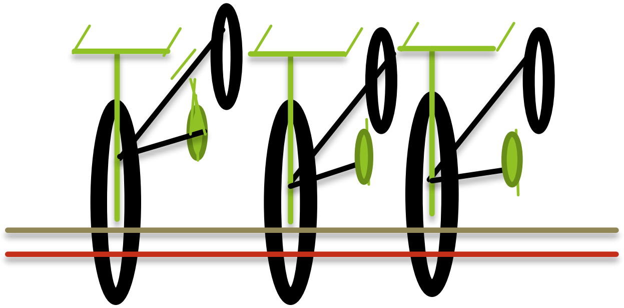
SOLAR POWERED BIKE RACK SYSTEM



- Daniel Adarme (E.E)
- The Pham (E.E)
- Christine Erwin (E.E)
- Nha Nguyen (E.E)

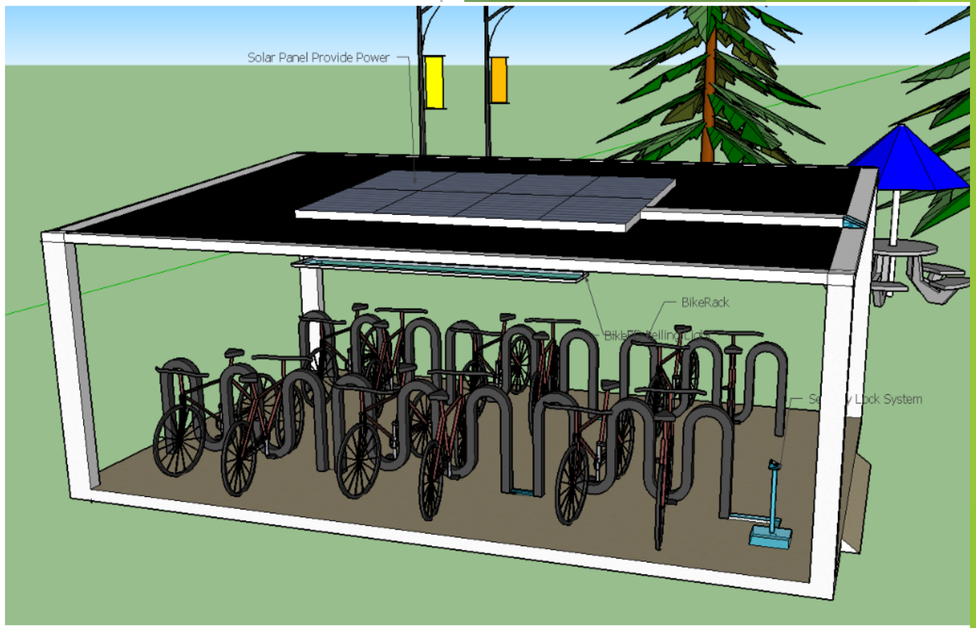
Table of Content

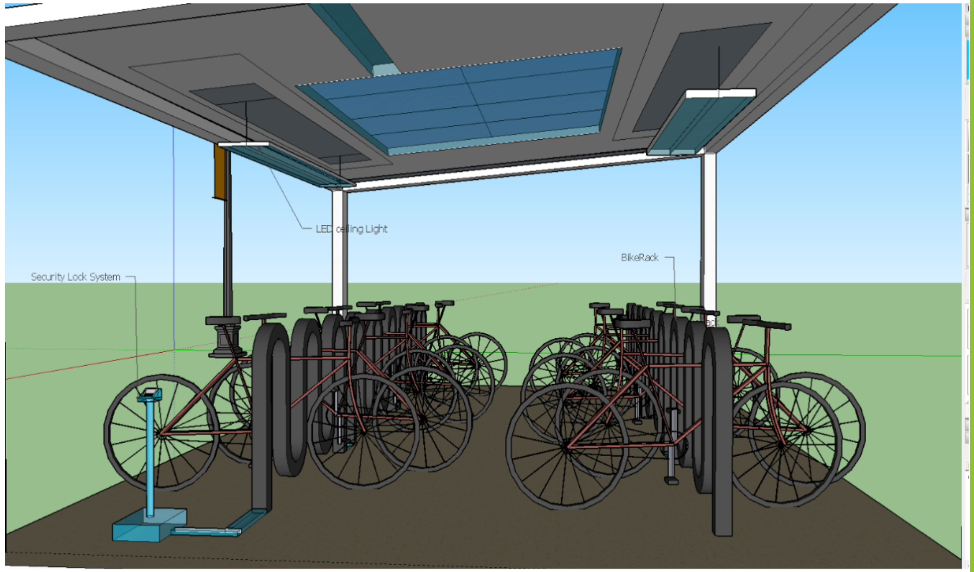
MOTIVATION

- Typical bike rack does not fully protect the bike from bad weather
- Not safe to walk to the bike rack at NIGHT TIME on campus
- BIKE LOCK KEY can be STOLEN or LOST
- BIKE can still be STOLEN even if it is locked to the rack
- Campus is large and time gap between classes is short
- There is a huge demand for charging station for Electric Bikes

Goals and Objectives

- Bikes can be **fully protected** from bad weather by **built-in roof**
- **Embedded locking system** is added to the rack for **easy access**
- **Magnetic Card Reader** device is added to locking system to **improve security/Identification purpose**
- Only student with valid ID has the access to the bike station (preventing outside thefts)
- **LED lights and Security camera** being added the system provide **more safety at night time**
- **Motion Detection Sensor** is added to the system for **energy efficient purpose**
- **Bike Sharing System** is designed to help students with **easy commuting between place to place**
- **The 110V AC outlet** is provided to **charge electric bikes**
- **Power** will be provided 100% by the **OFF-GRID Solar Power System**

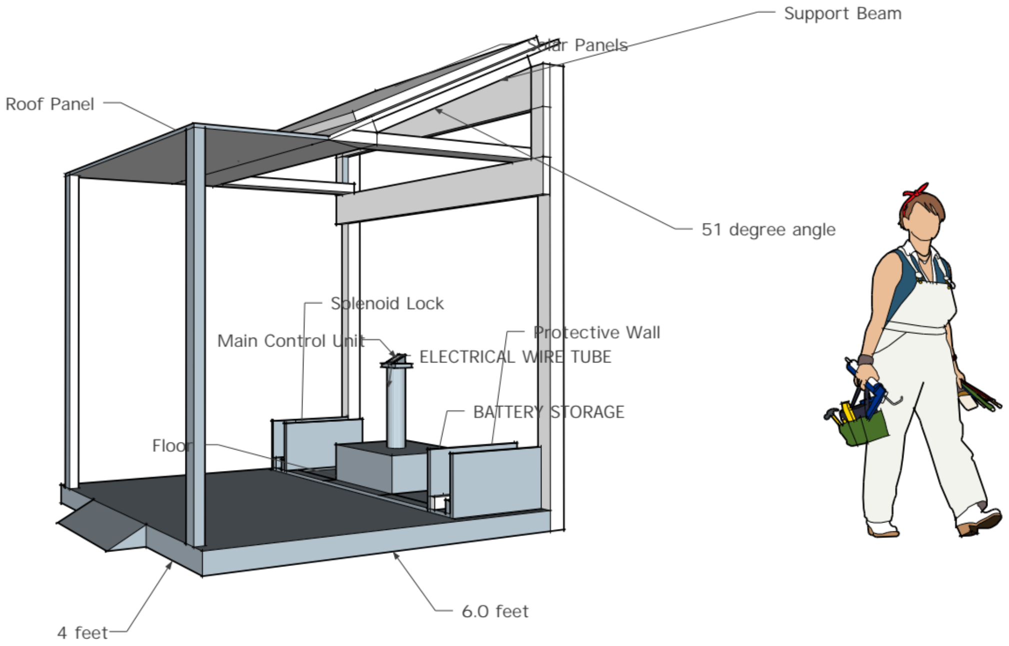


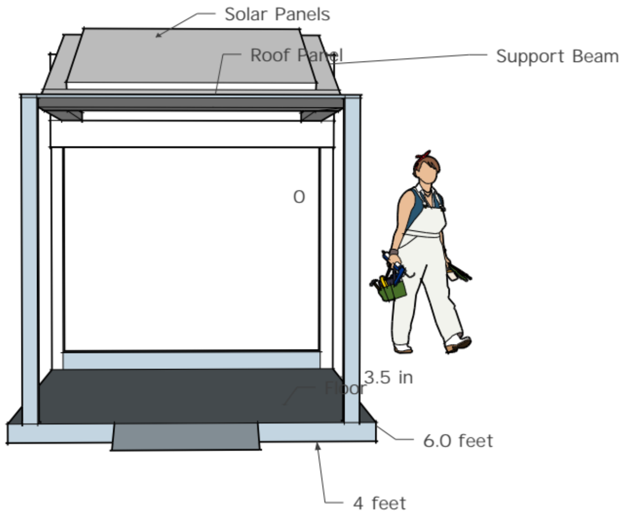


Specifications

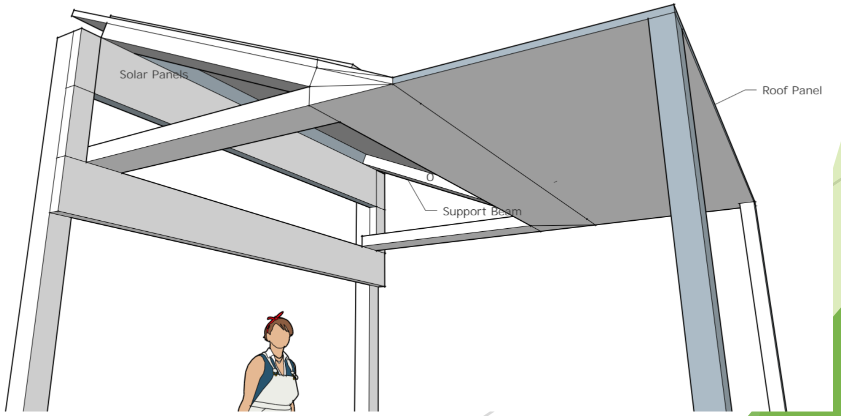
Component	Parameter	Design Specification
Power Storage System (Deep Cycle Battery)	Discharging Duration without power provided by solar panel STILL MAINTAIN ABOVE 50% CAPACITY	12 HOURS
Solar Charge Controller	VOLTAGE RATING and CURRENT RATING	~12V DC and 5A DC
Solar Charge Controller	Power Efficiency	greater than 75%
Power Distribution System (DC-DC converter)	Power Consumption	Less than 5W
Power Distribution System (DC-DC converter)	Total System Efficiency	Above 95%
DC-AC inverter	Stable AC Power Supply	110V 60Hz
Microcontroller	Low power, wireless comm. capable	3.3V max, WiFi
Motion Detection Sensor	Viewing distance/range	270 degree, 2 meters

Over All Structural Design





Component	Parameter	Desired Value
Over All Structural	Height	6.0 Feet ~ 7.0 Feet
Structure	Support Force Capability	60 lbs
Structure	Estimated Cost	$50~$100



