The SpeedyBee 25 Project: Documentation of a DIY FPV Racing Drone Build

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Introduction

A drone, also known as UAV (Unmanned Aerial Vehicle), is an aircraft that can be remotely controlled using onboard sensors and flight controllers. In the FPV (First-Person View) world, drones are equipped with live video transmission that lets the pilot experience flying as if inside the cockpit. Unlike photography drones, FPV drones are built for speed, agility, and racing performance.

A drone typically consists of several key components: Frame , Motors & Propellers, Flight Controller (FC), Electronic Speed Controller (ESC), Radio Receiver (RX) , Battery (LiPo)

When building a drone, there are generally these approaches

1. Buy a ready-to-fly drone – easier for beginners but limits customization.
2. Build or assemble from parts – more challenging, but it provides a deeper understanding of how drones work, and the ability to troubleshoot and repair anytime.
3. Build own drone from scratch - without relying on the available firmware, building the whole drone system, difficult

This documentation follows the second path — assembling our own FPV racing drone. The focus will be on learning the essentials: selecting parts, assembling step by step, flashing firmware, tuning in Betaflight, and setting up controls. Since this is for drone racing, the video system will not be included in this version. By building from scratch, we gain not only a working drone but also the knowledge to repair, upgrade, and fine-tune in future.

For beginners, platforms like Douyin (抖音) provide a wealth of resources, especially in Chinese content. They are useful for gaining insight, learning about the essential components and their functions, exploring shopping list recommendations, and becoming familiar with trusted brands in the FPV community.

This documentation will therefore guide beginners from the very start: understanding drone components, making procurement decisions, documenting the assembly process, and preparing the drone for its first flight.

Background / Theory

The foundation of any drone lies in its ability to achieve stable flight through the coordination of its motors and sensors. Quadcopter generates lift directly from four propellers. By adjusting the speed of each motor individually, the drone can move in different directions, rotate (yaw), tilt forward/backward (pitch), or sideways (roll).

At the heart of this process is the flight controller (FC) — a small onboard computer equipped with sensors such as gyroscopes and accelerometers. The FC constantly measures orientation and motion, then applies corrections by adjusting motor speeds. This feedback loop ensures the drone stays balanced, even in turbulent conditions. The theory behind this control is often managed by algorithms such as PID control (Proportional–Integral–Derivative), which balances stability and responsiveness.

Finally, a critical part of theory for beginners is understanding firmware vs. hardware: the hardware (motors, ESCs, FC, receiver) only provides the physical capability, while the firmware (Betaflight, INAV, Ardupilot, etc.) defines how the drone interprets sensor data and translates pilot input into actual flight behavior. Without firmware, the flight controller would be unable to stabilize the drone or process commands.

Basic Flight Mechanism

> Lift → Generated when all propellers spin at the same speed. Increasing throttle (more motor RPM) makes the drone ascend, while reducing it makes the drone descend.
>
> Pitch (forward/backward) → Achieved by increasing the speed of the rear motors while decreasing the speed of the front motors (or vice versa). This tilts the drone, causing forward or backward movement.
>
> Roll (left/right tilt) → Similar principle, but by varying left vs. right motor speeds.
>
> Yaw (rotation) → Controlled by adjusting diagonal motor pairs to spin faster or slower. Since propellers spin in opposite directions, the torque balance can be shifted to rotate the drone clockwise or counterclockwise.

Over time, the FPV community has developed different categories of drones based on size, purpose, and flight style:

> Cinewhoop → Small, ducted-prop drones (2–3 inch props) designed for stable cinematic footage. They usually come with propeller guards or ducts, making them safer to fly indoors and in tight spaces. Example: SpeedyBee Flex25.

Freestyle drones → Typically 5-inch builds, optimized for acrobatics, tricks, and smooth flow flying. They prioritize maneuverability and durability.

Racing drones → Built for speed and agility, with lightweight frames, high-KV motors, and sharp response tuning. These are designed to compete in obstacle courses.

Components

Frame

The frame is the structural foundation of a drone, acting as the housing that secures all of its components. A good frame needs to balance rigidity, durability, and lightness, while also offering protection to the more delicate electronics.

Drone frames are generally categorized by the size of propellers they are designed to carry. For example, a 2-inch frame is meant for motors and propellers suited to 2-inch blades,. Smaller frames in the 2–3 inch range are more suitable for beginners because they are more resilient in crashes, and can be flown in tighter environments. In contrast, 5-inch frames, though popular for racing and freestyle, tend to be faster and harder to manage for new pilots.

