GROUP C

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Motivation

- Growing world population leading to escalating food waste issues
- Roughly 1/3 of food produced – 1.3 billion tons – are scrapped annually
- Food waste results from:
  - Damage in transportation
  - Expiration
  - Partially eaten and thrown away
- Wasted labor, energy, and other resources
- Home composting is laborious

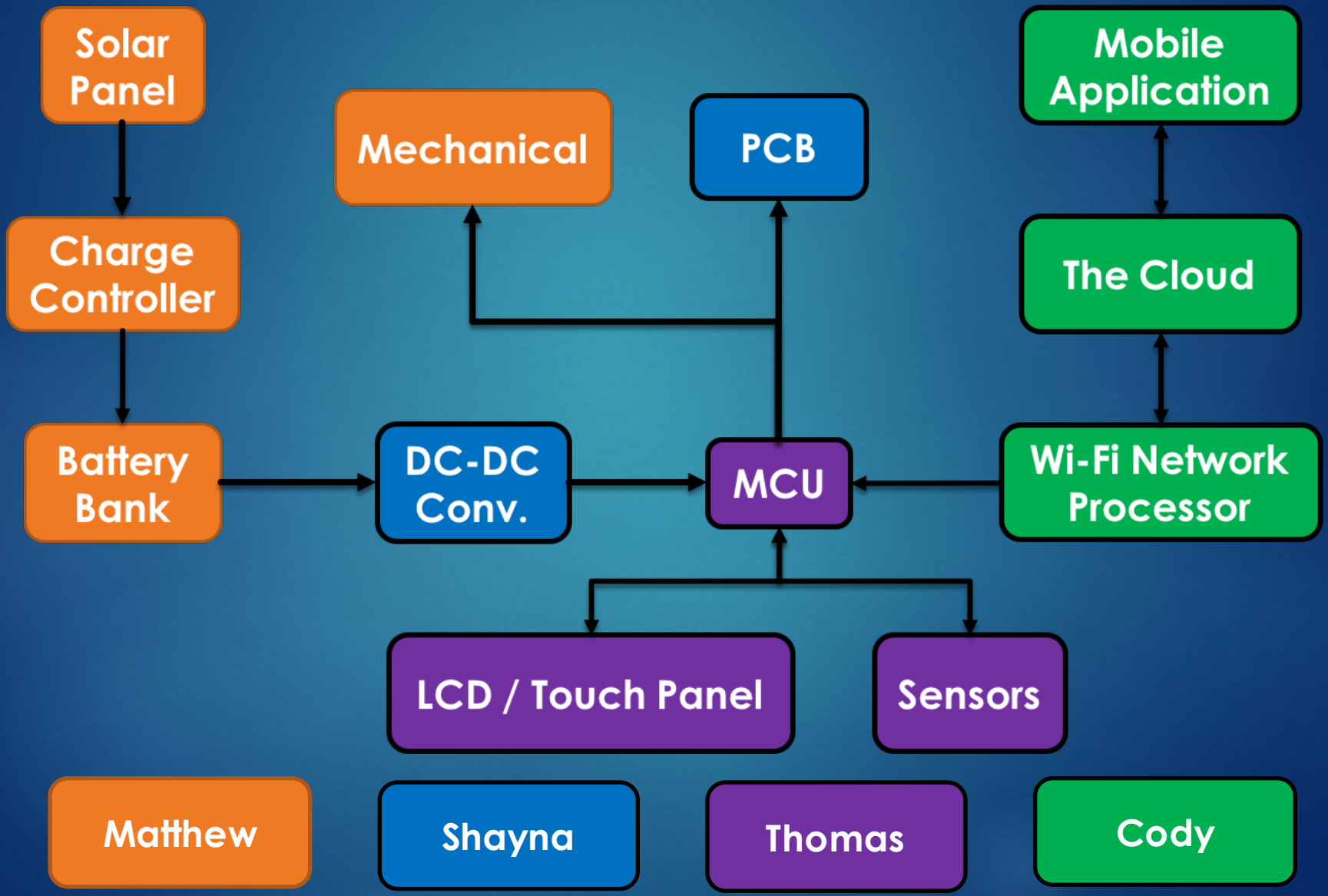
Goals & Objectives

- Provide a system that will enable anyone to easily convert food waste into usable compost
- Grid-independence
- Automatic monitoring and operation
- Provide a simple user interface while giving experienced users the necessary controls
- Allow remote monitoring and control through a mobile application

Specifications & Requirements

Part	Requirement	Reason
Mobile App	Provide remote access for controls and stats	The user will easily be able to look at all information pertaining to their machine at any time.
Mobile App	User shall have access to historical data related to their machine	Providing history will give better insight into the composting process for future adjustments.
MCU	Must have at least 62 GPIO pins	Needs to be able to interface with all of the peripherals
MCU	Must be able to function normally in -30°C to 85°C over an extended period of time	With the MCU in an enclosed space and the system located outside, temperature could be extreme depending on location
Battery	The life of battery shall last 6-8 hours	This will ensure that the compost process will continue despite low sunlight levels.
Charge Controller	Efficiency shall be above 80%	Maximizes power delivery from solar panel to battery storage.
Sensors	All sensors shall withstand temperature range of -10°C to 85°C	Needs to be able to withstand varying outside temperatures.
Motor	Will rotate the cylinder at a consistent pace for 6-8 hours	To ensure that compost is continuously mixed and turned at appropriate times.

System Block Diagram



Embedded Control System

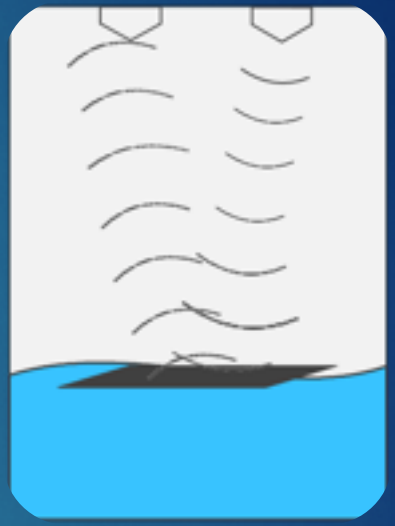
MICROCONTROLLER, LCD DISPLAY, SENSORS: WATER, MOISTURE, TEMP

Parts List

Name	Model	Price	Quantity
IR Receiver	350-00014	Free	1
IR Transmitter	350-00017	Free	1
Capacitive Soil Moisture Sensor	SKU:SEN0193	$7.90	3
Programmable Resolution 1-Wire Digital Thermometer	DS18B20	$1.50	3
4-Button LCD 16x2	Olimex Shield-LCD	Free	1
Tiva C Launchpad	EK-TM4C1294XL	Free	1

Water Level

- Sensor will be located at the top of the water tank, attached to the lid
- A float will be used to bounce infrared back for detection
- GPIO pin read HIGH or LOW from receiver
- PWM module controls LED



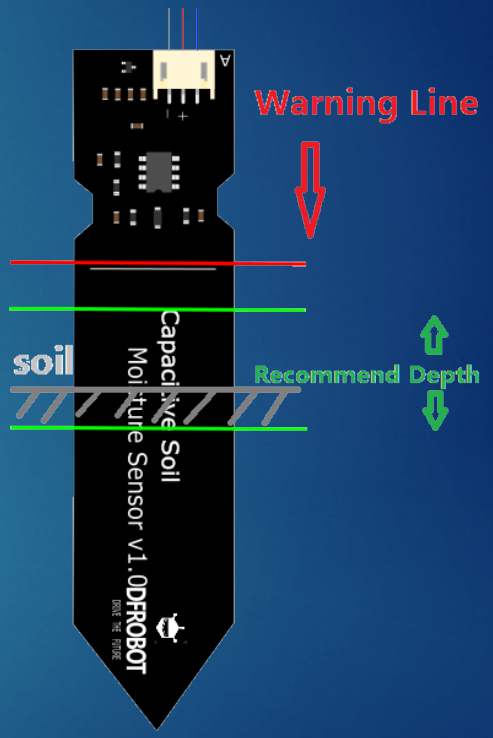
Sensor Usage Illustration

IR Receiver

IR LED + Shield

Moisture Content

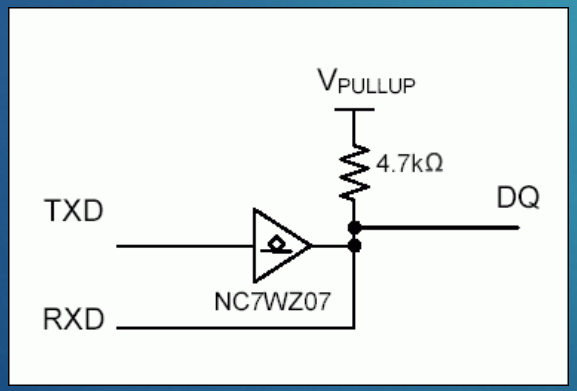
- Placed inside mixing container
- Protective layer wrapped around circuitry
- Communicates with ADC module on MCU



