This flight controller (FC) is designed to explore the creation of custom FCs for FPV drones. Unlike most advanced FCs that use STM32 M4 or H7 series microcontrollers, this one is built around the RP2040 from Raspberry Pi, featuring an Arm Cortex-M0/M0+ architecture. The key reason for choosing the RP2040 is its low power consumption and 32-bit processing capability.

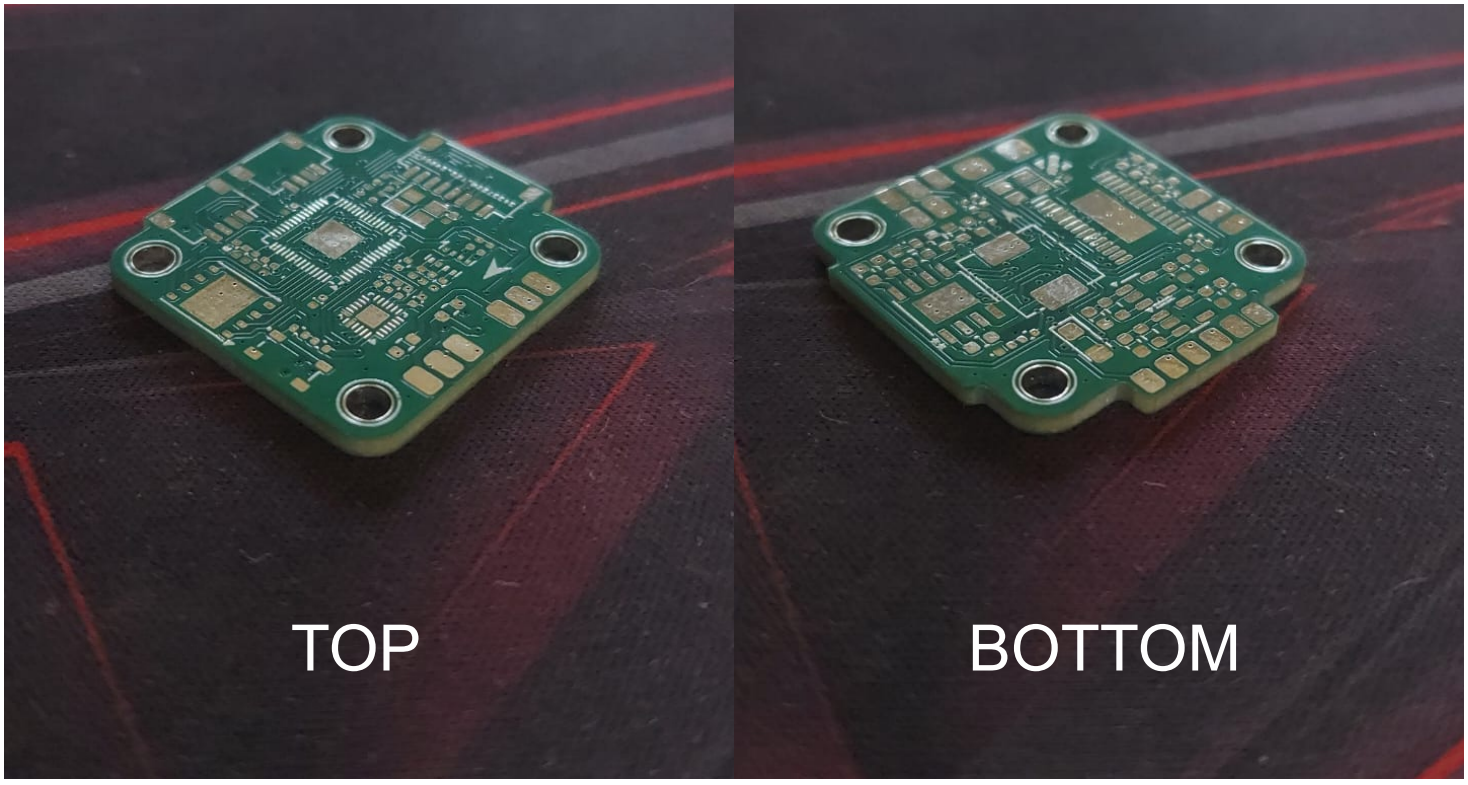
The IMU on board is the ICM-20948, an advanced variant of the MPU-9250, capable of operating at 1.8V instead of 3.3V. It is connected to the RP2040 via SPI0. Additionally, a BMP280 barometer is included for altitude measurement, interfaced through I2C0.

