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Killis FPV Racing Drone

Revision History

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Killis FPV Racing Drone

1. Introduction

This document contains the components of FPV Racing Drone and the components specifications for **Killis FPV Racing Drone**. This requirement document outlines the essential components and specifications for a high-performance FPV Racing drone. Designed for competitive sports and high-speed maneuvers, this FPV racing drone features a durable carbon fiber frame with standard mounting holes, a powerful flight controller equipped with advanced processors and sensors, and high-KV motors for exceptional speed. Robust ESCs ensure precise control, while the best propellers and a high-capacity LiPo battery provide extended flight times. The versatile video transmitter delivers clear FPV video, complemented by a high-resolution FPV camera and a reliable receiver for long-range communication. Optional GPS enhances navigation capabilities.

An FPV racing drone is composed of several key components, each contributing to its high performance and durability. The frame, usually made of carbon fiber, is available in common sizes like 3", 5", 6", and 7". These sizes indicate the diameter of the propellers it can hold. This material ensures the frame is lightweight yet robust enough to handle high-speed impacts. The motors, usually brushless are rated by their KV which indicates RPM per volt; high-KV motors (e.g., 2300KV) provide more speed, while lower-KV motors offer more torque for better control and stability. Electronic Speed Controllers (ESCs) regulate power to the motors and are rated by their maximum continuous current capacity in amps, crucial for preventing overheating and ensuring reliable performance. The flight controller acts as the drone's brain, processing pilot inputs and sensor data to control movement, and includes sensors like gyroscopes, accelerometers, barometers, and magnetometers for enhanced stability.

Propellers, made from durable plastic or carbon fiber must match the frame size while their design and pitch support the drone's speed and manoeuvrability. High-capacity LiPo (Lithium Polymer) batteries are used for their high energy density and discharge rates, providing extended flight times. The video transmitter (VTx) sends live video feed from the FPV camera to the pilot's goggles or monitor, with power output measured in mW affecting range and quality. High-resolution FPV cameras provide clear video feeds essential for precise flying, with a wider field of view (FOV) aiding in navigation and obstacle avoidance. The receiver, which receives control signals from the pilot's transmitter must be reliable over long distances to ensure uninterrupted control. Optional GPS enhances navigation capabilities offering features like return-to-home and position hold. These components are carefully selected to ensure optimal performance, durability, and ease of maintenance, making the drone ideal for competitive sports and dynamic flying experiences.

2. The Components List

1. Drone Frame
2. Flight Controller
3. 4 in 1 ESC with Power module
4. BLDC Motor
5. Propeller
6. Transmitter and Receiver
7. GPS
8. Video Transmitter Module
9. Antenna
10. FPV Camera
11. Goggles
12. Battery
13. Battery Charger
14. LED strip for night racing

These products (1), (2), (3) & (5) should be designed and manufactured by Killis Bird LLP.

3. FPV Racing Drone

In an FPV Racing Drone, the strategic placement of components is essential for optimal performance and balance.

- **Flight Controller**:

  Typically, centred for stable control and minimal vibrations.

- **4-in-1 ESC with Power Module**:

  Often placed beneath the flight controller for efficient power distribution.

- **Motors**:

  Mounted on the arms for balanced thrust.

- **FPV Camera**:

  Positioned at the front for a clear forward view.

- **Video Transmitter (VTx)**:

  Usually placed at the back to reduce interference.

- **Battery**:

  Securely fastened on the top or bottom of the frame to maintain balance.

- **Antennas**:

  Placed to ensure a strong signal, often at the back or on the arms.

- **Receiver**:

  Positioned away from the VTx to avoid interference.

Proper placement of these components enhances the drone's stability and performance, ensures minimal signal interference, and allows for efficient power management, leading to a smoother and more responsive flying experience.

