C.H.A.N.O.S.

Controlled. Hydration. Automated. Nutrient. Optimization. System.

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Motivation and Background

- Gardening can provide joy, relieve stress, and build confidence
- Busy schedule of modern life and long work hours
- Disruption between people and nature ↔ reduced cognitive function, increased anxiety and depression
- Many existing products do not emphasize low power consumption or alternative green sources of energy

Goals

- ❑ Basic Goals
  - ❑ Automatically waters and nourishes a plant
  - ❑ Automatic drainage of the water runoff
  - ❑ Adaptable to a plant of the user’s choosing
- ❑ Advanced Goals
  - ❑ Reduce the environmental footprint of the design
  - ❑ Low energy consumption and use of sustainable energy sources

Objectives

- ❑ Objectives for Basic Goal
    - ❑ Measurement of the soil moisture
    - ❑ Transport of the runoff from the pot to separate container
    - ❑ Design of a web or mobile app
- ❑ Objectives for Advanced Goal
    - ❑ Periodically sampling sensors
    - ❑ Selection of lower voltage components
    - ❑ Reuse of water runoff

Features

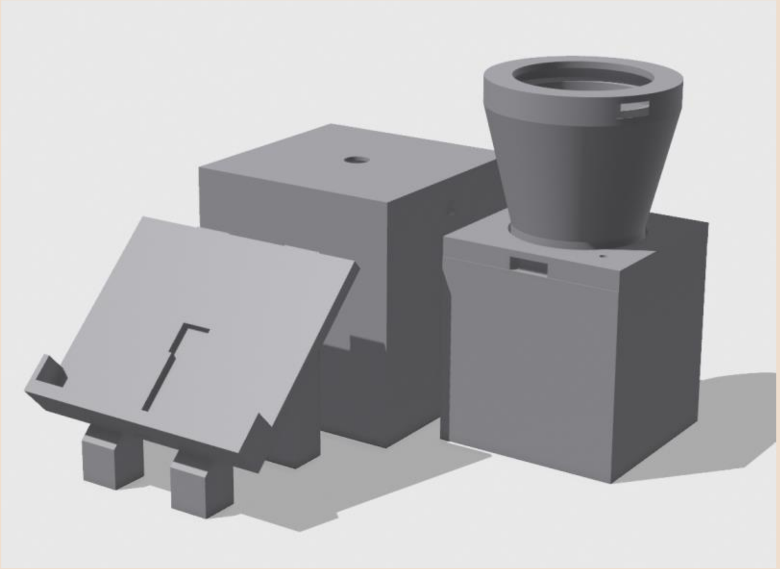
- Custom pot system/design
- Soil moisture sensor
- Solar/light sensor
- Water level (float switch) sensor
- Solar Panel + Charging
- USB Charging port
- Lithium-ion batteries
- Web application for user input/monitoring

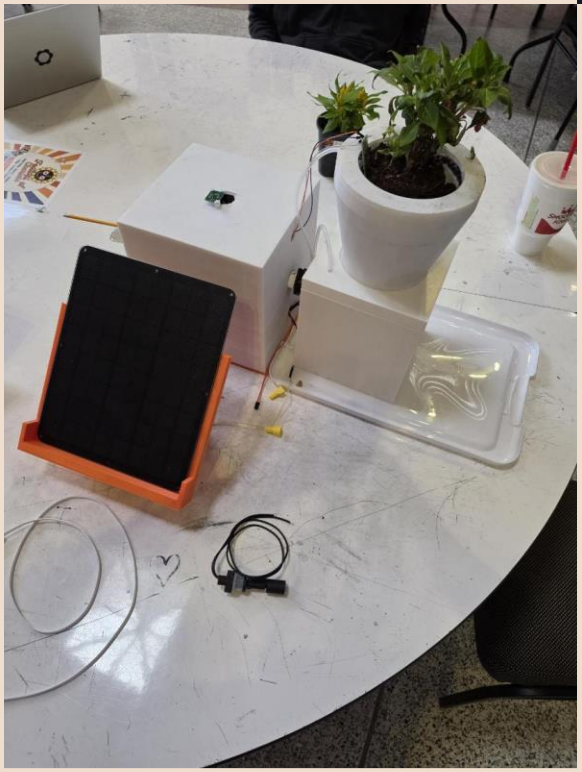
Engineering Specifications

Table 2.4.1 Specifications for System.

Parameter	**Specification**
Sampling of sensor data frequency	15 - 20 min
Time to observe sensor data in web app after wakeup	< 5 min
Accuracy of water level	<.5L
Water Flow Rate	0.1 - 5 mL / s
Supply Water Level Accuracy	>= 90%
Cost of final design	< $75 USD
Battery life	21-27 hours
Time to activate water pump after low soil moisture detection	< 1 min
Temperature	21 C < temperature < 50 C

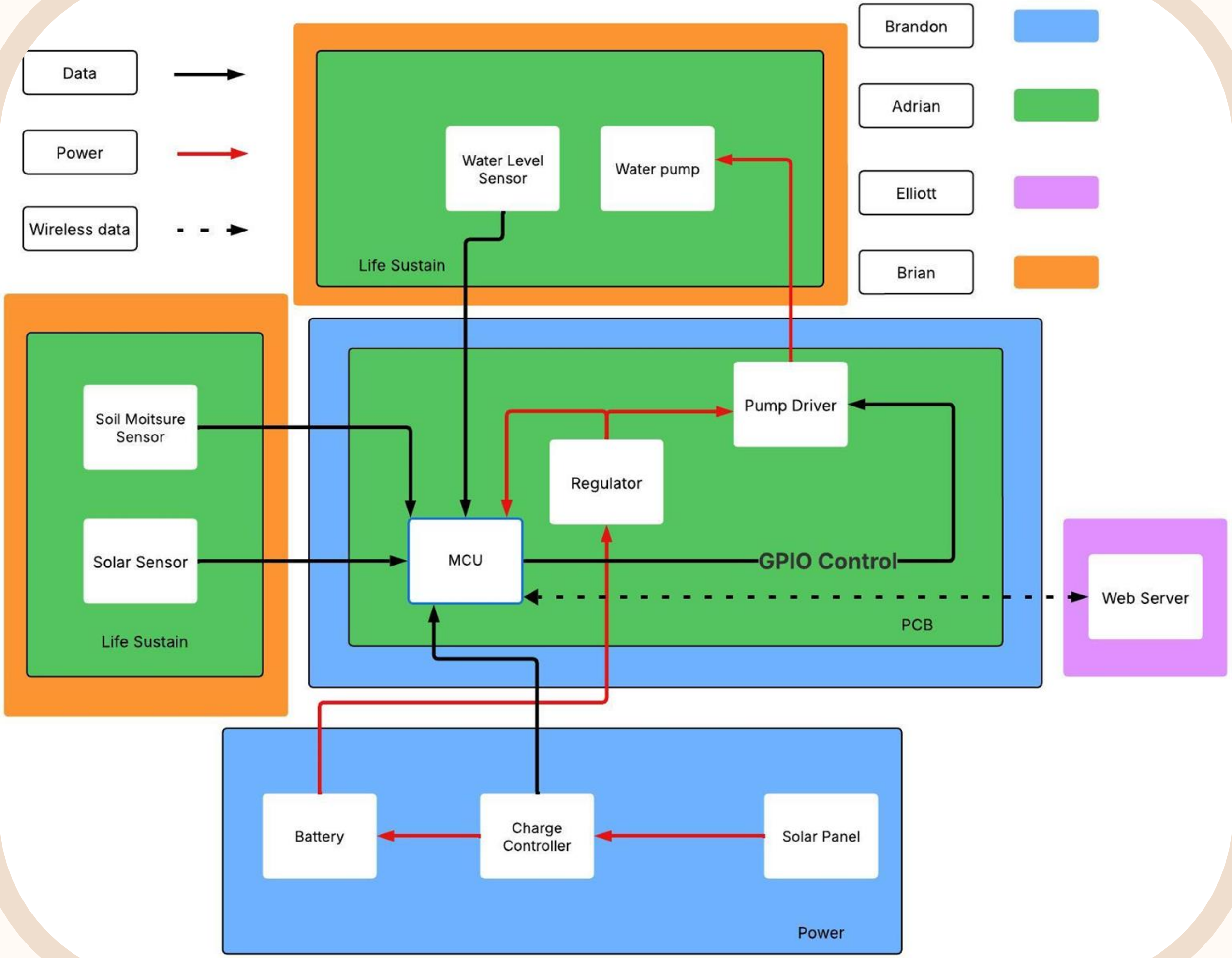
Image of Product





Hardware Block Diagram

Hardware Design



Comparison and Selection of Hardware

MCU v. MPU v. FPGA

	Microprocessor	Microcontroller	FPGA
Energy Consumption	Highest	Lowest	High
Cost	High	Lowest	Highest
Processing Speed	High	Lowest	Highest
Design Complexity	High	Lowest	Highest
Built-in Peripheral	Lowest	Highest	Low
Size	Large	Smallest	Largest

Microcontroller was selected due to low energy consumption, cost, complexity, size, and peripheral support

Microcontroller Products

	ESP32	STM32	nRF	CC3220	PIC32MZ
Built-in Wireless	Yes	No	No	Yes	Yes
Dev Kit Cost	$0	N/A	N/A	$47.99	$73.04
IC Cost (PCB)	$4.84-$5.71	N/A	N/A	$5.37	$4.31
Low Power Modes	3	N/A	N/A	4	4

The ESP32 WROOM was selected due to availability, low cost, and sufficient power modes.

Soil Moisture Sensor Technology

	Capacitive	Resistive	TDR	FDR
Cost	\$1-\$10	\$1-\$10	\$100+	\$100+
Accuracy	Moderate	Low	Very High	Very High
Speed	Slow	Slowest	Fastest	Fast
Susceptible to Corrosion	No	Yes	No	No
Calibration	Least	Low	High	High
Design Complexity	Low	Least	High	High

Capacitive soil moisture sensors were selected due to low cost, sufficient accuracy, and resistance to corrosion.

Soil Moisture Sensor Product

	STEMMA Soil Sensor	SparkFun	SunFounder	DFRobot
Cost	$7.50	$6.44	$6.39	$5.90
Interface	4-pin I2C	3-pin	3-pin	3-pin
Input Power	3-5 VDC	3.3-5 VDC	3.3-5 VDC	3.3-5.5 VDC
Coating of Metal Probes	Not exposed (N/A)	Electroless nickel immersion gold	Not exposed (N/A)	Not exposed (N/A)

The DFRobot Soil Moisture Sensor was selected due to available schematic and low cost.

Light Sensor Comparisons

	How It Works	Pros/Cons	Common Uses
Light Dependent Resistor	Resistance decreases with light intensity	Very cheap, easy to use./Slow response, not very precise.	Used for night lights and basic light detection products
Photodiode	Semiconductor generates small current when photons strike.	Fast response, high precision, reliable./Very small output (needs amplifier).	Used in barcode scanners, smoke detectors, and various medical devices
Phototransistor	Like photodiode but with built-in amplification	Higher sensitivity, strong signal./Directional, doesn't output lux without extra circuitry	Consumer electronics, light detection in automation
Digital Lux Sensor	Uses photodiodes + ADC to directly output lux values over I^2C/SPI	High accuracy, calibrated output, wide measurement range./ More expensive than analog sensors,	Smartphones, agriculture systems, plant monitoring

Light Sensor Selection

	Cost	Voltage/ Current	Pros	Cons	Reasoning
BH1750	$11 for 3	3.3 V/ 120uA	Accurate to ab peak of around 70k lux, stable readings, easy microcontroller integration	More expensive than using analog sensors.	Best balance of precision and simplicity. Ensures consistent light level detection for plant monitoring.
TSL2561	$12 for 2	3.3V/ 500mA	Dynamic range max of 40K lux more precision under varying sunlight conditions	More complex overall setup.	Overkill for our project needs. Had more components that would be difficult to replicate on our own pcb

Water Level Sensor Comparisons

	How It Works	Pros/ Cons	Common Uses
Float Switch	Mechanical float rises/falls with water, triggering a switch	Simple, low cost, reliable./ Only provides on/off	Water tanks, pumps, plant watering systems
Ultrasonic Sensor	Emits sound waves and measures reflection time to detect distance to water surface	Non-contact, works with various liquids./ More expensive, can be affected by turbulence or vapor	Reservoirs, fuel tanks, smart appliances
Pressure Sensor	Measures hydrostatic pressure at bottom of tank to calculate water depth	Accurate over large depths, continuous measurement./ Needs calibration for liquid density, more costly	Wells, deep tanks, industrial monitoring
Capacitive Sensor	Measures change in capacitance as water level changes	No moving parts./ Sensitive to liquid type, can be affected by dirt/minerals	Industrial tanks, beverage dispensers

Water Level Sensor Selection

	Cost	Output	Pros	Cons	Reasoning
Ximimark Horizontal Float Switch	$9 for 3	Digital On and Off	Reliable, simple, inexpensive, and needs no calibration	Only detects the presence or absence of water, not the specific depth	For the purpose of this project, we don't need to know the exact depth of the water, so having it at a fixed point is fine.
HC-SR04 (Ultrasonic)	$9 for 5	Distance measurement	Measures continuous water height	Needs clear air path and can be affected by condensation	A lot more complicated than the float switch and while it would be nice to have continuous measurement, it is not

Pump Selection

	How It Works	Pros/ Cons	Common Uses
Peristaltic Pumps	Rotating rollers compress flexible tubing, pushing liquid forward	Accurate flow control, self-priming, can run dry/ Lower flow rate, tubing wears over time	Medical devices, dosing nutrients, small plant watering
Centrifugal Pumps	Spinning impeller creates centrifugal force to move liquid	High flow rate, simple design/ Cannot self-prime (needs priming), not ideal for low flow precision	Irrigation, water circulation, sump pumps
Submersible Pumps	Pump motor sealed and submerged directly in the liquid	Quiet operation, efficient for moving larger volumes / Harder to maintain, must be waterproof sealed	Wells and aquariums

Water Pump Selection

	Cost	Volatge/ Current	Flow Rate (ml/min)	Pros	Cons
Adafruit Peristaltic Pump	$24.95	12V/ 250mA	100	Precise and consistent flow, water stays in the tubing. Good specs transparency.	Higher cost, may need to use smaller tubing if you want lower flow rates
Diiatao	$14.00	12V/ 80mA	70	Cost effective, can reverse directions	Much less documentation, reviews say that different units perform differently

Power Distribution Table

Device	Voltage	Current	Power	Runtime per hour
Pump	12V	250mA	3W	1.5 min
Float switch	3.3V	.1mA (current rating)	.33W (max power)	1 min
Soil Moisture	3.3V	~120 uA	~0.4 mW	1 min
Light Sensor	3.3V	~120uA	~.4mW	1 min
MCU	3.3V	300 mA	1.65 W	5 min

Daily usage = 5.1 Wh
Total runtime without any charging is 4.9 Days.

