

#### The Team



Andrew D'Aquila

Electrical Engineering



Spencer Spalding

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Electrical Engineering



Antonio De Leon

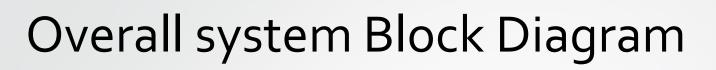
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Electrical Engineering

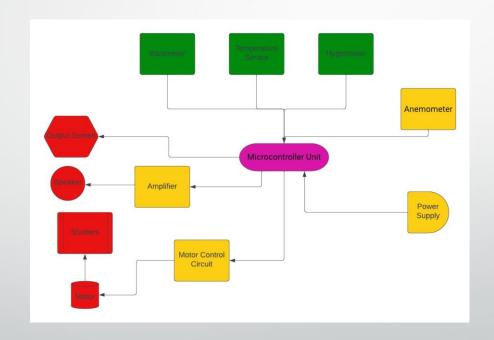


Aidan Dion

Computer Engineering







#### Motivation and Background



- Hurricane damage is both inevitable and disastrous. Over the course of history natural disasters have been a prevalent part of society. Hurricanes specifically have cost countless lives.
- 742.1 billion dollars in damages done the last five years alone.
- This is especially alarming since in the last forty-two years the total cost of damage is 2.155 trillion dollars, making the last five years greater than one third of the overall cost.



#### Our Solution



- Hurricane shutter protection system with automatic detection, sensing, and activation. This product should not only mitigate the damages of hurricanes and natural disasters alike but also help drive down the ever-growing disaster costs.
- Our design will be bringing back an aesthetically pleasing part of the home that was lost to modern building techniques and architecture. Revisiting and reviving old technology with a new twist.







# Goals and Objectives

# Goals and Objectives



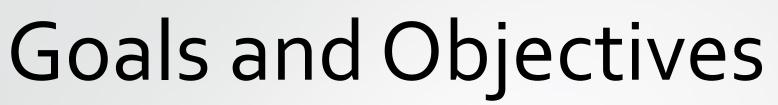
- Have a barometer, temperature sensor, and anemometer read / process data in real time.
- Have an LCD display on the housing unit that will give the status of the running system.
- Have the system communicate with an external weather api.
- Have a speaker that will be used to notify when the system is performing certain actions.
- Have the MCU be able to take in all this information and decide whether to activate / deactivate the shutters.



# Goals and Objectives

#### Advanced

- Develop a web-based system with an integrated database to efficiently store and manage the collected data.
- Enable remote control of system operations, allowing for seamless activations and deactivations via the website interface.





#### Stretch

- Facilitate manual activations using a Bluetooth remote for added convenience and flexibility
- Enable users to remotely activate or deactivate the system via a dedicated mobile application for seamless control and accessibility.

Main Target Focuses

Cost

Power consumption

Response time



### Overall Requirement Specifications



Requirement Specifications				
Category	Metric	Requirement		
Cost	USD	< \$400		
Power Consumption	Watts	< 120		
Battery Life	Hours	> 12		
Installation Time	Hours	<1		
Networking	Wireless Standard	≥ Bluetooth 4.o		
	Wireless Standard	≥ WiFi 4		
Wireless Range	Feet	> 100		
Response Time	Seconds	< 4		



#### Cost

- One of the first decisions that we made was that we wanted to make the system cost-effective without sacrificing on features and longevity.
- Ensuring Affordability: We aim to design a cost-effective system, recognizing that those most in need of its protection should not have to sacrifice their financial stability for safety.
- Economic Consideration: With self-funded resources, we're mindful of our college student budget. Our research guides component selection, prioritizing quality within budgetary limits. This can be seen in the slides to come.
- Product Cost: Our target is to keep the device cost below \$400 per unit.



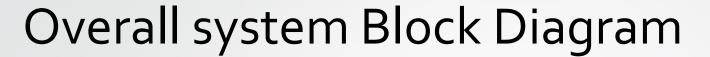
#### Power consumption

- Low Power Consumption: The system is designed for efficiency, consuming minimal power during operation. The peak power consumption must be less than 120 watts.
- Battery-Powered Operation: Integrated batteries reduce reliance on the grid, further enhancing energy efficiency.
- Reliable Operation During Power Outages: The system functions seamlessly even in power outages, ensuring continuous safety. We require that our system be able to run for greater than 12 hours solely on battery power.
- Component Efficiency: Careful selection of components that can deliver quality results while consuming minimal power. This can be seen in the parts comparisons.