When selecting a frame, one of the most important considerations is component compatibility. FC(Flight Controller) are mounted on standardized hole patterns such as 20×20 mm, 25.5×25.5 mm, or 30.5×30.5 mm, and the frame must match the FC you intend to use. Similarly, the motors have their own mounting standards—commonly 9×9 mm or 12×12 mm hole patterns—which must align with the motor arm cutouts in the frame. Failing to check these measurements can result in parts that don't fit together.

Propeller guards are another key feature for beginners. Propeller guards protect the blades from damage and also safeguard the environment around the drone, making flying safer when people or fragile objects are nearby.

For our project, we chose the SpeedyBee 25 frame kit. This frame is well-documented in the FPV community, meaning there are plenty of resources and guides to learn from. It supports 25.5×25.5 mm all-in-one flight controllers and 1404 motors, which are the components we plan to use. Most importantly, it comes with integrated propeller guards, making it a beginner-friendly and durable choice while still allowing us to practice drone racing.

Flight Controller (FC)

The flight controller (FC) is essentially the brain of a drone. It houses the microcontroller and various sensors, such as the IMU (inertial measurement unit), which includes a gyroscope and accelerometer. These components allow the FC to continuously monitor the drone's orientation and movement. Based on this information and the pilot's input, the FC calculates the required motor speeds and sends control signals through the electronic speed controllers (ESCs). In other words, it is responsible for stabilizing and controlling the entire drone in flight.

There are two main types of flight controller setups: stack and all-in-one (AIO). The FC stack uses two separate boards — one for the flight controller and one for the ESC. This configuration is more robust and better suited for high-performance drones, especially larger 5-inch racing or freestyle builds that draw higher current. Because the power and control systems are separated, the stack design is also less prone to electrical noise and heat issues.

On the other hand, the AIO flight controller integrates both the ESC and the FC onto a single compact board. This makes it lighter and space-efficient, ideal for smaller drones such as 2–3 inch cinewhoops or sub-250-gram builds. However, AIO boards are less durable for high-current applications because all components are concentrated on one board, which increases heat and electrical stress during operation.

Modern FCs mainly use STM32 F4 or F7 processors. The F4 boards are reliable, affordable, and suitable for most builds, while F7 boards feature faster processors and support more UART ports. Older generations like F1 and F3 are no longer supported by current firmware such as Betaflight. For most users, the difference between F4 and F7 performance is minimal unless the build involves advanced configurations or heavy peripherals.

When selecting an FC, there are a few specifications to pay close attention to. The mounting pattern must be compatible with your frame — common sizes include 20×20 mm, 25.5×25.5 mm, and 30.5×30.5 mm. The number of UART ports determines how many external devices you can connect, such as receivers, GPS modules, and LEDs. You should also check the ESC current rating and battery voltage compatibility, ensuring the FC can handle the power from your LiPo battery (for example, a 4S setup) and provide sufficient current for your motors.

Lastly, consider whether the FC supports accessories like LEDs, buzzers, and barometers, depending on your needs.

For this project, we are using the SpeedyBee F407 AIO 40A, which is a popular and well-reviewed option in the FPV community. It supports 4S batteries, provides a 40A continuous current rating, and fits perfectly on a 25.5×25.5 mm mounting pattern. The SpeedyBee F407 AIO is also widely documented online, with many tutorials and setup guides available.

Brushless DC Motors (BLDC Motors)

Among the various types of electric motors — such as brushed DC motors, stepper motors, and brushless DC motors — brushless DC (BLDC) motors are the dominant choice for drones. They are favored because of their high efficiency, power-to-weight ratio, durability, and precise control. Unlike brushed motors, BLDC motors do not have physical brushes for commutation. Instead, they use electronic switching controlled by a circuit, which reduces friction, heat, and wear. This makes them ideal for applications like drones, where smooth and responsive control is essential.

A brushless motor requires three wires for operation, corresponding to the three phases of current it needs to spin. Although they operate using DC power (from the battery), the Electronic Speed Controller (ESC) converts that DC into a three-phase AC-like waveform that sequentially energizes the motor coils. This synchronized switching allows the motor to spin continuously — similar in principle to a three-phase AC motor, but still powered by DC. Therefore, each motor in a drone requires its own ESC to control speed and direction independently.

