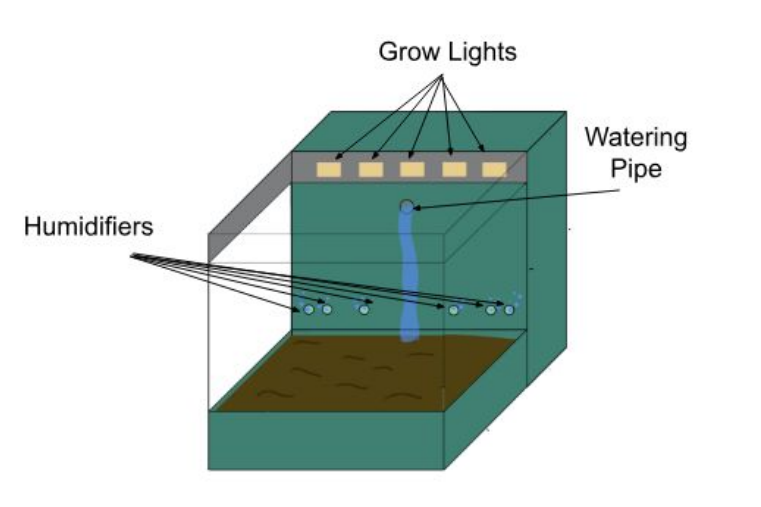
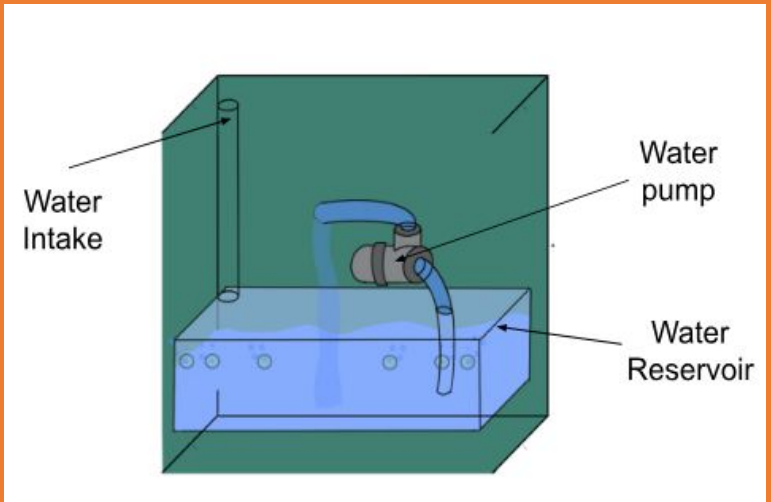


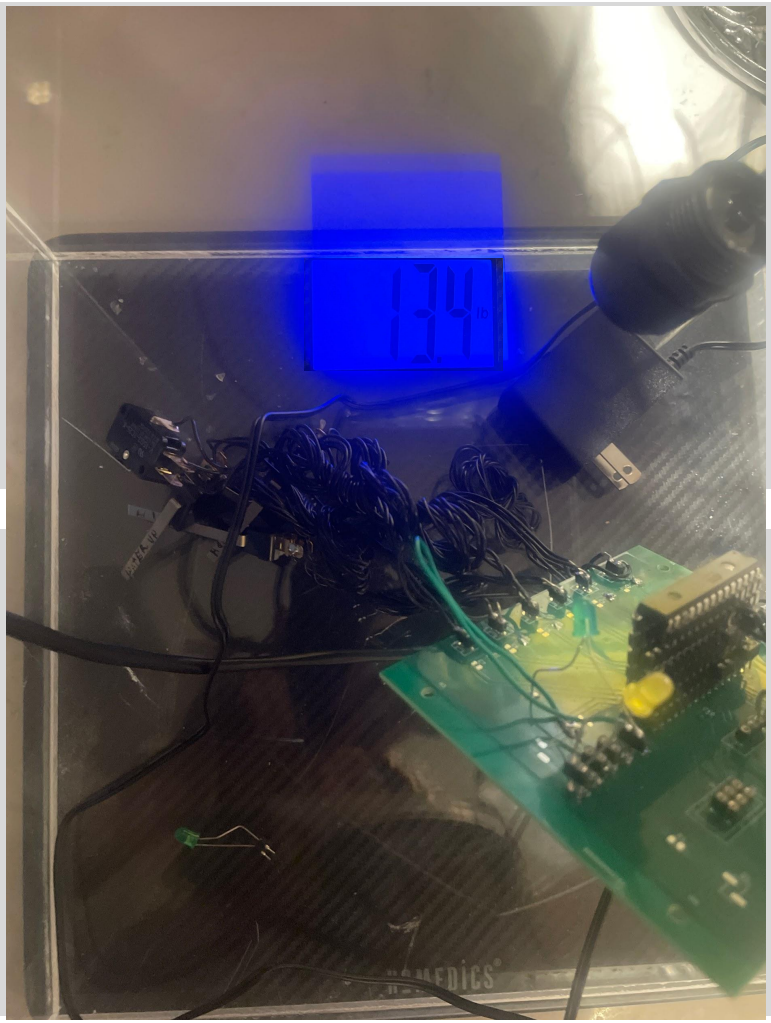




# About The Project

The goal of our project is to design a box which will allow plants to be grown within the home where the climate may not match the growing requirements of the plant.

Example: Growing a cactus in an office building in florida

# High Level Requirement - Ease of Use



**Product must be accessible to the average consumer in ease of use**

## Verification:

- **Single, unified chassis with all components contained within it**
- **Moveable by single person**
- **less than 25 lbs with plant inside**

# High Level Requirements - Accuracy

```
Humidity: 45.10 %, Temp: 29.60 Celsius
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Humidity: 45.40 %, Temp: 29.60 Celsius
Humidity: 45.50 %, Temp: 29.50 Celsius
```
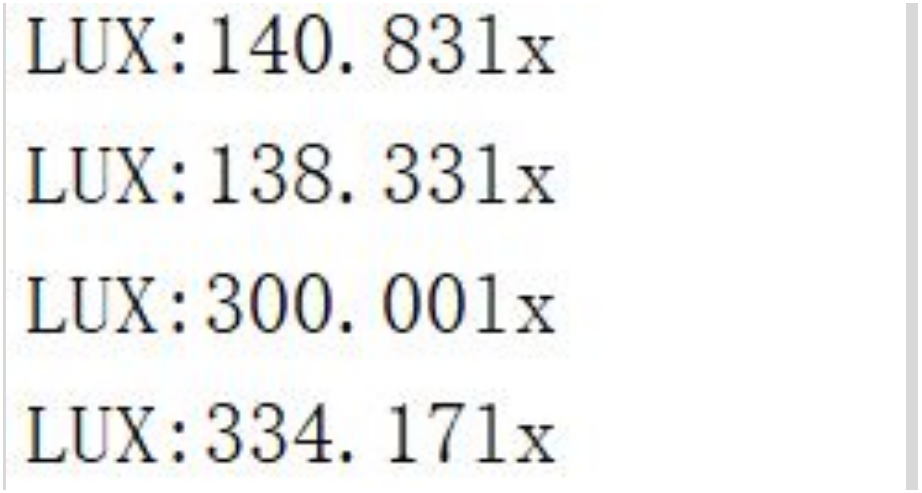
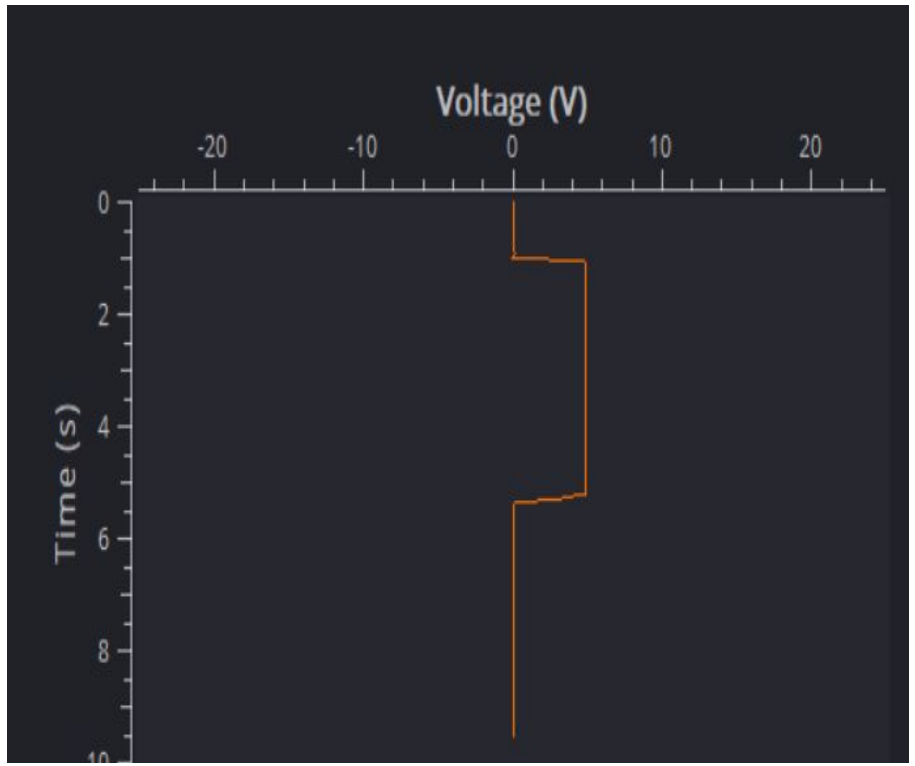