SYSTEM OVERALL BLOCK DIAGRAM

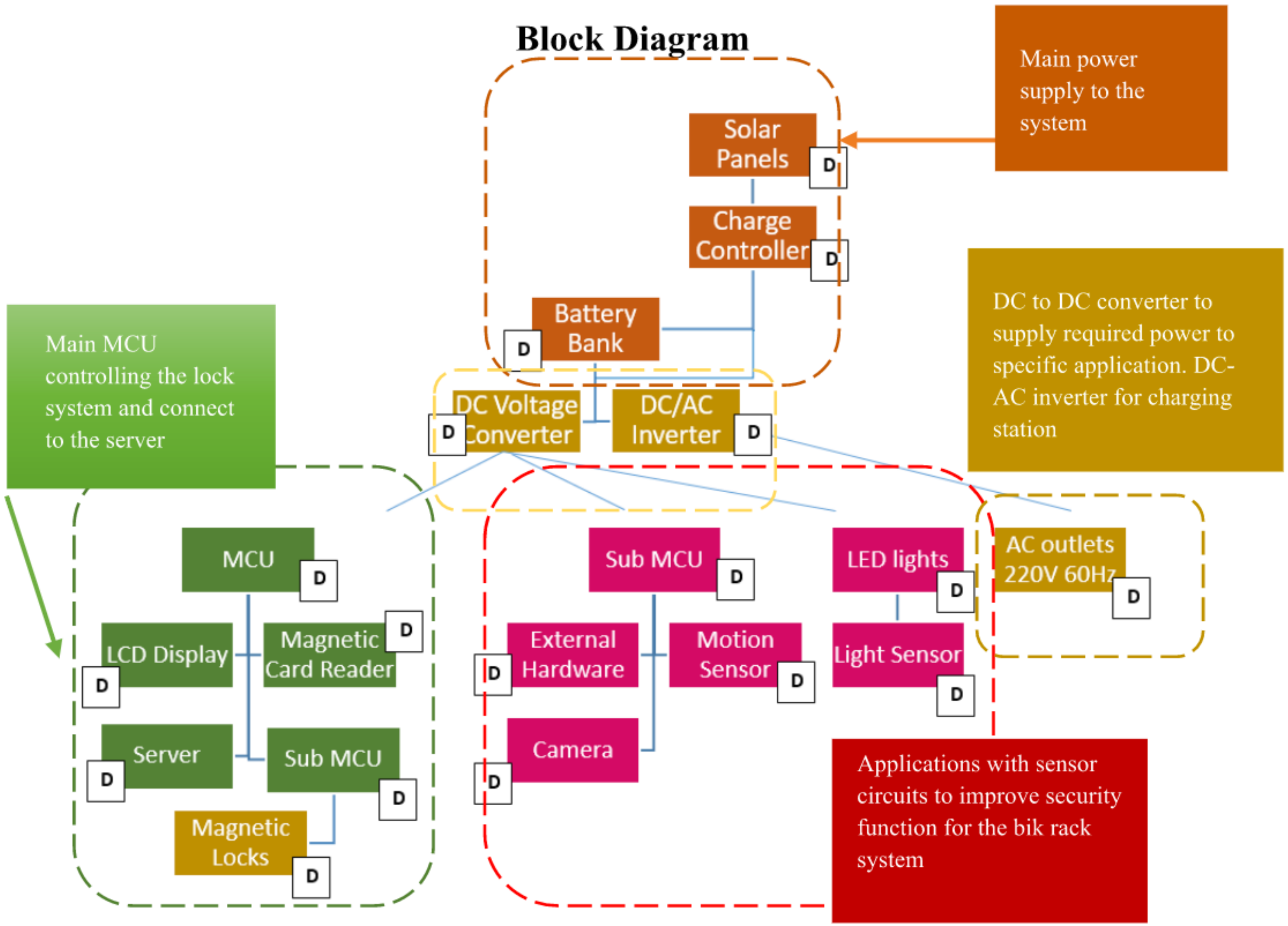


Figure 7.1 - Hardware Block Diagram and Engineering tasks

Changing Decision on POWER SYSTEM

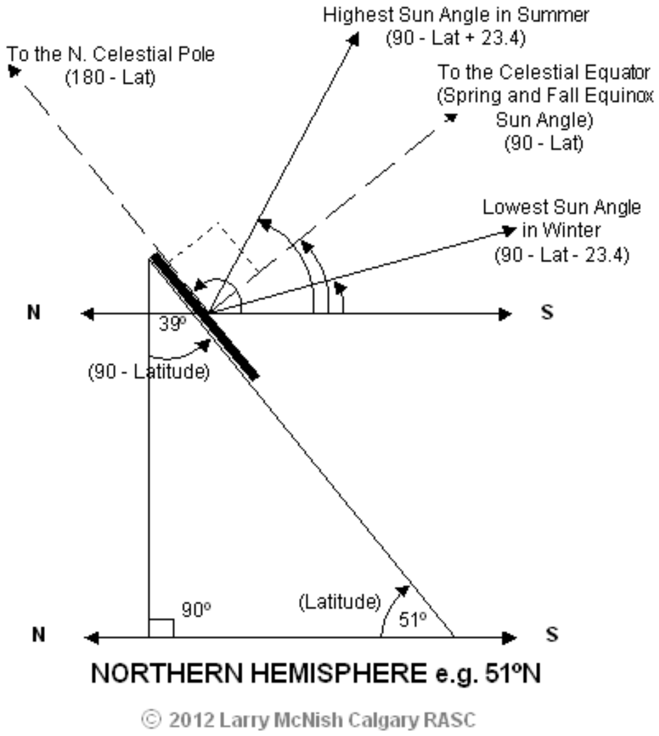
- Time and financial constraints affected on initial system design decision

NAME	INITIAL DESIGN	NEW DESIGN	Reason to Change	ADVANTAGE/ DISADVANTAGE
SOLAR PANELS	200W Polycrystalline 18V rating voltage 10A rating current	100W Monocrystalline 18V rating voltage 6A rating current	Financial Constraint	• Less weight • Smaller Dimension • Cost Reduced by $80 • Taking longer to charge
BATTERIES	Golf Cart Batteries Deep Cycle 430 Ah 12V 5.16 kWh	AGM Deep Cycle 105 Ah 12V 1.26 kW	Financial Constraint Lack of information	• Cost reduced by $200 • Smaller Size • Less power capability
SOLAR CHARGE CONTROLLER	MPPT PMP765 TI CHARGE CONTROLLER REFERENCE DESIGN	SOLID STATE SWITCH CHARGE CONTROLLER	Time Constraint Budget Constraint Required knowledge in coding	• No Codes Required • Cost reduced by $50 • Less Efficiency

Solar Photovoltaic Devices for the System

- Photovoltaic Device Materials Choice: Monocrystalline Technologies
- HIGHER POWER EFFICIENCY and SMALLER IN SIZE

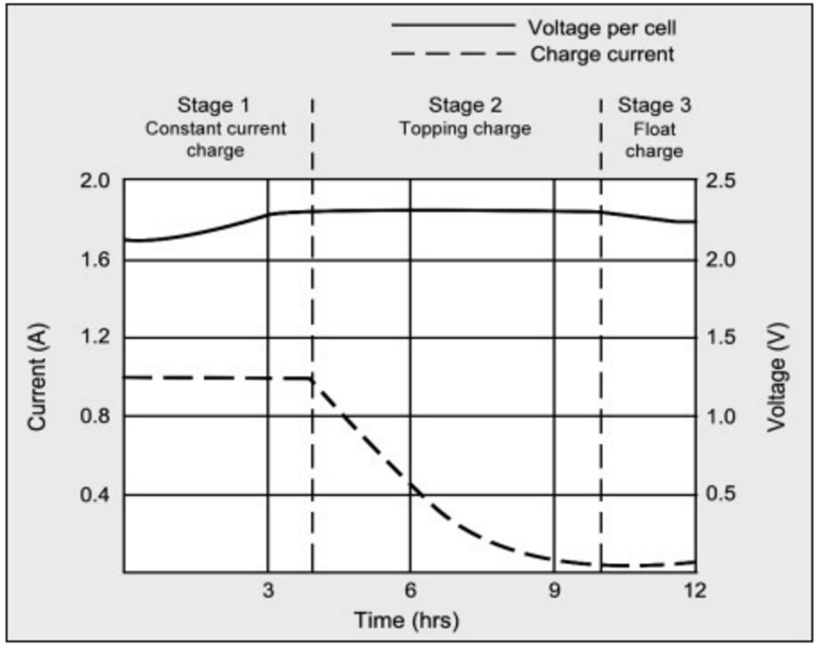
Specifications	
Quantity	2 Panels connects in Parallel
Optimum Operating Voltage (V_{mp})	18.5V
Optimum Operating Current (I_{mp})	5.40 A



Power Storage System

- AGM (Absorbent Glass Mat) Deep Cycle Battery
- Most Safety and Least Maintenance required compared to other types

Specifications	
Quantity	3X Battery
Cycle Use Voltage	14.5V~14.9V
Total Capacity	105 Ah Or 1.43 kWh
Charging Time required to reach full stage from 50% capacity	10 Hours

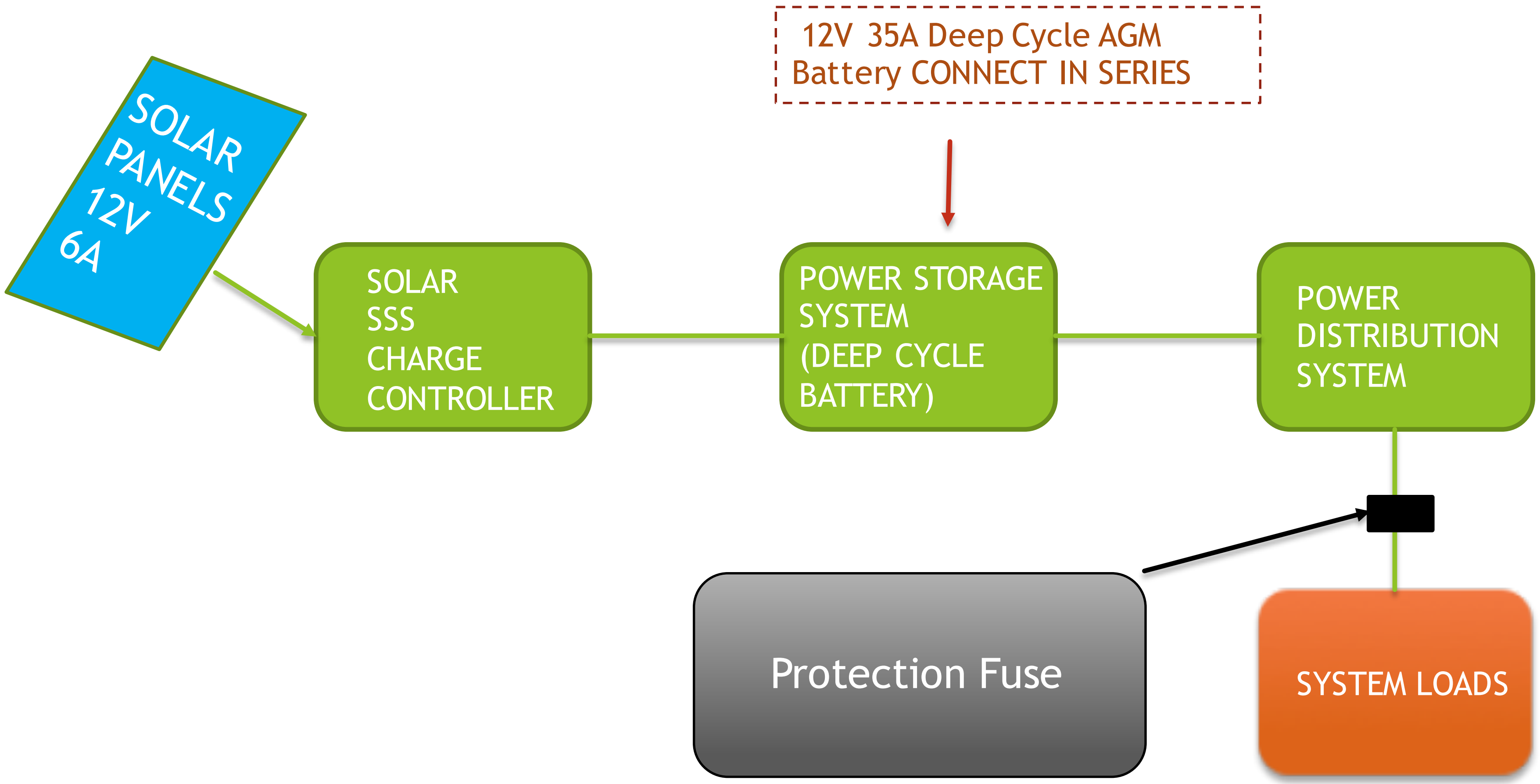


Stage 1: Voltage rises at constant current to V-peak.

Stage 2: Current drops; full charge is reached when current levels off

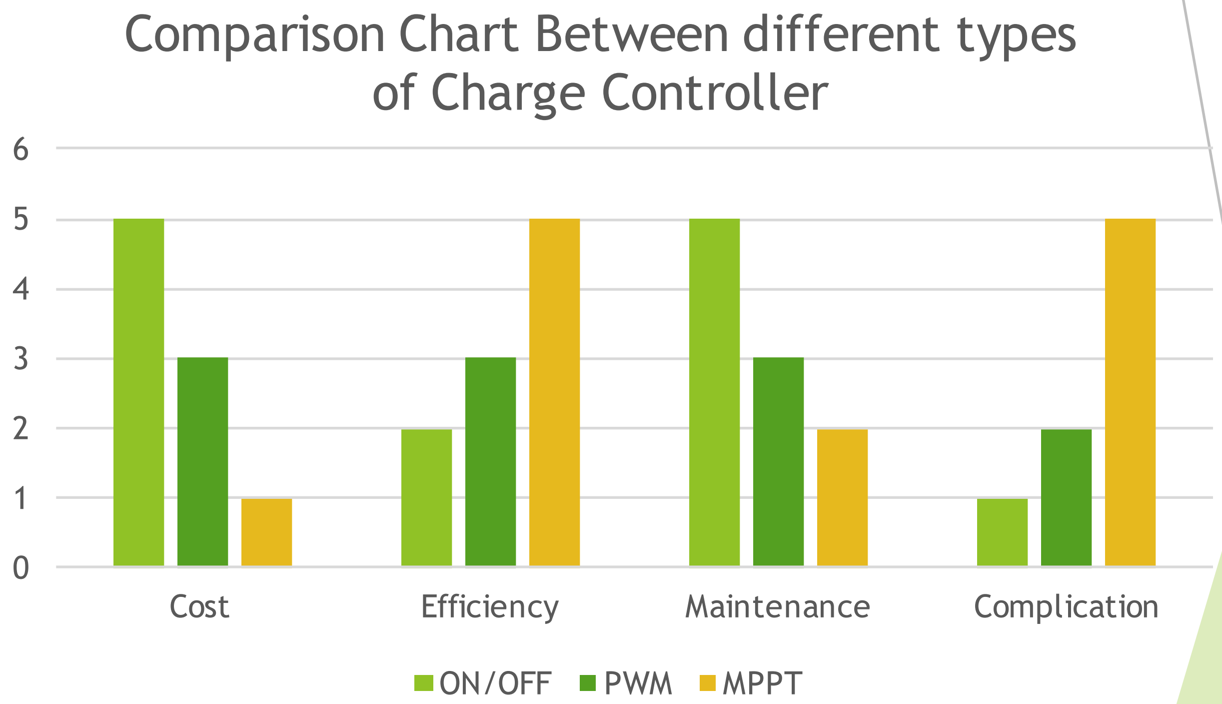
Stage 3: Voltage is lowered to float charge level

