# Wander Watch

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# Motivation

- Provide an affordable and reasonably sized device for Alzheimer's patients.
- There are many tracking devices available on the market, but most are too expensive
- Some do not have desirable features

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# Goals and Objectives

- To create a product for patients with Alzheimer's that will provide tracking technology in combination with functionality

- The device must be:
  - Wearable
  - Minimal in size
  - Functional for the wearer
  - Include a phone app to monitor and track the patient

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# Specifications

| Component | Design Specifications | Actual |
|---|---|---|
| Screen Size | 128 x 64 pixels | 128 x 64 pixels |
| Weight | ≤ 75 grams | |
| Cost | ≤ $75 (final product) | approx. $130 |
| Battery Life | 1 day | |
| GPS accuracy | ≤ 3 meters | ≤ 3 meters |
| Alert Message | ≤ 10 seconds after leaving home | ≤ 30 seconds after leaving home with 15s update |

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# Redesign

| Problems | Solutions |
| --- | --- |
| • How do we get the data gathered by the GPS to the caretaker's mobile device? | • Replace Wi-Fi with GSM |
| • Redunant components | • Dual purpose components |

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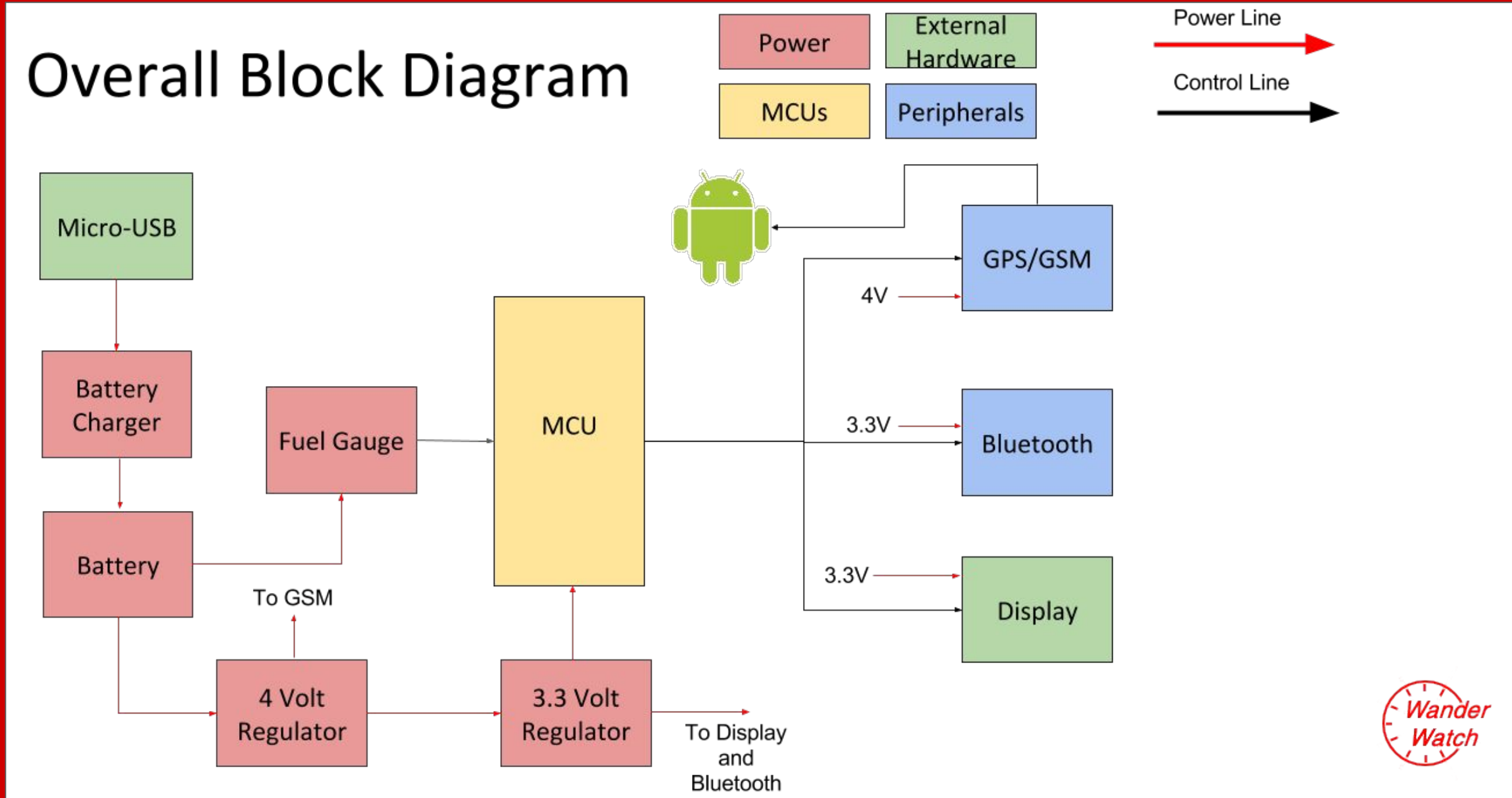
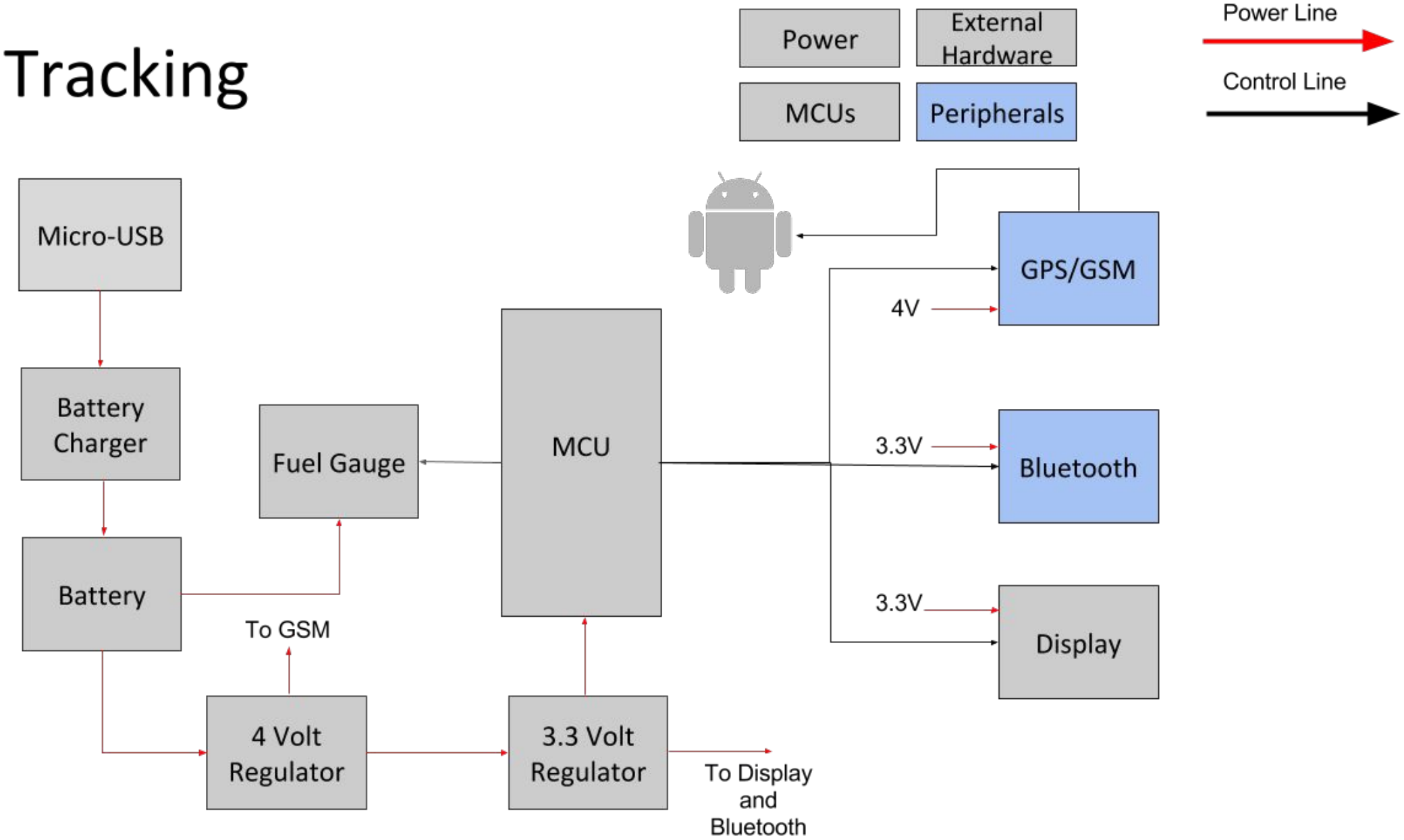
# Overall Block Diagram



# Tracking

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# GPS

**Purpose:**

1) Determine if the patient left their home, using geofencing
2) Provide caretaker with patient’s location

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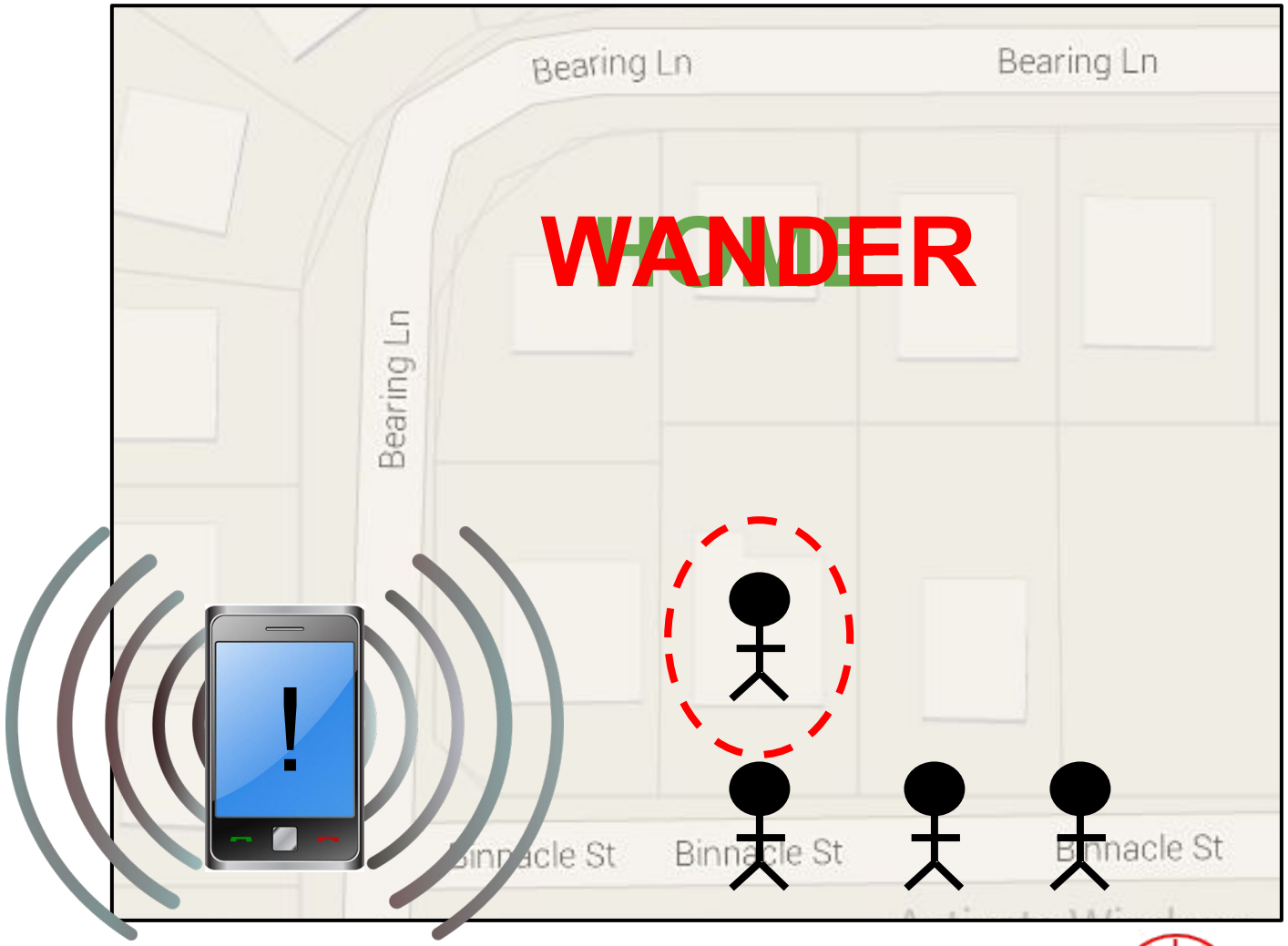
# Geofencing

## What is it?

A virtual, predefined boundary set up so when a device enters (or exits) the perimeter an alert is sent.