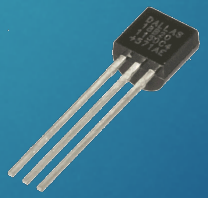
SEN0193 Operating Region

Temperature

- Placed inside mixing container
- MCU uses UART modules to interface with 1-Wire protocol
- Requires MCU to transmit command before sending back data
- Temperature data in 16-bit hex Celsius
- Each sensor on separate bus, but could be placed on a single bus with single-master multiple slaves



UART to 1-Wire Circuit

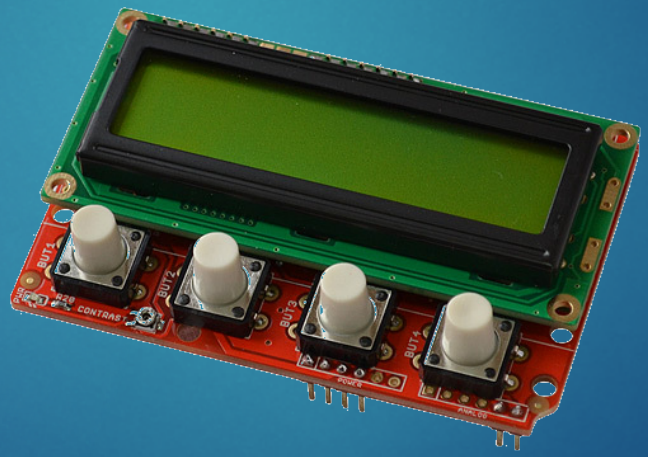


DS18B20+ (back)

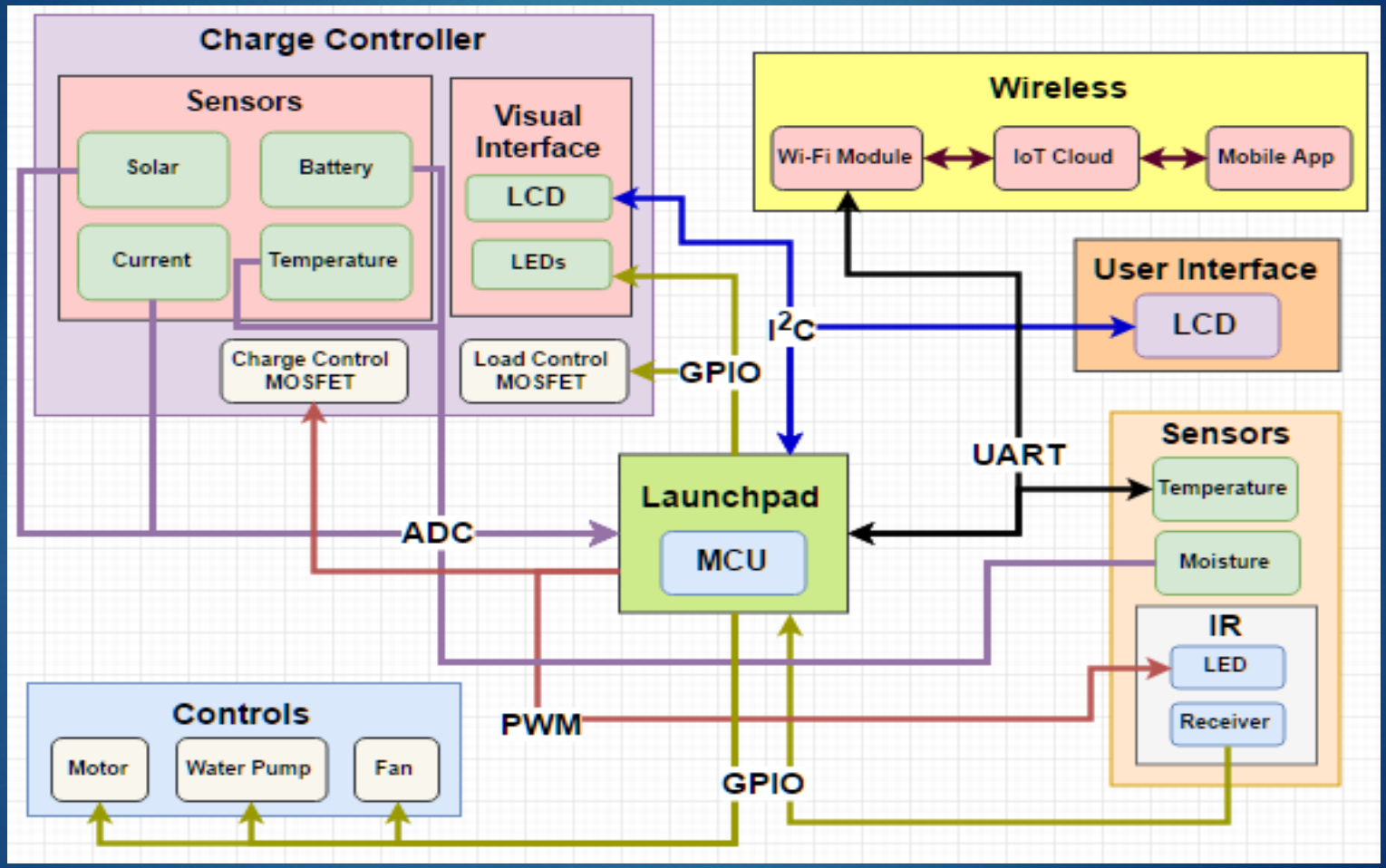
Waterproof Version

Display

- Communicates using I2C protocol
- 4 button inputs
- Requires both 5V for LCD and 3.3V for shield