POWER SYSTEM BLOCK DIAGRAM



SOLID STATE SWITCH SOLAR CHARGE CONTROLLER

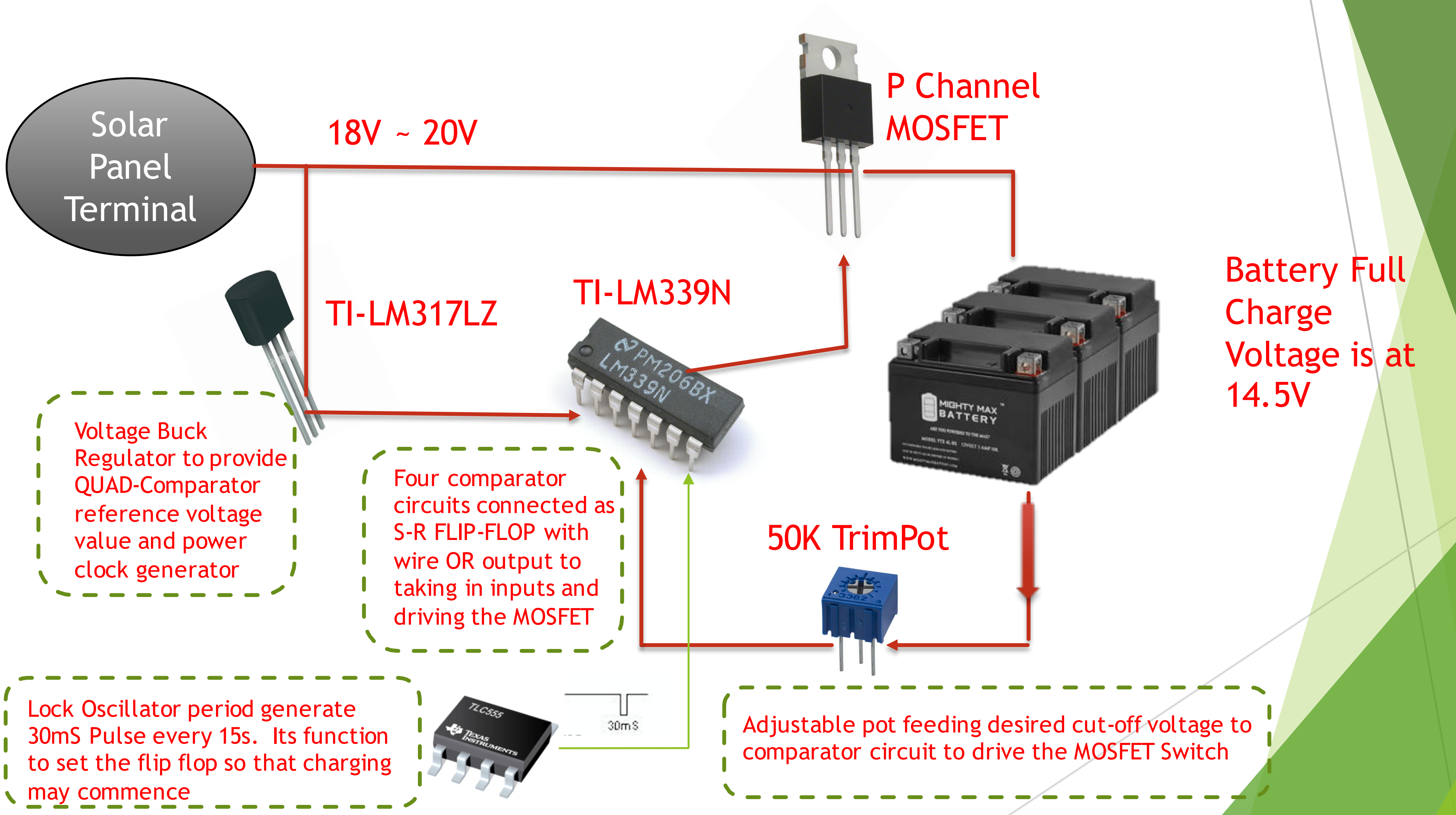
- Low cost construction
- Easy to troubleshoot
- Requires less power consumption
- Requires less maintenance
- Light weight and small dimension
- No programming code required



Rating Scale

- **5: Desirable**
- **2-4: Average**
- **1: Not Desirable**

Solid State Switch Charge Controller Block Diagram



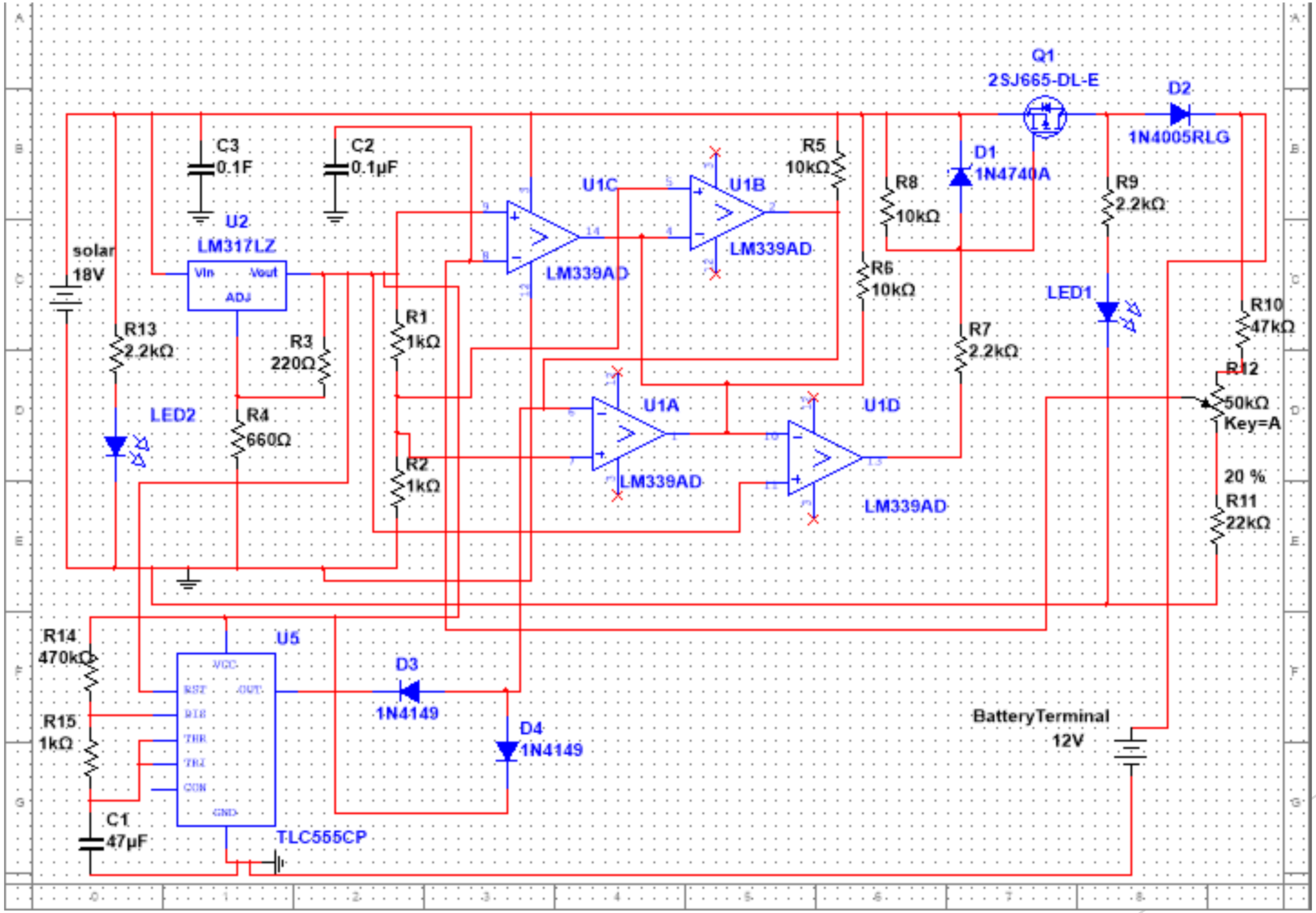
Voltage Buck Regulator to provide QUAD-Comparator reference voltage value and power clock generator

Four comparator circuits connected as S-R FLIP-FLOP with wire OR output to taking in inputs and driving the MOSFET

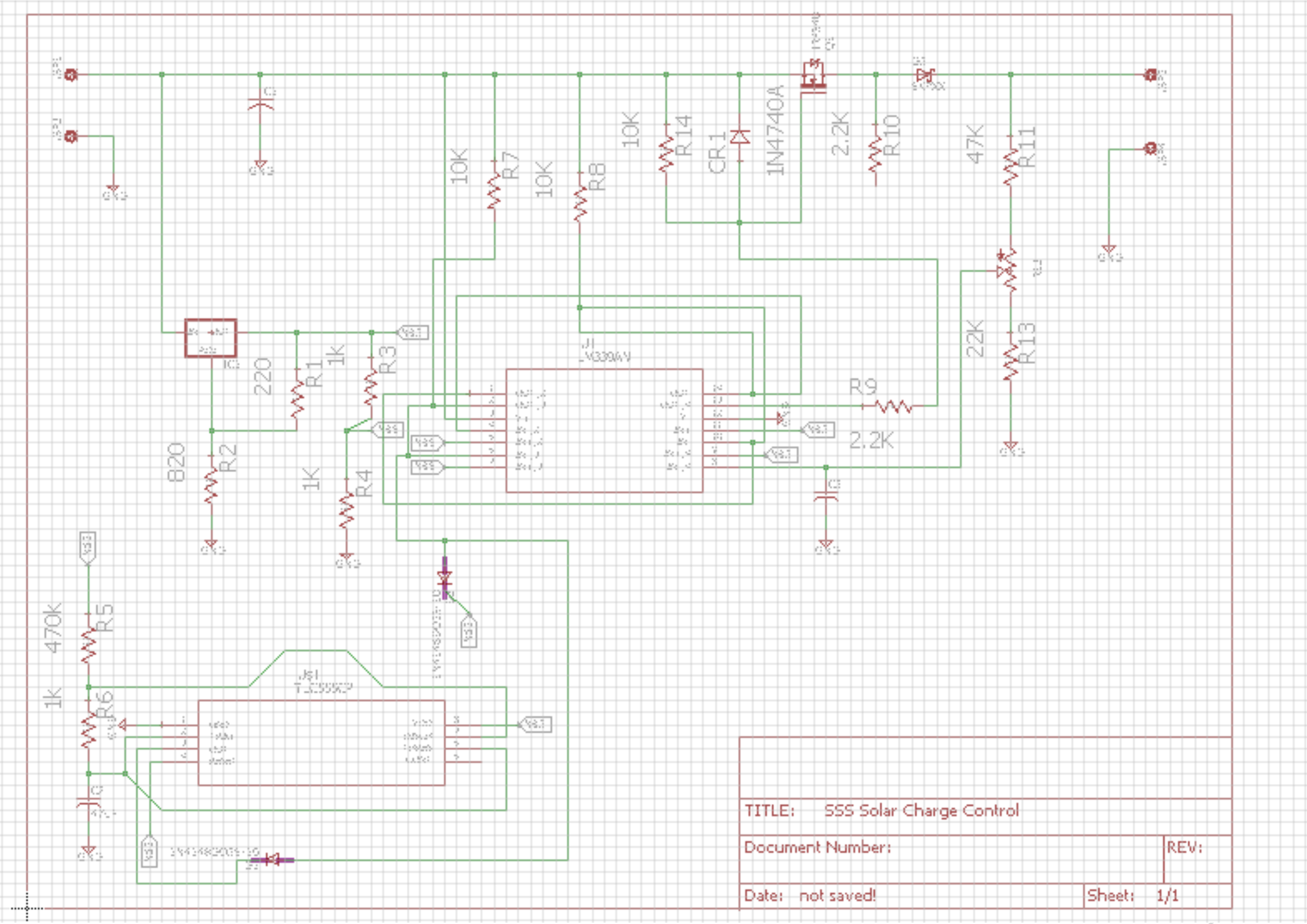
Lock Oscillator period generate 30mS Pulse every 15s. Its function to set the flip flop so that charging may commence

Adjustable pot feeding desired cut-off voltage to comparator circuit to drive the MOSFET Switch