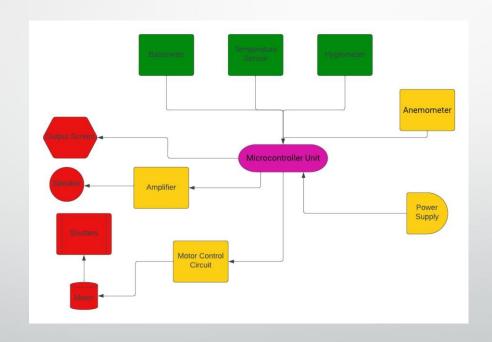


#### Response time

- Enhanced Safety: The system's quick reaction time significantly enhances safety levels, offering peace of mind to users in emergency situations.
- Continuous Monitoring: The system is vigilantly monitoring conditions, guaranteeing a timely response to changing weather patterns or potential threats.
- Swift Response: The system will have a quick response time, ensuring immediate
  action during critical weather events. This is set to be a time of less than a 4 second
  response time from when the threshold condition is met, and the system activates.







# Shutter Technology Comparison





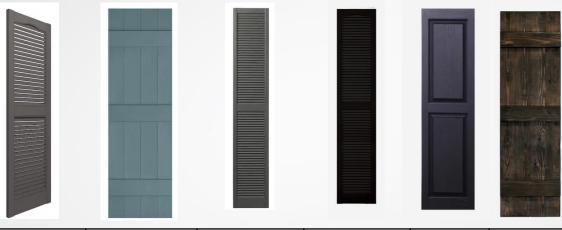






	Accordion	Motorized roll down	Hinged	Custom (our design)
Cost	Low	High	Low	Low
Ease of Installation	Mid	Low	High	Low
Maintenance	Low	High	Low	Mid
Power consumption	Low	High	Low	Mid

# Shutter Parts Comparison



Features	Builders Edge	Ekena Millwork	PlyGem	Vantage	Alpha	Dogberry
Style	Louvered	Jointed Board- n-Batten	Louvered	Louvered	Raised panel	Jointed Board-n- Batten
Material	Vinyl	Composite	polypropylen e	copolymer	copolym er	Red cedar
Durability	4/10	7/10	5.5/10	6/10	6/10	8.5/10
Visual Appearance	7.5/10	6.5/10	7.5/10	7.5/10	8/10	6.5/10
Cost	~50\$	~250\$	~50\$	~50\$	~50\$	~250\$



## MCU Technology Comparison









	Tensilica (ESP32)	Arduino	Raspberry pi
Cost	Low	Medium	Medium
Availability	High	Medium	Medium
Component Compatibility	Medium	Medium	Medium
User Friendliness	Medium	High	High

# MCU Parts Comparison







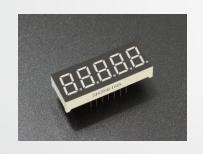


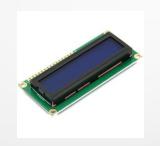


Microcontroller	ESP <sub>32</sub> -WROOM- <sub>32</sub> E-	ESP32-WROOM-32E-	STM <sub>32</sub> WB <sub>35</sub> CCU6A	nRF52840-QFAA-F-R7
	N <sub>4</sub>	N8		
Communication	3 UART	3 UART	1 UART	2 UART
Protocols	2 l2C	2 l2C	2 l2C	2 l2C
	4 SPI	4 SPI	2 SPI	4 SPI??
GPIO	34 GPIOs	34 GPIOs	71 GPIOs	48 GPIOs
Memory	4MB Flash	8MB Flash	256KB Flash	1MB Flash
	448KB ROM	448KB ROM	256KB SRAM	256KB SRAM
	520KB SRAM	520KB SRAM		
	16KB SRAM in RTC	16KB SRAM in RTC		
Power Consumption	3V~3.6V operating	3V~3.6V operating	1.71V~3.6V operating voltage	1.7V~5.5V operating voltage
	voltage	voltage	8o3mW	16.5mA at radio
	5μA hibernation mode	$5\mu A$ hibernation mode		transmitting
	240mA during WiFi or	240 <i>mA</i> during WiFi or		$3.16\mu A$ with system
	Bluetooth	Bluetooth transmission		operating
	transmission			
Availability	18000+ on Mouser	15000+ on Mouser	3000+ on Mouser	4000+ on Mouser
Additional Madules	Duilt in WiFi	Duilt in WiFi Dlustooth	Duilt in Dlugtaath madula	Duilt in DE module
Additional Modules	Built in WiFi,	Built in WiFi, Bluetooth	Built in Bluetooth module	Built in RF module
	Bluetooth modules,	modules, and PCB		
No. 1. 1. 1. 1.	and PCB antenna	antenna	5 5700	5 DT06
Native Libraries Supported	FreeRTOS, MQTT	FreeRTOS, MQTT	FreeRTOS	FreeRTOS