**High level of accuracy within the control system to maintain the desired environment type with a low tolerance for fluctuations**

**Verification:**

- **Humidity system allows tolerance of +-5% humidity when set in the acceptable range of +-10% of the external humidity levels**
- **The water dispersions allow an error bound of +-10g per dispersal of water**

# High Level Requirements - Responsivity




## The system needs to respond to external stimuli in a timely manner

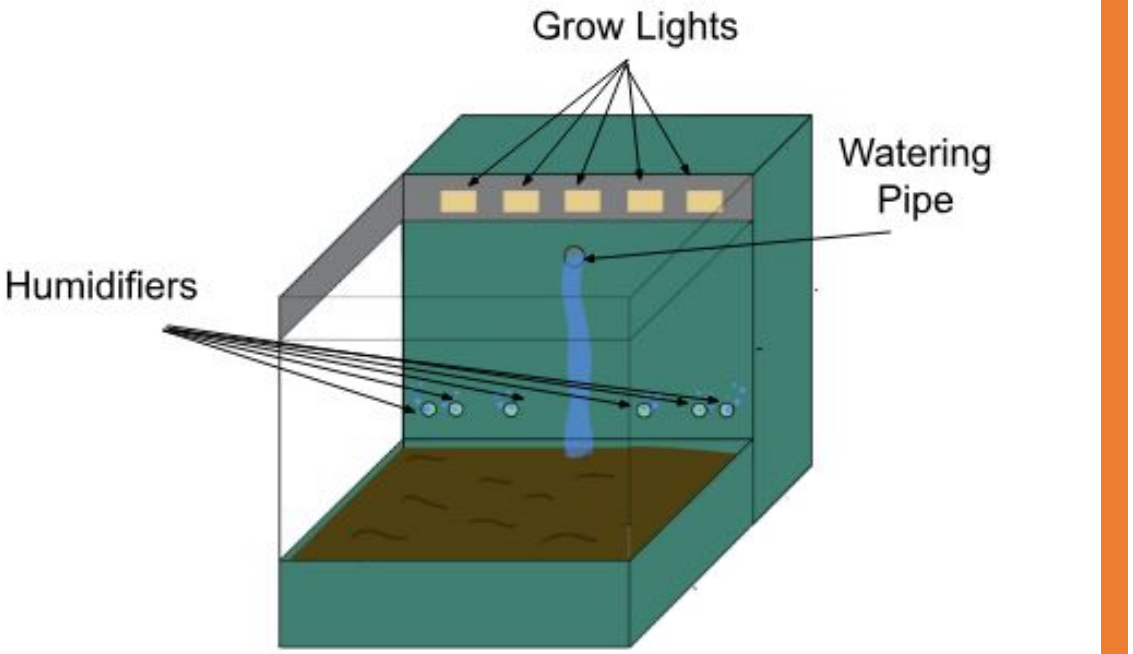
### Verification:

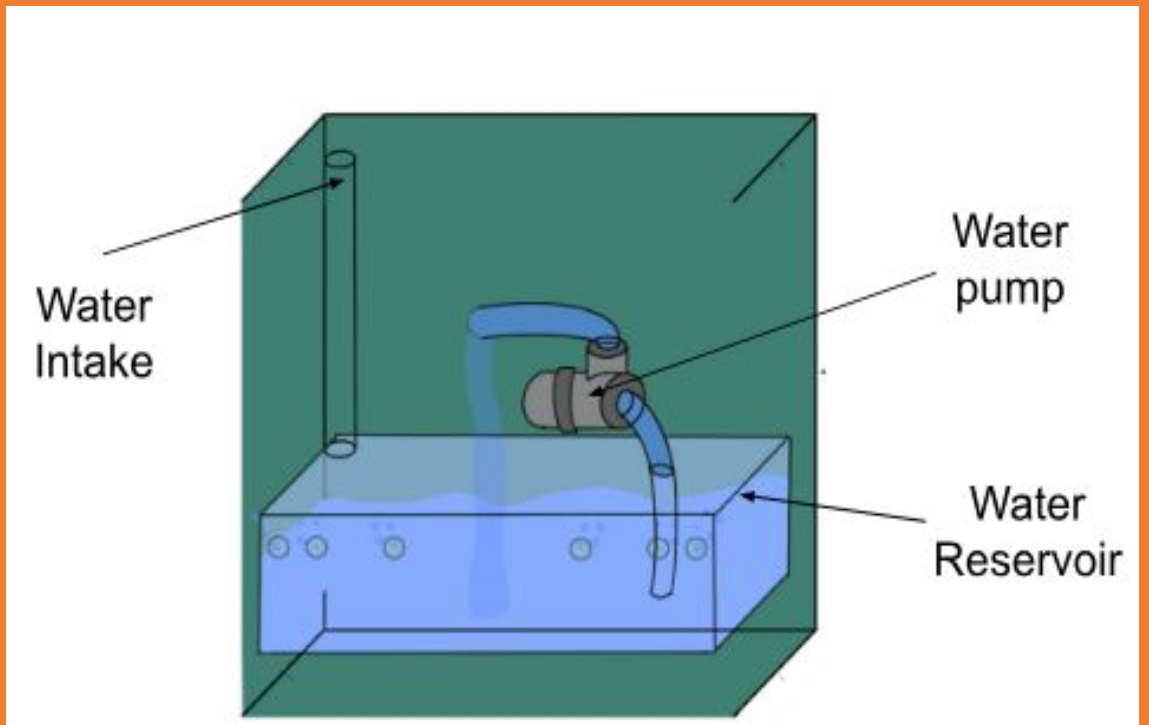
- **Response time will allow for proper setting of the internal climate**
- **External stimuli detected at every three minutes and begins change process within five seconds of detecting external stimuli**

