Ichabod Jr. Gab707 filming kit

A small guide by Gabriel ‘GAB707’ Kocher
Revision - May 2019

The Ichabod Jr is a 245mm 5" quadcopter for aerial video. It is designed to get the best possible handling and performance while still being flexible to get any shot. the Hero is lined up with the fpv camera to help your frame your video. There are no props in view, and the camera cluster tilts from -45 to 30 degrees to support any kind of shot. The on screen display (OSD) allows you track the aircraft’s status and tune all of the flight controller parameters in a breeze.

The kit contains all the parts needed to build it up like Gab707 into all round high performance fpv video platform with premium and reliable parts. This manual contains everything from building it, configuration and both tips for flying and filming. Hopefully, pretty much everything you need to know to get the most out of the drone!

1. Disclaimer

Our request to you: the aircraft may not be used to infringe on people's right to privacy. We have designed a tool with mind blowing capabilities. It is your responsibility to use it reasonably and according to your experience level. Use common sense. Fly safe. You are on your own. TBS and Gab707 have no liability for use of this aircraft.

- Locate an appropriate flying location
- Obtain the assistance of an experienced pilot
- Practice safe and responsible operation
- Always be aware of the rotating blades
- Prevent moisture
- Keep away from heat or excessive amounts of sunlight
- Always brief people you’re going to be filming

Different countries will have different rules regarding drones, with differences if you are just flying for fun or commercially. Watch out!

Additionally, flying FPV (first person view), i.e. through goggles, is usually not allowed under the typical VLOS (visual line of sight) rules. In some cases, having a spotter or visual observer allows you to adhere to the VLOS operation rules, so make sure you understand the ins and outs of this kind of operation.

The transmitters in the kit may require a radio operator certificate to operate in your country at power levels above 25mW. Please be mindful of local regulations.

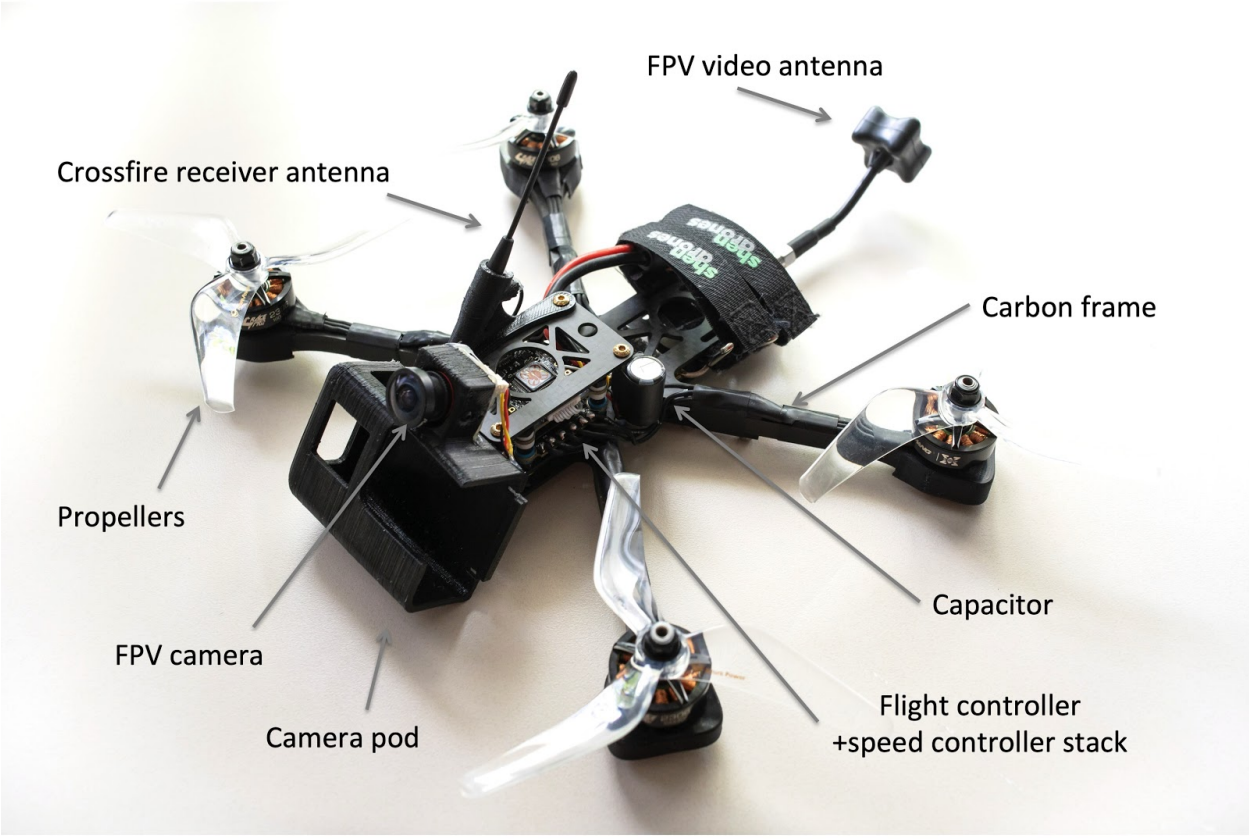
2. Beginner notes

Are you getting into fpv? This kit is a great tool for filming, but doesn't make a good training quad. Here are a few scenarios. In each one, no matter where you are in the world there is most likely a local community of fpv pilots who can help you out to find good spots to fly, where to buy your parts, or just help you get started! Look up local drone racing chapters and local fpv groups.

