Smart Cooler

Group 23
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Project Overview

Project Motivation

- Recreational enjoyment
- Assortment of technologies
- Practicality
- Previously encountered problems
- Quality of Life (QoL)

Project Goals and Objectives

Basic Goals

- PDLC technology
- Solar Panel
- Motion Sensor
- Temperature/ Humidity Sensor
- UV Sensor
- LED Lights

Advanced Goals

- USB-A Charging Ports
- Rechargeable Battery
- Graphical Interface
- Adjustable transparency on PDLC film

Stretch Goals

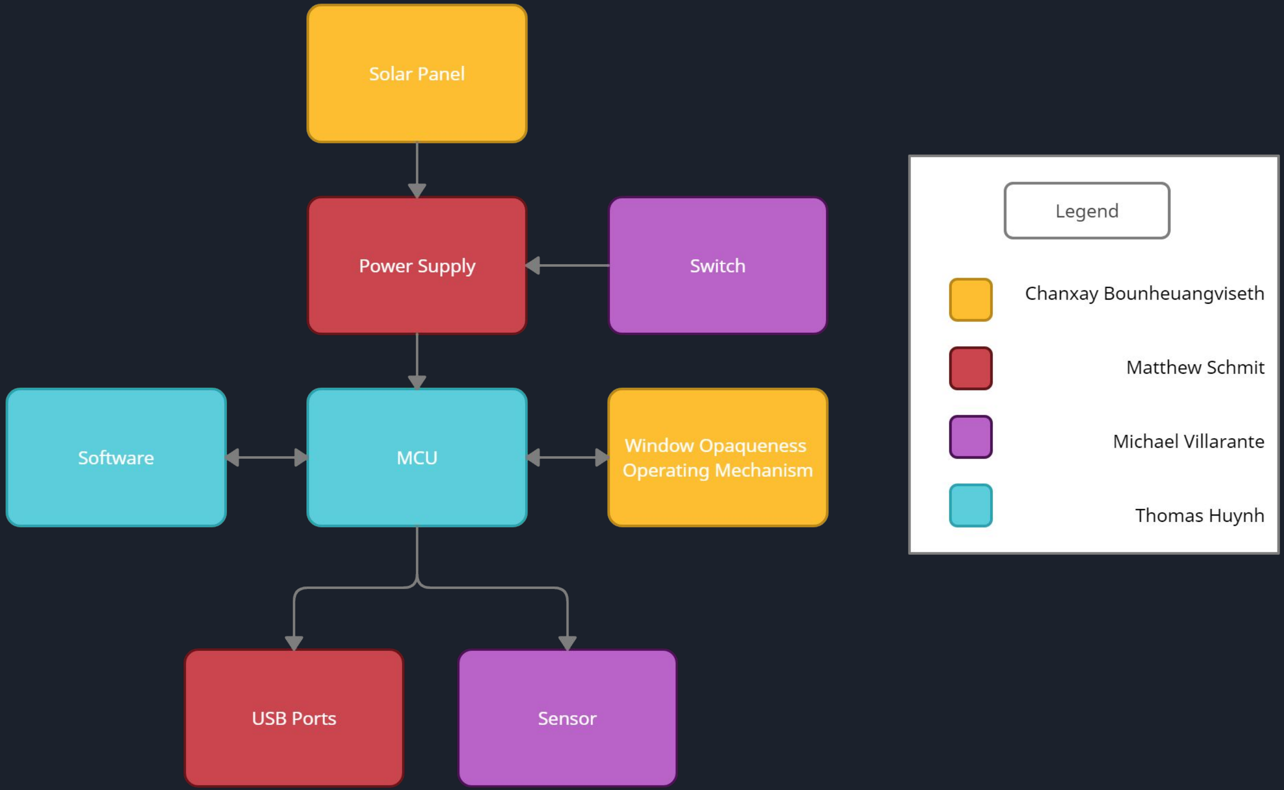
- Bluetooth speakers
- Mobile IOS/Android App
- Camera

Specifications

- The main feature to test is the PDLC Film itself and the overall Cooler weight
- The other components can be tested as an added bonus on top of the chosen specifications