# The System as a Whole

a high level overview of the
projects subsystems

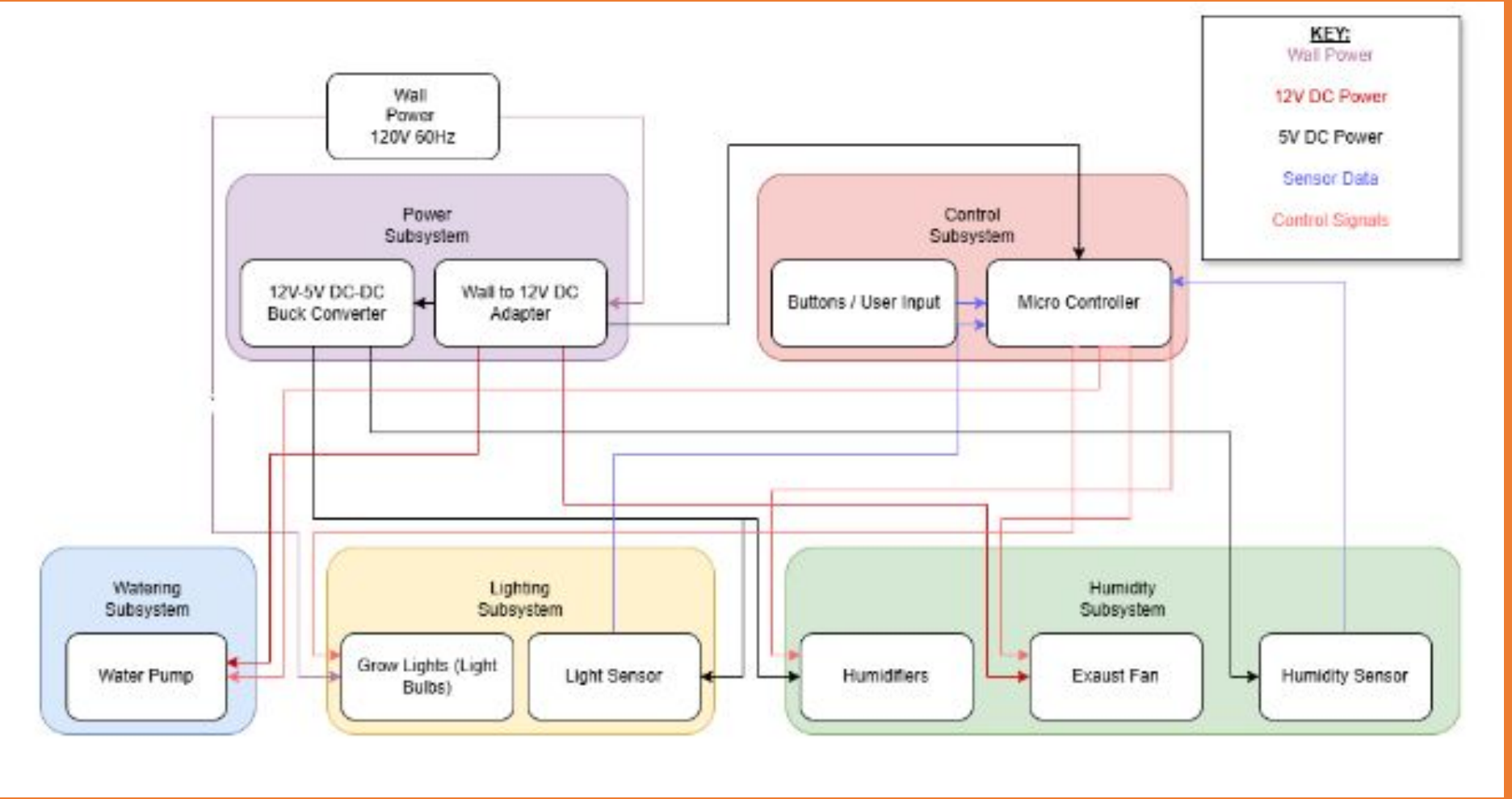
# The Box



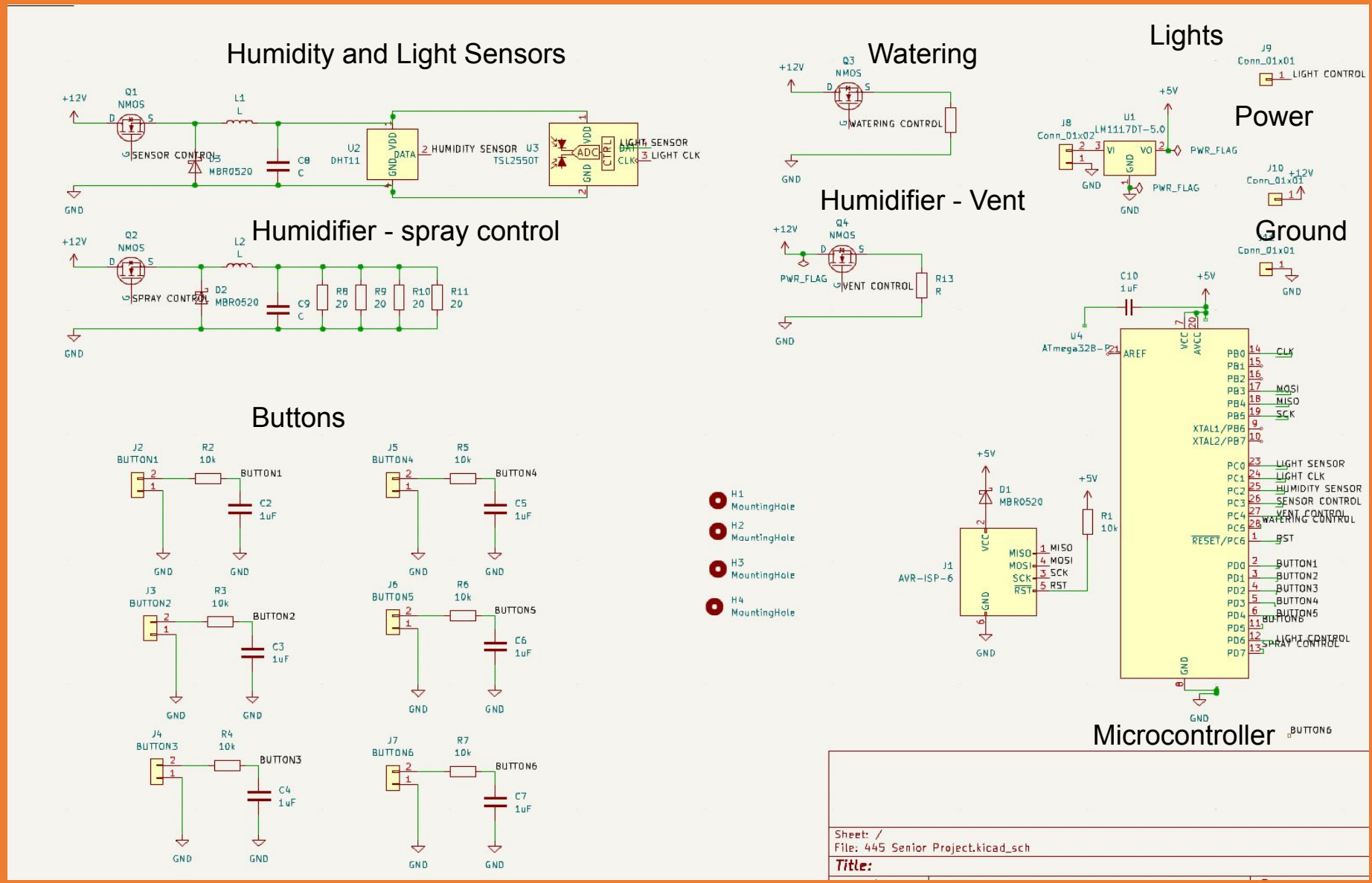




Initial Diagram of the box