You know how filming drones work (dji etc.) but have never tried fpv
You should first get a controller and try your hand on a simulator to understand the flying mechanics. There are quite a few options out there, I'd recommend the DRL simulator on steam, because it has a beginner mode that teaches you how to fly. Other option: Velocidrone.
Once you know how to fly you should be able to pick this drone up. You need to learn to fly the drone line of sight first in angle mode(without the goggles), but your previous experience should help you with that. Then put some goggles on and the simulator experience should get you to fly in no time!

You've never used a drone before
You should definitely pick up a controller first, and try a simulator first. There are quite a few options out there, I'd recommend the DRL simulator on steam, because it has a beginner mode that teaches you how to fly. Other option: Velocidrone.
You should then pick up a nano drone like the tiny whoop nano drone. You should first learn to fly it line of sight (without the goggles), and can train your skills with goggles on too. Those drones are tiny and and make a very cute and safe platform to learn indoors. You are then ready for the Ichabod. Start line of sight again until you understand the machine's handling before proceeding with fpv.

3. Overview, gear list



Here are the parts that comprise the drone:

- Shendrones Ichabod Jr. (the carbon frame)
- Hobbywing 45A 4-in-1 electronic speed controller
- Brain FPV Radix flight controller
- Hobbywing 2306 1600kv motors
- Team blacksheep Crossfire nano rx
- Team blacksheep unify PRO 5G8 HW (SMA) video transmitter
- Team blacksheep triumph RH antenna (SMA)
- Azure 5140 props
- Runcam micro Eagle with RC25G lens

Additional things not included in the kit that you may need to fly and shoot:

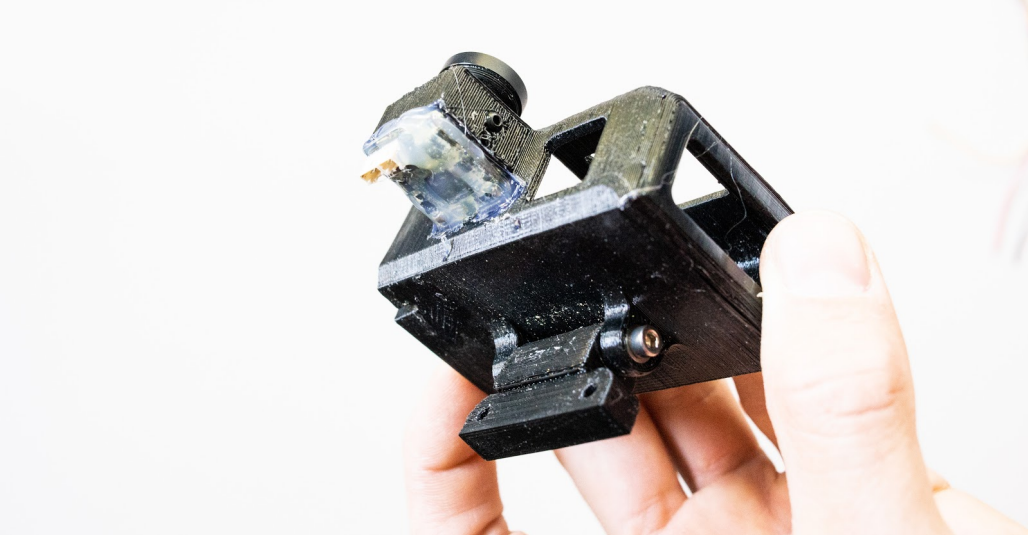
- **Radio controller:** A decent transmitter is important, and it needs to have JR module compatibility. I'd recommend something like a Frsky Taranis X9D or QX7, or a Team Blacksheep Tango.
- **Crossfire Transmitter module:** It comes in two flavours, a full model that supports output powers up to 1W, and a more limited lite version. I would recommend the full version if you plan to fly long range.
- **Lipo Batteries:** 6s 1300mAh (more agile) or 6s 1800mAh (more flight time, 10 mins+ of easy flying)
- **Lipo charger:** I recommend not cheaping out on the charger. Lipo batteries have an associated fire hazard which is very high. RC lipos do not come with an internal control circuit like laptop batteries so you are fully in charge of the proper use of the batteries to avoid burning down your house. Get a decent charger, always balance charge, respectfully dispose of damaged packs and always stay next to charging batteries! I'd recommend something like an ISDT D2 charger.
- **Goggles:** Goggles can range from simple to quintuple in price, but they complete the same role at heart. While top of the line Fatshark HDO's offer the best screen resolution, lag and portability, cheaper box goggles are a bit bulkier but work just fine.
- **Goggle module:** Several companies offer goggle modules, I'd recommend the Team Blacksheep goggle module.
- **Antennas:** the kit comes with an omnidirectional antenna for the drone, but you need to decide which kind of antenna you want for your goggles. Omnidirectional antennas will give you coverage in all directions, while directional patch antennas give you enhanced coverage to fly longer distances. Upgrades exist for your Crossfire TX module too.
- **GoPro:** you will need a GoPro hero 5, 6 or 7 to film with the Ichabod Jr. Look at the Filming tips below to learn about some key differences.
- **ND filters:** more about those in the filming tips section.
- **More props:** a few sets are fine to start, but count on having a few sets ready for any day of flying, since a single crash can easily mean you need to swap out 4 props. So far I prefer the Azure 5140 props for

