INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY

PCB Design of Wireless Power bank

Project Report

Electronic System Packaging (VLS603)

Done by: -

TUSHAR PRAKASH KATOLE	MT2024518
OMKAR GAVANDI	MT2024524
PHANEENDRA M V	MT2024526
LIKITHKUMAR RACHAPUTI	MT2024528

Submitted to: -

Prof. Kurian Polachan

Assistant Professor,

Connected Devices and Wearables Lab,

International Institute of Information Technology - Bangalore

1. Introduction:

- A **wireless power bank** is a portable device used to charge smartphones and other gadgets.
- It charges devices **without the need for a cable**.
- You simply place your device on top of the power bank to start charging.
- It uses **wireless charging technology**, usually based on the **Qi standard**.
- It's **convenient and easy to use**, especially while traveling or when there's no access to a power outlet.
- Helps keep your charging setup **neat and tangle-free**.

2. Specification:

- Capacity: 10000 mAh
- Input: 21W (Max.)
- Output: Wireless - 15W
- Max. Output: 15W (Max.)
- Charging Protocols: USB PD 3.0, QC 3.0.
- Recharging Time: Up to 2 hours using 20W PD chargers
- Protection: Multiple layers of protection, auto-connect feature

2.1.1. Recharging Time Calculation:

Recharging Time: 10000mAH/5A = 2 hours.

3. Working:

- Input is drawn from wall mounted charger using USB C, which provides input current in the range of 2- 5 A, and voltage in the range of 4 – 11 V.
- USB C uses USB PD protocol to negotiate for 21W of output power for charging the power banks battery.
- Power delivery module is used when USB PD negotiation fails, and a safe power of 5W is delivered to the Power Bank’s battery.
- Battery management system is used cut the supply to the transmitter coil module, when the battery voltage fall below 3V.
- Boost converter is used to step up the voltage from BMS to transmitter coil IC as inputs of this IC is in the range of 5-9V.
- Wireless Transmitter module provides 15W as output power for charging the electronic devices.

4. Components used(Main ICs):

- CYPD3176-24LQXQ: USB Type-C port controller for power sinks
  - The CYPD3176-24LQXQ is a highly integrated USB Type-C sink port controller from Infineon Technologies, designed primarily for power sink applications in USB Type-C systems. It belongs to the Barrel Connector Replacement (BCR) family and comes pre-programmed to simplify integration in devices requiring USB Type-C power delivery

- TPS61088RHLR (Boost Converter)
  - The TPS61088RHLR is a high-power density, fully-integrated synchronous boost converter IC from Texas Instruments designed for efficient step-up voltage conversion in portable and battery-powered applications.

- WLC1115-68LQXQ (Wireless Charging Transmitter IC)
  - The WLC1115-68LQXQ from Infineon Technologies is a highly integrated wireless charging transmitter IC designed to enable efficient and low-cost wireless power transfer for various applications. It supports the latest Qi2 standard and multiple wireless charging power profiles, making it suitable for a wide range of consumer and industrial devices.

5. Battery Management System Design:

Designing the Resistor R1 for Safe Operation of Zener Diode and Transistor

5.1.1. Introduction:

In BMS, a **Zener diode** is used to regulate the base voltage of an **NPN transistor**. The Zener diode ensures that the transistor turns on and off based on a predefined voltage threshold. To ensure the safe operation of the Zener diode, a **series resistor (R1)** is introduced to limit the current flowing through the Zener diode, preventing it from exceeding its maximum current rating. The purpose of this calculation is to design **R1** such that the diode operates within its safe limits and the transistor triggers at the correct voltage threshold.

5.1.2. Key Parameters:

- **Battery Voltage (Vbatt)** = 3.7 V (maximum supply)
- **Zener Voltage (Vz)** = 3.0 V (reverse breakdown voltage of the Zener diode)
- **Maximum Power Rating of Zener Diode (Pz)** = 500 mW
- **Base-Emitter Voltage of Transistor (Vbe)** ≈ 0.7 V (for conduction)
- **Maximum Zener Diode Current (Iz_max)** = 166.67 mA (calculated below)

5.1.3. Calculation of Maximum Zener Current (I_{z_max}):

The current through the Zener diode must be limited to prevent damage due to excessive power dissipation. The **maximum current** is determined by the power rating of the Zener diode. Using the power dissipation formula:

$Pz = Vz \cdot Iz$

Where:

- **Pz** = 500 mW
- **Vz** = 3.0 V

Rearranging to solve for **Iz**:

$Iz = Pz / Vz = 500\ mW / 3.0\ V = 166.67\ mA$

Thus, the **maximum Zener current (Iz_max)** is **166.67 mA**.

5.1.4. Calculation of Resistor R1:

Now, we calculate the value of **R1** to ensure that the current through the Zener diode does not exceed the maximum allowable value. The current flowing through the Zener diode is determined by the voltage difference between the battery supply and the Zener diode, divided by the resistance **R1**:

$R1 = (Vbatt - Vz) / Iz$

Substituting the known values:
$R1 = (3.7\ V - 3.0\ V)/166.67\ mA \approx 4.2\Omega$

Thus, the **ideal value for R1** is approximately **4.2 ohms** to allow the maximum current of **166.67 mA** to flow through the Zener diode.

5.1.5. Verifying the Resistor Value of 30 Ohms:

If we choose a **resistor value of 30 ohms** instead of 4.2 ohms, it will limit the current flowing through the Zener diode to a much lower value. Let's calculate the current through the Zener diode with **R1 = 30 ohms**:

$Iz = Vbatt - Vz * R1 = (\ 3.7\ V - (3.0\ V * 30\ \Omega\ ))\ \approx 23.3 mA$

The current through the Zener diode is now **23.3 mA**, which is much lower than the maximum allowable current of **166.67 mA**. This ensures that the **Zener diode operates well within its safe limits**.