# Display Technology Comparison











Туре	Segment	LCD	OLED	ePaper
Low Power consumption	Х	Х		Х
MCU compatibility	Х	Х		
Character Capabilities		Х	Х	
Pixel density, Color accuracy		X	Х	

# Display Part Comparison









Features	DAOKI LCD module	Waveshare general IPS	Oumefar LCD
Formfactor	5x3 inches	2X1 inches	3.5x2.5 inches
Cost	9\$	15\$	20\$
Resolution	20X4	240X320	480x320
Communication Type	I <sub>2</sub> C	SPI	SPI

# Speaker Technology Comparison









Туре	Tweeter	Mid-range	Sub-woofer
Desired frequency range		X	
Gain	Х		Х
Cost		Х	
Low power consumption	Х	Х	

# Speaker Part Comparison





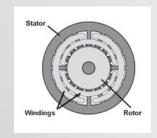


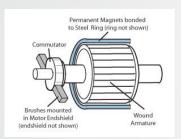


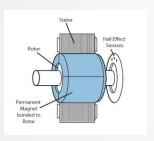
Features	Skar Audio NPX65-8	CQRobot	Adafruit mini
Wattage	300 watts	3 watt	.5 watt
Resistance	8 ohm	8 ohm	8 ohm
Form factor	6.5 inches	3 inches	1 inch
Durability	5/10	7.5/10	4/10
Cost	40\$	9\$	2.50\$
MCU Compatibility	None	Yes	Yes

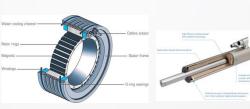
# Motor Technology Comparison

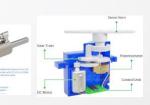


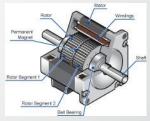












Туре	AC Brushless	DC Brushed	DC Brushless	Direct Drive	Linear	Servo	Stepper
Cost		Х	Х				
Durability	Х	Х	Х				Х
Sound	Х					Х	Х
Strength		Х	Х	Х	Х	Х	Х
Precision					Х	Х	
Maintenance			Х				
Power to run				Х			

## Motor Part Comparison









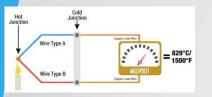


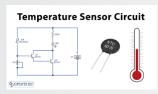


Features	Тороох	AUTOTOOLHOME	STEPPERONLINE	DC4.8-6 servo	Greartisan
Power consumption	1.5-3V	6-12V	12-24V	4.8-6V	6V
Form factor	Small	Medium	Large	Small	Small
Price	1.2\$	7\$	12\$	9\$	12\$
Torque	10g/cm	96g/cm	45Ncm	5.5kg/cm	.1Nm
RPM (max)	15000RPM	12000RPM	NA	NA	1500RPM
Purpose	Hobby	Hobby	Robotics	Robotics	Smart Home

### Sensor Technology Comparison

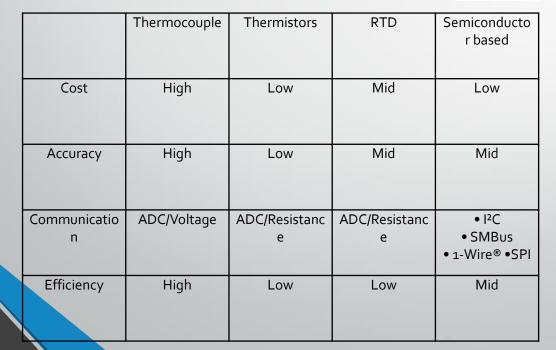
#### Thermometers













#### Hygrometer





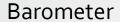


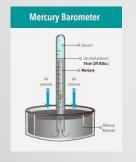
	Capacitive humidity sensors	Resistive Humidity Sensors	Thermal Conductivity Humidity Sensors
Cost		X	
Size		Х	
Accuracy	Х		X
Durability		Х	Х
Measurement Range	X		
Signal Strength		Х	
Ease of use		Х	

