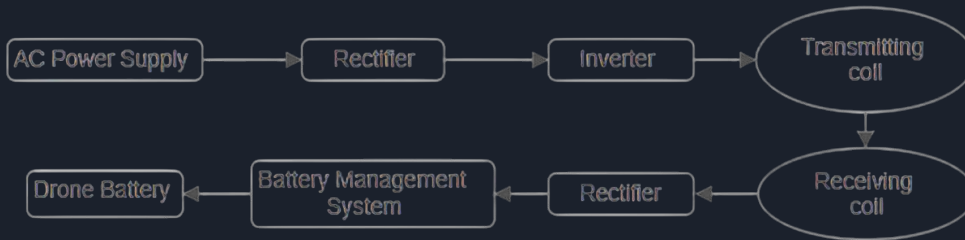


Smart BMS Module for DronePad System

By Adityaraj Panchal
To Dr. Dr. Ashwani Sharma, Associate
Professor, IIT Ropar

Objective

- To Develop a **Battery Management System (BMS)** support module for a **wireless charging drone system**.
- To Design a **digitally switchable** BMS for different configurations (3S to 6S).
- To Achieve **real-time battery reconfiguration** during autonomous drone operations.





Initial Learning

- Studied fundamentals of **Battery Management Systems (BMS)**:
 - a. Function, importance, safety features
 - b. Commercial limitations
- Explored working of **NXP RDDRONE-BMS772**
 - a. Fixed jumper-based configuration
 - b. Lack of dynamic reconfigurability
- Understood drone power requirements:
 - a. Multi-cell Li-Po batteries (3S–6S)
 - b. Role of BMS in autonomous drones

🧠 *“Spent the first week studying the theory and evaluating existing hardware capabilities.”*



Understanding the problems

01

Commercial BMS like RDDRONE-BMS772 lacked:

- **Real-time switching** of battery configuration
- **Digital control** via onboard system (e.g., Raspberry Pi)

02

Configuration (3S/4S/5S/6S) required **manual jumper settings**

03

Problem in drone application:

- Cannot adapt battery setup mid-mission
- Not suitable for autonomous wireless charging scenarios



*“We needed a solution that supports **digital, mission-aware switching** between battery configurations.”*



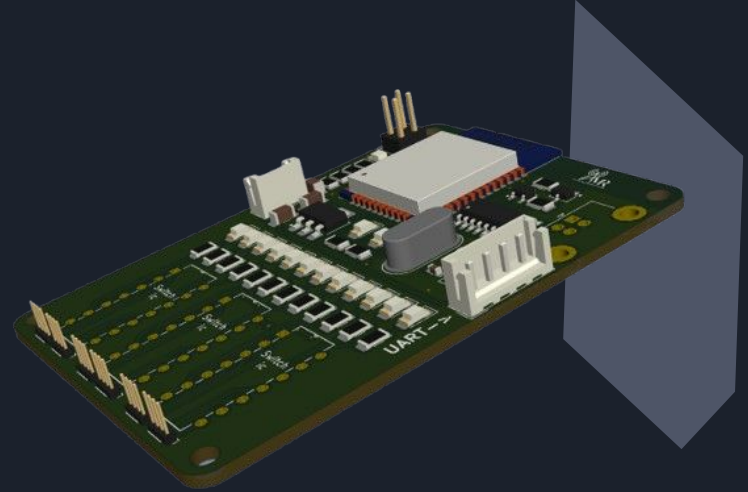
My Contribution



- Designed a **custom Smart Switching Module** using **ESP32**.
- Made conventional BMS digitally switchable using software logic.
- Achieved control over battery config via commands from Raspberry Pi.
- Configurations supported: **3S, 4S, 5S, 6S**