efficiency and faster flying, and the Azure jfp props for more precise technical flying.

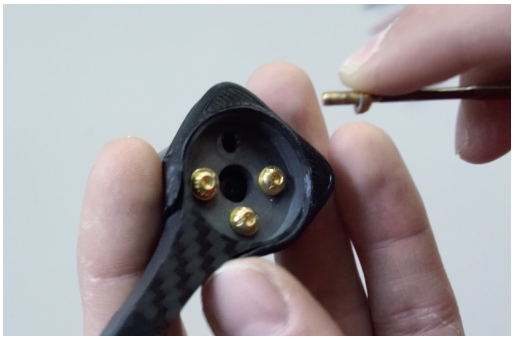
4. Short build guide

If you're into videos, the build is detailed in a video on the Gab707 youtube channel. Here are the highlights.

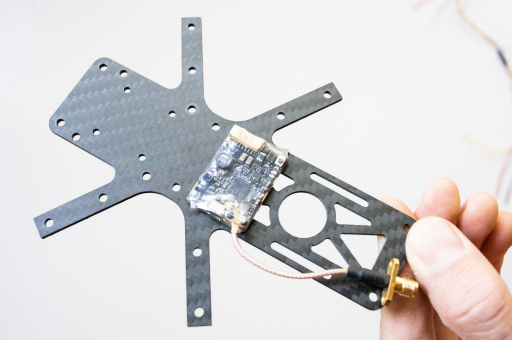
- **Prepare the camera pod**
  First insert the standoff into the TPU holder, attach it to the camera pod, and insert the screws from the side. Make sure to put the washers on the screws soas not to destroy the plastic. Make sure to sawp out the stock lens on the runcam micro eagle for a RC25G lens. Then insert the camera into the mount and fix with 2 screws on the side. Optional: hot glue the camera backside to protect from water.



- **Motor preparation on the arms**
  First insert the tpu bumpers onto the arms, then attach the motors. Make sure to use 2 washers per screw. Once tightened down, the screws needs to be well clear of the motor windings. Motor wires need to be about 10cm long for the front motors, and 13cm long for the back motors. Cut them and pre-tin the ends.

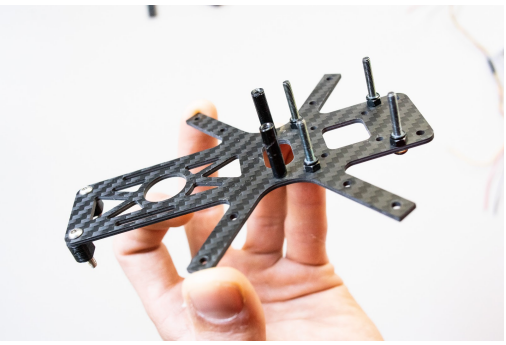



- **Mount the video transmitter to the bottom plate**
  Double sided tape works just fine

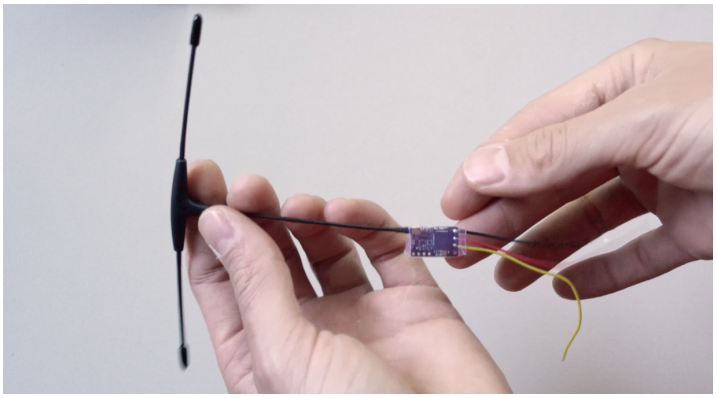


- **Prepare the bottom plate**
  Prepare the back bumper just by pressing the screws through, put on the back standoffs and fasten the flight control stack screws. Make sure to use a washer at the bottom of the plate, since the screws are slightly too long.