Battery Selection

Model	Capacity (mAh)	Max Discharge (A)	Protection Circuit	Voltage Range	Notes
Samsung 30Q [18]	3000	15	No	2.5–4.2 V	High current, unprotected
LG MJ1 [19]	3500	10	No	2.5–4.2 V	High capacity, low cost
Panasonic NCR18650B [20]	3400	4.9	Optional	2.5–4.2 V	Lower discharge rate
Panasonic/Sanyo NCR18650GA [21]	3500	10	Yes (Protected)	2.5–4.2 V	Selected: Best balance of capacity and protection
Shockli Protected 18650 (GA)	3500	10	Yes	2.5–4.2 V	Similar spec, less tested source

The Panasonic NCR18650 was selected due to being protected and meeting capacity requirements.

Buck Converter

Part Number	Type	Output Voltage	Max Current	Package	Pros	Cons
LM2596-3.3	Buck (Fixed)	5 V	2–3 A	Through-hole	Easy to prototype, tolerant of wide input range	Lower efficiency, large footprint
AMS1117-3.3	Linear Regulator	3.3 V	~800 mA	TO-220	Plug-and-play, reliable for testing	Inefficient, not scalable
MP1584	Buck (Adjustable)	Adjustable	2–3 A	SMD	Compact and capable	SMD-only, noisier, limited support
TPS62162	Buck (Adjustable)	Adjustable	1 A	SMD (WSON)	High efficiency, low quiescent draw, clean output	Requires careful layout, SMD-only

The LM2596-3.3 was selected due to its reliability and meeting power delivery requirements.

Boost Converter

Part Number	Output Voltage	Max Output Current	Package	Pros	Cons
MT3608	Adjustable	~1–1.5 A (realistic)	SMD module	Small, cheap, easy to test	Underperforms under load, voltage sag
XL6009	Adjustable	~2 A	SMD module	Higher current handling, quick to prototype	Noisy output, low efficiency
TPS61088	Adjustable	2–3 A+ sustained	SMD (VQFN)	High efficiency, tight regulation, solid protection	Requires custom layout, SMD-only
LM2577	Adjustable	~1 A (continuous, practical)	TO-220 / TO-263	Easy to use, robust	Large size, lower efficiency, needs bulky external components

The LM2277 was selected due to its reliability and meeting power delivery requirements.

Solar Panel

Panel Model	Rated Power (W)	Open-Circuit Voltage (Voc)	Max Power Voltage (Vmp)	Size (mm)	Notes
Voltaic Systems P108	3.5 W	22.5 V	18.0 V	178 × 114 × 3	Compact, rugged ETFE coating, selected panel
Tycon Systems TPS-12-15W	15 W	22.1 V	18.0 V	340 × 230 × 17	Larger capacity, sealed frame
ACOPOWER HY-12P-35W	35 W	21.6 V	17.9 V	470 × 340 × 25	High output, bulkier footprint

The Voltaic Systems P108 was selected due to meeting size and power requirements of the system.

Solar Charger

Part Number	MPPT	Battery Chemistry	Max Cells	Input Voltage	Key Features	Limitations
CN3791	Yes	Li-ion	2S	4.5–28 V	Simple integration, few external parts	Limited control, fixed logic thresholds
BQ24650	Yes	Li-ion/LiFePO4/LA	Up to 6S	5–28 V	Highly configurable, robust protection, MPPT	More complex to implement, SMD-only
BQ24210	No	Single-cell Li-ion	1S	4.35–6.5 V	Compact, USB charging, low part count	Not compatible with 2S batteries or solar

The bq24650 was selected due to its MPPT functionality and ability to configure set points with components and not with I2C.

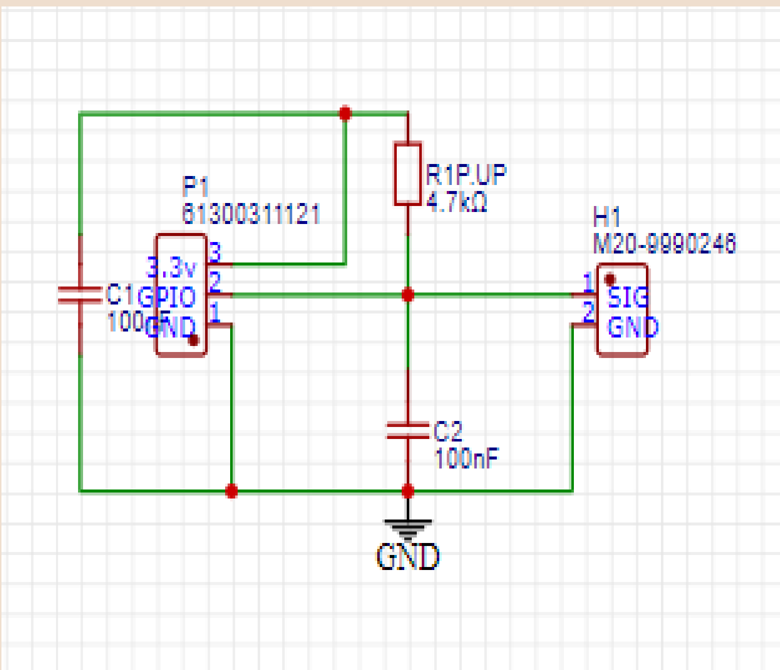
USB Charging

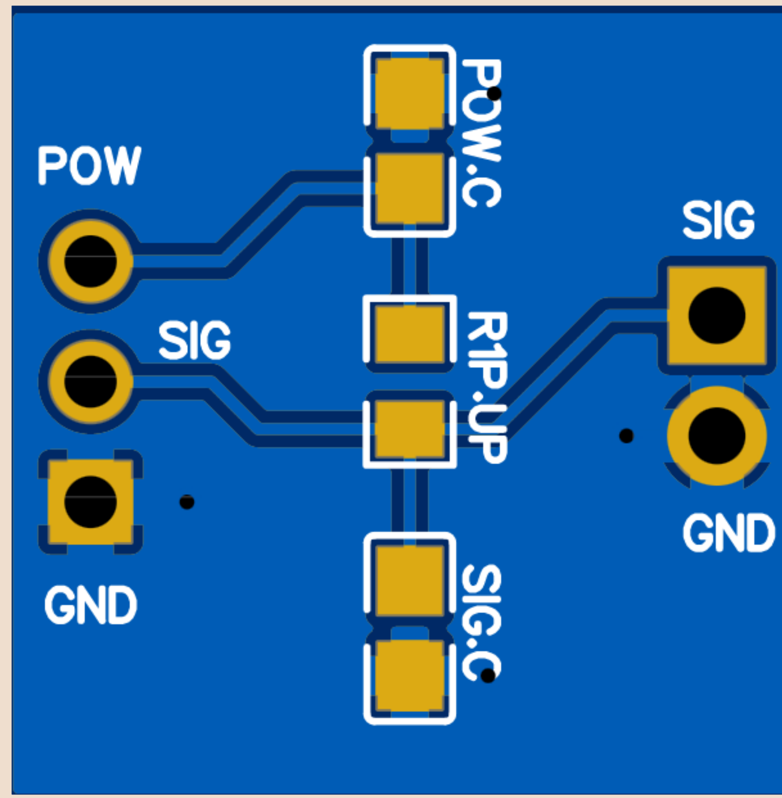
Device	Input Voltage	Battery Type	Charge Current	Voltage Accuracy	SYS Output	Iq	Protection	Package	Notes
CN3302	4.5–6 V	2S Li-ion	Up to 2 A	±0.5%	None (battery only)	<200 µA	OVP, OCP, OTP	SOP-8	Simple, low-cost
MP2672A	4.5–6 V	2S Li-ion	Up to 2 A	±0.5%	Yes (3.4–4.4 V)	~100 µA	OVP, OCP, OTP, Input limit	QFN-16 (3×3 mm)	Power-path, load sharing

The bq24650 was selected due to its load balancing and ability to configure set points with components and not with I2C.

