A document detailing the design decisions regarding power management and debugging features

Power Management Design

The system supports two power sources:

1. **USB-C (5V)**:
    - Provides power to the ESP32 and charges the LiPo battery via **TP4056**.
    - Powers the CH340G for UART communication.
    - **Schottky diode** prevent reverse current into USB.
2. **LiPo Battery (Two 3.7V Cell in parallel, 1S2P Configuration)**:
    - Supplies power when USB is **disconnected**.
    - Connected to ESP32 via **P-MOSFET (AO3401A)** for automatic switching.

Power Protection Mechanisms

1. **Reverse Polarity Protection**
    - **Schottky diode** prevents incorrect battery connection damage.
    - **P-MOSFET prevents backflow from LiPo to USB.**
2. **Overcurrent & Thermal Protection**
    - **AMS1117 has thermal shutdown at high currents.**
    - **Polygon pour, thermal vias, wide traces** for handling charging current (~1A for TP4056).

Debugging Features

Test Points & Diagnostics

To ease debugging, **test points (TPs)** are included at key locations:

- **Power Monitoring**:
    - **Designator: TP**
    - Helps verify power source switching and battery voltage.
- **UART Debugging (CH340G - ESP32)**:
    - **TP** for serial communication debugging.

- **I2C Debugging (MPU6050)**:
    - **TP** added for logic analyzer probing.

Thermal Considerations

1. **AMS1117 Heat Dissipation:**
    - Generates heat due to **1V drop (5V → 3.3V) at high current**.
    - **Copper pours and thermal vias** included for heat dissipation.
2. **TP4056 Charging Heat Management:**
    - **Max charging current = 1A** → Can heat up.
    - **PCB traces widened** for thermal efficiency.
    - **Heatsink/Thermal pad on TP4056 GND connected to copper pour** for better heat dissipation.

Conclusion

The power system ensures **automatic power switching**, **safe LiPo charging**, and **robust debugging features** while maintaining **thermal and electrical safety.** This setup allows the ESP32 to function reliably in different power conditions while providing easy testing and debugging access.