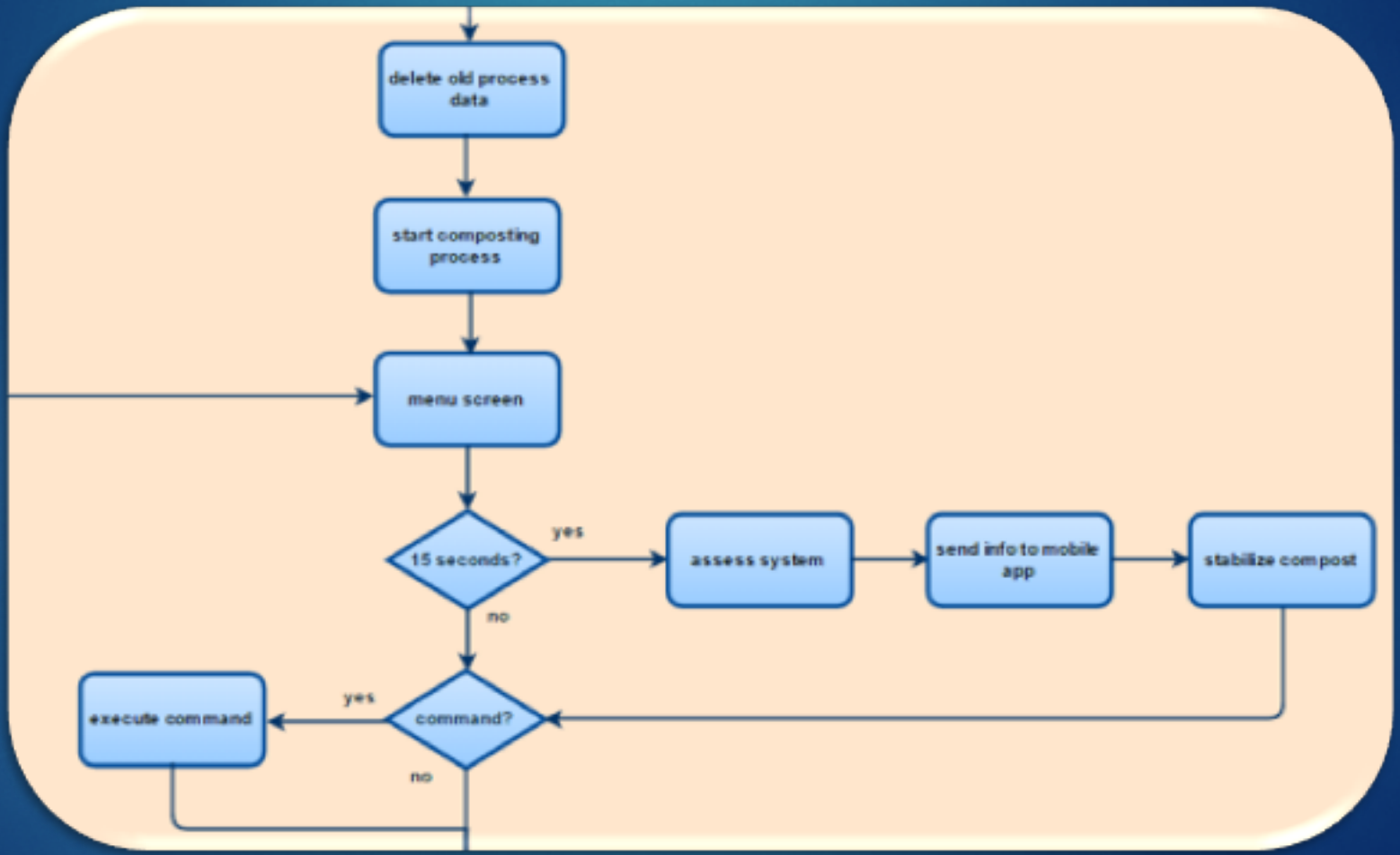


Communication Diagram

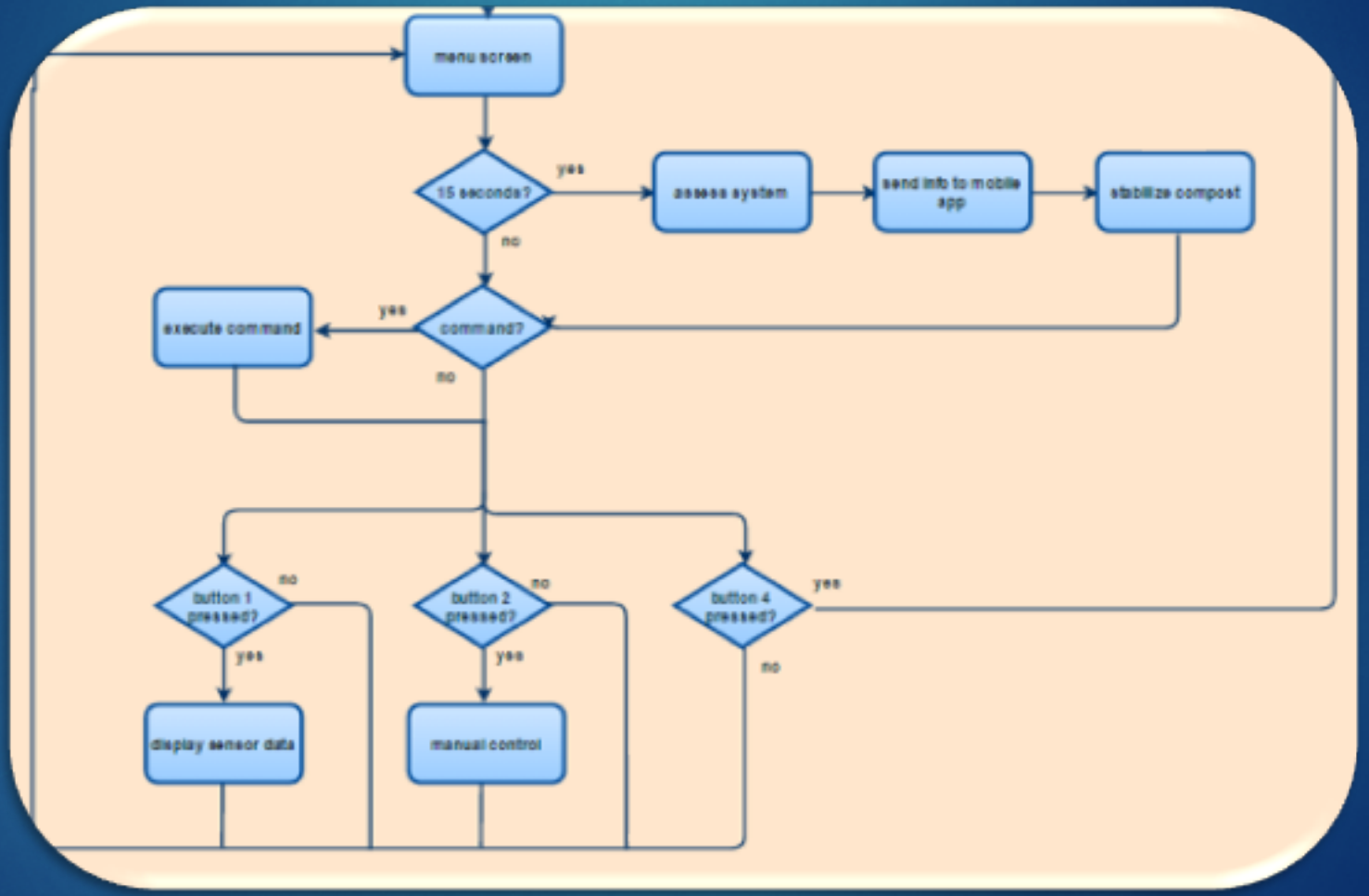


System Control Flow

(continued)


delete old process data
start composting process
menu screen
15 seconds?
yes
assess system
send info to mobile app
stabilize compost
no
command?
yes
execute command
no

(continued)


menu screen
15 seconds?
yes
no
assess system
send info to mobile app
stabilize compost
command?
yes
execute command
no
button 1 pressed?
no
yes
display sensor data
button 2 pressed?
no
yes
manual control
button 4 pressed?
yes
no

Challenges & Difficulties

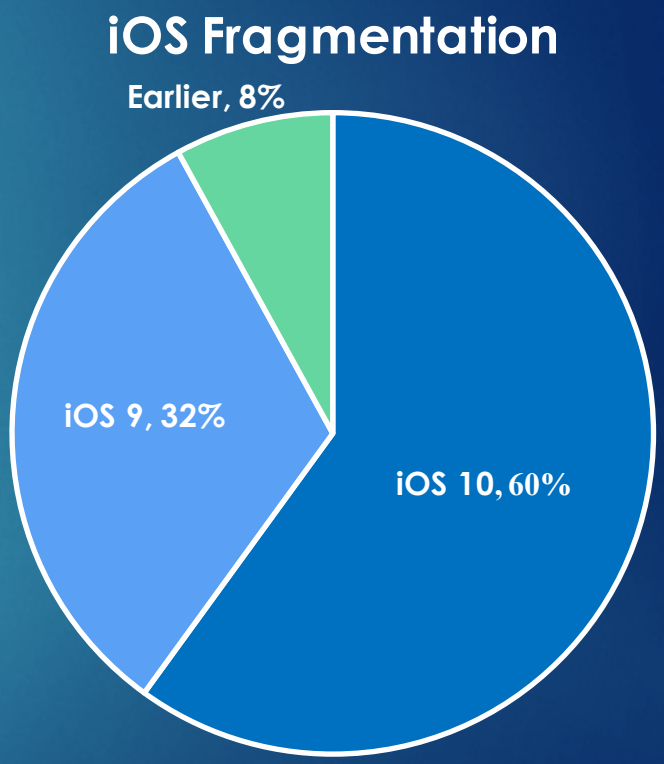
- Program faulting most likely due to reaching stack limit
- Debugging stops working; caused by same issue
- IR sensor overloading
- Timing and wire length issues with I2C
- Little to no embedded design experience