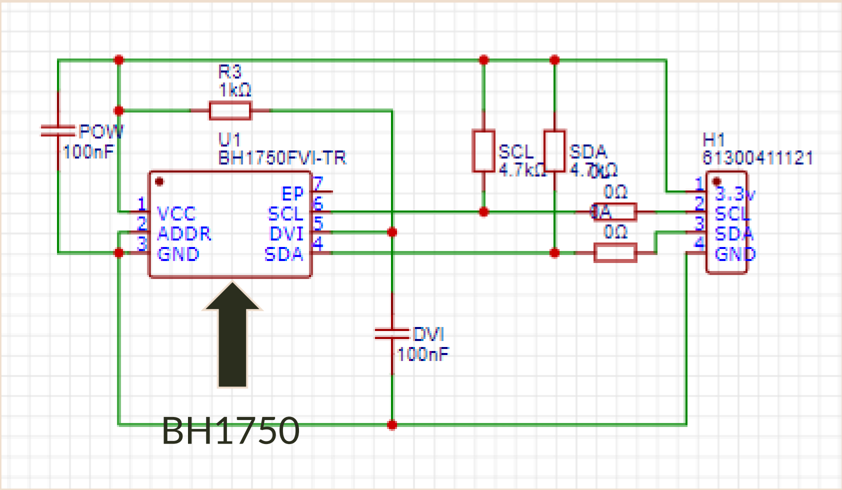
PCB Layouts

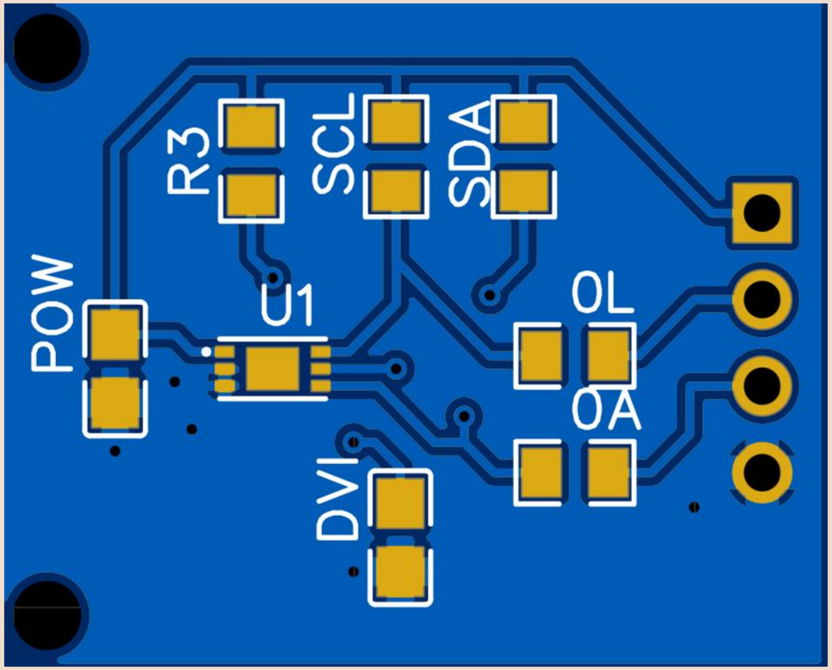
Water Level Sensor PCB



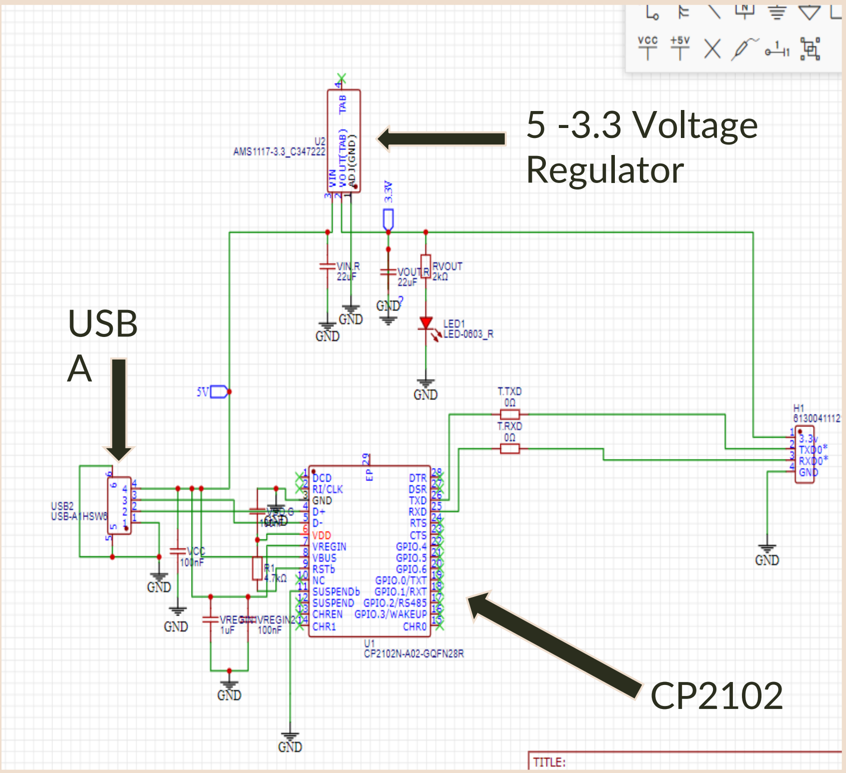


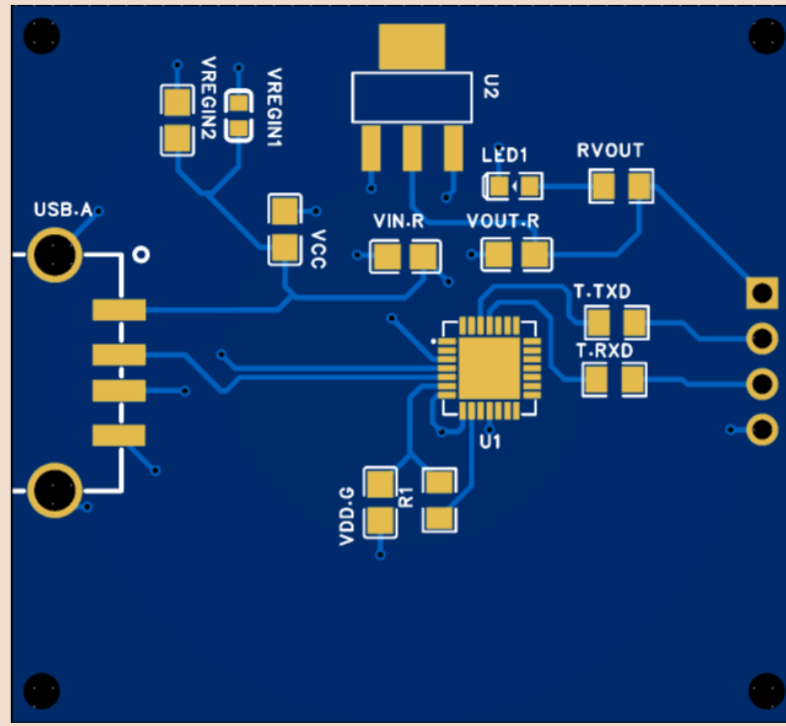
BH1750 Light Sensor PCB



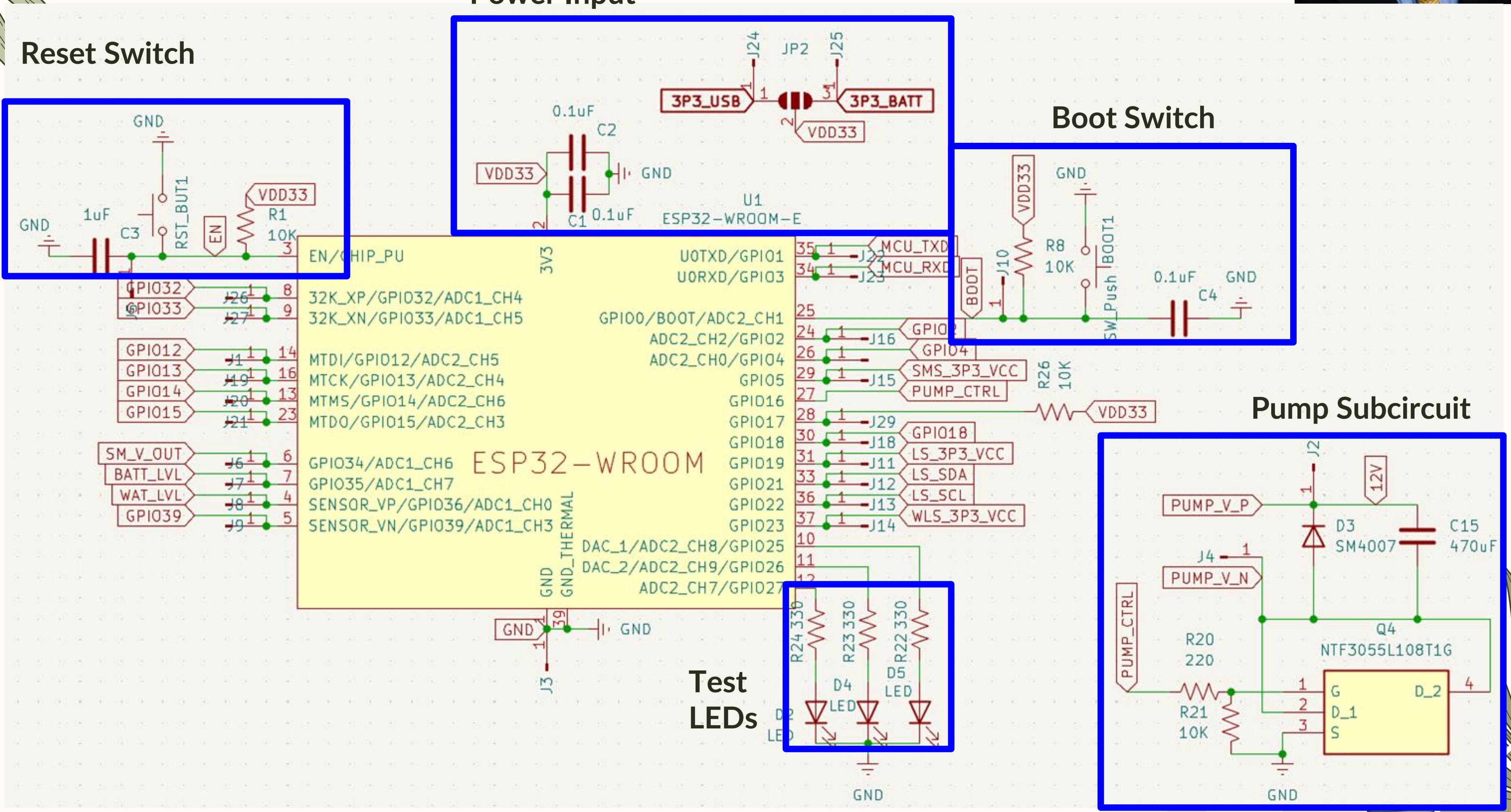


UART - USB PCB

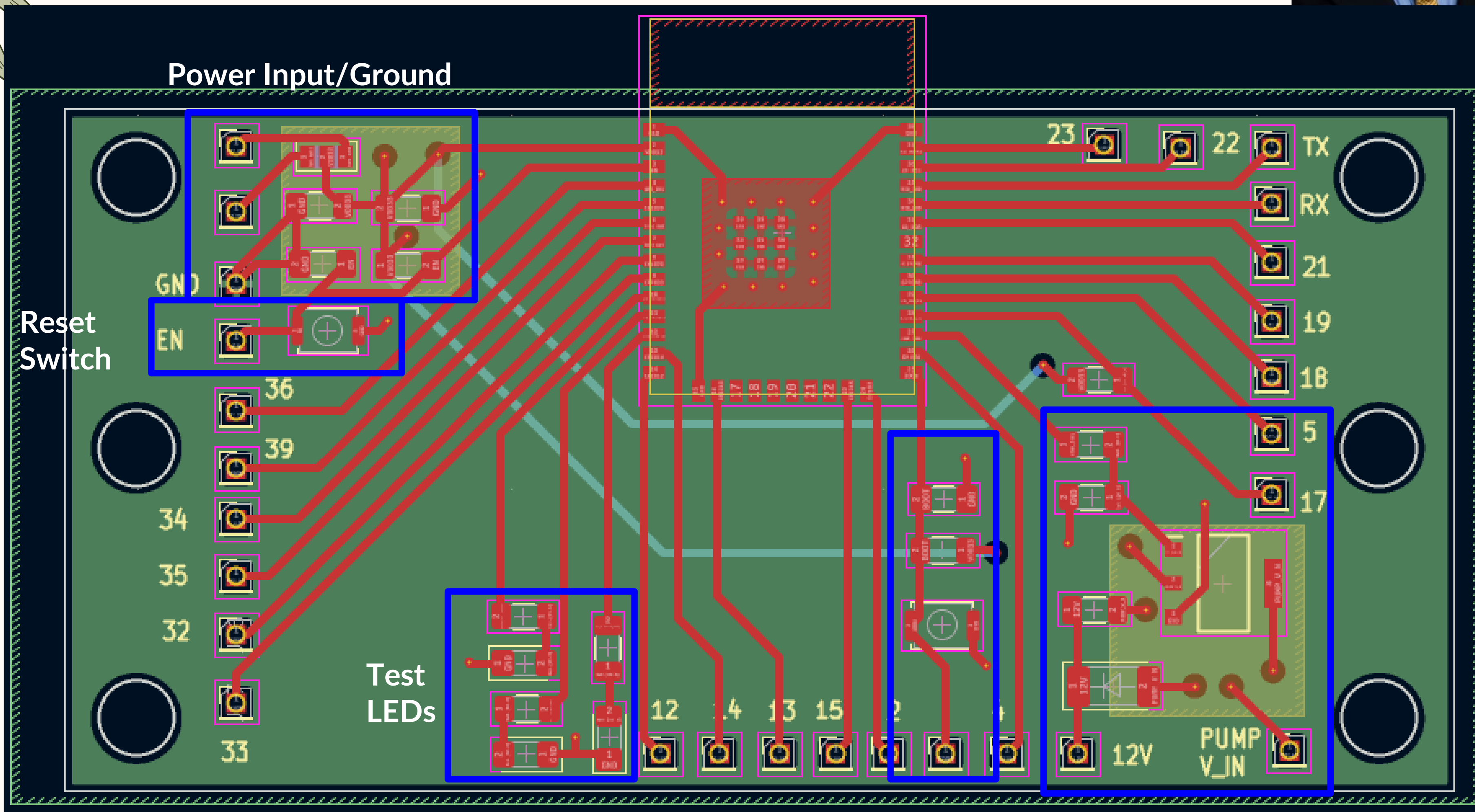

5 -3.3 Voltage Regulator
USB A
CP2102
AMS1117-3.3_C347222
3.3V
VIN.R
22uF
VOUT.R
22uF
RVOUT
2kΩ
LED1
LED-0603_R
GND
5V
T.TXD
0Ω
T.RXD
0Ω
H1
6130041112
DCD
RI/CLK
GND
D+
D-
VDD
VREGIN
VBUS
RSTb
NC
SUSPENDb
SUSPEND
CHREN
CHR1
DTR
DSR
TXD
RXD
RTS
CTS
GPIO.4
GPIO.5
GPIO.6
GPIO.0/TXT
GPIO.1/RXT
GPIO.2/RS485
GPIO.3/WAKEUP
CHR0
U1
CP2102N-A02-GQFN28R
TITLE:


U2
VREGIN2
VREGIN1
LED1
RVOUT
USB.A
VIN.R
VOUT.R
VCC
T.TXD
T.RXD
U1
VDD.G
R1

MCU Schematic



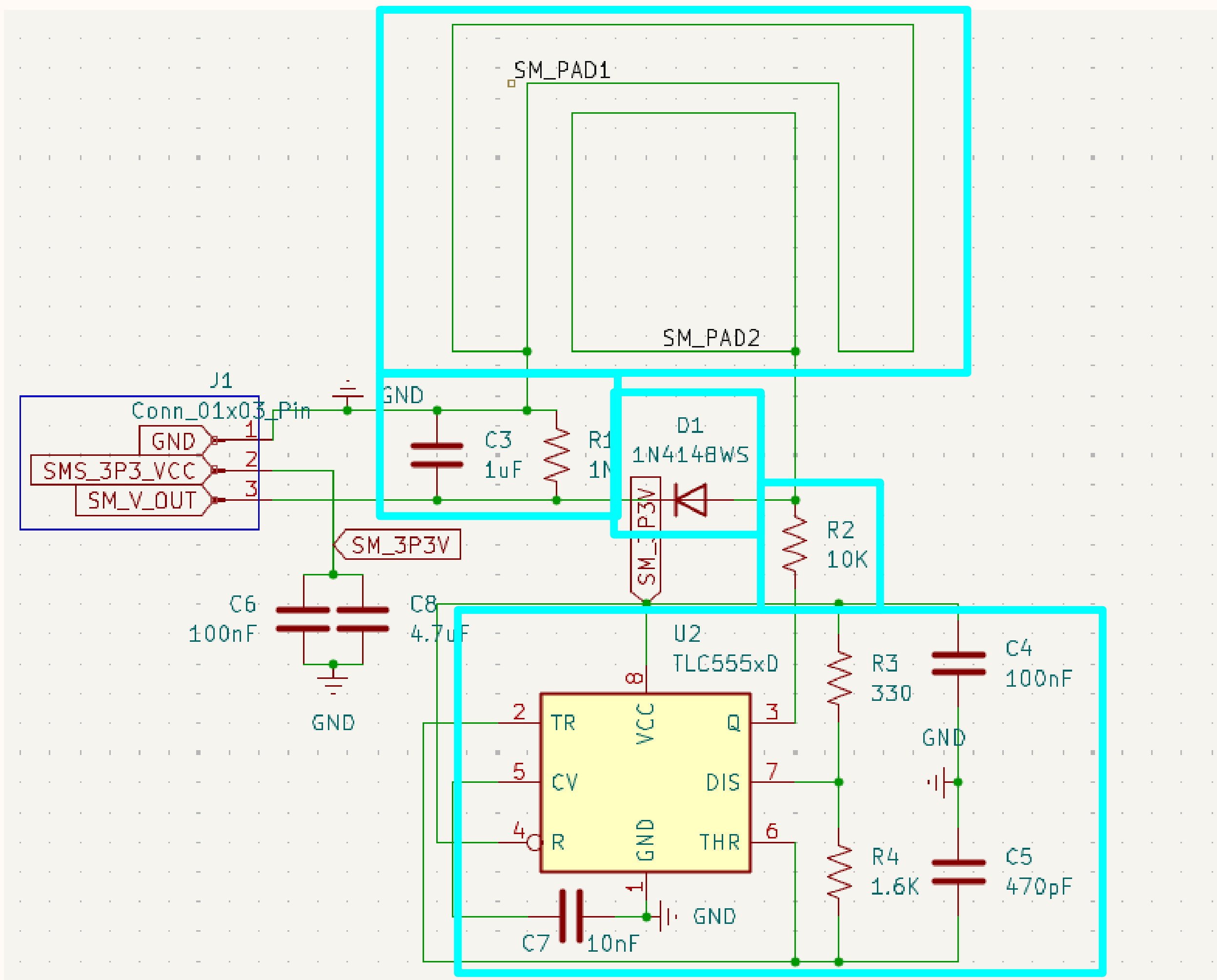
MCU PCB



Boot Switch

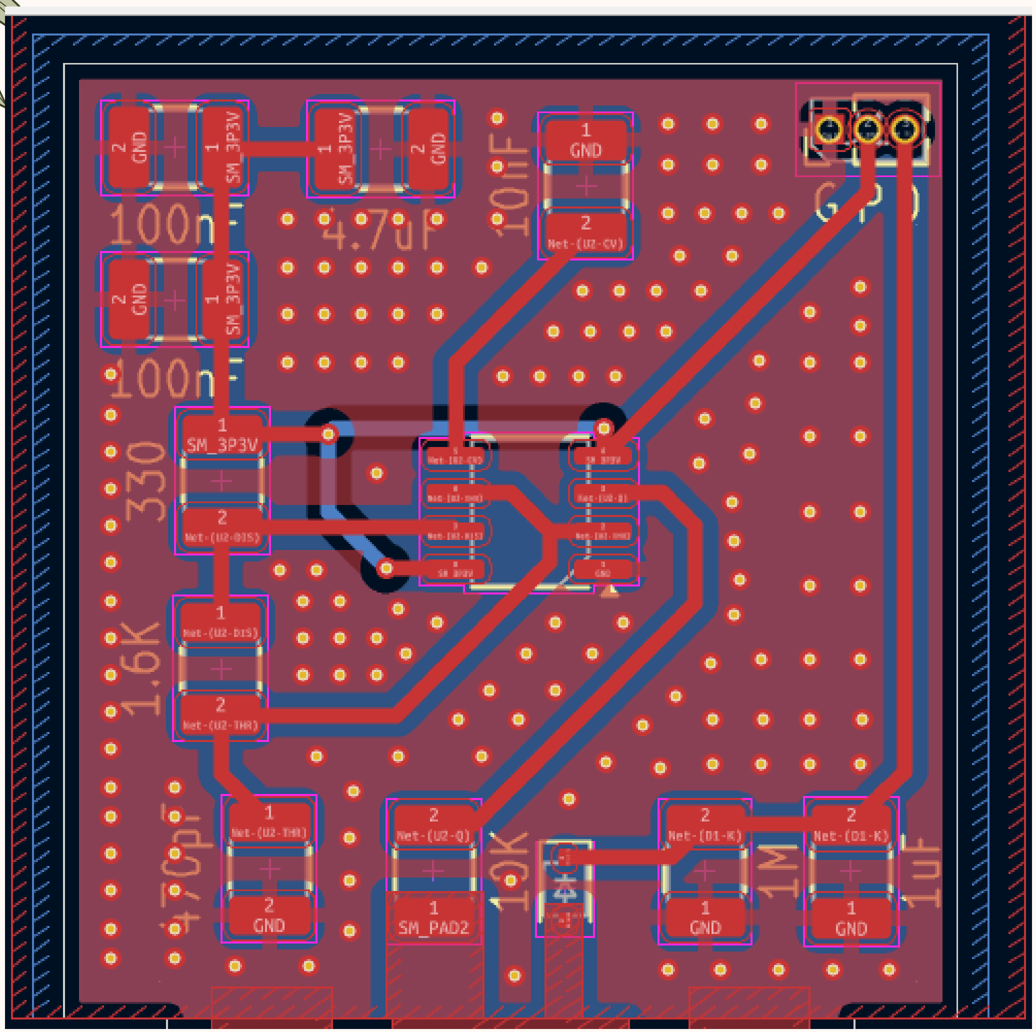
Pump Control

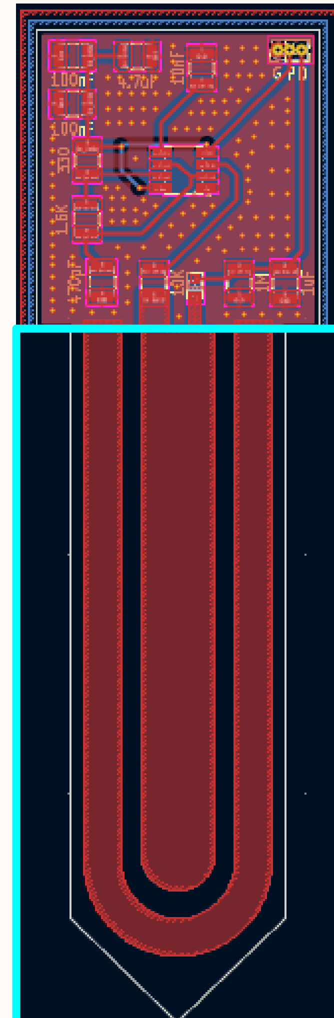
Soil Moisture Sensor Schematic



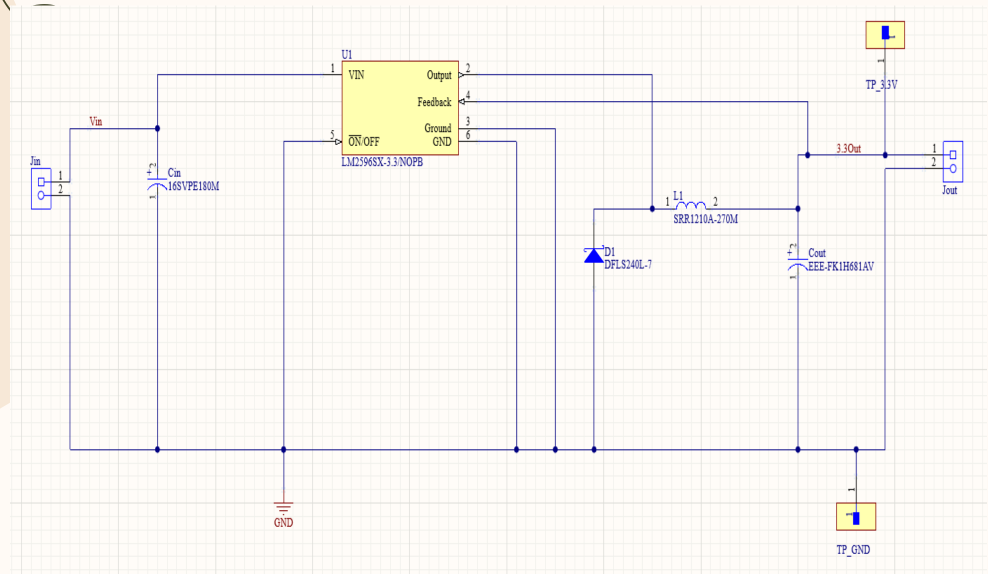
This circuit was originally released by Bernie Chen at DFRobot on August 27, 2015.
The original circuit can be found at:
https://dfimg.dfrobot.com/nobody/wiki/25ce0211fa0bf9fb5653d67dafcf2aba.pdf.
Permission to use this circuit schematic was given by the DFRobot Customer Service Team.
Modifications have been made to the original schematic, as detailed in the Final Senior Design report.

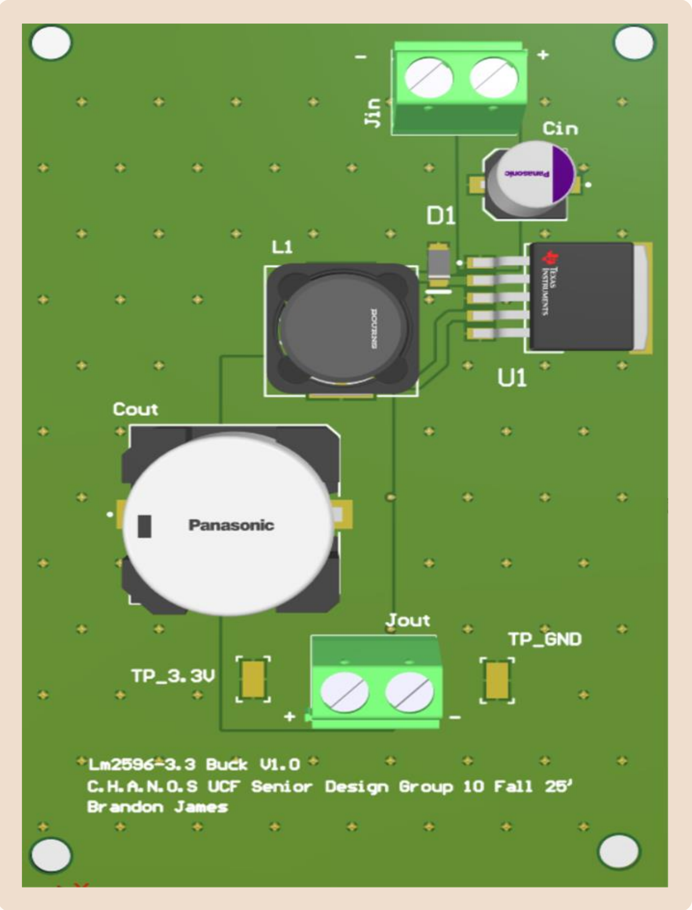
Soil Moisture Sensor PCB



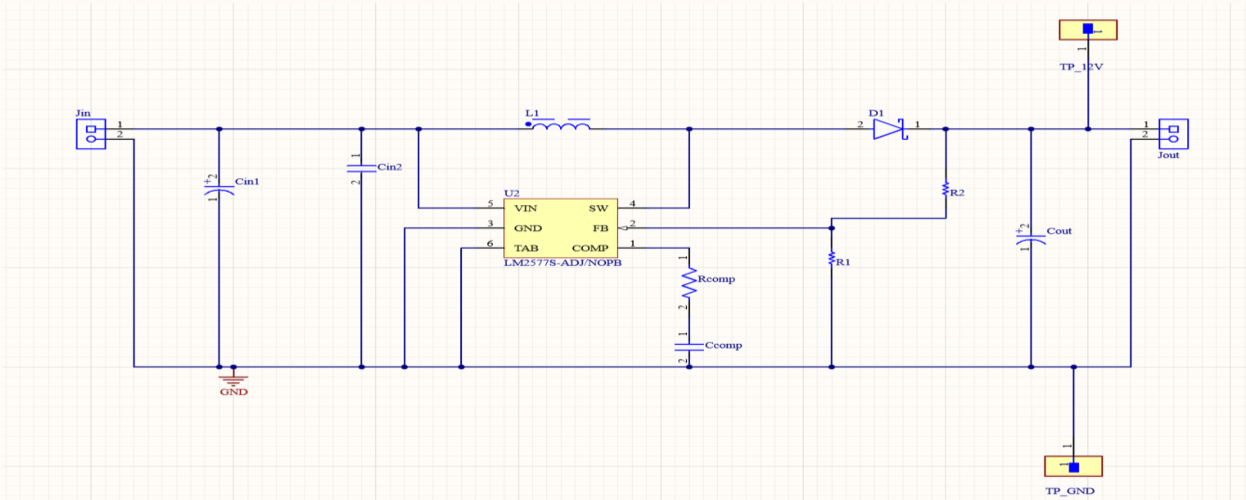


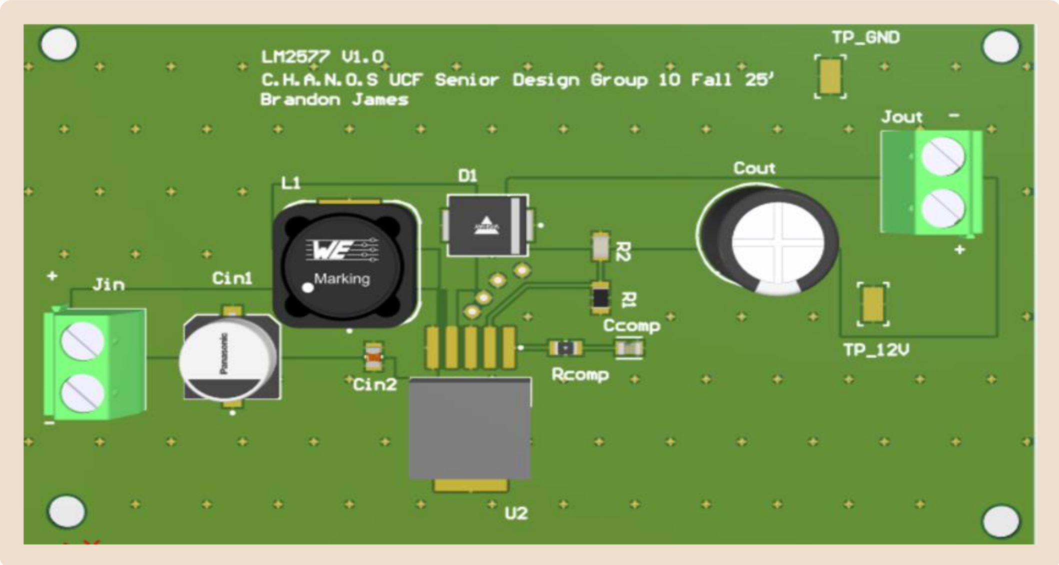
PCB Layout and Schematic - LM2596 3.3V Buck



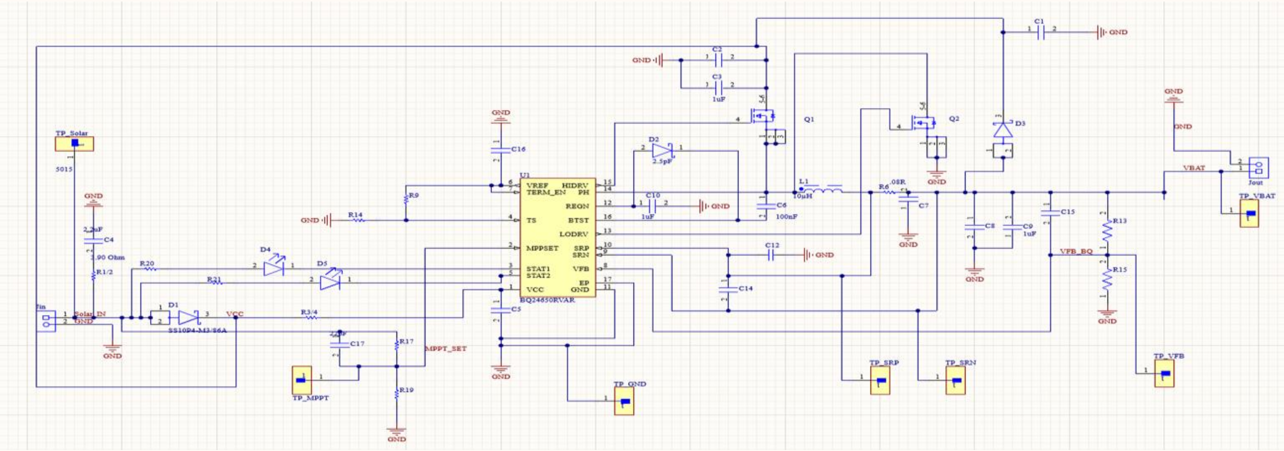


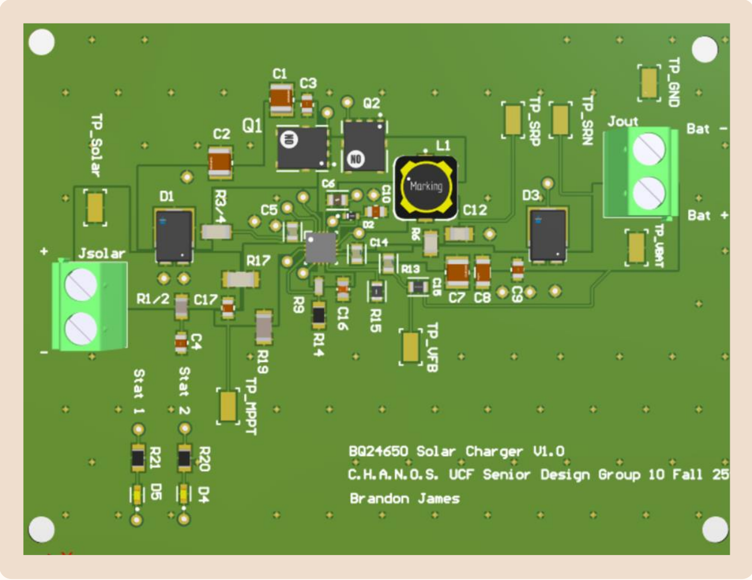
PCB Layout and Schematic - LM2577 12v boost