## Modes

1) **HOME** - Patient is within the geofence
2) **WANDER** - Patient has left the geofence. Text alert is sent.



# Implementation of the Geofence

- TinyGPS library by Arduiniana
- Method called DistanceBetween
- Gets GPS initial and current locations (lat./long.)
- Utilizes the Haversine Formula
- Compare distance from home to a set max distance

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# GPS Component Comparison

| | Original | Current |
|---|---|---|
| **Key Features** | **Venus638FLPx-L** | **SIM808** |
| **Functionality** | GPS | GSM/GPS |
| **Cost** | $39.95 | $29.95 |
| **Power Consumption** | 2.8 - 3.6 V | 3.4 - 4.4 V |
| **Update Rate** | ≤ 20 Hz | ≤ 5 Hz |
| **Positional Accuracy** | ≤ 2.5 m | ≤ 2.5 m |
| **Communication** | UART | AT Command |

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# Bluetooth

**Purpose:**

1) Determine if the patient left their home
2) Used as a redundant safety feature for the geofence

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# Bluetooth Component Comparison

| | Original | Current |
|---|---|---|
| **Key Features** | **Laird BT800** | **Sparkfun BlueSMiRF Gold** |
| **Class** | 1 | 1 |
| **Cost** | $10.60 | $29.95 |
| **Power Consumption** | < 80mA | avg. 25 mA |
| **Communication** | USB, GPIO | USB, GPIO, UART |
| **Features** | None | Bluetooth Antenna |

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# Why GSM?

- Allows for communication on 2G mobile network which is compatible with device chosen
- Device is able to send SMS messages to the caretaker of the patient's whereabouts
- Device is able to be tracked so that the patient can be found


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# GSM Comparison

| | Original | Current |
|---|---|---|
| **Features** | **Quectel M66** | **SIM808** |
| Price | Unknown | $29.95 |
| Dimensions | 17.7 x 15.8 x 2.3 mm | 24 x 24 x 3 mm |
| Weight | 1.3 g | 3.2 g |
| Quad-band | 850/900/1800/1900 MHz | 850/900/1800/1900 MHz |
| Connects to SIM | Yes | Yes |
| GPS Capability | No | Yes |

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# Implementation of GSM

- Activate account with Ting (T-Mobile)
- Use breakout board for testing
- Use AT Commands to program device
- Verify that is sends a message to caretaker’s phone
- Message is sent with updated coordinates every 15 seconds

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# Why use a SIM card?

- Needed for authorization on T-Mobile network
- Allows for network to be used on different device if necessary
- This SIM card and phone company were chosen because of the pay as you go option which kept costs down


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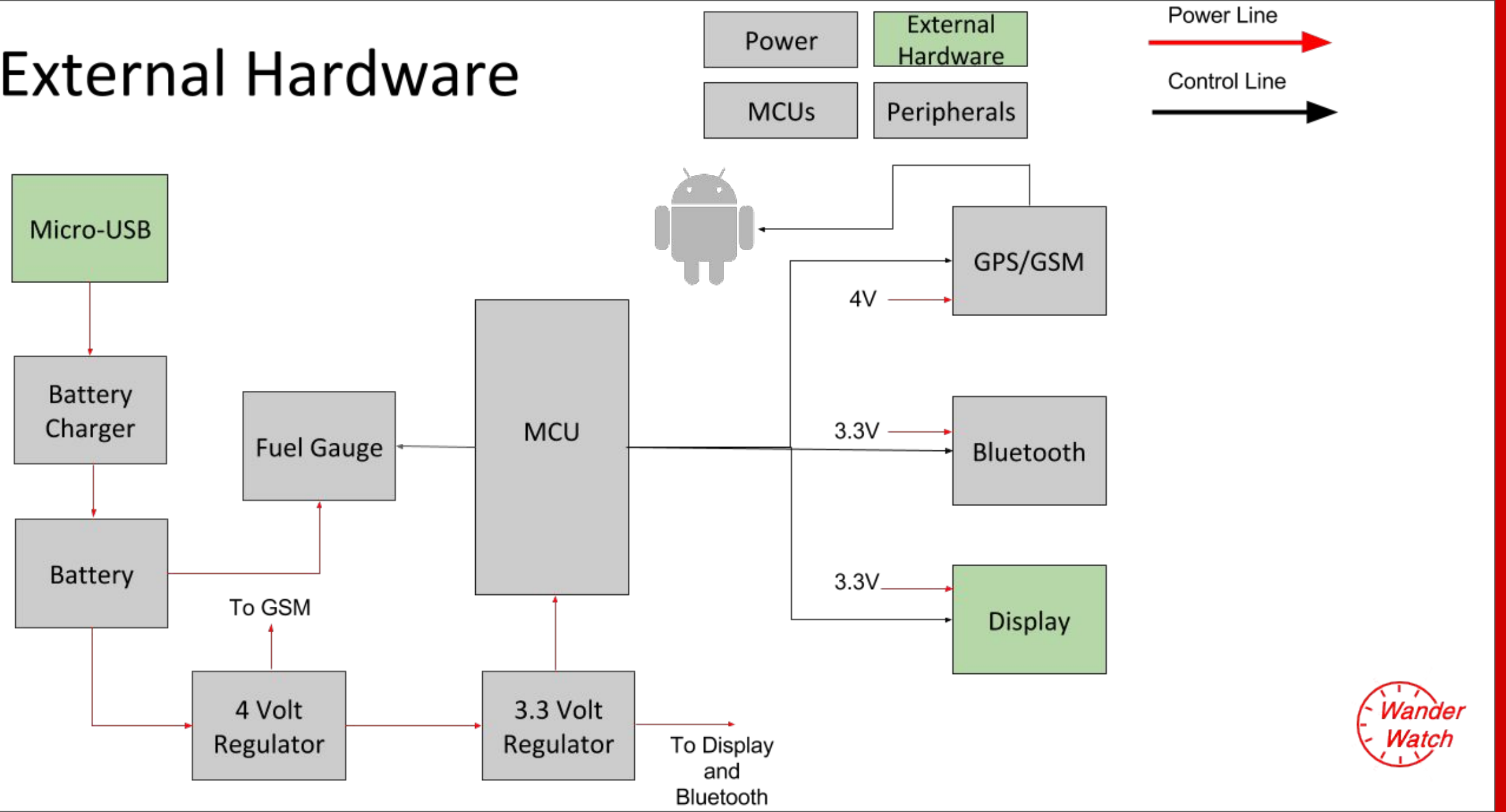
# External Hardware



# Display Comparison

| Category | LCD with Backlight CFAH0802ATTIJT | OLED SSD1306 | Color TFT LCD CFAF128128B0145T |
|---|---|---|---|
| Price | $6.99 | $9.95 | $12.95 |
| Size (Diagonal) | 0.96” | 1.3” | 1.8” |
| Weight | 21g | 2.18g | 7.12g |
| Power Consumption | 20mA | ~25mA (max) | ~50mA (max) |
| Peripheral | 4 or 8 bit parallel | I2C or SPI | SPI |

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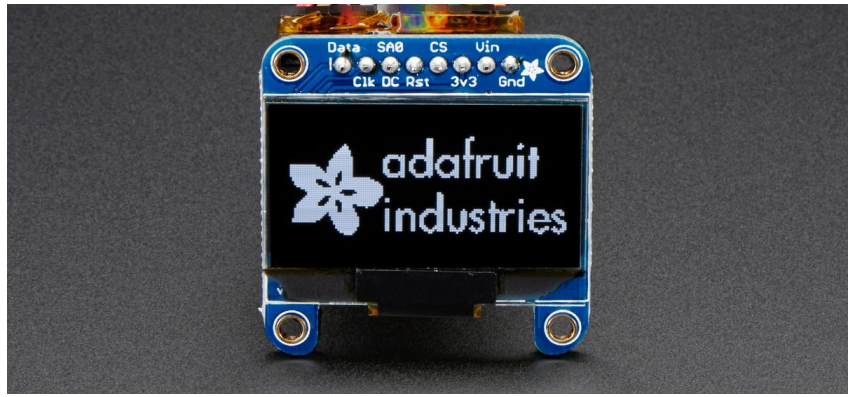
# Display

- Using a 1.3” OLED display
- OLED is slim and lighter than the LCD
- LCD needs a backlight while OLED’s brightness is based on the pixels
- OLED consumes less power than the Color TFT LCD




| Vendor | Adafruit |
|---|---|
| Voltage | 3.3V |
| Size | 128 x 64 px |

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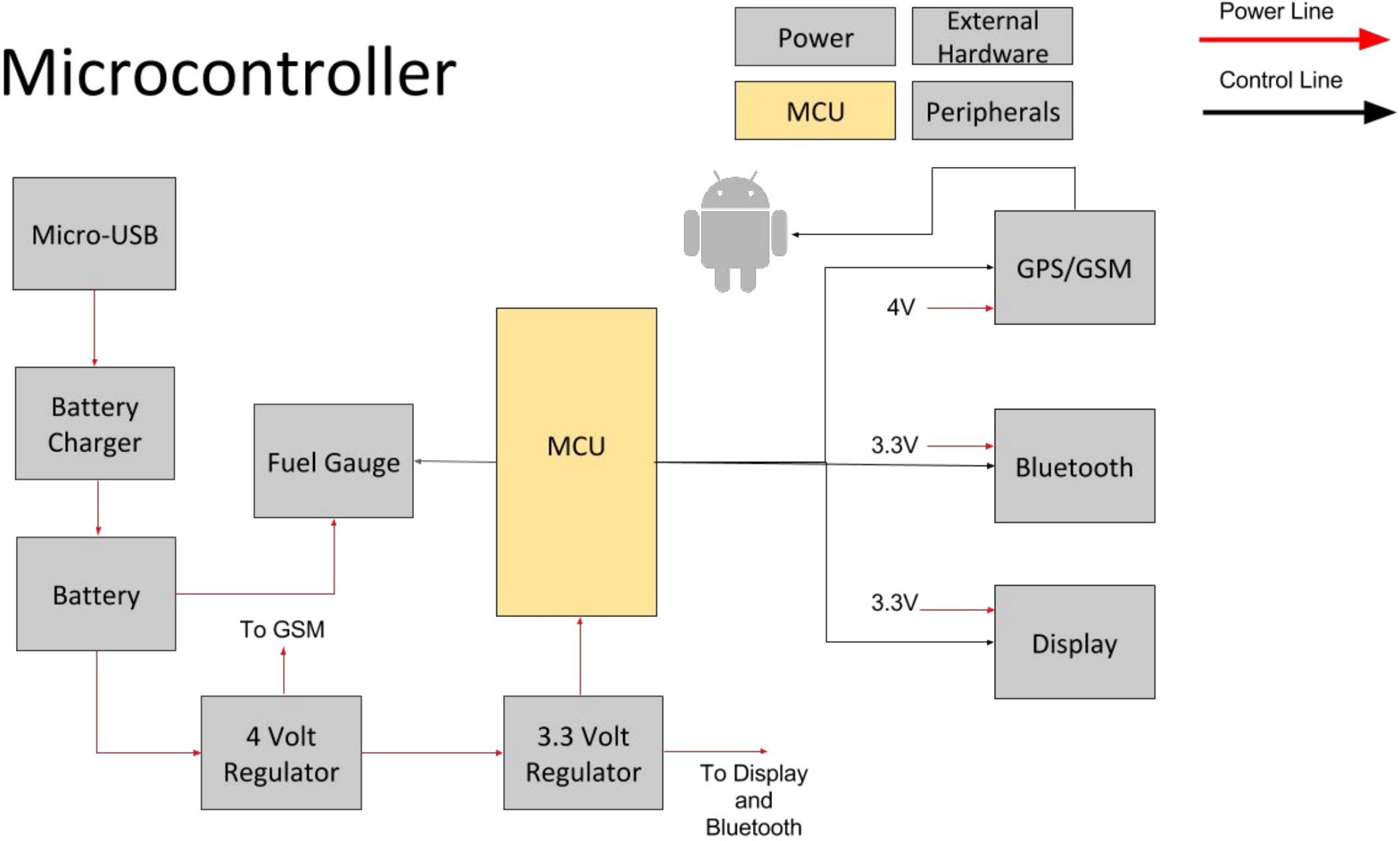
# Microcontroller