# Block Diagram



# PCB Schematic



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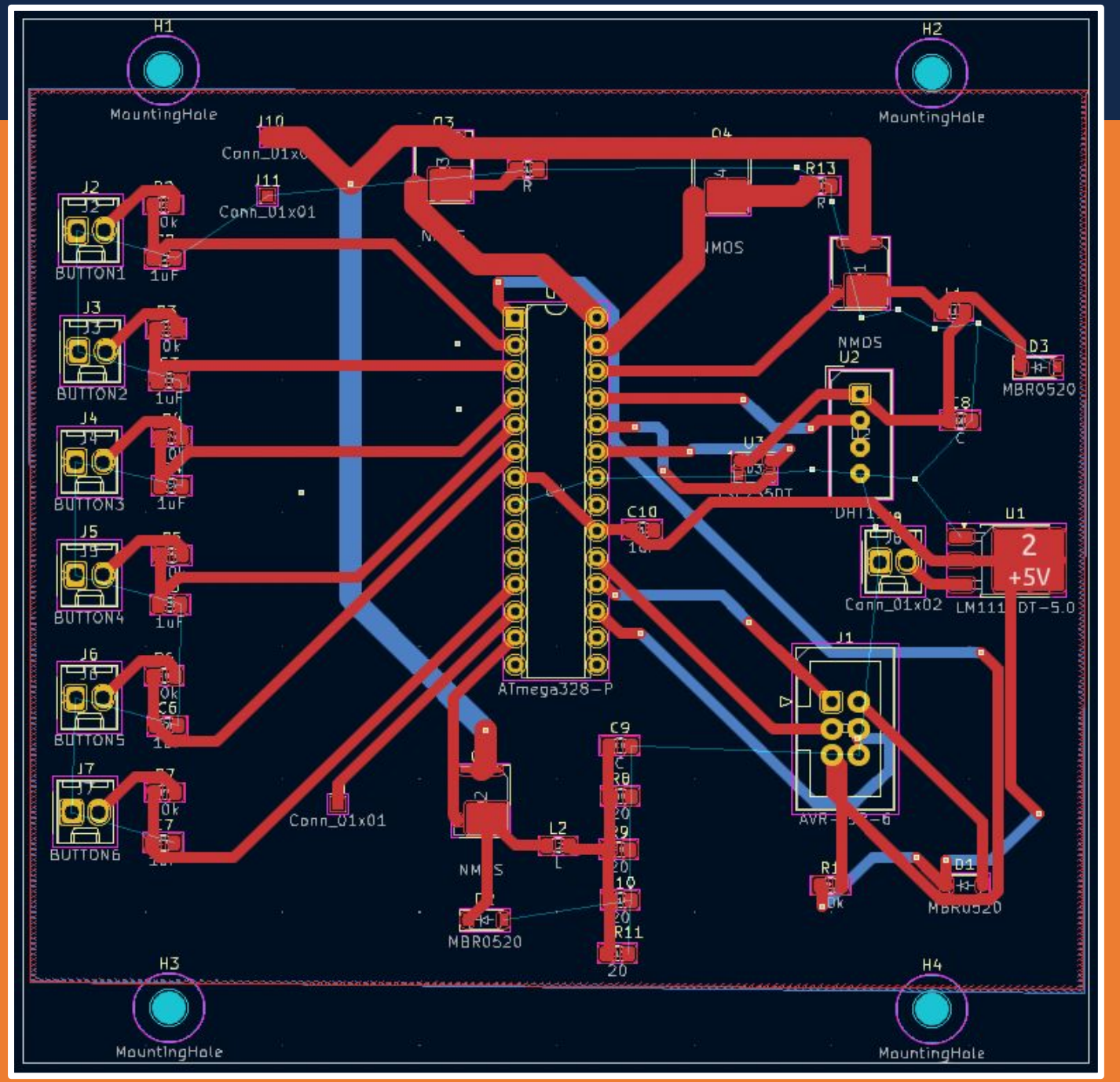
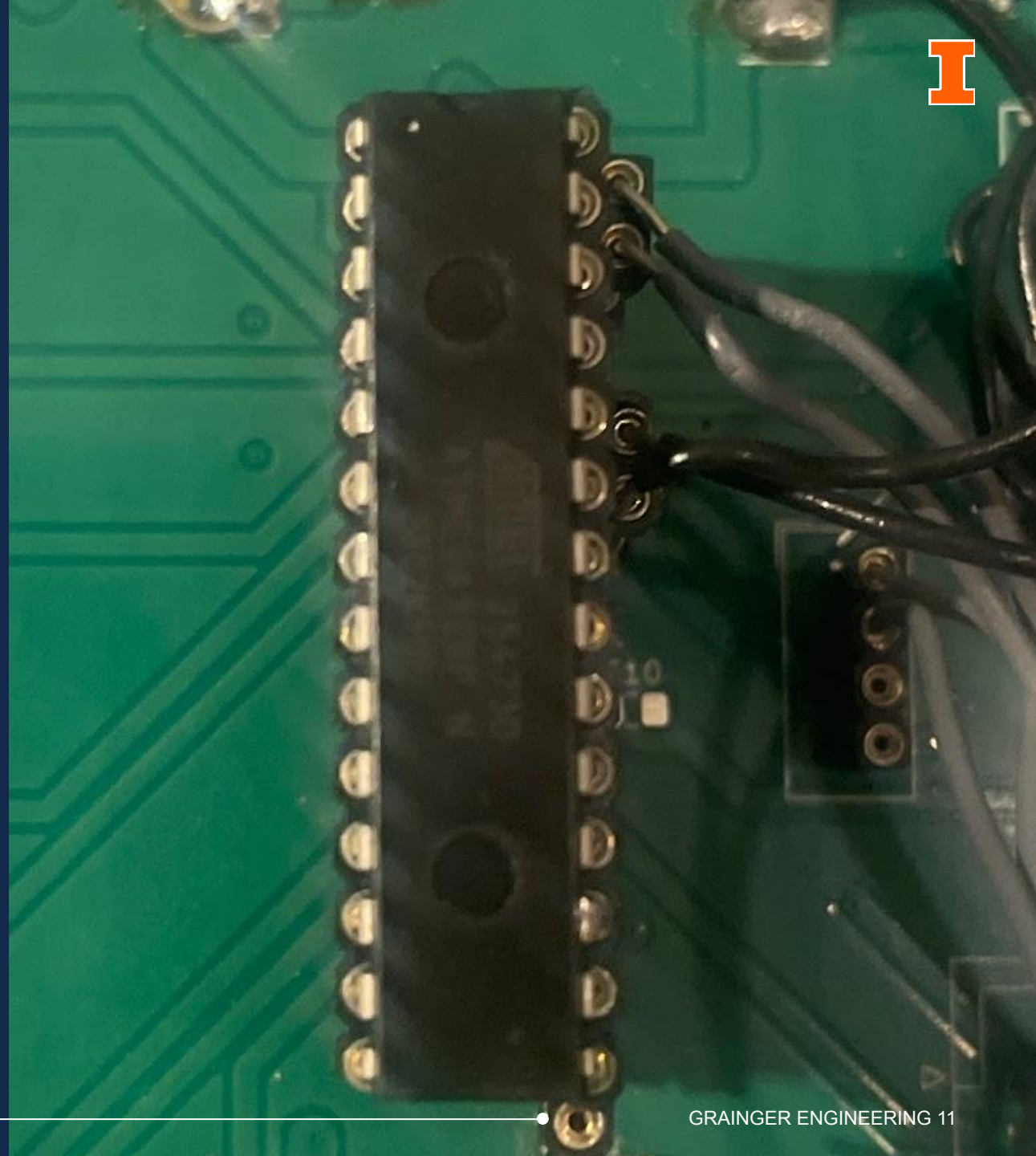