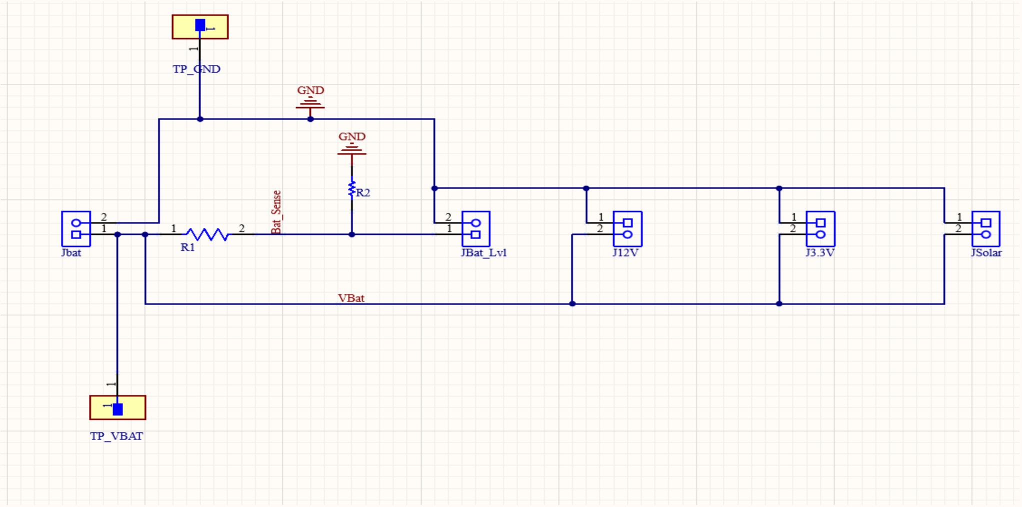


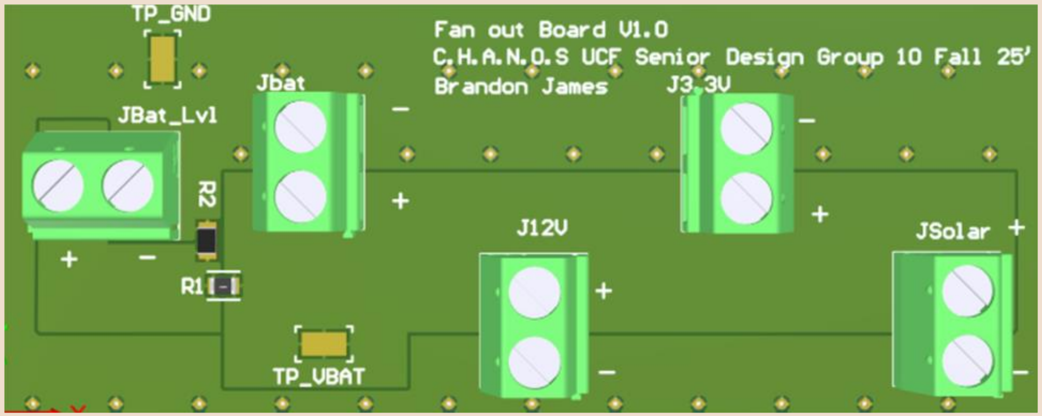
PCB Layout and Schematic - BQ2650 Solar Charger



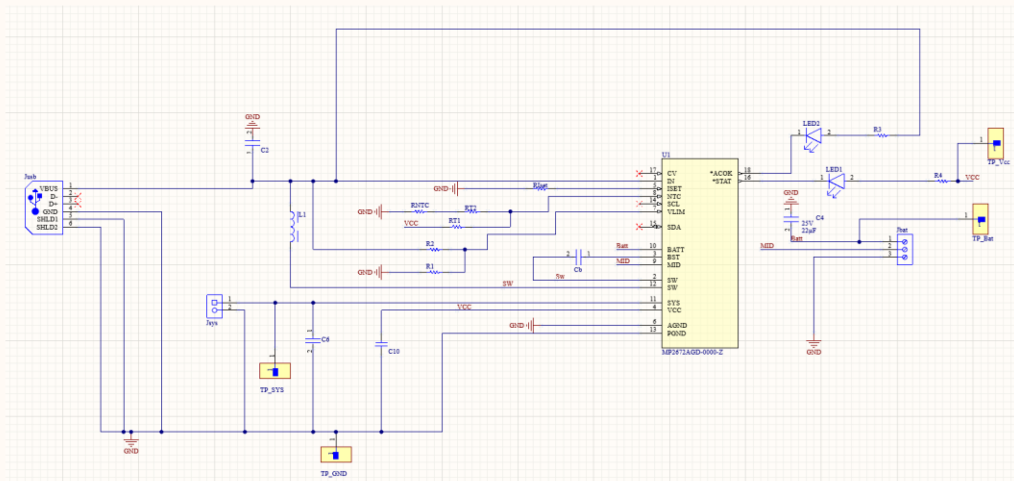


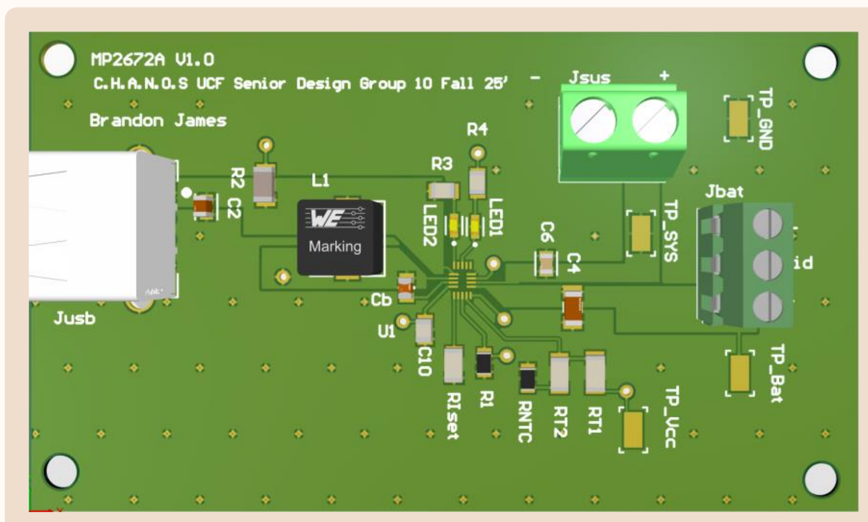
PCB Layout and Schematic - Fan out





PCB Layout and Schematic - MP2672a USB Charging





Communication Protocols / Technology

Internet Communication

	Wireless Communication	Wired (cable, fiber-optic, ethernet)
ESP32 WROOM 32 Built-In Support	Yes; IEEE 802.11, Bluetooth, ESP-NOW	No
Secure	Less Secure	More Secure
Consistent	Less Consistent	More Consistent
User Convenience	More Convenient	Less Convenient

	Bluetooth	IEEE 802.11 (Wi-Fi)
Network Range / Type	Personal Area Network	Wide Area Network
Power Usage (TX / RX) (mA)	130 / 95	180 / 95

	HTTP	MQTT	ESP-NOW
Overhead	Higher (with more messages)	Lower (with more messages)	Low
Familiarity / Documentation	Most	Less	Least
Common Use Case	Web Interaction	IoT	IoT

USB-UART Conversion

Schematic Source	sam_moshiri	Espressif / ESP32 Dev Kit	SparkFun
USB-UART IC	MCP2200	CP2102	FT231X
Compatible with ESP32	Unsure	Yes	Yes
Additional Functions/Subcircuits	Voltage regulator	N/A	Voltage regulator; Auto-reset
Recommended by Dr. Weeks	N/A	Yes	No

The CP2102 IC was selected due to its use in an official ESP32 dev kit schematic and wide support.

Comparison and Selection of Software

Embedded Software Language/IDE

	C/C++	Python
Framework	ESP-IDF/Arduino	MicroPython / CircuitPython
Abstraction	Lowest / Low	Highest
Performance / Overhead	Better	Worse
Memory Usage	Lower	Higher

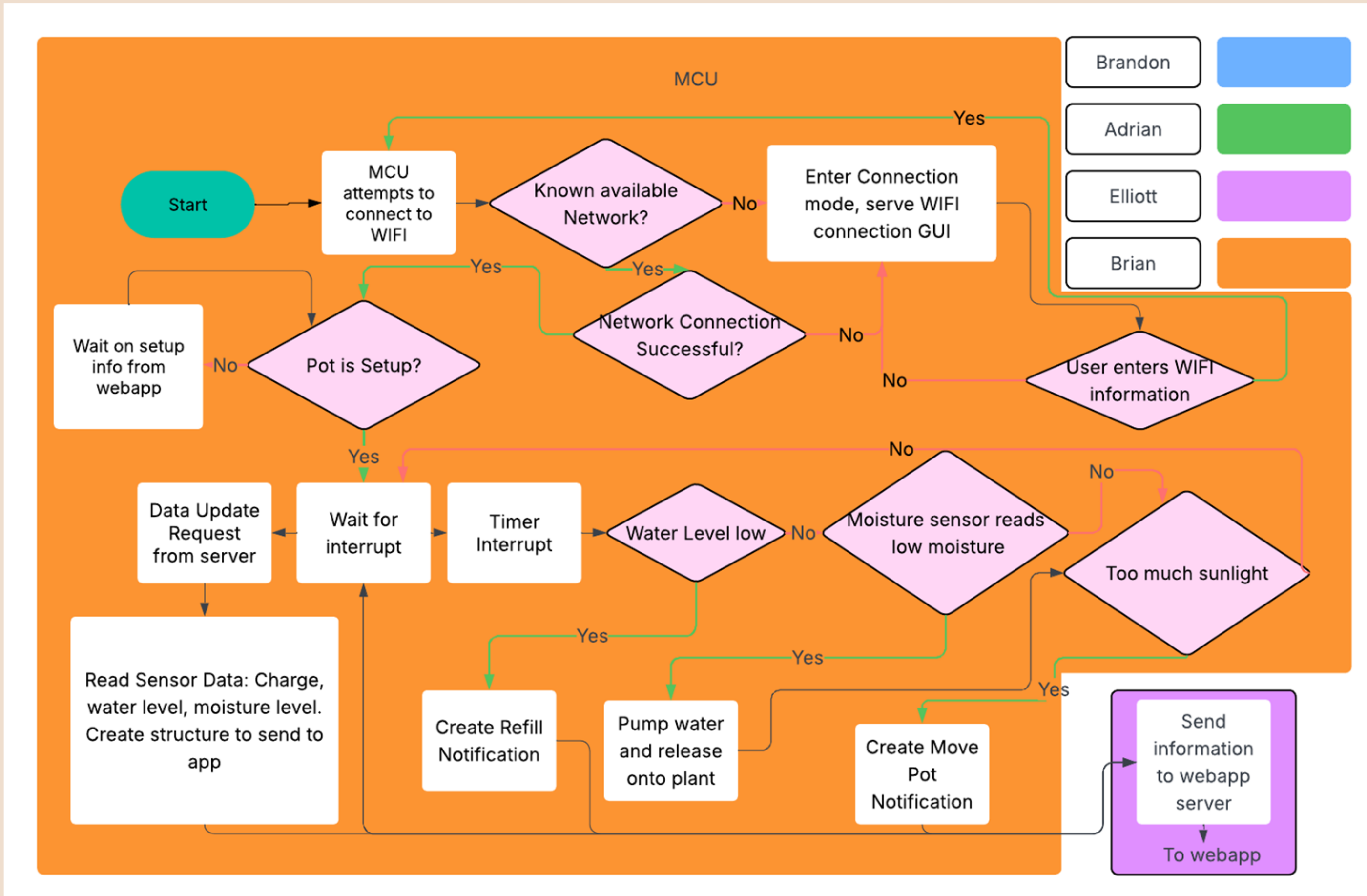
	Arduino IDE	Visual Studio Code	Espressif IDE
Familiarity	Moderate	Most	Least
Support for ESP-IDF	No	Yes	Yes
Abstraction	Highest	Low	Lowest

Web Stack Software

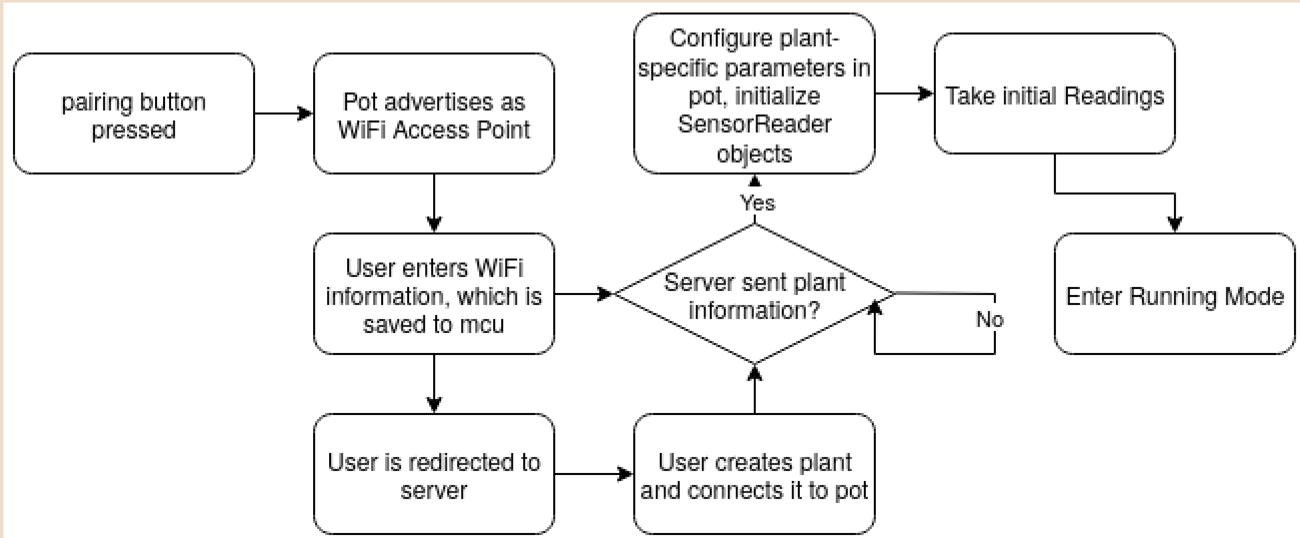
	Frontend	Backend	Database	Platform
LAMP	Simple, lightweight JS & HTML, not good for complex UI elements or animations	PHP; lightweight & simple language for manipulating backend data	MySQL; robust SQL-based DB that stores data in rows and columns, not very flexible	Lightweight Linux OS - wide variety of methods for maintaining dependencies
MERN	ReactJS; libraries that are resource heavy but easy to work with	ExpressJS; easy API creation and routing for requests	MongoDB; a flexible DB that stores data in a JSON-like structure	streamlined dependency management through NPM
PERN	same as MERN	same as MERN	Postgres; SQL-based robust DB similar to MySQL with added flexibility	same as MERN