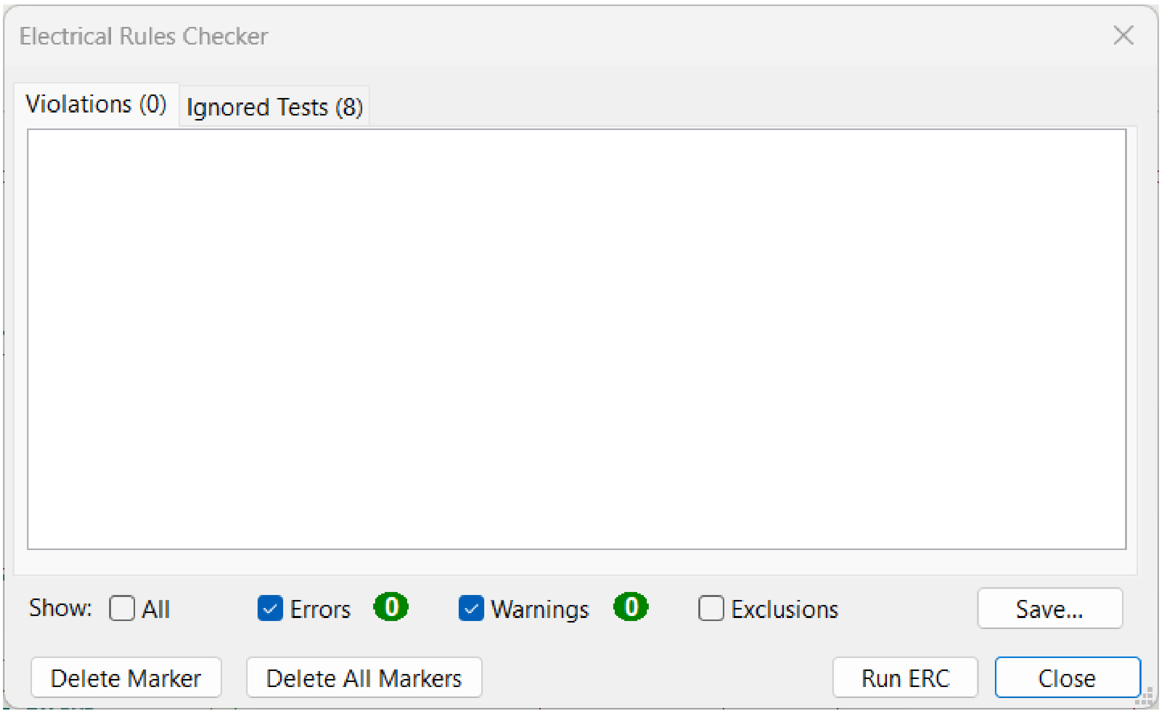
5.1.6. Power Dissipation in the Zener Diode:

Next, we calculate the power dissipation in the Zener diode with **R1 = 30 ohms**. The power dissipated in the Zener diode is:

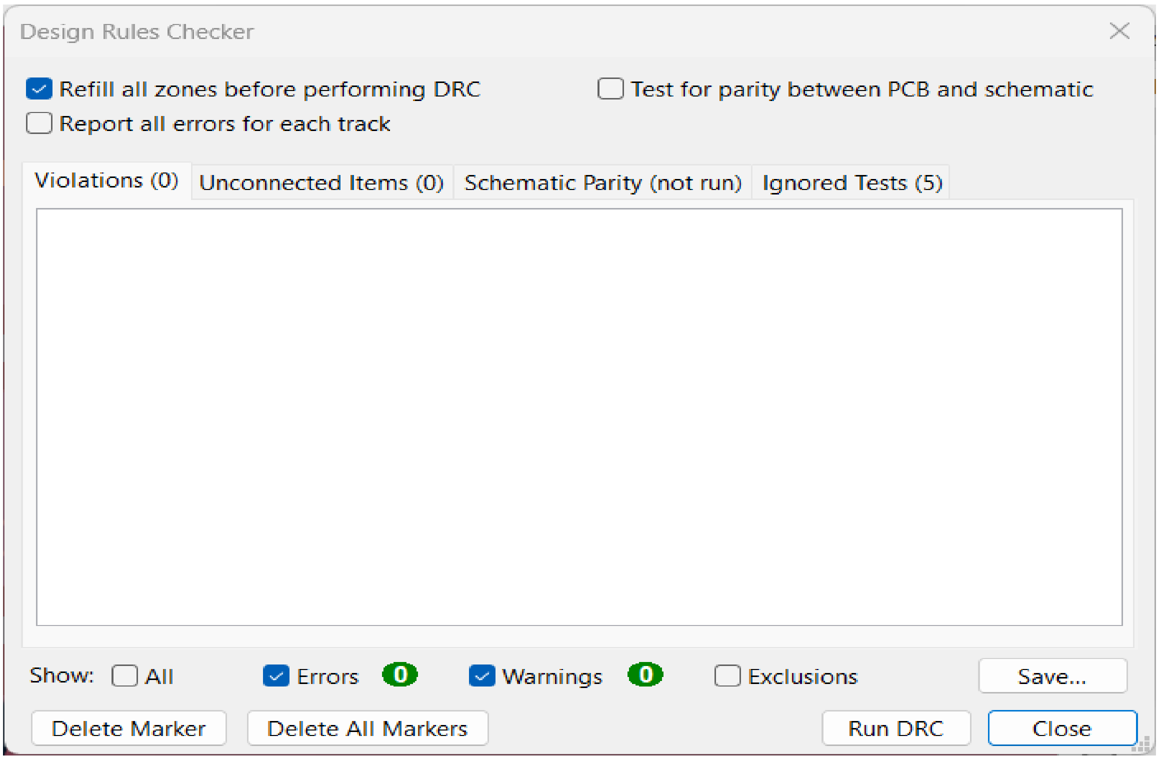
$P_z = V_z * I_z = 3.0\ V * 23.3\ mA = 69.9\ mW$

Since **69.9 mW** is significantly lower than the **500 mW** maximum power rating of the Zener diode, this further ensures the safe operation of the Zener diode.

