Easy Park

Group 26

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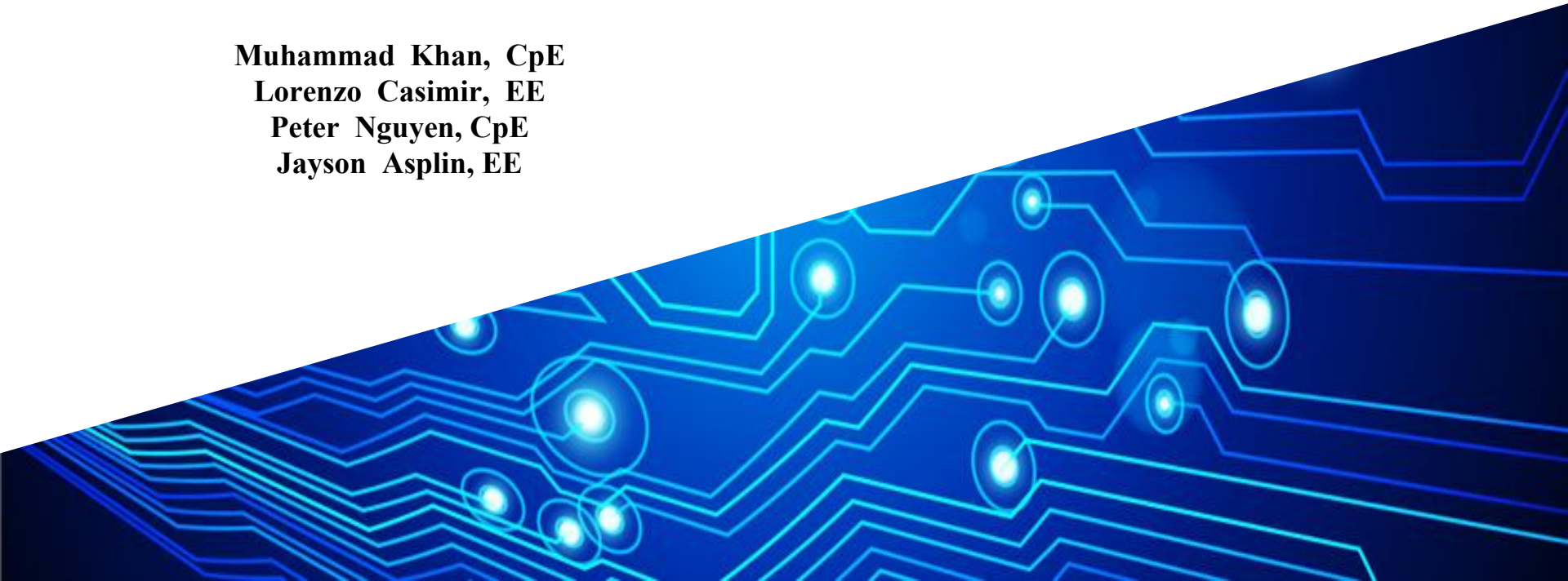


Motivation

- For years on end, students and faculty complain about on campus parking.
- To alleviate the stress of parking during peak times.
- To reduce the amount of time to find parking.
- To relieve traffic congestion around campus.

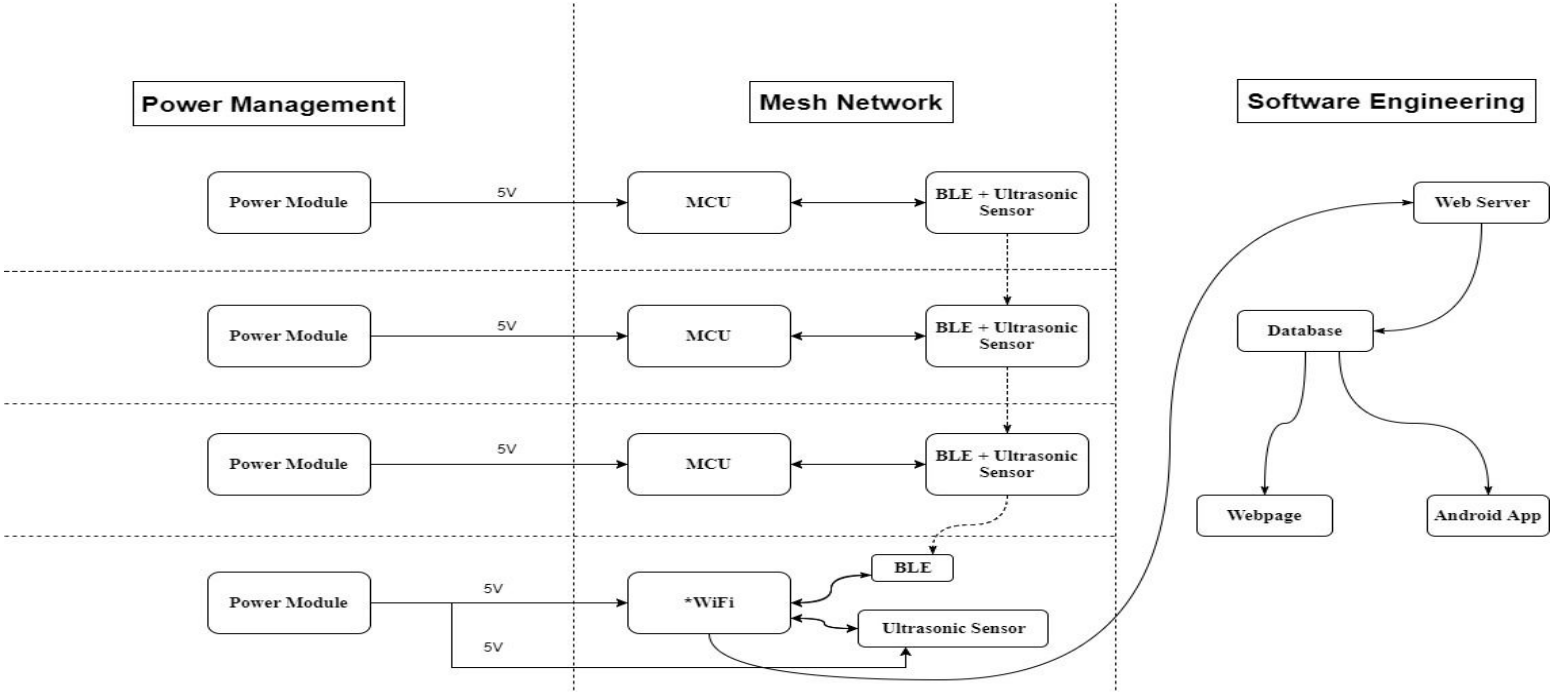
Goals & Objectives

- Implement the use of sensors, or a deep learning algorithm, to detect occupied parking spaces.
- Retrieve the data from the low-powered microcontroller back to a server of any parking space(s) available.
- Design a system that is low cost and low-powered.
- App capability for monitoring parking occupancy in real time.
- Energy harvesting without using power provided by UCF.
- Low maintenance frequency.

Specifications and Requirements

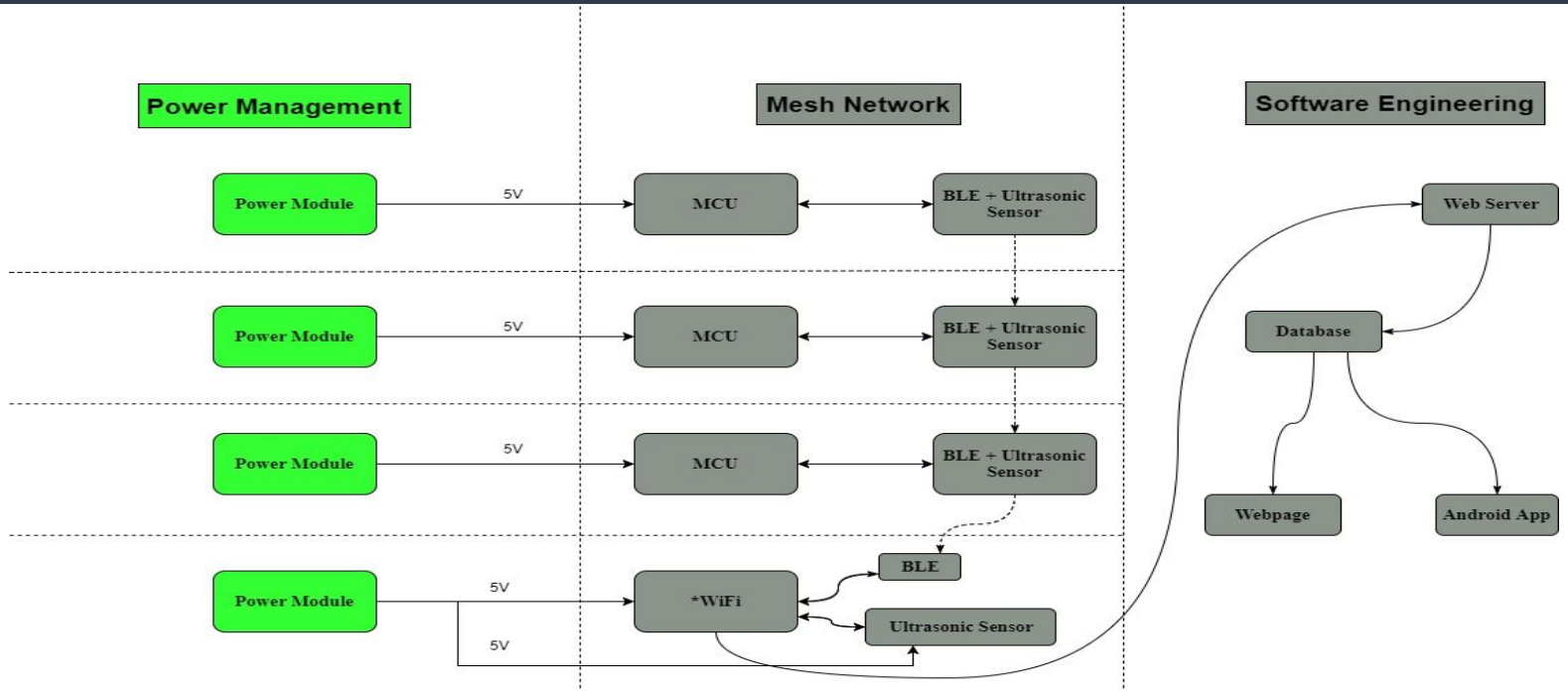
L,W = 5 in by 4 in
Thickness < 2 in
Power Dissipated Max < 0.5W
App update rate ~ 10 sec
Sensing Range > 2 ft
Weight < 1 lbs