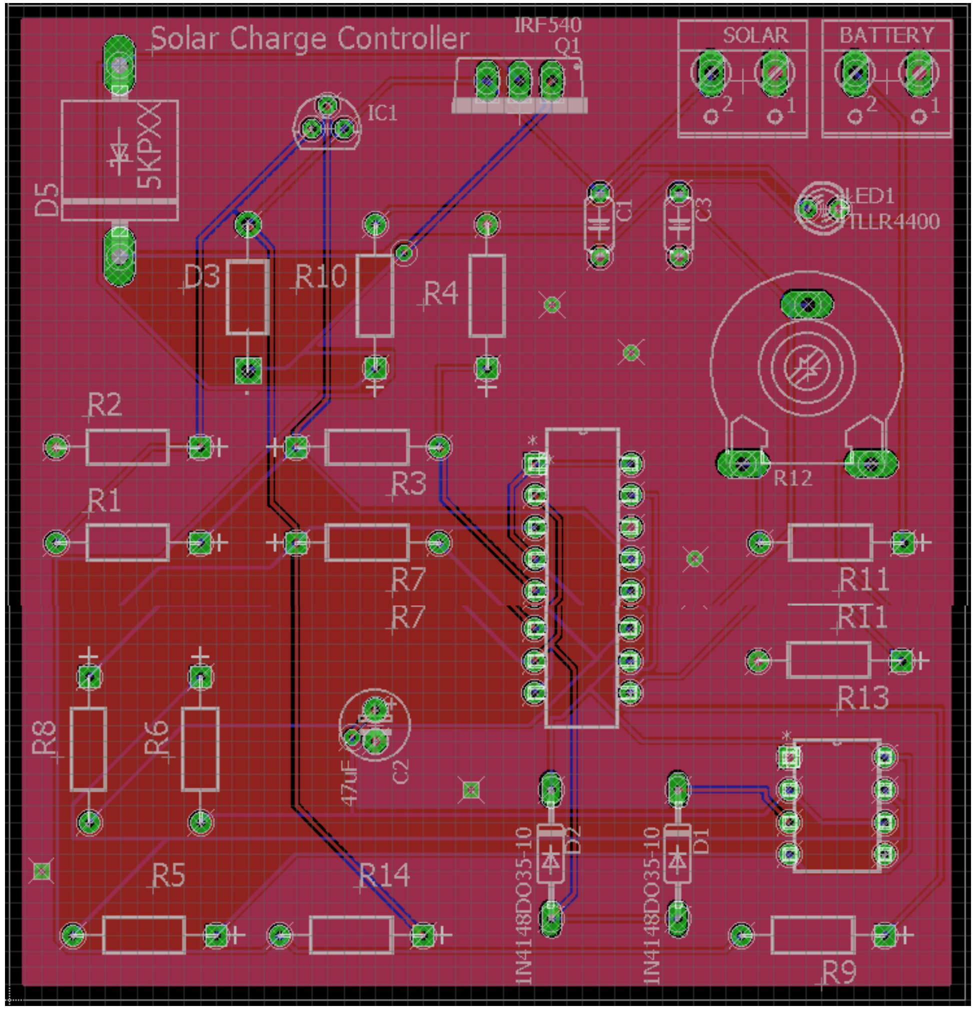
Solar Charge Controller Schematic Design



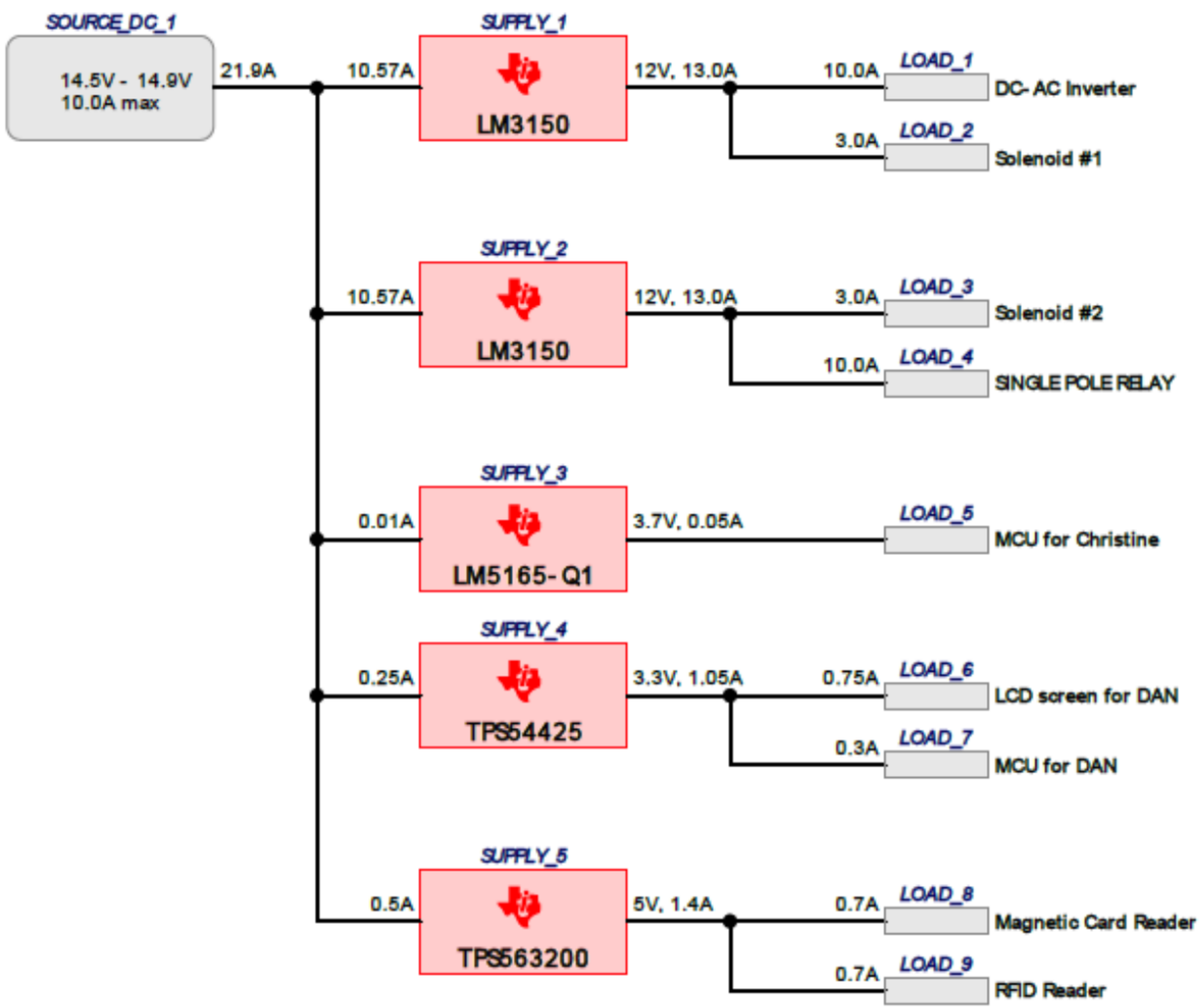
EagleCAD Solar Charge Controller Schematic Design



PCB Board Design



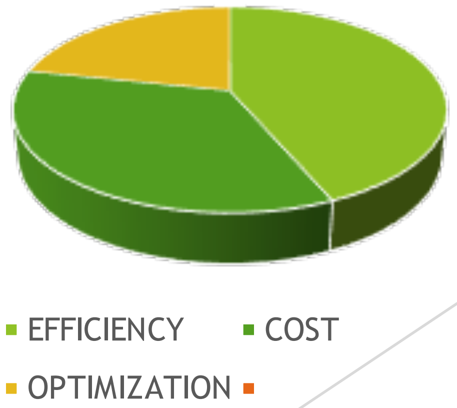
Power Distribution System



Project Summary

1. Total System Efficiency	98.89%
2. Total System BOM Count	64.0
3. Total System Footprint	2.614kmm2
4. Total System BOM Cost	$16.68
5. Total System Power Dissipation	3.622W

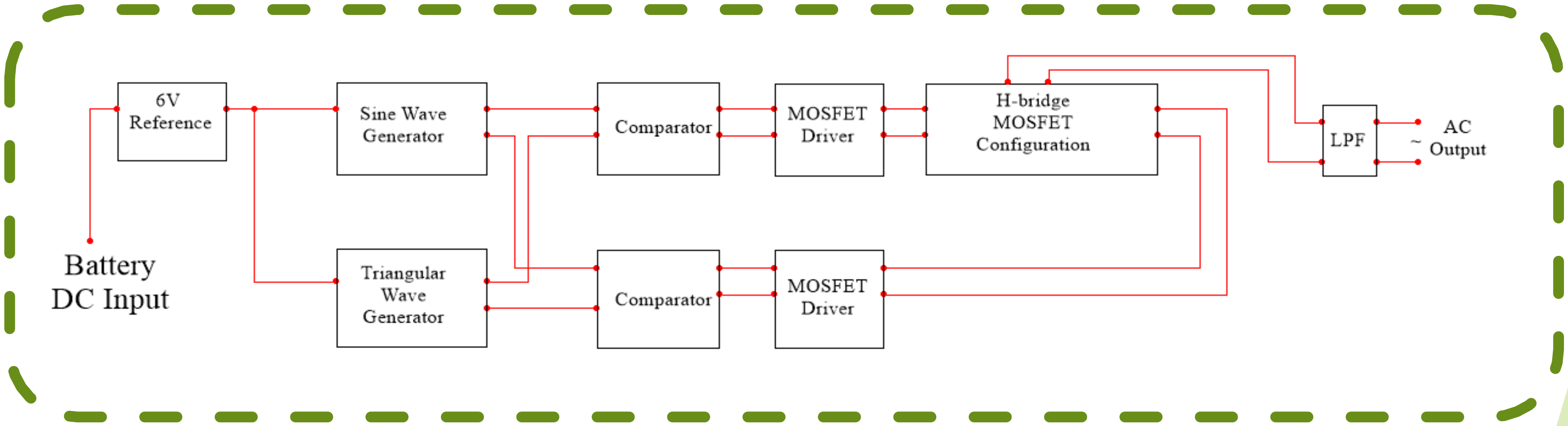
COMPARISON CHART



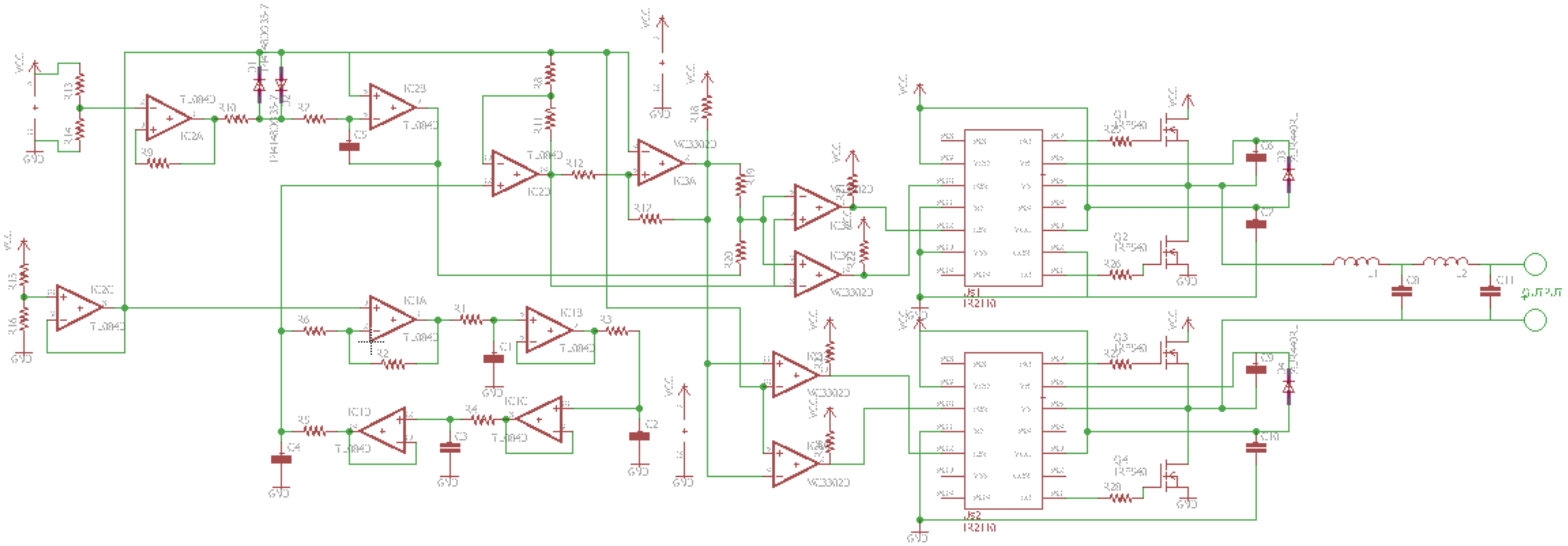
DC-to-AC Power Converter

- Input 12VDC / Output 120VAC 60Hz
- N-channel MOSFET H-bridge Configuration
- MOSFET Driver
- Pulse Width Modulation (Sine wave Reference Signal, Triangular Carrier Signal, and Comparators)
- Low Pass Filter
- Surge Protection