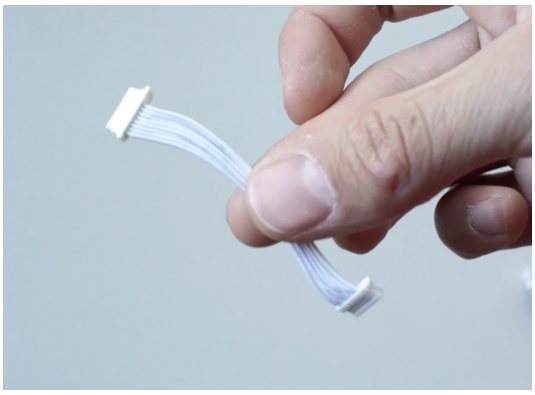




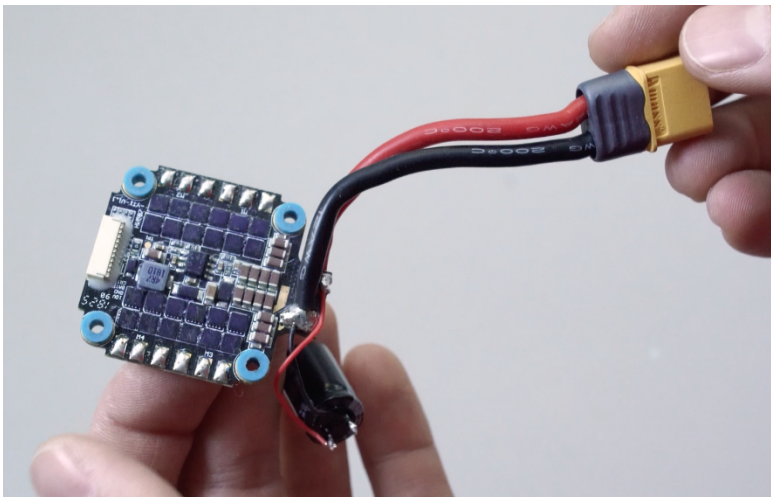
- **Prepare the nano RX**
  Solder the ground, signal and 5V pads, pop on the antenna and heat shrink the unit. Wires need to be about 9cm long.



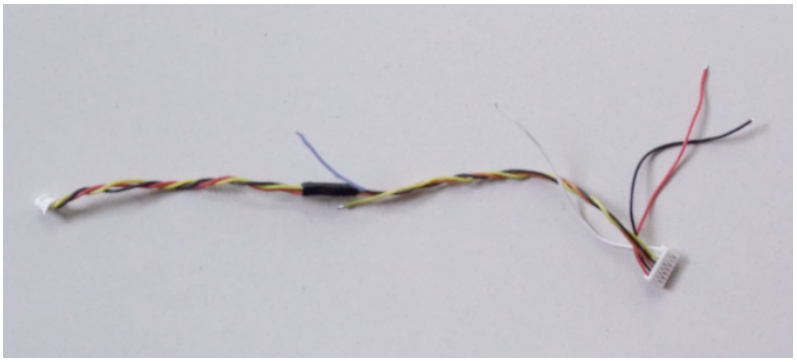
- **Flight control cable**
  A long 10 pin cable should come with the Hobbywing ESC, make sure to de-pin the red and black cables on there



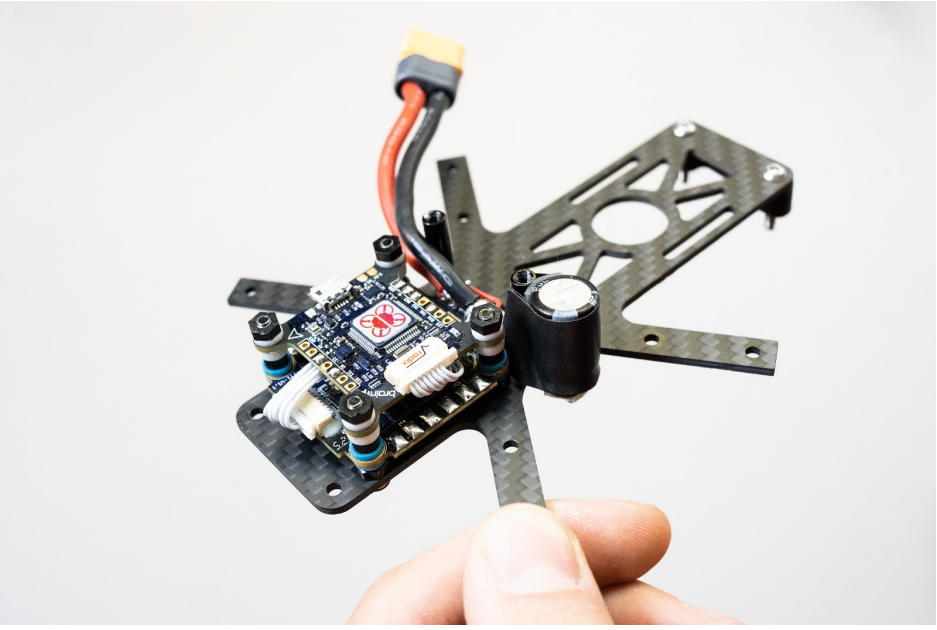
- **ESC prep**
  Solder the power cable at a 90 degree angle onto the ESC. Cable length about 7 cm. Use a small cable to solder the large capacitor that comes with the 4-in-1 to the ESC. The cap should be about 4 cm away from the positive pad. Isolate the legs of the cap with hot glue.