## Sensor Technology Comparison



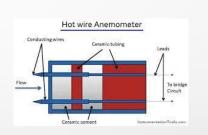
#### Anemometer















	Mercury Aneroid	Digital MEMs	Precision Digital
Digital output		X	X
Accuracy	X	X	X
Cost		X	

	Hot-Wire	Vane	Сир
Application	Scientific/Industrial	Mobile	Meteorological
Size	Sub-Hand-Held	Hand-held	~1ft^3
Complexity	Depends heavily on software to interpret sensor data.	Complex, requiring wind direction to be known	Simple, emplace device in open area. Digital or analog.

## Sensor Part Comparison

#### Humidity, Temperature, and Pressure









Barometer	MPL115A1	BME <sub>2</sub> 80	MS5637
Power supply	2.375 V to 5.5 V	1.71 V to 3.6 V 1.5 V to 3.6	
Digital interfaces	SPI Interface	I2C (up to 3.4MHz), SPI (up to 10 MHz)	I2C interface
Atmospheric pressure range	50 kPa to 115 kPa	300-1100 hPa	300 - 1200mbar
Temperature range	-40°C to +105°C	-40°C to +85°C	-40°C to +85°C
Humidity range		o to 100%	
Current consumption	5μA active mode	1.8 µA @ 1 Hz humidity and temperature	o.6μΑ Active mode
	1μA sleep mode	·	
Size	3mm x 5mm x 1.25mm	2.5mm x 2.5mm x 0.93mm	3mm x 3mm x o.9mm
# of Pins	8	8	4
Cost in Dollars	\$7.95	\$6.43	\$8.69
Additional features	Monotonic Pressure and Temperature Data Outputs	Also measures humidity and Temperature.	Temperature Data Output

## Sensor Part Comparison

#### Anemometer











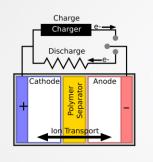


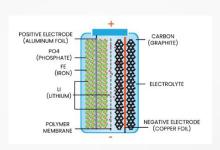
Model	SENo483	SEN0170	1733	TV-4-A	YGC-FS-24V
Communication Protocol	RS-485 Modbus Protocol	Analog [o-5V]	Analog [0.4-2V]	Analog/pulsed DC/AC	Analog[o-5V]
Operating Voltage	7-24V	12-24V	7-24V	10-36V	5V
Power Draw	Not specified	o.3W or less	Not specified	~25mW	Not specified
Range	0.4-32.4m/s	o.4-30m/s	0.2-70m/s	0.27-60m/s	0.5-45m/s
accuracy	(+/-)o.3m/s	(+/-)3%	(+/-)1m/s	(+/-)o.89m/s	(+/-)o.5m/s
lp rating	N/A	IP65	N/A	N/A	N/A
Cost(\$)	45	48	44.95	769	66.9
Supplier	Digikey.com	Dfrobot.com	arrow.com	scientificsales.c om	Amazon.com
Manufacturer	Dfrobot	Dfrobot	adafruit industries	Texas Electronics	Calt

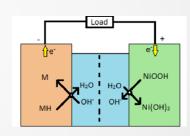
### Battery Technology Comparison











	Lithium Ion	Lithium Polymer	Lithium Iron Phosphate	Nickel Metal Hydride
Cell Voltage	3.7	3.7	3.2	1.2
Specific Energy(	100-265	100-158	100-120	30-80
Energy Density	185-220	185-220	135-150	140-300
Power Density	245-430	245-430	~200	450-550
Self-Discharge rate	0.3	0.3	0.3	~25%
C-rating	1	1	1	
Memory effect	No	No	No	Yes

## Battery Part Comparison









Model	PCIFR18650-1500	PSL-FP-IFR18650PC	PSL-FP-IFR18650EC
Nominal Voltage(V)	3.2	3.2	3.2
Capacity(mAh)	1500	1100	1500
Charge Voltage(V)	3.65	3.65	3.65
Charging Current(mA)	300	?	~
Max Charge Current(mA)	750	1100	1500
Max Discharge Current(mA)	4500	33000	4500
Cut off Voltage(V)	2	2.5	2.5
Cycles	2000	2000	2000
Price	5.26	7.18	5.07
Supplier	Digikey	Digikey	Digikey
Manufacturer	Zeus Battery Products	Power Sonic Corp.	Power Sonic Corp.

