

# uMesh

Bring-Up Documents

Version 1.0

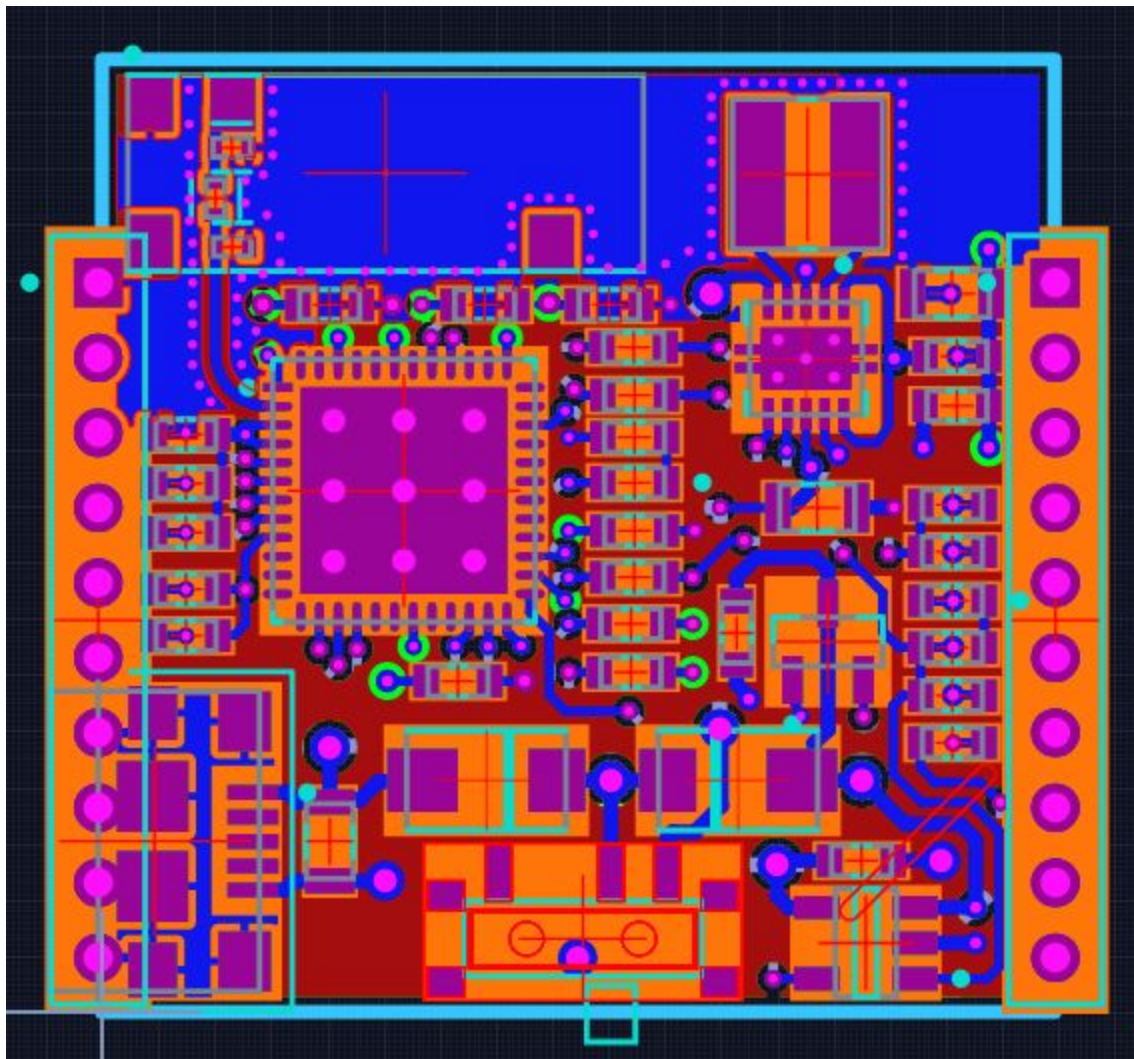
uMesh R1

Jarrett Rainier

August 2018

<https://www.jrainimo.com>