Component(s)	Parameter	Specification
Battery	Discharge Time	4 Hours
PDLC Film	Power Consumption	≤ 10 Watts
PDLC Film	Time to Activate	≤ 5 Seconds
PDLC Film	Transparency	≥ 80%
PDLC Film	Opaqueness	10 - 90 %
Sensor	Accuracy	≥ 95%
Cooler	Weight w/o Food/Drinks	≤ 30 Pounds
PV Panel	Power Output	≥ 10 Watts

Overall Block Diagram



Significant Design Considerations

- Electrical components contained within the cooler should take up as little space as possible
- Electrical components, when power, should not change the temperature of the cooler by a large amount
- Electrical components contained within the cooler should not be disturbed by other items put inside the cooler (i.e. food, drinks, ice, etc.)
- New design of the cooler lid must be able to fit properly back onto the cooler to insure the cooler is still effective

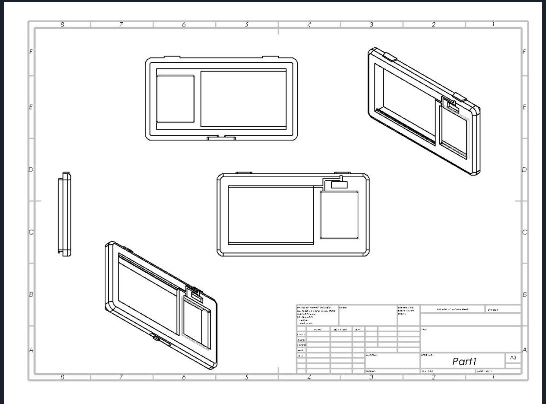
Significant Component Decisions

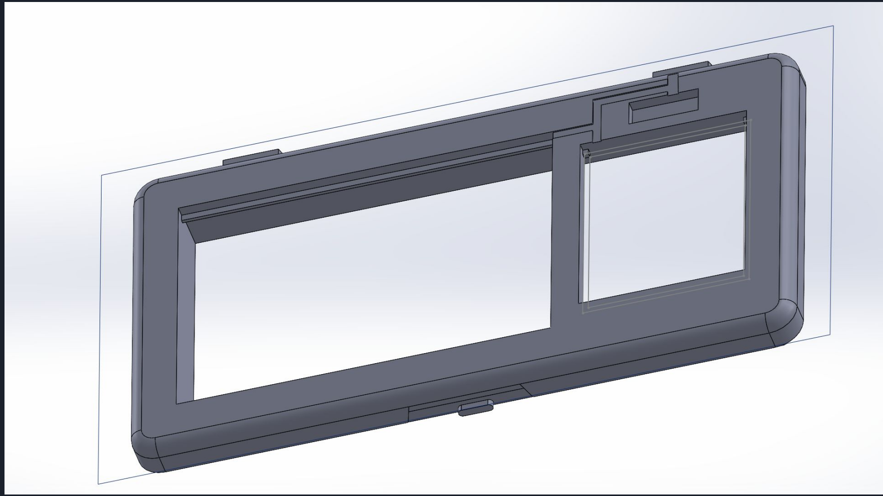
- Cooler: Large enough to have components embedded, able to be carried
- Sensors: Functionally benefit a cooler and our implementation
- PDLC: Ease of use as a film, size constraints
- Solar Panel: Needed to fit on the cooler lid
- Battery: Price, amount of charge it can hold
- LED lights: bright, efficient

Cooler

Cooler Lid Design

- Cooler Lid needs a redesign to fit the new components
- Redesign specifically compensates for the Solar Panel, LCD, PDLC Glass, and wiring routes
- Cooler Lid intended to be 3D printed
- Area of the lid is measured to be around 60.1 ± .1 cm x 33.4 ± .1 cm