6. DRC Errors:

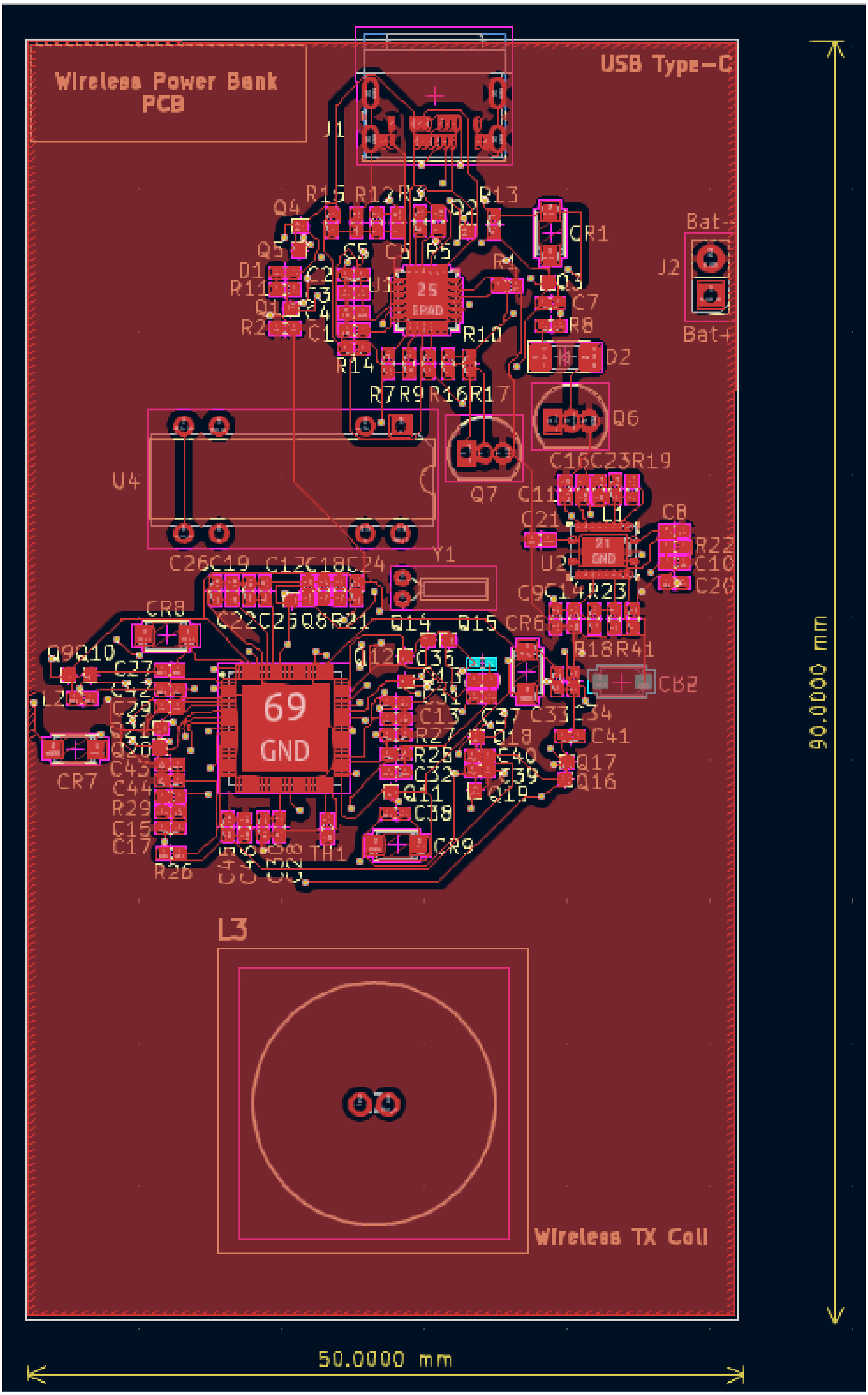


7. ERC Errors:

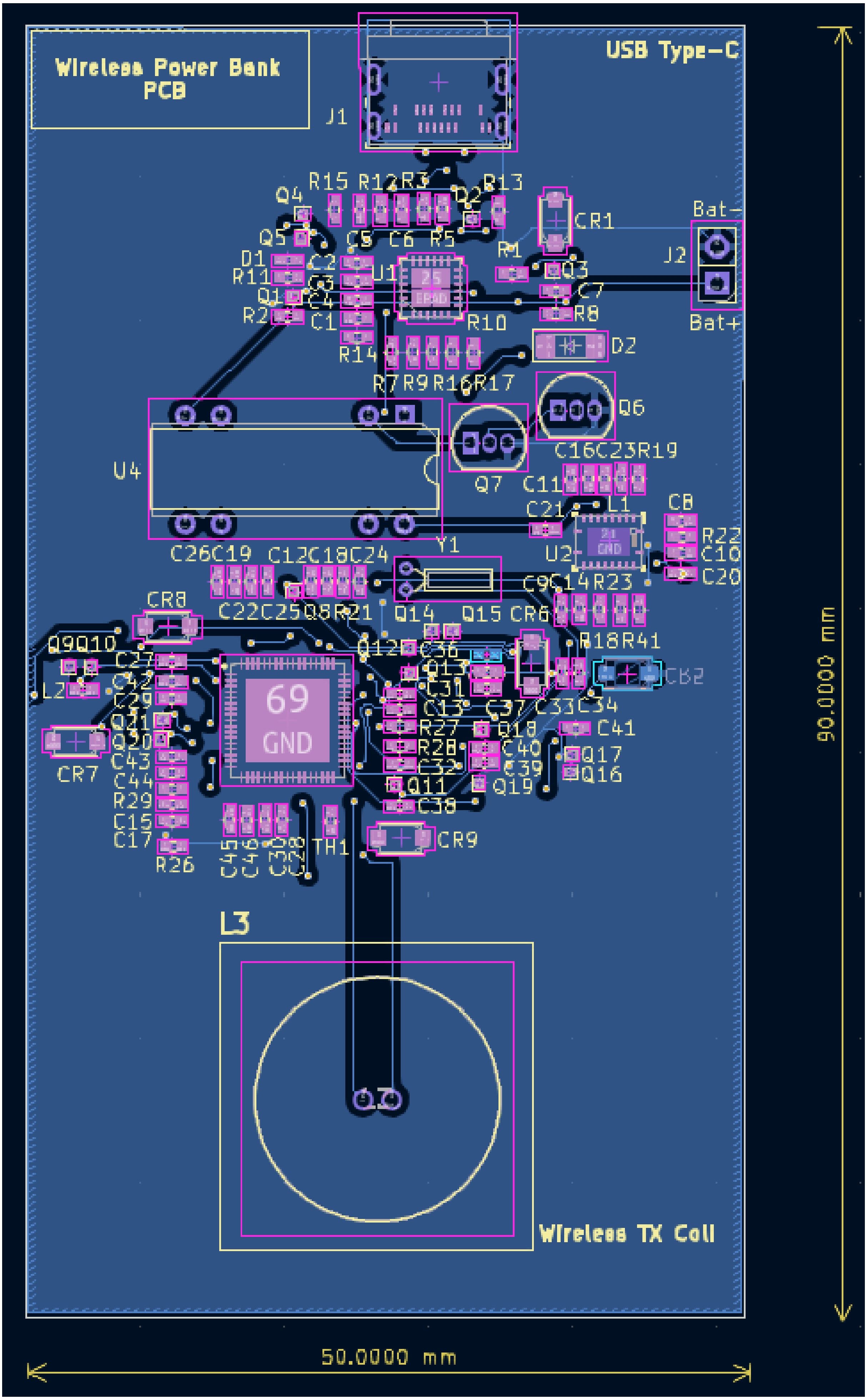


8. Layout:

8.1.1. Front Cu:

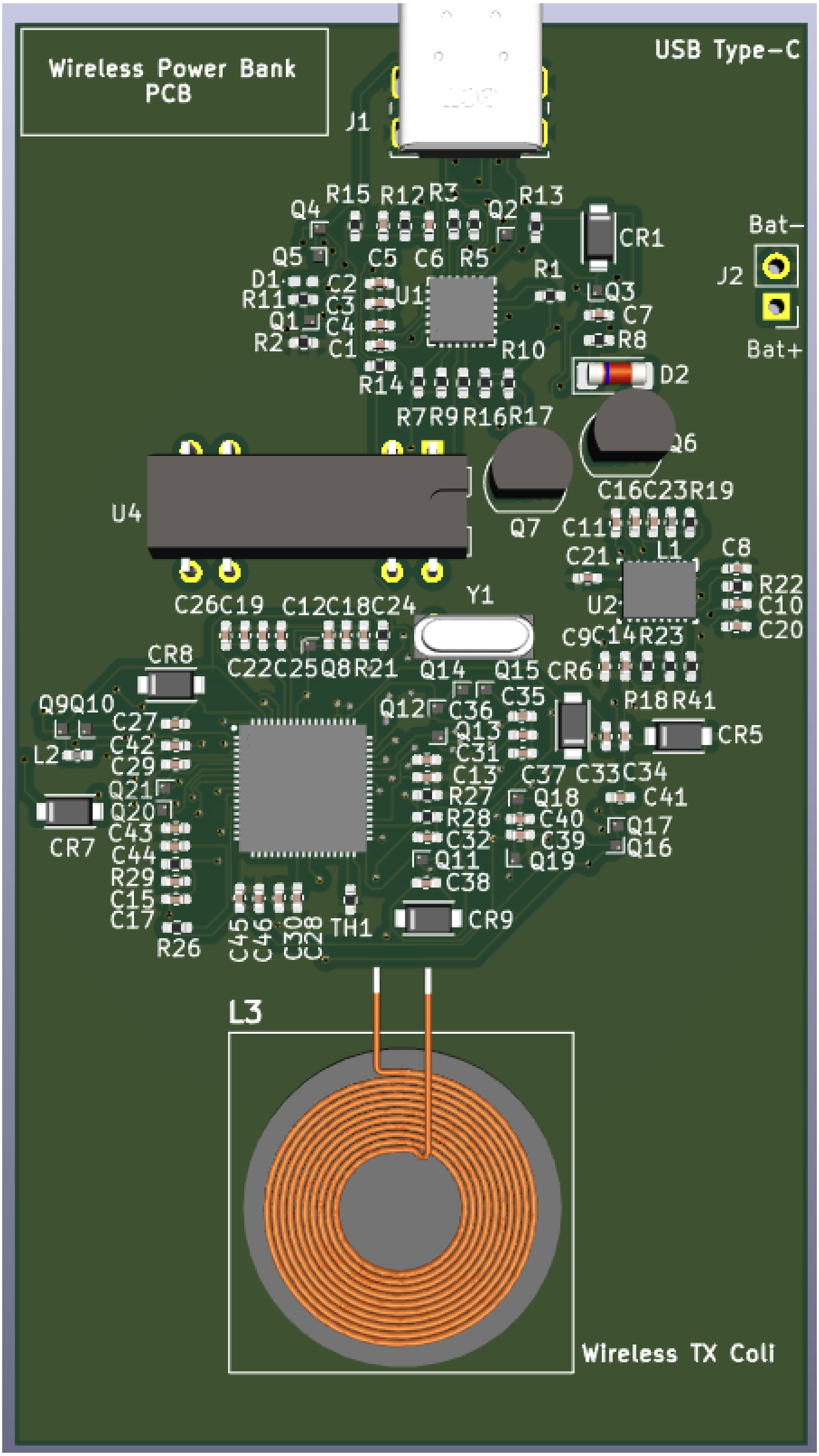