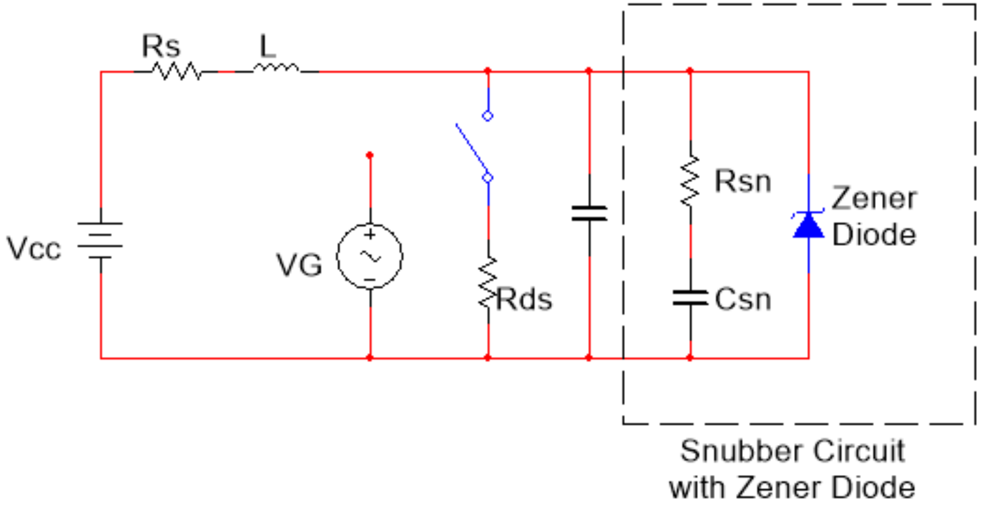
DC-to-AC Power Converter Block Diagram



DC-to-AC Power Converter Schematic Design

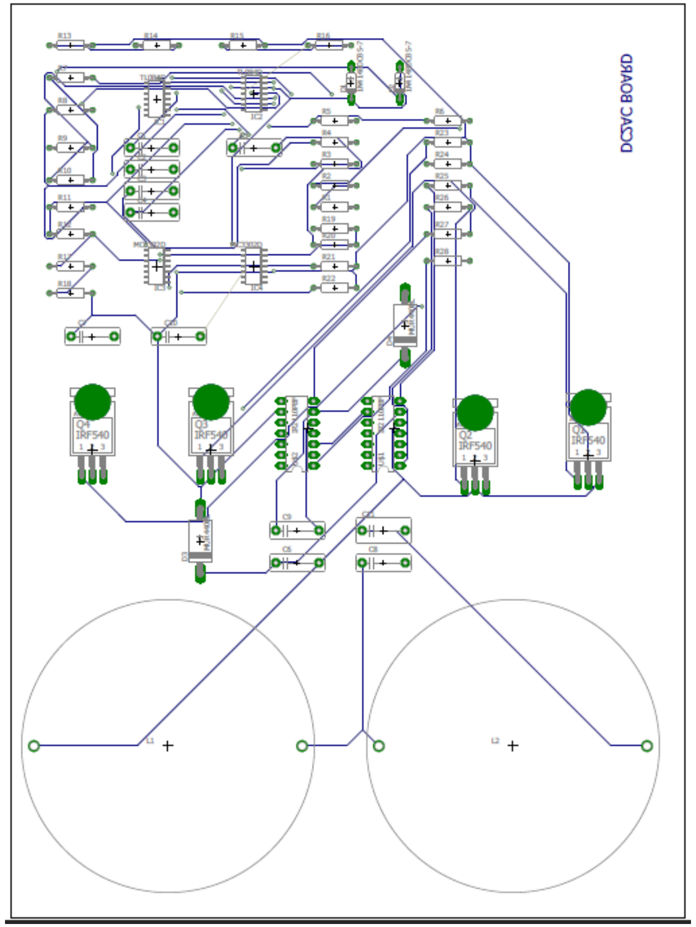


DC-to-AC Power Converter Surge Protection



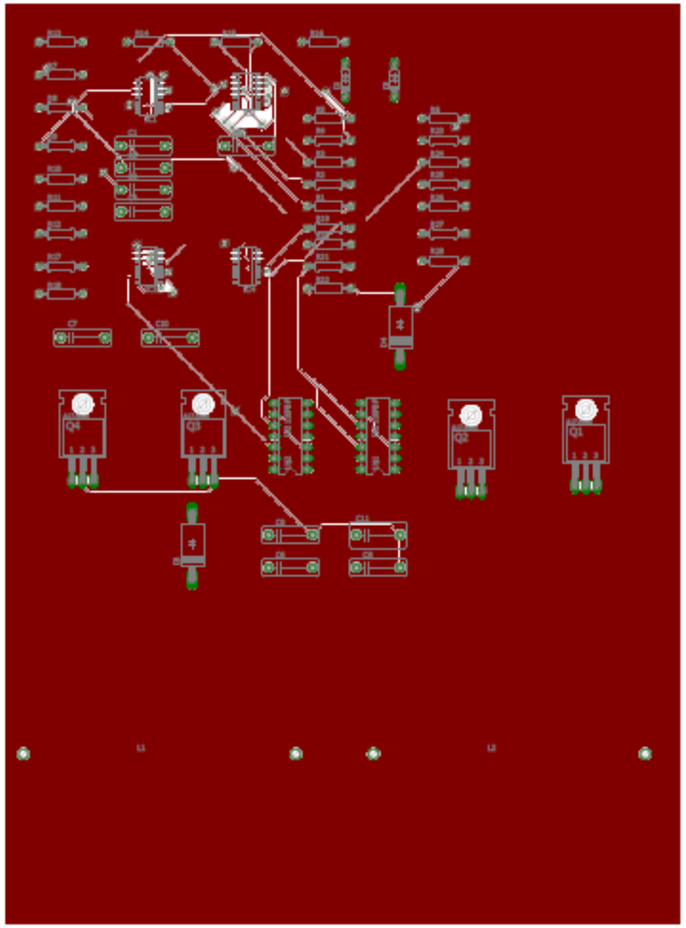
- Current from Inductors flow back to off MOSFETs
- Snubber Circuit with Zener Diode is used to damped the surge current
- R_{sn}, C_{sn}, and Zener Diode are connected parallel to MOSFETs

DC-to-AC Power Converter PCB Design

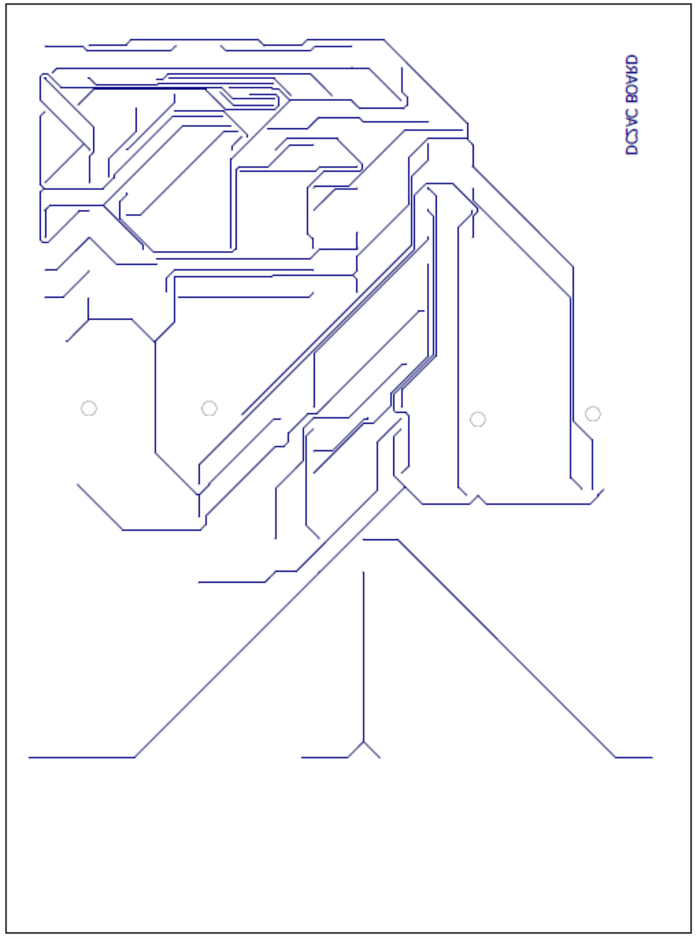


- Dimension : 159 mm x 213 mm (W x L)
- 2 Layers
- Designed by Software CS EAGLE ver 7.5.0

DC-to-AC Power Converter PCB Design

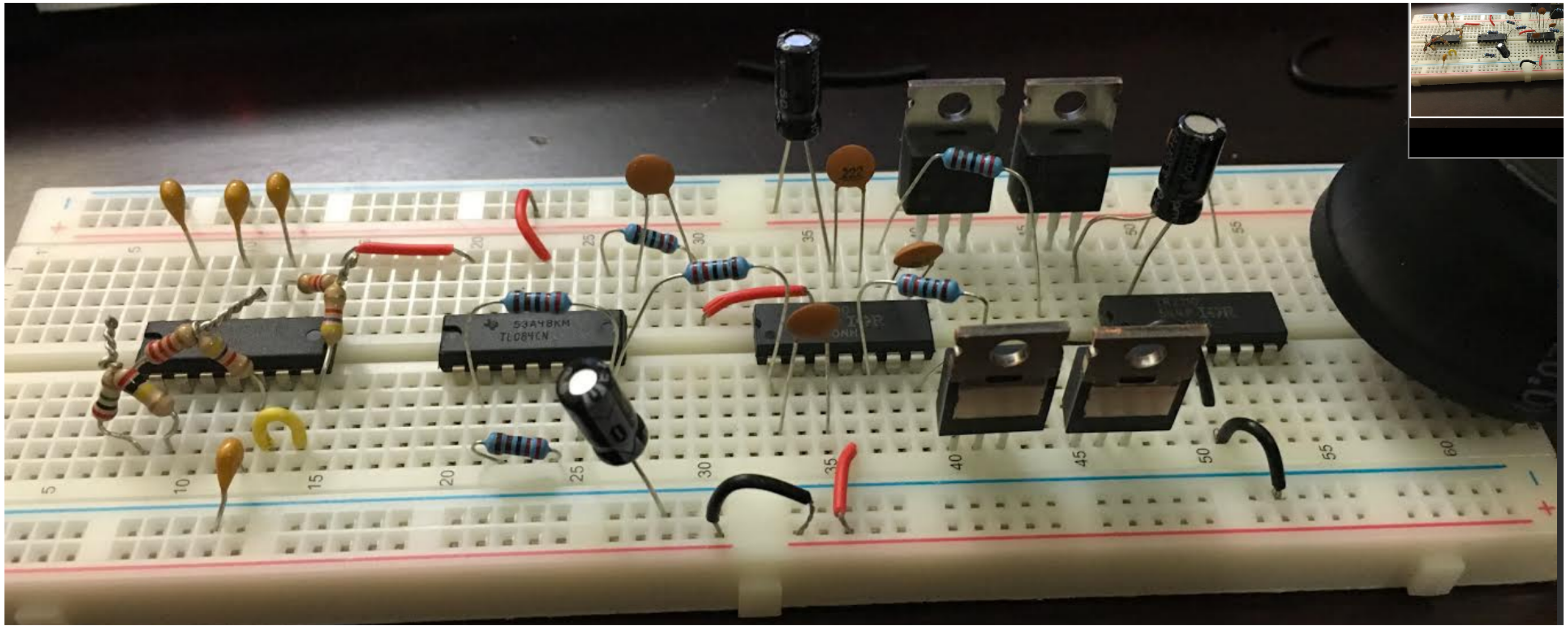


Top View



Bottom View

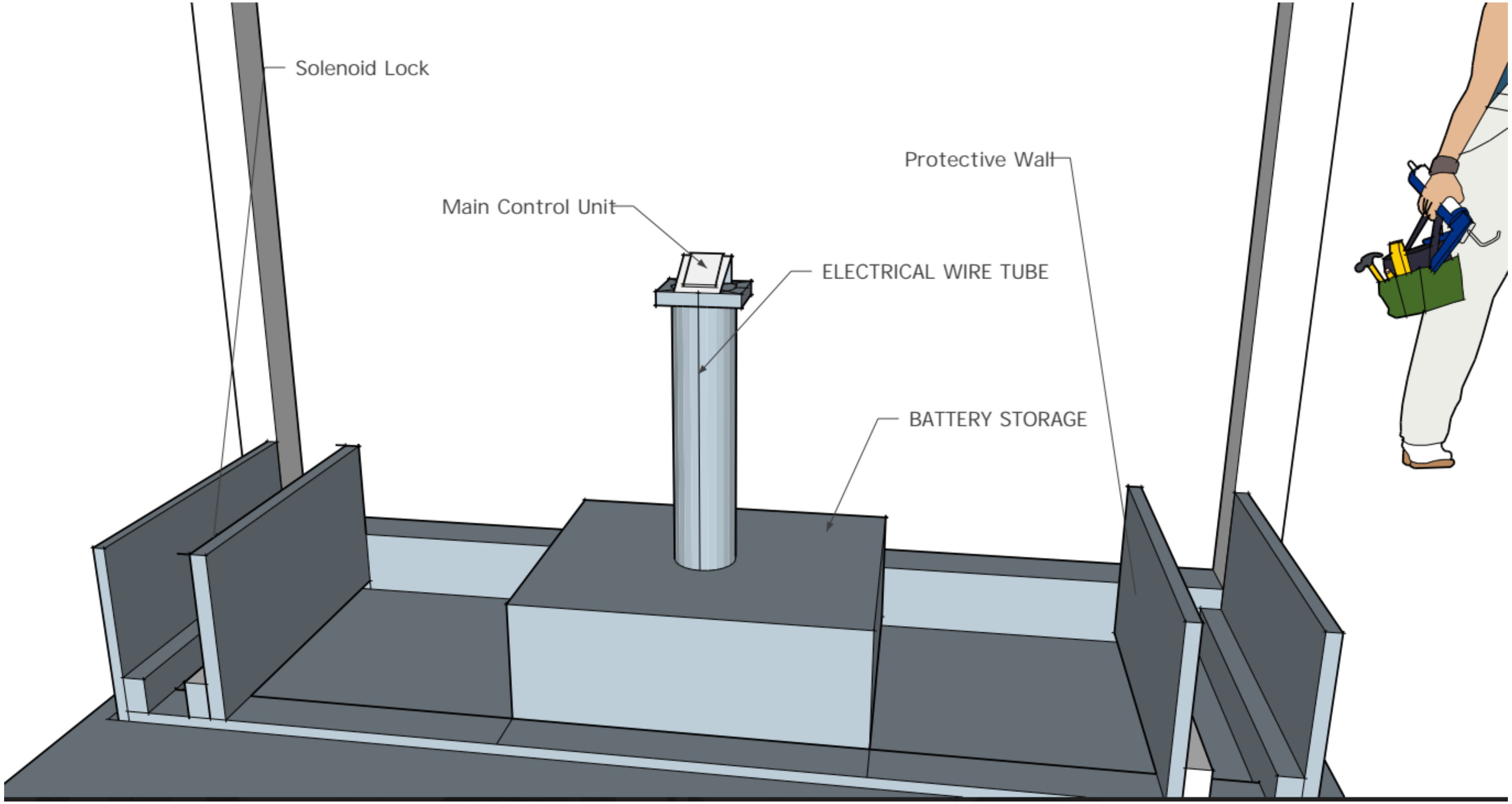
DC-to-AC Power Converter Design Implementation on Breadboard