Motor specifications are usually expressed in a format such as 1404 4600KV. The first two digits ("14") indicate the stator diameter in millimeters, and the next two digits ("04") represent the stator height. This helps determine the motor's size and torque characteristics. The KV rating describes the motor's speed constant — it means the motor will theoretically spin at 4600 RPM per volt applied (under no load). In general, higher KV motors spin faster but produce less torque, making them suitable for smaller propellers and lighter drones.

Conversely, lower KV motors offer more torque, which is ideal for larger propellers or heavier builds.

When choosing motors, several factors must be considered:

> KV range and compatibility — Ensure the KV matches your intended LiPo battery voltage (e.g., 4S) and propeller size. These recommendations are often provided in the flight controller or frame documentation.
>
> Mounting pattern — Common mounting hole distances are 9×9 mm or 12×12 mm, which must match the frame's motor arm holes.
>
> Quality and brand — Choose motors from reputable brands like iFlight, EMAX, T-Motor, or BrotherHobby. Reliable motors ensure better balance, smoother flight, and less vibration.
>
> Screw length caution — When installing motors, ensure the mounting screws do not touch the stator windings beneath the motor base. If the screw is too long, it may contact the coils and cause short circuits or damage when the motor spins.

For our project, we selected the GEPRC GR1404 4500KV. It is lightweight, efficient, and designed for 2.5-inch cinewhoop-style builds. Its mounting pattern (9×9 mm) is compatible with the SpeedyBee 25 frame, and it matches our 4S LiPo setup perfectly. This combination ensures stable performance while keeping the build compact and responsive.

Propellers

Propellers are one of the most critical components in a drone system, as they are responsible for generating lift by rotating rapidly and pushing air downward, producing the upward thrust that allows the drone to fly. Choosing the right propeller is essential for balancing efficiency, thrust, and control. Propellers are usually labeled with specifications such as 2.5×3.1×2 or 2531-3, which indicate important physical characteristics. The first number refers to the diameter (in inches), which determines the overall size and how much air the propeller can move — for instance, a 4-inch prop is suitable for a 4-inch FPV drone.

The second number represents the pitch, which is the theoretical distance the propeller would move forward in one rotation if it were cutting through a solid medium. A higher pitch provides greater thrust and faster response, suitable for racing drones, but it generally reduces efficiency and increases current draw. The third number indicates the number of blades, where 2-blade and 3-blade propellers are most common. Two-blade props tend to be more efficient and provide longer flight times, while three-blade props deliver smoother control and more stability.

Propeller mounting styles also vary. For example, larger drones (typically 5-inch and above) often use M5 nut-type mounts, while smaller drones or cinewhoops commonly use T-mount systems, secured by two M2 screws. When selecting propellers, always ensure compatibility with the motor shaft type and mounting holes. Another crucial aspect is the rotation direction: propellers are designated as CW (clockwise) or CCW (counterclockwise). Each motor position on the drone requires a specific orientation — installing them incorrectly will cause unstable flight or prevent takeoff entirely. Additionally, some setups use pusher configurations, where the propellers are inverted; in such cases, both the prop direction and motor rotation must be adjusted accordingly.

Radio Controller

The radio controller (RC) plays a vital role in drone operation by transmitting pilot commands to the drone over long distances with high reliability and minimal latency. It acts as the primary interface between the user and the aircraft, allowing for precise control of movement and flight modes. Besides controlling real drones, many RCs can also be used with simulators, which is highly beneficial for beginners to practice flying skills safely before actual flights.

Most modern radio systems used in FPV drones operate on popular communication protocols such as ELRS (ExpressLRS) and FrSky, among others. ExpressLRS has gained significant popularity due to its open-source nature, wide community support, excellent long-range performance, and low latency. When selecting a radio controller, it is advisable to choose one with built-in ELRS to ensure compatibility and ease of setup with many flight controllers.

Radio controllers generally come in two main form factors: full-size and gamepad-style. Full-size transmitters typically offer more switches, sliders, and advanced customization options, making them ideal for professional pilots or those seeking fine control. However, they are bulkier and more expensive. Gamepad-sized controllers, on the other hand, are compact, affordable, and portable—perfect for beginners who only need essential flight controls.

In most standard drone setups, especially for FPV, the Mode 2 configuration is the most commonly used. In Mode 2, the left stick controls throttle (up/down) and yaw (left/right), while the right stick controls pitch (forward/backward) and roll (left/right). Apart from the sticks, radio controllers feature switches and toggles, often two- or three-position switches, which can be assigned to specific functions such as arming/disarming the motors, activating flight modes (Angle, Horizon, or Acro mode), or triggering custom features.