# Microcontroller Comparison

| Category | CC3200 | MSP430F5529 + CC3100 | CC2650 | Atmel 1284p |
|---|---|---|---|---|
| Price | $9.99 | $12.28 | $6.99 | $7.99 |
| Power Consumption | up to 229mA | up to 223mA | up to 9.1mA | 0.4 mA |
| Peripherals | 1 I2C, 1 SPI, 2 UART | 2 I2C, 4 SPI, 2 UART | 1 I2C, 2 SPI, 1 UART | 1 I2C, 3 SPI, 2 UART |
| GPIO | 27 | 63 | 10 - 31 | 32 |
| Memory | 256kB | 128kB | 128kB | 128kB |

# ATmega1284p

## Selection Process

- Resources available for bootloading Arduino onto the chip
- Enough peripherals to communicate with other devices

| | |
|---|---|
| **Manufacturer** | Atmel |
| **Part No.** | 556-ATMEGA1284P-AU |
| **Price** | $7.99 |
| **Operating Voltage** | 1.8V - 5.5V |
| **I/O Lines** | 32 GPIO Lines |
| **Peripherals** | 1 I2C, 3 SPI, 2 UART |
| **Memory** | 128KB |

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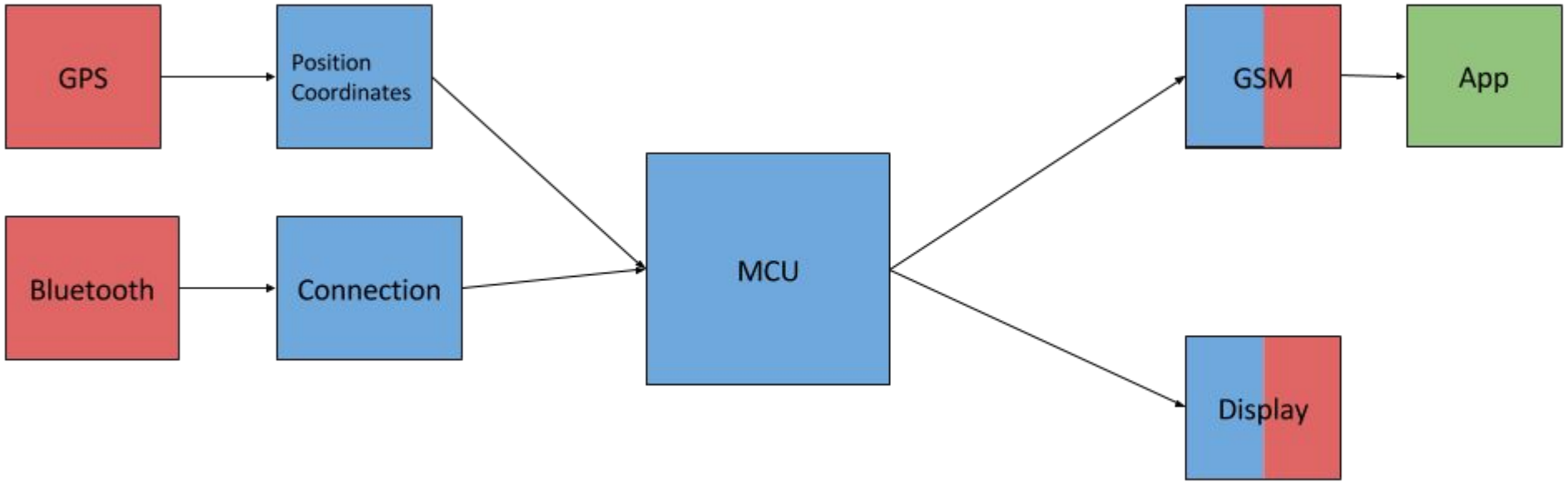
# MCU Software




Hardware Peripheral

Software Component

Mobile Device

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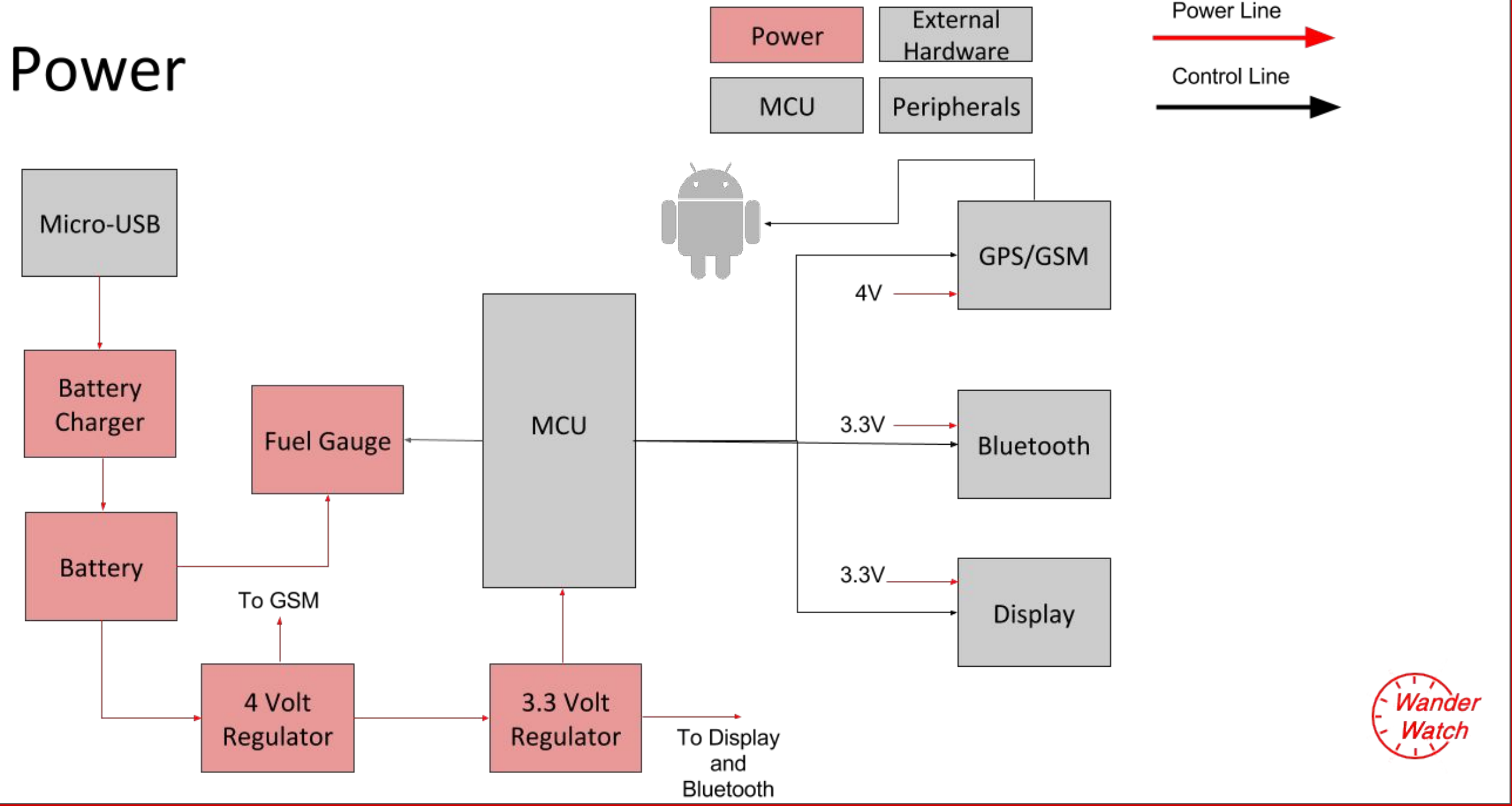
# Power


Power
External Hardware
MCU
Peripherals
Power Line
Control Line
Micro-USB
Battery Charger
Battery
Fuel Gauge
MCU
GPS/GSM
4V
3.3V
Bluetooth
3.3V
Display
To GSM
4 Volt Regulator
3.3 Volt Regulator
To Display and Bluetooth
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# Battery Comparison

| Category | Coin Cell CR2477 | Rechargable AA AA/HR6 | Li-Po 503562 |
|---|---|---|---|
| Price | $3.61 | $5.47 | S9.95 |
| Weight | 10.5g | 29g | 23g |
| Height | .276” | .571” | .2” |
| Voltage | 3V | 1.2V | 3.7V |
| Capacity | 1000mAh | 2000mAh | 1200mAh |
| Rechargeable | No | Yes | Yes |

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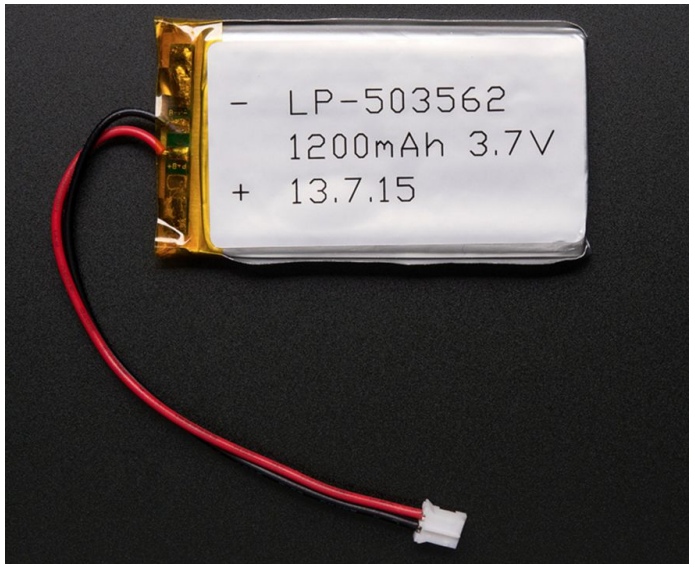
# Battery

- Li-Po battery for recharging capabilities
- Small in size relative to overall product specifications




| | |
|---|---|
| **Vendor** | SparkFun |
| **Voltage** | 3.7V |
| **Capacity** | 1200mAh |
| **Size** | 54mm x 60mm x 5.8mm |

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# Battery Charging Comparison

| Category | BQ24232 | BQ24210 | MCP73831 |
|---|---|---|---|
| Price (1ku) | $1.00 | $1.10 | $0.42 |
| Battery Charge Voltage | 4.2V | 4.2V | 4.2V |
| Charge Current | 500mA | 800mA | 500mA |

# Battery Charging

- Designed for the 3.7V Li-Po battery
- High input voltage
- Customer will be able to use any wall adapter available to them
- Least expensive of the choices

| | |
|---|---|
| **Manufacturer** | Microchip |
| **Input Voltage (max)** | 10.2V |
| **Charging Voltage** | 4.2V |
| **Charge Current** | 0.5A |

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# Fuel Gauge Comparison

| Category | BQ27010 | BQ27510-G3 | MAX17043 |
|---|---|---|---|
| Price (1ku) | $1.60 | $1.10 | $1.10 |
| Power Consumption | <90uA | 103uA | 50uA |
| Peripheral | I2C | I2C | I2C |

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# Fuel Gauge

- Designed with handheld devices in mind
- Communicates with the MCU to display battery life on screen
- Consumes the least amount of power while active.

| | |
|---|---|
| **Manufacturer** | Maxim Integrated |
| **Battery Capacity (max)** | 6000mAh |
| **Communication Interface** | I2C |

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# Regulator Comparison

| Category | TPS782 | TPS799 | TPS63000 | TPS63050 |
|---|---|---|---|---|
| Price (1ku) | $0.25 | $0.48 | $0.95 | $0.78 |
| Dropout Voltage | 130mV | 130mV | - | - |
| Accuracy | 3% | 2% | - | - |
| Noise | 86 uVrms | 33.5uVrms | - | - |
| Switch Frequency | - | - | 1.25MHz | 2.5MHz |
| Quiescent Current | 500nA | 7.8uA | 40uA | 45uA |
| Max Output Current | 150mA | 250mA | 800mA | 500mA |
| Efficiency | - | - | 91% | 94% |