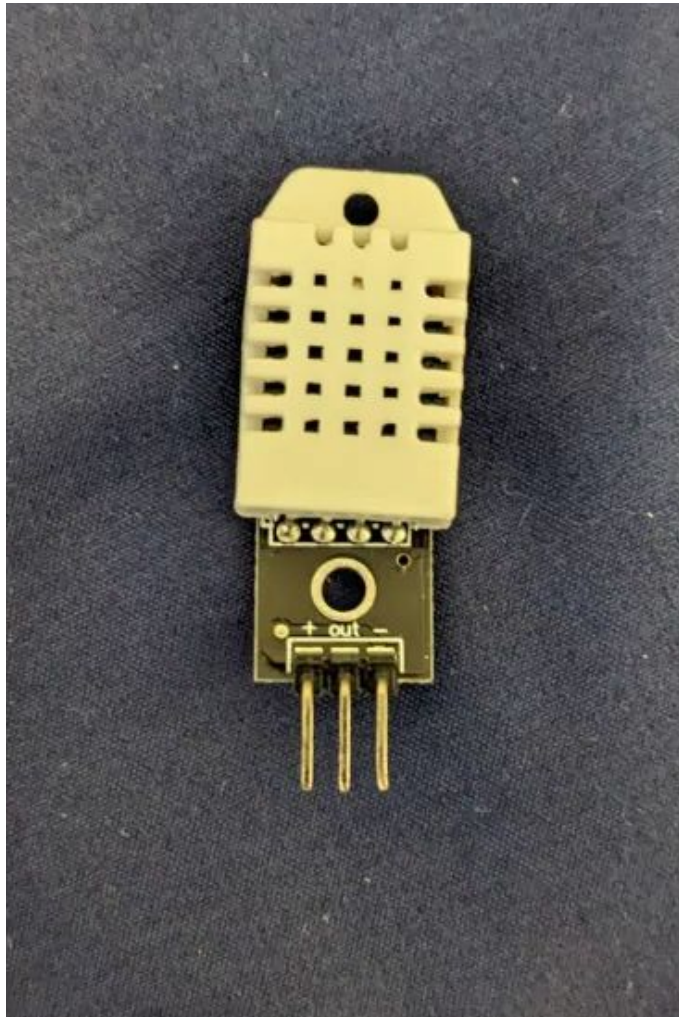
# Subsystems

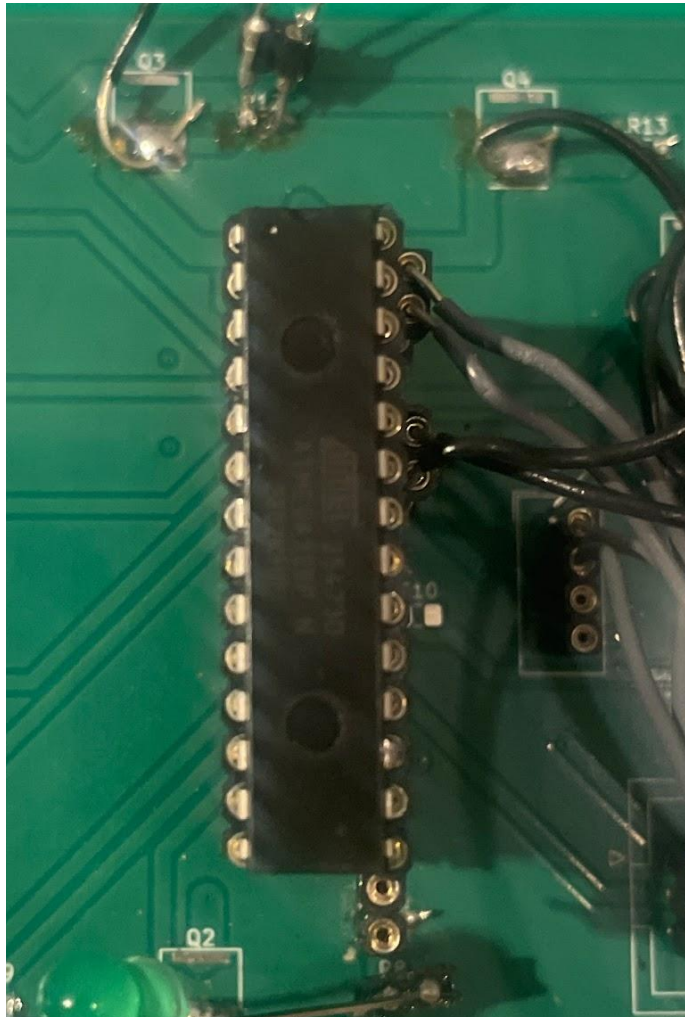
# Control

This system uses buttons to select the value for the lighting, watering, and humidity. The controller will take these values and use them to determine how to act with the system.

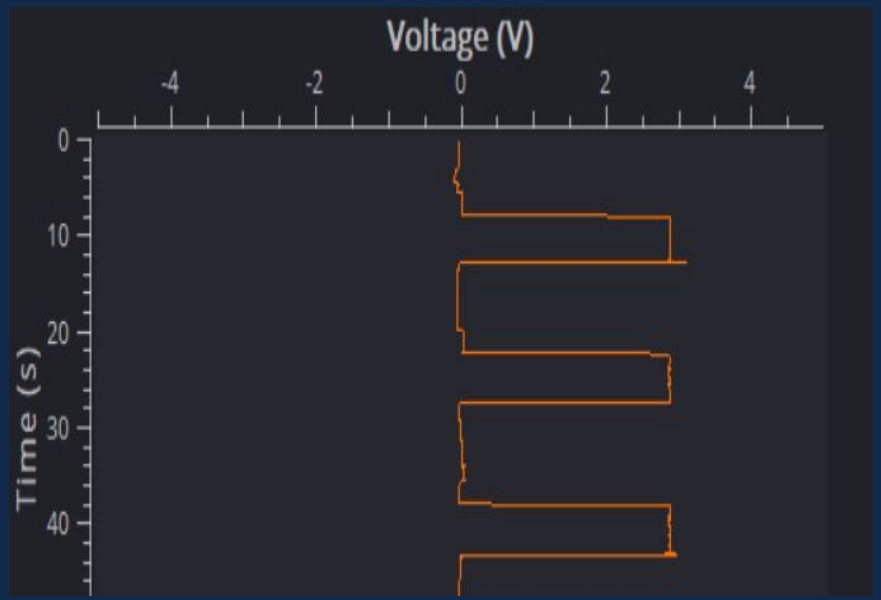


# Humidity Components




```
//outputsignals
int HUMIDITYOUTPIN = 7;
int LIGHTOUTPIN = 6;
int VENTOUTPIN = A0;
int WATEROUTPIN = A1;
```




# Control Requirements and Verifications

- Must be able to create the control variables for humidity and light
- Must be able to operate timer control for the water subsystem
- The controls must correctly activate the MOSFETs

# Power

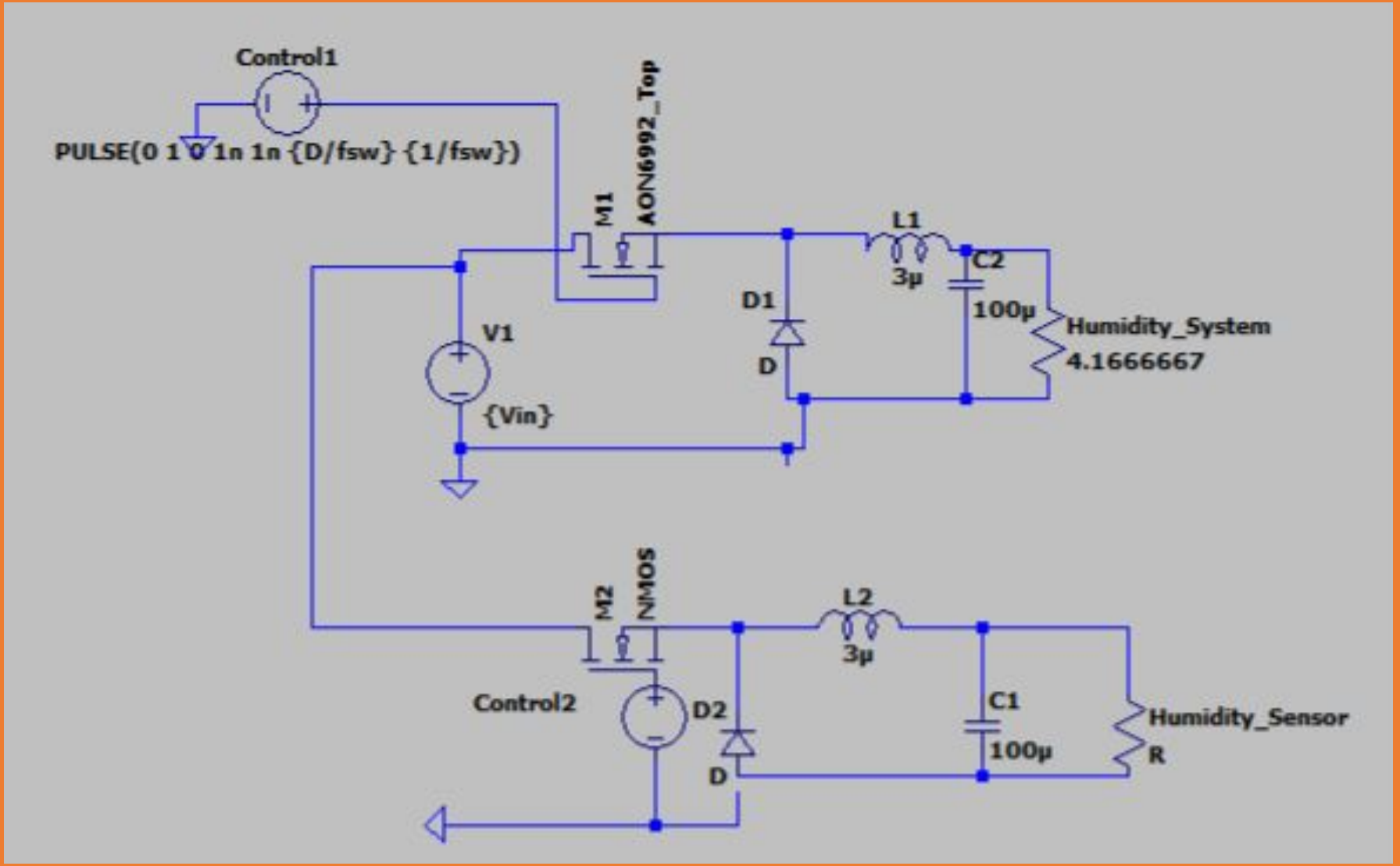
Various systems have different voltage requirements. This requires us to adjust the voltage that is pulled into the system.