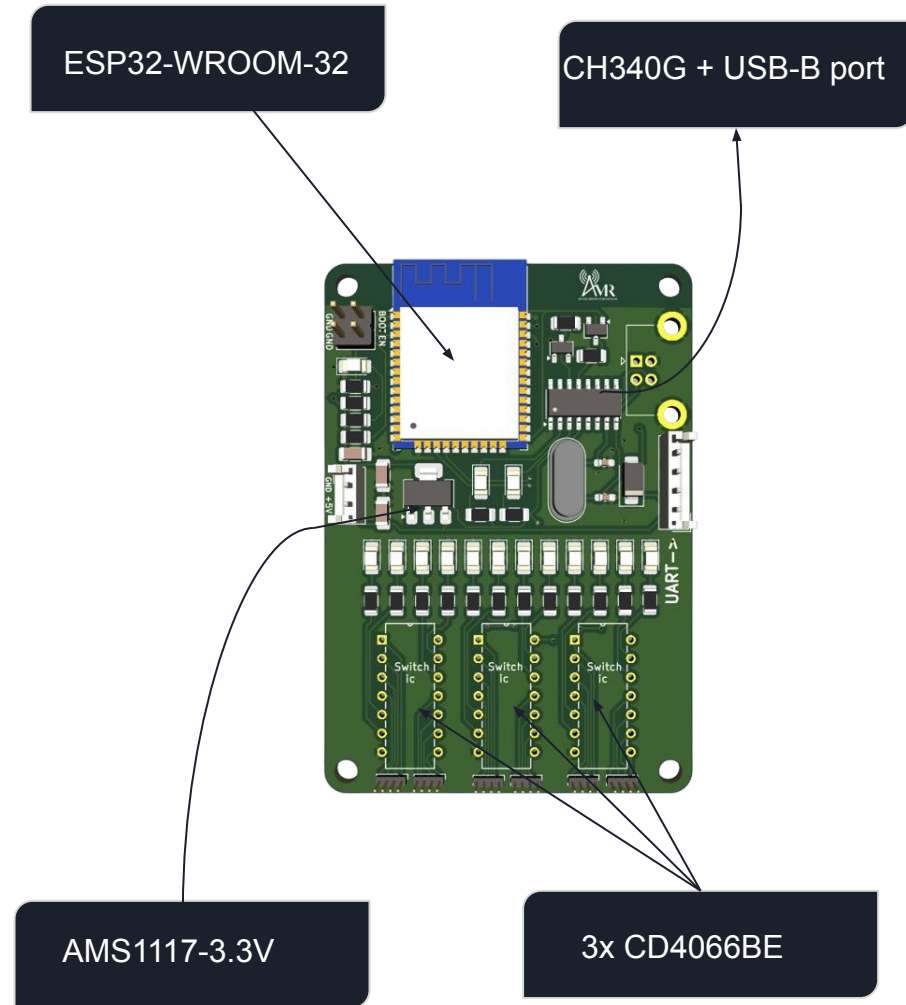
System Overview

- **ESP32-based module** receives commands via UART.
- Uses **CD4066 analog switch ICs** to route cell taps.
- Controls BMS input taps **without changing its firmware**.
- Enables **wireless charging + battery config switching** on drones.



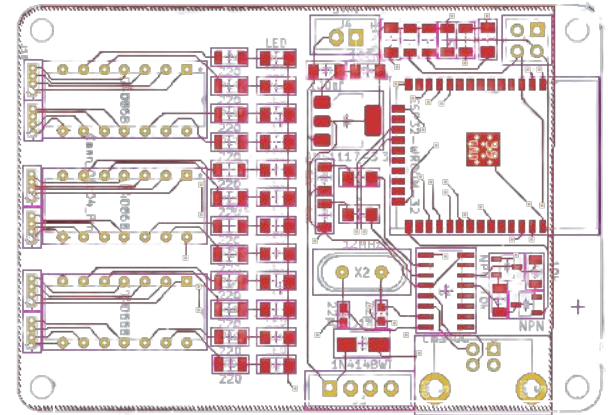
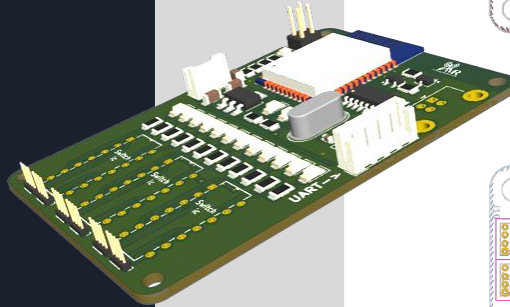
Hardware Highlights

- **Microcontroller:** ESP32-WROOM-32
- **Switching ICs:** 3x CD4066BE
- **Power Regulator:** AMS1117-3.3V
- **Communication:** UART (with Raspberry Pi)
- **Programming Interface:** CH340G + USB-B port

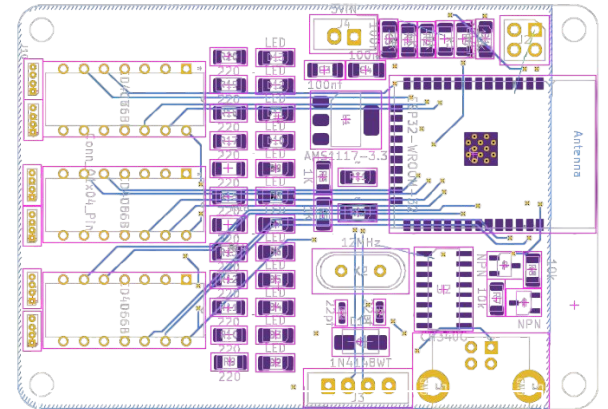


PCB Design

- Designed in **KiCad** with 2-layer layout.
- Compact form factor with mount holes for drone integration.
- Ground planes, decoupling, and proper signal routing ensured.
- Added indicator LEDs for debug and verification.



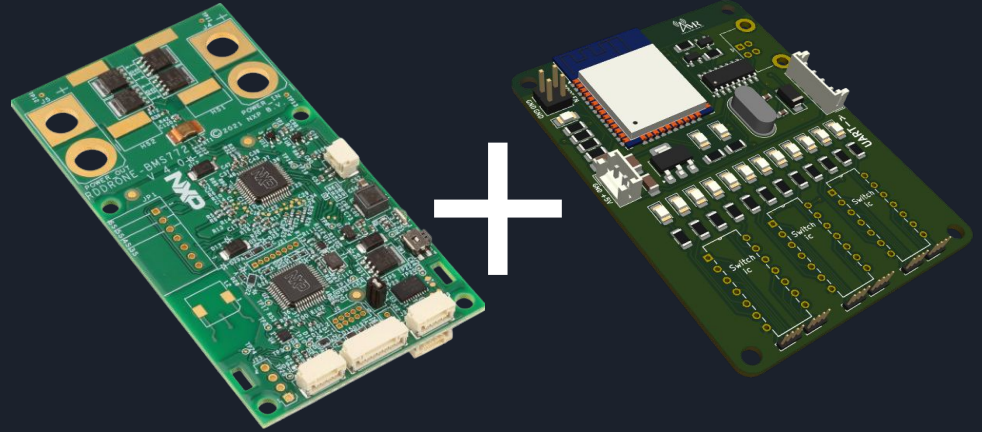
Top Layer design



Bottom Layer design



Key Outcomes



- Achieved **real-time switchable BMS** system.
- System integrates with **wireless charging + autonomous drone operation**.
- Ready for real-world drone applications with dynamic power needs.

Acknowledgment



- Grateful to **Dr. Ashwani Sharma** for mentorship.
- Thankful to IIT Ropar and AMR Lab for the opportunity.
- Looking forward to applying this experience in future electronics design work.