8.1.2. Back Cu



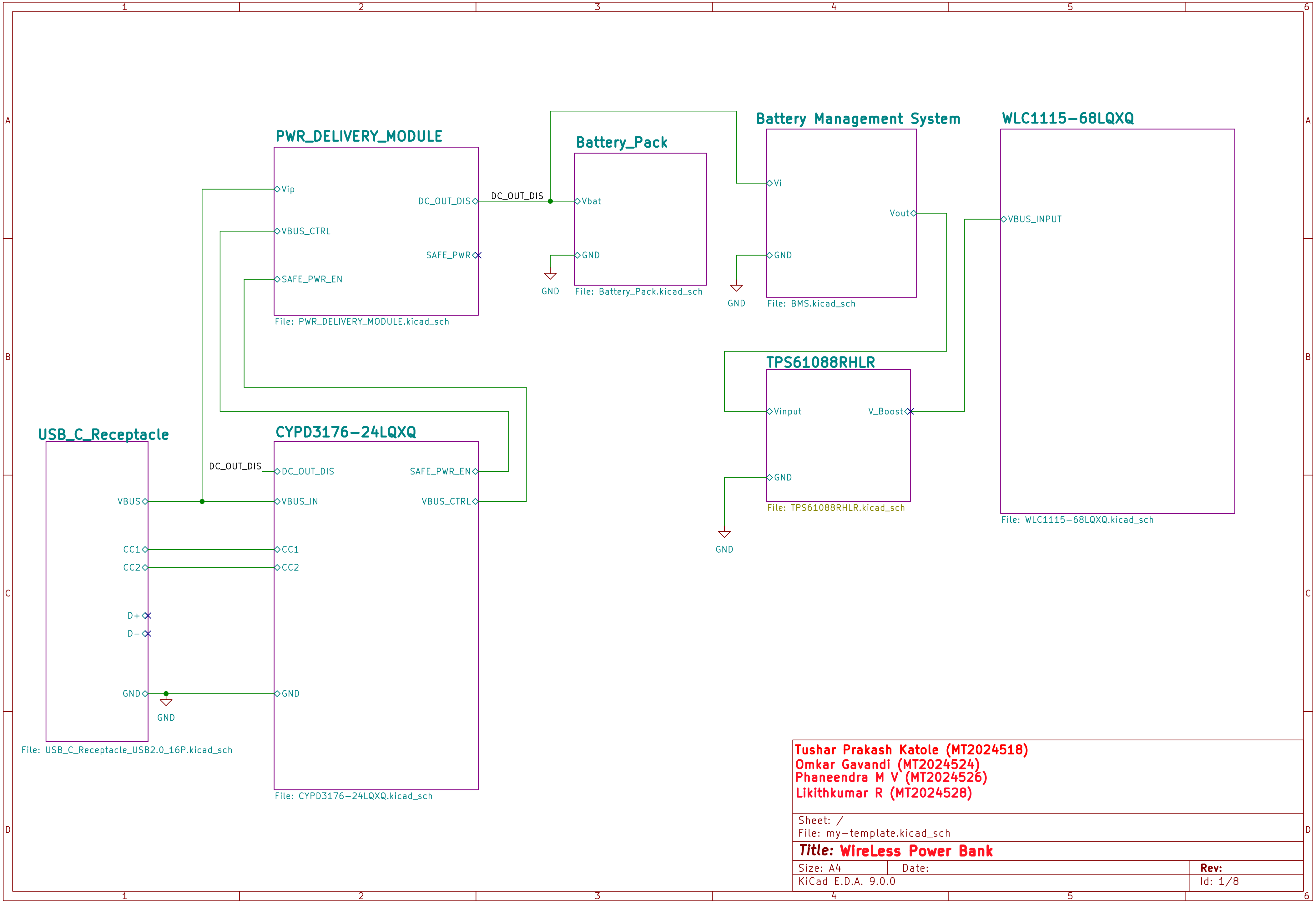
Wireless Power Bank PCB
USB Type-C
J1
Bat-
J2
Bat+
U4
Y1
L3
Wireless TX Coil
69 GND
90.0000 mm
50.0000 mm