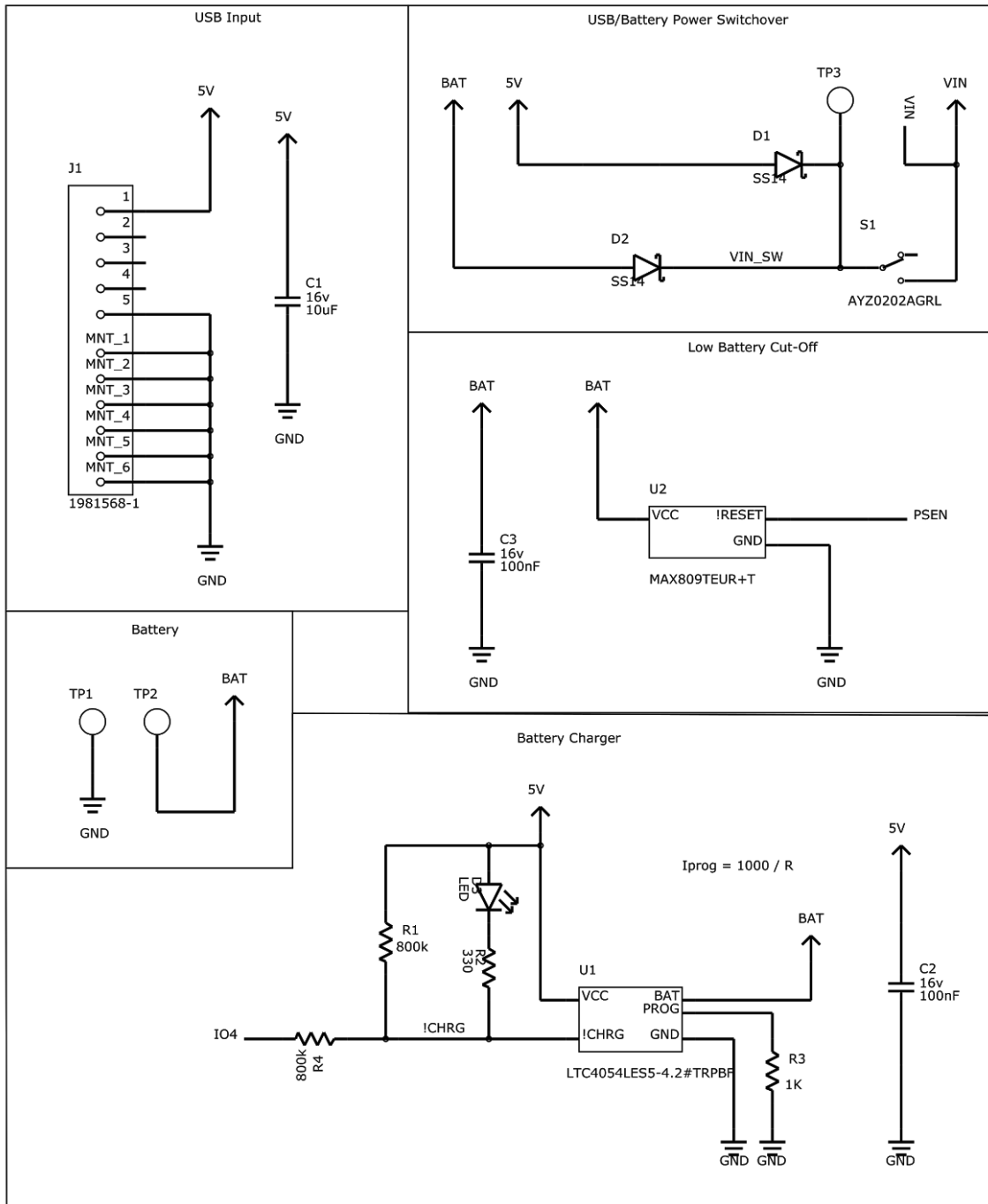
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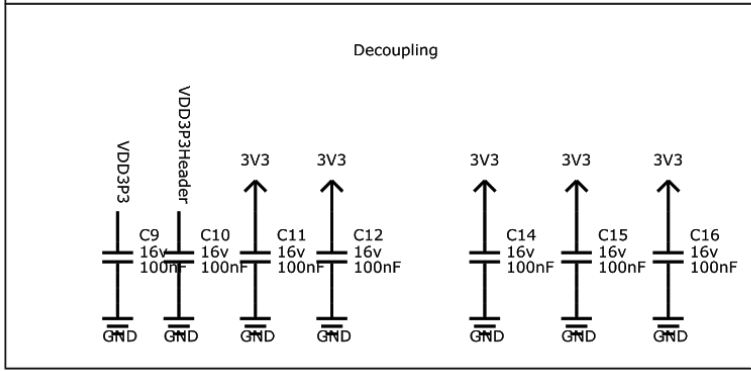
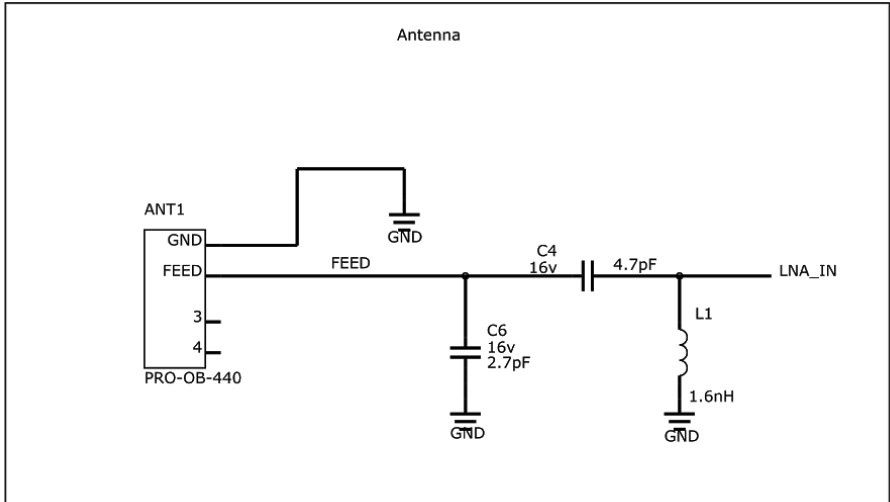