The binding process—linking the radio controller to the drone's receiver—varies slightly depending on the brand and firmware. Typically, this involves powering the drone on and off a few times to enter bind mode, then pressing the bind button on the radio controller. Once successfully bound, you can connect the drone to Betaflight Configurator to ensure that each channel (throttle, yaw, pitch, roll, and auxiliary) corresponds correctly to the expected movements. The AUX channels are particularly important for switching modes or triggering special functions mid-flight.

Lipo Battery

The LiPo (Lithium Polymer) battery is the primary power source for drones, providing the necessary current and voltage to drive the motors, flight controller, and other onboard electronics. It plays a crucial role in determining the drone's flight time, performance, and responsiveness. Among the various types of batteries available, LiPo batteries are preferred in drones due to their high energy density, lightweight design, and ability to deliver large amounts of current required for rapid motor response.

LiPo batteries are usually classified by their cell count, commonly seen as 4S or 6S configurations in the FPV drone community. The letter “S” denotes the number of cells connected in series, which determines the total voltage of the battery. Each cell has a nominal voltage of 3.7 V, meaning a 4S battery provides about 14.8 V, while a 6S battery outputs approximately 22.2 V. Typically, 5-inch drones use 6S batteries, as they can provide more power and efficiency for high-performance builds.

Each LiPo cell is considered fully charged at 4.2 V and fully discharged at 3.0 V. It’s important to never over-discharge or overcharge the cells, as doing so can cause permanent damage, swelling, or even fire hazards. When storing the battery for an extended period, it should be kept in storage mode, around 3.8 V per cell, to prevent degradation.

A LiPo battery is characterized by several key specifications printed on its label:

> Capacity (mAh) – Indicates how much charge the battery can hold. For example, a 1500 mAh battery can theoretically supply 1.5 A for one hour before being empty.
>
> C Rating – Represents the maximum discharge rate, showing how much current the battery can safely provide without overheating or damage. For instance, a 1500 mAh battery with a 100 C rating can deliver up to 150 A (1.5 × 100) continuously.
>
> Cell Count / Voltage – Shows how many cells are in series and the corresponding voltage (e.g., 4S = 14.8 V).
>
> Main Connector – The plug that connects to the drone’s power input, commonly XT30 for smaller drones and XT60 for larger 5-inch builds.
>
> Balance Connector – A small plug used during charging to monitor and balance each cell’s voltage, ensuring even charging and safe operation.

Charger

A LiPo charger is an essential tool for safely charging and maintaining your drone batteries.

Modern LiPo chargers typically feature two main charging modes — Balance Charge and Storage Charge. The Balance Charge mode ensures that each cell in the battery is charged evenly by monitoring individual voltages through the balance connector. This helps maintain the overall health of the battery and prevents one cell from being overcharged while others are undercharged. It is the most recommended mode for regular charging. Meanwhile, Storage Charge mode is used when the battery will not be used for a long time. This mode automatically discharges or charges the battery to around 3.8 volts per cell, the optimal voltage for storage. Storing a LiPo battery at full charge or too low a voltage can degrade the cells over time, reducing capacity and lifespan.

When setting the charging rate, the 1C rule is a useful guideline. The “C” refers to the charging rate relative to the battery’s capacity. For example, if your battery has a capacity of 1500 mAh (1.5 Ah), charging at 1C means charging at 1.5 A. While some batteries can handle faster rates like 2C, charging at 1C or below is safer and helps extend the life of the battery.

Safety during charging cannot be overstated. Never leave the battery unattended while charging. Always charge in a fireproof LiPo bag or on a non-flammable surface such as ceramic or concrete. Do not puncture, bend, or press on the battery, as internal damage may lead to dangerous chemical reactions. If the battery becomes hot, emits a smell, or starts to swell, stop charging immediately and disconnect it. Overcharging (above 4.2 V per cell) and deep discharging (below 3.0 V per cell) should also be strictly avoided, as both can cause irreversible damage and safety risks.

For beginners, a smart LiPo charger is highly recommended since it automatically detects the cell count, handles balancing, and offers storage mode. In this project, we chose the Neosky LiPo Charger due to its reliability, simple interface, and compatibility with common FPV drone batteries. It supports both XT30 and XT60 connectors, offers balance and storage modes, and includes safety cutoffs to prevent overcharging — making it an ideal choice for beginner to intermediate drone builders.