| Component | Voltage | Power |
|---|---|---|
| Spray Humidity Module | 5V-DC | 7.5W |
| Venting Fan | 12V-DC | 7W |
| Sensors | 5V-DC | <1W |
| Water Pump | 12V-DC | 10W |
| UV Grow Lights | 110V-120V-AC | 50W |

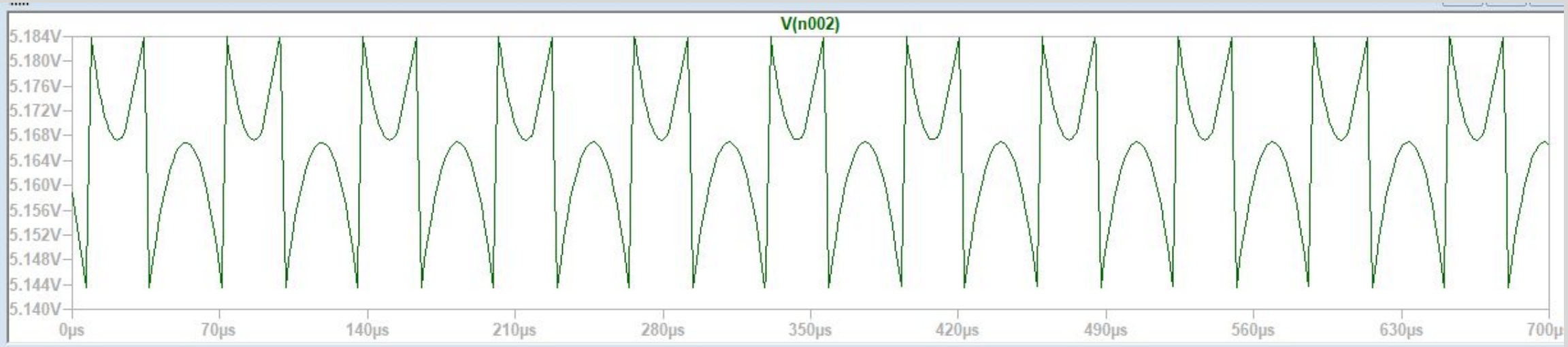
# The Power Converter Schematics

## Ideal Values:

## Duty Ratio of 45%

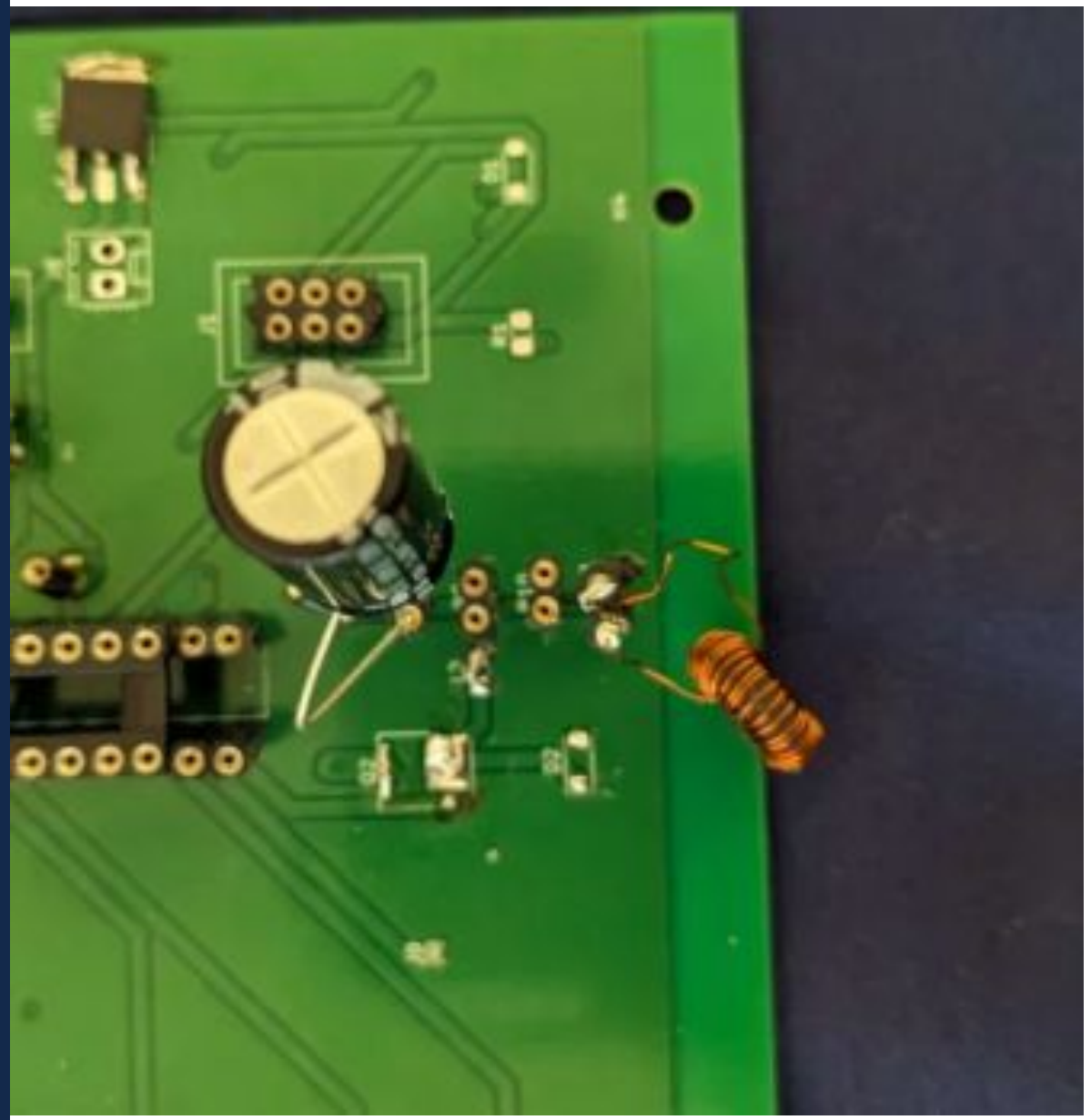


# Simulated Results

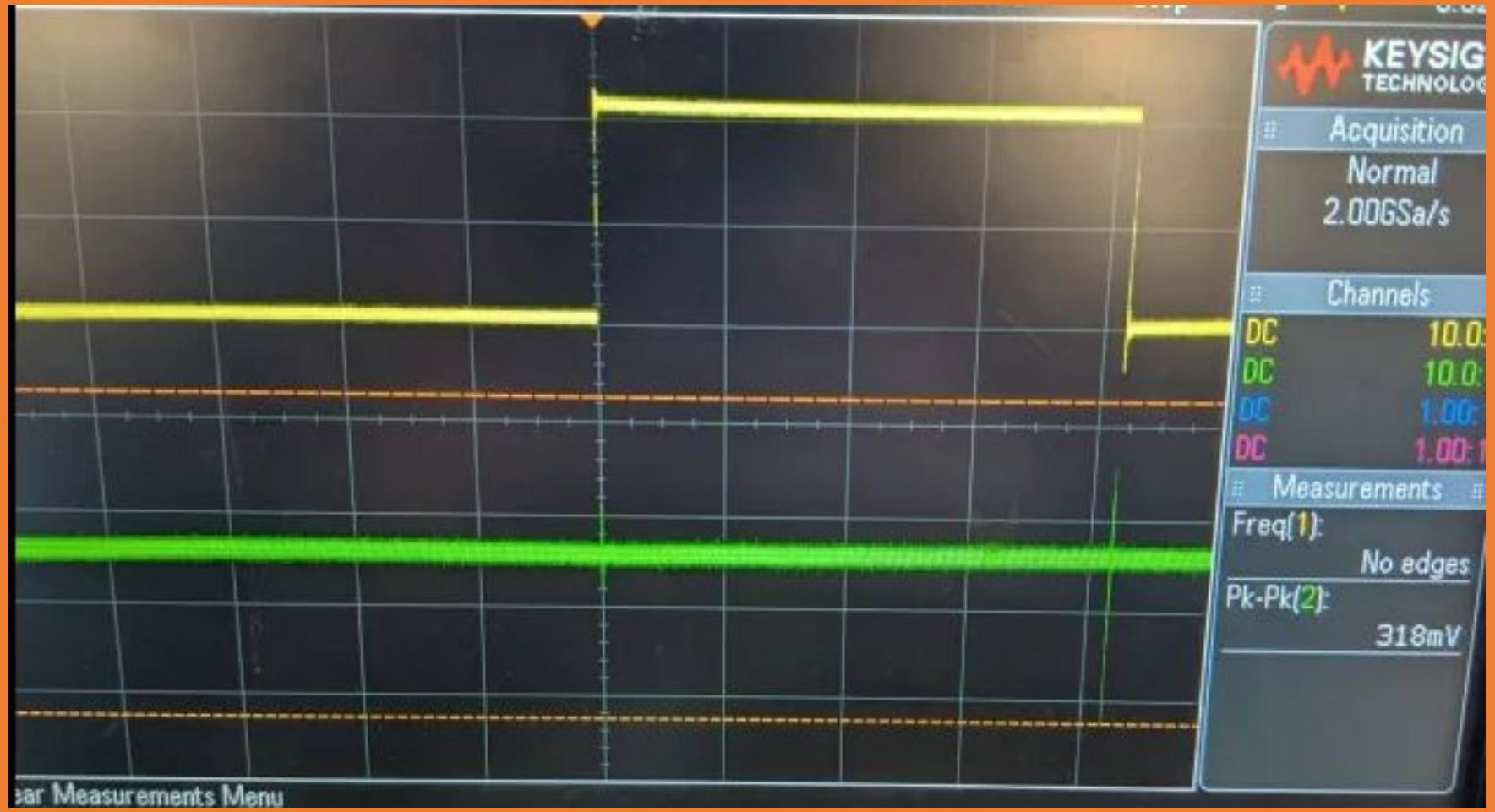
# The Final System

The system was originally designed to operate at a frequency of about 50 kHz. When testing with the lab bench equipment a duty ratio of about 39% provided us with a system that operated with a maximum of 5.1 V.



# The Power Converter Results

We also saw that the system in this case only had a peak to peak difference of about 300mv which means it remained within the 5% bounds




Power Results

# The Results

In the end the controller was not able to obtain the originally tested duty ratio and we saw a duty ratio much slower(1.8 kHz).


Power Results

# Humidity

The humidity control subsystem is responsible for the monitoring of and the regulation of humidity within the enclosure of the grow box