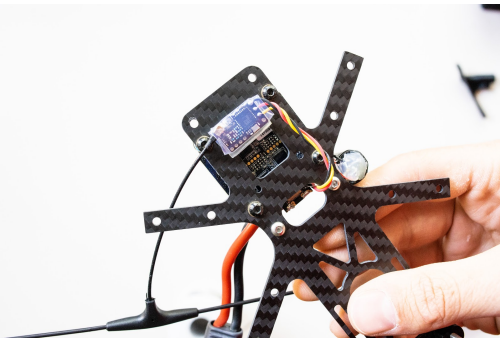
- **VTX/Cam cable**
  You need to make this cable. De-pin the green audio cable, and cut the power, ground and smart audio cables to 6.5cm on the vtx cable. Extend the 5v and ground cables to 17.5cm. The video cable from the vtx connector needs to be 9.5 cam, while the video cable from the camera connector needs to be around 12 cm. This is needed for the tilting mechanism to work unhindered.

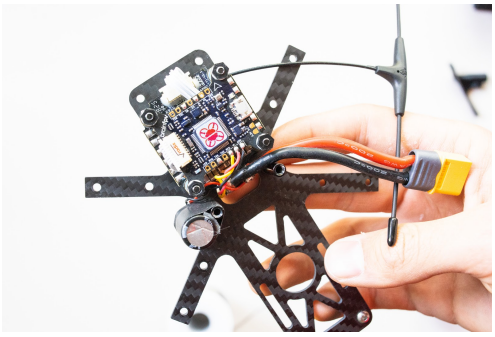


- **Build the stack on the middle plate**
  Build the stack adding a spacer between the esc and fc. Attache the Cap to the standoff, facing out. Make sure not to pinch any wires.



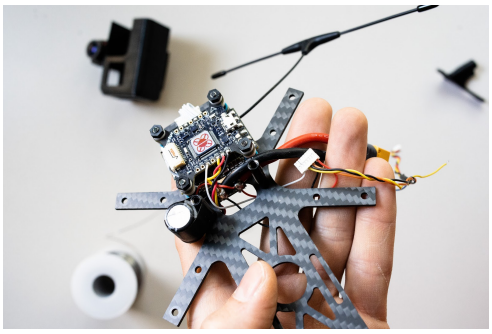
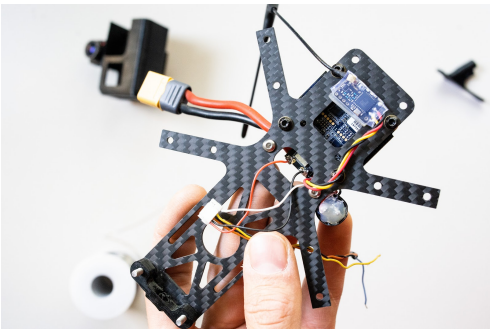
- **Mount the nano rx to the bottom of the middle plate**
  And solder it to the fc, running the wires through the middle hole. Signal to RX3, 5v and ground are right next to it.