3.1 Component Placement for Reference:

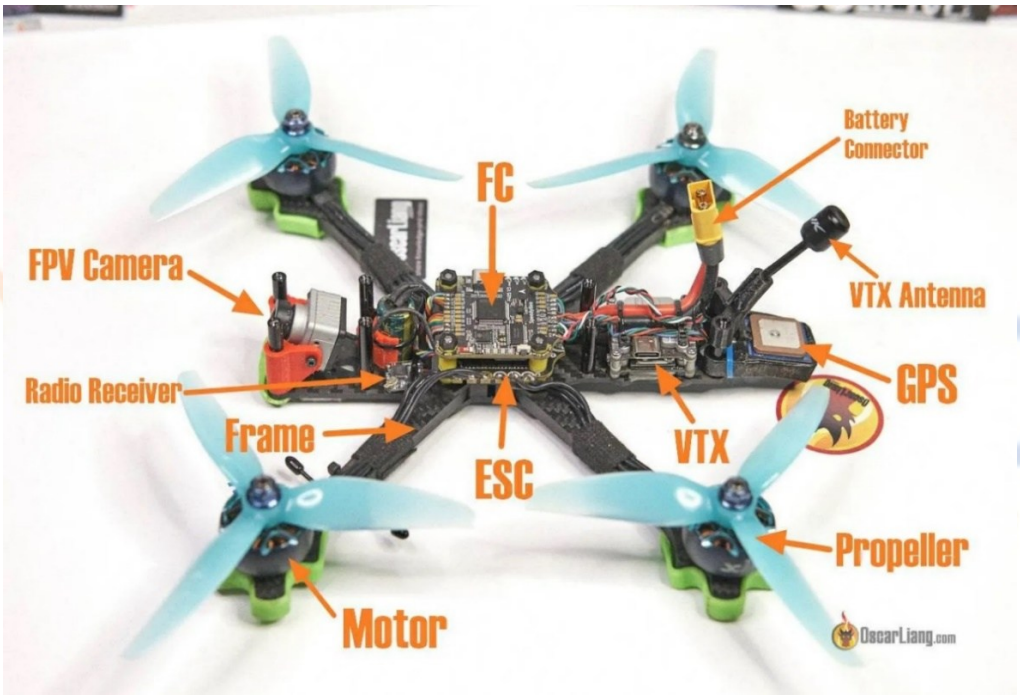

Figure 1: Component Placement

4. Drone Frame

The Drone frame is important thing, and it will show the performance of the entire integrated drone. So, listed some drone frames below for reference to make best drone frame in the market. When it comes to choosing the best FPV Racing Drone frame for a 5-inch propeller configuration, there are several excellent options that cater to different needs and preferences.

4.1 Drone Frame models

4.1.1 GEPRC FPV Racer:

Known for its high-performance and lightweight design, this frame is perfect for competitive racing. It features a durable T700 carbon fiber and 7075 aluminium alloy construction, ensuring both strength and agility. The quick-release arms make maintenance a breeze, and the multiple FC mounting options provide great flexibility for different setups.

4.1.2 iFlight Mach R5:

Renowned for its robust build and aerodynamic design, this frame is ideal for serious racers. It comes in two versions, offering options for different preferences. The 6mm arms and 7075 CNC middle plate provide excellent stability and durability. With its compact design and versatile FC mounting options, the Mach R5 is a top choice for competitive racing.

So, each frame has its own advantages over strength depending on its category and need in market. Killis FPV Racing Drone is more focused on racing pilots. If Killis FPV Racing Drone frames can give solution for various aspects like racing category and free style, it will be one of the best frames in the market.

Reference from annexure 17.1 the frame weight between **80g – 110g** including but not limited to the following components **Shark fin for turtle mode, Battery pads, Battery Strap and Screws.**

Frame Configuration: **True X frame** because of its good maneuverability in high speeds and turns in the FPV Drone racing. The Total take-off weight should be around **495g to 555g** for FPV Racing drone.

4.2 Drone Components with dimensions

Table 1:The specifications for the components of your FPV racing drone

Component		Dimensions	Weight
1) Frame		**Wheelbase 200mm**	**80g to 110g**
2) Flight Controller		Max 38mm x 38mm	**15g**
3) ESC		Max 38mm x 38mm	**15g**
4) VTX	Analog	36mm x 36mm x 8mm	**13g**
	Digital	34mm x 34mm x 18mm	36g
5) Camera	Analog	19*19*22mm	**6.3g**
	Digital	27.4mm x 21.1mm x 20.1mm	8.2g
6) Antenna	**Analog**	**16mm*60mm**	**4.5g**
	Digital	105mm	8g
7) Motor		Mounting Holes 16x16mm and 19x19mm with M3 hardware	**118.4g**
8) Propeller		5” to 5.5”	**16.8g**
9) Receiver		18mm x 13mm x 5.4mm	**2.2g**
10) Battery:	**6S 1400mAh LiPo**	81mm x 39mm x 36mm (May vary with company)	**212g**
	4S 1550mAh LiPo		172-196g
11) GPS module		22mm x 20mm x 6mm	**7g**
12) LED		57mm x 10mm	**5g**
		Total Weight	**495g-555g**

Note:

- Need to adjust FPV camera angle between **0deg to 60deg** in the drone frame.
- Required Thrust to weight ratio is **15:1** and the drone frame must be able to withstand the respective acceleration.
- The maximum horizontal speed of the drone is set to **240km/hr** (Market reference -Iflight Mach R5 maximum speed)

For more drone frames refer annexure 17.1.

5. BLDC Motor

Brushless DC (BLDC) motors are favored for FPV Racing Drones due to their efficiency, power, and reliability. Key considerations include the KV rating, which indicates RPM per volt and affects speed and torque; motor size, with larger motors providing more power and torque; weight, where lighter motors are preferred for racing and heavier ones for freestyle or long-range.