Main Block Diagram



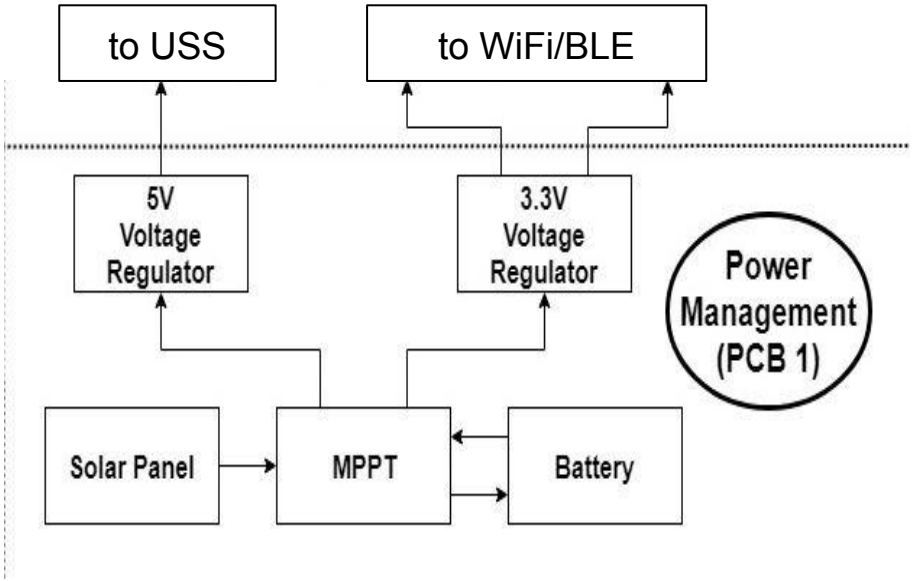
*The WiFi module has a built-in MCU that would be utilized instead of the ATMega.

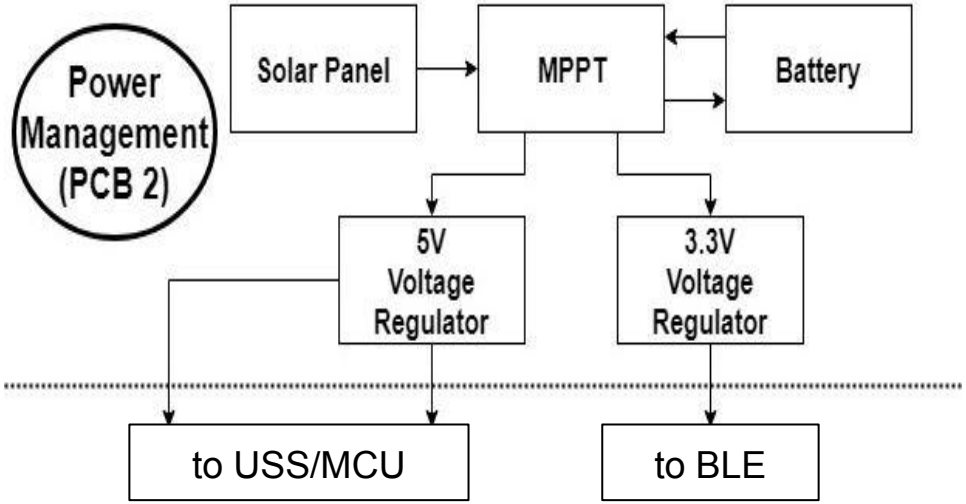
Power Management Components



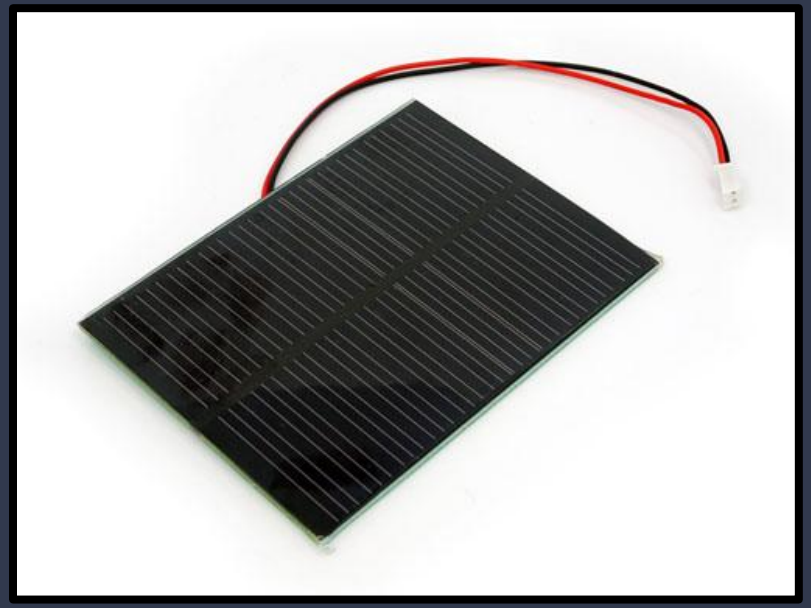
*The WiFi module has a built-in MCU that would be utilized instead of the ATMega.

Power Module Components





Solar Panel Selection



Monocrystalline 1W Solar Panel
Mtr. Seeed Studio

FEATURES

Dimension: 100x80x2.5(±0.2) mm

Efficiency: 15.5%

Typical peak power: 0.935W

Typical voltage: 5.5V

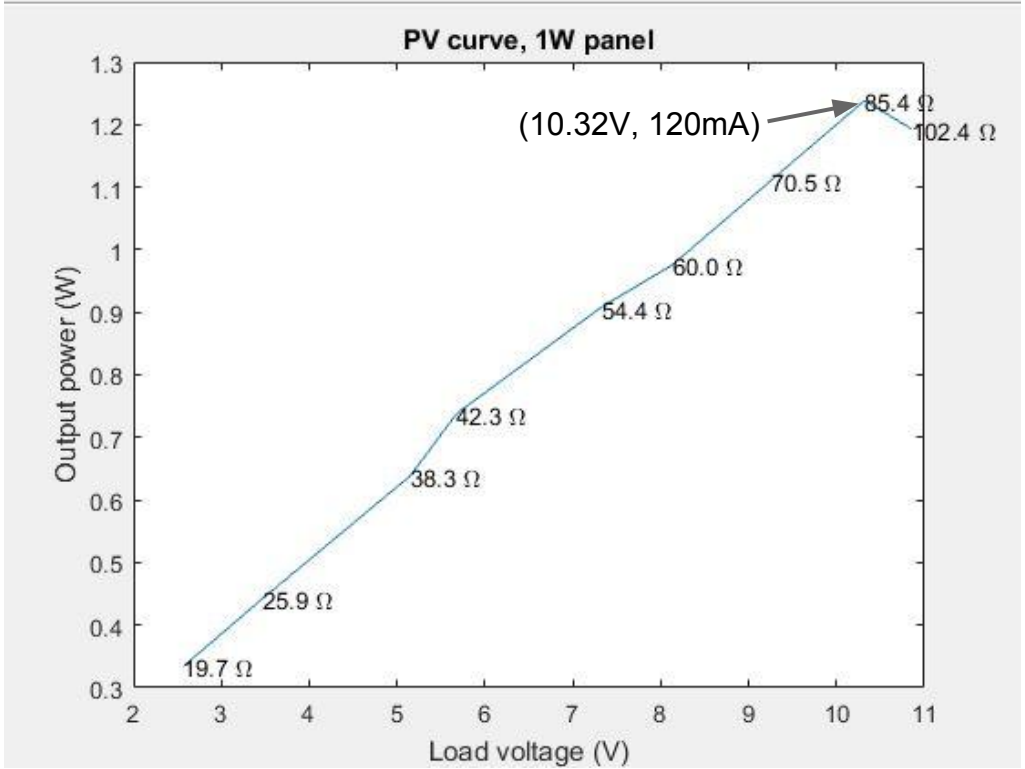
Typical current: 170mA

Open-circuit voltage: 8.2V

Maximum load voltage: 6.4V

Weight: 33g

Cost: $4



This plot illustrates the PV curve testing the two 1W panel in series with a range of resistor loads from 19.1 ohms to 102.4 ohms.

We found the maximum power point around (10.32V, 120mA) using a 80.4 ohm, 2W load resistor.