Wireless Communications

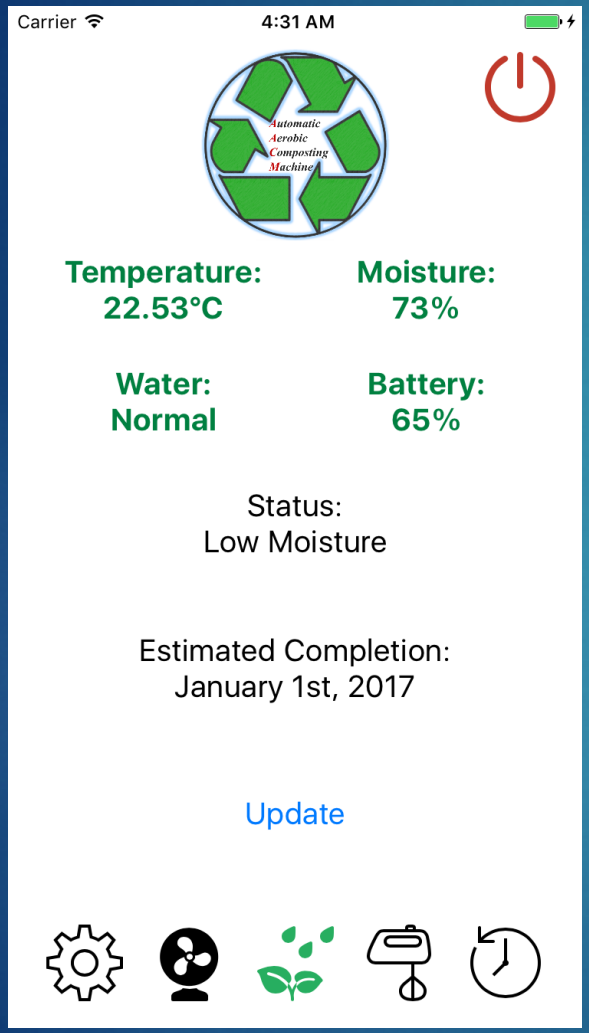
WI-FI CONTROLLER, THE CLOUD, MOBILE APP

Mobile Application

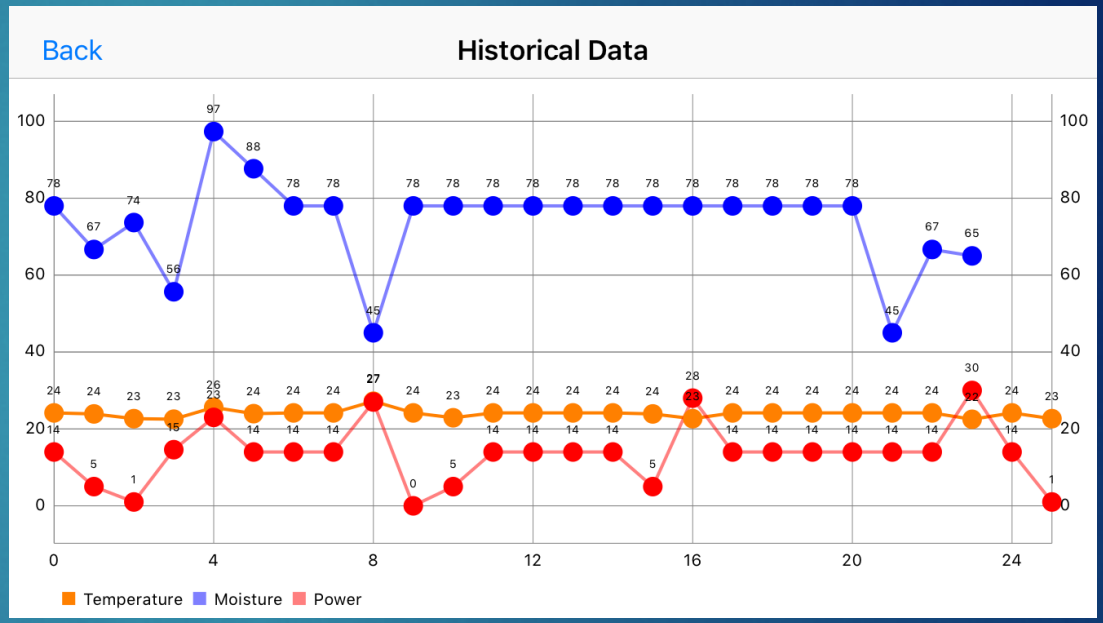
- iOS
  - Substantial amount of users (>100 million)
  - Less fragmentation
  - Platform with the most experience
- Model-View-Controller
  - Software model representing the system
  - ViewController classes for each page
  - Update protocols for communicating with the model
- ThingSpeak API for wireless communication



User Interface

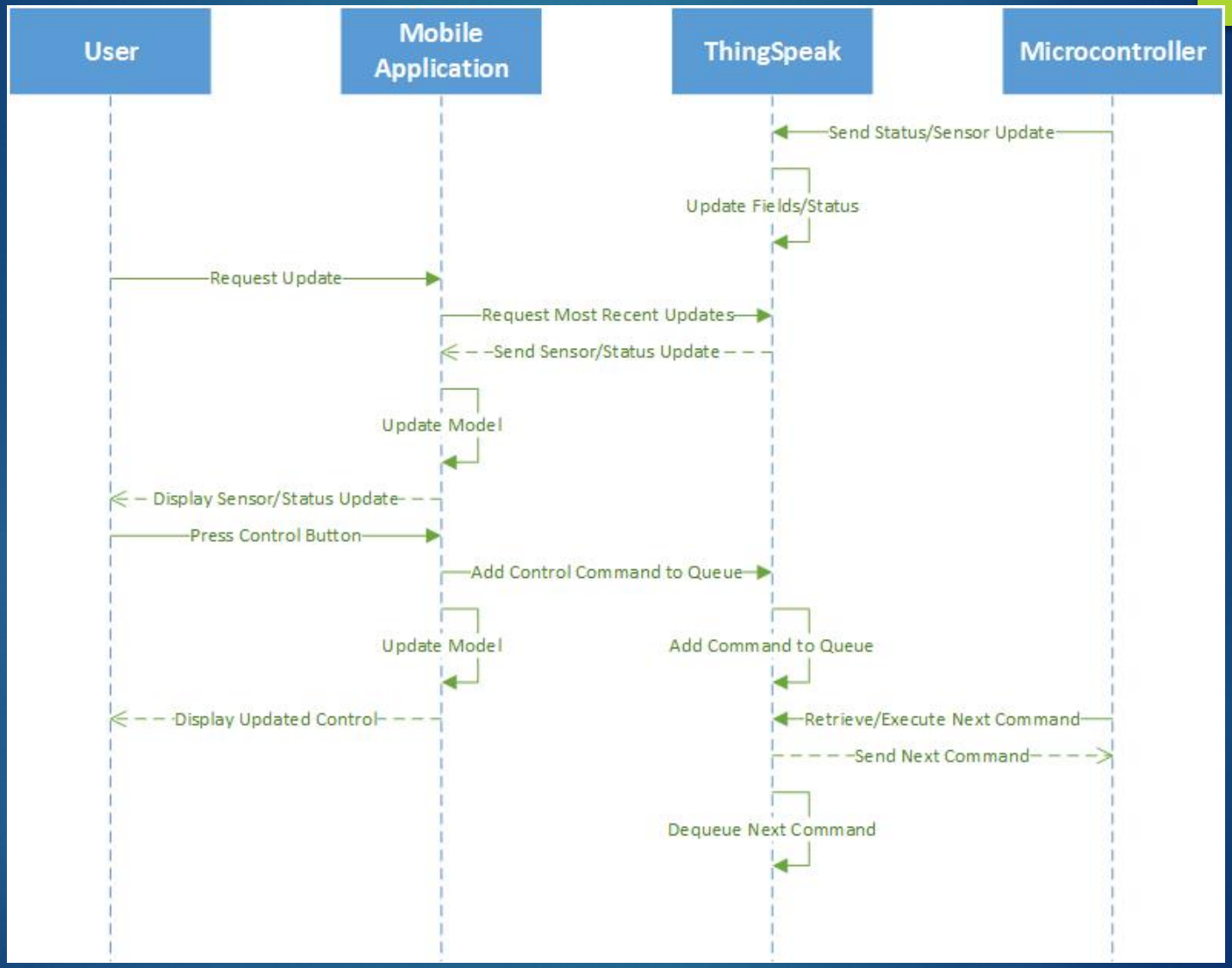


Home Page



History Page

Command Control

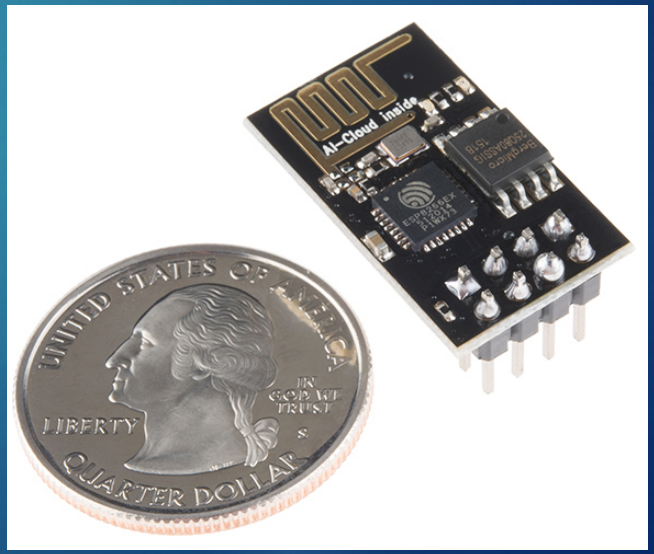


Wireless Communication Sequence Diagram

The Cloud & Wi-Fi Controller

- ThingSpeak IoT Cloud Network
  - Open data platform for IoT
    - Http requests for communication
    - Developed Swift and C APIs
  - Free!
- Espressif ESP8266 Wi-Fi Module
  - 32-pin, 5mm X 5mm QFN
  - TCP connections
  - AT commands through UART
  - $6.95 through Sparkfun

