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ENGINEERING
TEXAS A&M UNIVERSITY

Team 60: Solar Lighting System
Bi-Weekly Update 3

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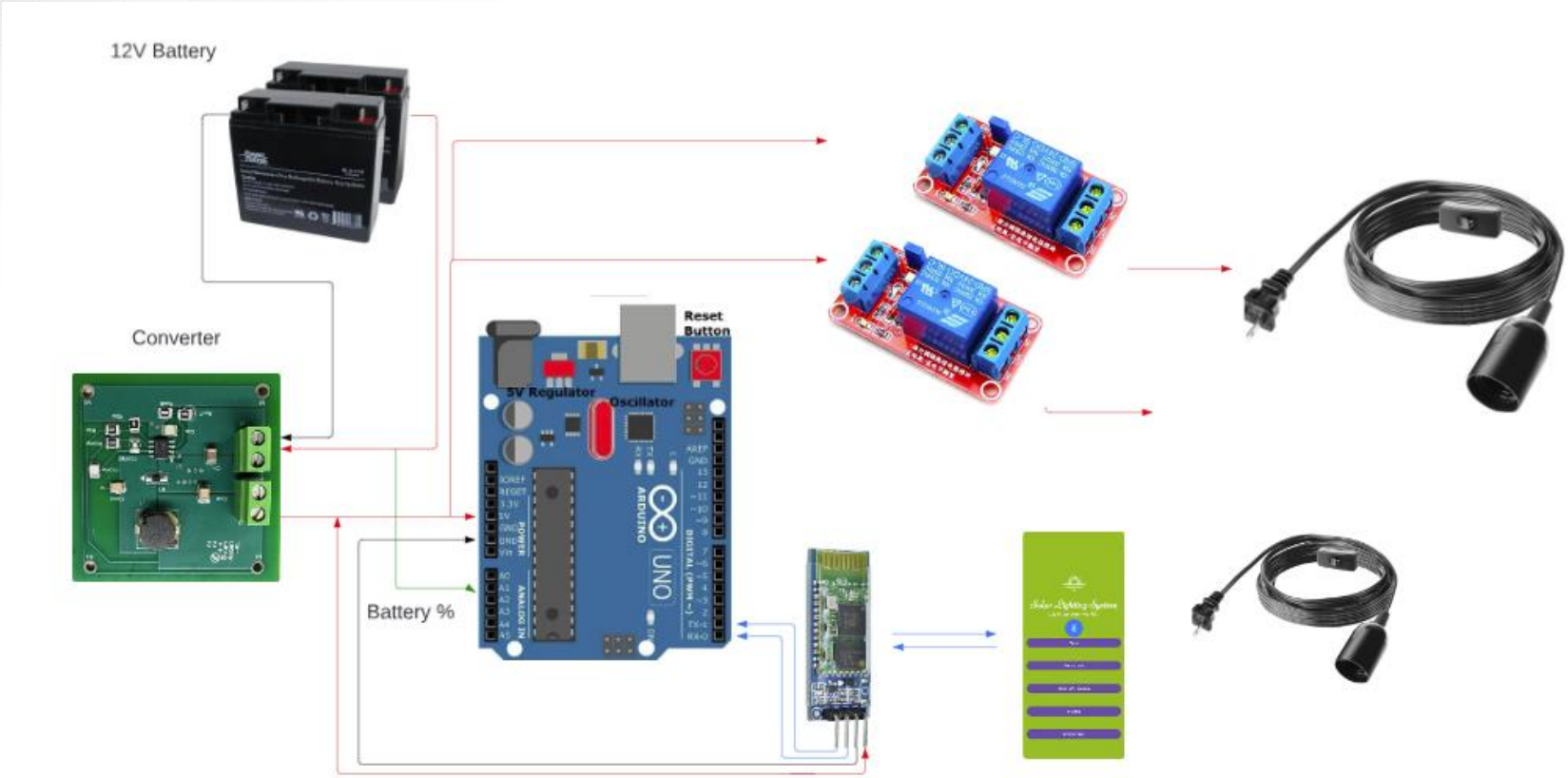
Sponsor: Dr. Wonhyeok Jang
TA: Rhett Guthrie

Project Summary

- A need for clean, renewable sources becomes more apparent than ever.
- Our home indoor and outdoor lighting system is the first step towards this, using **solar power.**
- Design an indoor/outdoor home lighting system that operates with a battery, power conversion, mobile application functionality, BT microcontroller for switch automation from motion sensors.