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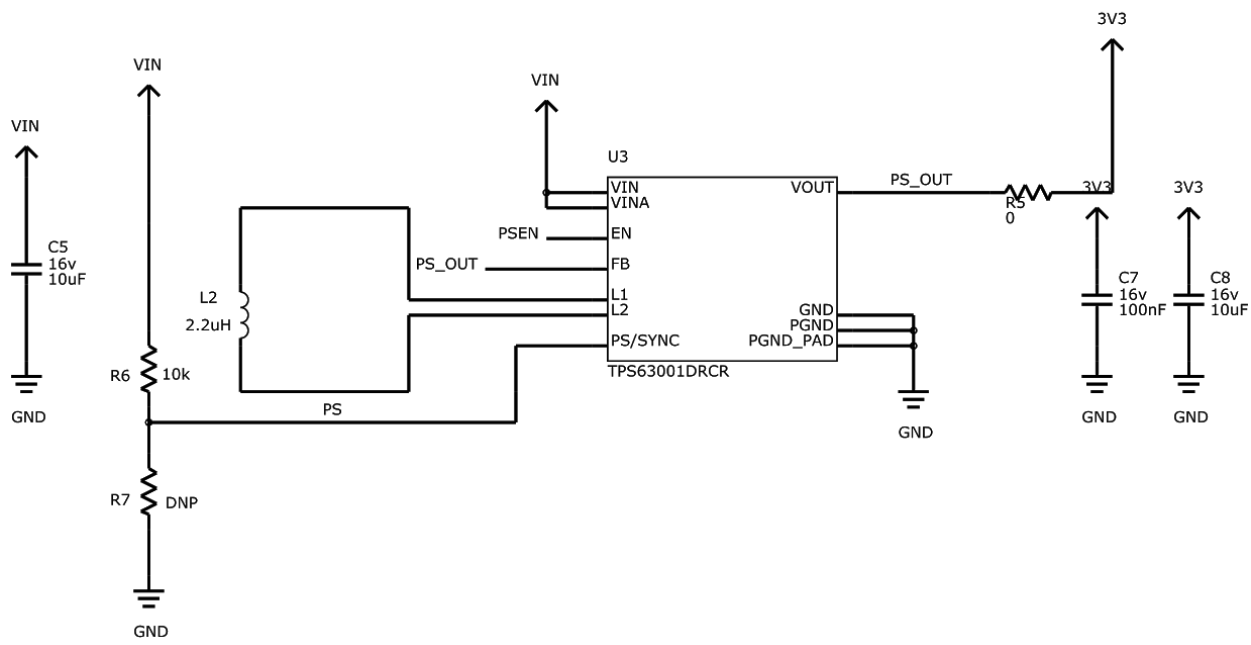
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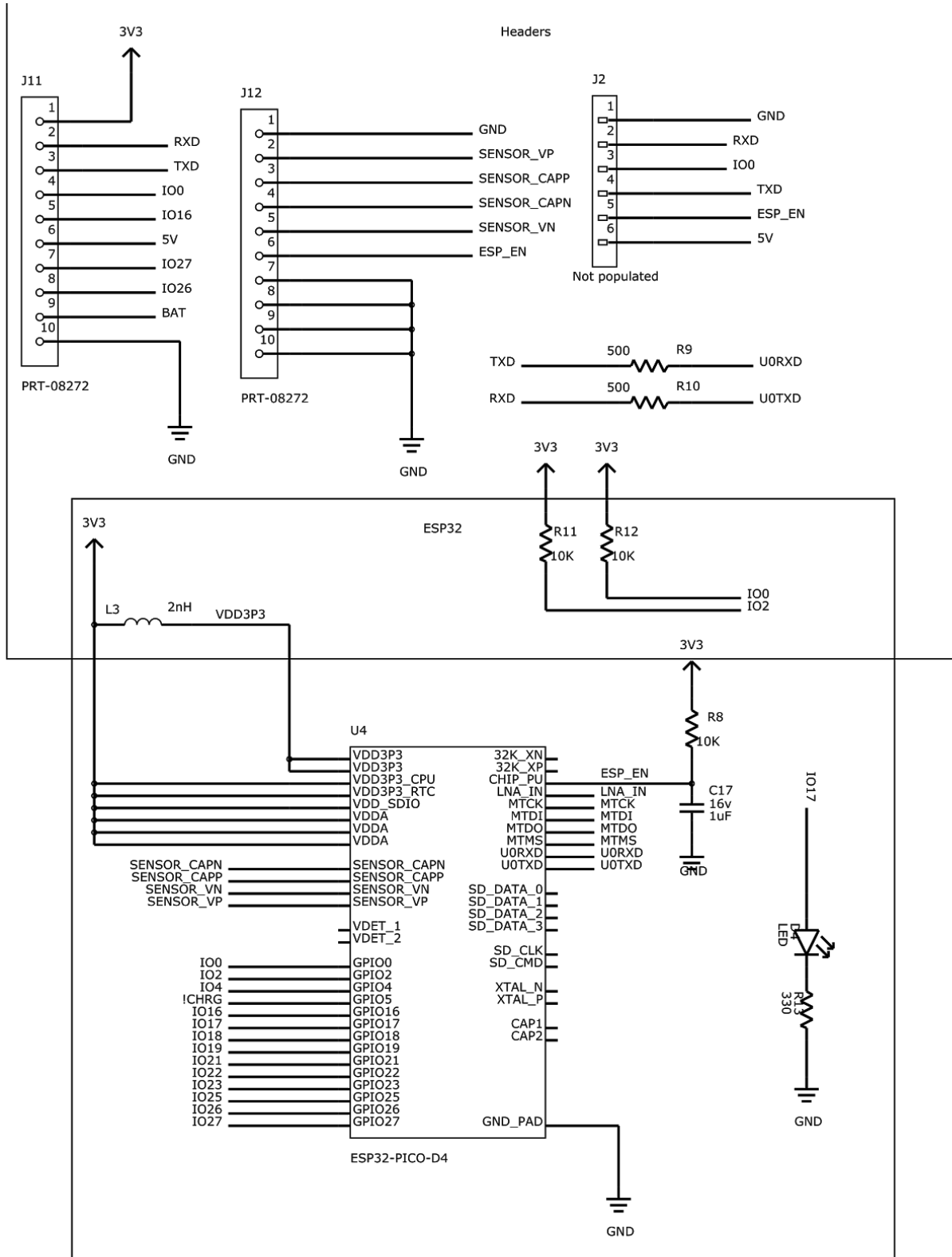
# Schematic