The T/W required is 15:1

Reference from annexure 17.2,

- **SPEEDX2 2107.5 1960KV** motor is selected for Killis FPV Racing Drone.
- It produces maximum thrust of **2009g** with DAL T5147.5 propeller
- So, the total thrust produced by quadcopter is **8036g**.
- So, it gives us T/W of **14.48**(MTOW-555g) to **16.23** (MTOW-495g).

5.1 Specifications

- Shaft Diameter: 4.0mm
- Weight: **29.5g**
- Recommended battery: 6S 1050mAh-1550mAh LiPo

5.2 Feature

- **High-efficiency** and smooth
- Perfect for Freestyle and **Racing FPV**
- **Motor dynamic balance,** stable operation
- Best for 5-inch frame

6. Propeller

When it comes to FPV (First-Person View) drone racing, the size and characteristics of the propellers play a crucial role in performance. Here are some key points to consider:

6.1 Propeller Size:

- **Smaller Propellers (2.5-3 inches)**: These are ideal for tight, indoor tracks or micro drones. They offer higher RPMs and faster response times, making them perfect for quick maneuvers and agility.
- **Medium Propellers (5 inches)**: This is the most common size for racing drones. They provide a good balance between speed, thrust, and control, making them versatile for various racing conditions.

6.2 Blade Pitch:

- **Higher Pitch (4.5-5 inches)**: These propellers produce more thrust and are suitable for high-speed racing. However, they require more powerful motors and can drain the battery faster.
- **Lower Pitch (3-3.5 inches)**: These are better for smooth and controlled flying, offering more efficient power usage but at the expense of top speed.

6.3 Blade Count:

- **Two-Blade Props**: Lighter and produce less drag but may lack stability at high speeds.
- **Three-Blade Props**: Offer better stability and control, which is why they are popular in racing.

6.4 Material and Weight:

Lightweight Materials: Propellers made from lightweight materials. For example, **polycarbonate** can improve responsiveness and reduce the load on motors

So, we can choose a **5-inch 3 blade propeller** configuration.

NOTE: Carbon fiber and metal propellers are not allowed in FPV Racing Drone Racing. Carbon fiber and metal propellers are much more rigid and can shatter or break into sharp pieces upon impact. This poses a significant safety risk for pilots, spectators, and equipment

So, reference from annexure 17.3,

A single propeller should not weigh more than **4.2g** and thrust produced by a single propeller should be greater than or equal to **2009g** with **SPEEDX2 2107.5 1960KV** motor therefore the weight of collective propellers should be equal to or less than **16.8g**

The following propellers are selected for reference:

- Orange HD 51466 V2 Hurricane PC 3 Blade – Midnight Gray (2CW,2CCW)- **3.8g**
- Foxeer DalProp SpitFire Triblade T5147.5 Propeller 2 Pair CW+CCW-Crystal Fluorescent Green- **4.2g**

For more propeller configurations refer annexure 17.3.

7. Flight Controller

The Killis FPV Racing Drone will be integrated with Killis H7 flight controller. So, the Killis H7 flight controller ensures to have the following minimum requirements.

- **Mounting Holes dimension**: 30.5*30.5/ M3 hardware, 25.5*25.5/M3 hardware, 20*20mm/M3 hardware
- **FC outer dimension**: Not More than 38*38mm
- **Weight:** Not More than 11g
- **Mandatory Inbuilt Bluetooth support**.
- **Mandatory Inbuilt OSD support**
- Compatible to all types of **receiver module**
    - **ExpressLRS**
    - **PPM**
    - **Sbus**
    - **ibus**
    - **Crossfire (CRSF)**
    - **SRXL2**
- **Minimum 4 LED** output pads

Ports:

- **UART Ports: 4**
    1. MSP (Multiwii Serial Protocol)
    2. Bluetooth
    3. Receiver- Solder pad or Dupont Connector
    4. GPS- Solder pad or JST-SH connector

- **PWM Outputs -** 4 Motor output to connect 4 in 1 ESC(JST-SH) and 4 LED solder pads
- **ESC Connection –** 8pin JST-SH connector
- **Analog Camera –** 4pin solder pads (5 – 36 V output)
- **VTx Connector-** 6pin JST-SH (9V output)

Example diagram for the FC for suggestions for the connectors position in FC.