For video overlay functionality, the AT7456E OSD chip is integrated, allowing text and graphics to be displayed over an analog video feed. This module communicates with the RP2040 via SPI1.

The board also provides two UART connections, accessible via two 4-pin JST connectors on the right side, for connecting receivers or GPS modules. At the bottom, an 8-pin JST connector interfaces with a 4-in-1 ESC board, offering four GPIOs for motor control. Additionally, two pins from I2C0 are available, allowing for future integration of a digital voltage sensor in the next ESC design.

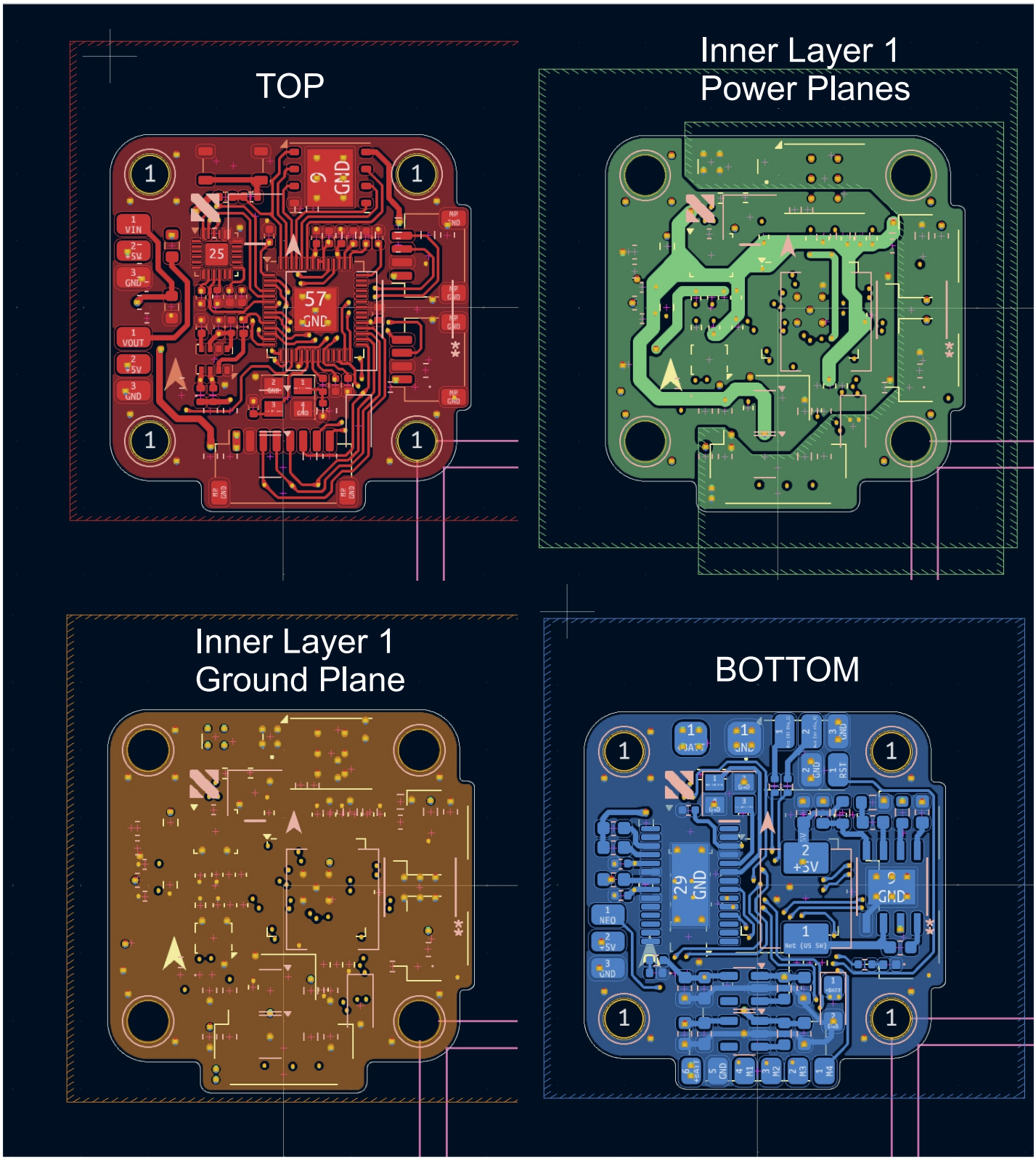
The main purpose of designing this flight controller is to create a low-power, low-cost FPV system for drones, including swarm drones. The cost of this system can be reduced by almost half by replacing the ICM-20948, which is the most expensive IMU, with older but reliable alternatives like the MPU6050 or MPU6000. While these older sensors may not have the latest features, they are sufficient for swarm drones, which are typically used only once in the field.