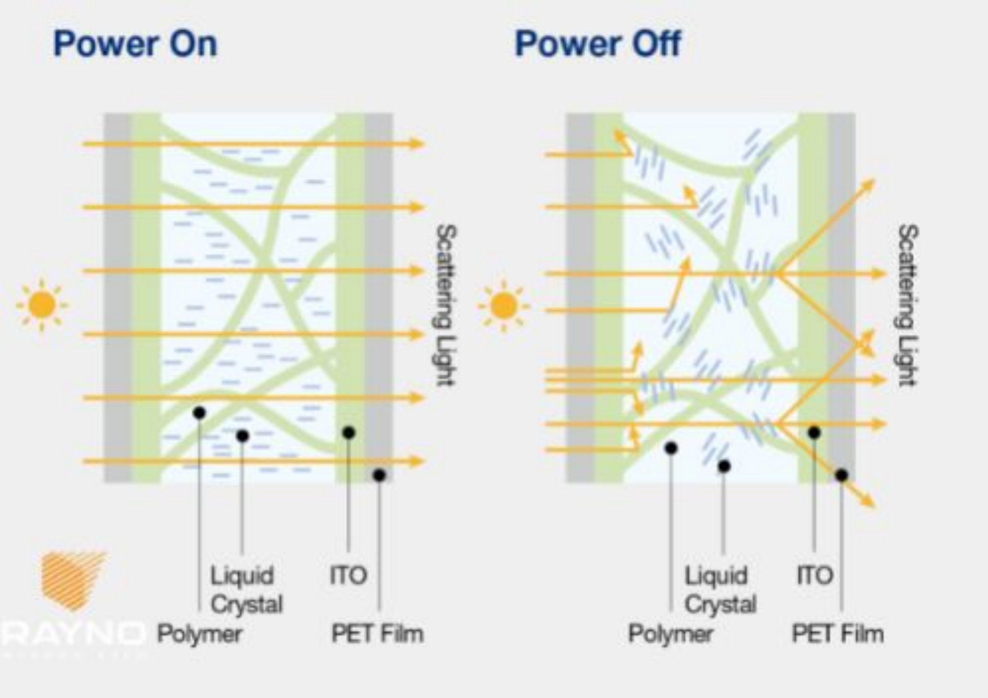




Polymer-Dispersed Liquid Crystal (PDLC) Film

- Opaque state while inactive
- Transparent while active
- Stripping and soldering the wires
- Window of the cooler lid

How PDLC Technology Works



Source: Rayno Window Film

Solar Panel

- 10 Watt/12 Volts Panel
- Monocrystalline
- 10 Amp Solar Charge Controller
- Mounting holes
- 34.29 x 23.37 x 1.524 cm
- Waterproof junction box

Solar Charger Regulator

- Regulating current flow from solar panel into battery bank
- Ensures battery is properly changed and not being damaged overtime
- Device acts as a pulse width modulator
- Cheaper compared to maximum power point trackers

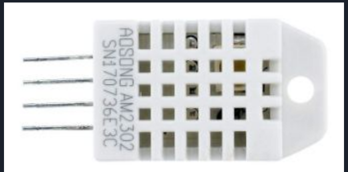
LED Lighting Feature

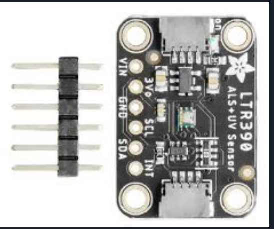
- Brightness can be controlled
- Will be placed near the top of the inside of the cooler
- When on allows the contents of the cooler to be seen when lid is closed

Sensors

- Chosen sensors were the DHT22 (temperature/humidity), the Stemma QT LTR390 (uv), and the IRA-S210ST01 (motion)
- Cost effective and most useful towards the project but can be modified in the future
- Easy to setup and use for specific collection of data

Type of Sensor	Voltage	Dimensions	Price Range
Temperature	3.3V-6V	Small: 14mm x 18mm x 5.5mm; Big: 22mm x 28mm x 5mm	~$10.00-$11.00
Humidity	3.3V-6V	Small: 14mm x 18mm x 5.5mm; Big: 22mm x 28mm x 5mm	~$10.00-$11.00
UV	3V-5V	3cm x 2cm x 1cm	~$5.00
Motion	2V-15V	9.2mm x 9.2mm x 18.2mm	~$3.00
Tilt	24V	4mm x 22mm	~$2.00
Pressure	N/A	18.3mm x 32mm x 0.4mm	~$5.00
Sound	3.3V-5.3V	18.67mm x 34.42mm	~$3.00-$4.00