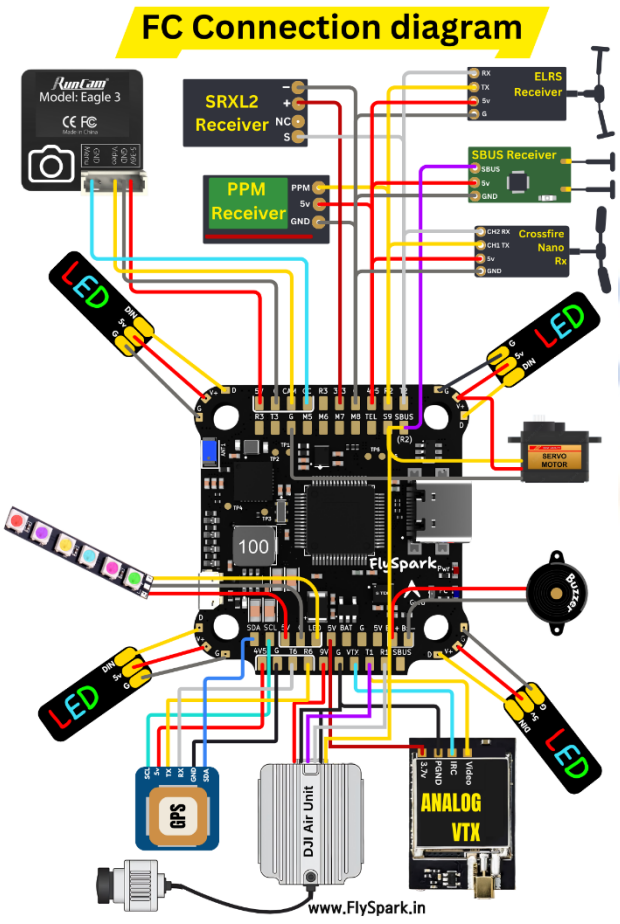

Figure 2: FlySpark F4 V1

8. 4 in 1 ESC

In FPV Racing drones, the 4-in-1 ESC (Electronic Speed Controller) is essential for power distribution, providing power to the flight controller (FC), and handling current and voltage sensing. It integrates four ESCs into one board, simplifying wiring and reducing weight. Current and voltage sensors, offering real-time data for telemetry, safety, and efficiency. Advanced features like telemetry support and protection mechanisms further enhance the drone's performance and reliability, making the 4-in-1 ESC a crucial component in high-performance drones. Ensure **Killis 4 in 1 ESC** compatible with **Killis H7 FC** and other market FCs with the following minimum requirements.

- **Mounting Holes**: 30.5*30.5/M3 hardware, 25.5*25.5/M3 hardware, 20*20mm/M3 hardware
- **Current Rating**: SPEEDX2 2107.5 1960KV – **Peak current 39.6A**
- **Voltage Rating**: 2-6S LiPo (most common in the market)
- **ESC Protocols**: DShot150/300/600/1200 & MultiShot / OneShot / Proshot/ PWM etc.
- **Dimensions**: Not More than 38*38mm
- **Weight**: Not more than 15g
- **Additional Features**: Built-in current sensor, telemetry support, BLHeli_32 firmware or AM32 firmware
- **Capacitor**: Recommend best capacitor for 6s setup (Market recommendation-1000uf 35v capacitor highly recommended for 6s setup)

9. GPS

GPS modules are crucial for FPV Racing Drones, providing features like Rescue Mode and Return to Home. Key considerations include compatibility with your flight controller, support for multiple satellite systems (GPS, GLONASS, Galileo, Beidou), size and weight, and whether it has a built-in compass. Examples of popular GPS modules are the HGLRC M100 Mini, Flywoo GOKU GM10 Nano V3, and Beitian BN-220, known for their performance and reliability. The specifications are tabulated in annexure 17.4.

For Killis FPV Racing Drone, the **mico air M10** selected because of its small size with integrated compass and M10 chip has high accuracy.

Specifications:

- Dimension: **20mm*20mm*8mm**
- Weight: **7g**

10. Battery

For FPV Racing Drones, Lithium Polymer (LiPo) batteries are preferred due to their high energy density and ability to deliver high currents. Key considerations include voltage (e.g., 4S, 6S), capacity (mAh), C rating (discharge rate), and weight. Popular examples are the Tattu R-Line 1550mAh 6S 150C, GNB 1300mAh 4S 120C, and Lumenier 1300mAh 4S 75C, chosen for their performance and reliability. Balancing these factors is crucial for optimal drone performance.

- **6S 1300mAh LiPo**: Approximately **207-242 grams**.
- **4S 1550mAh LiPo**: Approximately **171-192 grams**.

These weights can vary slightly depending on the specific brand and model of the battery. Some batteries are tabulated in annexure 17.5.

- Bonka 22.2V 1400mAh 130C 6S FPV U2 Series Lithium Polymer Battery Pack is selected to purchase. Its weigh is **212g**.

Killis FPV Racing Drone must achieve a minimum endurance of **15 minutes** in hover condition.

11. Receiver

For manoeuvring control in FPV Racing Drone racing, having a top-notch transmitter and receiver is essential. Some of the best options available in the market are tabulated in annexure 17.6.