Buck-Boost Power Supply

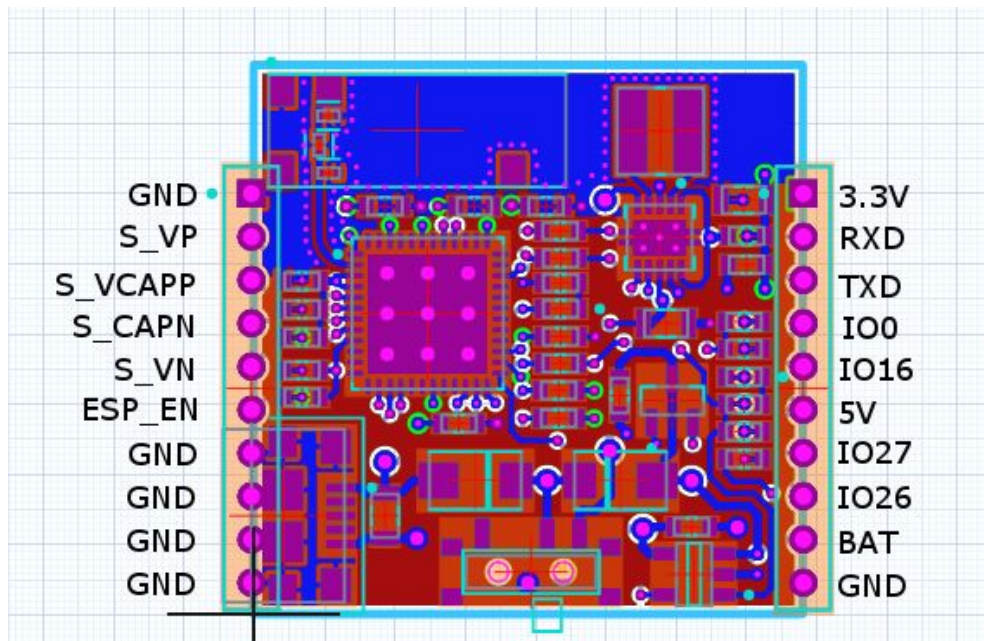
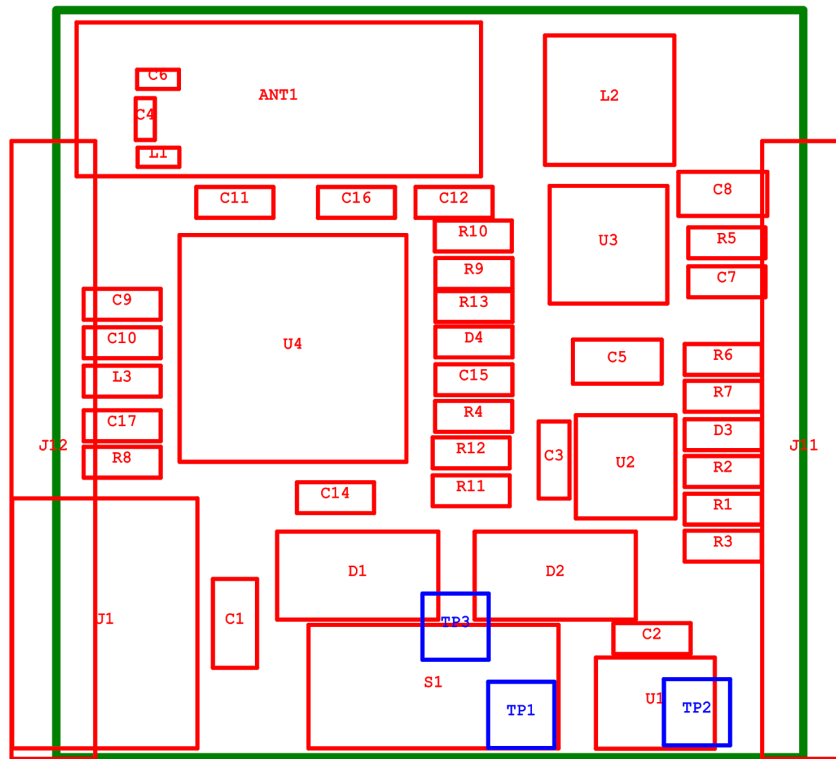




## Components

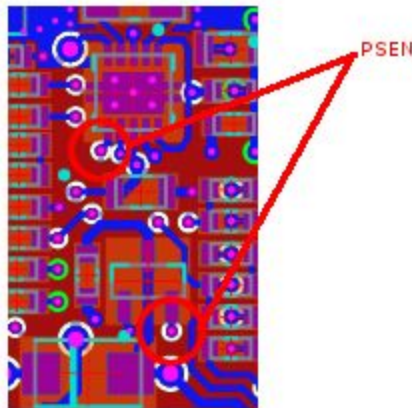
| Reference Designator                | Package                          | Quantity | Value |
|-------------------------------------|----------------------------------|----------|-------|
| ANT1                                |                                  | 1        |       |
| C1 C5 C8                            | 0805 (2012 metric)               | 3        | 10uF  |
| C17                                 | 0603 (1608 metric)               | 1        | 1uF   |
| C2 C10 C11 C12 C14 C15 C16 C7 C9 C3 | 0603 (1608 metric)               | 10       | 100nF |
| C4                                  | 0402 (1005 metric)               | 1        | 4.7pF |
| C6                                  | 0402 (1005 metric)               | 1        | 2.7pF |
| D2 D1                               | DO-214AC (SMA)                   | 2        |       |
| D3 D4                               | 0603 (1608 metric),<br>polarized | 2        |       |
| J1                                  | SMT_USB_REC_TYPE_<br>B           | 1        |       |
| J11 J12                             | HDR10                            | 2        |       |
| L1                                  | 0402 (1005 metric)               | 1        | 1.6nH |
| L2                                  | IND_SMD_4MM0_4MM0                | 1        | 2.2uH |
| R1 R4                               | 0603 (1608 metric)               | 2        | 800k  |
| R10 R9                              | 0603 (1608 metric)               | 2        | 500   |
| R12 R6 R8                           | 0603 (1608 metric)               | 4        | 10k   |
| R13 R2                              | 0603 (1608 metric)               | 2        | 330   |
| R3                                  | 0603 (1608 metric)               | 1        | 1.6k  |
| R5 L3                               | 0603 (1608 metric)               | 1        | 0     |
| R7 R11                              | 0603 (1608 metric)               | 1        | DNP   |
| S1                                  |                                  | 1        |       |
| U1                                  | TSOT-23-5                        | 1        |       |
| U2                                  | SOT23-3                          | 1        |       |
| U3                                  | VSON10                           | 1        |       |
| U4                                  | QFN48                            | 1        |       |