PV Curve, 1W Panel Testing

Battery Selection

EBL 840 9V Li-ion

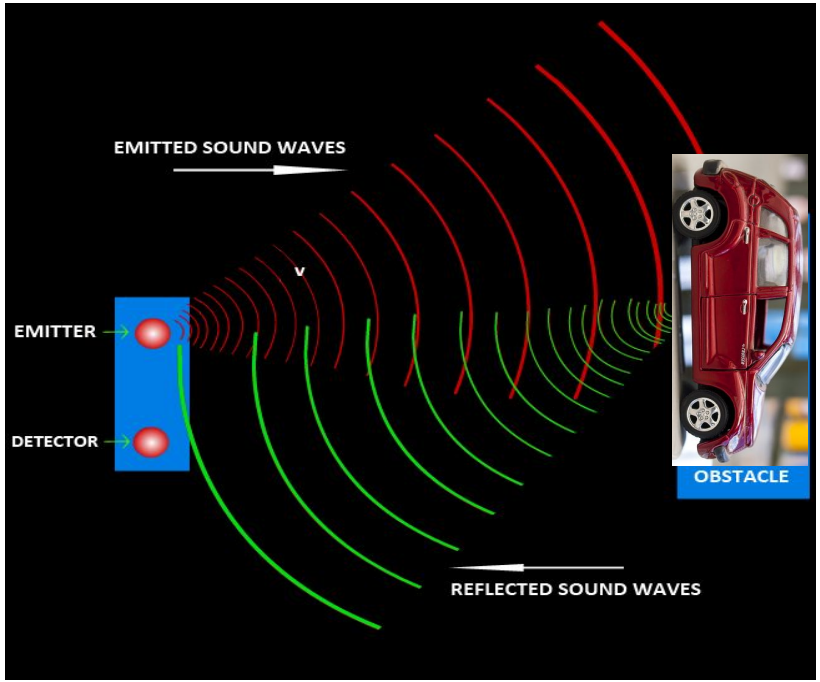
- Rated capacity: 600 mAh
- Estimated battery life: ~5 hours
- Protection provided
- Cost: ~$4.75

Ipower IP 9V Lithium Polymer (LiCoO2)

- Rated capacity: 700 mAh
- Estimated battery life: ~5.5 hours
- Protection provided
- Cost: ~$19.95

HC-SR04 Ultrasonic Module

Features	Specifications
Operating Voltage	5VDC
Operating Current	15mA
Effectual Angle	<15°
Measuring Angle	30°
Min-Max Range	2cm-4m
Dimension	45mm x 20mm x 15mm
Cost	$3 ea.



MPPT Selection

BQ24650 Solar Battery Charge Controller

- 5V to 28V Input Solar Panel.
- 2.1-V to 26-V Battery Charge Voltage.
- 10A Charge Current (Max).
- Switch-Mode Buck Control Topology.

Regulator Chips

TLV62568DBVR

- Input Voltage: 2.5V - 5.5V
- Output Voltage: 0.6 to Input
- Efficiency: Up to 95%
- Overcurrent Protection
- Soft Start Current
- Cost: $0.38

TPS560200DBVR

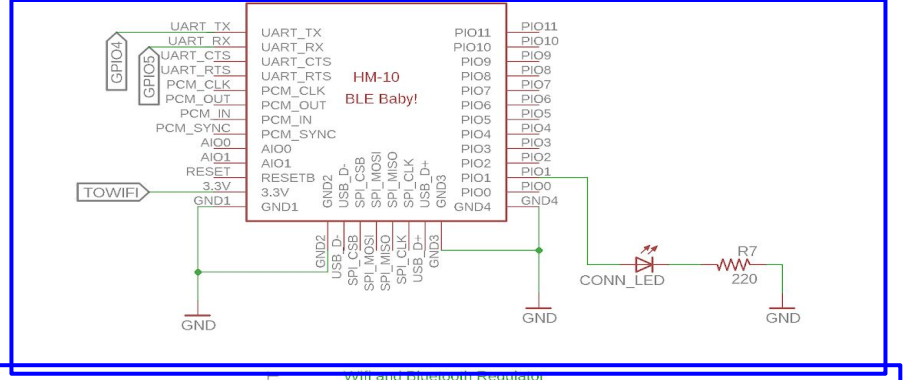
- Input Voltage: 4.5V - 17V
- Output Voltage: 0.8V to 6.5V
- Efficiency: Up to 90%
- 500mA Current
- Soft Start Time: 2ms
- Cost: $0.32

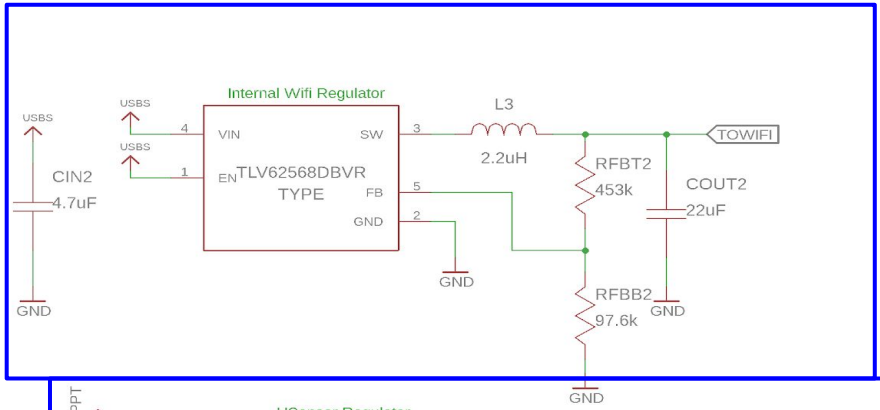
TPS56220(0,1,8)DDCR

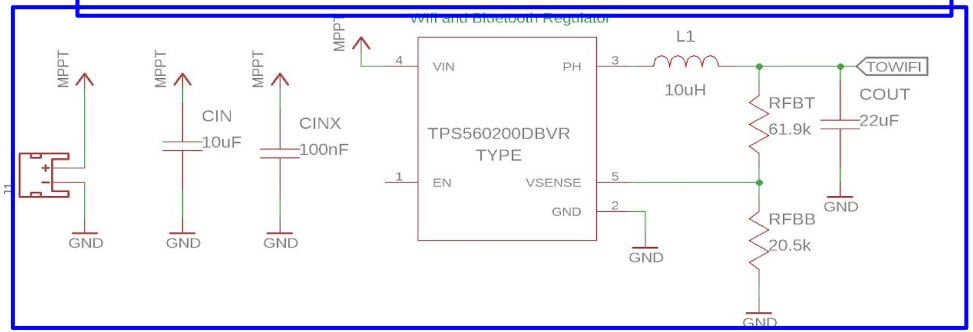
- Input Voltage: 4.5V - 17V
- Output Voltage: 0.76V to 7V
- Efficiency: Up to 95%
- Advanced Eco at low loads
- Soft Start time: 1ms
- Cost: $0.35

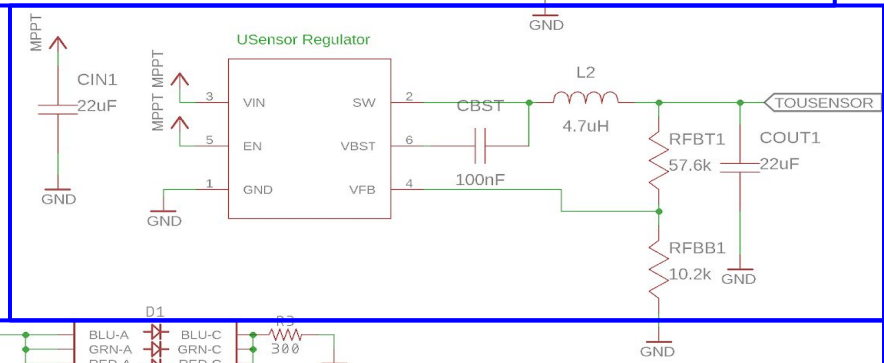
Main PCB with Wifi

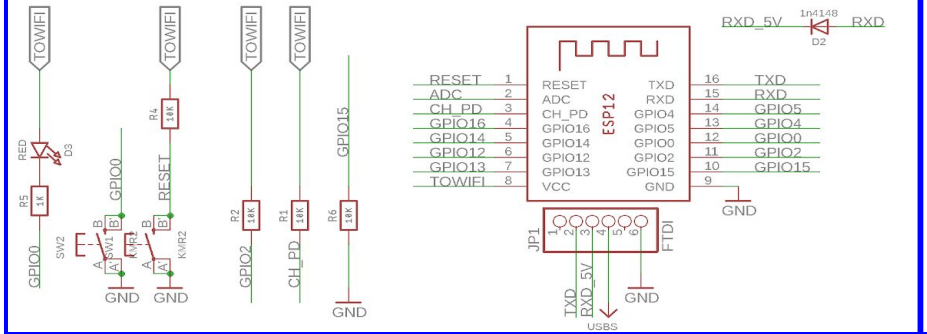
(Schematic & PCB Layout)

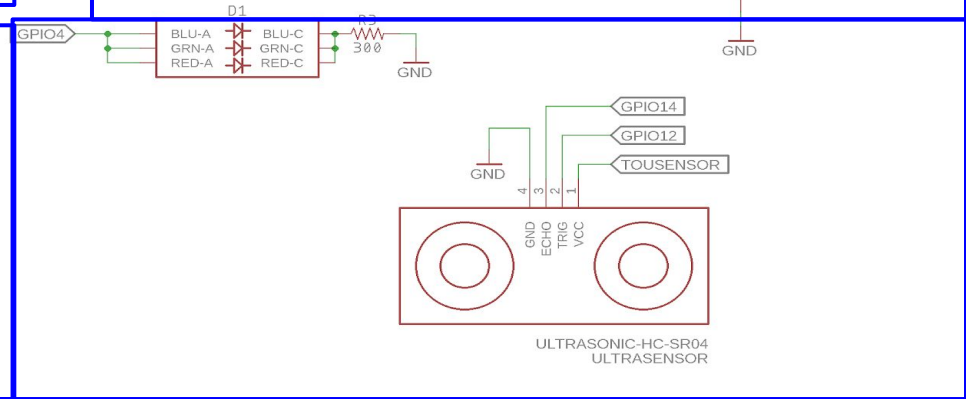

HM-10
BLE Baby!
UART_TX
UART_RX
UART_CTS
UART_RTS
PCM_CLK
PCM_OUT
PCM_IN
PCM_SYNC
AIO0
AIO1
RESETB
3.3V
GND1
GND2
USB_D-
SPI_CSB
SPI_MOSI
SPI_MISO
SPI_CLK
USB_D+
GND3
PIO11
PIO10
PIO9
PIO8
PIO7
PIO6
PIO5
PIO4
PIO3
PIO2
PIO1
PIO0
GND4
GPIO4
GPIO5
TOWIFI
CONN_LED
R7
220
GND