Component list and cost

No	Category	Item / Part Name	Spec / Model	Buyer Source	Qty	Price (Single unit)(RM)	Price (RM)
1	SpeedyBee Frame Kit	Pro	Wireless Bluetooth Tuning, LED Strips	Aliexpress	1	147.54	147.54
2	Speedybee F405 aio	F405 AIO 40A 25.5x25.5 3-6S	-	Local Shopee	1	309	309
3	BLDC motor	GEPRC GR1404 4500KV Brushless Motor	1404 4500kV	Local Shopee	5	65	325
4	Receiver ELRS	EP1 HappyModel ExpressLRS ELRS 2.4G RX	ELRS 2.4G	Local Shopee	1	69	69
5	Propeller	Gemfan D63 2.5Inch Hole 3 Blade Propeller (4 pairs/8pcs)	D63	Local Shopee	1	13	13
6	Battery charger	Original SkyRC B6 neo Lipo Balance charger	-	Local Shopee	1	148	148
7	4S battery lipo	850mAh14.8 V 4S 70C Lipo Battery **XT30**	4S	Local Shopee	2	74	148
8	Radio remote Control	Betafpv Literadio 3	support ELRS 2.4G protocol	Aliexpress	1	147.61	147.61
							1307.15

Assembly and building process

Note: Refer to the SpeedyBee25 user manual and wiring diagrams for the most accurate and up-to-date information.

Speedybee25 pro frame spec: https://www.speedybee.com/speedybee-bee25-frame/

User manual:
https://support.speedybee.cn/?d=SRC2B0&s=1000&a=p&ref=TRONCATFPV&sub_id=undefined&l=en

Speedybee25 AIO spec & firmware: https://www.speedybee.com/speedybee-f405-aio-40a-bluejay-25-5x25-5-3-6s-flight-controller/

User manual:
https://support.speedybee.cn/?d=SF40A0&s=1000&a=p&ref=TRONCATFPV&sub_id=undefined&l=en

Assembly Components

1. Identify Flight Controller Orientation

Front (Forward): Locate the arrow printed on the SpeedyBee25 AIO board. The direction of this arrow indicates the front of the drone.

Rear (Back): The port labeled EXT on the AIO board is typically oriented towards the back of the drone.

2. Connect the Power Cord and Capacitor

Before Begin: Ensure you are familiar with safe soldering practices. Tinning the wire and pad before connecting is critical for a good, strong joint. Double-check your polarity (+ and GND) before soldering.

1. Solder the Main Power Cable:

Solder the red wire (+) of the power cord to the VCC pad on the AIO. Solder the black wire (-) of the power cord to the GND pad.

2. Solder the Capacitor:

3. Solder the Motors

1. **Prepare the Wires**: Cut the motor wires to an appropriate length to reach the solder pads on the SpeedyBee25 AIO without excess slack.
2. **Secure the Motors**: securely mount the motors to the frame.

3. **Solder the Motors**: Solder the wires from each motor to its corresponding pad on the AIO (M1, M2, M3, M4).

Tip: It doesn't matter which order you solder the three motor wires, as you can reverse motor direction later in the Betaflight Configurator.

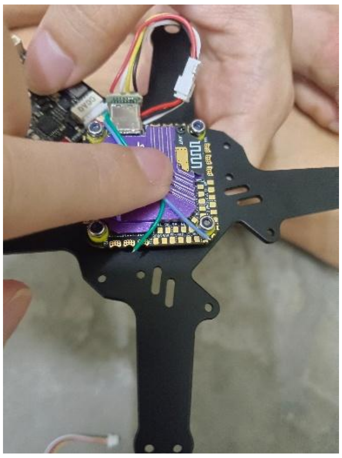
4. Connect the External Type-C Port

The external USB-C port is a convenient way to access the flight controller without disassembling the drone.

Connect to UART5: Your instructions indicate connecting the external USB-C to UART5. Solder the two data wires (TX and RX) from the extension port to the corresponding UART5 pads on the AIO.

- Refer to the SpeedyBee25 AIO manual for the pinout of the 6-pin connector.

Provide Power: Since the AIO doesn't power the external USB-C, you need to power the drone with a battery to use the extension.