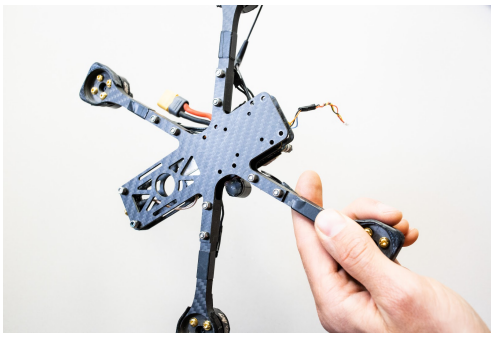


- **Solder on the VTX connector**

Red and black cables go to the main battery pads, and the smart audio to RX6

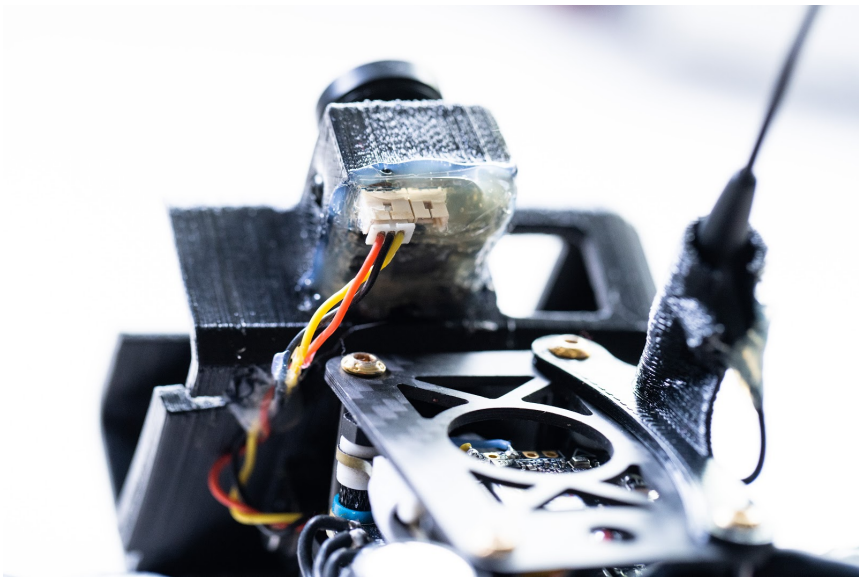



- **Frame assembly with the arms, solder on motors**
  Route the camera connector cable through the hole under the esc, so it sticks out the front. Then connect the vtx, then assemble the back screws, then 2 bolts per arm, then solder on the motors. The order of the pads does not matter.

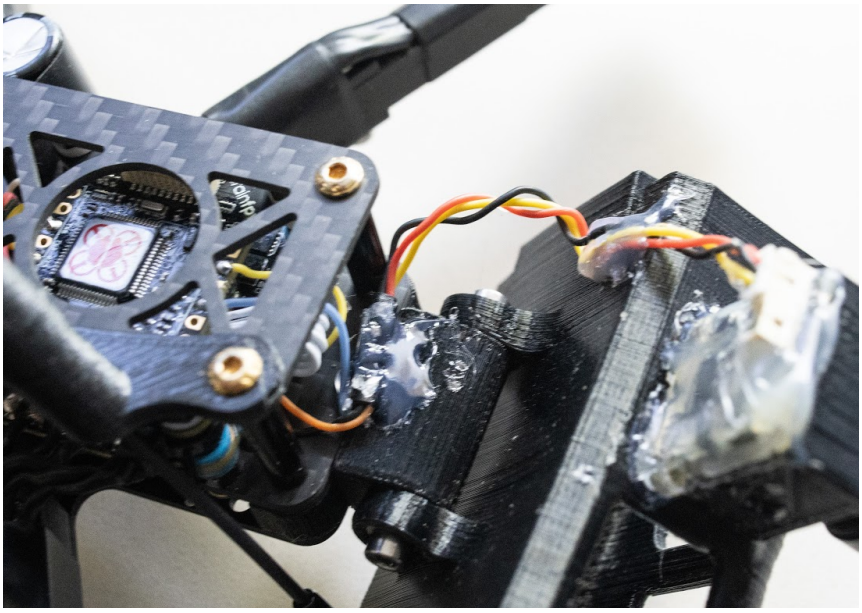



- **Mount the camera pod, top plate and immortal T mount**

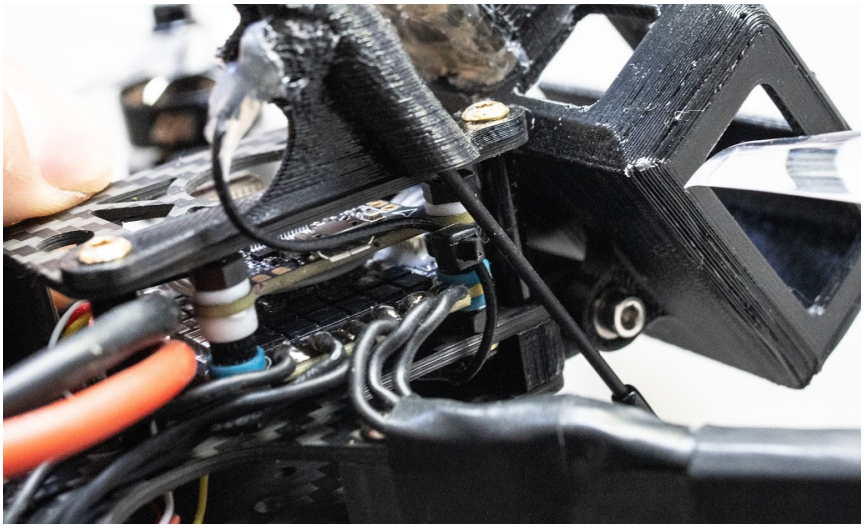
- **Last steps**
  Hot glue the camera cable to the camera pod, making sure the cable is to the side of the top plate. This is so that the wire doesn't get pinched if you tilt too far back.



Also hot glue the wires down in front of the stack so they don't get caught in the props.



Zip tie the cable to the Immortal T antenna to the front standoff of the stack. This is so that it doesn't get caught or gets in contact with the wires off the ESC



Optional hot glue on the Immortal T as strain relief for the cable to the antenna.

Make sure to focus your fpv camera. To do that, look at the picture from it, and turn the lens until the image is the sharpest. You can use a focus chart to help you with that, and turn the sharpness down in the in-camera menu. Make sure to tighten the lens down once the lens is focused.