8.1.3. 3D Front View

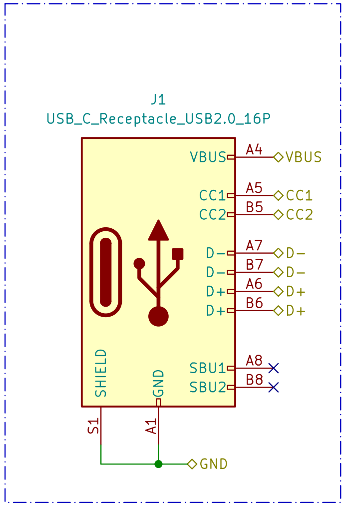


8.1.4. 3D Back View:

SCHEMATIC


PWR_DELIVERY_MODULE
Vip
VBUS_CTRL
SAFE_PWR_EN
DC_OUT_DIS
SAFE_PWR
File: PWR_DELIVERY_MODULE.kicad_sch
DC_OUT_DIS
Battery_Pack
Vbat
GND
GND
File: Battery_Pack.kicad_sch
Battery Management System
Vi
Vout
GND
GND
File: BMS.kicad_sch
WLC1115-68LQXQ
VBUS_INPUT
File: WLC1115-68LQXQ.kicad_sch
TPS61088RHLR
Vinput
V_Boost
GND
File: TPS61088RHLR.kicad_sch
GND
USB_C_Receptacle
VBUS
CC1
CC2
D+
D-
GND
GND
File: USB_C_Receptacle_USB2.0_16P.kicad_sch
CYPD3176-24LQXQ
DC_OUT_DIS
DC_OUT_DIS
VBUS_IN
CC1
CC2
GND
SAFE_PWR_EN
VBUS_CTRL
File: CYPD3176-24LQXQ.kicad_sch
Tushar Prakash Katole (MT2024518)
Omkar Gavandi (MT2024524)
Phaneendra M V (MT2024526)
Likithkumar R (MT2024528)
Sheet: /
File: my-template.kicad_sch
Title: WireLess Power Bank
Size: A4
Date:
Rev:
KiCad E.D.A. 9.0.0
Id: 1/8

USB-C RECEPTACLE



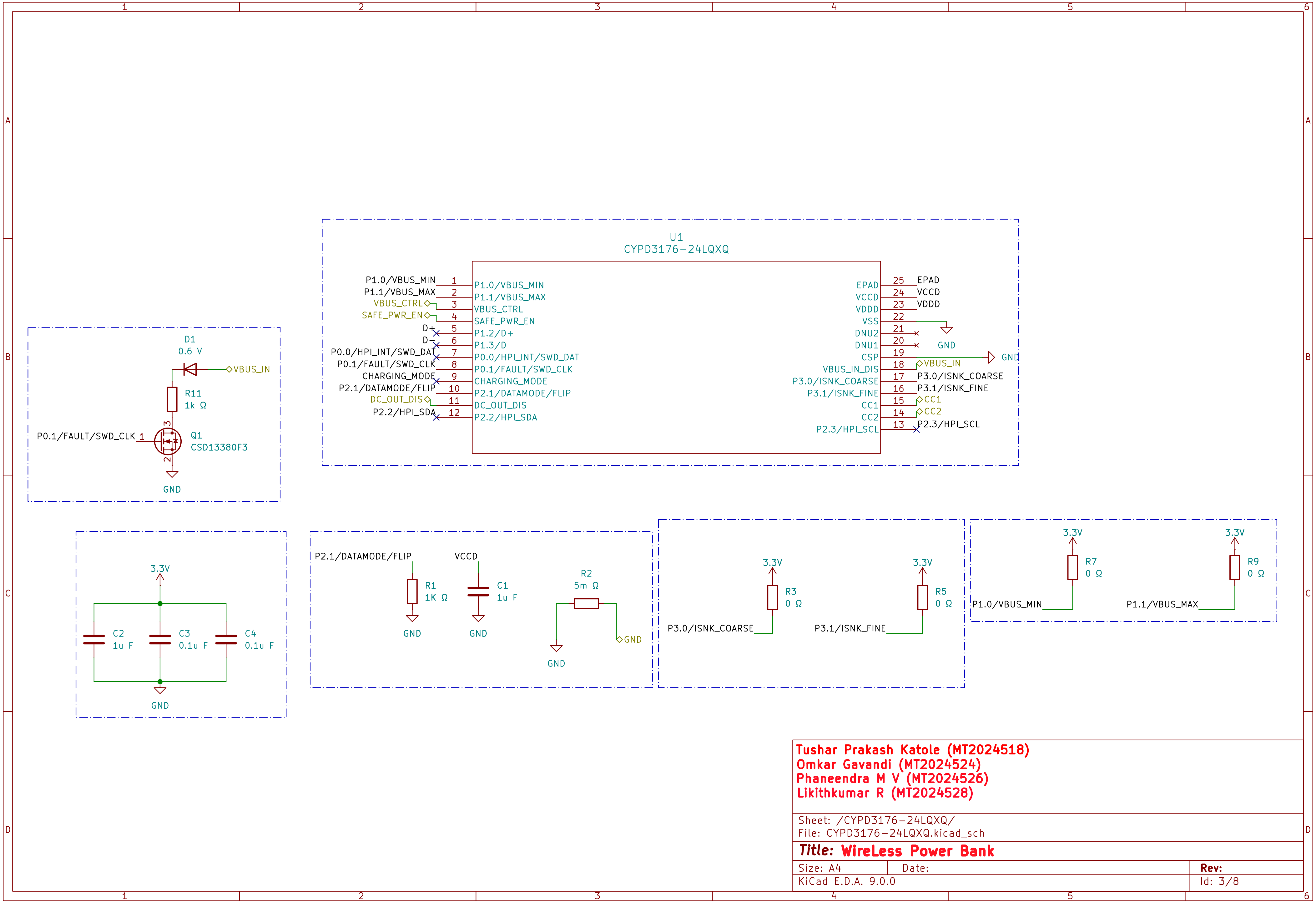
Tushar Prakash Katole (MT2024518)
Omkar Gavandi (MT2024524)
Phaneendra M V (MT2024526)
Likithkumar R (MT2024528)