Locking Mechanism

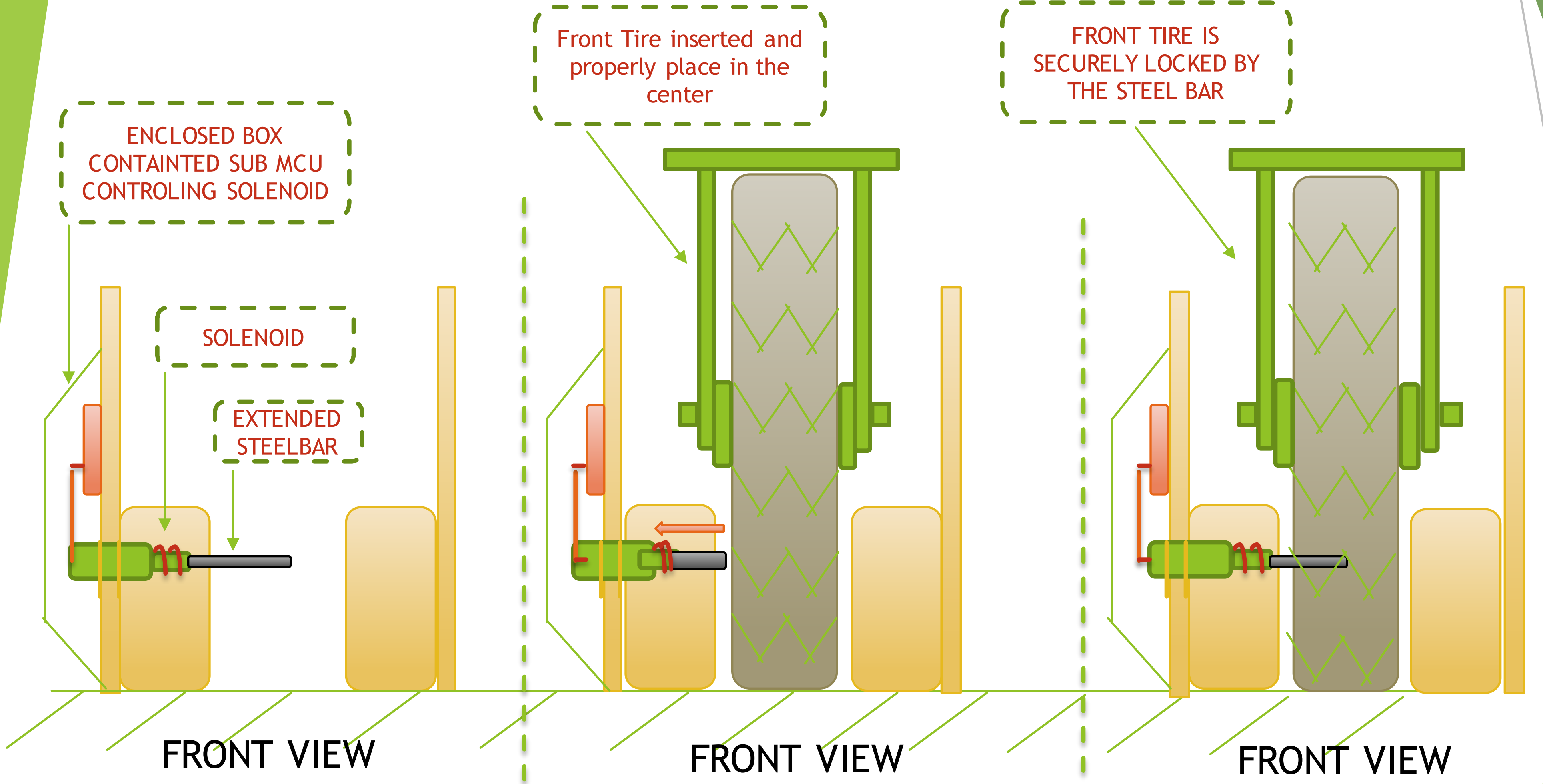
- Pull-type Solenoid
- Part A#420-066842-00 manufactured by Guardian Electric is used for low power consumption and high achievable pull force

	A420-066843-00	A420-064867-00	A420-066842-00	A420-064866-00
AC/DC	DC	DC	DC	DC
Volts	12 VDC	12 VDC	12 VDC	12 VDC
Push/Pull	Pull	Pull	Pull	Pull
Duty Cycle	Intermittent	Intermittent	Continuous	Continuous
Stroke	1.00 in	1.00 in	1.00 in	1.00 in
Pull Force	20 Oz	10 Oz	8 Oz	3 Oz
Resistance at 70F	5.6 Ohm	4.6 Ohm	17.5 Ohm	14.8 Ohm
Power	27 VA	32.4 VA	8.6 VA	10.2 VA
Current Seated	2140 mA	2580 mA	686 mA	811 mA
Holding Force	205 oz	160 oz	179 oz	139 oz
Style	Tubular	Tubular Long-life	Tubular	Tubular
Model No.	T12x19-12	T12x19-I-12	T12x19-C-12	T12x19-C-12
Intermittent Duty Condition	25% 'On' Time, (100 Seconds 'On' Max. Followed By 300 Seconds 'Off' Min.)	25% 'On' Time, (100 Seconds 'On' Max. Followed By 300 Seconds 'Off' Min.)		



Solenoid Lock
Protective Wall
Main Control Unit
ELECTRICAL WIRE TUBE
BATTERY STORAGE

Locking Mechanism

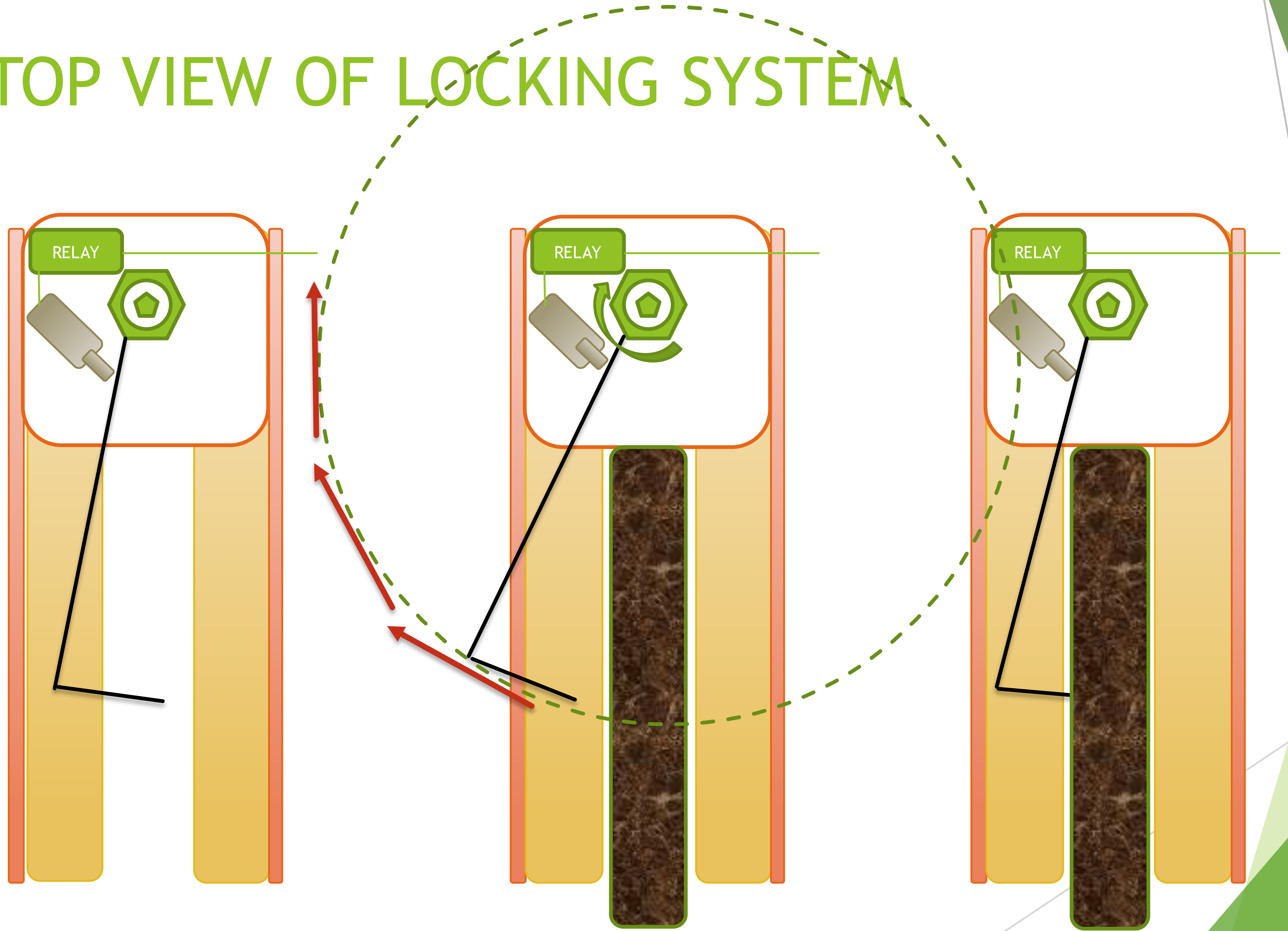


INITIAL STAGE
At this stage, system verifies user's valid ID

SIGNAL IS SENT TO SUB MCU
STEEL BAR PULLED BACK BY SOLENOID WHILE WAITING FOR PROPER PLACEMENT

SIGNAL OFF,
BACK TO INITIAL STAGE

TOP VIEW OF LOCKING SYSTEM



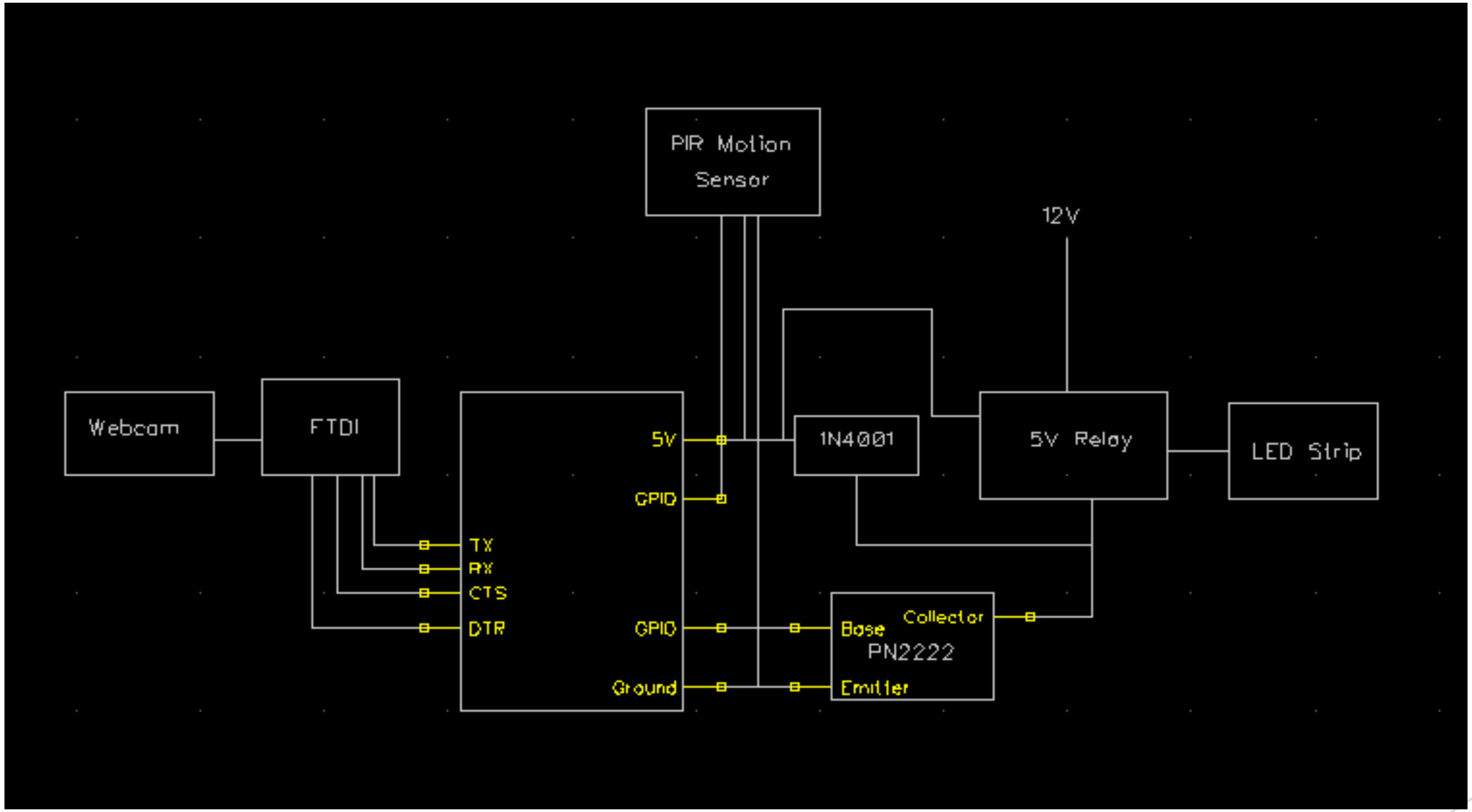
Lighting System Features

- Only on between the hours of 6:00 PM and 6:00 AM and off otherwise using RTC
- Activated via motion sensor
- Controlled using TI CC3200
- Designed for the safety of the user
- Circuit switched using 5V relay
- Flyback diode used to protect against relay spikes