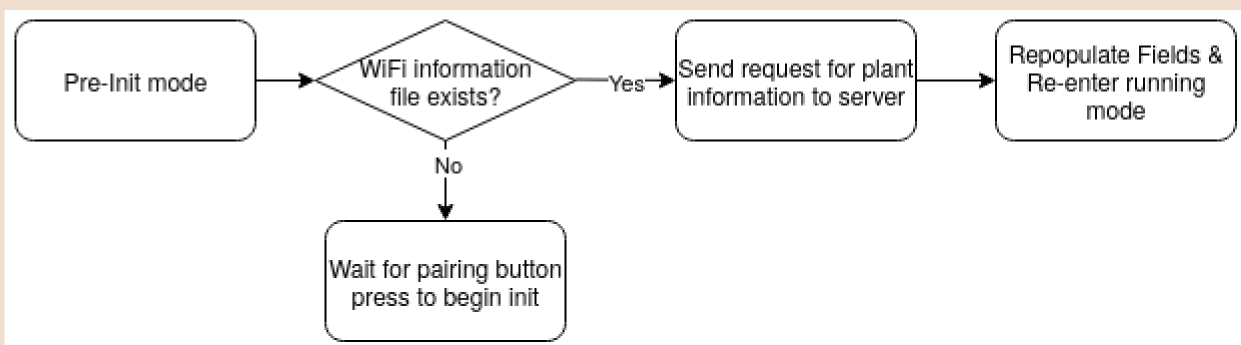
Software Design

MCU Top Level Flowchart

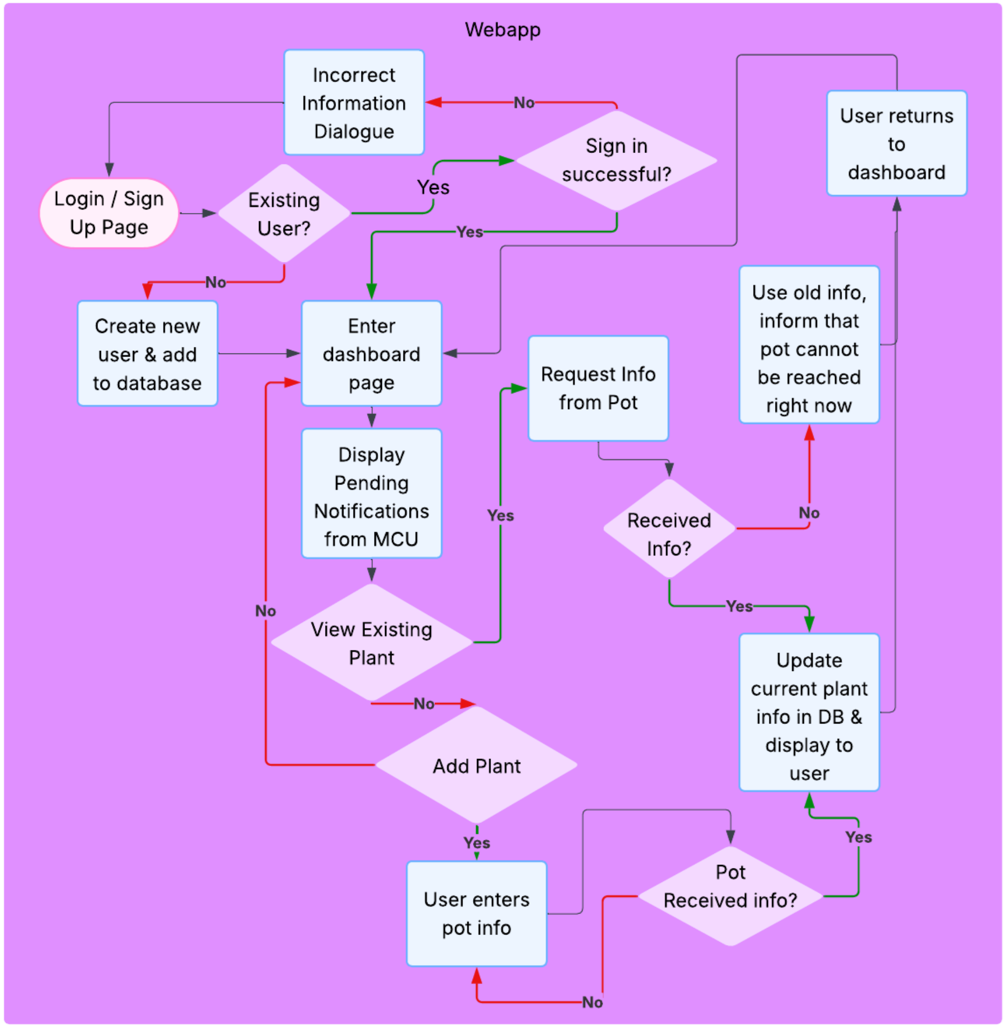


MCU Initialization Flowchart





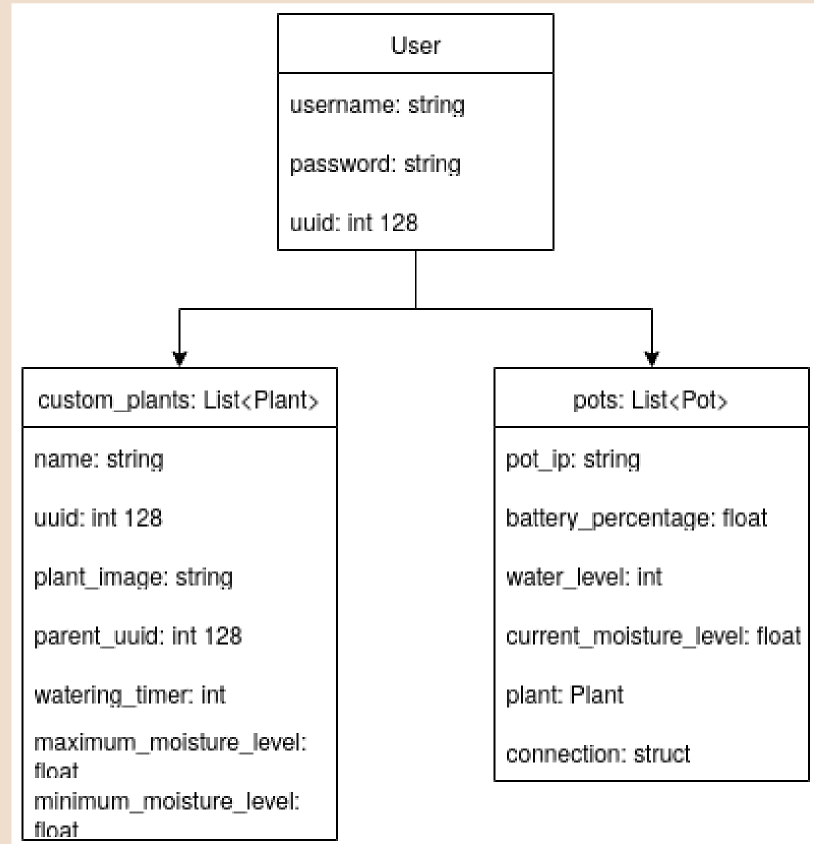
Web App Flowchart



Software Data Organization

User data is at the top level

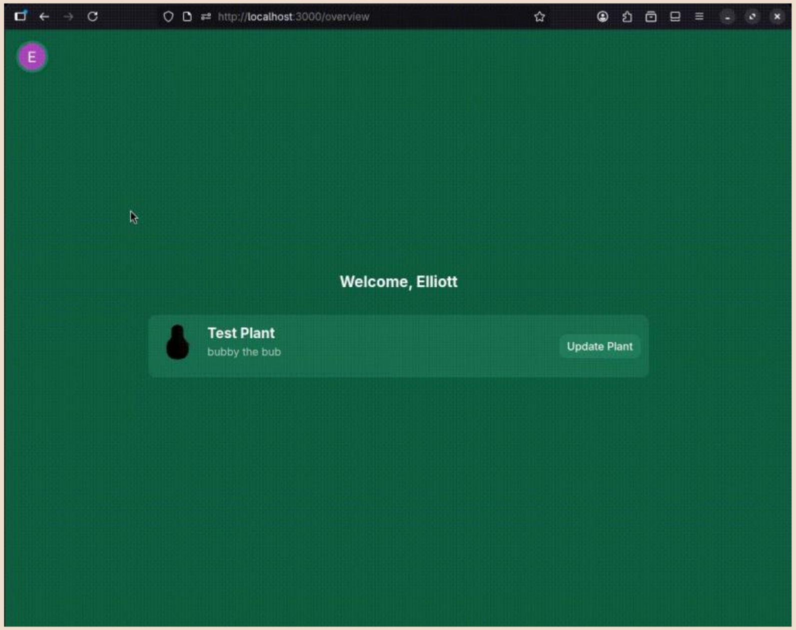
- ❑ Users can have multiple pots and plants
- ❑ Custom plant data linked to user
- ❑ Embedded system only knows pots



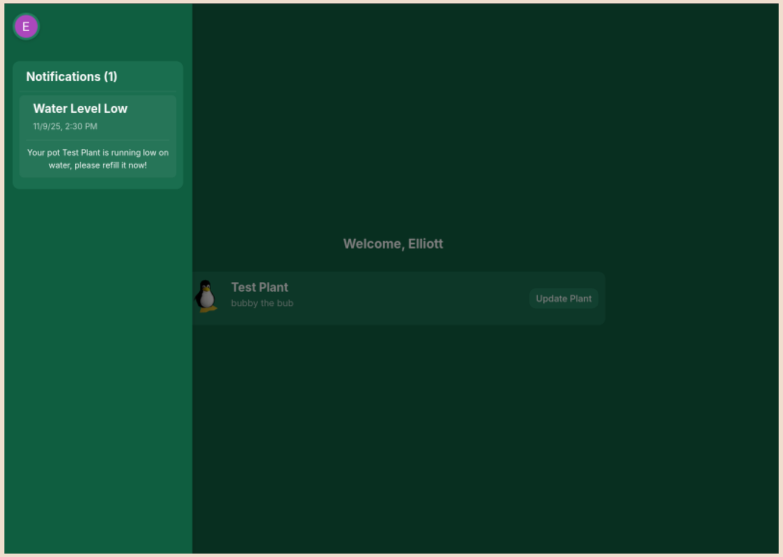
Software Webapp Design: Client

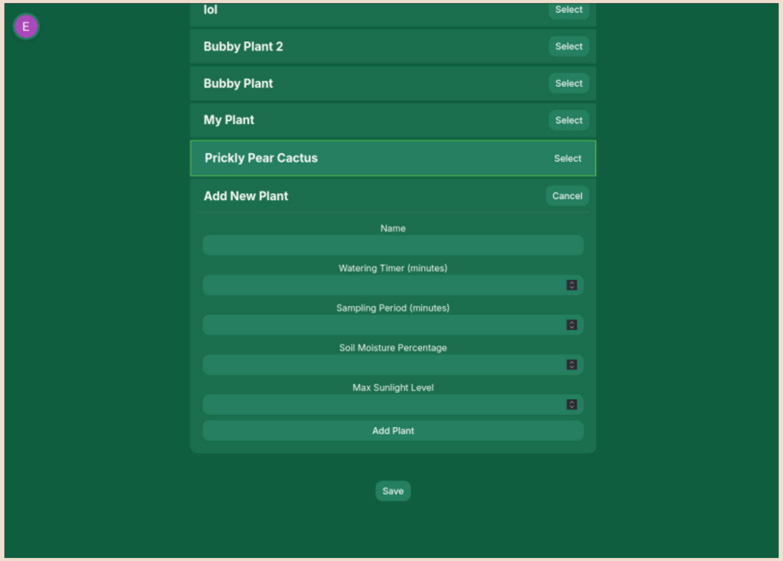
Focus on following design guidelines:

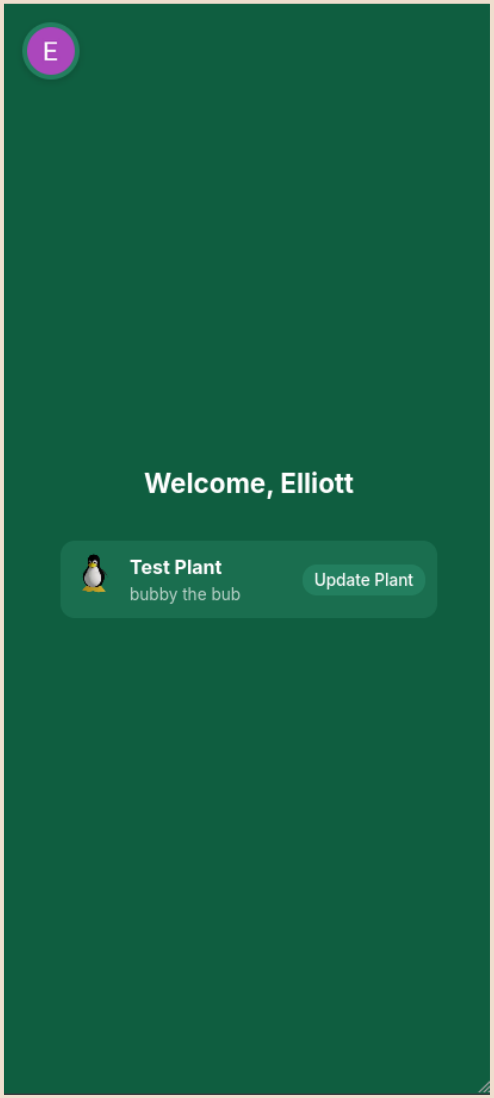
- ❑ Adaptability
- ❑ Content-Centric View
- ❑ Readability
- ❑ Accessibility