# Assembly



## Bring-up

1. Continuity test, See netlist
  - a. GND at all points
  - b. 3V3, 5V, BAT at all points, not at GND
2. Visual inspection - vias and traces. See issue 1
3. Solder **power supply switchover**:
  - a. Wire to GND, 5V, BAT, TP3
  - b. Solder C1, D1, D2, S1
4. Test:
  - a. 3V to BAT, ~2.3V at TP3
  - b. 3V to BAT, 5V to 5V, ~4.7V at TP3
5. Solder **battery cutoff**:
  - a. Solder C3, U2
6. Test:
  - a. 3.5V to BAT, ~3.5V at PSEN
  - b. Down to 3.0V, cutoff at 3.0V



7. Solder **SMPS**:
  - a. Solder C5, R6, U3, L2, C7, C8
8. Test:
  - a. 3.5V to BAT, measure 3.3V at R5
  - b. 5.4V down to 3.0V, measure 3.3V out, cutoff to 0V at BAT= 3V
9. Solder **battery charger**:
  - a. Solder U1, D3, R2, R4, R3, C2
10. Test:
  - a. 5V at 5V, Measure s/c current from BAT to GND (~625mA)
  - b. LED on when charging



11. Solder **ESP32**:
  - a. Solder R5, U4, L3 (0 Ohm or 2.2nH), D4, R13, R8, C17, R12, R9, R10, C9-12, C14-16
12. Test:
  - a. Power 5V to 5V, Connect serial programmer:
    - i. RTS to ESP\_EN
    - ii. DTR to GPIO0
    - iii. RX to RX
    - iv. TX to TX
    - v. Disable hardware flow control
  - b. Program blink IO17
  - c. Program charge feedback on IO4 to detect which power source in use
  - d. Program continuous antenna test - RSSI readings sent over MQTT
13. See Antenna section
  - a. Solder C4, C6, L1
  - b. Solder antenna
  - c. Test with VNA
  - d. Desolder all, update values, goto B
14. Solder a battery to TP1 and TP2, test charge, discharge, cutoff, logging to MQTT

