Esp-32 MINI DRONE FLIGHT MODULE

Physics of Semiconductor Devices (BAPHY107)

Slot: A2+TA2

(Challenging Assignment Report-Fall 2025 - 2026)

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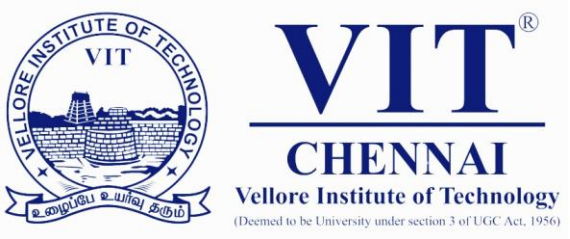


November, 2025

ABSTRACT

This work describes the design, construction and performance testing of a very small (50mm), ultra-lightweight micro-drone flight module called the "ESP Fly." A desire to create a cheap low cost drone . It’s based on a Xiao ESP32-S3 microcontroller, and is an all-in-one solution to control flight, communicate over Wi-Fi, and manage power. This controller utilizes a custom PCB (4-layers) that embeds the MPU 6050 Inertial Measurement Unit (IMU) and motor driver. The drone body frame was made using 3D technique. Open-source firmware "ESP drone" was modified and implemented so that it can be controlled remotely by the application imposed in mobile phone. The prototype model weighed 25 grams and had a flight duration of 5-6 minutes, a control range in excess of 15 meters. The project justifies that ESP32-S3 can be treated as a compact, economical, integrated solution dedicated for contemporary MAV (Micro air Vehicle) development and not requiring archetypical independent radio transmitter.

INTRODUCTION

The ESP-FLY project is A ultra-lightweight and small-size drone flight module designed around the ESP32 chipset that can be great as a easy introduction to drone for young makers or professionals whom wanna built their own professional drones since it is cost-effective, flexible, reliable and durable! But unlike typical quadcopters, ESP-FLY eschews the need for dedicated hardware transmitters or complicated ground stations: rather, it takes advantage of the dual-core WiFi-compatible functionality of the XIAO ESP32-S3 microcontroller by directly connecting to a smartphone through a custom mobile application or WiFi network.

Key motivations for this project:

Lightweight And Miniaturized: Use the lightweight structure (as low as 25g total with battery) and mini electronics to make it capable for excellent flight performance in clean environment meanwhile greatly more portable.

Customisation: Provide open source hardware and firmware documents/solutions, R&D frame options and expandable features (e.g. FPV) so the users are encouraged to form their own ideas from an early age and after a few projects obtain mature experience then enjoy the pilot's world.

Ease of Use: Enable makers to build, program, tune, and fly the drone quickly with straightforward documentation and a smartphone controller interface.

METHODOLOGY

The ESP-FLY drone series of projects is a structured sequence that integrates hardware design, PC board prototype, software setup stages towards the end goal of a working palm-sized flight module.

Parts Selection and Procurement

Core Electronics: XIAO ESP32-S3 microcontroller (21×17 mm), MPU6050 IMU for motion detection, SI2300 N-MOSFETs for motor drive, SMDs (resistors, capacitors, diodes, LEDS), wire connector (JST PH22), micro coreless motors and tri-blades.

PCB Circuit Design and Assembly

Schematic Design PCB design software (Flux) with AI guidance to produce the schematic: incorporating IMU, motor drivers, LEDs, connectors and power distribution stage.

Prototyping: The Robu manufacturer, where Gerber files are made and all circuit boards manufactured according to a four-layer board with best electromagnetic stability. We recommend using an SMD stencil to accurately apply solder paste.

Assembly- Dip Soldering and hand soldering methods for only surface mount components with alternate professional PCB assembly options available on simplified workflows.

Integration and Wiring

Parts Installation: controller and antenna into cut slots as per design specs; secure with wiring to inside of frame, solder on assigned PCB pads.