# Communication Technology Comparison









	Wi-Fi	Radio Frequency	Bluetooth
NetworkType	WLAN	P <sub>2</sub> P Mesh	WPAN
Transfer Rates (comparatively)	High	Low	Low
Range (comparatively)	Long-Range	Dependent on application (from very short to very long)	Short-Range
Power Consumption (comparatively)	High	Low	Low

### Weather API Comparison





	WeatherAPI	Forecast
Calls Per Month	1,000,000 (No Bulk Calls	300 (10 per day)
Forecast Days	3 days	14 days
Forecast Interval	Daily and Hourly	Daily
Marine Weather Interval	Daily	N/A
Weather Alerts	Yes	N/A
Coordinate Based Data	Yes	Yes (Daily)



# Operating System Comparison





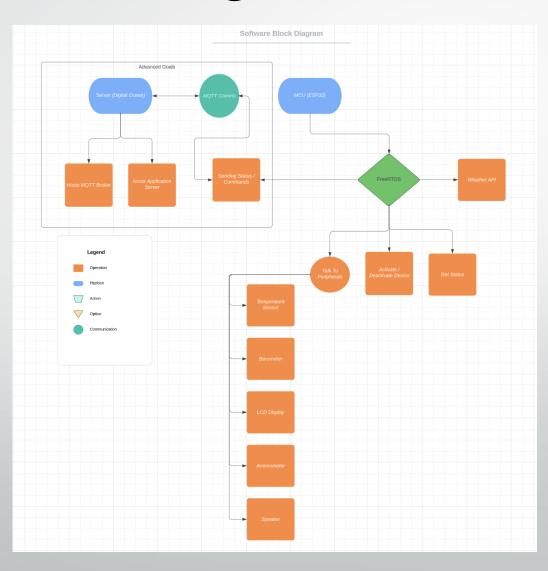




	FreeRTOS	Contiki	Zephyr
System Weight (comparatively, all are light)	Medium	Light	Heavy
Ease-Of- Entrance	Easy	Easy	Medium
RTOS Architecture	Microkernel	Event Driven System	Monolithic Kernal
Native ESP32 Support	Yes	No	No

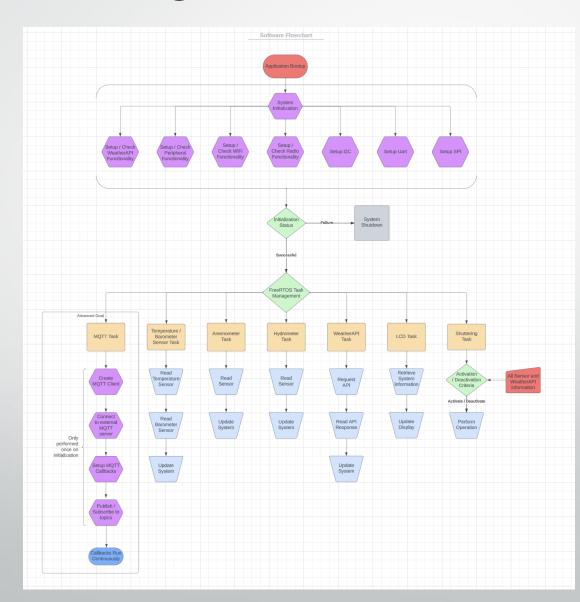
### Software Block Diagram





### Software Design





# System Activation/Deactivation Factors



Factor	Activation Criteria	Deactivation Criteria
Temperature	> 70 ° F	< 65 ° F
Pressure	< 1000 mb	> 1010 mb
Wind Speeds	> 30 mph	< 20 mph
WeatherAPI	Received an alert for severe weather in the systems geographical area	Expiration of weather alert occurs