The Radiomaster RP1 V2 ExpressLRS Nano Receiver is selected to using in Killis FPV Racing Drone, because of **low latency**, this is a great option for FPV racing.

11.1 Specifications

1. Telemetry RF power: **10mW**
2. Antenna 65mm 2.4ghz T Antenna
3. Maximum receive refresh rate 500Hz / F1000Hz
4. Minimum receiver refresh rate 25Hz
5. Dimension: **13mm x 11mm x 3mm**
6. Weight: **2.2g** (Including antenna)

12. Video Transmitter (VTx)

The Video Transmitter (VTx) is a crucial component in an FPV Racing Drone, responsible for sending the live video feed from the drone's camera to your FPV goggles or monitor. Here are some key points to consider when choosing a VTx for FPV Racing:

12.1 Key Features of a VTx

1. **Frequency Bands**: Most FPV VTxs operate on the 5.8GHz band, which offers a good balance between range and video quality.
2. **Power Output**: Measured in milliwatts (mW), common options range from 25mW to 800mW. Higher power output provides better range and penetration but can cause more interference and consume more battery.
3. **Size and Weight**: For racing drones, a compact and lightweight VTx is preferable to keep the drone agile.
4. **Connectors**: VTxs come with different antenna connectors like SMA, RP-SMA, U. FL, and MMCX. Choose one that matches your antenna and is durable enough for frequent use.
5. **Smart Audio/Tramp Protocol**: These features allow you to change the VTx settings (like channel and power) via your flight controller and OSD, adjusting easier and more convenient.

Some VTx models are listed in annexure 17.7.

Foxeer 5.8G Reaper Extreme V2 **2.5W** 72CH VTx is selected for Killis FPV Racing Drone because it offers a powerful video transmission range of up to **2 miles** (approximately 3.2 kilometers) with its 2.5W output power. This makes it

an excellent choice for long-range FPV (First Person View) flying, providing reliable and stable signal transmission.

Specifications:

- Input Voltage- 9~36V
- Output Voltage -5V
- Power- 25mW/200mW/500mW/1.5W/2.5W
- Weight-**13g**
- Mounting Hole- 20*20mm M2 2.8mm depth
- Size - **36*27.5*8mm**
- Consumption - **1.2A/9V**

13. Antenna

FPV (First Person View) antennas for VTx (Video Transmitter), there are a few key factors to consider:

1. **Frequency**: Make sure the antenna matches the frequency of your VTx, typically 5.8 GHz for most FPV systems.
2. **Polarization**: Choose between linear and circular polarization. Circular polarized antennas (like cloverleaf or pagoda) are popular because they handle multipath interference better.
3. **Gain**: Higher gain antennas (measured in dBi) provide longer range but have a narrower beam, while lower gain antennas offer a wider beam but shorter range.
4. **Durability**: Consider the build quality, especially if you're flying in rough conditions. Some antennas come with protective covers or are made from more durable materials.

13.1 Commonly used antenna types:

- **Pagoda Antennas**: Known for their good performance and durability.
- **Cloverleaf Antennas**: Commonly used for their circular polarization and good range.
- **Patch Antennas**: High gain and long range, but more directional.

Foxeer Lollipop 4 Plus High Quality 5.8G 2.6dBi FPV Omni LDS Antenna is selected for Killis FPV Racing Drone since it uses circular polarization and have good range.

Specs: Dimension: approximately **16mm*60mm;** Weight: **4.5g**

14. FPV Camera

When choosing an FPV camera for a drone, we have two main options: analog and digital. Each type has its own advantages and considerations

The FPV Camera sizes are listed below:

- Standard, aka “full size” (28mm)
- Mini (21mm)
- Micro (19mm)
- Nano (14mm)

The most 5-inch frame configuration are suggested **mini and micro** type FPV cameras.

14.1 Analog FPV Cameras

Analog FPV cameras are known for their **low latency and simplicity.**

Some Analog Cameras are listed in annexure 17.9.

- **Foxeer Predator 5 Mico** Racing Camera 4ms Latency Super WDR is selected for Killis FPV Racing Drone.
- The Foxeer Predator 5 Micro is **a highly popular FPV camera choice** among **racing pilots**. Its **ultra-low latency**, high image contrast makes obstacles stand out clearly. Additionally, it offers a **wide field of view**, which is desirable in racing.

Specifications:

- Dimension (LxWxH)-19*19*22mm
- Weight (g) - Full Case:6.3g (Exclude cable)

14.2 Digital FPV Cameras

Digital FPV cameras offer **higher image quality** and less interference but typically have **higher latency and cost.**

Some Digital Cameras are listed in annexure 17.9.