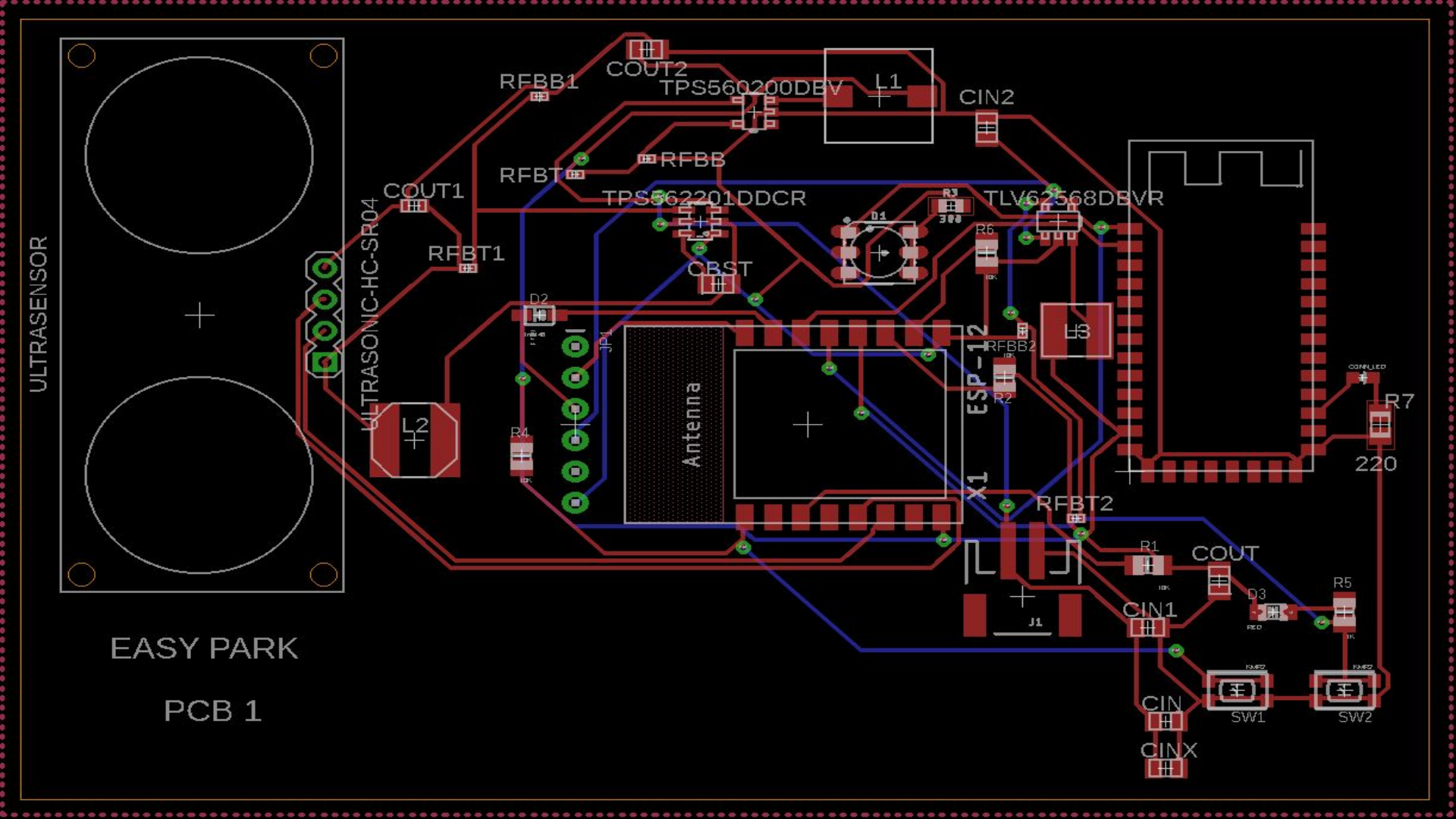

Internal Wifi Regulator
TLV62568DBVR
TYPE
USBS
VIN
SW
EN
FB
GND
CIN2
4.7uF
L3
2.2uH
RFBT2
453k
COUT2
22uF
RFBB2
97.6k
TOWIFI
GND


Wifi and Bluetooth Regulator
TPS560200DBVR
TYPE
MPPT
VIN
PH
EN
VSENSE
GND
CIN
10uF
CINX
100nF
L1
10uH
RFBT
61.9k
COUT
22uF
RFBB
20.5k
TOWIFI
J1
GND


USensor Regulator
MPPT
CIN1
22uF
VIN
SW
EN
VBST
GND
VFB
CBST
100nF
L2
4.7uH
RFBT1
57.6k
COUT1
22uF
RFBB1
10.2k
TOUSENSOR
GND

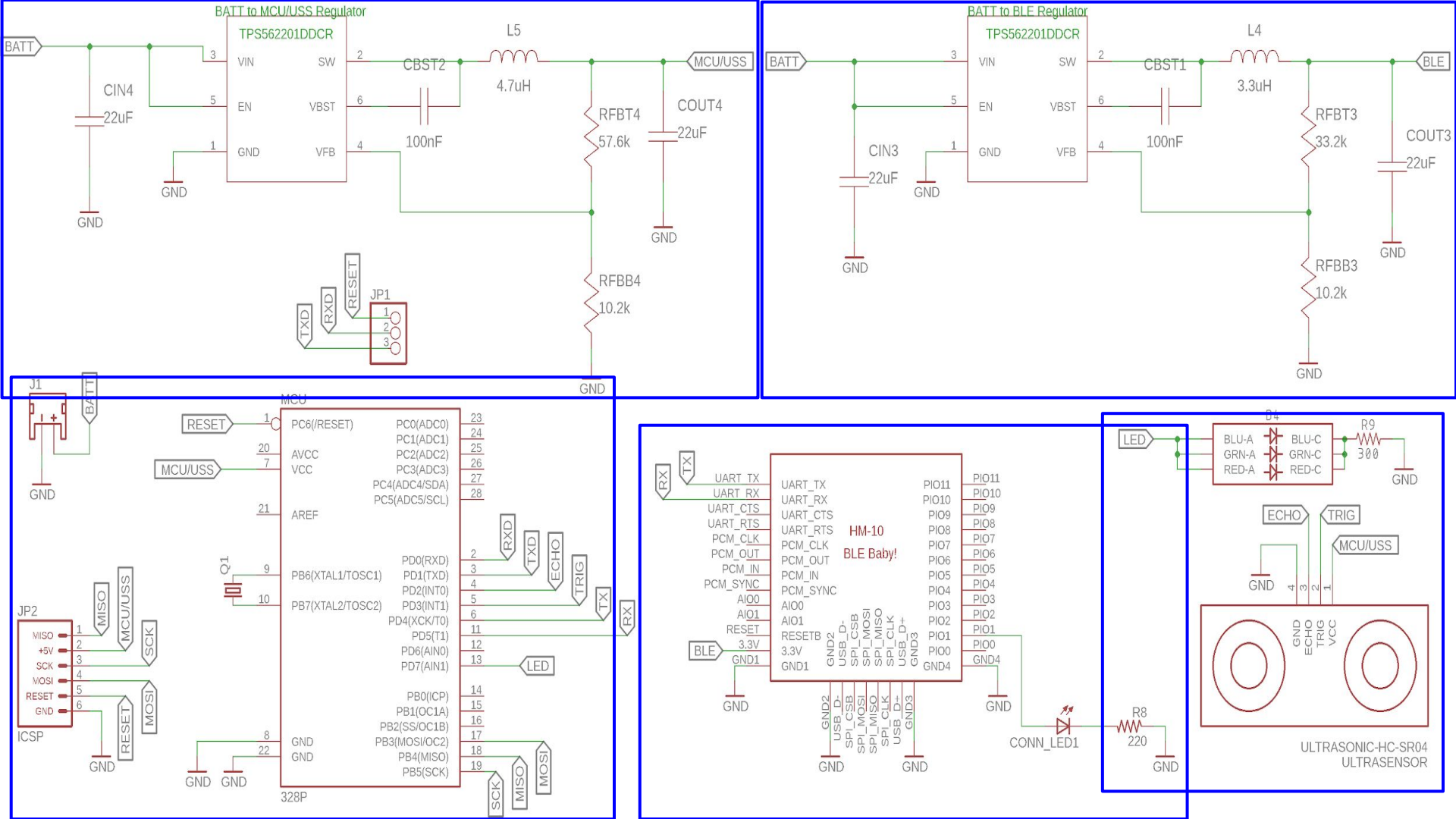

TOWIFI
RED
D3
R5
1K
GPIO0
SW2
R4
10K
RESET
R2
10K
GPIO2
R1
10K
CH_PD
R6
10K
GPIO15
GND
RESET
ADC
CH_PD
GPIO16
GPIO14
GPIO12
GPIO13
TOWIFI
ESP12
TXD
RXD
GPIO4
GPIO5
GPIO0
GPIO2
GPIO15
VCC
RXD_5V
1n4148
D2
RXD
JP1
FTDI
USBS