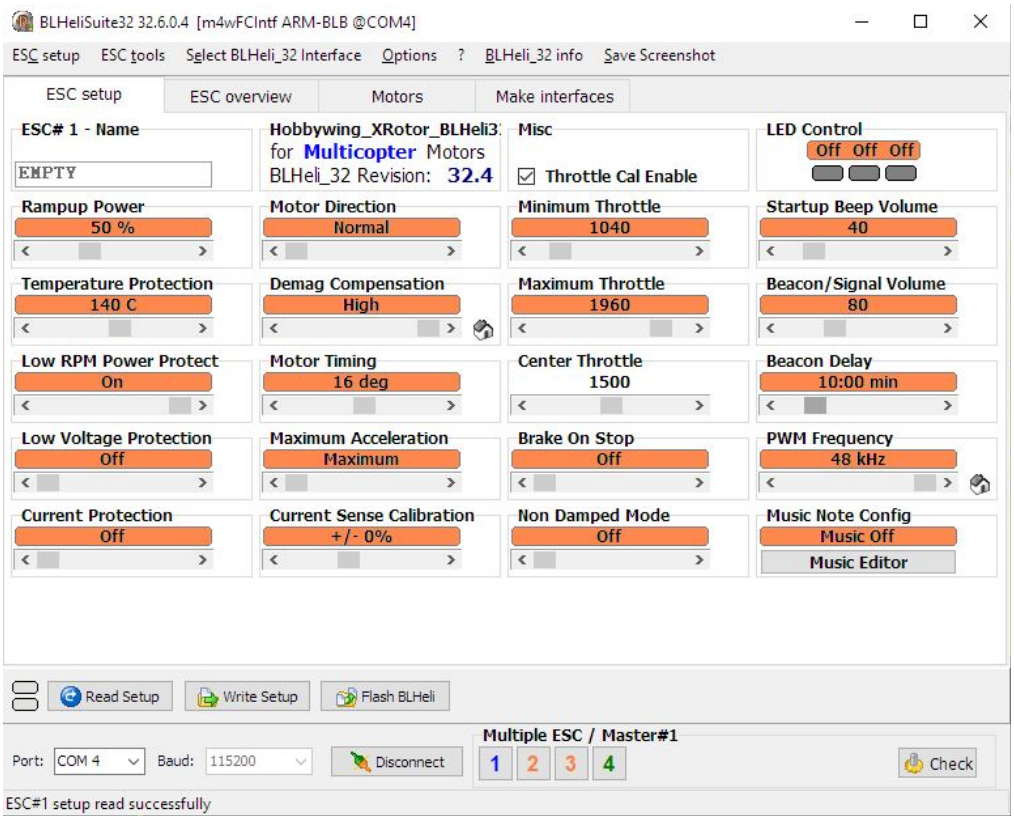
Well done! The build part is complete.

5. Configuration

Don't put any props on yet!

- **Binding** Un-screw the camera pod to access the nano RX. Power your transmitter up. Put the transmitter in bind mode, power the drone up and then press the button on the nano rx. You may get a blinking red light if the rx needs to be updated. Follow instructions on the crossfire module. Once the aircraft is bound you should get a solid green light. See the crossfire manual for more details on updating and binding.
- **Crossfire setup** On your crossfire module, in the nano rx menu, in the output map set the first out to CRSF TX, and in the Channel map, set channel 8 to LQ.
- **Betaflight setup** There is a diff for betaflight 3.5.1. At the end of this manual. Go to the CLI tab, and then copy-paste this into there. Type save, and then hit enter. This should save all my parameters to the flight controller. Using this config, arm is on aux 1, angle mode is on aux 2, and aux 3 serves to activate the motor beeps and turtle mode. Please consult a betaflight guide for more details about configuring the drone and the OSD. If you are using a newer firmware, just copy over the PID's and program the rest yourself. Crossfire is on RX3, smartaudio on RX6, Set RSSI to Aux4, and the current meter calibration is 175.
- **Radio configuration** in case you haven't used the radio before, using the dump, arm is on aux 1, angle mode is on aux 2, and aux 3 serves to activate the motor beeps and turtle mode.
- **BLheli32 setup** In betaflight, go to the motors tab, and make sure that the props rotate props out (top right and bottom left clockwise, and bottom right and top left counter-clockwise). If a motor is running in the wrong direction, you can fix that in the BlHeli32 software. Please consult a tutorial for it to find out how.

Set up the rest of the parameters of the esc using the parameters off this next picture.



- **VTX unlocking** To access higher output powers, you will need to unlock the unify VTX, please consult its manual on instructions for that.

You can now test the aircraft on the ground without props. Test the video and radio link, motor directions. When you are certain that everything is correct and as it should be, you can take it out for a test flight, good luck!

6. Pre-flight preparation

Pre-flight checklist

A bunch of things should be done before every flight. Especially when you are trying to get a shot!