Switches

- Switch chosen to use was the micro-push button switch
- Very simple to use for operating the LED lights and cost effective for the project
- Other modifications can be made in the future for better functionalities

Type of Switch	Voltage	Size	Operation	Price Range
LED	N/A	Small	Physically push button	~$2.00-$3.00
Limit	125V AC	Small	Presence/absence of object	~$1.00-$2.00

LCD Screen

- 16x2 character display
- Allows for the data received from the sensors to be displayed
- Will cycle through the different readings from the sensors to allow everything to be displayed

Power Management

- The system will be powered by a 12 Volt 7200 mAh battery.
- The 12 Volts will power the PDLC film and LED Lights
- The 5 Volt Regulator and 3.3 Volt Regulator will step down the 12 Volts from the battery into manageable power for the other electronics.
- Mains Electricity will be the primary way to charge the battery.
- Solar panel will provide secondary charging to the battery while on the go.

Microcontrollers

- Chosen microcontroller is the ESP32-WROOM-32E on the HUZZAH32 breakout board
- Cheap and allows for potential upgrades in the future
- Allows for easy testing before creating final product

Description	ESP32	MSP430FR6989	ATmega4809
Architecture	32-bit	16-bit	8-bit
Integrated Development Environment	Arduino		AVR Studio
Bluetooth	Dual Mode Bluetooth (Classic and BLE)	n/a	n/a
Wi-Fi	802.11 b/g/n ~2.4 MHz	n/a	n/a
Microprocessor Speed	240 MHz	16 MHz	20 MHz
Voltage Supply	3 V ~ 3.6 V	1.8 V ~ 3.6 V	1.8 V ~ 5.5V
Operating Temperature	-40ºC ~ 105ºC	-40ºC ~ 85ºC	-40ºC ~ 125ºC
Memory Type	4 MB, Flash	128 kB, FRAM	48 kB, Flash
ROM	448 kB	n/a	256 kB
SRAM	536 kB	2 kB	6 kB
Costs	$13.50	$20.00	$20.89

Difficulties and Successes

Difficulties

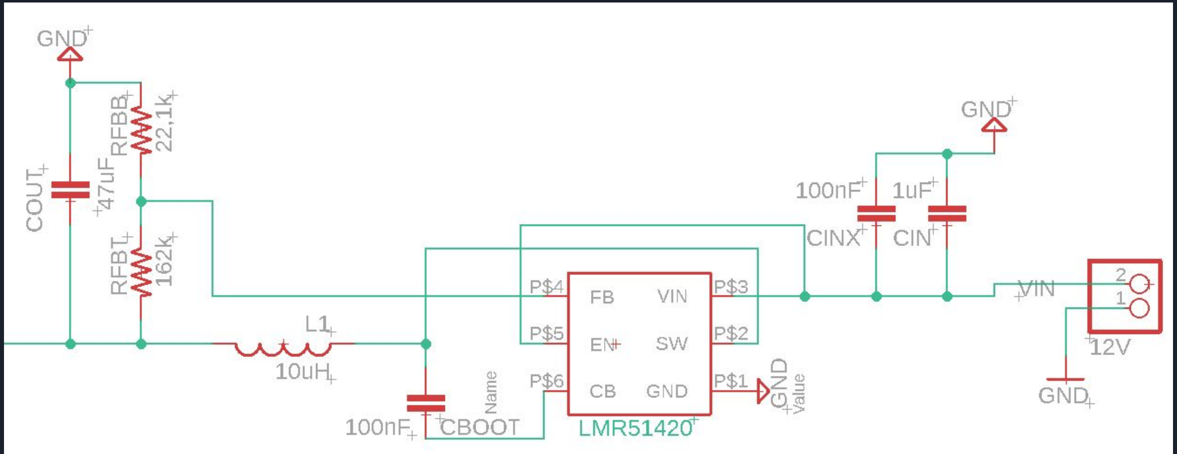
- Learning to operate 3D printing and other programs
- Working around everyone's schedule
- Certain parts took longer to test compared to others
- Design layout to make sure all the parts can fit with all the wiring and sensors