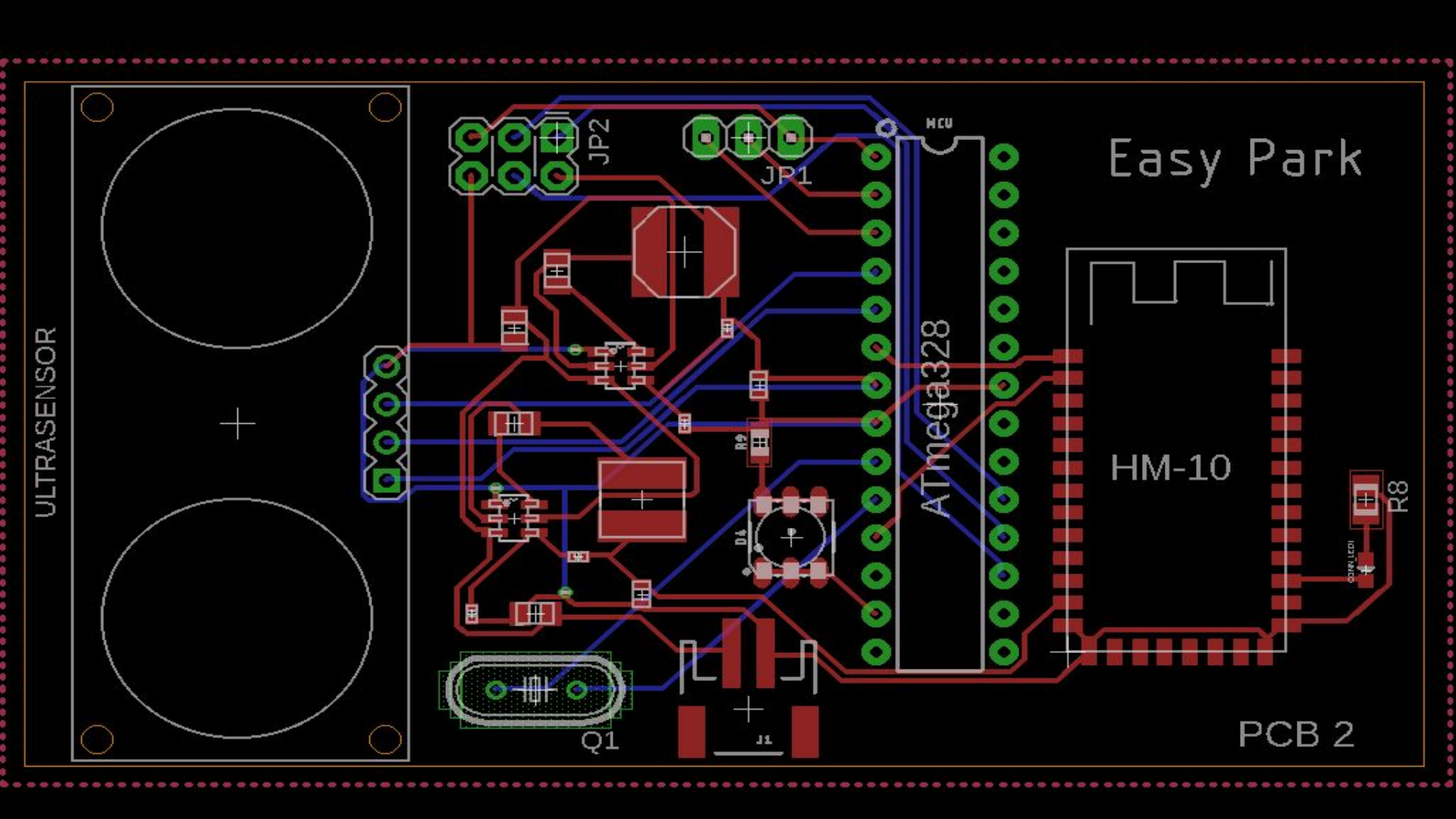

GPIO4
D1
BLU-A
GRN-A
RED-A
BLU-C
GRN-C
RED-C
R3
300
GND
GPIO14
GPIO12
TOUSENSOR
GND
ECHO
TRIG
VCC
ULTRASONIC-HC-SR04
ULTRASENSOR


ULTRASENSOR
ULTRASONIC-HC-SR04
RFBB1
COUT2
TPS560200DBV
L1
CIN2
RFBT
RFBB
COUT1
TPS562201DDCR
TLV62568DBVR
RFBT1
CBST
D1
R3
R6
D2
JP1
L2
R4
Antenna
ESP-12
X1
L3
RFBB2
R2
R7
220
RFBT2
R1
COUT
D3
R5
CIN1
J1
SW1
SW2
CIN
CINX
EASY PARK
PCB 1

Mesh Network PCBs

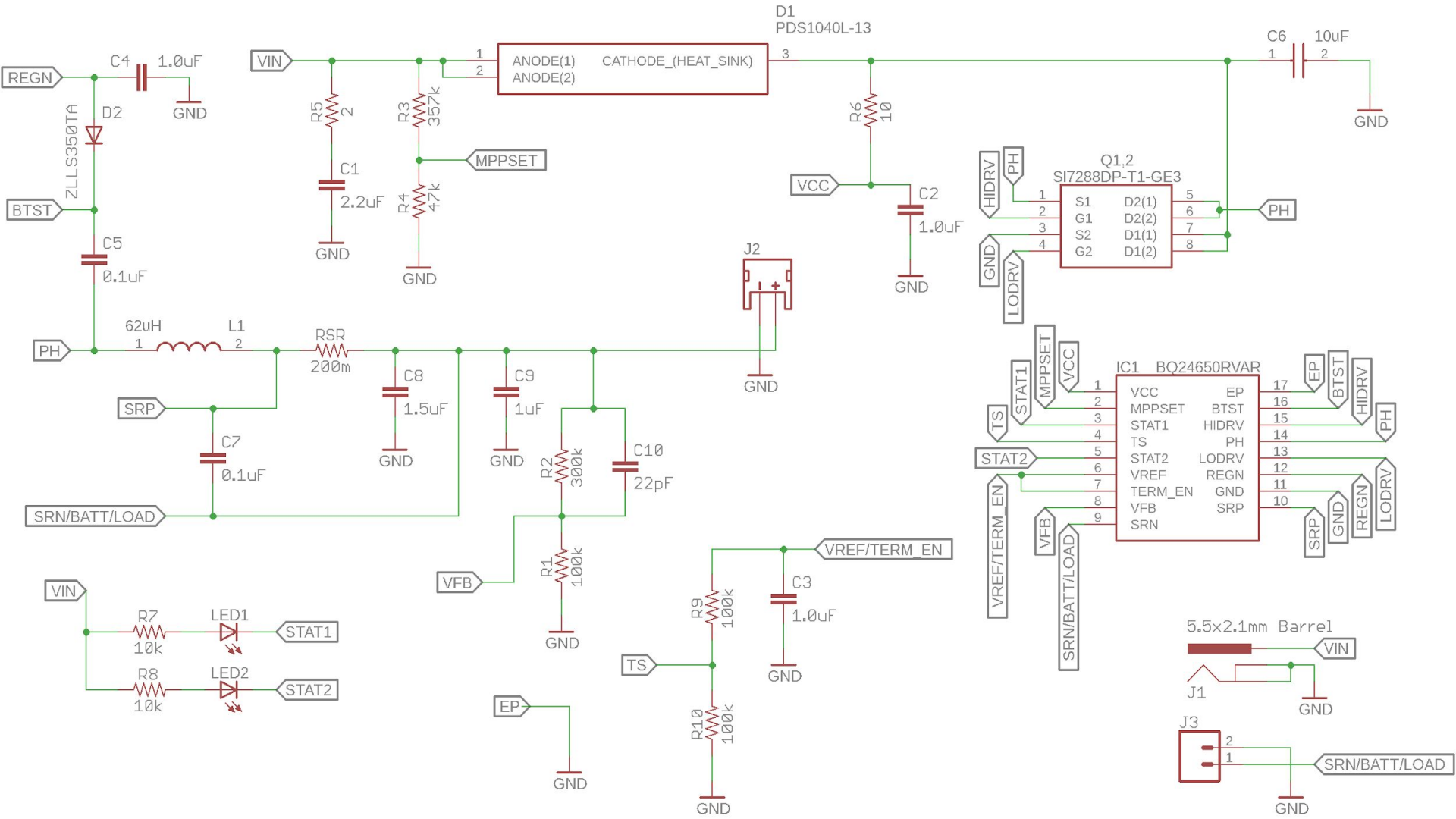
(Schematic & PCB Layout)