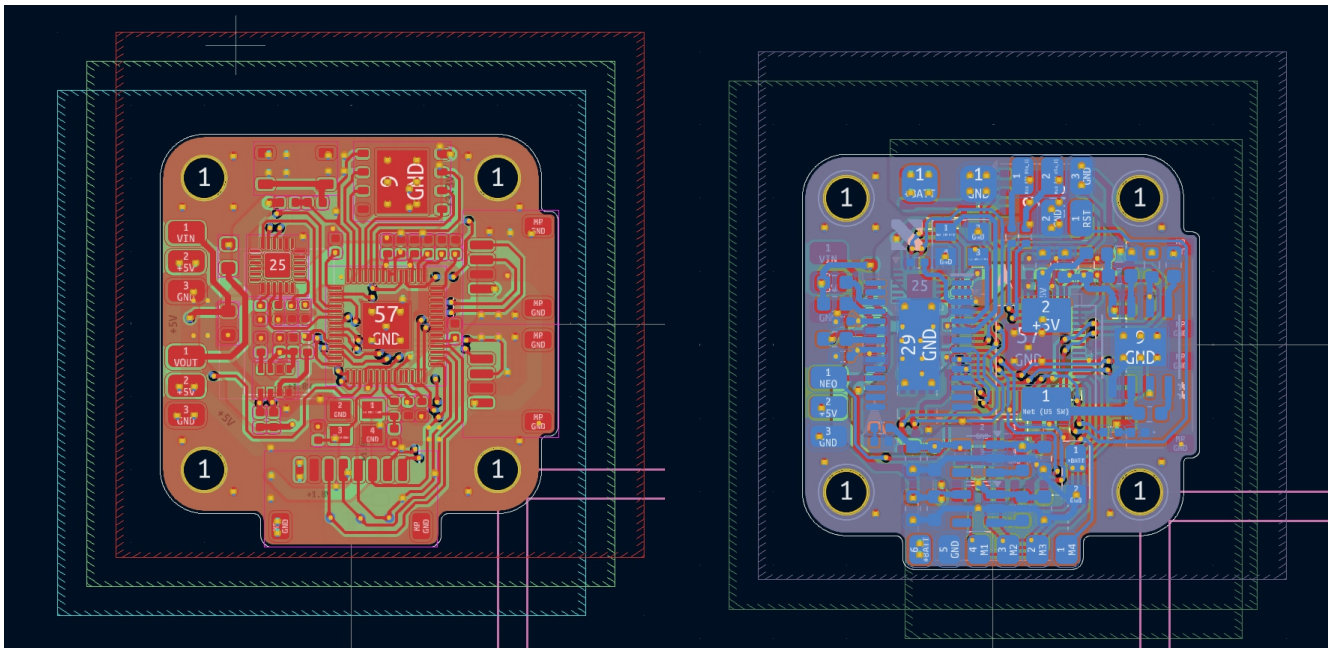
The inspiration for this project comes from the ongoing Russia-Ukraine war, where Ukrainian soldiers are using FPV drones to counter Russian forces. This concept can also be extended for indoor flying drones to engage terrorists in confined spaces. However, such applications would require additional advancements, such as thermal vision integration, to enhance target detection and effectiveness in low-visibility environments.



In this report, I have attached images of all four layers of the flight controller PCB, which includes blind and buried vias embedded within the layers. However, the final image showcases an alternative version of the same PCB, which utilizes through-hole vias (spanning all layers). This design modification was made to reduce costs, leading to the development of a more affordable variant.