Software

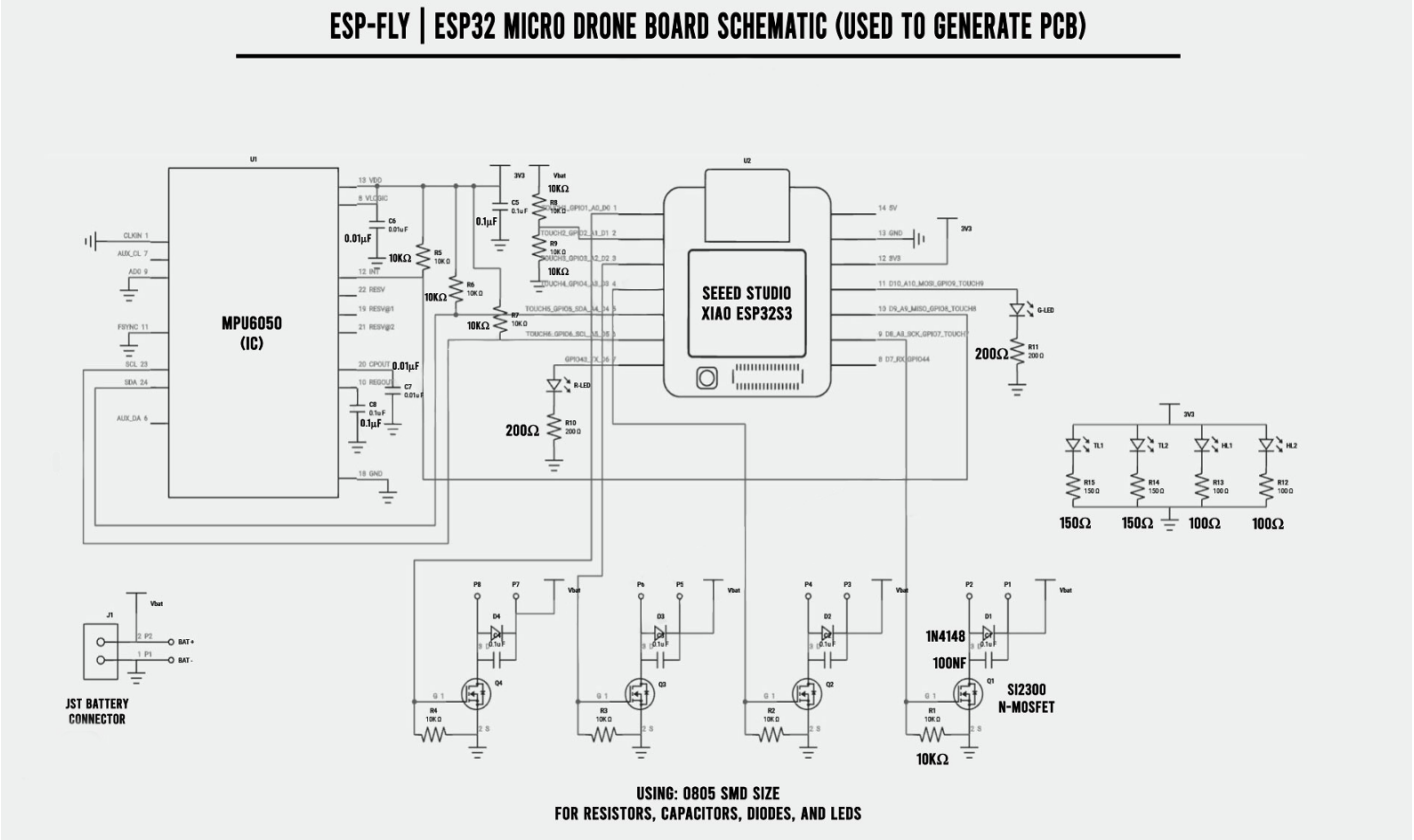
for software use the open source ESP-IDF power shell to input the code into the esp 32.The code of the flight control module is also given and highly customisable with the user having the freedom to change the pitch ,yaw and roll as the per the users need .

with the help of mpu6050 present in the module it acts as a gyroscope and stabilises the drone automatically

the app to control the drone is also open source and user friendly with customisable sensitivity and added features in case the user decides to add to the drone.

the app uses the wifi feature of the esp 32 in order to connect to the mobiles and has a range of about 10-15 meters.

CIRCUIT DIAGRAM



Result

The final result is a small highly customisable flight module which can deliver a smooth experience for any drone enthusiasts and with a flight duration of about 5-6 mins and a sensitive manoeuvrability. The range is between 10-15 meters as given by the official esp site.

CONCLUSION

This project has successfully established the design and fabrication of a low-cost (~₹2000) and high-performing 50mm micro-drone, dubbed 'ESP Fly.' The highlight of our work, though, is showing the ESP32-S3 microcontroller can be a stand-alone flight control and communication system, and therefore, the flight control system does not require a proprietary and traditional radio controller and receiver.

The results have demonstrated that this a light-weight micro-drone with such a small mass can reach flight times of 5-6 minutes while on a trajectory of greater than 10 meters. These capabilities provide an efficient platform for people looking to fly a useful drone.

Additionally, the project has validated manufacturing process for the hardware assembly (3D printing) that are highly reproducible for various users with varying degrees of access to resources, from people with 3D printers, to those with simple workshop tools.