ThingSpeak



Wireless Communication Issues

- ThingSpeak Limitations
  - Update once every 15 seconds
  - Can only store up to 8 different fields
- Wi-Fi Module
  - Little support for ARM applications
- iOS Application
  - Apple push notification services only available to paid developers

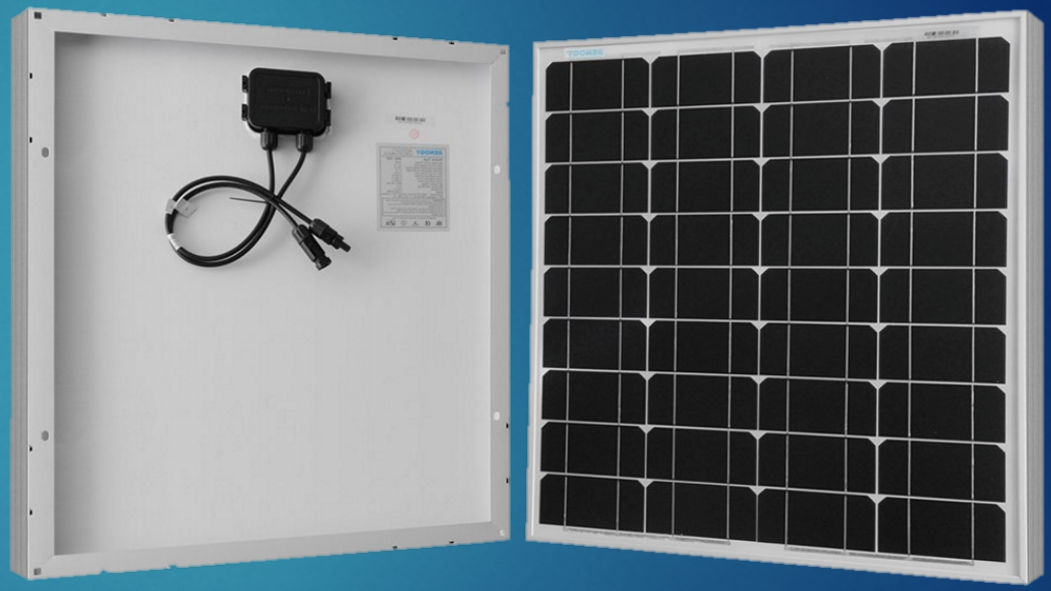
Power System

SOLAR PANEL, CHARGE CONTROLLER, BATTERY

Solar Panel

- Panel Specifications
  - 50 Watt
  - Monocrystalline
  - Compatible with universal mounting brackets
  - Equipped with MC4 Connectors
  - Aluminum framing
- Easily Maintained
- Produces close to 12V in Fluorescent lighting

Back **Front**



Renogy RNG-50D

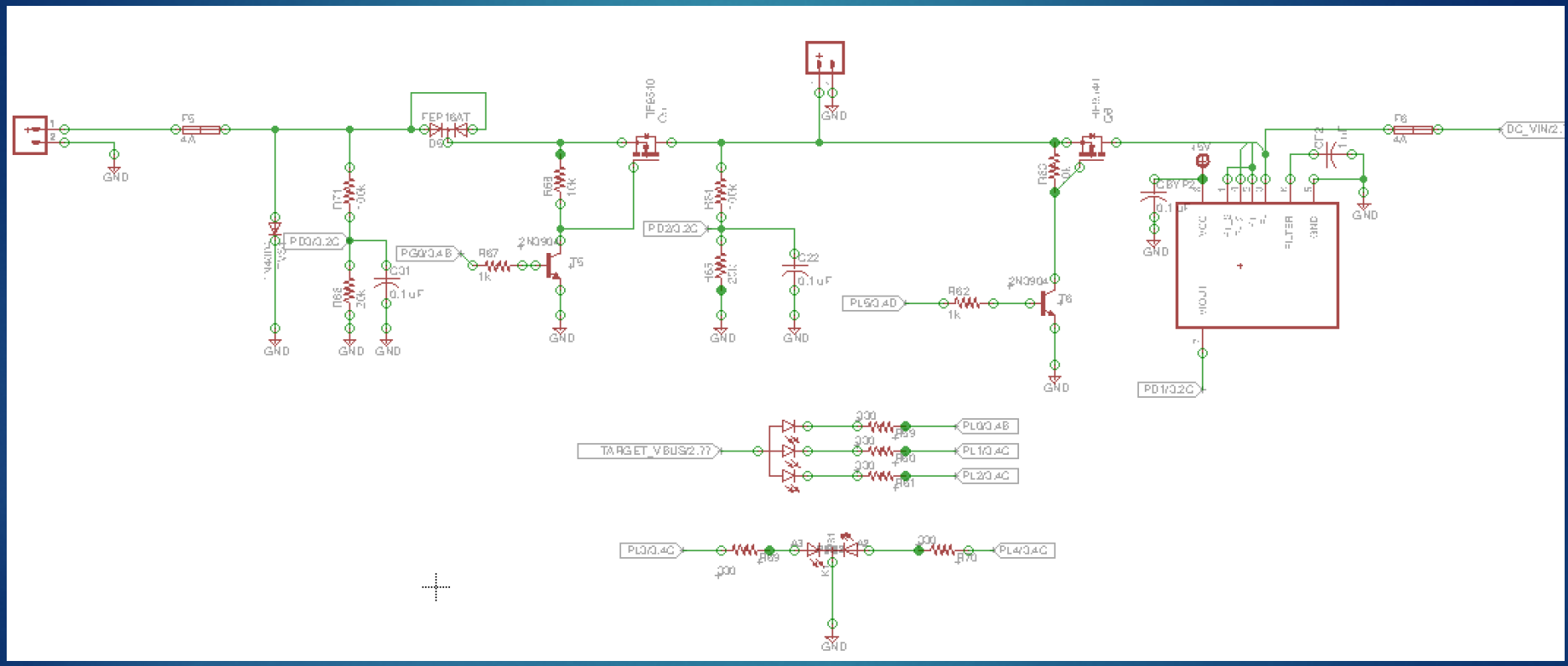
Charge Controller

- PWM (Pulse-Width Modulation) Design
- Suitable up to 100W/12V panel
- Customizable charging modes
- LED indicators for state of charge and load status
- LCD Display:
  - Battery voltage
  - Panel voltage
  - Load Current
  - Load values: Watts, Watt hours
  - Temperature (near battery)

Charge Controller

- Voltage dividers utilized to sense battery and solar panel voltage
- Panel voltage compared to battery voltage, if greater, charging takes place
- Based on voltage level of battery, current is either maximized or limited by IRF9540 MOSFET
- Load current sensed by ACS712ELCTR-05B-T
- If battery drains too low, load is disconnected