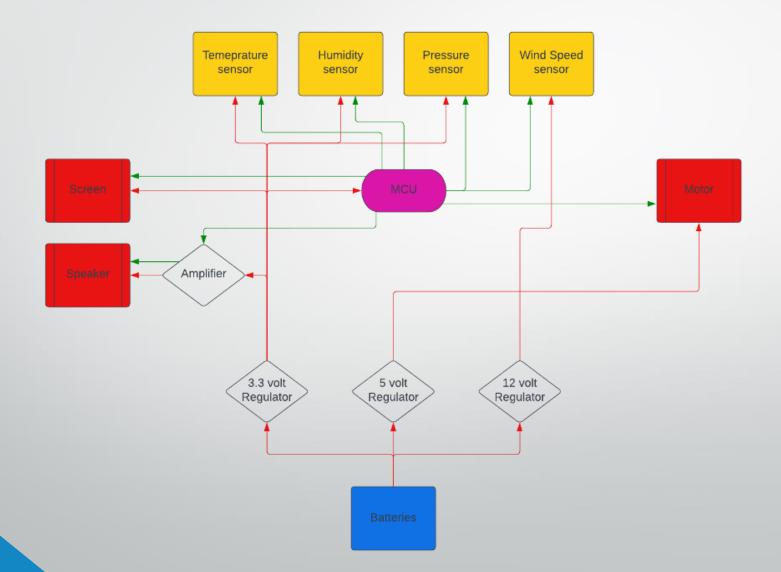
# LCD UI Layout



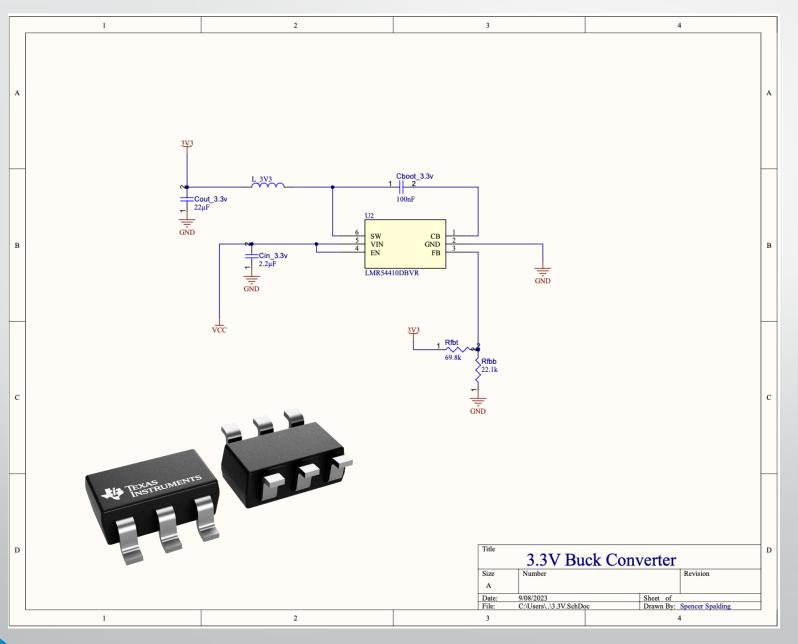


## Hardware Design



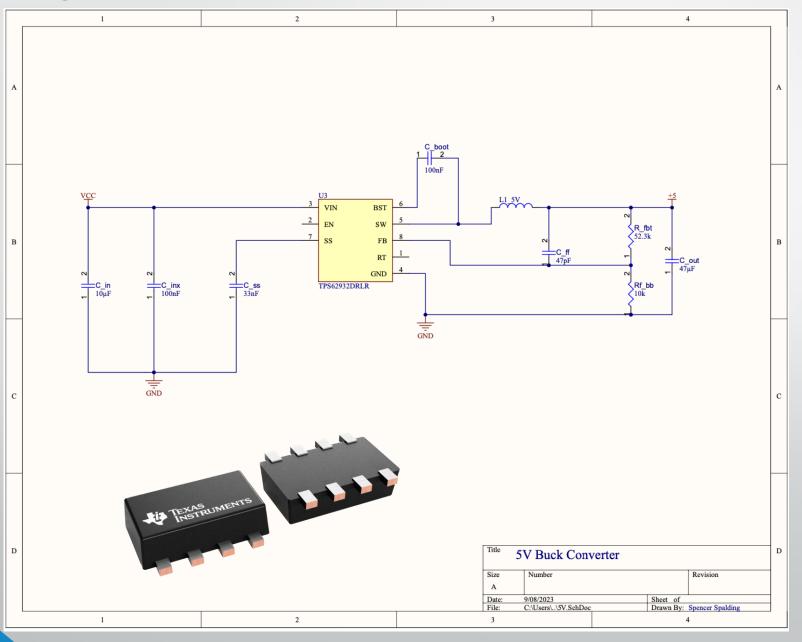


# 3.3V Regulator





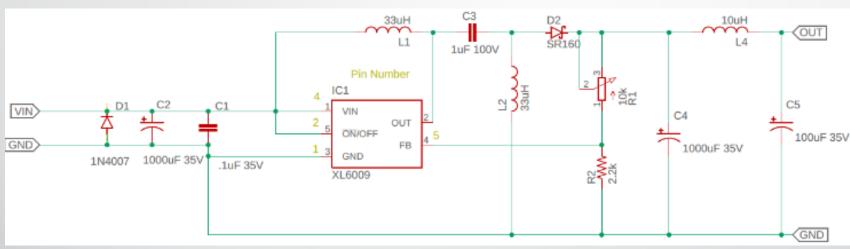
# 5V Regulator





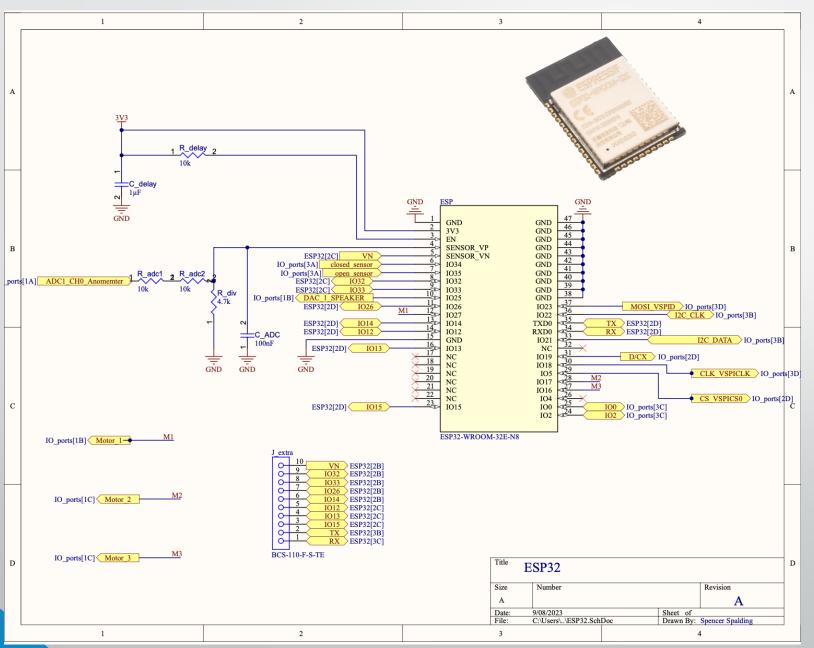
## 12V Regulator





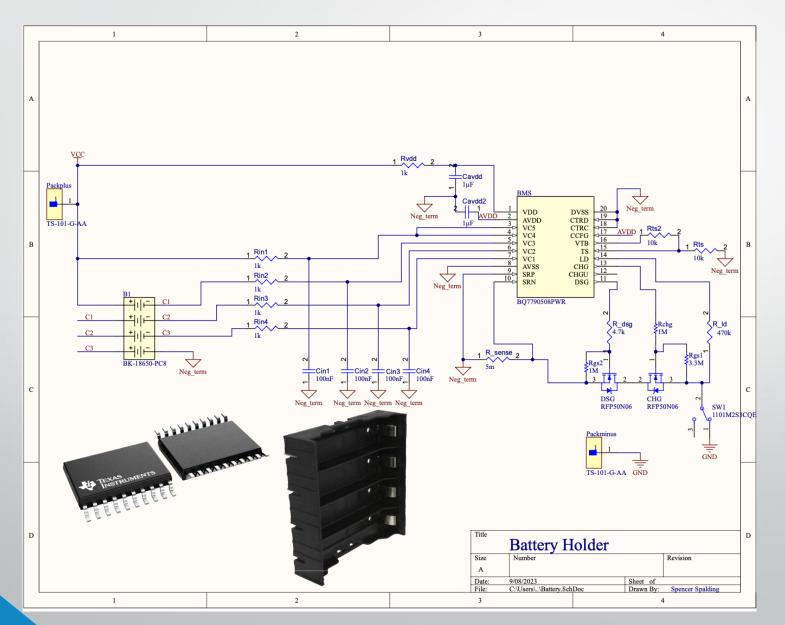