Solar Lighting System Diagram



Project Timeline

Subsystem Designs (completed 01/16)	Subsystems ordered and soldered (2/14)	Integration of Bluetooth and Arduino (3/18)	Integration of Solar Charge Controller and MCU (3/9)	Final Integration (to complete by 3/15)	System Test (to complete by 3/21)	Validation (to complete by 3/25)	Demo and Report (to complete by 4/1)

Solar Charge Controller

Accomplishments since last update 13 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Datapoints for battery percentage reading measured. - Designed battery terminal block networking. - PCB successfully attached to battery, verified full charge functionality.	- Print 3D model for enclosure. - ON-GOING testing of battery percentage limits. - Testing limit needed for Solar Charge Controller to function.

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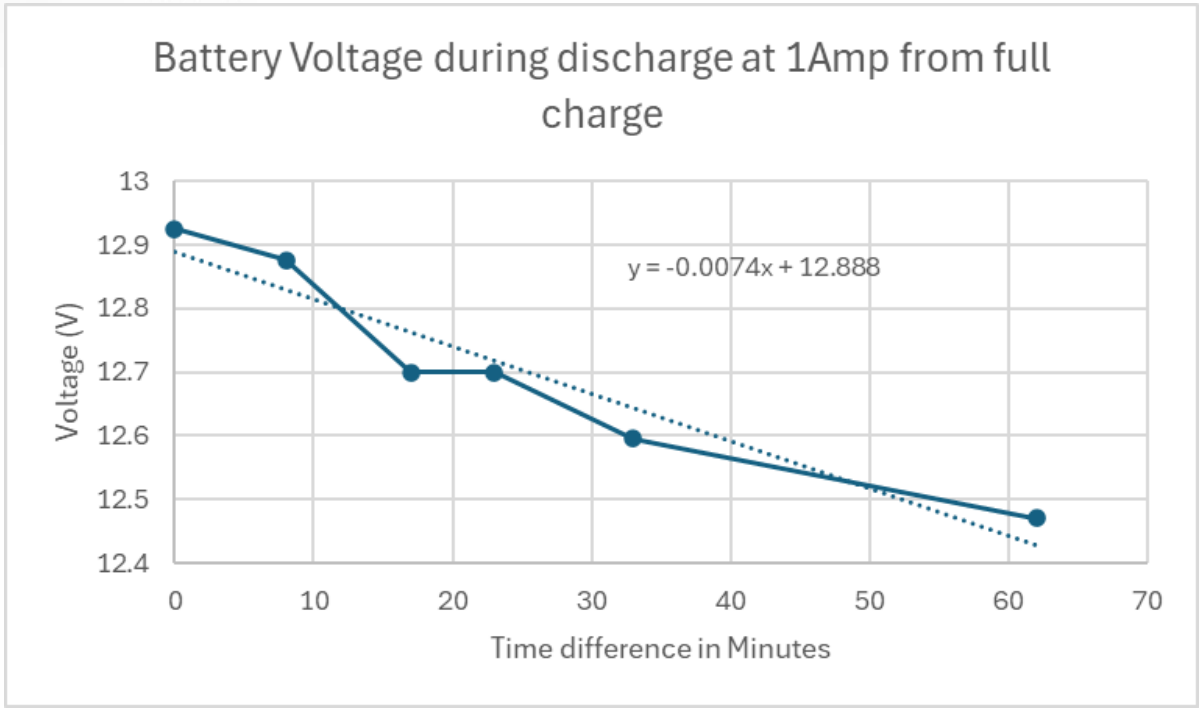
Solar Charge Controller

Lyric Haylow

Testing Battery percentage using electronic load set at 1Amp

time diff (m)	Batt1 (V)
0	12.925
8	12.876
17	12.7
23	12.7
33	12.595
62	12.47



Power Subsystem

Jeb Malek

Accomplishments since 403 33 hrs of effort	Ongoing progress/problems and plans until the next presentation
Power transformer voltage invalidated Converter Ordered/Assembled	Converter Validation Attach Arduino, Sensor, Light Loads