Sheet: /USB_C_Receptacle/
File: USB_C_Receptacle_USB2.0_16P.kicad_sch

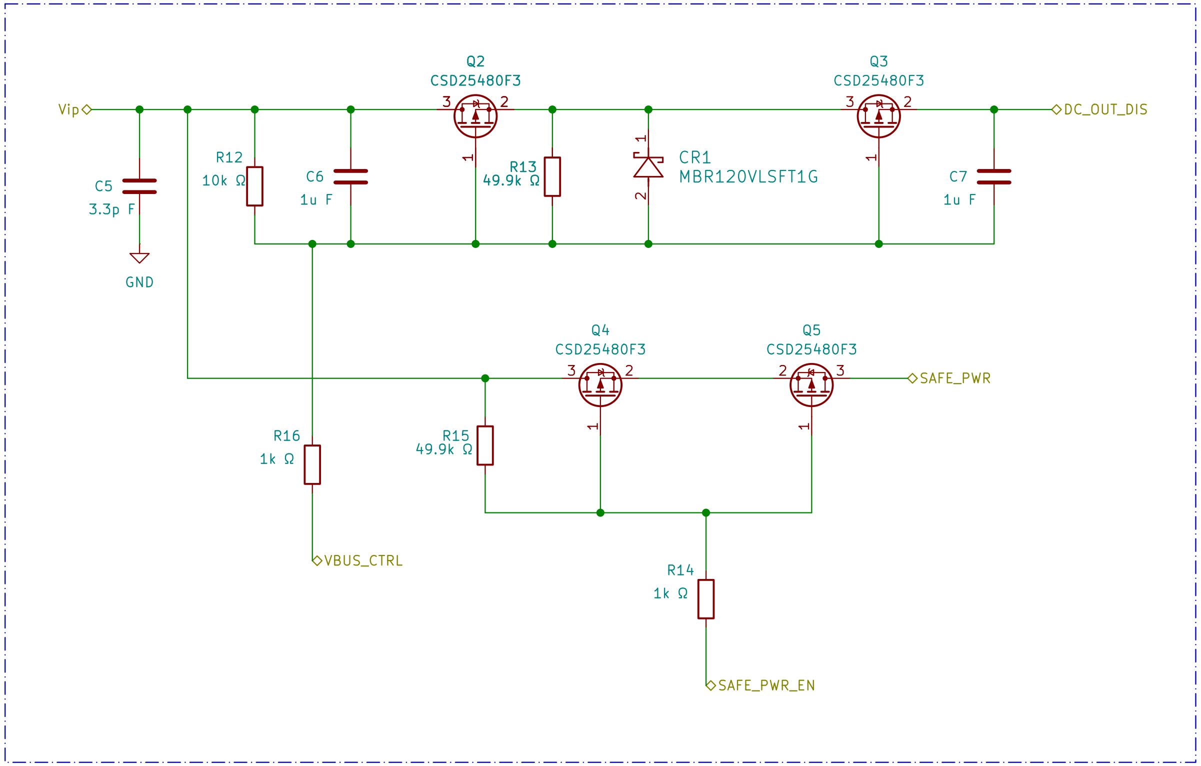
Title: WireLess Power Bank

Size: A4	Date:	**Rev:**
KiCad E.D.A. 9.0.0		Id: 2/8

CYPD3176-24LQXQ (POWER NEGOTIATING IC)



PWR_DELIVERY_MODULE



Tushar Prakash Katole (MT2024518)
Omkar Gavandi (MT2024524)
Phaneendra M V (MT2024526)
Likithkumar R (MT2024528)

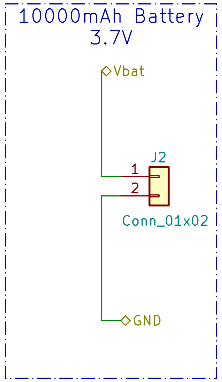
Sheet: /PWR_DELIVERY_MODULE/
File: PWR_DELIVERY_MODULE.kicad_sch

Title: **WireLess Power Bank**

Size: A4 Date:
KiCad E.D.A. 9.0.0

Rev:
Id: 4/8

BATTERY_PACK



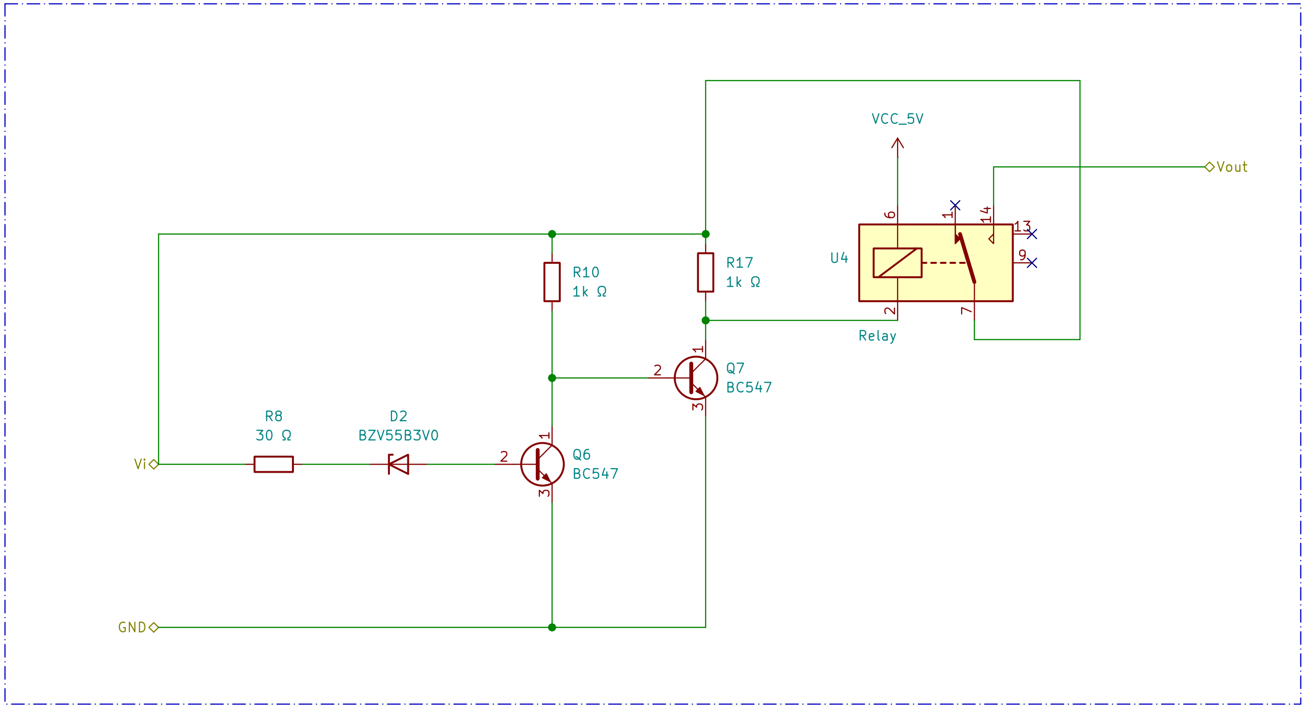
Tushar Prakash Katole (MT2024518)
Omkar Gavandi (MT2024524)
Phaneendra M V (MT2024526)
Likithkumar R (MT2024528)