Successes

- Parts chosen all passed the testing process and work as they should
- Completing work on the project in a timely manner
- Acquiring skills with new technologies

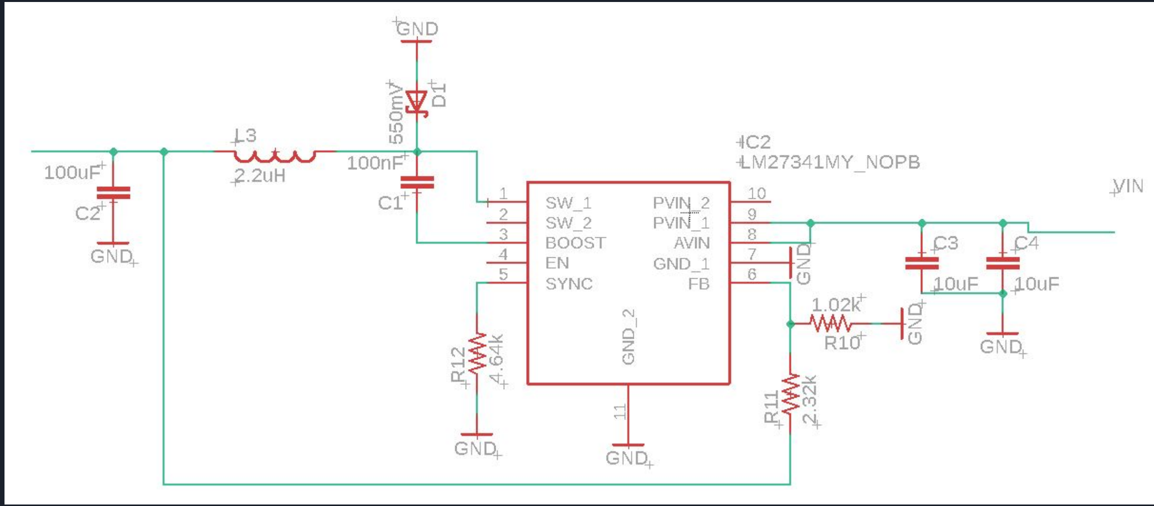
Electrical Schematic/PCB

5V Voltage Regulator



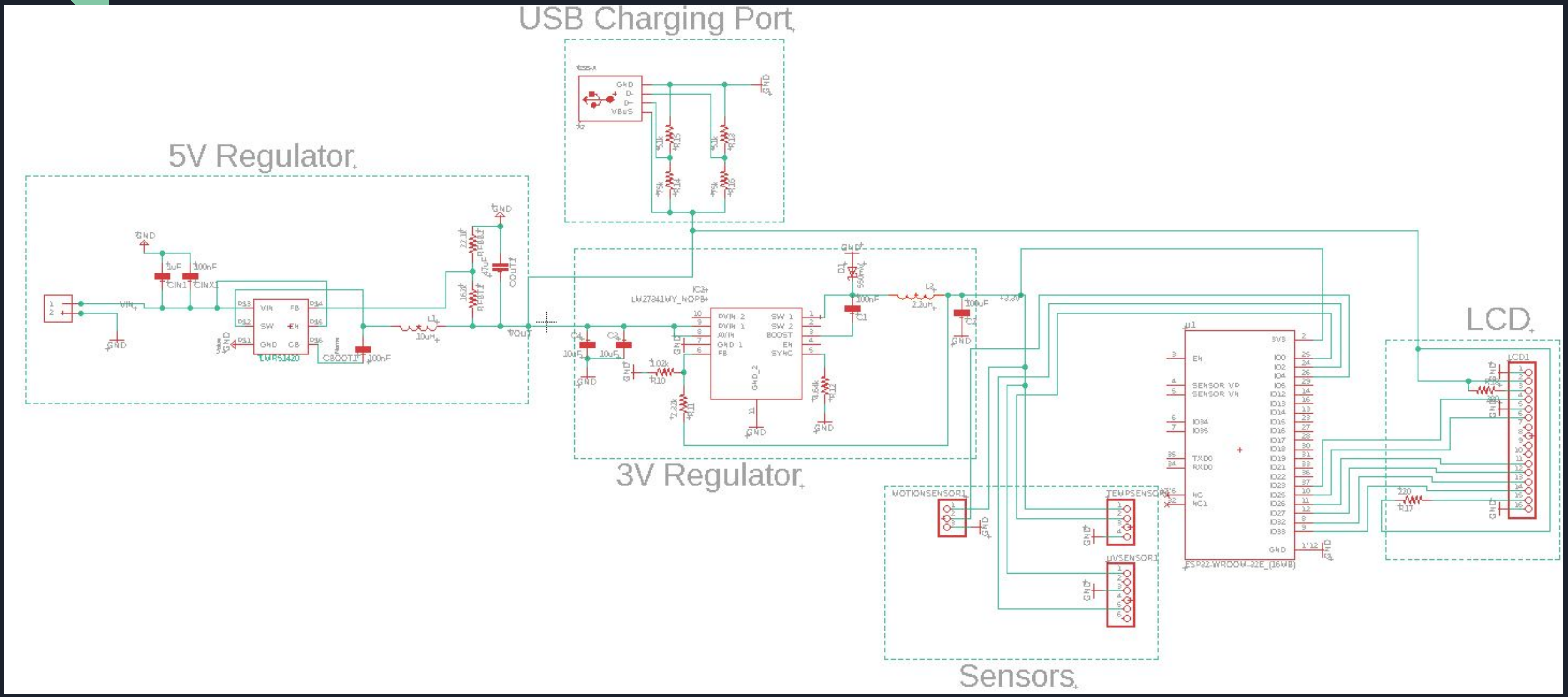
- Schematic of 5V Voltage Regulator