- Tested Flyback Transformer , Received & Tested Converter

Power Subsytem

Jeb Malek

Verification of Flyback Transformer

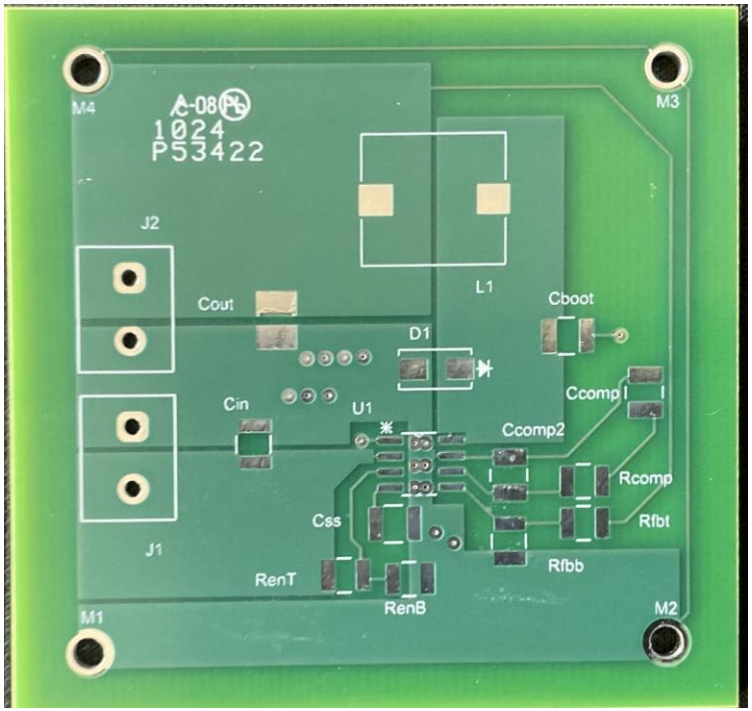
Shorting Issue , Testing with Dr. Jang on Variable AC Load, proved does not operate with AC input/output with short circuit test.

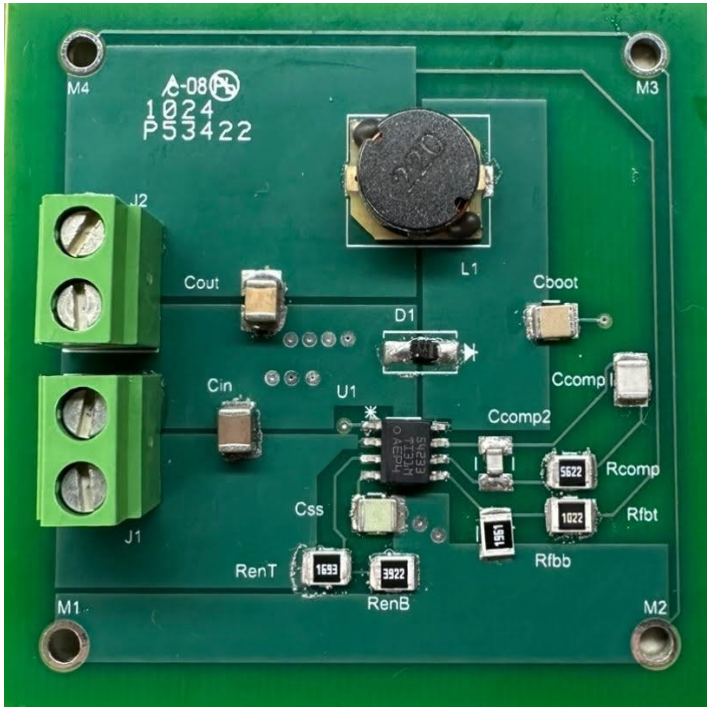
Advisor directed to postpone inverter validation and power LED load with purely DC source.