15. Human Interface Components (User's Choice)

In FPV Racing drone, human interface components are crucial for optimal performance and a great flying experience. Here's a breakdown of the human interface components:

1. **Transmitter:** For manoeuvring control in FPV Racing Drone racing, having a top-notch transmitter and receiver is essential. Some of the best options available in the market are tabulated in annexure 1.1.
    - **Radiomaster TX16S** MKII HALL V4.0 ELRS Radio Transmitter is selected for its compatibility to all types of receivers.
2. **Goggles**: FPV goggles provide an immersive first-person view by displaying the live video feed from the drone's camera. Some Goggles are listed in annexure 17.11
    - **SKYZONE SKY04O Pro** FPV Goggle with OLED Screen is selected, because of its high level of resolution and many features.
3. **Battery Charger**: A reliable charger is necessary to keep your drone's batteries charged and ready for flight.
4. **LED Strip for Night Racing**: LED strips enhance visibility during night races, making it easier to track your drone and adding a cool visual effect.

Note: In market, if a user buys a complete drone kit or ready to fly kit, the components (1), (2), (3) and battery will not be included. The user will need to buy these separately.

16. Conclusion

The requirements and components for the Killis FPV Racing Drone were concluded in the document. The drone's frame specifications are **true X frame** with a **200mm** wheelbase. The frame should not weigh more than **80–100g**. The maximum speed of the drone is **240 km/hr**. The drone T/W ratio is **15:1**. To achieve maneuverability and stability at high speeds, the **5-inch 3-blade** was chosen.

Table 2: List of selected products for respective components

BLDC Motor	**SPEEDX2 2107.5 1960KV**
Propeller	**51466/ T5147.5**
Transmitter	**Radiomaster TX16S MKII HALL V4.0**
Receiver	**Radiomaster RP1 V2 Express LRS Nano**
GPS	**Mico air M10**
Video Transmitter Module	**Foxeer 5.8G Reaper Extreme V2 2.5W 72CH**
Antenna	**Foxeer Lollipop 4 Plus High Quality 5.8G 2.6dBi**
FPV Camera	**Foxeer Predator 5 Mico**
Goggles	**SKYZONE SKY04O Pro**
Battery	**22.2V 1400mAh 130C 6S**

17. Annexure

17.1 Drone Frames

Table 3: Best 5" propeller Racing Drone Frames

Frame Model	Wheelbase	Weight	FC Mounting Size	Features
iFlight Mach R5	**210mm**	107g (Canopy Ver.) / 128g (Top Plate Ver.)	20x20mm, 25.5x25.5mm, 30.5x30.5mm	6mm arms, 7075 CNC middle plate, compact design
GEPRC Racer	208mm	78g ± 2g	20x20mm, 25.5x25.5mm, 30.5x30.5mm	7075 aluminium alloy, T700 carbon, quick-release arms
Falcon Multirotors Bannilite 5"	220mm	72g	30x30mm	5mm arms, camera protection, easy arm swap
HYPERLITE FLOSS 3.0 Race Frame	220mm	69.5g	20x20mm, 30x30mm	Soft edge 5mm carbon arms, 85+ degrees tilt, easy arm removal
Hyperlite F3LX True-X Racing 5"	220mm	59g	20x20mm	5mm durable arms, 7075 aluminum core, TPU camera mount
TBS Source PodRacer 5"	**200mm**	47g	19x19mm, 20x20mm, 26x26mm	Ultralight, 5mm arms, optimized for

				speed and minimal drag
TBS Source Two 5" Racing Frame V0.1	220mm	72g	30.5x30.5mm, 20x20mm	Ultralight, single-bottom stretched, 4mm arms
TBS Stardust SB5 PRO 5"	**200mm**	65g	Not specified	Handmade carbon fiber, 4.6mm bottom plate, titanium screws
The Phat Ultralight FPV Racing 5"	Not specified	55g (60g with camera mount)	Not specified	Innovative arm locking design, dedicated receiver and antenna mounting
Xhover R5LX	Not specified	82g	Not specified	Forward sweep design, easy arm removal, custom PDB with 5V/12V output
Zeez Design Capish 5.5"	225mm	79g	Not specified	Japanese T700 carbon, easy arm swap, lightweight

17.2 BLDC Motor

Table 4: Some FPV motors for reference

Motor Model	KV Rating	Weight	Battery Compatibility	Prop Combination	Maximum Thrust
T-Motor F60 Pro IV 2207	1950KV	33.5g	6S (22.2V)	5x4.3x3	~1700g per motor
Lumenier Chief 2207	2050KV	28g	6S (22.2V)	5x4.5x3	~1600g per motor
iFlight XING2 2207	1800KV	31.6g	6S (22.2V)	5x4.3x3	~1650g per motor
Emax Eco II Series 2207	**1700KV**	**33.4g**	**6S (22.2V)**	**5x4.3x3**	**~1980g per motor**
XING-E 2207	6S 1800KV / 4S 2750KV	33.8g	6S (22.2V) / 4S (14.8V)	5x4.3x3	~845W (6S) / ~800W (4S)
SPEEDX2 2107.5	1960KV (6S) / 2450KV (4S)	29.5g	6S (22.2V) / 4S (14.8V)	5x4.3x3	~1600g per motor
Ethix Mr Steele Stout V4 2306	1750KV	32.4g	6S (22.2V)	5x4.3x3	~1650g per motor