#### Esp-32 Schematic



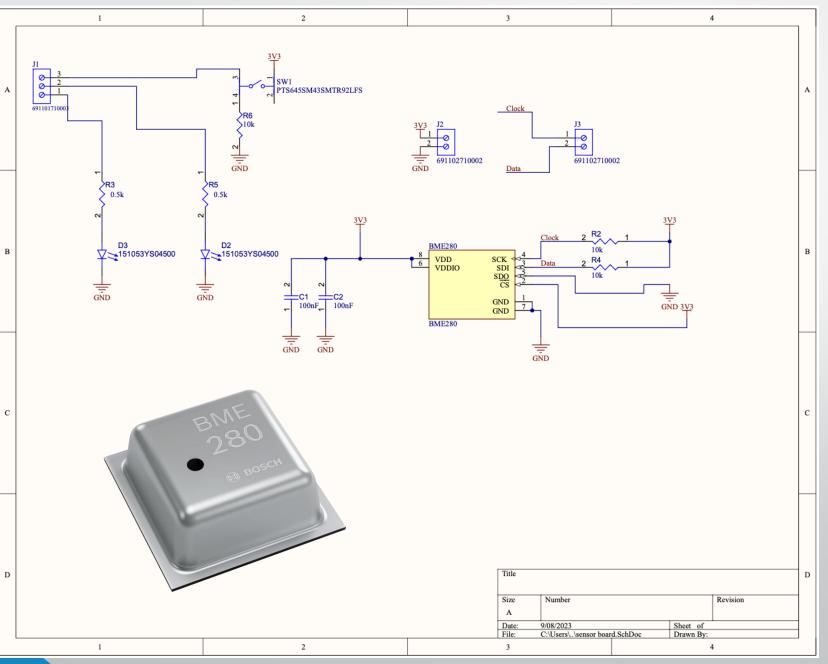


#### **Battery Protection**



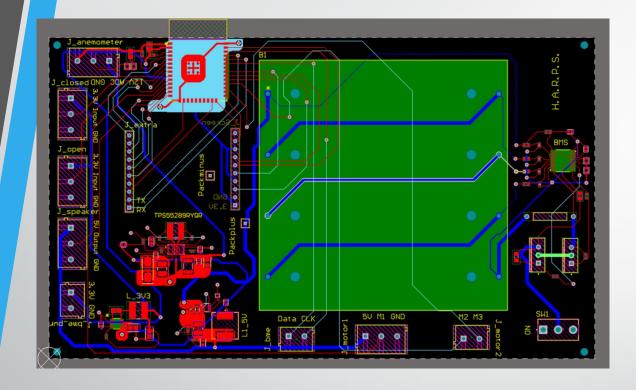


#### Sensor Board



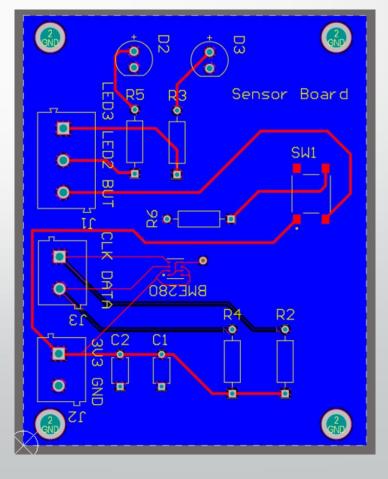


# **Board Layout**







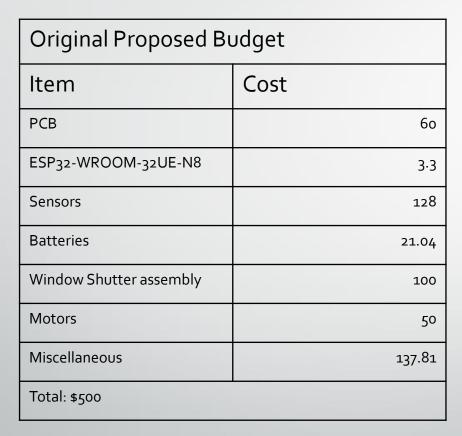


#### Work Distributions

Component	Primary Team Member	Secondary Team Member
MCU	Aidan	Everyone
Software		Spencer
Barometer	Antonio	Andrew
Temperature Sensor		
Humidity Senor		
Screen	Andrew	Antonio
Speaker		
Shutter		
Motor		
Power Supply	Spencer	Aidan
Anemometer		



# Budget





Expenses So Far	
Item	Cost
РСВ	46.65
Assembly	15
Components	172.4
Total: 234.05	

# Progress





#### What's Left?

- -Final presentation
- -Cleaning up wiring routes
- -Final testing





Questions?