Power Subsytem

Jeb Malek

Converter PCB





Microcontroller Subsystem

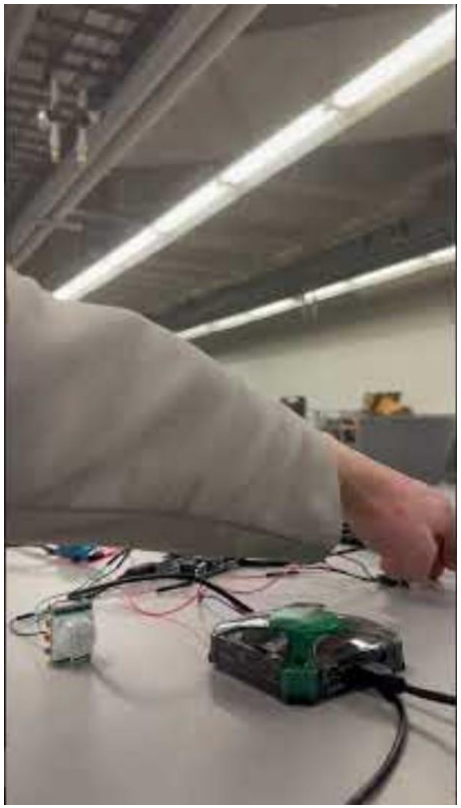
Jeb Malek & Josh George

Accomplishments since 403 20 hrs of effort	Ongoing progress/problems and plans until the next presentation
Testing of Controlled Relay Communication with Arduino, and Light Load Testing of Sensor proximity operation switching light load	Enclosure design & 3D Print Synchronization of switch operation and motion sensing and distance sensitivity.

- Bluetooth App works to actuate relay control, regardless of motion sense

Microcontroller Subsytem

Jeb Malek & Josh George



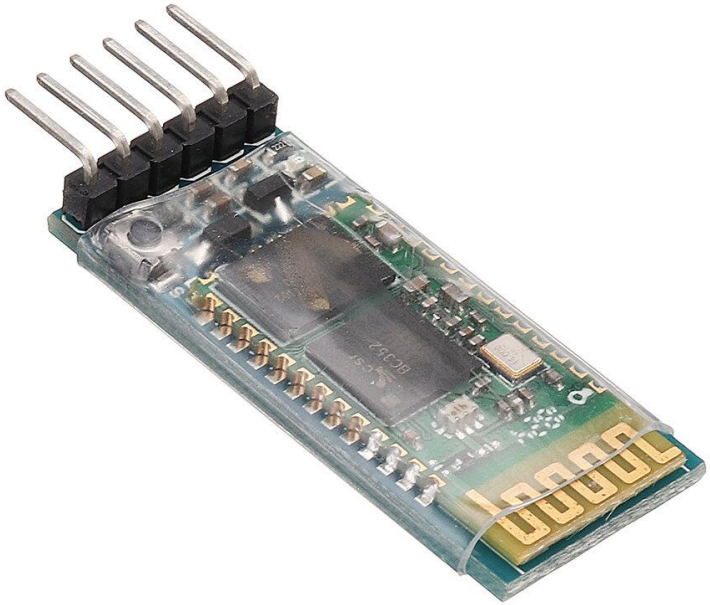
Motion Sensor Motion and Light Switch Test

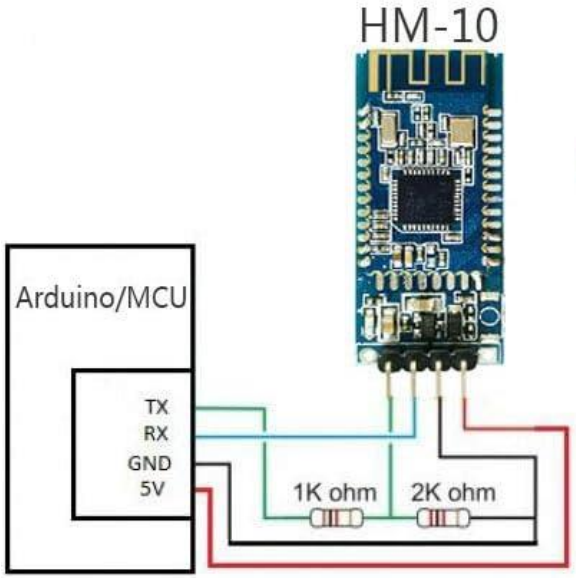
Mobile Application

Josh George

Accomplishments since last update 14 hrs of effort	Ongoing progress/problems and plans until the next presentation
-Solved an issue where arduino pins would cross-talk -Modified Bluetooth connectivity to read and drive voltage to pins -New page for graphing -Implemented array scatterplots showing battery percentages	-Implement HC-05 Bluetooth module coming tomorrow -Use values taken from solar charge controller in the graphing fragment