## Netlist

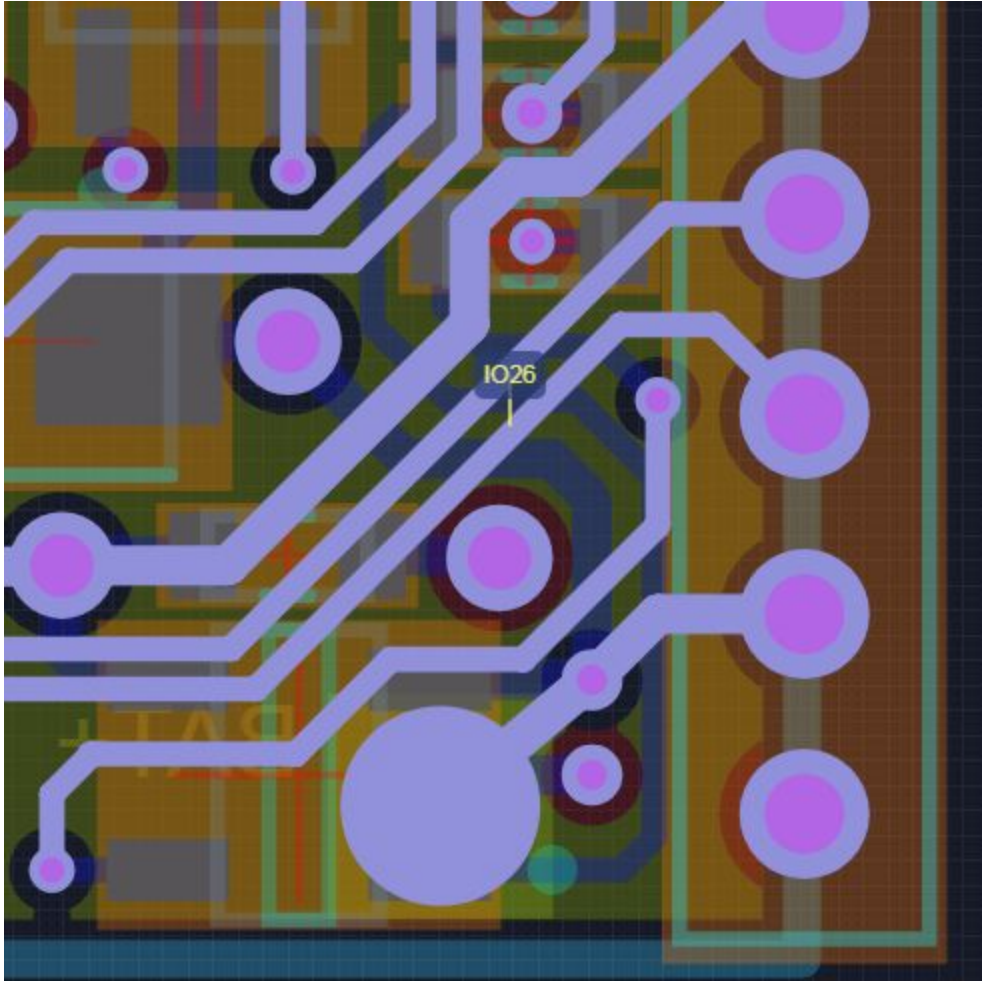
| Name  | Component | Pin | Name              | Component | Pin |
|-------|-----------|-----|-------------------|-----------|-----|
| BAT   | U2        | 3   | MTCK              | U4        | 20  |
| BAT   | C3        | 1   | (L2 - 2) (U3 - 2) | U3        | 2   |
| BAT   | J11       | 9   | (L2 - 2) (U3 - 2) | L2        | 2   |
| BAT   | D2        | 2   | IO22              | U4        | 39  |
| BAT   | TP2       | 1   | (D3 - 1) (R2 - 1) | R2        | 1   |
| BAT   | U1        | 3   | (D3 - 1) (R2 - 1) | D3        | 1   |
| U0RXD | U4        | 40  | TXD               | R9        | 2   |
| U0RXD | R9        | 1   | TXD               | J11       | 3   |
| IO19  | U4        | 38  | TXD               | J2        | 4   |
| GND   | J11       | 10  | RXD               | J11       | 2   |
| GND   | C7        | 2   | RXD               | J2        | 2   |
| GND   | C12       | 2   | RXD               | R10       | 2   |
| GND   | U3        | 11  | SENSOR_VN         | J12       | 5   |
| GND   | U3        | 3   | SENSOR_VN         | U4        | 8   |
| GND   | U3        | 9   | IO4               | U4        | 24  |
| GND   | J2        | 1   | IO4               | R4        | 2   |
| GND   | C2        | 2   | IO17              | D4        | 2   |
| GND   | ANT1      | 1   | IO17              | U4        | 27  |
| GND   | R13       | 2   | !CHRG             | U4        | 34  |
| GND   | C17       | 2   | !CHRG             | R2        | 2   |
| GND   | U2        | 1   | !CHRG             | U1        | 1   |
| GND   | C14       | 2   | !CHRG             | R1        | 2   |
| GND   | R7        | 2   | !CHRG             | R4        | 1   |
| GND   | C9        | 2   | IO16              | U4        | 25  |
| GND   | C10       | 2   | IO16              | J11       | 5   |
| GND   | J1        | 11  | SENSOR_CAPN       | J12       | 4   |
| GND   | J1        | 5   | SENSOR_CAPN       | U4        | 7   |
| GND   | J1        | 6   | IO27              | J11       | 7   |
| GND   | J1        | 7   | IO27              | U4        | 16  |

|       |     |    |  |                   |      |    |
|-------|-----|----|--|-------------------|------|----|
| GND   | J1  | 8  |  | IO0               | J2   | 3  |
| GND   | J1  | 9  |  | IO0               | J11  | 4  |
| GND   | J1  | 10 |  | IO0               | U4   | 23 |
| GND   | C3  | 2  |  | IO0               | R12  | 2  |
| GND   | J12 | 7  |  | SENSOR_VP         | J12  | 2  |
| GND   | J12 | 8  |  | SENSOR_VP         | U4   | 5  |
| GND   | J12 | 9  |  | VIN_SW            | D2   | 1  |
| GND   | J12 | 10 |  | VIN_SW            | S1   | 2  |
| GND   | TP1 | 1  |  | VIN_SW            | TP3  | 1  |
| GND   | U1  | 2  |  | VIN_SW            | D1   | 1  |
| GND   | J12 | 1  |  | IO2               | R11  | 2  |
| GND   | C1  | 2  |  | IO2               | U4   | 22 |
| GND   | C6  | 2  |  | FEED              | C4   | 2  |
| GND   | C16 | 2  |  | FEED              | ANT1 | 2  |
| GND   | R3  | 2  |  | FEED              | C6   | 1  |
| GND   | C5  | 2  |  | (L2 - 1) (U3 - 4) | U3   | 4  |
| GND   | L1  | 2  |  | (L2 - 1) (U3 - 4) | L2   | 1  |
| GND   | C11 | 2  |  | LNA_IN            | C4   | 1  |
| GND   | C8  | 2  |  | LNA_IN            | L1   | 1  |
| GND   | U4  | 49 |  | LNA_IN            | U4   | 2  |
| GND   | C15 | 2  |  | ESP_EN            | J12  | 6  |
| VIN   | U3  | 5  |  | ESP_EN            | U4   | 9  |
| VIN   | U3  | 8  |  | ESP_EN            | C17  | 1  |
| VIN   | C5  | 1  |  | ESP_EN            | R8   | 2  |
| VIN   | S1  | 3  |  | ESP_EN            | J2   | 5  |
| VIN   | R6  | 1  |  | VDD3P3            | L3   | 2  |
| U0TXD | U4  | 41 |  | VDD3P3            | U4   | 3  |
| U0TXD | R10 | 1  |  | VDD3P3            | U4   | 4  |
| 3V3   | C14 | 1  |  | VDD3P3            | C9   | 1  |
| 3V3   | R12 | 1  |  | VDD3P3            | C10  | 1  |
| 3V3   | C7  | 1  |  | PS                | R6   | 2  |
| 3V3   | L3  | 1  |  | PS                | U3   | 7  |
| 3V3   | U4  | 1  |  | PS                | R7   | 1  |
| 3V3   | U4  | 19 |  | IO26              | J11  | 8  |