- Using the LMR51420 Part
- Design with assistance of TI-WEBENCH
- Purpose is to power USB-A charging port
- Around 93.3% Efficiency

3.3V Voltage Regulator

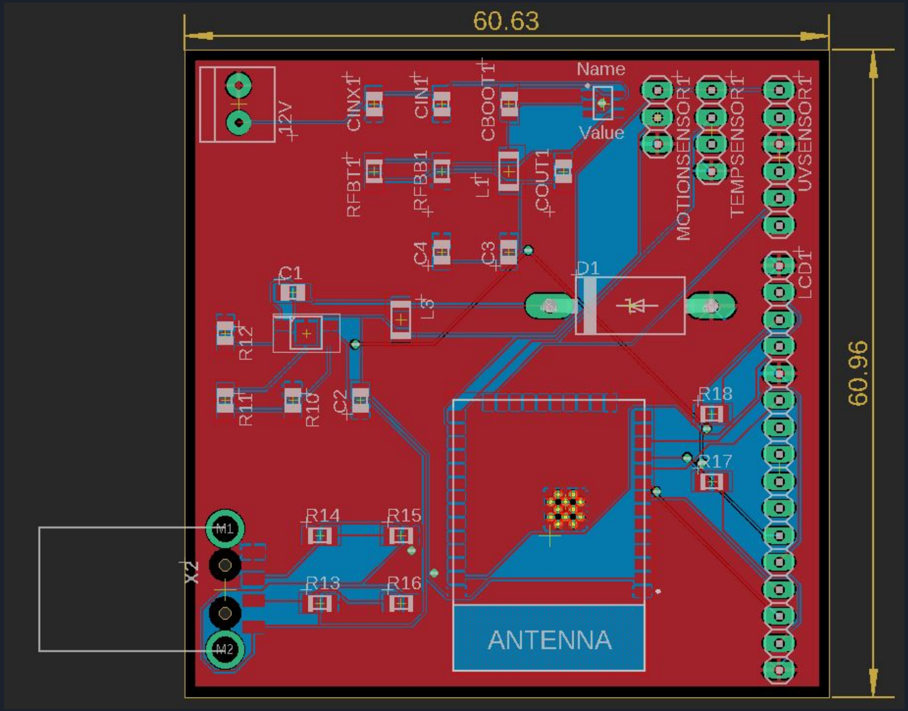


- Schematic of 3.3V Voltage Regulator
- Using the LM27341MY_NOPB Part
- Design with assistance of TI-WEBENCH
- Purpose is to power the ESP32