5. Connect and Bind the ELRS 2.4G Receiver

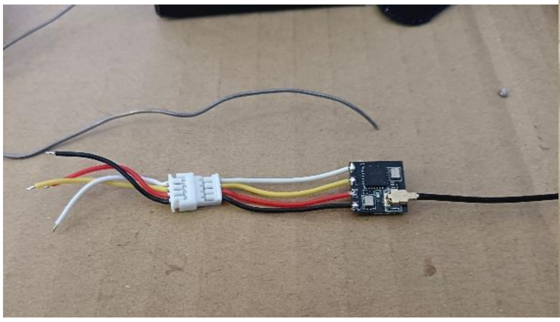
1. Wiring the Receiver:

Connect the 4-pin connector from the ELRS 2.4G receiver to the specified UART pads on the SpeedyBee25 AIO. Your notes correctly state using UART6.

Power: Solder the 4.5V wire to the 4.5V pad on the AIO.

Ground: Solder the GND wire to a GND pad on the AIO.

TX6/RX6: Connect the receiver's data wires to the TX6 and RX6 pads.



2. Binding the Receiver:

   To bind the LiteRadio 3 with the SpeedyBee25 ELRS AIO, first ensure both the radio and the drone are powered off. Press and hold the LiteRadio 3 **Bind** button for about three seconds to enter ELRS bind mode. Then power on the drone, wait a few seconds until the ELRS receiver begins **double-blinking**, and perform a **short press** on the receiver's bind button. The receiver LED will turn **solid green** once binding is successful. Finally, power-cycle both the radio and the drone to confirm the link is stable.

6. Verify and Finalize

1. After assembly, perform a final visual inspection. Ensure all solder joints are clean, and there are no stray wires that could cause a short.

2. Betaflight Setup: Connect to Betaflight via the internal USB-C port or the external extension.

Betaflight Setup

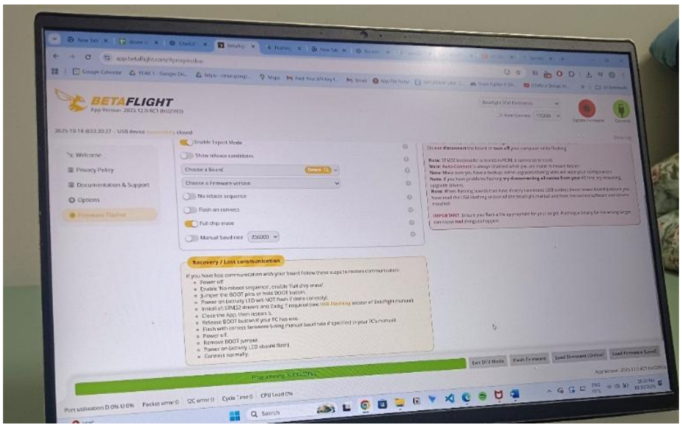
Upload Firmware (DFU) for SpeedyBee25 AIO

1. **Enter DFU Mode**: On the SpeedyBee25 AIO, press and hold the **BOOT button** while connecting the flight controller to your computer via a USB cable.

2. **Launch Betaflight Configurator**: With the SpeedyBee25 still in DFU mode, open the Betaflight Configurator. The top-right dropdown menu should automatically switch to DFU.

3. **Flash Firmware**:

    - Navigate to the **Firmware Flasher** tab.
    - Select the correct target for your SpeedyBee25.
    - Click Load Firmware [Online] to download the latest firmware. For Betaflight versions 4.4 and newer, you must select the receiver protocol (e.g., CRSF) and other desired features before flashing.
    - Click Flash Firmware and wait for the process to complete.



DFU indicator in the configurator

Once the SpeedyBee is in DFU mode, the most reliable indicator is on your computer:

- Open the Betaflight or INAV configurator.
- Check the top-right corner of the screen where the connection ports are listed.
- Instead of a COM port number, you will see the word **"DFU"**, confirming that the flight controller is in DFU mode.

CRSF Receiver Binding (UART Port)

1. **Wire Receiver to UART**: Connect the CRSF receiver's signal wires to the SpeedyBee25 AIO. For CRSF, the receiver's TX pad connects to the flight controller's RX pad, and the receiver's RX pad connects to the flight controller's TX pad. The specific UART (e.g., UART2, UART6) depends on your board's wiring diagram.
2. **Enable UART in Betaflight**:
    - Connect the flight controller to Betaflight and navigate to the **Ports** tab.
    - Find the UART you used and enable Serial Rx for that port. You should only enable one function per UART.
3. **Set Receiver Protocol**:
    - Go to the **Receiver** tab.
    - Under Receiver Mode, select **Serial-based Receiver**.
    - Under Serial Receiver Provider, select **CRSF**.
4. **Verify Connection**: Go to the **Receiver** tab in Betaflight and move the sticks on your LiteRadio. The corresponding bars on the screen should respond correctly.