Charge Controller



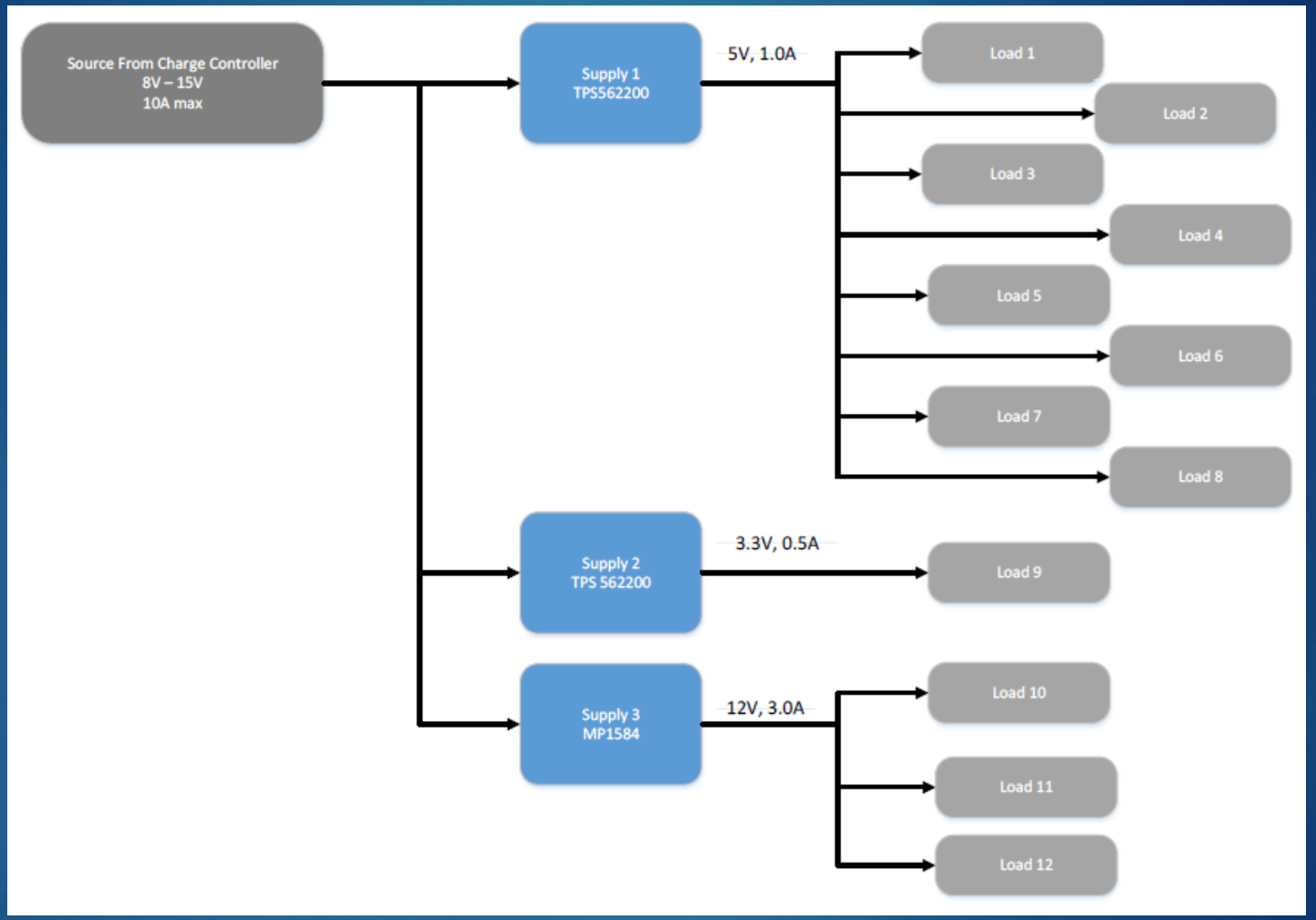
Battery Bank

- 12V/18 Ah
- If under full load, will provide continuous power for 4 hours (if drained to 0% from full charge)
- Sealed Lead Acid
- Compact Size
- Maintenance free

Power System Challenges/ Improvements

- Calibration Issues
  - Voltage
  - Current
  - Temperature (Surface mount vs through hole)
- More testing
  - Integration
- Full test with battery and solar panel testing duration of run time
- Ensure charging algorithm is robust

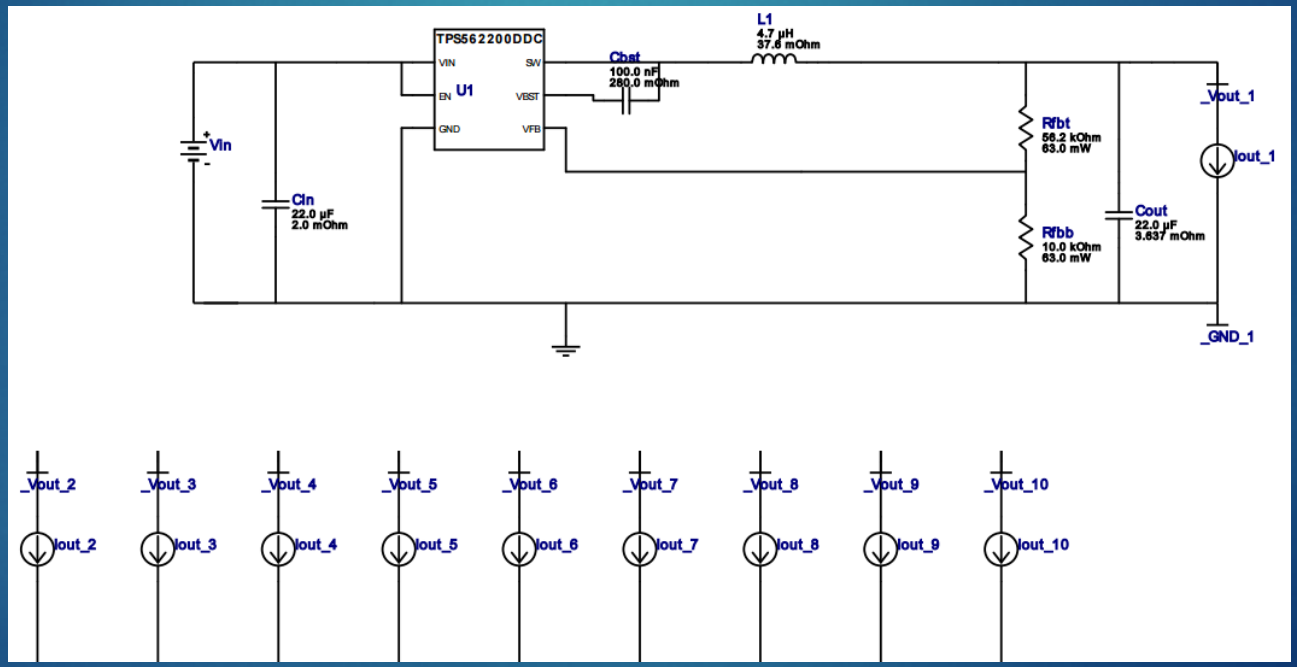
DC-DC Converter



DC-DC Converter Layout

DC-DC Converter

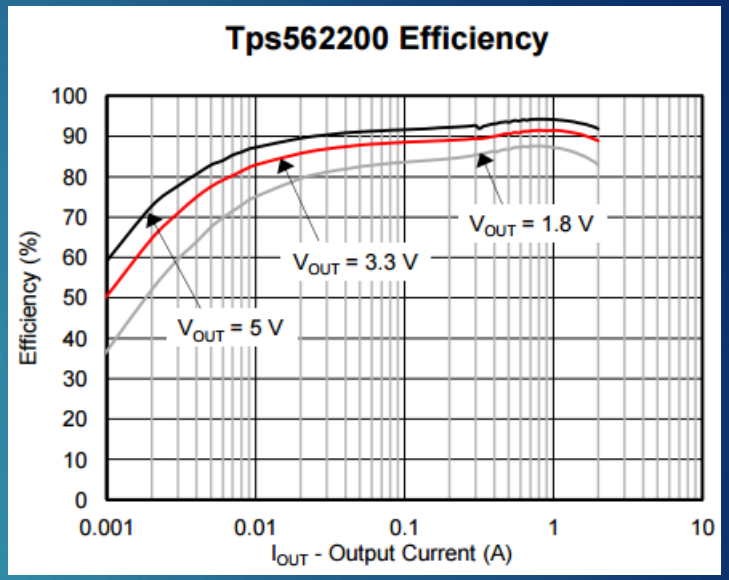
- TPS 562200: 5V, 1A synchronous step-down buck converter
- Sensor and MCU applications
- Efficiency 93.3%

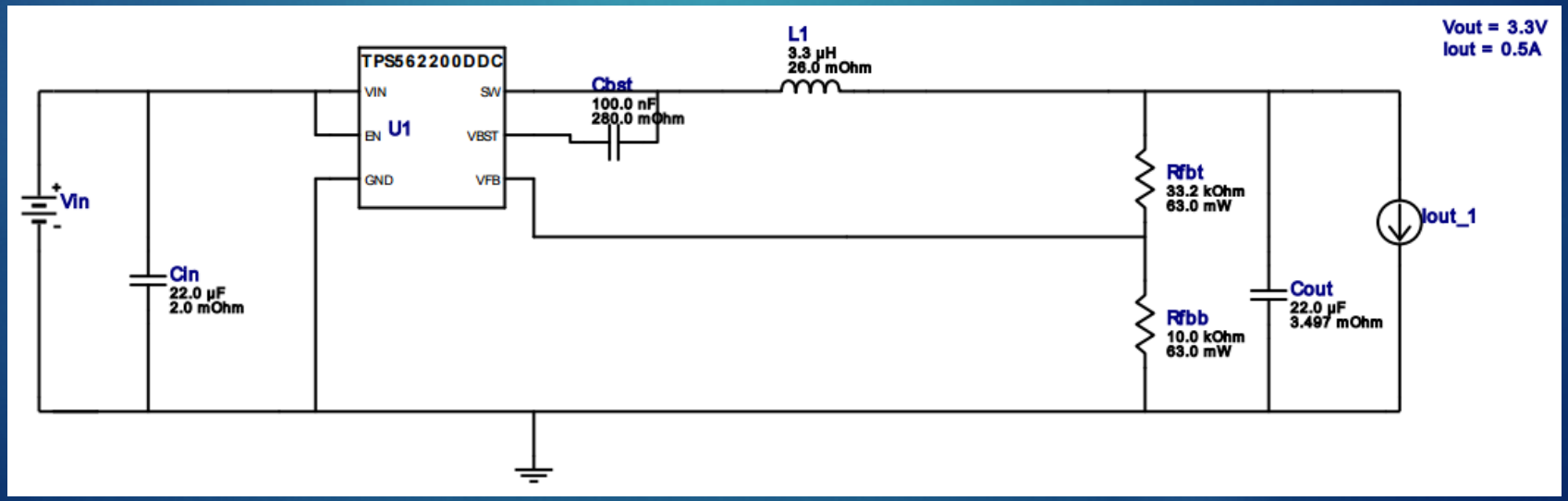


Supply 1

DC-DC Converter

- TPS 562200: 3.3V, 0.5A synchronous step-down buck converter
- Wi-Fi Controller and applications
- Efficiency 90.2%