Overall Schematic



PCB Design



60.63
60.96
12V
CINX1
CIN1
CBOOT1
Name
Value
MOTIONSENSOR1
TEMPSENSOR1
UVSENSOR1
RFBT1
RFBB1
L1
COUT1
C4
C3
C1
L3
D1
LCD1
R12
R11
R10
C2
R18
R17
R14
R15
R13
R16
X2
M1
M2
ANTENNA

Circuit Design Successes and Difficulties

Difficulties

- Footprint building for voltage regulators
- Proper connections to the microcontroller
- Testing voltage regulators

Successes

- Functioning electrical components
- Solar Panel generates an acceptable amount of energy
- No issues with power

Software/Programming

Arduino IDE

- C/C++
- Program the ESP32 Huzzah (Supported by Adafruit ESP32 Feather on Arduino)
- Testing components and prototyping
- Intuitive application
- Support from a wide range of libraries

AutoCAD

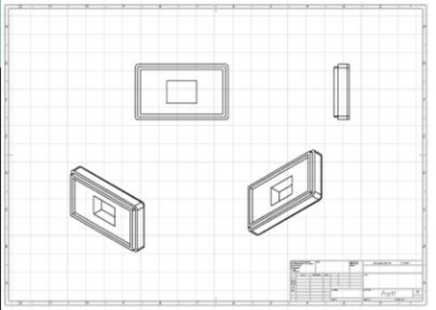


Figure 33: Schematic of Version 1 Lid Design

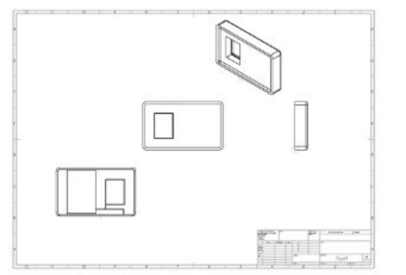


Figure 34: Schematic of Version 2 Lid Design

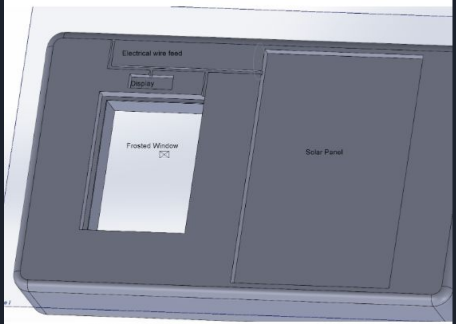