|     |     |    |  |                    |     |    |
|-----|-----|----|--|--------------------|-----|----|
| 3V3 | U4  | 26 |  | IO26               | U4  | 15 |
| 3V3 | U4  | 37 |  | MTMS               | U4  | 17 |
| 3V3 | U4  | 43 |  | PS_OUT             | U3  | 1  |
| 3V3 | U4  | 46 |  | PS_OUT             | R5  | 1  |
| 3V3 | C12 | 1  |  | PS_OUT             | U3  | 10 |
| 3V3 | C11 | 1  |  | SENSOR_CAPP        | U4  | 6  |
| 3V3 | J11 | 1  |  | SENSOR_CAPP        | J12 | 3  |
| 3V3 | R8  | 1  |  | IO23               | U4  | 36 |
| 3V3 | R11 | 1  |  | PSEN               | U2  | 2  |
| 3V3 | R5  | 2  |  | PSEN               | U3  | 6  |
| 3V3 | C8  | 1  |  | IO25               | U4  | 14 |
| 3V3 | C16 | 1  |  | (R3 - 1) (U1 - 5)  | U1  | 5  |
| 3V3 | C15 | 1  |  | (R3 - 1) (U1 - 5)  | R3  | 1  |
| 5V  | U1  | 4  |  | (D4 - 1) (R13 - 1) | R13 | 1  |
| 5V  | R1  | 1  |  | (D4 - 1) (R13 - 1) | D4  | 1  |
| 5V  | D3  | 2  |  | MTDO               | U4  | 21 |
| 5V  | J1  | 1  |  | IO21               | U4  | 42 |
| 5V  | C2  | 1  |  | IO18               | U4  | 35 |
| 5V  | J2  | 6  |  | MTDI               | U4  | 18 |
| 5V  | J11 | 6  |  |                    |     |    |
| 5V  | D1  | 2  |  |                    |     |    |
| 5V  | C1  | 1  |  |                    |     |    |

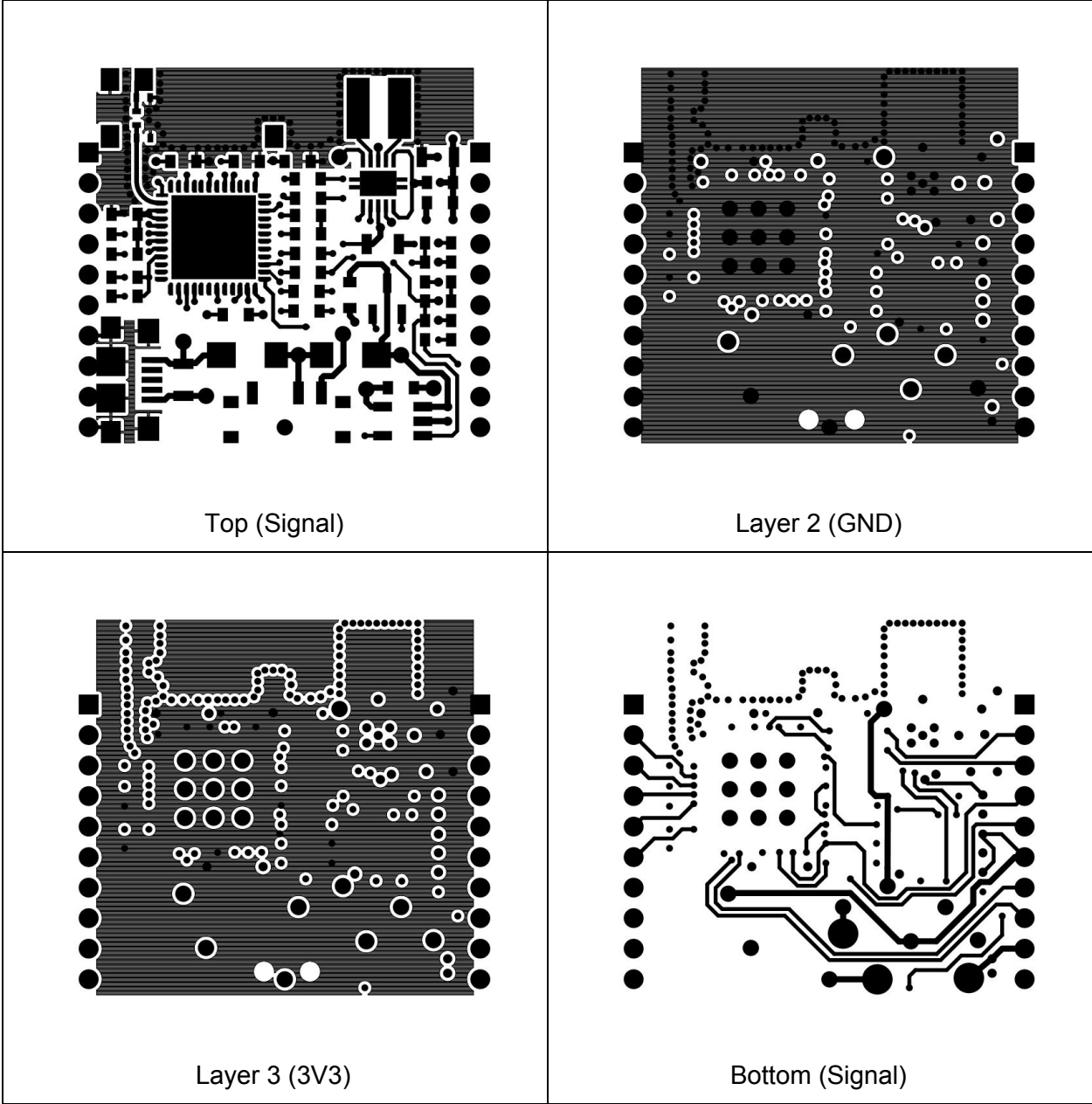
## Issues

1. IO26 (bottom layer) was unintentionally violating keepout distances to via. Image is flipped.



2. RX and TX on the castellations are connected to TX and RX on the ESP32, respectively
3. L3 can probably use a 0 Ohm resistance, skipping the ESP32 power filtering
4. R3 via is not tented, short circuit risk