HC-05 Bluetooth Module





Mobile Application

Josh George

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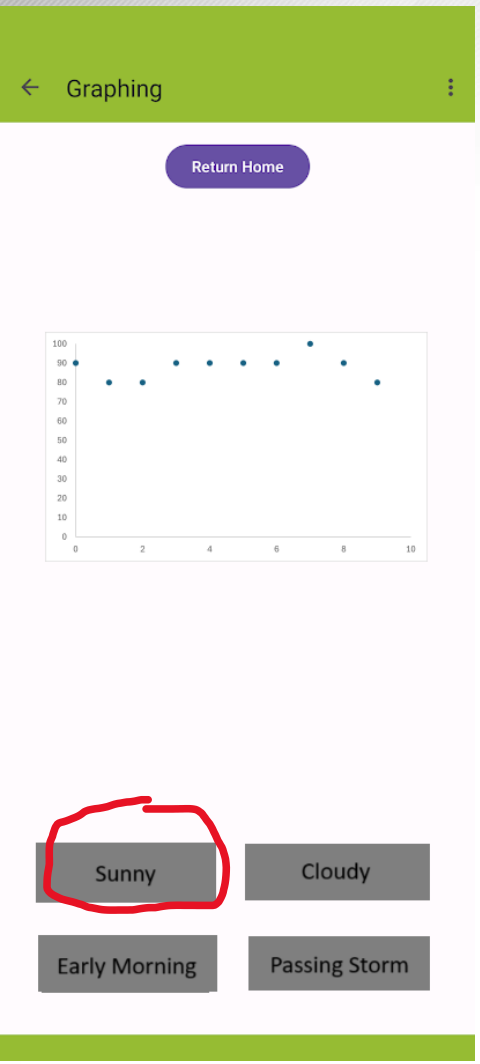
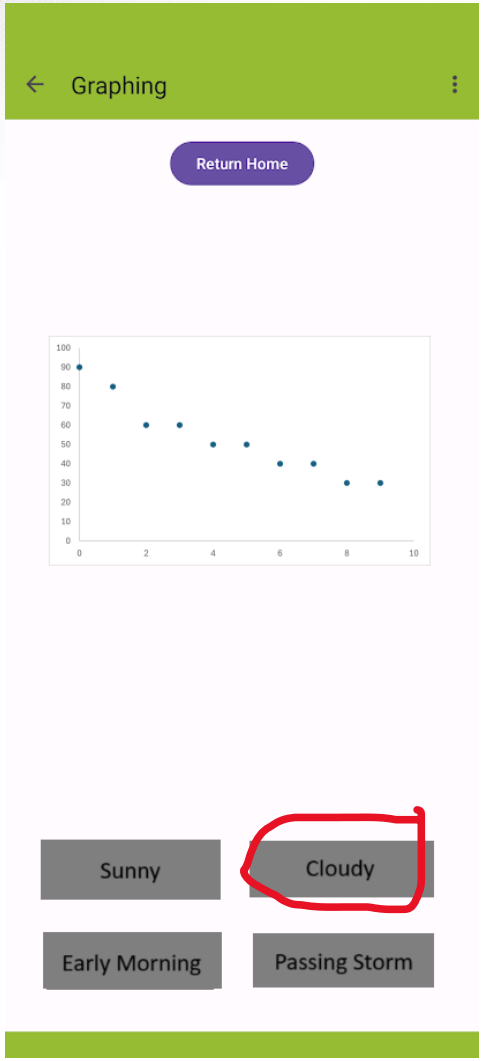
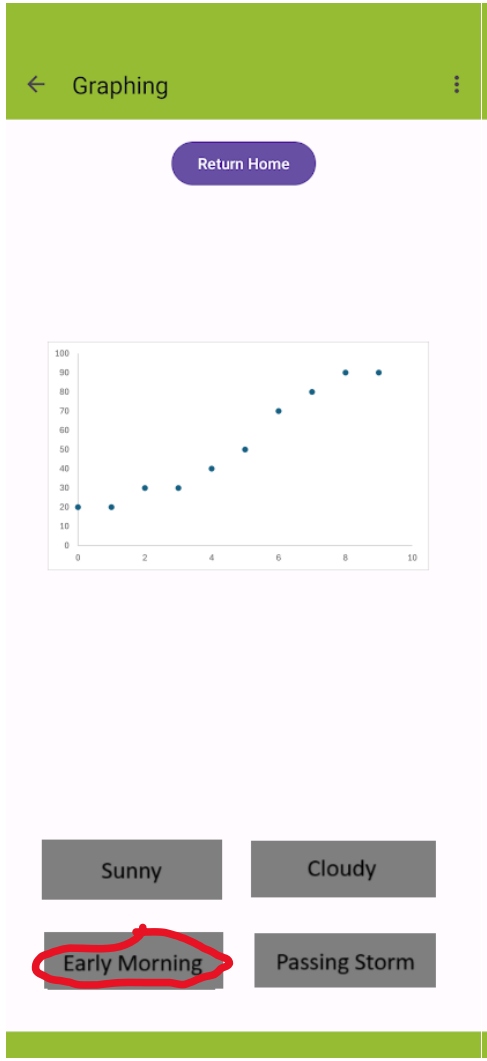
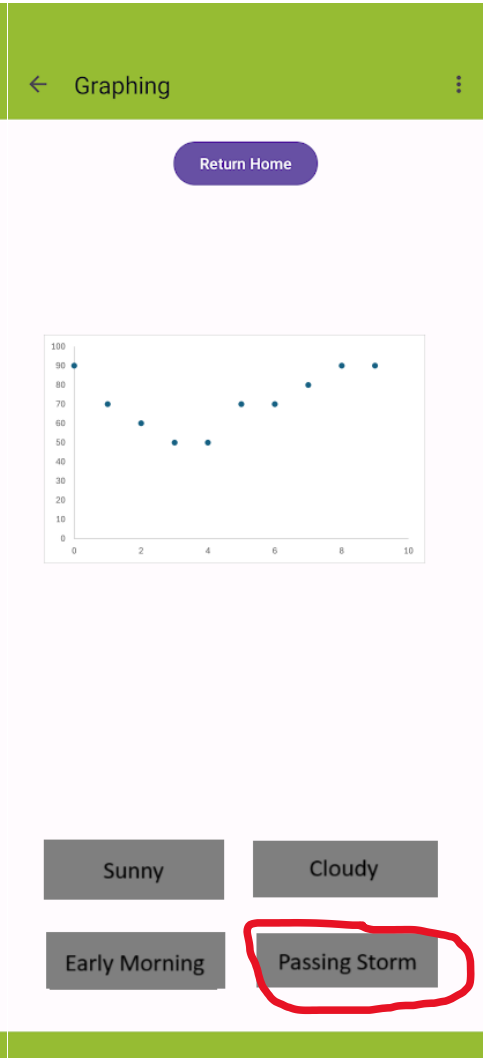
Mobile Application