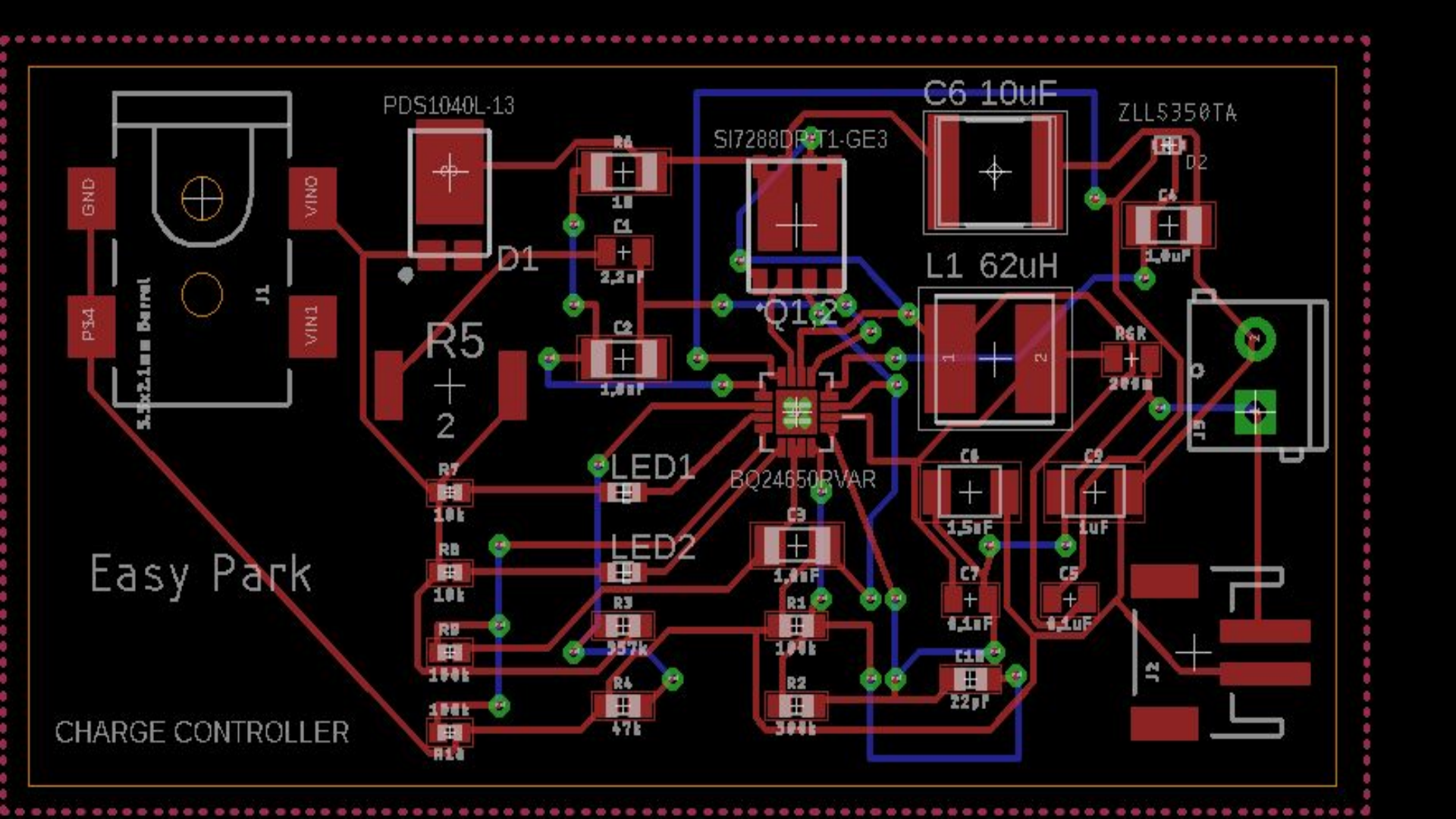

BATT to MCU/USS Regulator
TPS562201DDCR
BATT
VIN
SW
EN
VBST
GND
VFB
CIN4
22uF
CBST2
100nF
L5
4.7uH
MCU/USS
RFBT4
57.6k
COUT4
22uF
RFBB4
10.2k
JP1
RESET
RXD
TXD
BATT to BLE Regulator
CIN3
CBST1
L4
3.3uH
BLE
RFBT3
33.2k
COUT3
RFBB3
10.2k
J1
MCU
PC6(/RESET)
AVCC
VCC
AREF
PB6(XTAL1/TOSC1)
PB7(XTAL2/TOSC2)
PD0(RXD)
PD1(TXD)
PD2(INT0)
PD3(INT1)
PD4(XCK/T0)
PD5(T1)
PD6(AIN0)
PD7(AIN1)
PB0(ICP)
PB1(OC1A)
PB2(SS/OC1B)
PB3(MOSI/OC2)
PB4(MISO)
PB5(SCK)
PC0(ADC0)
PC1(ADC1)
PC2(ADC2)
PC3(ADC3)
PC4(ADC4/SDA)
PC5(ADC5/SCL)
328P
Q1
JP2
ICSP
MISO
+5V
SCK
MOSI
RESET
GND
HM-10
BLE Baby!
UART_TX
UART_RX
UART_CTS
UART_RTS
PCM_CLK
PCM_OUT
PCM_IN
PCM_SYNC
AIO0
AIO1
RESETB
3.3V
GND1
GND2
USB_D-
SPI_CSB
SPI_MOSI
SPI_MISO
SPI_CLK
USB_D+
GND3
GND4
PIO11
PIO10
PIO9
PIO8
PIO7
PIO6
PIO5
PIO4
PIO3
PIO2
PIO1
PIO0
CONN_LED1
R8
220
LED
D4
BLU-A
GRN-A
RED-A
BLU-C
GRN-C
RED-C
R9
300
ECHO
TRIG
MCU/USS
ULTRASONIC-HC-SR04
ULTRASENSOR


Easy Park
ULTRASENSOR
JP2
JP1
MCU
ATmega328
HM-10
R8
R9
D4
Q1
J1
PCB 2

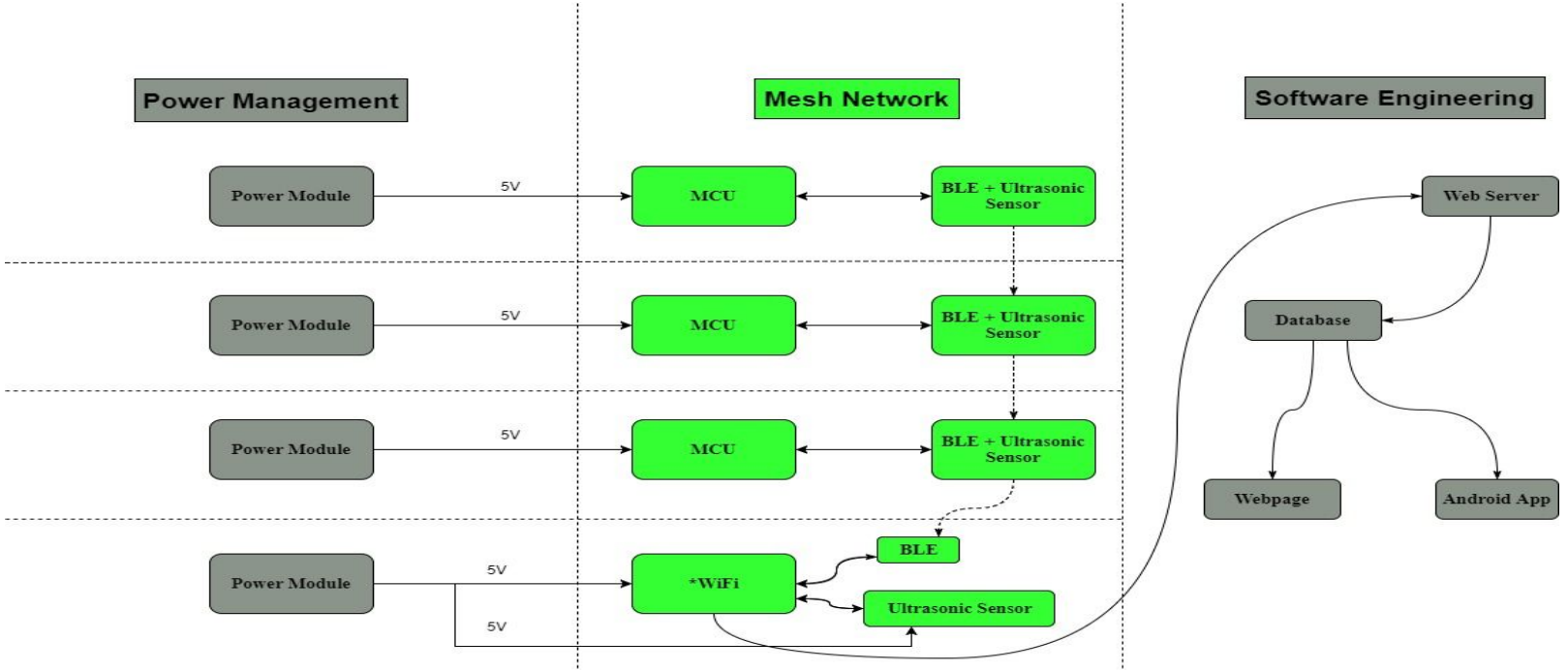
Solar Charger PCB

(Schematic & PCB Layout)


D1
PDS1040L-13
ANODE(1)
ANODE(2)
CATHODE_(HEAT_SINK)
VIN
REGN
C4
1.0uF
GND
D2
ZLLS350TA
BTST
C5
0.1uF
R5
2
C1
2.2uF
R3
357k
R4
47k
MPPSET
R6
10
VCC
C2
1.0uF
C6
10uF
Q1,2
SI7288DP-T1-GE3
S1
G1
S2
G2
D2(1)
D2(2)
D1(1)
D1(2)
HIDRV
PH
LODRV
J2
62uH
L1
RSR
200m
C8
1.5uF
C9
1uF
R2
300k
C10
22pF
SRP
C7
0.1uF
SRN/BATT/LOAD
VFB
R1
100k
IC1 BQ24650RVAR
VCC
MPPSET
STAT1
TS
STAT2
VREF
TERM_EN
VFB
SRN
EP
BTST
HIDRV
PH
LODRV
REGN
GND
SRP
VREF/TERM_EN
C3
1.0uF
R9
100k
R10
100k
TS
R7
10k
LED1
STAT1
R8
10k
LED2
STAT2
5.5x2.1mm Barrel
J1
J3
SRN/BATT/LOAD


PDS1040L-13
C6 10uF
ZLL5350TA
SI7288DP-T1-GE3
D2
D1
L1 62uH
Q1
R5
2
LED1
LED2
BQ24650RVAR
Easy Park
CHARGE CONTROLLER
GND
VIN0
P34
VIN1
J1
J2

Mesh Network Components



*The WiFi module has a built-in MCU that would be utilized instead of the ATMega.