Sheet: /Battery_Pack/
File: Battery_Pack.kicad_sch

Title: WireLess Power Bank

Size: A4 Date: Rev:
KiCad E.D.A. 9.0.0 Id: 5/8

BATTERY MANAGEMENT SYSTEM



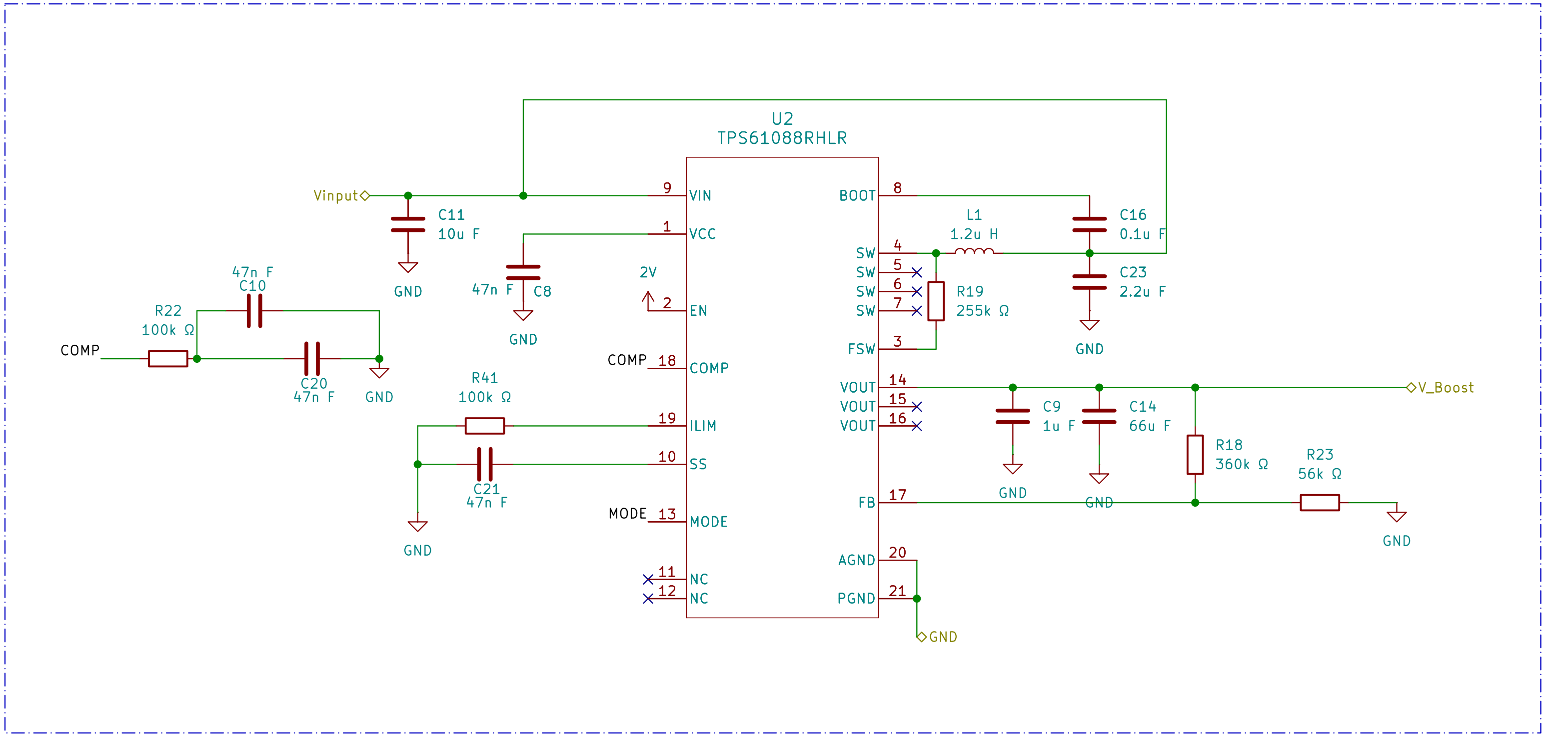
Tushar Prakash Katole (MT2024518)
Omkar Gavandi (MT2024524)
Phaneendra M V (MT2024526)
Likithkumar R (MT2024528)

Sheet: /Battery Management System/
File: BMS.kicad_sch

Title: WireLess Power Bank

Size: A4	Date:	Rev:
KiCad E.D.A. 9.0.0		Id: 6/8

TPS61088RHLR (BOOST CONVERTER)