Mode Setup (Arm, Disarm, Angle, Horizon, Manual/Acro)

1. Assign Switches: In the Modes tab of Betaflight, you will use switches on your LiteRadio to activate different flight modes.
    - Arm/Disarm: Click Add Range next to the ARM mode. Flip the switch you want to use for arming. Betaflight will detect the correct AUX channel. Adjust the yellow slider to cover the armed position of your switch.
    - Angle Mode: Click Add Range next to the ANGLE mode. Move the switch you want to use for this mode and adjust the slider to cover the Angle position.

- Horizon Mode: Click Add Range next to the HORIZON mode. Move the switch to the desired position and adjust the slider.
- Manual/Acro Mode: This is the default mode when no other flight mode is selected. You do not need to assign a switch for it unless you want to use a specific switch to disable Angle or Horizon mode.

Motor Testing

Warning: Remove all propellers before performing a motor test!

1. **Connect and Verify**:

   Connect the SpeedyBee25 to Betaflight via USB and plug in the flight battery.

   Navigate to the Motors tab and check the box to confirm you understand the risk.

2. **Test Individual Motors**:

   Move the sliders one at a time to test each motor individually.

   As you increase the slider, the corresponding motor should spin. A green light on the motor number indicates it is spinning.

   If a motor spins the wrong direction, you can reverse it using the BLHeli Configurator or by physically swapping any two of the three motor wires.

3. **Confirm Motor Layout**: The Betaflight motor layout image should match your quadcopter's physical motor layout and rotation direction. Ensure that the motor numbers and directions are correct

SpeedyBee 25 Drone Build Progress Log

Phase 1: Research and Planning (Pre-September 24th - October 7th)

Date	Activity	Key Outcomes / Notes
Pre-9/24	Initial Research	Established fundamental understanding of drone components (Oscar Liang's resources).
9/24	Drafting Shopping List	Created an initial shopping list (SpeedyBee 25 parts) on Google Sheets.
9/25	Procurement Planning	Arranged shopping list with links (Shopee/AliExpress). Identified parts requiring AliExpress due to availability. Motor substitution: Original SpeedyBee motor was unavailable, substituted with a similar iFlight motor (similar kV and dimension).
10/2	Team Discussion & Purchase	Agreed on budget. Started purchasing Frame and Lite Radio 3 from AliExpress (initial estimated 14-day delivery).
10/4	Documentation & Simulator Planning	Documented the radio controller. Lesson Learned: Should have bought a ready-stock controller for immediate simulator training.
10/7	Final Purchasing	Completed purchasing remaining items on Shopee.

Phase 2: Parts Delivery and Component Check (October 9th - October 13th)

Date	Activity	Key Outcomes / Notes
10/9	Parts Delivery	Success: All parts delivered much faster than expected (AliExpress: 7 days, Shopee: 2 days).
10/13	Component Inspection	Checked component condition and compatibility. Challenge: Neosky battery charger output (XT60) was incompatible with the 4S battery connector (XT30). Solution: Must purchase an XT60 Female to XT30 Male converter.

Phase 3: Assembly and Soldering (October 17th - October 18th)

Date	Activity	Key Outcomes / Notes
10/17	Start Assembly & Soldering	Began assembly: AIO board, battery pack, motor, USB extension. Discussed propeller direction. Major Challenge (Soldering): Experienced difficulty soldering to the AIO

		board compared to the practice board. Root Cause: AIO's better heat dissipation required more heat/energy. Resolution: Switched from YiHua 918-d to a Pro's Kit iron (provided consistent, effective temperature) and used lower melting point solder. Completed soldering for ELRS, Bluetooth, and 4 motor connection points.
10/18 (Morning)	Final Soldering & Mechanical Assembly	Soldered ELRS receiver and Bluetooth. Soldered power connection (verified polarity). Motor Mounting: Attached motors to the frame, ensuring M2 screws were not too long. Detached propellers for motor soldering. Wire Management: Carefully cut motor wires to precise lengths for soldering to the AIO (one point was tricky/brittle). Post-Soldering Check: All 4 team members checked connections for potential short circuits (power, motor phases, ELRS). Motor phase resistance checked at \$0.7 \Omega\$. Cleaned FC with a toothbrush.
10/18 (Evening)	Power-Up	Secured covers, antennas, propellers, and LED strips. Success: Powered on the AIO FC without incident ("no smoke").