Mesh Network Components Comparison

	Zigbee	**Bluetooth LE**
Current Consumption	~200mA	8.5mA
Range	291m	77m
Transmit Power	100mW	10mW
Network Type	LAN	PAN

ZigBee

Advantages
- Easy to setup mesh network
- Longer Range

Disadvantages
- Higher cost
- High latency

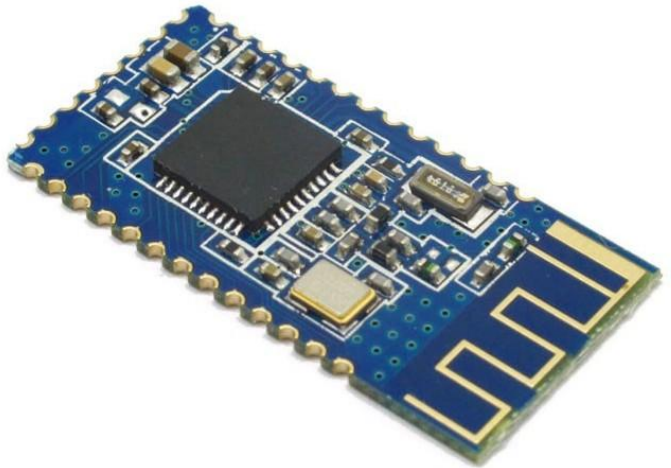
Bluetooth LE

Advantages
- Lower Cost
- More control/ flexibility

Disadvantages
- Shorter Range

HM-10 BLE (Bluetooth Module)

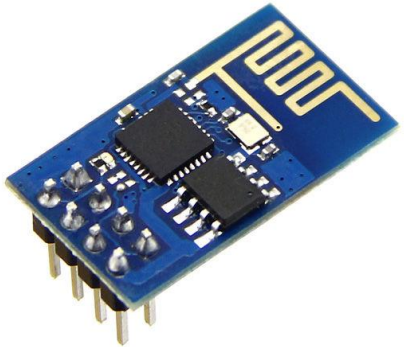
Features	Specifications
Range	100m (open space)
Working Temperature	-5 ~ 65 C
Power (Active Mode)	8.5mA
Input Voltage/Power	+3.3VDC/ 50mA
Power (Sleep Mode)	400uA~1.5mA
Chipset	TI CC2541
Cost	~$7.00



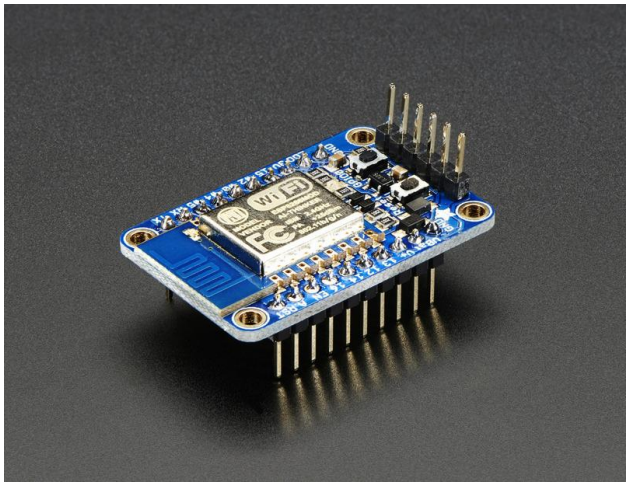
ESP8266 WiFi Module

- Good arduino and community support.
- Somewhat easy to program
- Powerful built-in MCU
- Has quite a few digital pins
- Cost: $3.00

ESP - 01

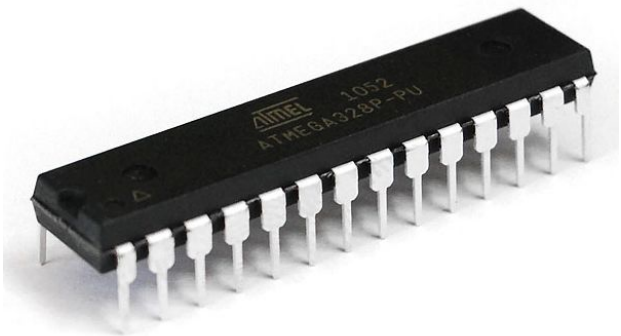


Huzzah ESP - 12F



MCU: ATMega328P-PU

- Multiple digital I/O pins.
- Low power module (especially in deep sleep mode).
- Great arduino library support and sketches.
- Easy to program with other modules.
- Cost: $3.00



LED

5050-G3500 SMD LED

- Input Forward Voltage: 3.2V - 3.4V
- Viewing Angle: 120 Degrees
- Input Current: 20 mA
- Lumens: 11
- Visible Frequency: 50 Hz
- Cost: $0.50

How we programmed the mesh network?

Hardware Serial

- Programmed through AT commands at the serial input stream.
- Usually to test each ultrasonic or bluetooth module.
- Command is executed directly with the module.

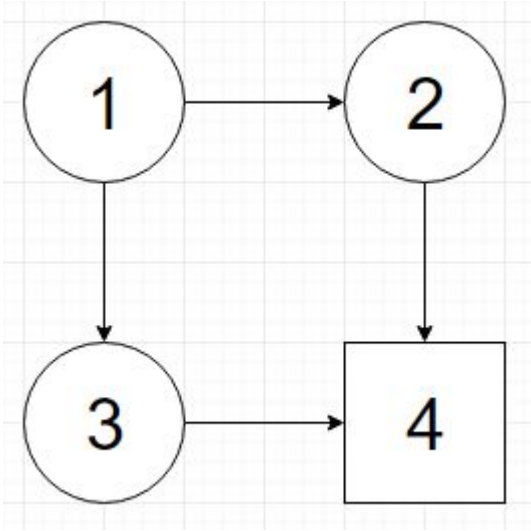
Software Serial

- Programmed through AT commands, but written in code.
- To make the mesh network possible after hardware serial testing is a success.
- Code is stored and flashed at the MCU.

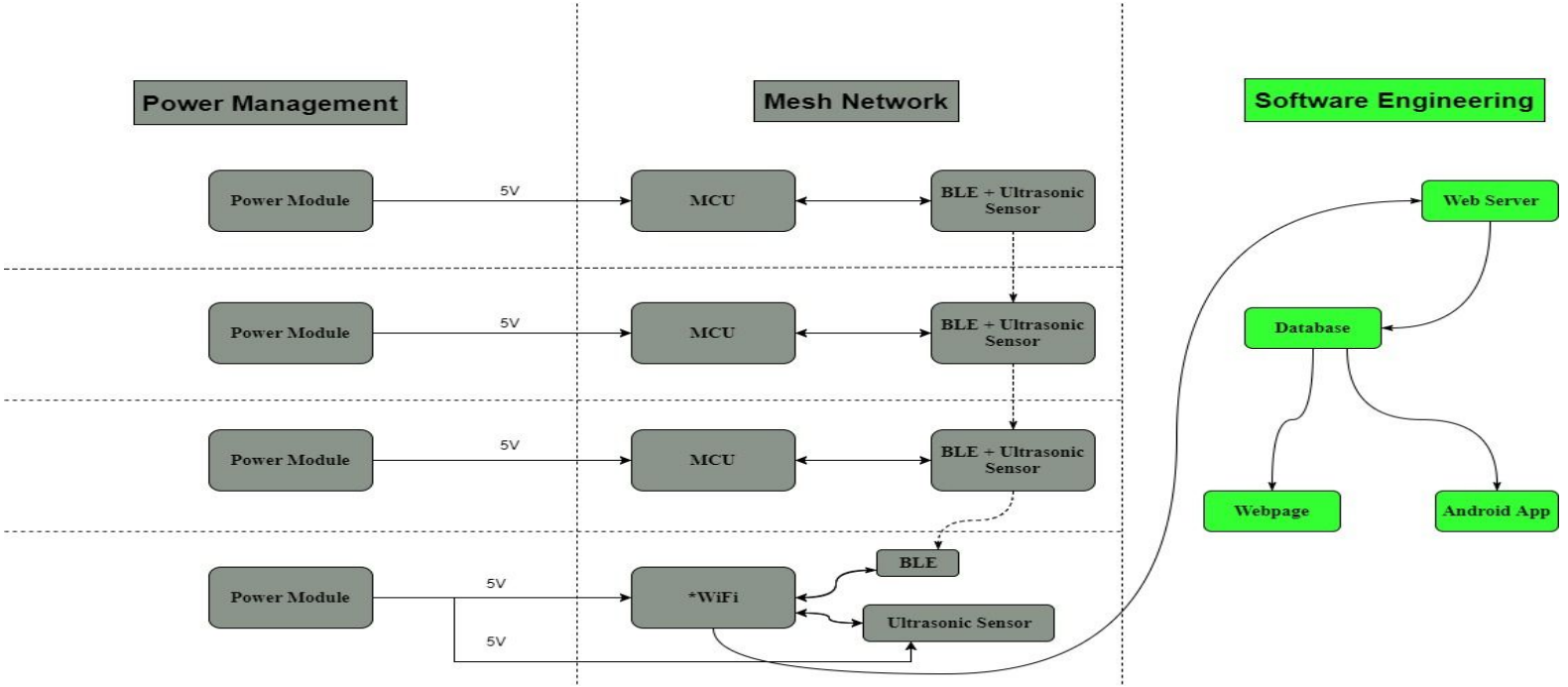
```
void setup(){
  Serial.begin(9600);
  BTSerial.begin(9600); // default baud rate
  while(!Serial);
  Serial.println("AT commands: ");
  delay(1000);
  BTSerial.write("AT");
  delay(500);
  BTSerial.write("AT+IMME1");
  delay(500);
  BTSerial.write("AT+ROLE1");
  delay(1500);
  BTSerial.write("AT+CON3CA308966811");
  delay(5000);
  BTSerial.write("AT");
```

How we programmed the mesh network?