# Layers



# Antenna



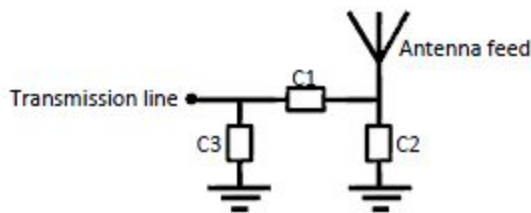
## 8. OnBoard SMD 2400 Evaluation board

The evaluation board is developed to simplify antenna testing and evaluation. It has an arbitrary size of 100 x 50 mm and includes an SMA connector. The purpose is to give a reference design for an optimal antenna implementation. The evaluation board can also be used to test other implementations by cutting and soldering the PCB into any device.



Evaluation board outline

The evaluation board has a matching circuit implemented next to the antenna. This is aimed to enable optimization possibilities for the user. The component positions are sized for 0402 (1005 metric) SMD components.



Matching circuit

The antenna needs a matching circuit to adjust the resonant frequency balance. When delivered, the evaluation board is tuned for optimum balance at the 2.4 GHz band. The component values for this setup is  $C1 = 1.5nH$ ,  $C2 = 0.5pF$ ,  $C3 = N/A$ . However, it is common that the resonant frequency will shift during implementation in an arbitrary device. Therefore, this matching may be changed for compensation of such effects. This is further described in chapter 9.

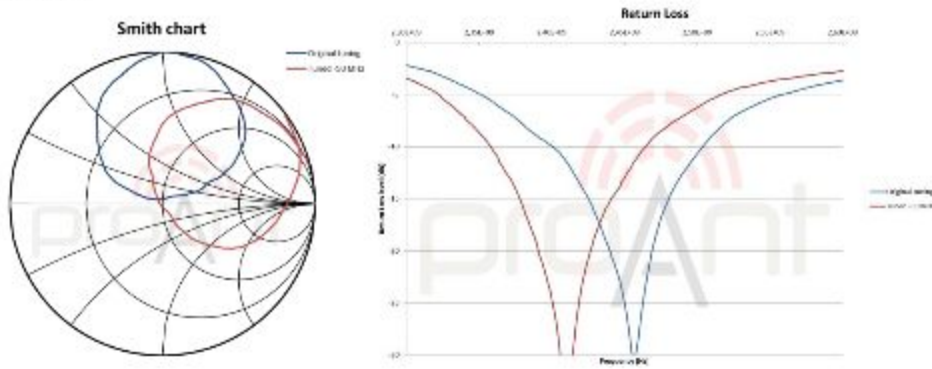


### 9. Antenna tuning and impedance matching

The antenna should have nominal tuning in most applications when  $C1 = 0$  Ohm (measured with coaxial cable on the evaluation board). However, the user may like to elaborate with the tuning if the implementation causes a resonant frequency shift. This part shows two examples of how a simple frequency tuning can be implemented.

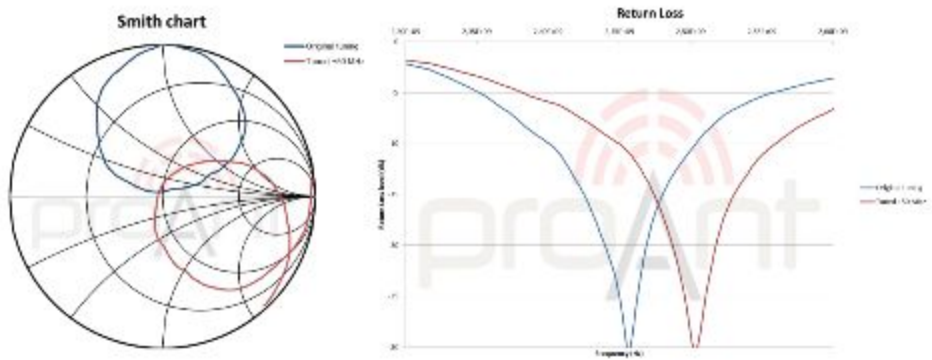
#### Tune 50 MHz down

- C1 = 2.7 nH (Murata LQW15AN2N7G80D)
- C2 = 0.75pF (Murata GJM1555C1HR75WB01)
- C3 = N/A



#### Tune 50 MHz up

- C1 = 1.0 nH (Murata LQP15MN1N0W02)
- C2 = N/A
- C3 = 1.0pF (Murata GJM1555C1H1R0WB01)





## **References**

Proant 440

<http://www.proant.se/files/user/Documents/Datasheets%20and%20appnotes/Upload%202018-06-08/Application%20note%20-%20OnBoard%20SMD%202400%20MHz%20rev%203.2.pdf>

ESP32 Hardware Design Guidelines

[https://www.espressif.com/sites/default/files/documentation/esp32\\_hardware\\_design\\_guidelines\\_en.pdf](https://www.espressif.com/sites/default/files/documentation/esp32_hardware_design_guidelines_en.pdf)

ESP-PICO-KIT

[https://dl.espressif.com/dl/schematics/esp32-pico-kit-v4.1\\_schematic.pdf](https://dl.espressif.com/dl/schematics/esp32-pico-kit-v4.1_schematic.pdf)

LTC4054

<http://www.analog.com/media/en/technical-documentation/data-sheets/405442xf.pdf>