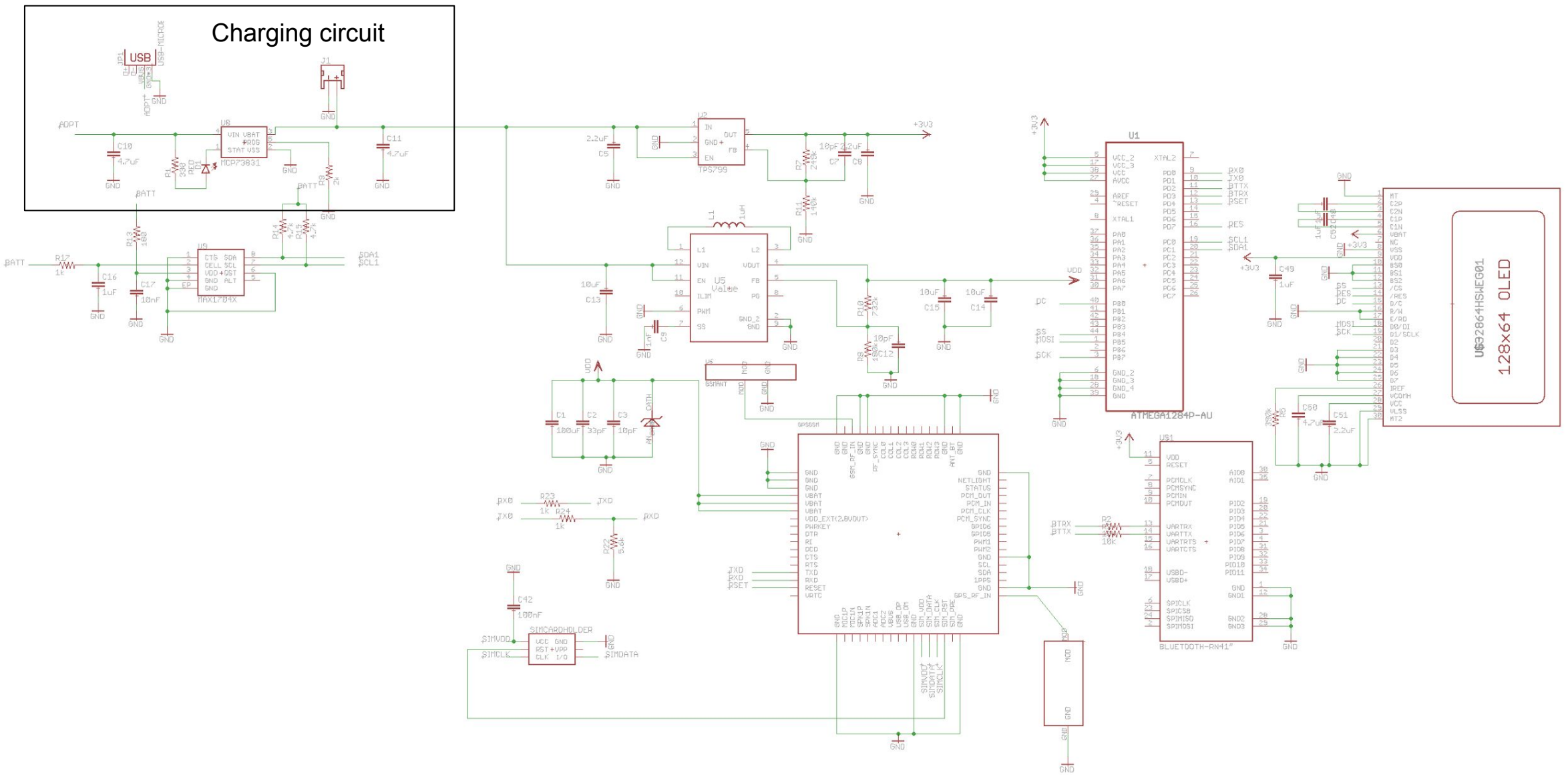
# Regulators

- Will use both TPS799 and TPS63050
- MCU, Bluetooth and Display need 3.3V to power on
- GPS/GSM needs 4.0V to power on

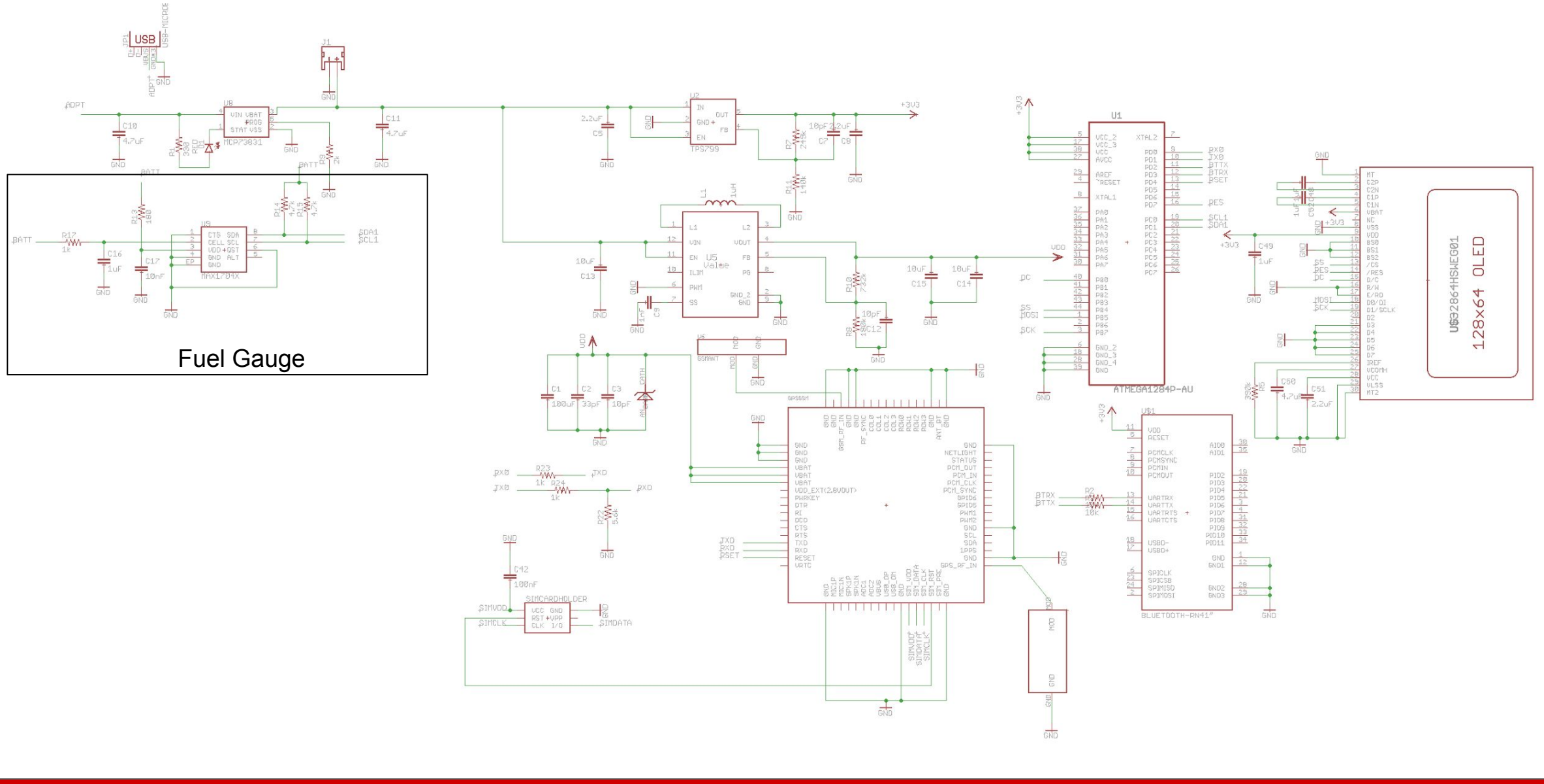


| Manufacturer/Part | TI / LDO | TI / Switching Regulator |
|---|---|---|
| **Input Voltage** | 2.7 - 6.5V | 1.6 - 6V |
| **Output Voltage** | 3.3V | 4.0V |
| **Output Current** | 200mA | 500mA |

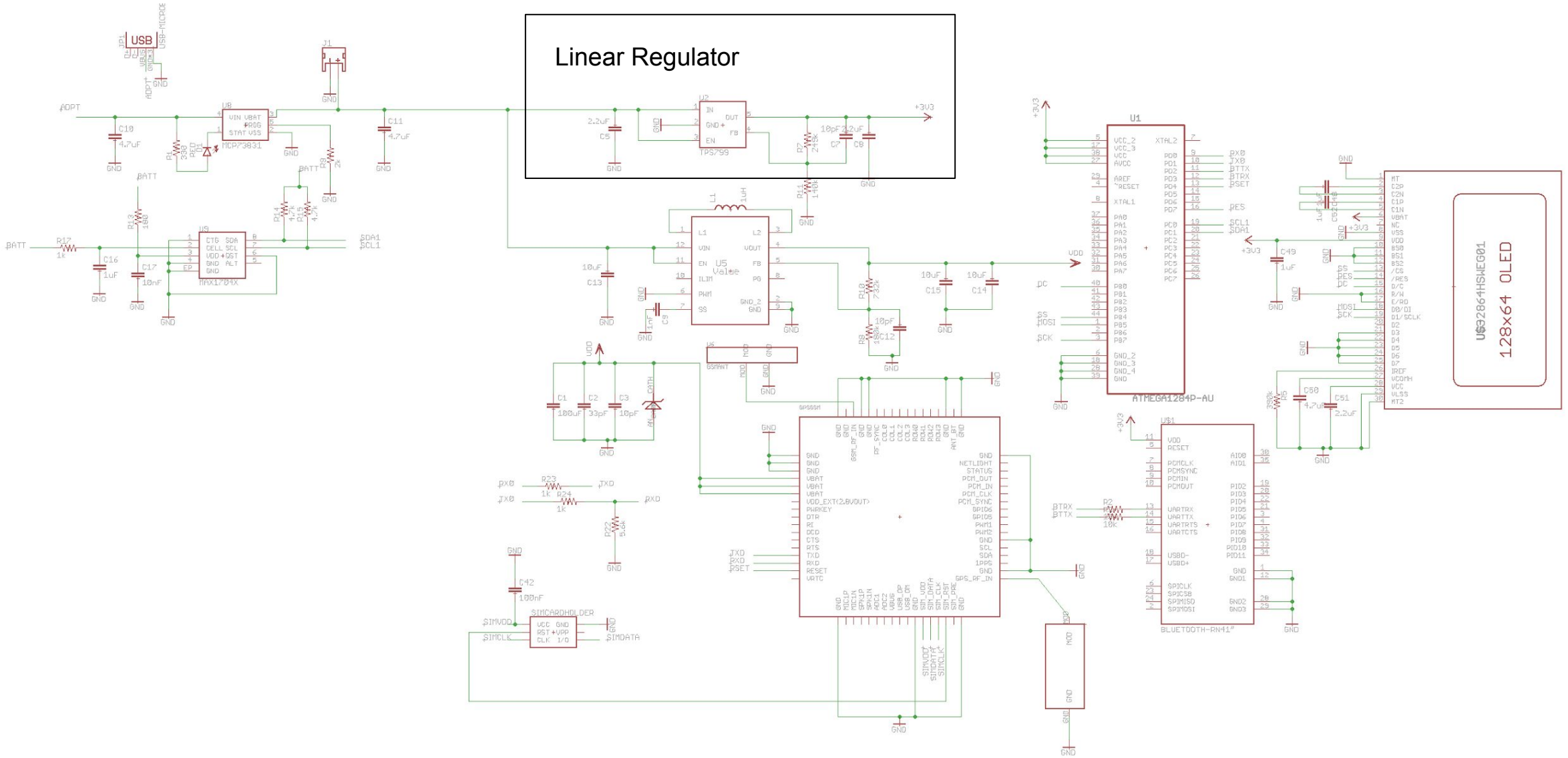
# Schematic


Charging circuit
USB
MCP73831
TPS799
U5
Value
MAX17043
ATMEGA1284P-AU
BLUETOOTH-RN41"
128x64 OLED
SIMCARDHOLDER
GSMANT
GPSSSH
BATT
+3V3
GND