- Ultrasonic sensors detect the difference in distance through sound waves.
- It then triggers BLE communication.
- The BLE will communicate with each other
- The last node will send the data to database/server
- Rudimentary mesh network.



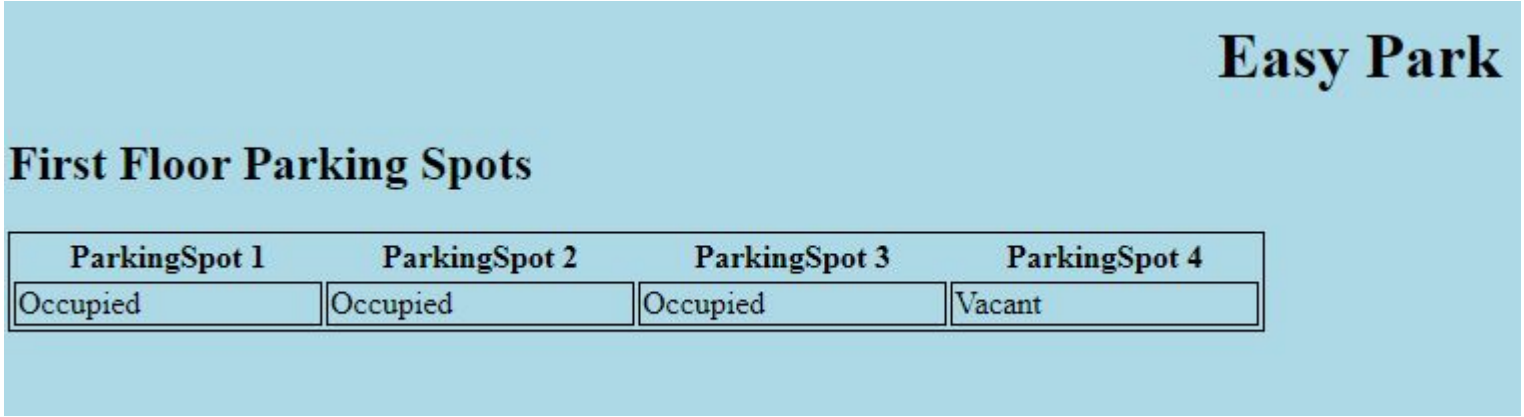
Software Engineering Components



*The WiFi module has a built-in MCU that would be utilized instead of the ATMega.

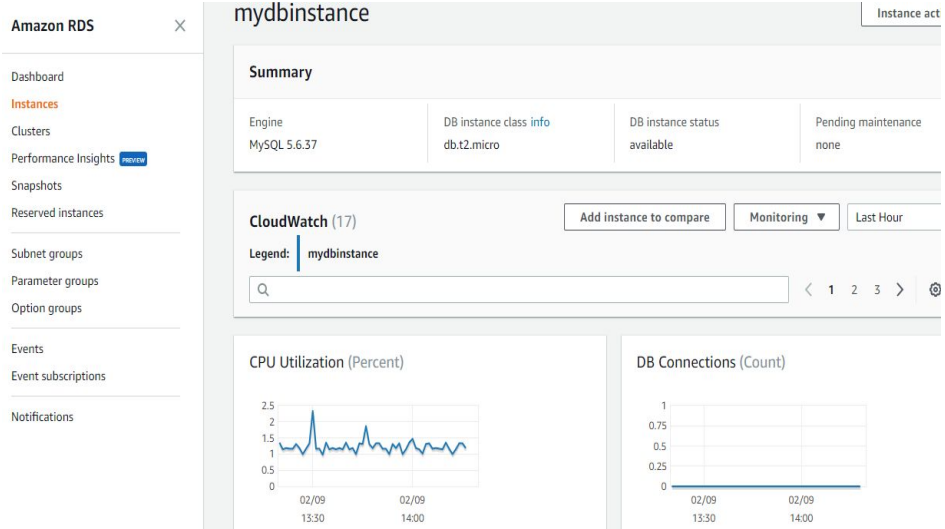
Web Server

- Using a free web hosting domain.
- Specifics are ***www.000webhost.com***
- Web Page shown below (to view the database, written in PHP).
- Arduino communicates with the web server.



Database

- Amazon relational database
- Storage capacity ~ 20GB
- Enough to cover all parking garages at UCF.
- Web server communicates with the database, written in PHP code.



Mobile App

Android Studio

Advantages
- Stronger Platform
- Good Documentation

Disadvantages
- Android only

JQueryMobile

Advantages
- Cross Platform
- Better for mobile applications
- Easy to use/develop

Disadvantages
- Limited capabilities

Bootstrap

Advantages
- Better for web applications
- Easy to use/develop

Disadvantages
- Not good for Mobile applications

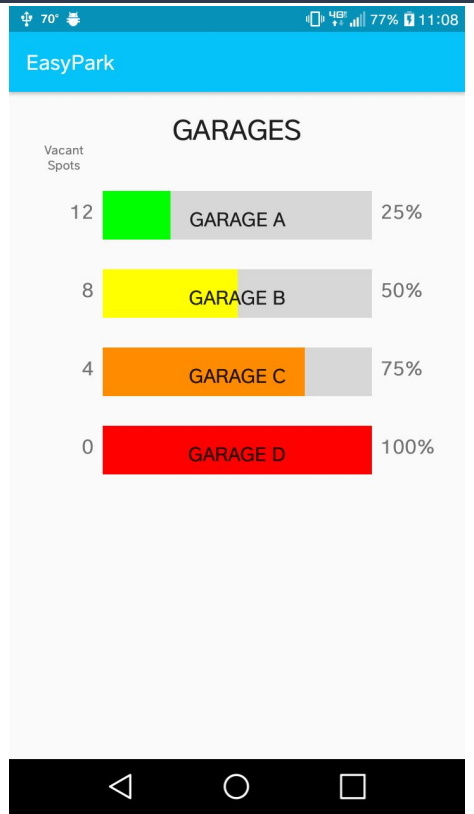
Mobile App

Design Goals

- Keeps eye off app as much as possible
- Easy to use
- Quick to use

Key Features

- Colored progress bar
- Map



Administration

Task Breakdown

	Jayson	Lorenzo	Muhammad	Peter
Wireless Communication	-	-	P	P
Power Systems	P	P	S	-
PCB Design	P	P	S	S
Mobile App	-	-	S	P
Server/Database		-	P	S

P: Primary
S: Secondary

Budget

Parts	Quantity	Unit Price	Development Cost
AMS117-5 Voltage Regulator	10	$0.81	$8.10
AMS117-3.3 Voltage Regulator	5	$1.80	$9.00
Arduino Nano	8	$3.88	$31.04
Barrel Jacks Adapters and connectors	10	$0.67	$6.70
Breadboard	6	$3.32	$19.89
ESP8266 w/ breakout board	3	$4.10	$12.30
ESP-12F w/ breakout board	1	$10.00	$10.00
HC-SR04	10	$1.70	$17.00
HM-10 /w breakout board	4	$10.00	$40.00
Jumper Cables	120	$0.05	$6.00
Solar Buddy (MPPT)	1	$24.95	$24.95
Solar Panels (.5W)	3	$1.95	$5.85
Solar Panels (1W)	5	$3.95	$19.75
Total Cost			**$210.58**

Budget

Parts	Quantity	Unit Price	Development Cost	Build of Material Cost(PCB1)	Build of Material Cost(PCB2)	Build of Material Cost(Solar Charging)
ATMega328p	10	$3.00	$30.00	$0.00	$3.00	$0.00
Barrel Jacks Adapters and connectors	10	$0.67	$6.70	$0.00	$0.00	$0.67
ESP-12F	2	$3.00	$6.00	$3.00	$0.00	$0.00
HC-SR04	10	$1.70	$17.00	$1.70	$1.70	$0.00
HM-10	4	$7.00	$28.00	$7.00	$7.00	$0.00
Solar Panels (1W)	5	$3.95	$19.75	$0.00	$0.00	$3.95
JST connectors	10	$0.50	$5.00	$0.50	$0.50	$0.50
HC49S Crystal(PCB2)	5	$0.58	$2.89	$0.00	$0.58	$0.00
Lithium Polymer Battery	4	$5.00	$20.00	$5.00	$5.00	$0.00
PCB1	3	$16.40	$49.20	$16.40	$0.00	$0.00
PCB2	3	$9.85	$29.55	$0.00	$9.85	$0.00
Solar Charger PCB	3	$5.93	$17.80	$0.00	$0.00	$5.93
Basic Parts PCB1	1	$4.40	$4.40	$4.40	$0.00	$0.00
Basic Parts PCB2	1	$3.43	$3.43	$0.00	$3.43	$0.00
Basic Parts BqSC	1	$9.35	$9.35	$0.00	$0.00	$9.35
Packaging	4	$1.13	$4.50	$1.25	$1.25	$0.00
Total Cost			**$253.56**	**$39.25**	**$32.31**	**$20.40**
Total Expenses			**$410.69**			

Successes and Difficulties

Successes:

- Able to program the new WiFi and use its MCU.
- Built an in-house working Bluetooth Mesh Network.
- Working android app.
- Solar charger works with PCBs.

Difficulties:

- Implementing and finding parts (EE).
- Learning curve for programming an Android app.
- Uploading sketches to ATMega328P-PU without an UNO.
- Having the mesh network run on the PCBs.
- Interference between BLE and PCB due to ground plane.

Questions?