Phase 4: Configuration (October 18th - Continued)

Date	Activity	Key Outcomes / Notes
10/18 (Post-Dinner)	Betaflight Setup	DFU Mode Challenge: Could not enter DFU mode via boot button (unsoldered) or Bluetooth (unconfigured). Solution: Entered DFU mode via Betaflight CLI command. Flashed the latest AIO firmware.
10/18 (Configuration)	Setup	Set orientation (verified on screen). Configured UART ports: Bluetooth (MSP only), ELRS receiver (RX receiver only, disabled MSP to avoid conflict).
10/18 (Binding)	ELRS Binding	Binding Challenge: Initial struggle due to misreading the ELRS light indicator (should be solid green). Solution: Calibrated the LiteRadio 3 firmware. Final successful procedure: 1. Drone off. 2. Press bind on LiteRadio 3 (3 seconds). 3. Power on drone (wait 5 seconds). 4. Short press bind on radio. ELRS turned solid green. Results: Successful binding. Range: 989 to 2012. Set modes

		(Arm/Disarm, Angle, Horizon, Manual) via AUX channel. Learned about Anti-flip and Failsafe.
10/18 (Testing)	Motor Spin Test	Tested motor orientation and direction. Success: Achieved disarm functionality by holding throttle below 1000 on a flat surface for 5 seconds. Motors spun successfully.

Phase 5: Testing, Failure, and Resolution (October 25th - November 2nd)

Date	**Activity**	**Key Outcomes / Notes**
10/25	First Flight Test (Failure)	Tested indoors (did not take off). Moved to the basketball court. Pushed throttle to ~20%, motor failure/burning occurred. Symptom: Front right motor spinning abnormally slower, overheating. Diagnosis: Propeller was likely installed inverted (pushing air *up* instead of *down*), causing the drone to press hard into the ground. Contributing Factors: Casual attitude, lack of a pre-flight checklist, lack of team presence, close proximity of propellers to the ground, and tiny debris/rocks on the court causing friction.
10/28	Post-Failure Solution	Ordered 3D printing parts for a landing pad and propeller protection.
10/30	Inspection	Performed an inspection test; dimensions were fine.
11/1	Protection Installation & Test Fly	Assembled 3D printed landing pad (TPU material for cushion/protection). Success: Did a fly test; the TPU absorbed cushion and protected the propellers. Confirmed need to keep throttle low for arm/disarm.
11/2	Race Day	Charged batteries and participated in an indoor race (checkpoint challenge). Performance: Completed the first 5 checkpoints in 25 seconds; took 4 minutes for the last 2. In-Flight Issues: Nets stuck in motors (motor unharmed); screws loosened after flight.

Concusion

This project successfully bridged the gap between theoretical knowledge and practical application. Through this process, we gained a comprehensive understanding of drone knowledge, from the physics of quadcopter flight to the specific parameters of components like BLDC motors, Flight Controllers (FC), and LiPo batteries.

The journey highlighted several key learning outcomes:

> **Technical Knowledge & Resource:** Utilizing resources such as Oscar Liang's documentation and Douyin's visual content , we learned to select components that met our specific requirements. We also developed essential hard skills, particularly in soldering high-heat dissipation components like the AIO board and configuring firmware in Betaflight.
>
> **Project Management & Procurement:** For the procurement, we balance budget allocation with shipping timelines across platforms like Shopee and AliExpress to ensure all parts arrived before the competition deadline.
>
> **Systematic Troubleshooting:** Perhaps the most valuable lesson came from our failures. The motor burnout incident during our initial test flight taught us that troubleshooting requires a logical approach rather than guesswork. By analyzing the situation we deduct that root cause is the inverted propellers that pushing the drone into the ground. Therefore, we use 3D-printed landing pads to protect the hardware without risking further damage to the system.
>
> **Safety & Protocol:** The experience reinforced the critical importance of pre-flight checklists and safety protocols. We learned that a successful flight is not just about assembly, but about rigorous verification, such as checking motor direction and securing loose components, to prevent preventable accidents.

In summary, this project was not only an exercise in engineering but also in teamwork and communication. It provided us with the experience to study and repair our drone in the future.

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