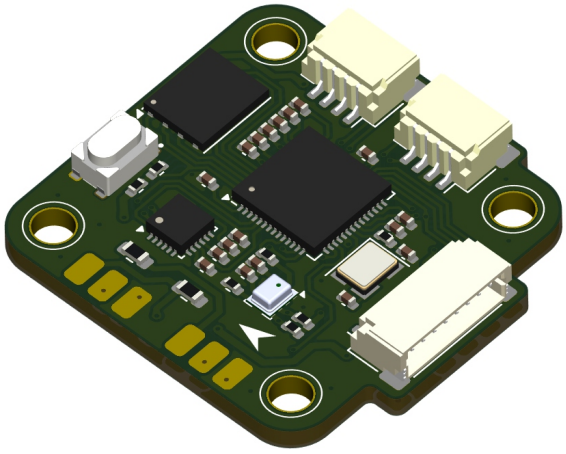
For prototyping, I placed an order with JLCPCB, which cost me only $2 for 5 pieces. All required components were sourced from LCSC to ensure compatibility and affordability.



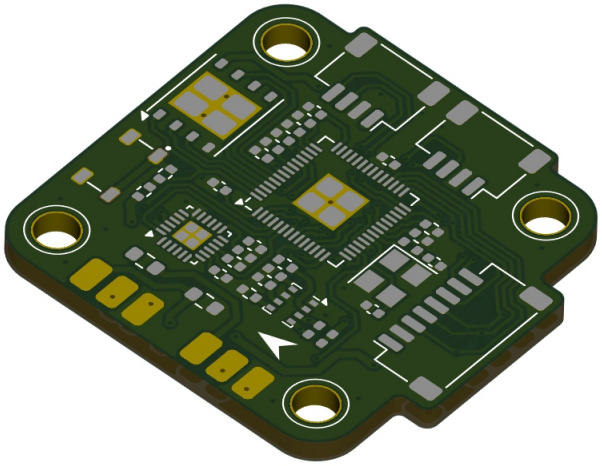


TOP SIDE (ALL LAYERS)

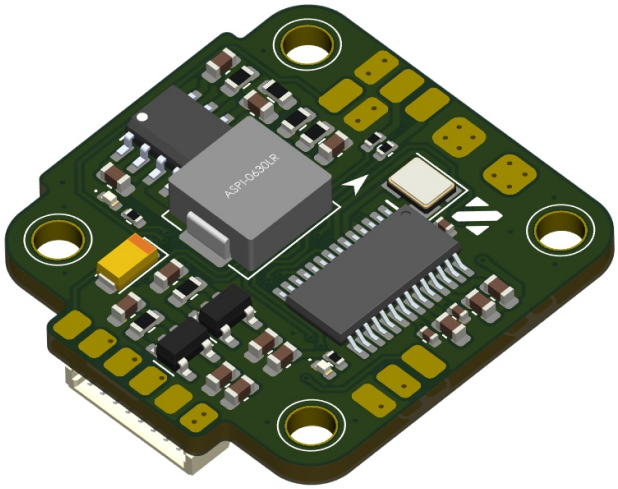
BOTTOM SIDE (ALL LAYERS)



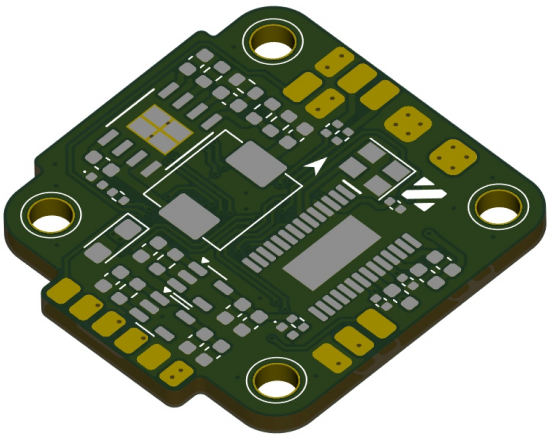
TOP SIDE (WITH COMPONENTS)



TOP SIDE (WITHOUT COMPONENTS)



BOTTOM SIDE (WITH COMPONENTS)



BOTTOM SIDE (WITHOUT COMPONENTS)