Figure 35: 3D CAD Model of Version 2 Lid Design

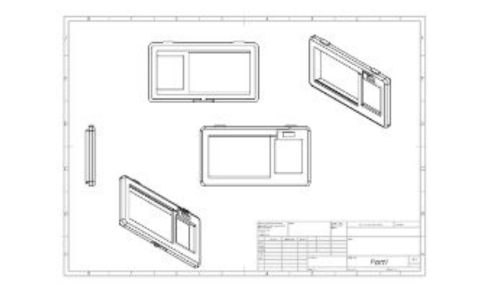


Figure 36: Schematic of Version 3 Lid Design

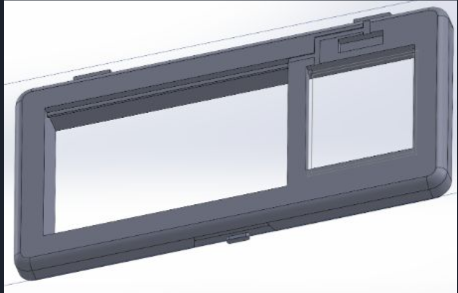


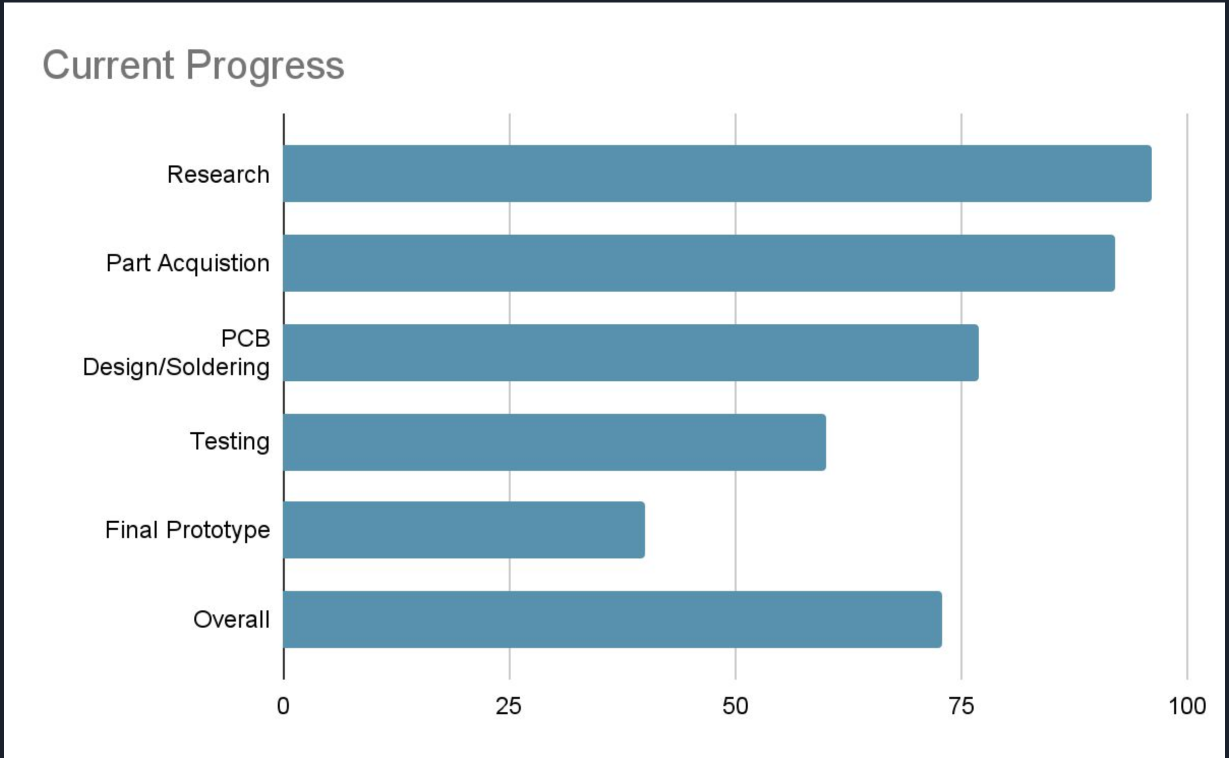
Figure 37: 3D CAD Model of Version 3 Lid Design

Administrative Content

Budget

Item	Supplier	Price/Unit	# Units	Total Cost
Coleman 48 Quart Cooler	Amazon	$34.99	1	$34.99
10 Watt 12 Volt Monocrystalline Solar Panel	Amazon	$32.99	1	$32.99
PDLC Switchable Smart Film	Amazon	$35.99	1	$35.99
Adafruit HUZZAH32 – ESP32 Breakout Board	Adafruit	$13.50	1	$13.50
12-Volt 7 Ah Sealed Lead Acid (SLA) Rechargeable Battery	Home Depot	$23.32	1	$23.32
DHT22 Digital Temperature and Humidity Sensor	Amazon	$10.35	4	$41.40
LTR390 UV Sensor	Adafruit	$4.95	4	$19.80
USB-A UJ2-AV-1-TH	Digikey	$0.70	4	$2.80
Battery Snap pre-connected to a Micro Push-button Switch	Amazon	$2.75	4	$11.00
LCD1602 Module	Amazon	$7.99	1	$7.99
Total				$223.78

Current Progress



Questions?