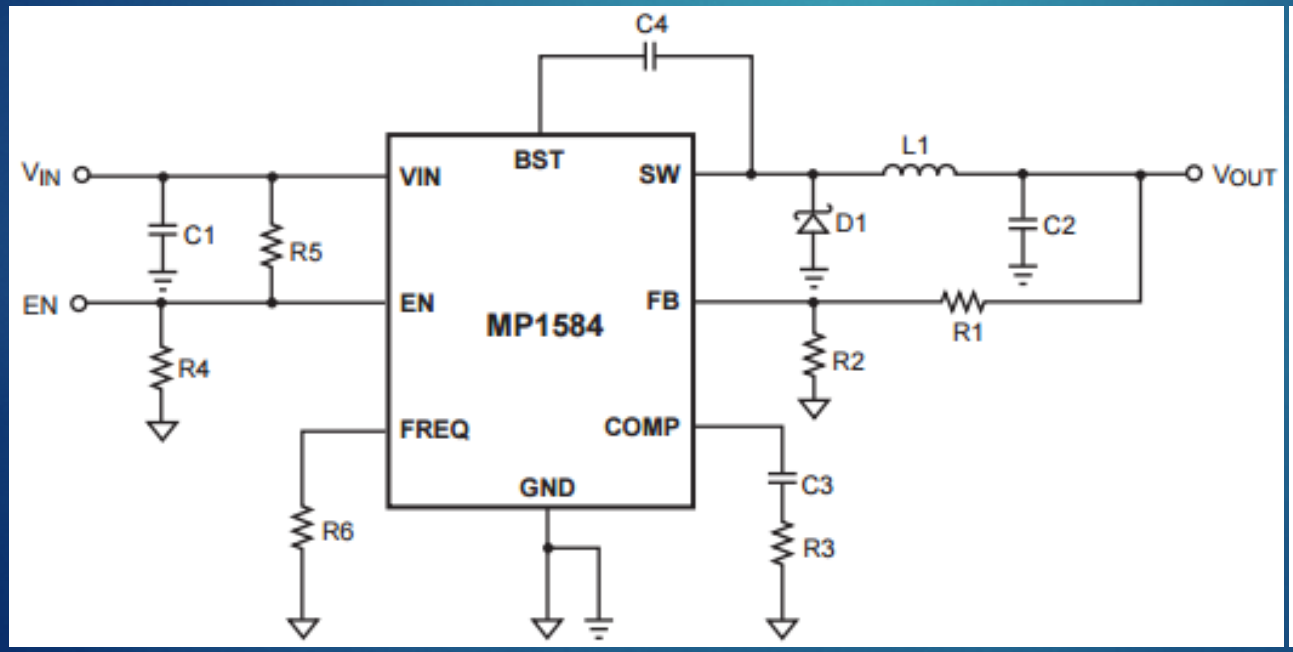


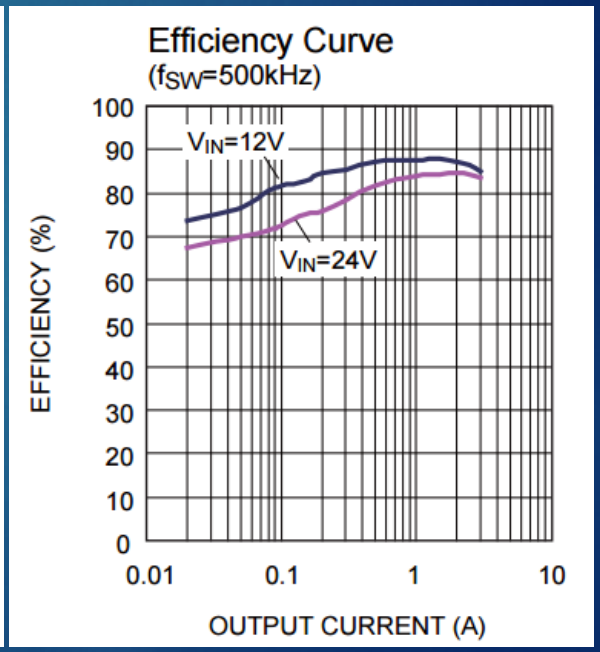


Supply 2

DC-DC Converter

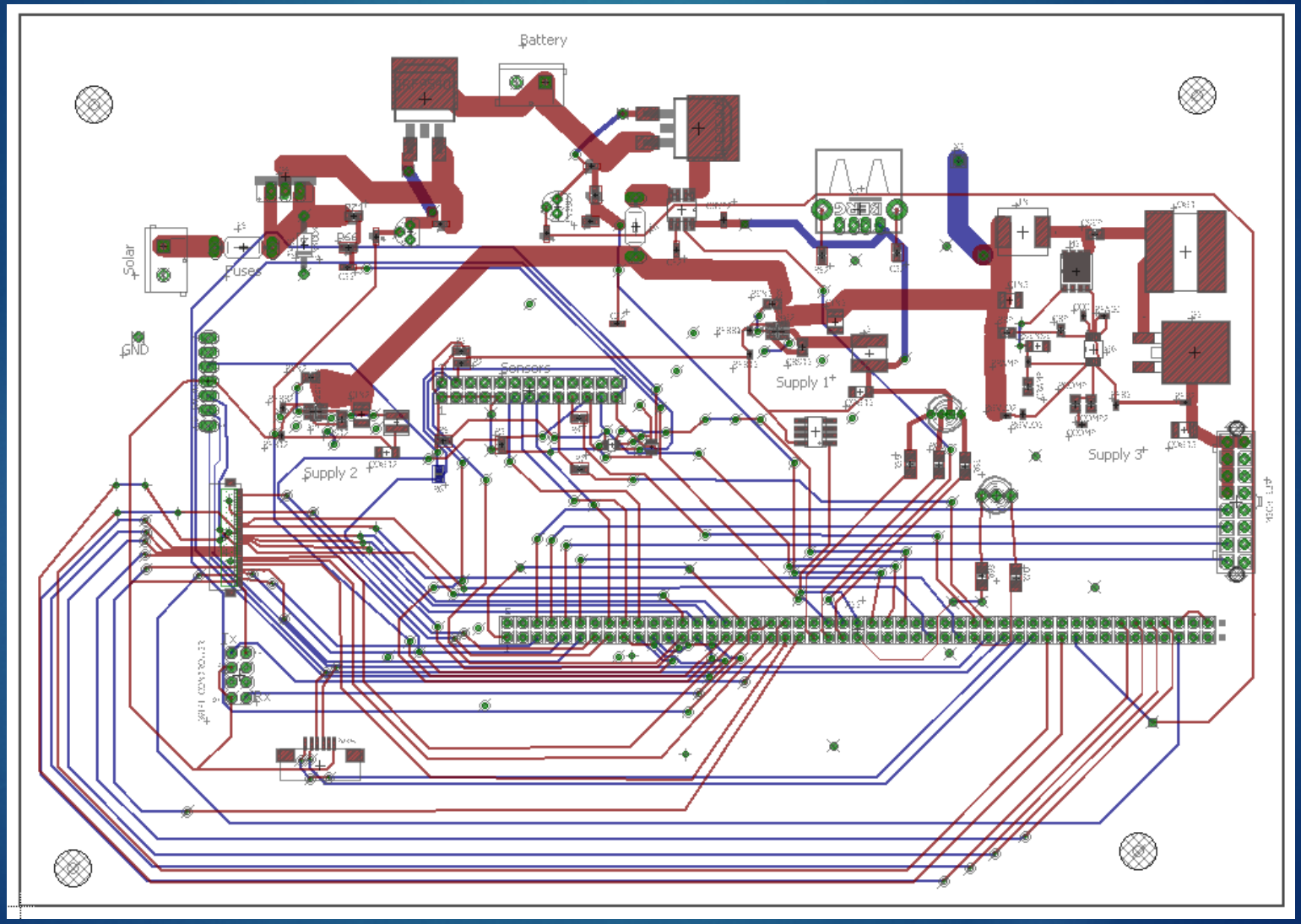
- MP1584: 12V, 3A high frequency step-down switching regulator
- Mechanical devices and relay board
- Efficiency 85%