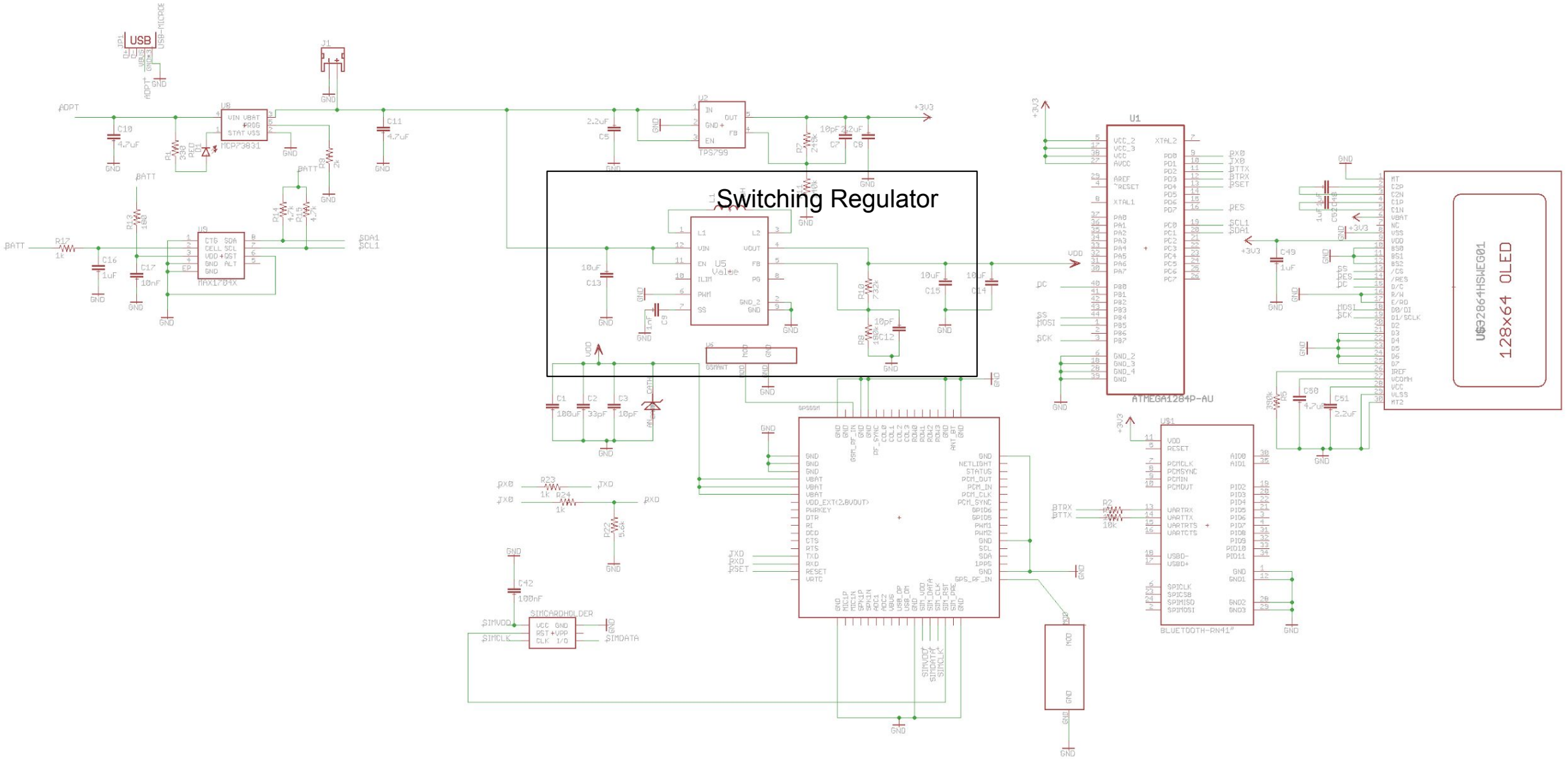
# Schematic


USB
MCP73831
TPS799
U5
Value
ATMEGA1284P-AU
BLUETOOTH-RN41"
128x64 OLED
SIMCARDHOLDER
Fuel Gauge

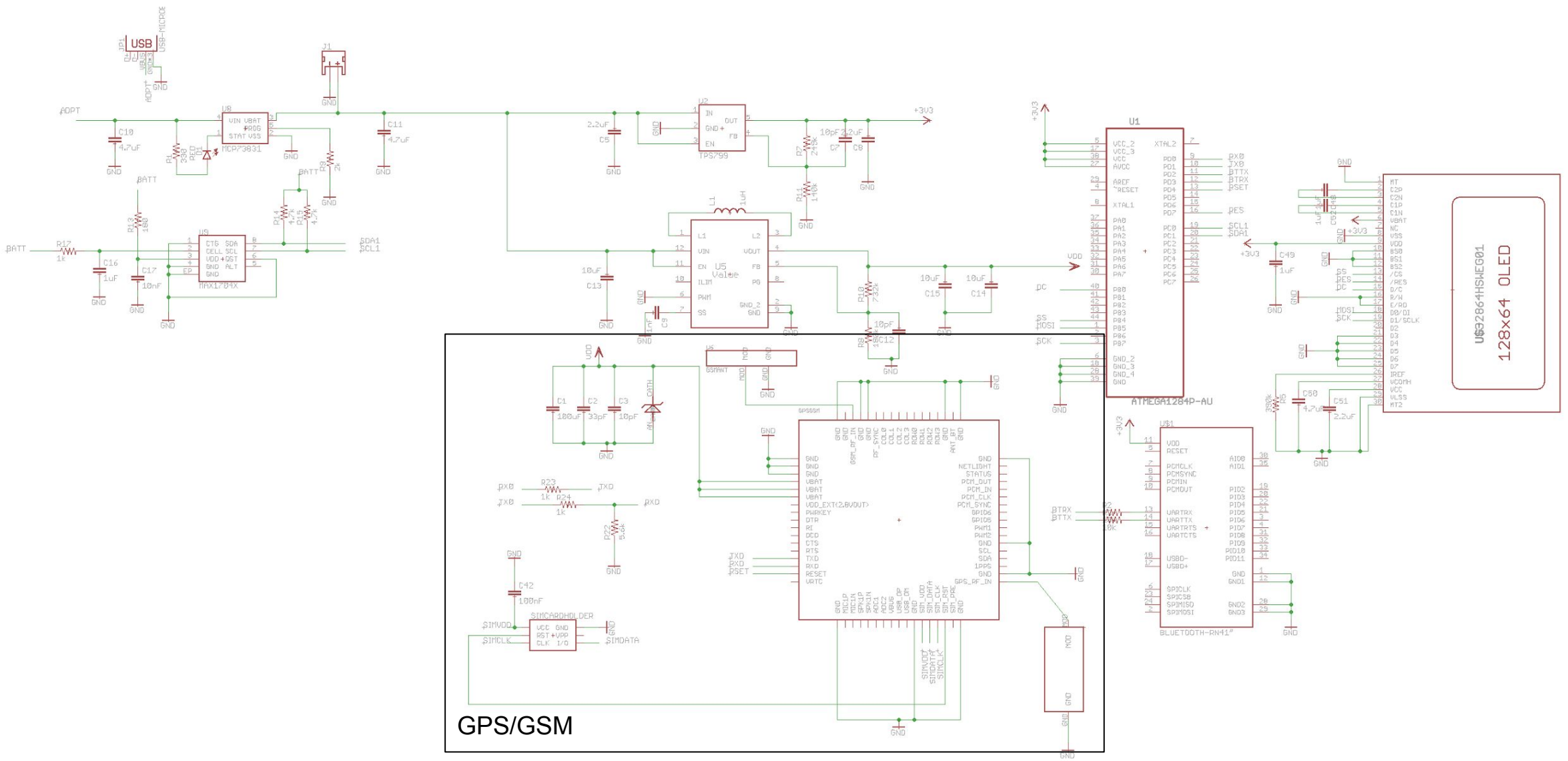
# Schematic


Linear Regulator
USB
ADPT
BATT
MCP73831
MAX17043
TPS799
ATMEGA1284P-AU
BLUETOOTH-RN41"
128x64 OLED
SIMCARDHOLDER
+3V3
GND

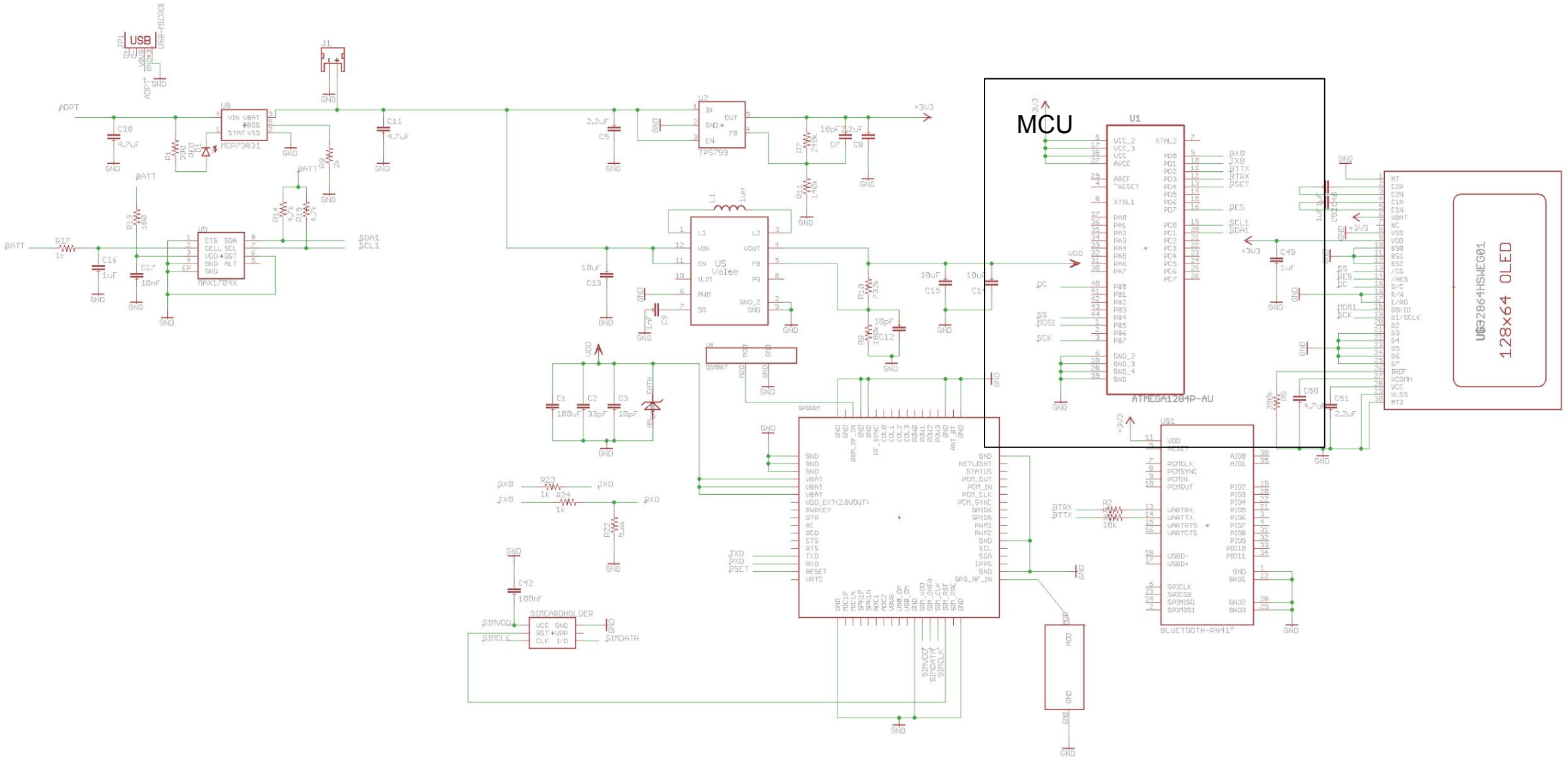
# Schematic


Switching Regulator
ATMEGA1284P-AU
128x64 OLED
BLUETOOTH-RN41"
TPS799
MCP73831
MAX17047X
SIMCARDHOLDER