Josh George









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Execution Plan

TASK	21-Jan-24	28-Jan-24	4-Feb-24	11-Feb-24	18-Feb-24	25-Feb-24	3-Mar-24	10-Mar-24	17-Mar-24	24-Mar-24	31-Mar-24
Application											
Bluetooth Widget											
Bluetooth Screen											
Working Connection to Arduino											
Data input to MCU											
Data output to MCU											
Graphing Interface											
Battery Preferences											
Complete Interface											
Solar Charge Controller (SCM)											
Solar Panel Testing											
Order Parts											
MK2 PCB Designing & Ordering											
Soldering Solar-PCB-Battery											
Test Battery Charging over time											
Design 3D print enclosure											
Solar-to-MPPT Testing and Verification											
Implement System											

Execution Plan

TASK	21-Jan-24	28-Jan-24	4-Feb-24	11-Feb-24	18-Feb-24	25-Feb-24	3-Mar-24	10-Mar-24	17-Mar-24	24-Mar-24	31-Mar-24	7-Apr-24	14-Apr-24
Power System													
Load Measurements, Operating Conditions													
Topology Selection for DC/AC Inverter													
Pulse Width Modulation Switching Part Select													
PWM Pure Sine Wave Schematic Verification													
Inverter PCB Design													
Inverter PCB Soldering													
MCU Programming													
Transformer Voltage Verification													
Power Regulation Verification/System Integration													
Switching Verification													
Full Load Support Testing													
Full Load Solar Light System Demo													
Microcontroller													
Select Microcontroller													
Select Components for Power Circuits													
Select Motion Sensors and Light Sensor													
Design Battery Monitor													
Order Parts													
Develop Code for Microcontroller													
Verify Sensors													
Verify Power Switches													
Verify Motion Sensor/Switch Synchronization													
Verify Battery Connection/Converter													
Final Testing and Verification													