| | Water Before | Water After | Water dispersed in 10 minutes |
|---|---|---|---|
| Humidifier 1 | 47.5g | 42.8g | 3.6g |
| Humidifier 2 | 44.7g | 39.9 | 4.2 |

To calculate Relative Humidity (RH) from Absolute Humidity (AH) and temperature, use the formulas:

RH = (AH / Saturation Vapor Pressure at given temperature) x 100

Absolute Humidity [AH] ($g/m^3$) = (Mass of Water Vapor (g) / Volume of Air ($m^3$))

40-50 ml/h * 6 = 240-300ml/hr = 240-300 g/hr = 4-5 g/m

$\Delta AH = 4\ (g/min) / 0.0566337\ (m^3) = 70.629\ ((g/m^3)/min)$

$\Delta RH = (\Delta AH/\text{Saturation Vapor Pressure})*100$

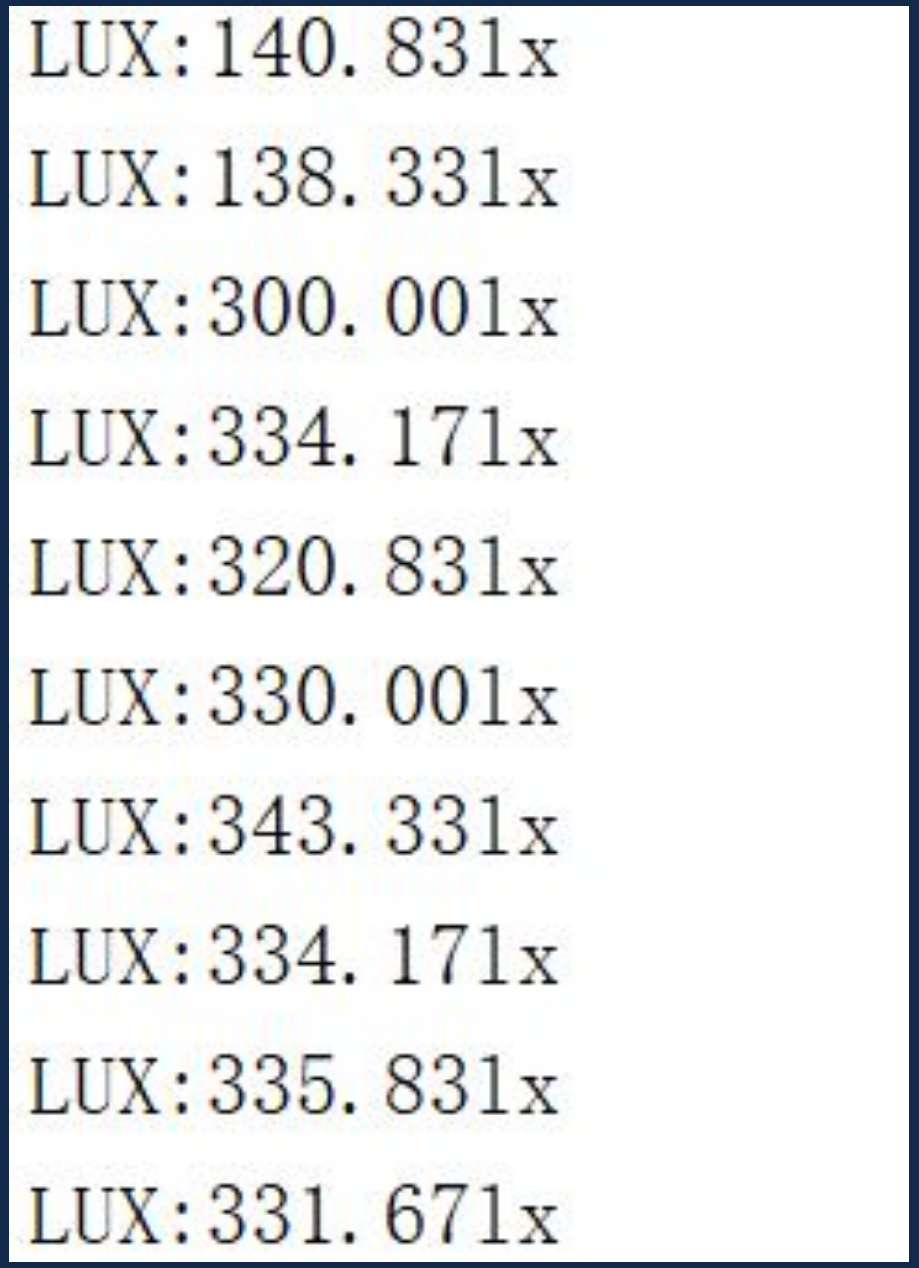
$= (70.629/ 781.95730806)*100 = 9.032$ humidity %/m

# Humidity Requirements and Verifications

- The humidity must be sensed with an accuracy of +-5%
- We must be able to raise the humidity within the enclosure by 10% in comparison to the external humidity level
- We must be able to lower the humidity within the enclosure by 10% in comparison to the external humidity level

# Light

The Light subsystem is responsible for monitoring and controlling the light intensity level within the enclosure