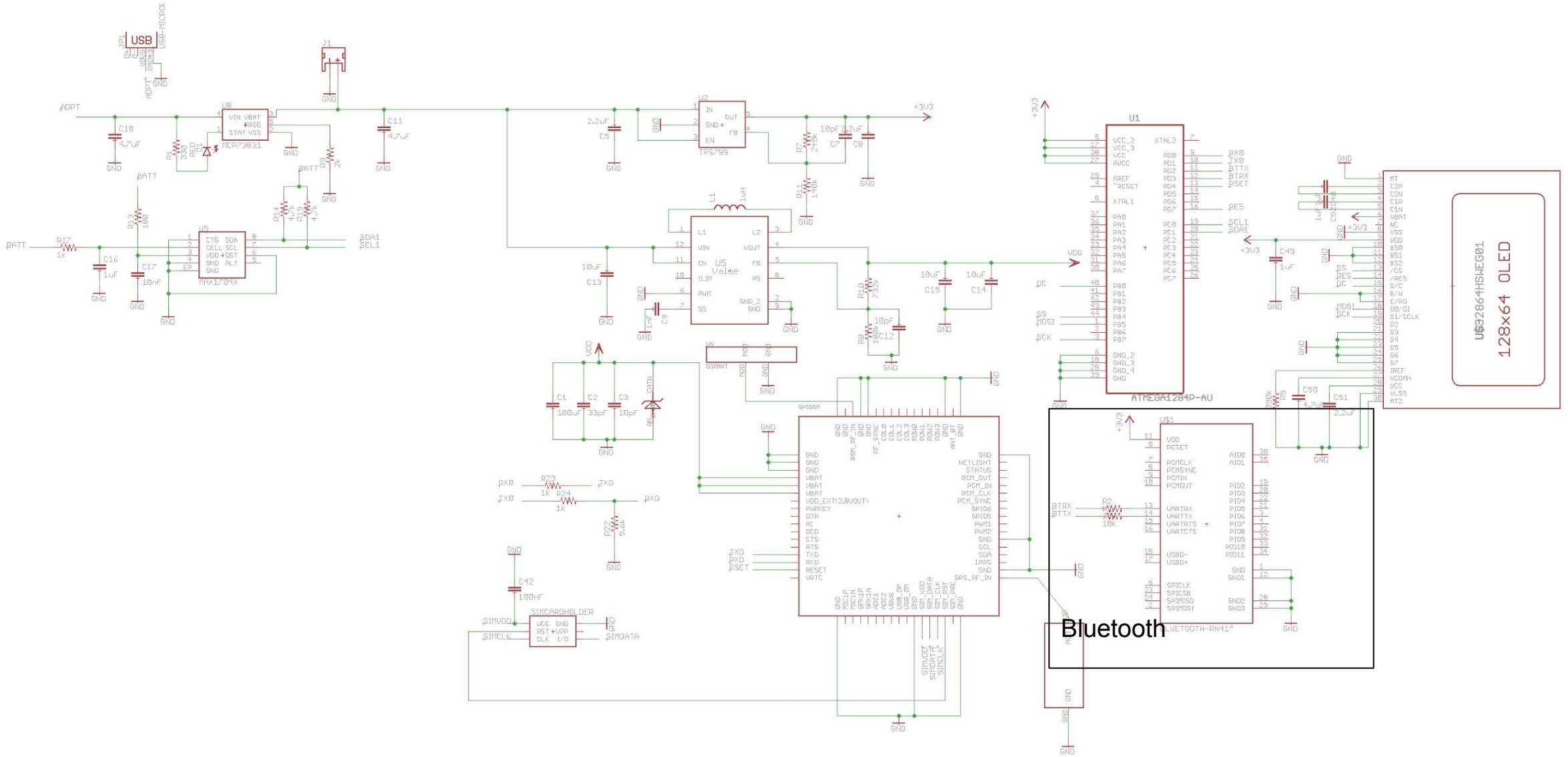
# Schematic


USB
ADPT
BATT
MCP73831
TPS799
U5
Value
MAX17043
ATMEGA1284P-AU
BLUETOOTH-RN41"
128x64 OLED
GPS/GSM

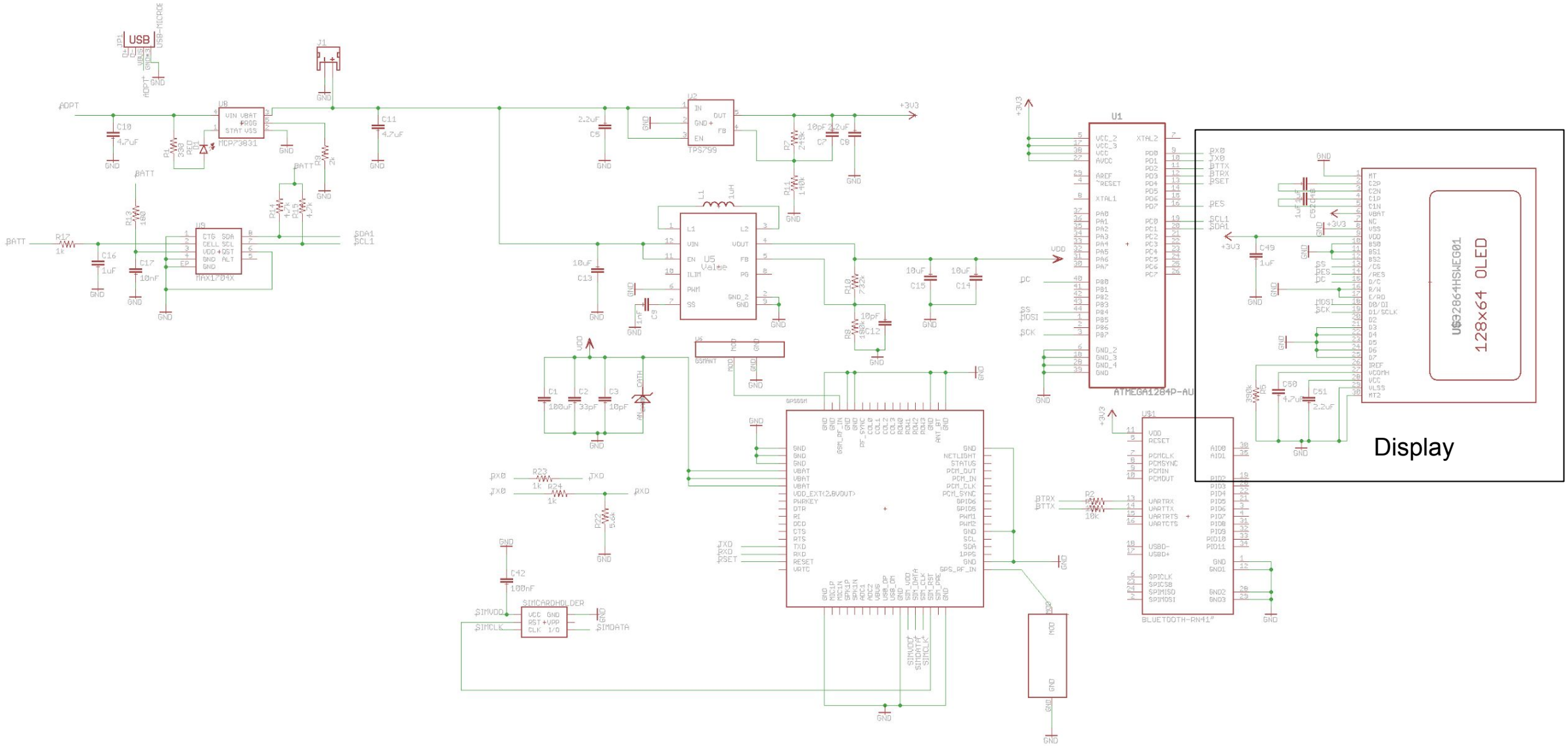
# Schematic


MCU
U1
ATMEGA1284P-AU
128x64 OLED
BLUETOOTH-RN41"
TPS799
MCP73831
MAX1704X
SIMCARDHOLDER
GPSSSH
GSMANT
ADPT
BATT
+3V3
SDA1
SCL1
TXD
RXD
RESET
BTRX
BTTX
SIMVDD
SIMCLK
SIMDATA

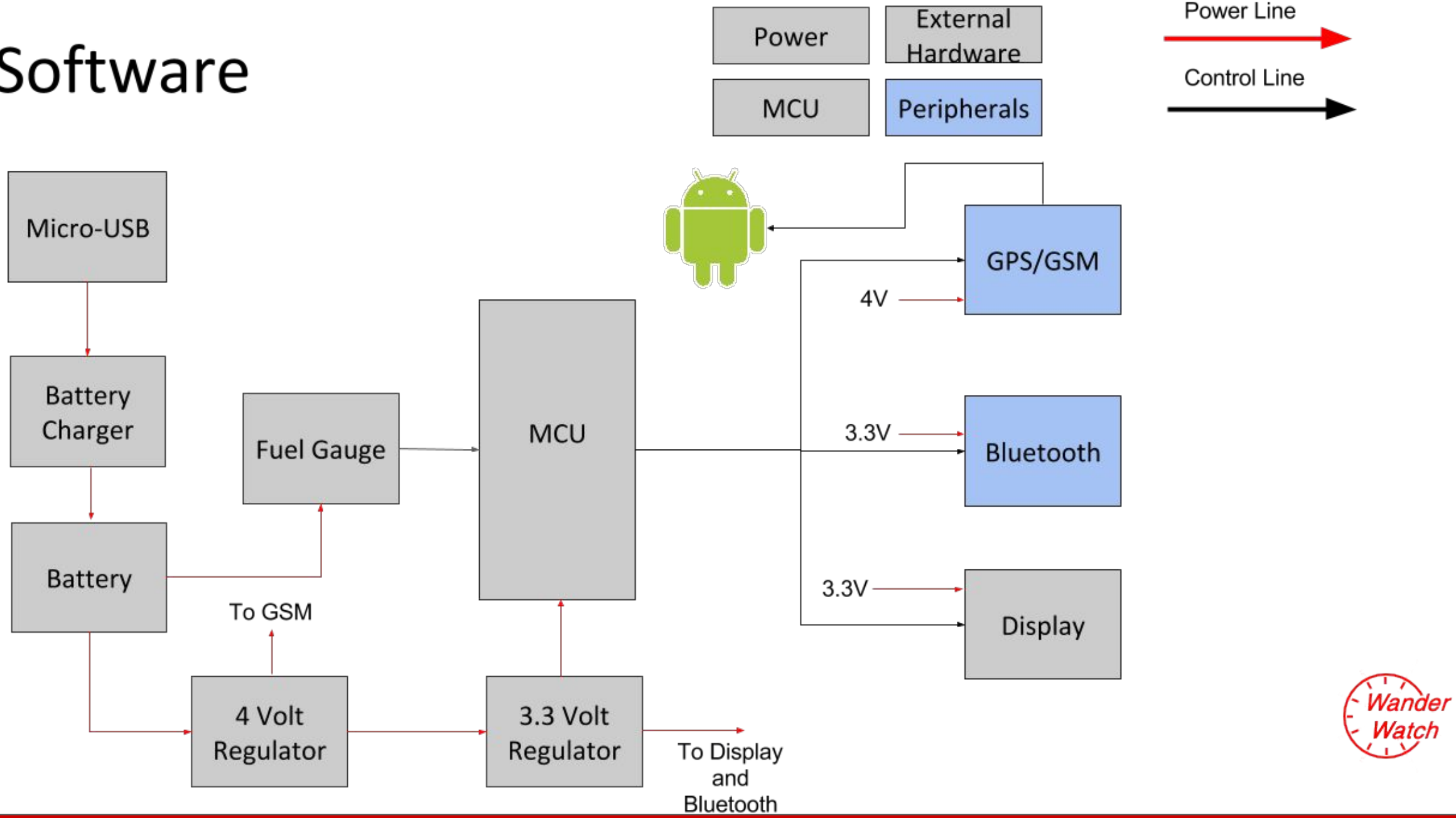
# Schematic


USB
ADPT
BATT
+3V3
U1
ATMEGA1284P-AU
128x64 OLED
Bluetooth
GND

# Schematic


USB
MCP73831
TPS799
U5
Value
MAX17043
ATMEGA1284P-AU
BLUETOOTH-RN41"
SIMCARDHOLDER
GSMANT
GPSSSH
U8G32864HSWEG01
128x64 OLED
Display

# Software


Power
External Hardware
MCU
Peripherals
Power Line
Control Line
Micro-USB
Battery Charger
Battery
Fuel Gauge
MCU
GPS/GSM
4V
3.3V
Bluetooth
3.3V
Display
To GSM
4 Volt Regulator
3.3 Volt Regulator
To Display and Bluetooth
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# Why Android?