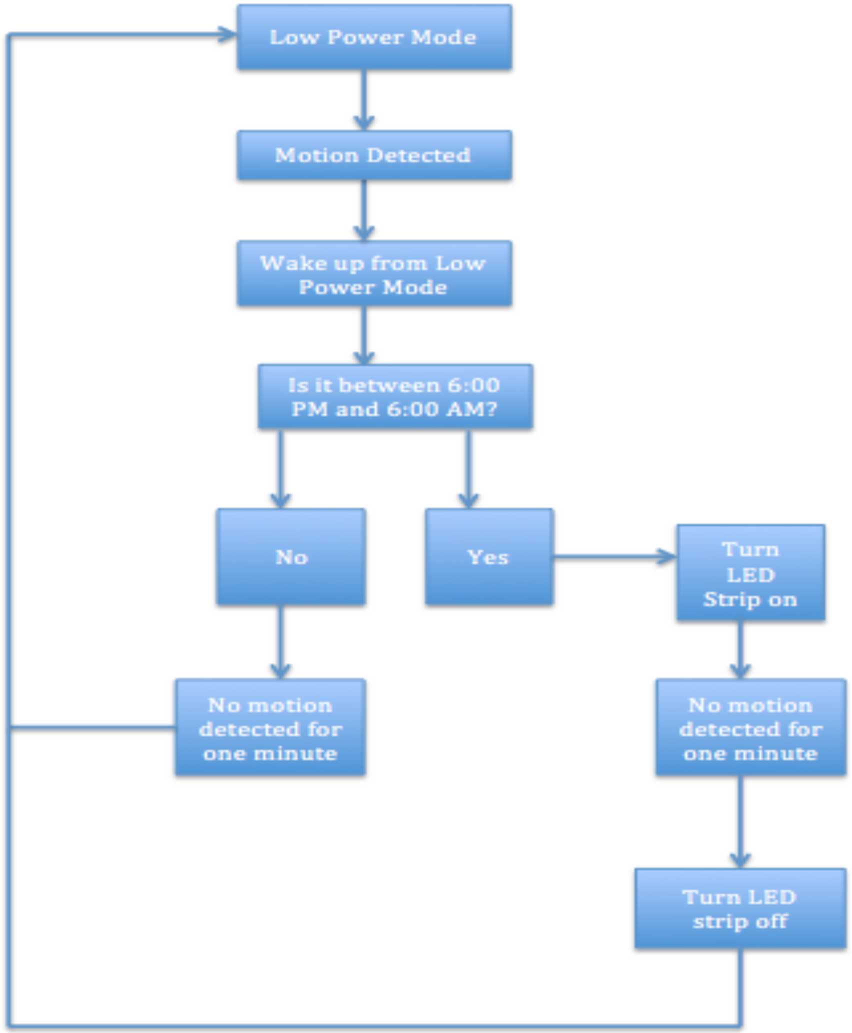
Camera System Features

- Sends video footage to a server
- Footage is intended to be used to retrieve information on stolen bicycles
- Surveillance deters theft
- Cameras are activated when someone is nearby via the PIR motion sensor
- Controlled using CC3200

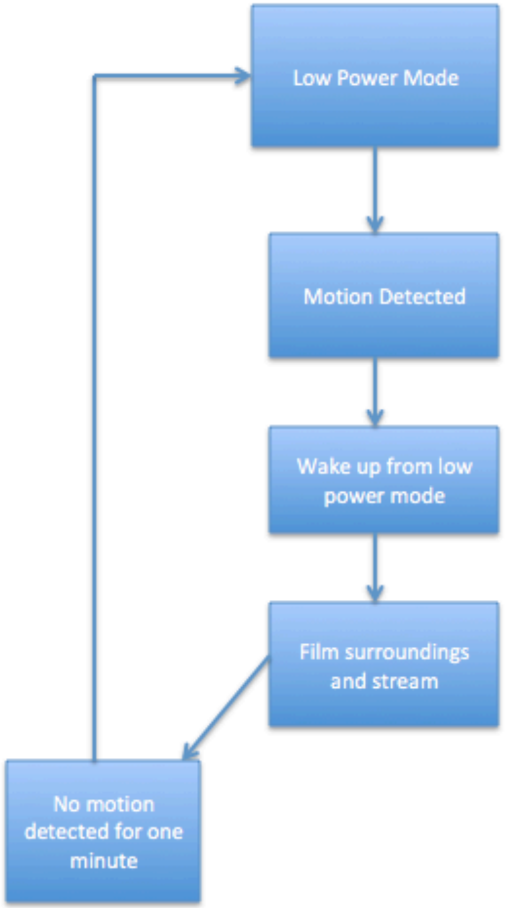
Lighting/Camera System Hardware General Diagram



Lighting System Code Block Diagram



Camera System Code Block Diagram

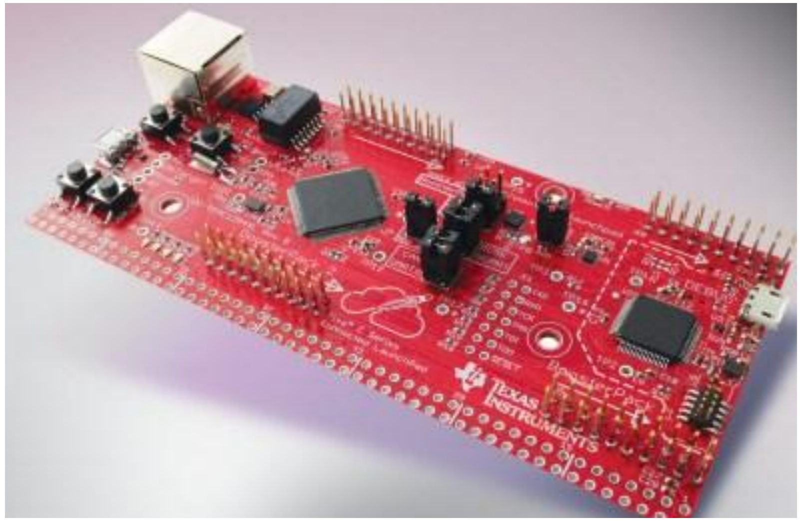


Embedded System

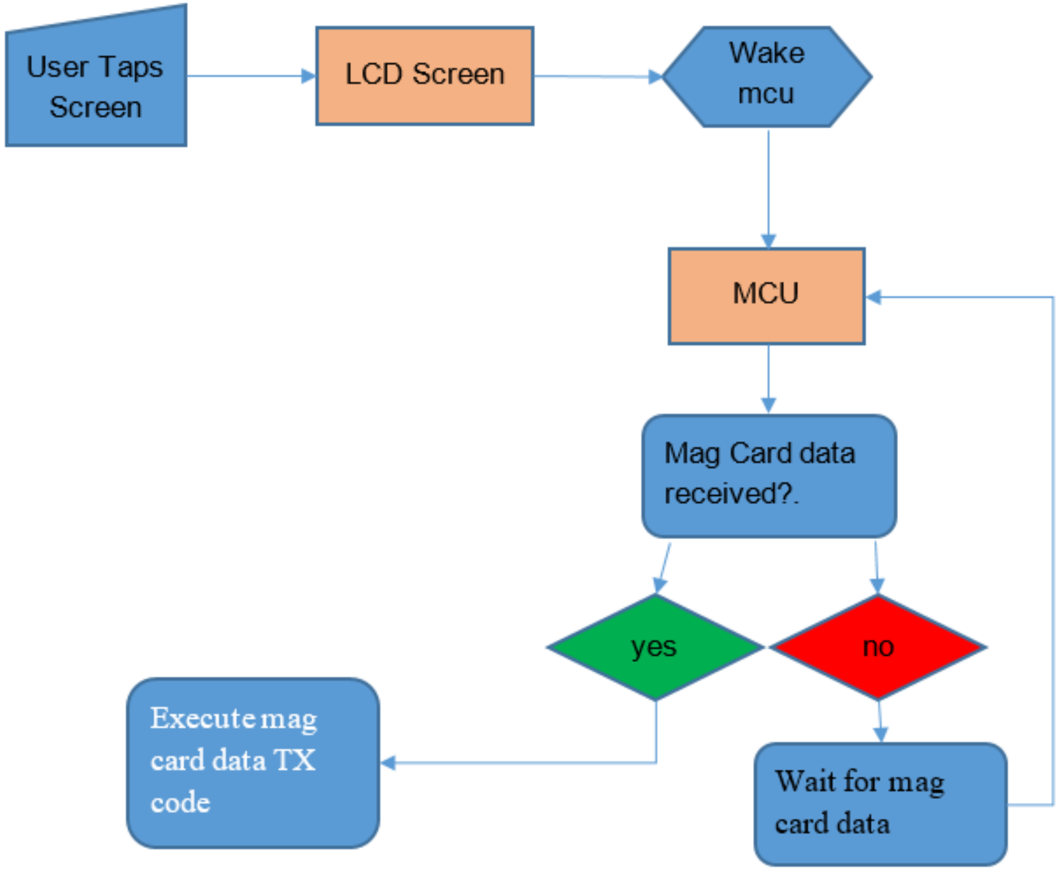
- Tiva C Series
- SimpleLink CC3200
- Code Composer Studio
- RFID Reader

User Interface

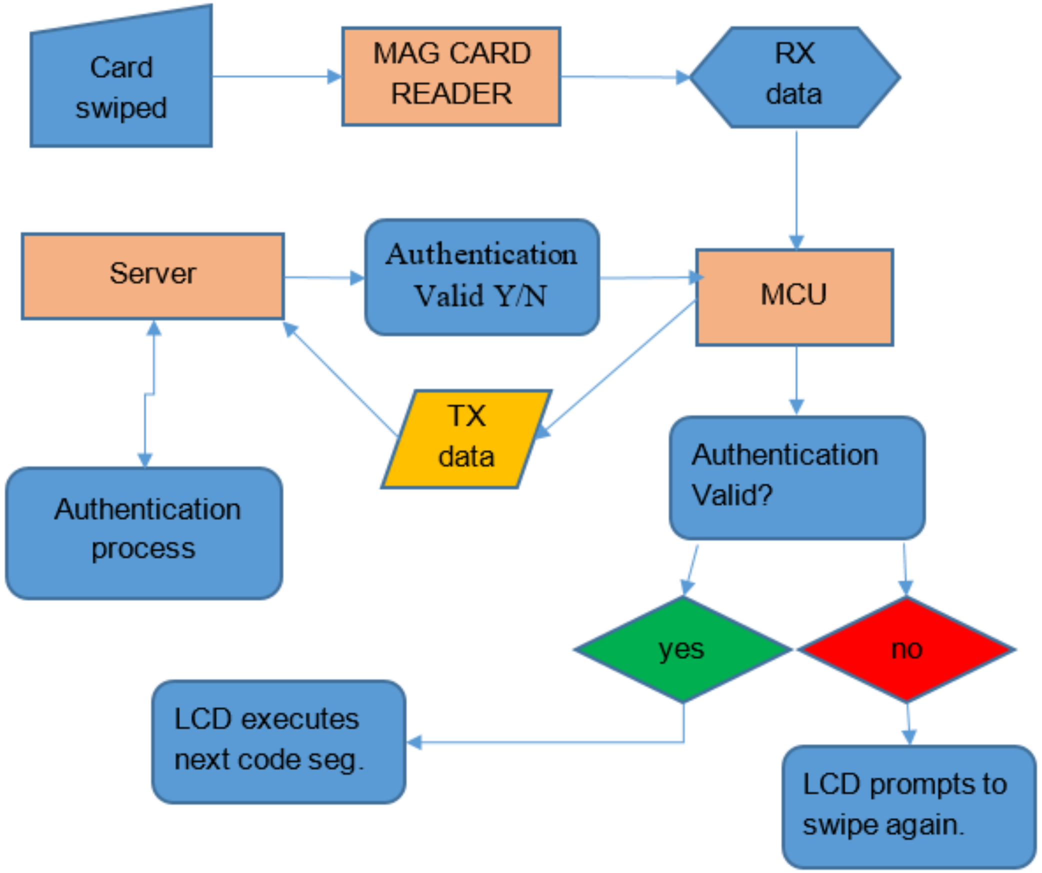
- Kentec LCD Touch Display
- Tiva C Series
- Magnetic Card Reader