Validation Plan

App Requirements				
3.2.5.1	App Connection to phone Via USB	Android studio establishes a connection with Android phone when connected via micro USB	Beginner code in android studio	
3.2.5.2	App Connection to phone Via APK F	Android studio establishes a connection with the Android phone when the app is downloaded on the phon	Beginner code in android studio, uploaded through Bluetooth	
3.2.5.3	Establish Bluetooth Connection witl	Able to connect to a bluetooth capable device and detect the serial number	Work with microcontroller Bluetooth package to connect to android studio	
3.2.5.4	Bluetooth Communication via App	App displays screen with good connection.	Make sure code runs successfully on Android device	
3.2.5.5	Main Screen	App is able to display a home screen	Code home screen in Android studio, make sure it runs, debug errors.	
3.2.5.6	Data from Charge Controllor	App is able to connect to charge controller and accurately display readings.	Understand how charge controller connects to MCU, adapt code accordingly.	
Solar Panel Battery Charge				
3.2.1.1	Solar Panel Mount	Stays in space mounted for several days time	Verifying Hardware is properly mounted	
3.2.1.2	MPPT Functionality	MPPT is working as expected within the IC	Set higher voltage than MPPT, check whether IC brings voltage down to set MPPT voltage level.	
3.2.1.3	Charge Controller Verification	Voltage levels are modulated along with Current Levels	Steadily increasing current will be applied to charge controller, to point of max expected	
3.2.1.4	Overvoltage Solar Panel Protection	Supply voltage levels do not exceed IC limits	Sending a increasingly higher voltage through the charge controller, eventually checking it functions as predicted	
3.2.1.5	Overcurrent Battery Protection	Charging current levels do not exceed expected input values	When charging battery, consistently measuring charging current upon increasing supply voltage using DC power supply	
3.2.1.6	PWM EMI Interference	Interference does not significantly alter design guidelines	Use a Broadband RF meter if one available, if not then the Oscilloscope to identify interference points.	
3.2.1.7	Battery Charging to Capacity	Battery stops being charged once it has a full charge	Feeback voltage will be applied back to IC as shown in documentation	
3.2.1.8	State of Charge (SOC)	Measurement for current State of Charge coincides with expected values	Measure the voltage with a multimeter and convert measured voltage to approximate power percentage expected	
3.2.1.9	Depth of Discharge (DOD)	Measurement for current State of Charge coincides with expected values after discharge	Measure the voltage with a multimeter and convert measured voltage to approximate power percentage expected	
Power Inverter Characteristics				
3.2.2.3	PWM EMI Interference	Amplitude modulation ration falls in desired values for correct switching frequency EMI	In a unipolar switching topology the pulse width modulated signal should be a desired value to obtain suit	
3.2.2.5	Output Voltage	Inverter will supply a steady 120 VAC RMS value	With an attached load a benchmark of current drawing configurations to satisify stable pure sine wave voltage of 120 RMS	
3.2.2.6	Output Frequency	Inverter will supply a steady output sinusoid at a frequency of 60 Hz	Proper inverted sine waves shall operate at normal operating constraint of 60 Hz	
3.2.2.7	DC/DC Conversion	Inverter will supply 3.3 V / 1 A USB-C regulated output	Attaching E-Load to Inverter USB-C Receptacle provides 3.3 V load at varying currents	
3.2.2.8	Output Stability	Output Voltage Ripple demonstrates acceptable output harmonic components below certain THD	Measurement with Oscilloscope and E-Load with charging and discharging states can cause voltage flucuation	
3.2.2.9	Varying Loads	Inverter will supply light loads of varying configurations	Measurement with Oscilloscope and E-Load with benchmark loads attached while charging, discharging, in all modes of operati	
Microcontroller and Sensor Characteristics				
3.2.3.1	Sensor Detection Rate	The indoor sensor miss rate does not exceed 5% and outdoor sensor miss rate does not exceed 10%	Move an object within detection ranges over a 30 min duration. Monitor for detected objects using its output.	
3.2.3.2	Response Time	The time from sensor detection to a I/O signal heading to the relay must be less than 2 seconds	Measure time between output of sensor detection and output from microcontroller to relays.	
3.2.3.3	Bluetooth Connectivity	Microcontroller is able to connect to a mobile device via Bluetooth	Use multiple devices and connect to the microcontroller via bluetooth.	
3.2.3.4	Peripheral Input Voltages	The input voltages of the microcontroller and peripherals shall be 3V-3.6V	Use a multimeter to validate.	
3.2.3.5	Application Communication			
3.2.3.6	System Integration	Arduino receives communication from motion sensors, Verified mobile application instruction	Check Logs of Arduino Bluetooth Communcations with Debugging circuit / application logs for sensor data continuity	
3.2.3.7	Response Time			
3.2.3.8	Response Time			