- Larger user base than Apple
- More experience with Java and Android app development
- Plenty of tutorials and references to help with issues
- Easier to debug
- Various features available in Android can be used for this app

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# Android Application Features

- One account for each phone
- View watch's location
- View alerts about watch's battery and location
- Change settings for handling alerts and account

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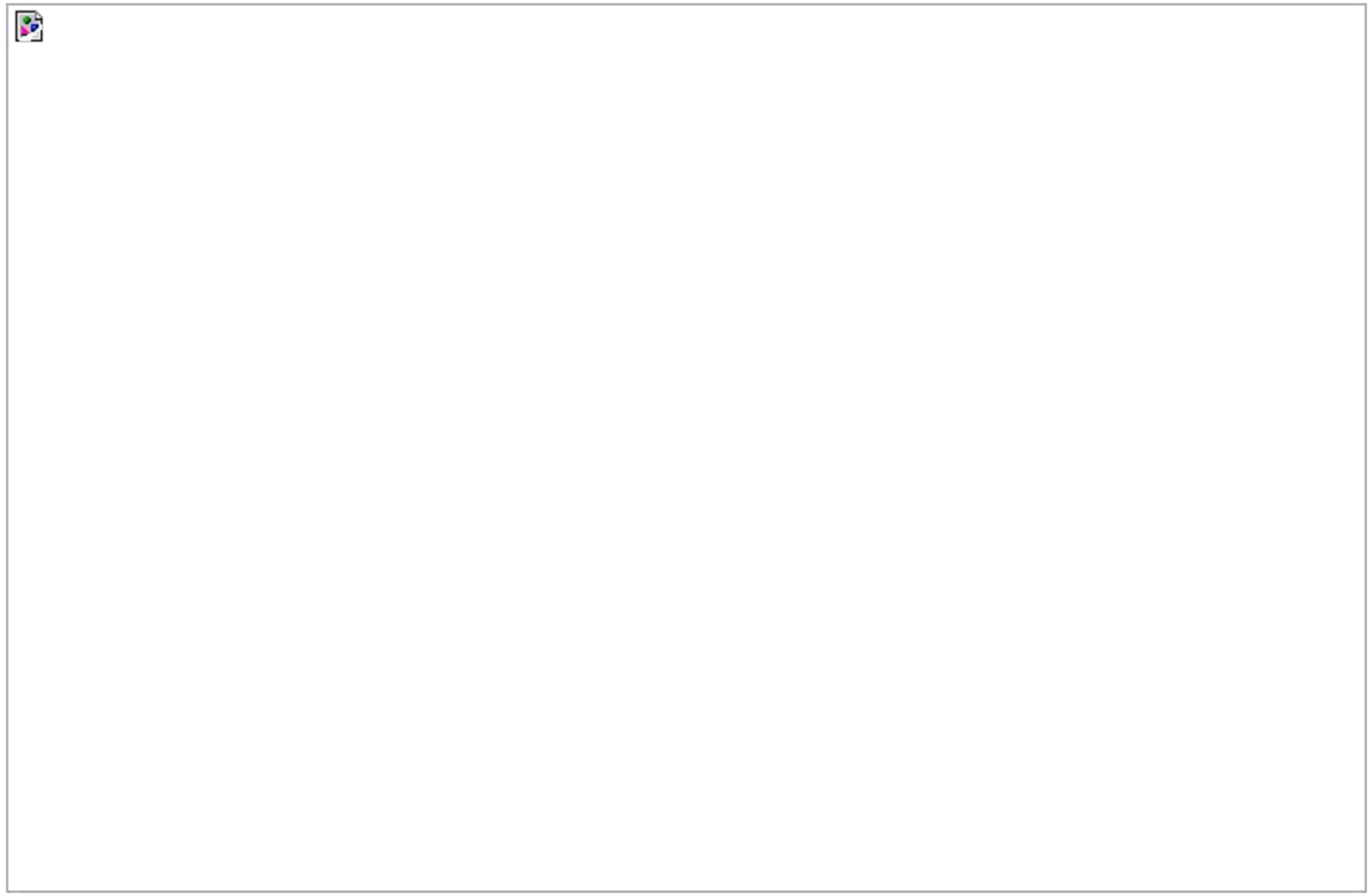
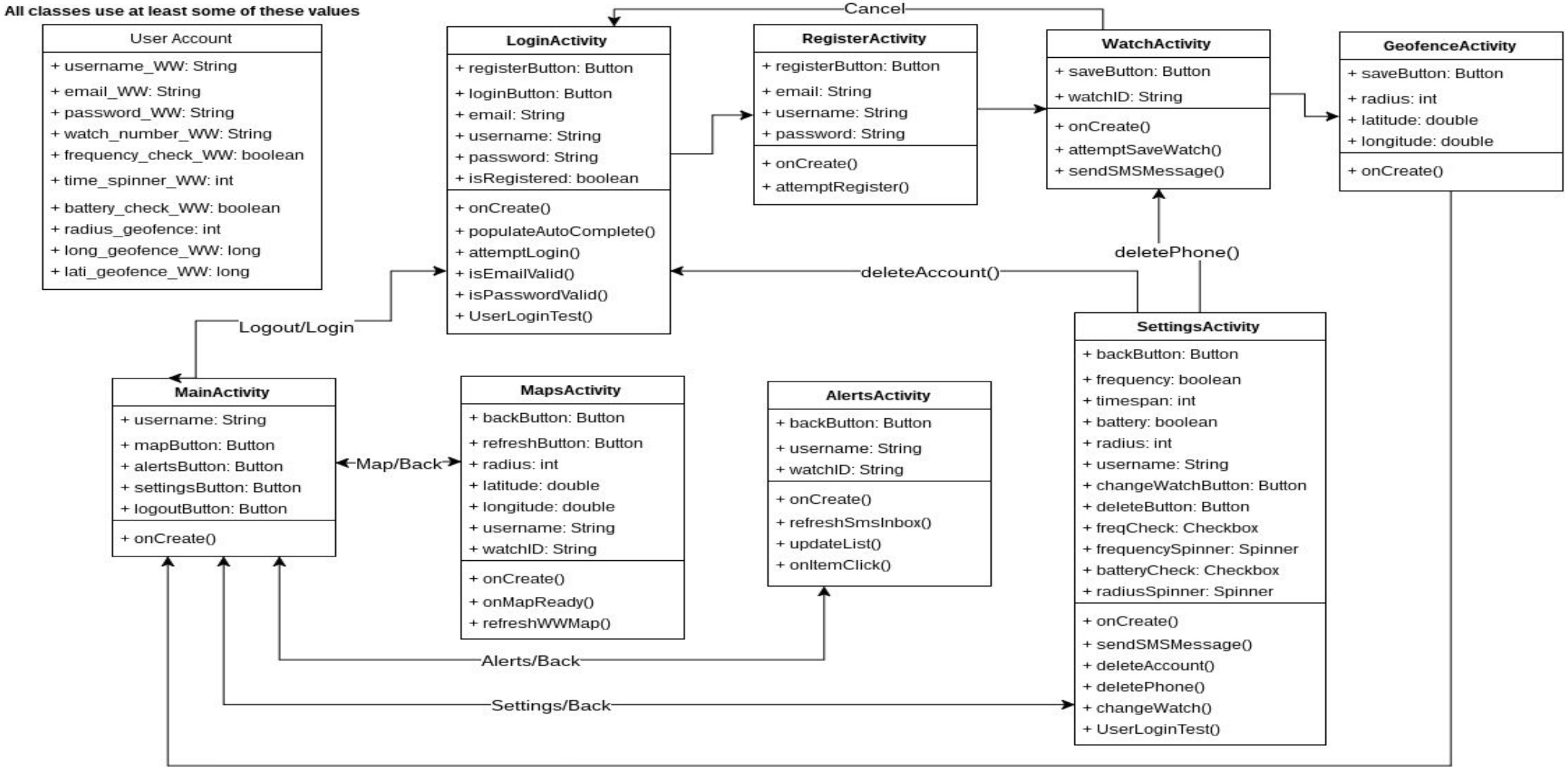
# Use Case Diagram



# Class Diagram

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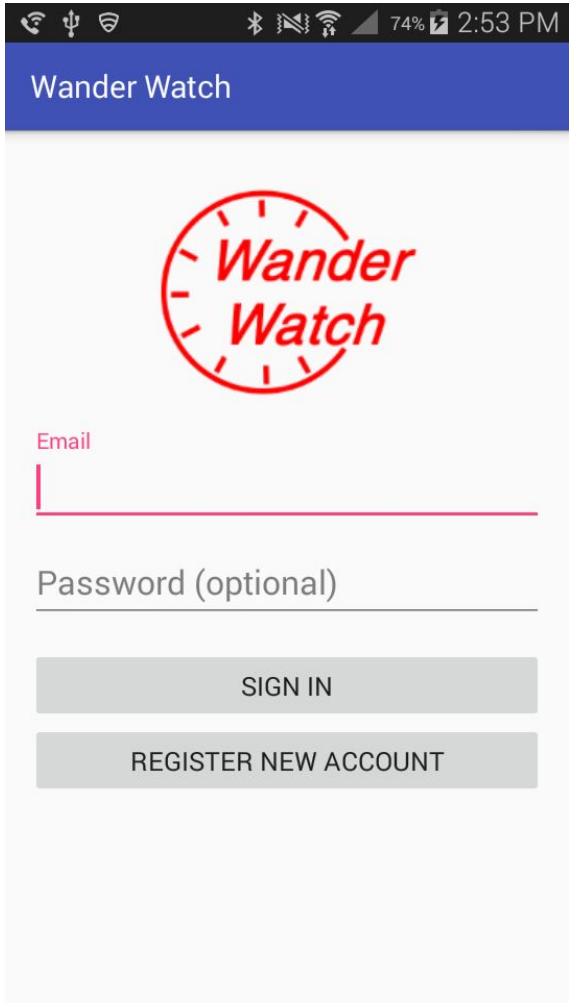
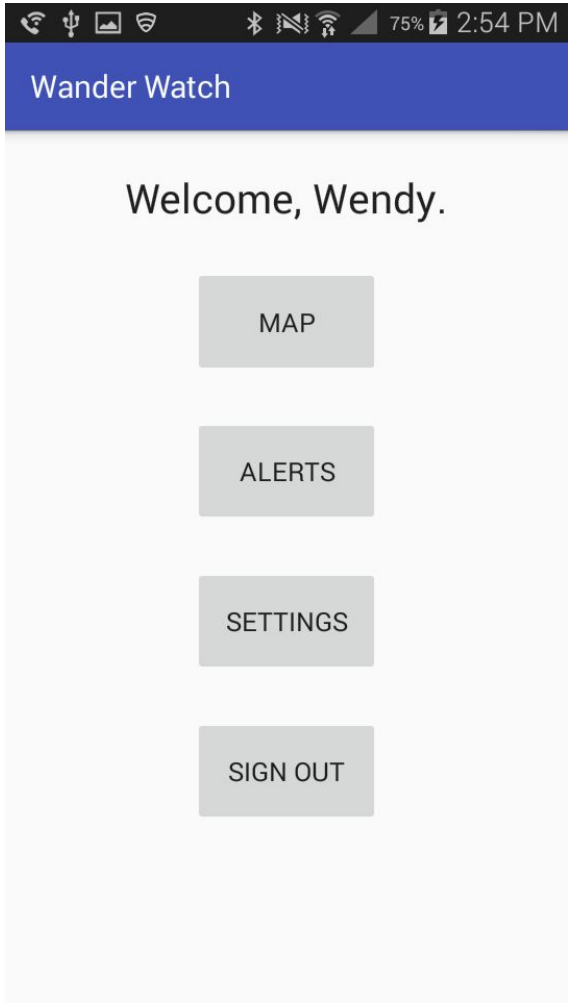
# Login Screen, and Main Menu