Software Webapp Design: Client







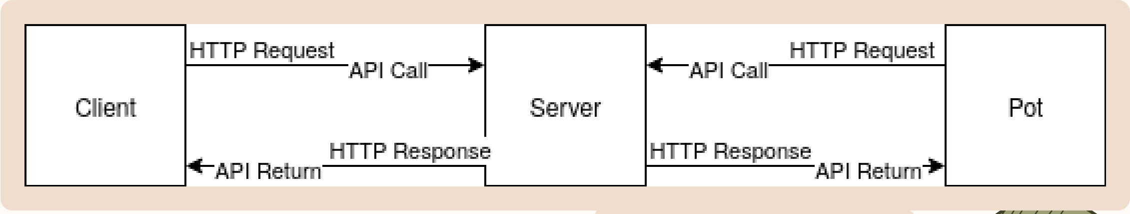
Software Web App Design: Server

Communication will be done using HTTP Requests

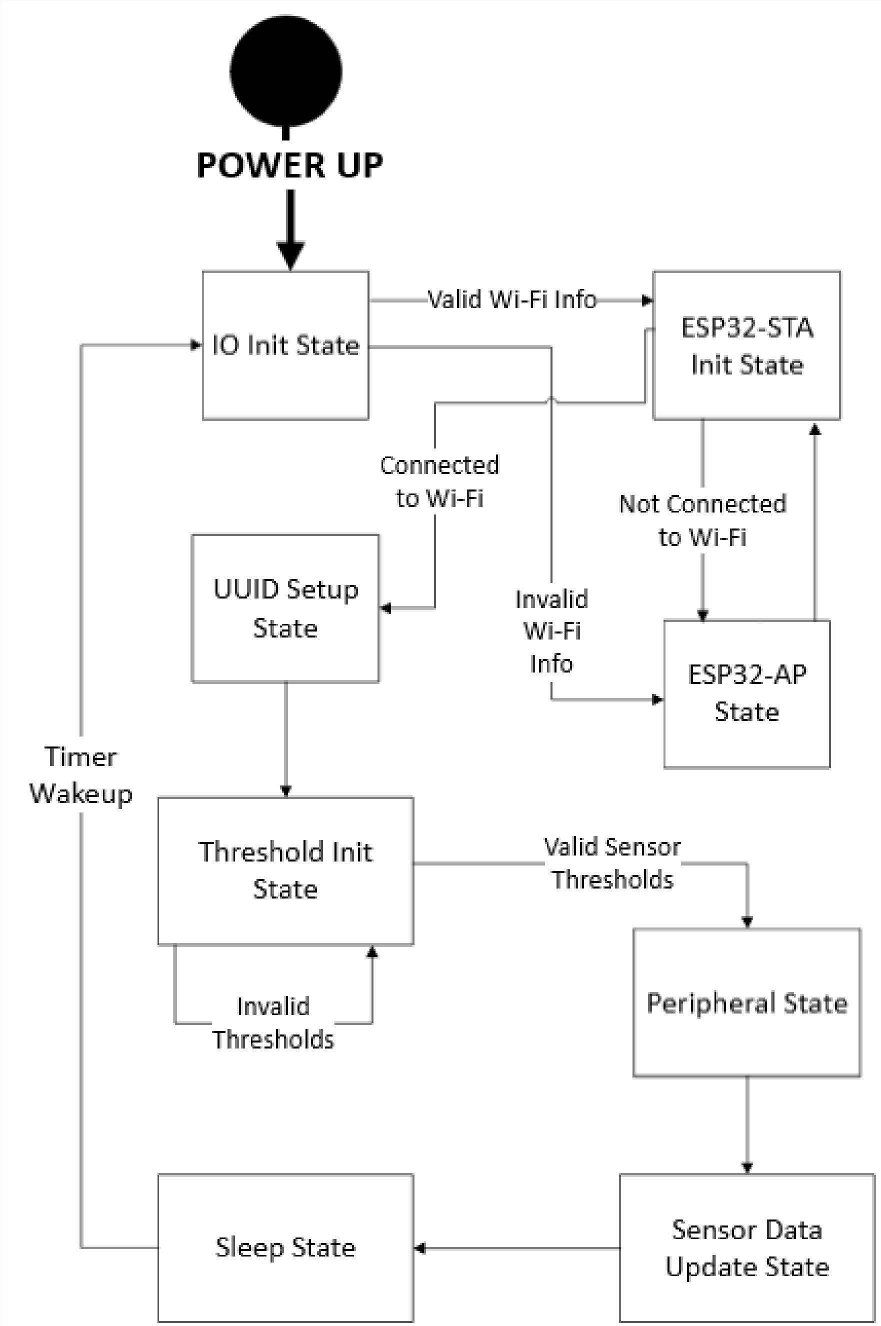
- ❑ No communication between pot and client; all use server as middleman
- ❑ Server should not make many requests; mainly responds to requests from pot and client

Organization of data will be accomplished through the use of Postgres

- ❑ Most data will be organized under the user
- ❑ Oauth (Google) will be used to authenticate the user before data is sent

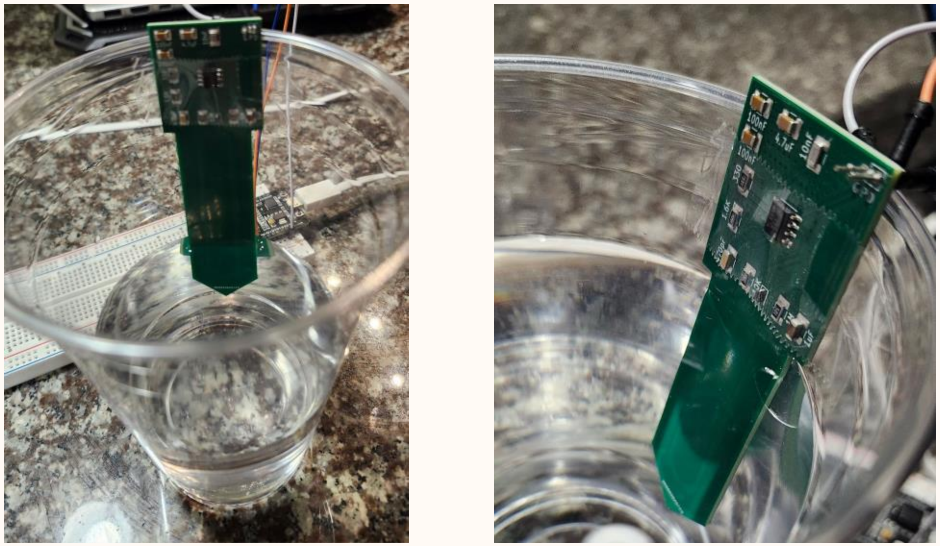


MCU Software Architecture



Prototyping & Testing

Soil Moisture Sensor Testing



Soil Moisture Sensor Testing

Environment	Water Amount	Mean (mV)	Standard Deviation (mV)	Standard Dev (%)
Cup, No Soil	0% of probes	3173.03	12.55	0.395
	25% of probes	1941.45	15.03	0.774
	100% of probes	1547.68	19.20	1.240
Pot, Soil	0 mL			
	100 mL			
	355 mL			

Light Sensor Testing

The BH1750 sensor was tested using the ESP32 microcontroller over the I2C.

- Ensured proper wiring to SDA and SCL lines
- Confirming communication via the serial monitor
- The BH1750.h library was used to simplify code implementation.
- The sensor successfully initialized and produced real-time lux readings.
- Multiple lighting scenarios were simulated including
  - Direct light
  - Room light
  - Full darkness

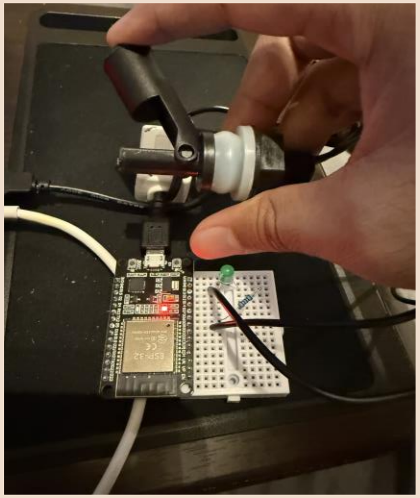
Time in Seconds	Sensor Readings 1 (Zero Light)	Sensor Readings 2 (Room Light)	Sensor Readings 3 (Flashlight)
0:01	0 lux	45.83 lux	33538.33 lux
1:00	0 lux	44.17 lux	33281.66 lux
2:00	0 lux	43.33 lux	33286.66 lux
3:00	0 lux	45.00 lux	33101.66 lux
4:00	0 lux	45.00 lux	33152.50 lux

Horizontal Water Level Sensor Testing

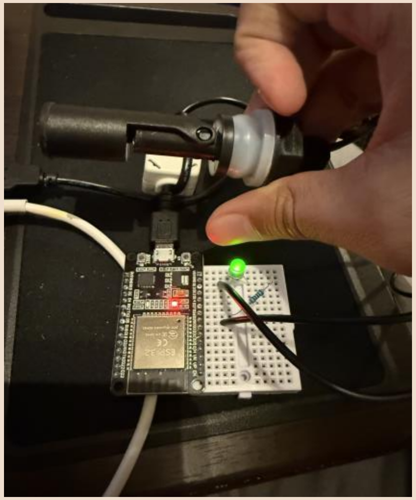
The float sensor is a mechanical switch activated by water level changes.

- ❑ First tested out of water to confirm functionality
- ❑ An LED was connected to the ESP32 to indicate its status
- ❑ Low water level -> turned on
- ❑ High Water Level -> turned off

“Water level is high” float sensor is up / LED is off

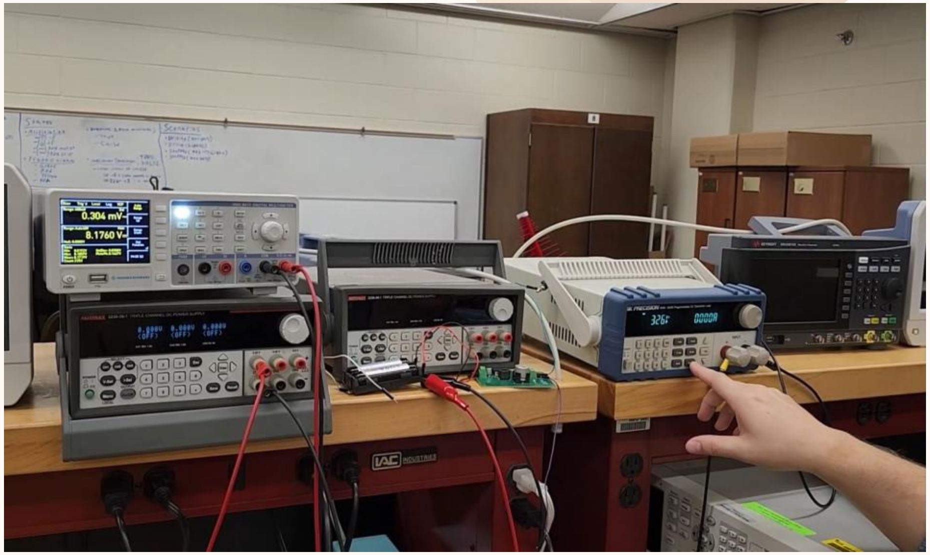


“Water level low” float is horizontal / LED is on



Regulator testing 3.3V

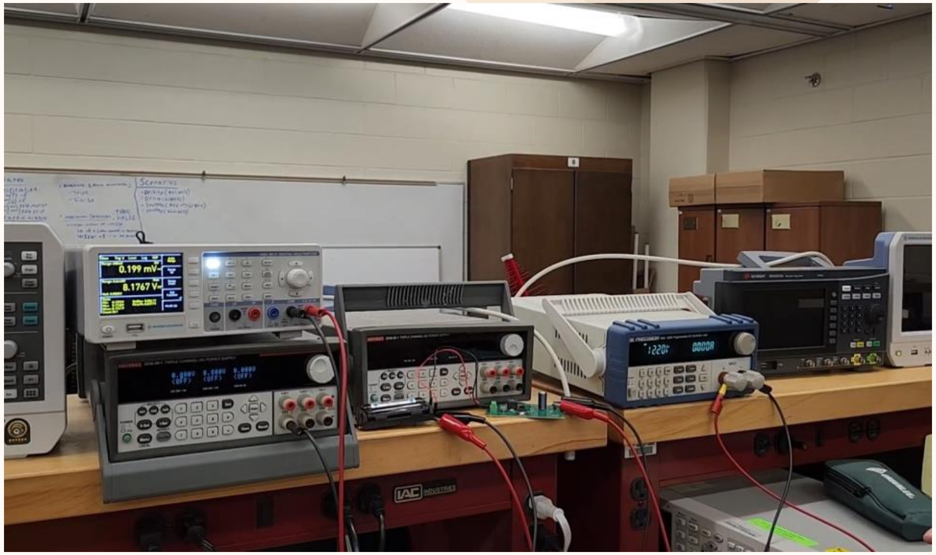
Current	Voltage
.1A	3.22V
.2A	3.17V
.3A	3.12V
.4A	3.08V
.5A	3.03V
1A	2.78V



Regulator is stable at required voltage and current.

Regulator testing 12V

Current	Voltage
.1A	12.1V
.25A	12.08V
.5A	12.04V
1A	11.98V

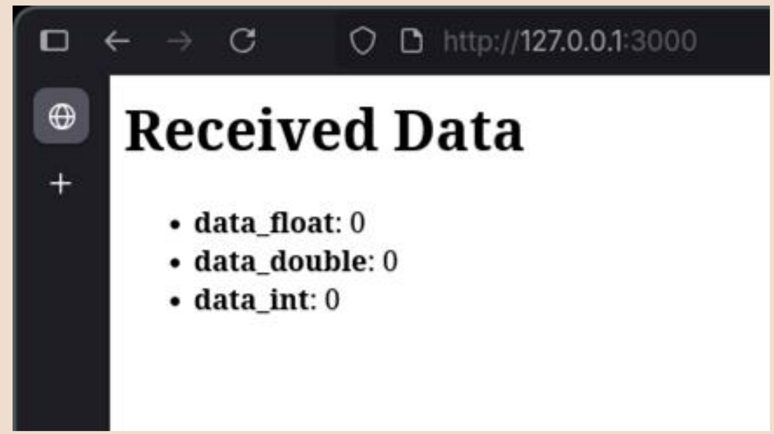


Regulator is stable at required voltage and current.