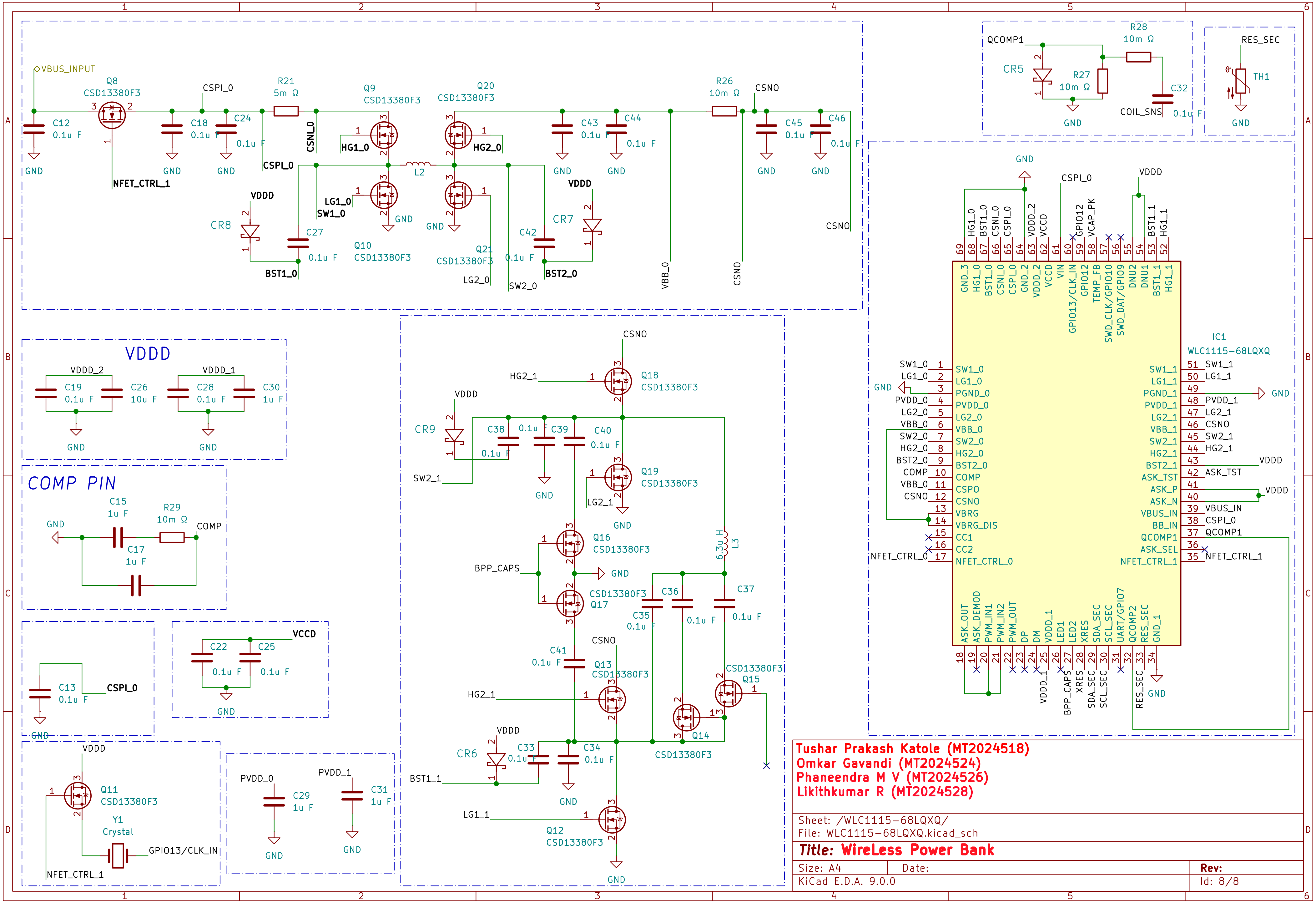
Tushar Prakash Katole (MT2024518)
Omkar Gavandi (MT2024524)
Phaneendra M V (MT2024526)
Likithkumar R (MT2024528)

Sheet: /TPS61088RHLR/
File: TPS61088RHLR.kicad_sch

Title: WireLess Power Bank

Size: A4 | Date: | Rev:
KiCad E.D.A. 9.0.0 | Id: 7/8

WLC1115-68LQXQ (WIRELESS TRANSMITTER IC)



(BOM)

Reference	Value	Qty	Digikey Part#	Digikey URL
C1,C2,C6,C7,C9,C15,C17,C29,C30,C31	1u F	10	587-1231-1-ND	Click Here
C3,C4,C12,C13,C16,C18,C19,C22,C24,C25,C27,C28,C32,C33, C34,C35,C36,C37,C38,C39,C40,C41,C42,C43,C44,C45,C46	0.1u F	27	1276-1002-1-ND	Click Here
C5	3.3p F	1	720-1318-1-ND	Click Here
C8,C10,C20,C21	47n F	4	445-6897-1-ND	Click Here
C11,C26	10u F	2	490-6473-1-ND	Click Here
C14	66u F	1	445-14671-1-ND	Click Here
C23	2.2u F	1	1276-1469-1-ND	Click Here
CR1,CR5,CR6,CR7,CR8,CR9	MBR120VLSFT1G	6	MBR120VLSFT1GOSCT-ND	Click Here
D1	0.6 V	1	SMMSD301T1GOSCT-ND	Click Here
D2	BZV55B3V0	1	1801-BZV55B3V0TR-ND	Click Here
IC1	WLC1115-68LQXQ	1	448-WLC1115-68LQXQ-ND	Click Here
J1	USB_C_Receptacle_USB2.0_16P	1	664-124019772112ACT-ND	Click Here
J2	Conn_01x02	1		Click Here
L1,L2	1.2u H	2	3526-WCI4532CP1R2GDGCT-ND	Click Here
L3	6.3u H	1	732-9676-ND	Click Here
Q1,Q8,Q9,Q10,Q11,Q12,Q13,Q14,Q15,Q16,Q17,Q18,Q19,Q20,Q21	CSD13380F3	15	296-47750-1-ND	Click Here
Q2,Q3,Q4,Q5	CSD25480F3	4	296-48903-1-ND	Click Here
Q6,Q7	BC547	2	BC547-ND	Click Here
R1	1K ohm	1	RMCF0603FT1K00CT-ND	Click Here
R2,R21	5m ohm	2	P19182CT-ND	Click Here
R3,R5,R7,R9	0 ohm	4	P0.0JCT-ND	Click Here
R8	30 ohm	1	311-30.0CRCT-ND	Click Here
R10,R11,R14,R16,R17	1k ohm	5	RMCF0603FT1K00CT-ND	Click Here
R12	10k ohm	1	311-10KJRCT-ND	Click Here
R13,R15	49.9k ohm	2	P49.9KDCCT-ND	Click Here
R18	360k ohm	1	P360KLCT-ND	Click Here
R19	255k ohm	1	P255KLCT-ND	Click Here
R22,R41	100k ohm	2	311-100KJRCT-ND	Click Here
R23	56k ohm	1	P56KDCCT-ND	Click Here
R26,R27,R28,R29	10m ohm	4	P19181CT-ND	Click Here
TH1	Thermistor_NTC	1	445-2550-1-ND	Click Here
U1	CYPD3176-24LQXQ	1	448-CYPD3176-24LQXQ-ND	Click Here
U2	TPS61088RHLR	1	296-43620-1-ND	Click Here
U4	Relay	1	374-1052-ND	Click Here
Y1	Crystal	1	1908-J49SMH-A-G-G-K-4M0CT-ND	Click Here

Conclusion:

- The project shows how wireless charging can be combined with a portable power bank.
- It allows charging devices without cables, making it more convenient.
- Wireless charging reduces wear and tear on charging ports.
- The power bank is easy to carry and use anywhere.
- This project supports the growing need for wireless and mobile power solutions.
- It helps create smarter and more user-friendly charging devices for the future.