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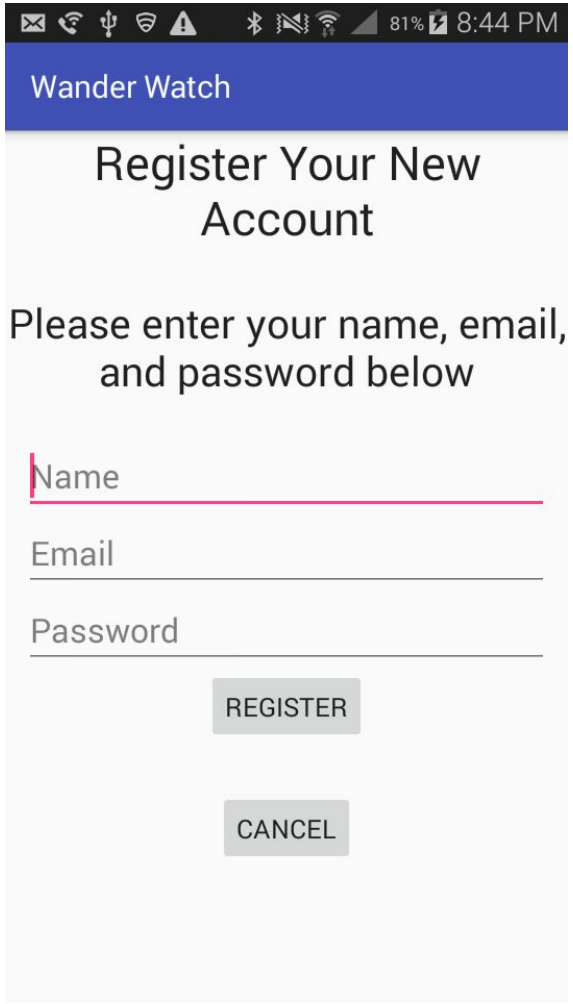
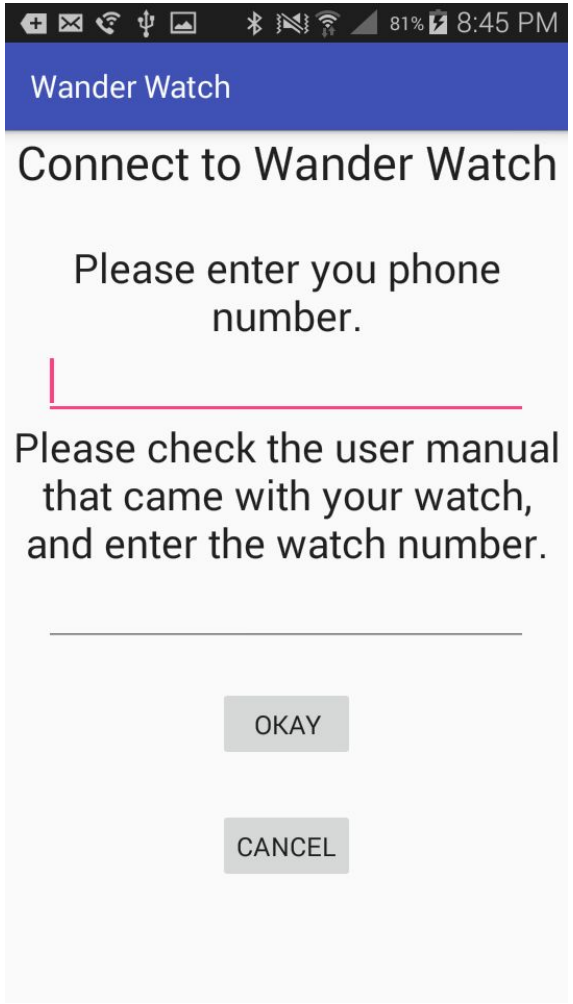
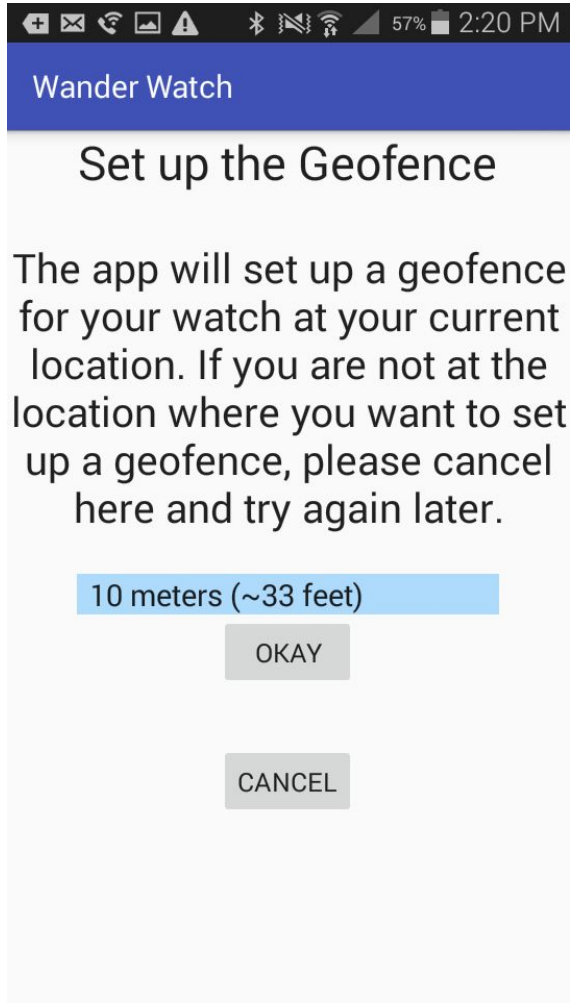
# The Account Set-up Process

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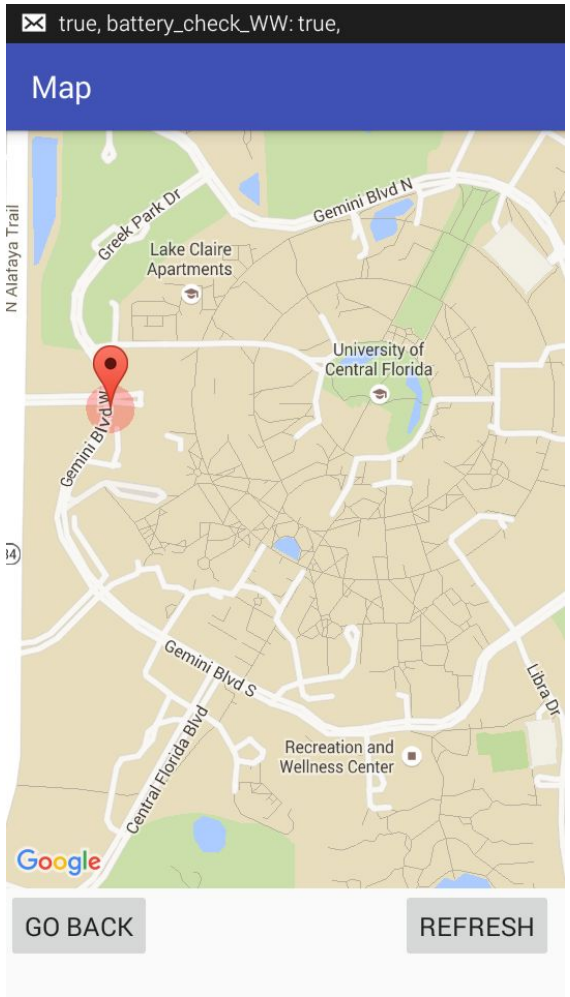
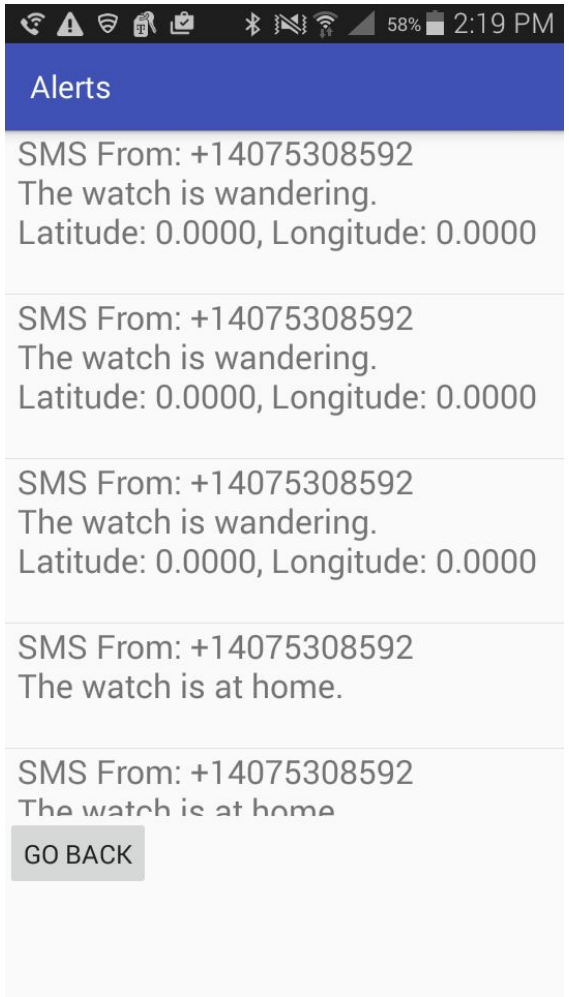
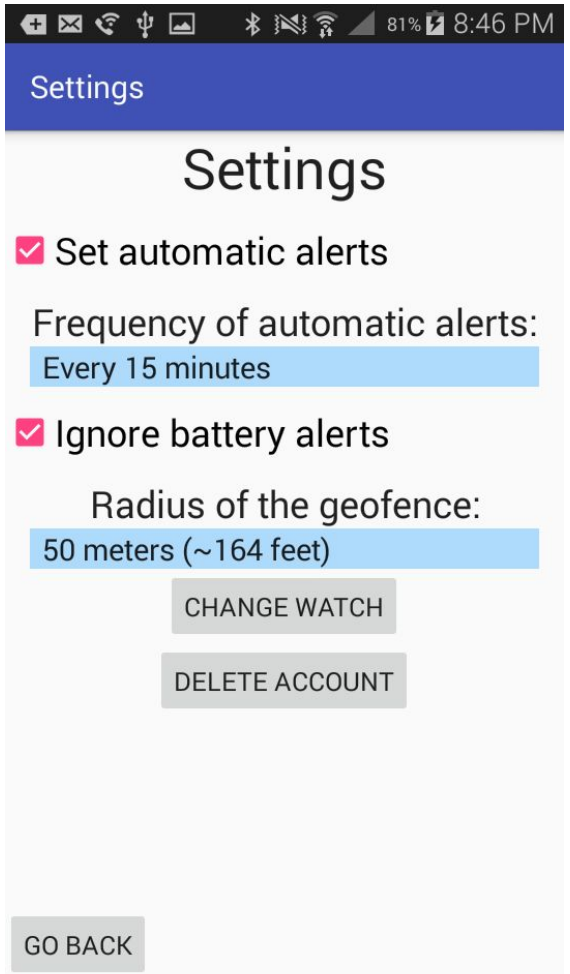
# Map, Alerts, and Settings Menus

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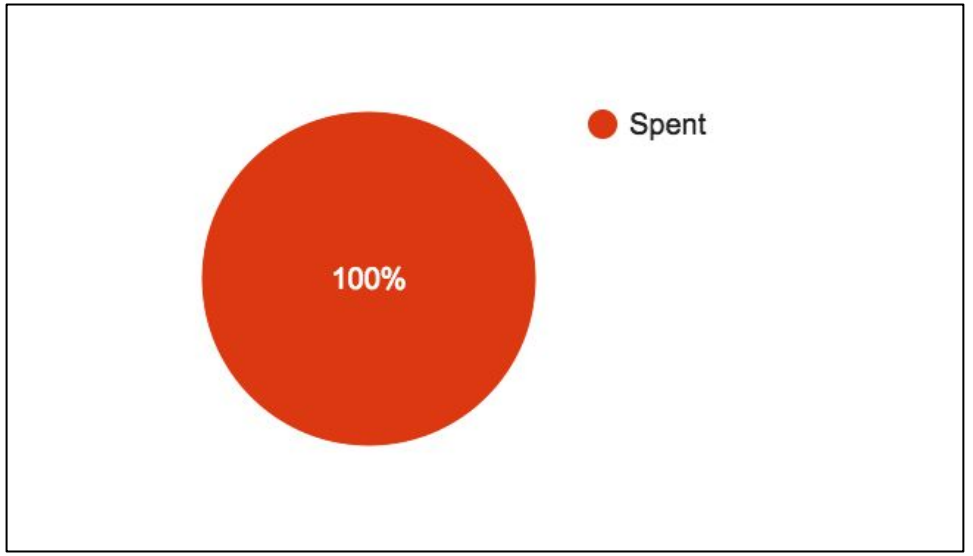
# Administrative Content

# Budget/Financing

- Sponsors: Group 16 members
- Total Budget: $300

| Item | Cost ($) |
|---|---|
| OLED Display | 9.95 |
| SIM808 GPS/GSM | 29.95 |
| Bluetooth Components | 61.90 |
| SIM Card and Holder | 11.00 |
| PCB | 25.00 |
| Hardware Components | 250.00 |
| Watch Strap | 11.85 |
| Phone Bill | 31.75 |
| **Total** | **$431.40** |




- Over budget by $131.40

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# Division of Work

| Category | Primary | Secondary |
|---|---|---|
| **Hardware** | Jeff | Sarah |
| **GPS/Tracking** | Alexis | Wendy |
| **GSM/Bluetooth** | Sarah | Alexis |
| **Software/App** | Wendy | Jeff |

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# Video

https://youtu.be/DRQPKrwXd0Q

Wander Watch