Software Testing

Moving Data from embedded device to server:

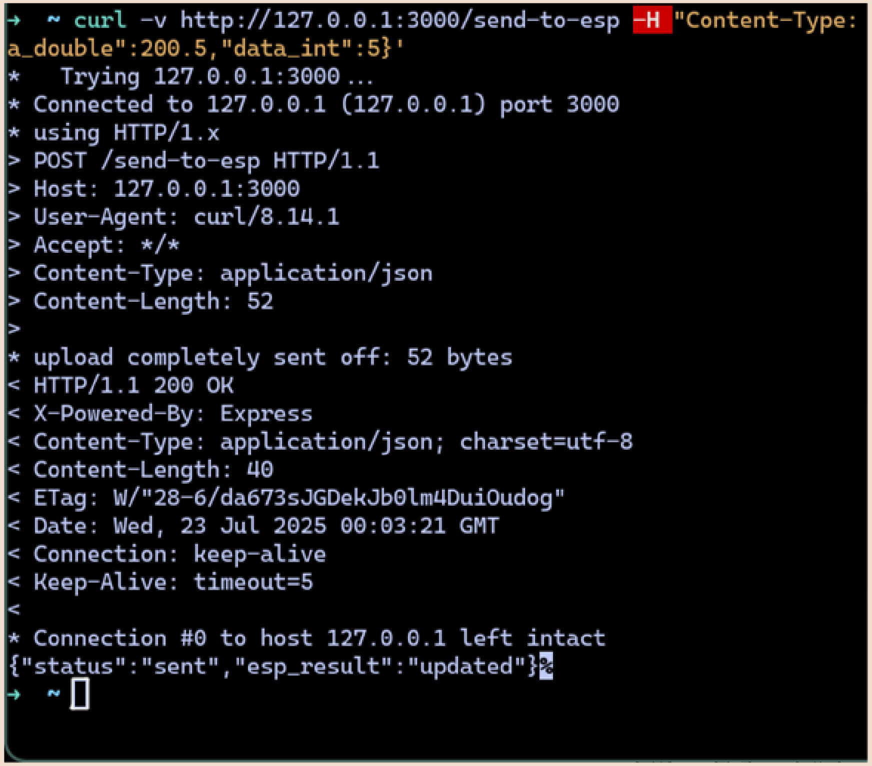
- ❑ ESP32 connects to WiFi network
- ❑ Sends data to IP address of server
- ❑ Server uses express to define HTTP requests it can handle
- ❑ server receives and displays data



Software Testing

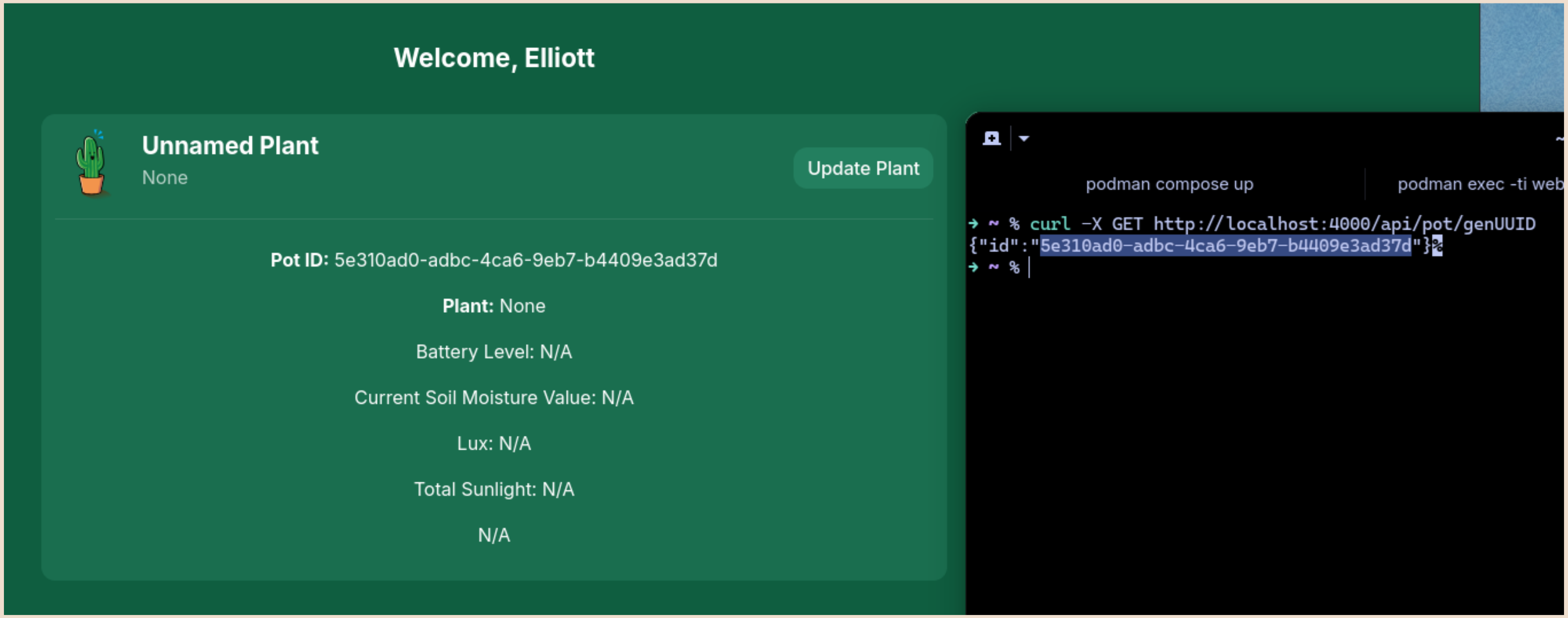
Moving Data from server to embedded device:

- ❑ Use curl to send JSON object to local server
- ❑ Server uses Express to handle data, sends to ESP32 with cached IP
- ❑ ESP32 updates data



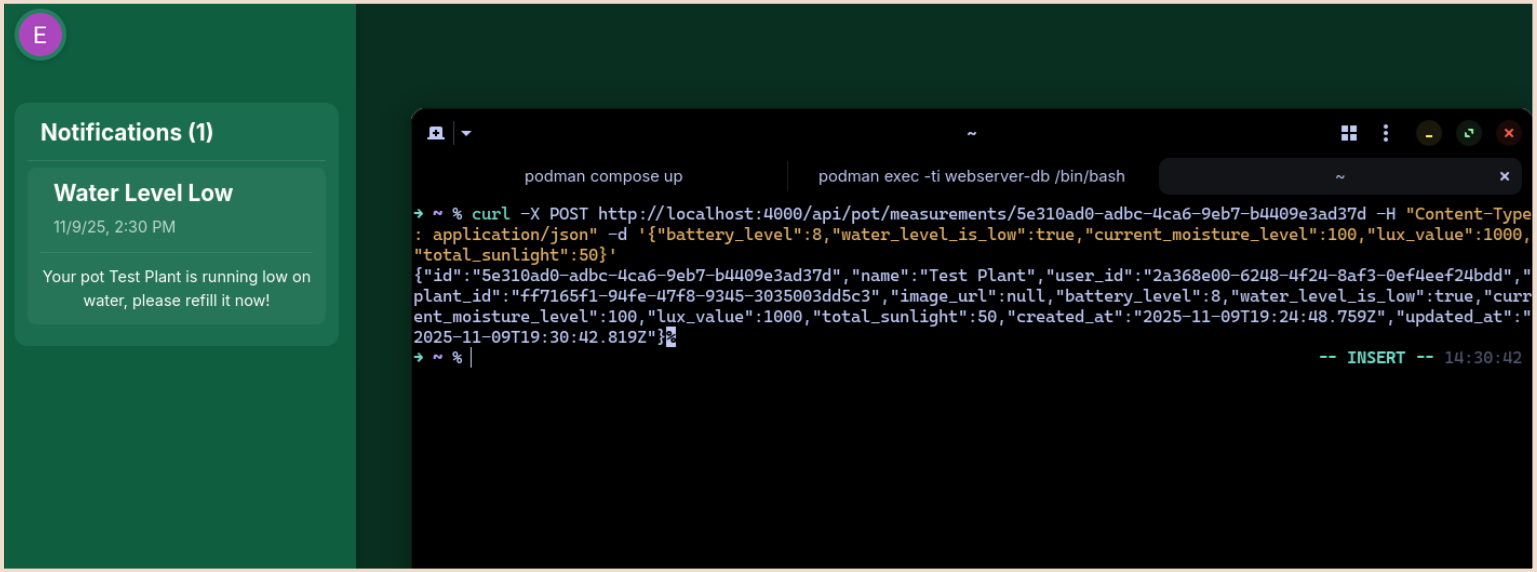
Software Testing

Connect Pot To User Account



Software Testing

Sending Data and Creating Notifications



Software Testing

Polling Rate:

- ❏ 15 second sampling period
- ❏ Time between updates show latency
- ❏ Sampling Period + Sampling Time + Time to send

Update	Time (UTC)	Polling Rate (seconds)	Latency (seconds)
0	17:54:44	N/A	N/A
1	17:55:16	32 sec	17 sec
2	17:55:48	32 sec	17 sec
3	17:56:21	33 sec	18 sec

```
[server]    | Update received at: Sat Nov 08 2025 17:54:44 GMT+0000 (
ated Universal Time)
[server]    | Update received at: Sat Nov 08 2025 17:55:16 GMT+0000 (
ated Universal Time)
[server]    | Update received at: Sat Nov 08 2025 17:55:48 GMT+0000 (
ated Universal Time)
[server]    | Update received at: Sat Nov 08 2025 17:56:21 GMT+0000 (
ated Universal Time)
[server]    | Update received at: Sat Nov 08 2025 17:56:52 GMT+0000 (
ated Universal Time)
[server]    | Update received at: Sat Nov 08 2025 17:57:24 GMT+0000 (
ated Universal Time)
[server]    | Update received at: Sat Nov 08 2025 17:57:56 GMT+0000 (
ated Universal Time)
[server]    | Update received at: Sat Nov 08 2025 17:58:27 GMT+0000 (
ated Universal Time)
```

Problems / Solutions

3D Design

Problem: Finding a way to represent our project in a 3D format, and making a design that would align with project needs. No experience with CAD, so I had to learn everything from scratch.

Learning Process: Found a CAD software that I could use on my IPAD, spent a couple days watching their tutorial videos to understand the basics. Tried making my own design for the project and had to watch a lot of videos to allow for certain features. For the final design, I had to think on how to make the project more modular since water leaks were a main concern.

Final Outcome: A 3D design separated into 3 major section including the pot, water tank, and component housing.

Solar charging

Problem: The bq24650 would consistently collapse the voltage on the solar panel below the voltage needed to charge the cells. This behavior was discovered on two of the dev boards and after proper configuration of the sense resistors.

Tested solutions:
-Higher power solar panel
-New dev board
-Change to USB charging

Final Solution:
-My design functioned properly, issue was possibly with the dev boards.

Water tank leaking

Problem: The water tank had a leak that was cases several issues. The problem was identified by filling up a tub of water and seeing where the air gaps were on the tank. There were several locations that the 3d print had failed.

Tested solutions:
-Thicker walls
-Thicker infill
-Water proof coating
-Caulking on corners and the sensor

Final Solution:
-The take had no leaks and performed as designed.

MCU-Light Sensor I2C Communication

Problem:
- System hangs on sensor check state
- Serial output reading “[BH1750] Device is not configured!”

Tested solutions:
- Used automatic/default configuration in software
- Issue began re-occurring on same backup PCB during testing
    - I2C GPIO and light sensor power pins on both PCBs were re-soldered
- Female connector on cable was observed to loosen or disconnect during assembly of the system, causing this issue to re-occur

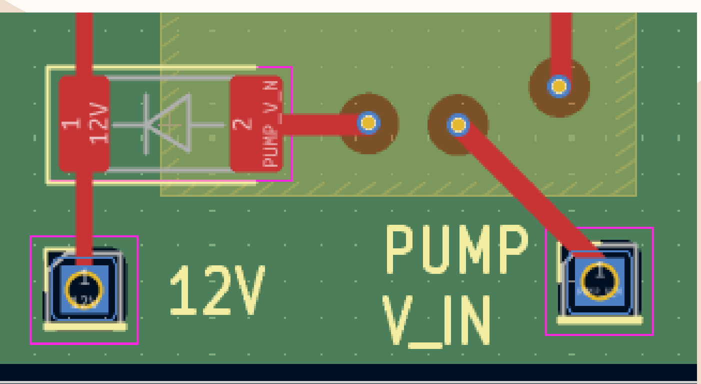
Final Solution:
- Wires soldered between MCU and light sensor PCBs
- Software modified to reconfigure I2C comm after failure
- Timeout added in software to prevent light sensor from being measured indefinitely if I2C can not reconfigure

MCU PCB Layout Mistakes

Problem:
- Incorrect footprint used for 470uF capacitor w/ >12V rating
- No common location on any PCB for all ground wires/signals to be connected

Tested solutions:
- Tried to bend and solder legs of through-hole capacitor and solder to 1206 footprint on MCU PCB
    - broke off soon after & cost lots of time to solder
- originally proposed to solder ground wires together or to a single wire

Final Solution:
- Purchased solderable breadboards instead of redesigning board(s)
- Soldered 470uF through-hole capacitor in parallel with wires connected to pump terminals.
- Soldered male connector pins to other end of the solderable breadboard as a common ground location.



Changes to Web Deployment Strategies and OAuth APIs

Problem: Web development is constantly evolving, and many deployment strategies and external APIs change frequently. Changes that were difficult to adapt to included frontend deployment changes, and changes to Google's Oauth API.

Tested Solutions:

- Downgrading software libraries
- Modifying container implementation
- Using new libraries to replace deprecated functionality

Final Solution: Replaced older software libraries with new, supported libraries (Vite for frontend deployment and googleapis for Oauth). Incurred some delays and rewrite time for switching, but allowed for continuation of development.

Administrative Content

Distribution of Work

Electrical Engineering	Responsibility
Brandon James	PCB Design and fabrication
	Solar and other power delivery
	3d printing pot design
	Regulator Design
Electrical Engineering	**Responsibility**
Adrian Vergara	PCB Design and fabrication
	Water pump system
	Solar, soil moisture and water level sensor
	3d printing pot design

Computer Engineering	Responsibility
Brian Ericson	MCU software design
	MCU/Sensor interfacing
	PCB Design & Fabrication
Computer Engineering	**Responsibility**
Elliott D'Amato	MCU software design
	MCU/Sensor interfacing support
	Web app development

Progress and Plan for Completion

In Progress / Done

- ❏ Research - 100%
- ❏ PCB and Part Sourcing - 100%
- ❏ Prototyping - 100%
- ❏ Testing - 100%
- ❏ Overall - 100%

Major milestones remaining

- ❏ Final Presentation