17.3 Propeller

Table 5:popular 5-inch propellers for FPV Racing Drones

Propeller Model	Material	Weight	Performance Characteristics
HQProp Ethix S5 5x4x3	Polycarbonate	3.7g	Smooth flight, good balance, ideal for freestyle flying
HQProp 5×4.3×3 V2S	Polycarbonate	3.5g	Mix of thrust and efficiency, suitable for both racing and freestyle
Gemfan Hurricane 51466	Polycarbonate	4.1g	High thrust, responsiveness, great for aggressive flying styles
DALProp Fold F5 5.1" V2	Polycarbonate	**4.8g**	Foldable design, solid performance in both racing and freestyle

17.4 GPS

GPS Module	Dimensions	Weight	GPS Variant	Accuracy	Other Features
HGLRC M100 Mini	15mm x 15mm x 5.2mm	2.6g	GPS, Galileo, BDS	Horizontal: 2.0m (Outdoor)	10th generation chip, fast positioning, ceramic antenna, onboard LED indicators
Flywoo GOKU GM10 Nano V3	12mm x 16mm x 4.5mm	2.2g	GPS, GLONASS, Galileo, BeiDou, QZSS, SBAS	Horizontal: 2.0m (CEP)	M10050 GNSS chip, high sensitivity, fast star search, plug-and-play design
Beitian BN-220	22mm x 20mm x 6mm	5.3g	GPS, GLONASS, BeiDou	Horizontal: 2.0m (CEP)	Integrated ceramic antenna, multiple satellite systems, low power consumption
MicoAir M10G-5883	20mm x 20mm x 7.8mm	7g	GPS, GLONASS, Galileo, BeiDou, QZSS, SBAS	Horizontal: 2.0m (CEP)	u-blox M10 chip, high-gain patch antenna, built-in flash, supports up to 32 satellites, integrated QMC5883L compass

17.5Battery

Table 6: Battery Specification and Endurance

Drone Model	Battery	Flight Time	Features
iFlight Nazgul5 V2	4S 1550mAh or 6S 1300mAh LiPo	Approximately 10-12 minutes	Durable frame, high-performance motors, and excellent build quality.
GEPRC Mark5	6S 1300mAh LiPo	Approximately 12-15 minutes	Innovative frame design, easy maintenance, and high-quality components.
Mr Steele Apex 5"	6S 1300mAh LiPo	Approximately 10-12 minutes	Designed by a professional FPV pilot, robust build, and optimized for racing.

17.6 Receiver

Table 7: Receiver Models

Receiver Model	Dimensions	Weight	Features	Pros	Cons
TBS Crossfire Nano RX	18mm x 13mm x 2mm	0.5g	Long-range, low latency, telemetry support	Excellent range and reliability, compact size	Requires Crossfire-compatible transmitter
FrSky R-XSR	16mm x 11mm x 5.4mm	1.5g	Full telemetry, SBUS/CPPM output	Lightweight, good range, easy to install	Slightly less range compared to Crossfire
Radiomaster RP1 V2 ExpressLRS Nano RX	10mm x 15mm x 2mm	0.6g	ExpressLRS protocol, telemetry support	Ultra-lightweight, excellent range, low latency	Requires ExpressLRS-compatible transmitter

17.7 VTx

Table 8:Analog VTx Options

Video Transmitter Model	Dimensions	Weight	Mounting Holes
TBS Unify Pro 5G8	36mm x 22mm x 6mm	7g	No specific mounting holes; typically mounted using double-sided tape or zip ties.
Foxeer 5.8G Reaper Extreme V2 2.5W 72CH VTx	36mm x 27.5mm x 8mm	13g	20*20mm M2 2.8mm depth
ImmersionRC Tramp HV	31mm x 20mm x **8mm**	4.5g	No specific mounting holes; usually mounted with double-sided tape or zip ties.
AKK FX2 Ultimate	**36mm x 36mm** x 4mm	7.8g	30.5mm x 30.5mm (standard stack mounting holes).