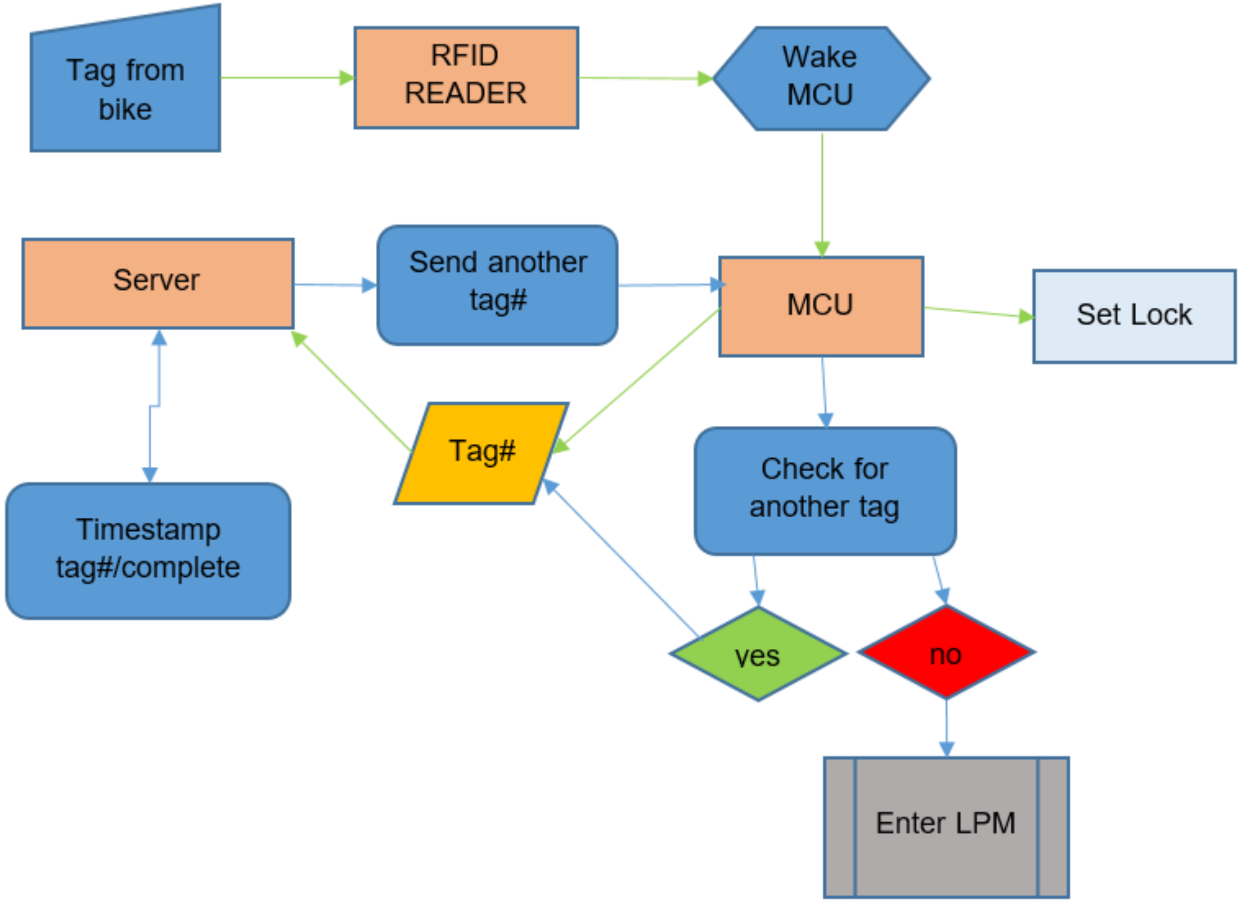
Software Block Diagrams



Software Block Diagrams



Software Block Diagrams



Software Diagram

SOFTWARE BLOCK DIAGRAM

Graphical User Interface

Graphical User Interface

Graphical User Interface

Graphical User Interface

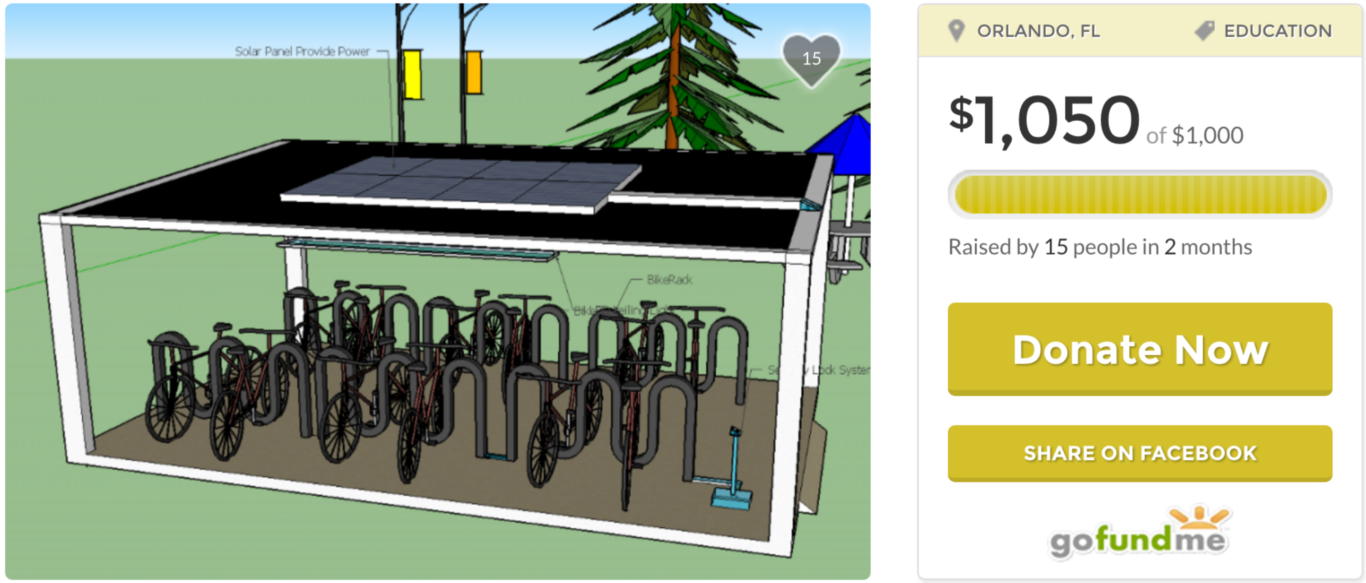
WORK DISTRIBUTION

Name	Major	Area of interest	Project design
The Pham	Electrical Engineering	Electric Power System and Electronic Device	• Solar Power System • Structural Design • DC-DC Converter
Nha Nguyen	Electrical Engineering	Electronic Device and Integrated Circuit Design	• DC-AC Inverter • Locking Mechanism • Embedded System
Christine Erwin	Electrical Engineering	Electric Power System and Application	• SecurityCamera • Motion Detection • Light Sensor
Daniel Adarme	Electrical Engineering	Embedded system and communication system	• Main Embedded system • Electric Lock system • Structural Design

Financing and Fundraising

- The project was not funded by any company
- Late in March, fundraising for the project was created on "**gofundme.com**" site
- Goal for Fundraising was set at $1000 and duration of 2 WEEKS
- Result: LESS THAN 2 WEEKS, the goal $1000 was reached by the helps from family and friends

Sr Electrical Eng. Design Project



Proposed Budget Table

Name	Quantity/Types	Price/unit	Status
Solar Panel	2x(50 watts offgrid solar panel)	$200	confirmed
Charge Controller	Charge Controller (Included PCB)	$35	research
Battery	2x(215 Ah 6V Golf Cart Battery)	$200	research
DC-DC inverters	5 Circuits	$70	research
DC-AC inverters	1	$30	research
TI CC3200 SimpleLink	1; sample from TI	$0	donated
TI CC3200 Launchpad	1	$0	donated
Magnetic card reader	1/prime eligible	$17.78	purchased
RFID reader	1/prime eligible	$12.80	purchased
TI Stellaris Launchpad	1	$13.38	In Transit
TI Stellaris LCD Module	1	$35	In Transit
FTDI Board	(2) USB 2 I2C	$9.95	In Transit
Phototransistor	1	$5	research
camera	1	$25	research
Microcontroller for the camera	1	$40	research
LED strip	1	$15	research
External hard drive	1	$65	research
Motion Sensor	1	$12	research
Bike Rack Structure			
Others	shipping cost, material cost	$200	research
	Total	$985~$1000	

Process

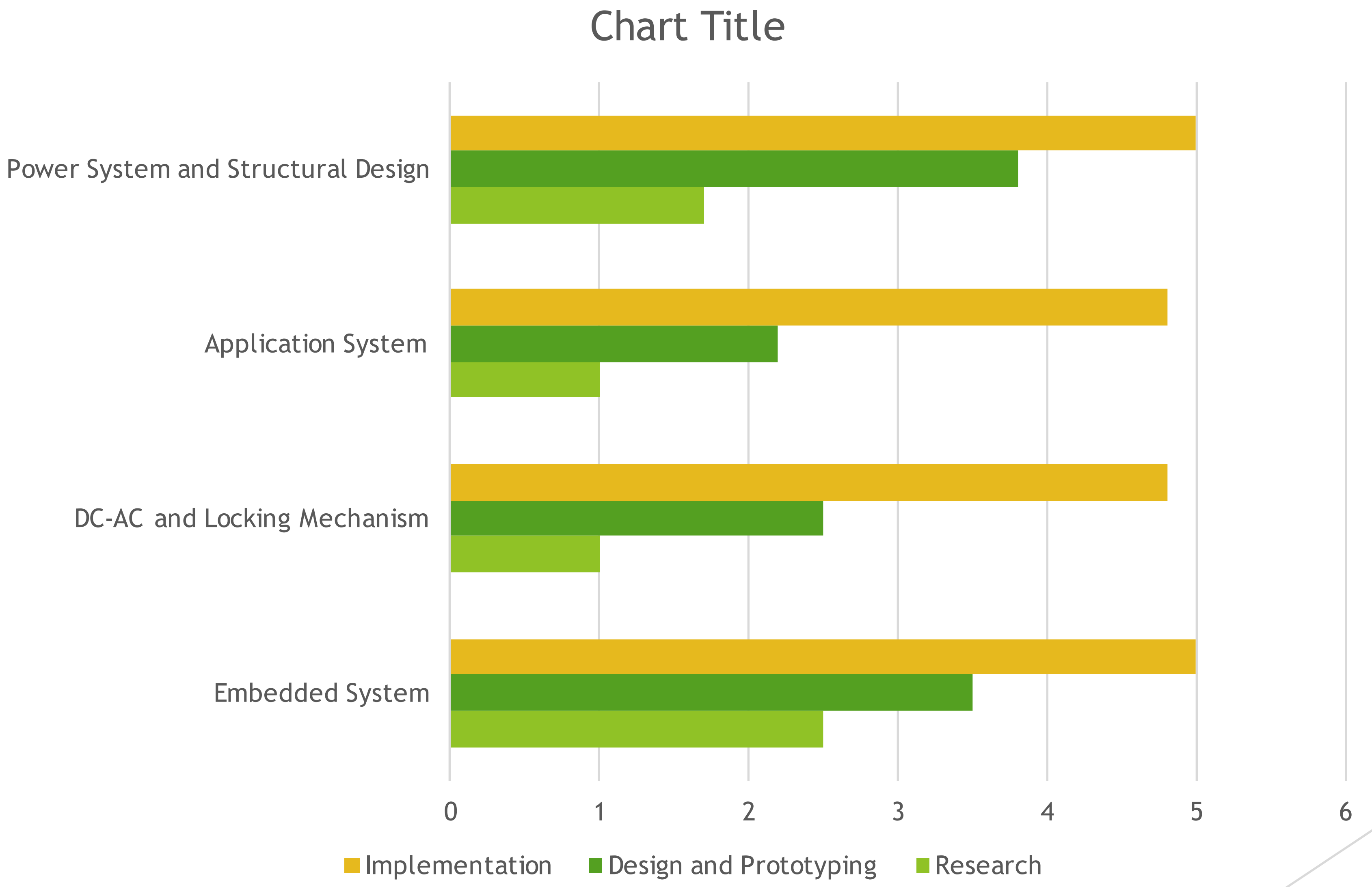


Chart Title
Power System and Structural Design
Application System
DC-AC and Locking Mechanism
Embedded System
0
1
2
3
4
5
6
Implementation
Design and Prototyping
Research

Question