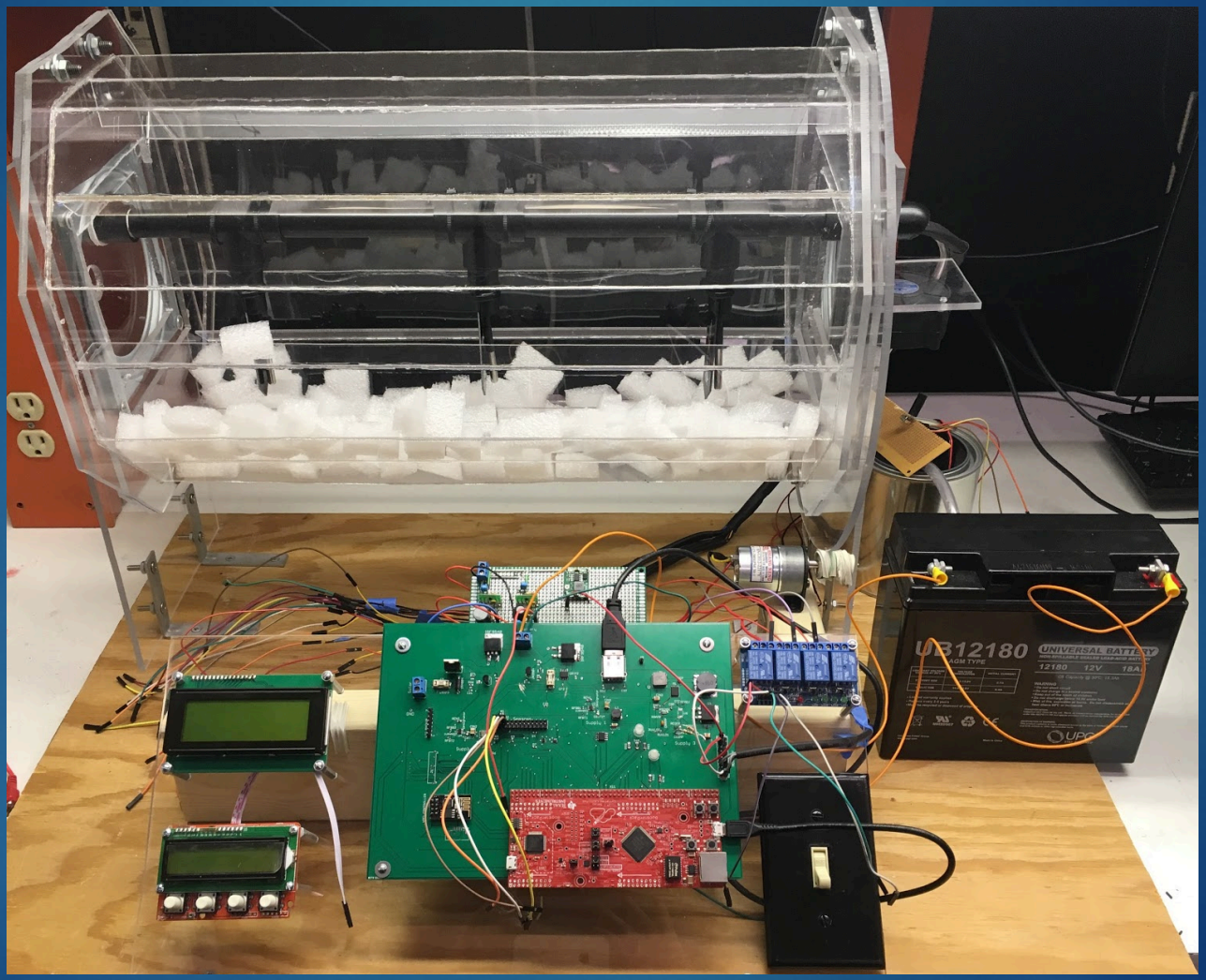
Supply 3

Printed Circuit Board



AACM System's PCB

Mechanical Design

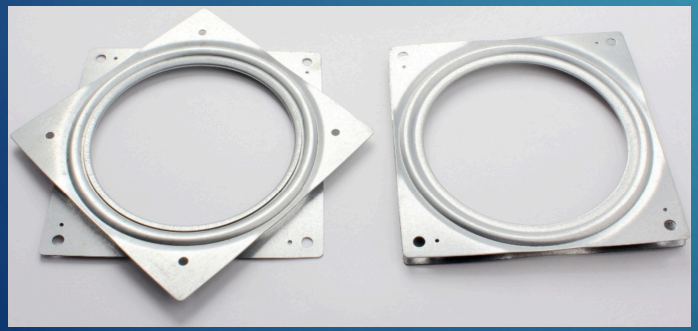


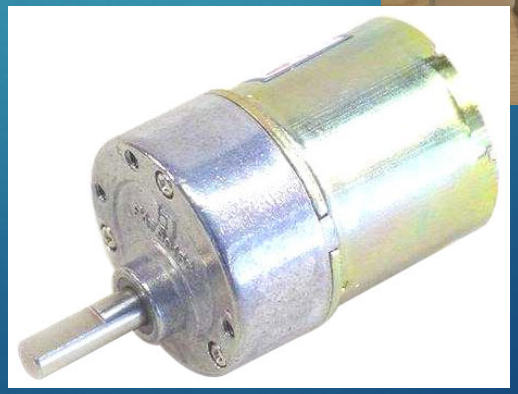
Mechanical Considerations

- Access to material that is also in a sealed container
- Ability to mix material distribution evenly
- Sensor protection and positioning
- Stable mounting and rotation
- Air flow and water distribution
- Acrylic utilized for system visibility

Mixing Mechanism

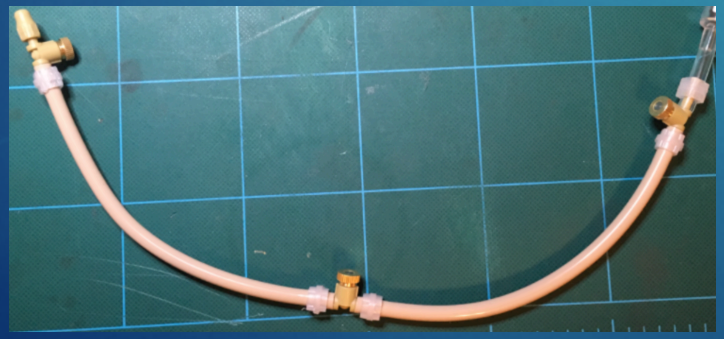
- Mixing Chamber
  - 20" length x 15 3/4" height of overall system
  - 19 3/8" blades inside chamber to mix material
- Motor
  - 12V DC motor with circular sprocket
- "Lazy Susan" type rotating bearings (6")
  - Enables stationary supports and rotation





Environmental Control

- Water Container & Pump
  - Cylindrical metal container
  - IR emitter measures water level
  - 4.8W; 400mA @ 12V
  - 2 inlets – input/output
  - Submersible
- Misting Pipeline
  - 3 misting points misting points
- 12V Fan (0.18A)



Mechanical Challenges

- Container
  - Manufacturing
  - Custom design
    - Rotation
    - Horizontal assembly
- Misting Pipeline
  - Misting valves + pump combination

Administrative Content

WORK DISTRIBUTION, BUDGET/FINANCE, PROGRESS

Work Distribution

Name	Power System	Mobile App / Wireless Communications	Hardware System	Embedded Control Systems
Matthew	P		S	
Cody		P		s
Shayna	S		P	
Thomas		s		P

P = Primary
S = Secondary

Budget

System	Description	Estimated Price	Actual Price
Wireless Communications	ESP8266 Wi-Fi Network Processor (Espressif	$23.23	$6.95
Power System	Solar Panel, Charge Controller, Battery	$235.67	$216.34
MCU	Tiva-C Launchpad, TM4C Microcontroller	Free	Free
Sensors	IR Recevier/LED, Moisture Sensor, Temperature Sensor	$35.62	$29.70
LCD	NewHavenDisplay Touch Display, Controller Board, Ribbon Cables, Molex Connectors	$63.95	$88.95
Mechanical System	Motor, Container, Water Tank, Water Pump, Misting Assembly, etc.	$392.98	$300.80
Total		**$751.45**	**$655.05**

Questions?