Table 9:Digital VTx Options

Video Transmitter Model	Dimensions	Weight	Mounting Holes
DJI Air Unit	44mm x 37.8mm x 14.4mm	45.8g	20mm x 20mm
Caddx Vista VTX	30mm x 29mm x 13mm	19g	20mm x 20mm (M2 mounting screws)
Walksnail Avatar HD VTX	**34mm x 34mm x 18mm**	16g	**25.5mm x 25.5mm, 20mm x 20mm**
DJI O3 Air Unit	32.5mm x 30.5mm x 14.5mm (transmission module), 21.2mm x 20mm x 19.5mm (	36.4g (with camera module)	20mm x 20mm (camera module)

	camera module)		

17.8 Antenna

Table 10: The popular antennas for analog VTx in FPV racing drones

Antenna	Type	Frequency	Gain	Dimensions	Weight	Features
Lumenier AXII 2	Circular Polarized (RHCP)	5.8 GHz	2.2 dBi	16mm x **70mm**	7.6g	Improved range, durable case, flexible cable, SMA connector
TBS Triumph Pro	Circular Polarized (RHCP)	5.8 GHz	1.26 dBi	**100mm** length	**11g**	Robust design, high-quality cable, SMA/MMCX connectors, excellent penetration
Foxeer Lollipop 4	Circular Polarized (RHCP)	5.8 GHz	2.5 dBi	60mm length	4.5g	Compact, lightweight, durable, SMA/RP-SMA/MMCX connectors, good stability
Pagoda 2	Circular Polarized (RHCP)	5.8 GHz	2 dBi	60mm length	8g	Excellent performance, simple design, SMA connector, affordable

Table 11: The popular antennas for Digital VTx in FPV racing drones

Antenna	Type	Frequency	Gain	Dimensions	Weight	Features
DJI FPV Air Unit	Circular Polarized (LHCP)	5.8 GHz	2.2 dBi	105mm length	3.9g	High-quality signal, durable, lightweight, MMCX connector
Caddx Vista	Circular Polarized (LHCP)	5.8 GHz	2.5 dBi	85mm length	3.5g	Compact, lightweight, high durability, MMCX connector
Walksnail Avatar HD Pro	Circular Polarized (LHCP)	5.8 GHz	2.3 dBi	**105mm**	8g	Dual antenna, high-definition video, SMA connector
HDZero Micro	Circular Polarized (LHCP)	5.8 GHz	2.0 dBi	60mm length	4g	Compact, lightweight, durable, U.FL connector

17.9 FPV Camera

Table 12: Analog FPV Cameras

FPV Camera Model	Dimensions	Weight	Mounting Holes
RunCam Swift 2	**28mm x 26mm x 28mm**	14g	**Standard 28mm x 28mm**
Foxeer Predator V5	19mm x 19mm x 19mm	5.5g	Standard 19mm x 19mm
Caddx Ratel	19mm x 19mm x 19mm	5.5g	Standard 19mm x 19mm

Table 13: Digital FPV Cameras

FPV Camera Model	Dimensions	Weight	Mounting Holes
DJI FPV Camera	**27.4mm x 21.1mm x 20.1mm**	8.2g	**20mm x 20mm**
Caddx Vista Nebula Pro	19mm x 19mm x 20mm	6g	Standard 19mm x 19mm
Walksnail Avatar HD	19mm x 19mm x 19mm	6g	Standard 19mm x 19mm

17.10 Transmitter

Table 14: Transmitter models

Transmitter Model	Features	Pros	Cons
RadioMaster TX16S MKII	Multiprotocol support, Hall Effect gimbals, large color touchscreen, EdgeTX firmware	Versatile, supports multiple receiver types, customizable settings	Can be complex for beginners
FrSky Taranis X9D Plus	16 channels, telemetry support, customizable switches	Reliable, extensive community support, good range	Slightly bulky

17.11 Goggles

Table 15: The key features of the top analog FPV goggles

Goggles	Resolution	Field of View (FOV)	Adjustability	DVR	Comfort	Other Features
Fat Shark Dominator HDO2	1280 x 960 OLED	46 degrees	Adjustable IPD and focus	Built-in DVR	High-quality faceplate foam, adjustable head strap	HDMI input, customizable OSD
Skyzone SKY04X	1280 x 960 OLED	46 degrees	Adjustable IPD and focus	Built-in DVR	Ergonomic design, comfortable faceplate	Head tracking, HDMI input, customizable OSD
Skyzone SKY04O Pro	1280 x 720 OLED	42 degrees	Adjustable IPD and focus, switchable aspect ratio	Built-in DVR	Ergonomic design, high-quality foam padding	HDMI input, head tracker, multiple language support
Eachine EV800D	800 x 480 LCD	82 degrees	Fixed IPD	Built-in DVR	Lightweight design, adjustable head strap	Built-in diversity receiver
Aomway Commander V1S	854 x 480 LCD	32 degrees	Adjustable IPD	Built-in DVR	Comfortable faceplate, adjustable head strap	Built-in diversity receiver, HDMI input

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