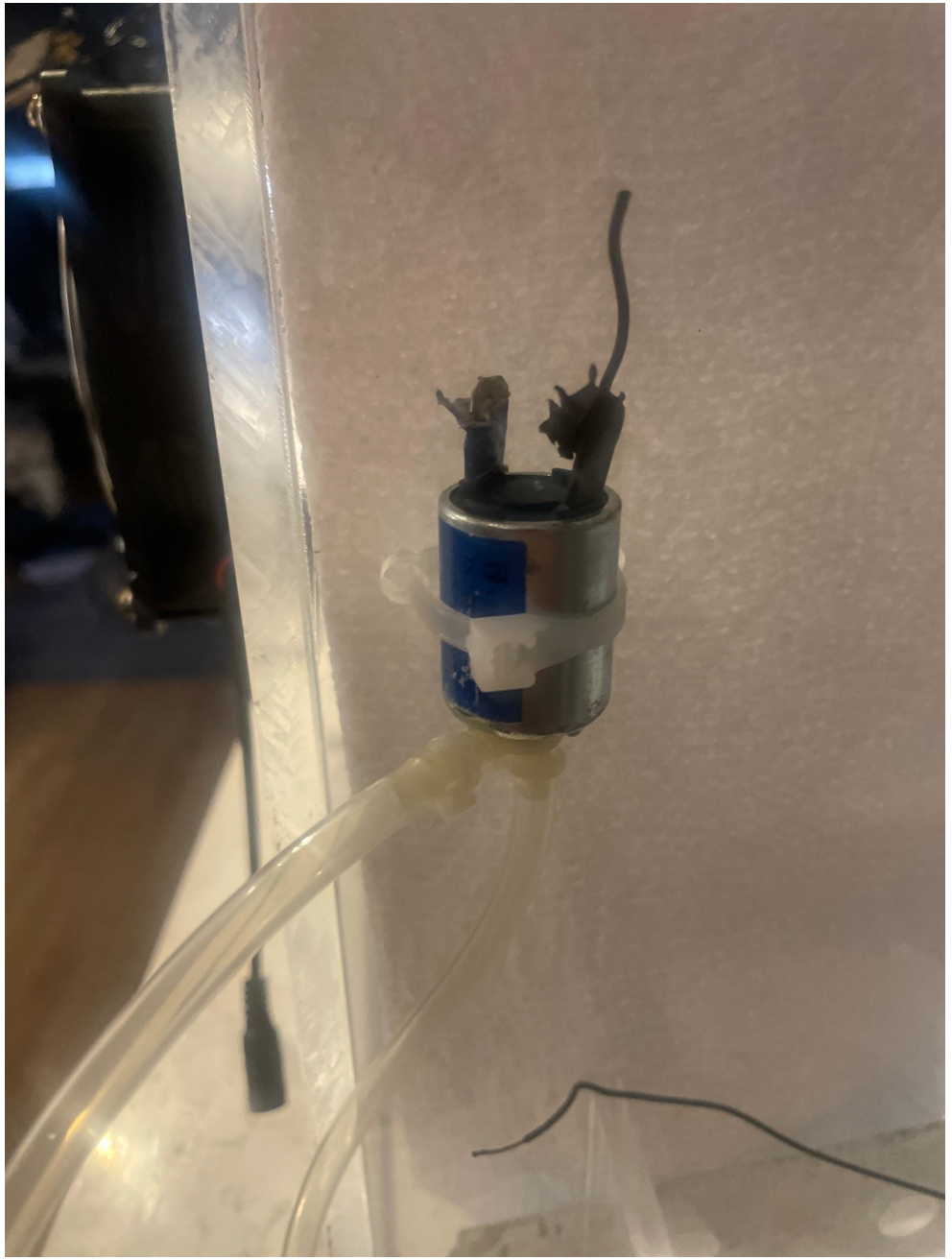


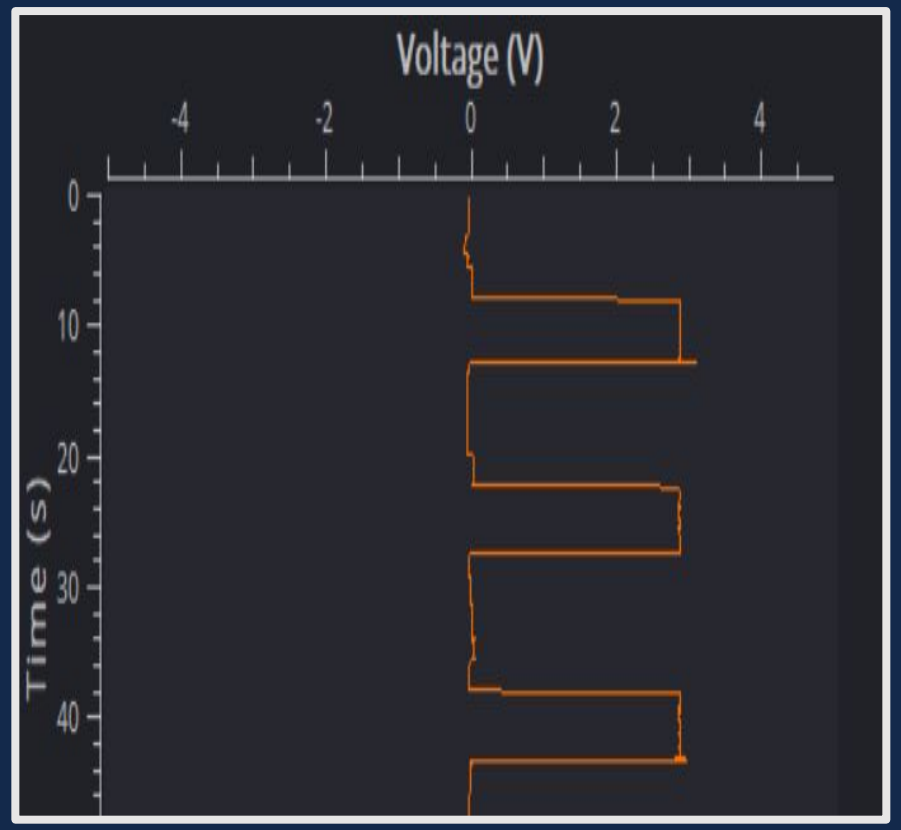

# Lighting Requirements and Verifications

- The luminosity level must be sensed with an accuracy of +-5lx
- The lights must turn on with an external signal
- Light should increase the light in an environment with less than 1000 lx when on

# Water

The Water Subsystem will be responsible for the water distribution for the plants inside the enclosure.





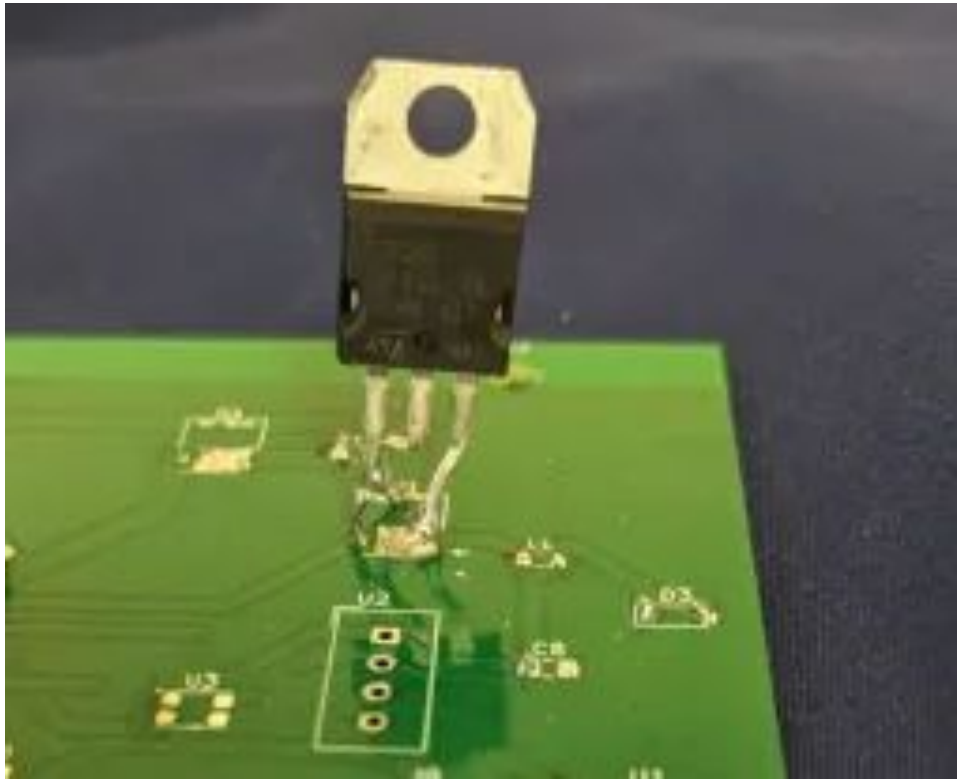

# Watering Requirements and Verifications

- Must be able to accurately dispense water using timed dispension in ¼ cup intervals up to dispensing the entire reservoir
- Must be able to stop dispersal of water within three seconds after the signal to dispense water has ended

# Other Things We Learned

We learned that we need to check how we place things on a PCB schematic. There were components that were made to be through hole and we had to surface mount them.

Coding issues, we overheated our components and had issues with the system connecting to the programer. One of the pins that we were using to control the power was also used to program the chip.



# Thank You!

# Questions?