- Props are tight, and rotating in the correct direction. Check hubs for cracks and blades for kinks. Replace as necessary
- Battery strapped on tight, battery leads tucked in and out of props way

- Quick visual check of screws, nothing should be loose
- FPV antenna is tight and not touching the carbon plates
- Lenses for the FPV camera and GoPro are clean
- GoPro settings are correct

Regular maintenance

Between shooting sessions, it is important to complete some basic checks

- Check all the motor and structural screws, they may loosen over time
- Check motor wires for cuts or prop strikes. Isolate as necessary, carbon is conductive, no exposed wire should touch the carbon
- Visual check of electronics, solder points and wires (those may weaken just behind the solder points with impacts)
- Check antennas. The wire to the immortal T can get snagged by branches. Replace as necessary
- Check all carbon parts for cracks. Replace as necessary
- Motor check. If necessary, clean the motors with water, and dry them after. Make sure there is no dirt or dust on them. Look for scratches or dents. Rapidly spin the motors by hand to make sure the bearings are still in good condition and the shaft and bell are still straight. Your motors are the part that generates all the vibrations on the drone, and also the first to take a hit in case of crashing so you want to make sure they stay in good condition. In case of doubt replace motor.

7. Flying tips

- ## Rate mode vs. auto-level

  As a beginner, it is easy to want to use the auto-levelling feature. While it helps you get started if you haven't flown a drone before, I highly recommend making the switch to full acro (or rate) mode as soon as possible. It will give you a better sense of control of the aircraft and make you a better pilot.

- ## When do I land?

  6s batteries have 6 cells, each ranging in voltage from 3.3Volts (absolute lowest voltage that should never be exceeded with risk of damaging the cells) to 4.2Volts (Maximum rated voltage, above which they may spontaneously catch fire), with the storage charge being 3.85V. So your full battery voltage should be around 25 V, and the storage voltage around 23V. To know when to land the drone, the best is to look at the mAh draw, shown on the OSD. It is best to land the drone while leaving at least 20% of the battery's capacity. For a 1300 battery, land once you reach 1000mAh, and for for an 1800, land when you go past 1400mAh drawn on the OSD. Another sanity check is to look at the voltage, if your Voltage goes below 22V during hover, you should land the drone immediately. This is especially important to know if you for example plug in a battery that isn't quite full.

- ## Framing and camera angles

  One of the key differences between filming and flying for fun is framing. You shot needs to tell a story, and that is the whole premise of the Ichabod Jr. The fpv camera has the same angle as the GoPro, but that doesn't mean that everything you see in the fpv feed gets recorded on the GoPro. If you choose a 16:9 form factor for example, the top and bottom of your screen will not be recorded on the GoPro. This is where the BrainFPV Radix comes in. In the OSD, find its 'HD frame' feature under Brainfpv>HDFrame. It allows you to create a box to match your particular GoPro's field of view. You may need to increase the x scaling

of the OSD. You will find it under brainfpv>OSD. The feature is called OSD X SC, I have it set to 8, to allow the frame to be set up properly.

FPV camera view:

Gopro view:

○ Long range flying

Flying distances is one of those tricky things. While you open up a whole world of possibilities to explore, you do not want to lose your equipment or litter. I would only recommend this to more experienced fliers. Here are few things to keep in mind:

- Make sure that everything on the drone is in good condition, run through the checklists once or twice to make sure she's reliable as can be

- Video link: make sure to use at least 1 directional antenna on the receiver, you may want to bump up the output power a bit, to 200mW or 500mW
- Control link: I'd recommend a directional antenna, and perhaps a bump to 500mW output power, depending on the environment. Keep in mind that holding your transmitter antenna at such output power close to the receiver may fry it. Be cautious.
- When flying, turn around a few times as you go farther away to make a mental map of the area to find yourself again when you are on the way back. Turn around at half battery at the latest. Leave yourself room in case of headwind or just to make sure you find yourself again.
- Make yourself a mental map of the terrain, the drone needs to stay in direct line of sight at all times, so you need to know how the hills go and where the drone is. Do not dip it behind trees hills or rocks at a distance. As you go twice farther away, your signal reduces by a factor 4! In case of doubt, stay high.

8. GoPro settings

GoPros are great filming tools. Super high resolutions, great frame rates, just press the button and go, and be confident that the footage is on there. However, there is a whole art to make GoPro footage looking like a more expensive camera. Some basic settings can help you get along a bit, but ultimately you will also need to learn a few things about manual settings for cameras to get the most out of them. GoPros have manual settings but they aren't very practical to use.

Basic settings for post-processing flexibility:

- **Protune on -** Pre-requisite to tune the settings yourself
- **White balance: native -** Makes sure the GoPro doesn't tint the footage for you dynamically while you fly. Native works pretty well all round, and you can tune it later on if needed.
- **Sharpness: Medium -** GoPro sharpness can be gnarly, medium works alright

- **Color: Flat -** Best if you like colour grading, otherwise use GoPro colour
- **Iso min: 100, Iso max: 400 -** A general setting that should work for most things, no questions asked
- **Shutter: Auto**
- **Ev comp: -0.5** This helps to make sure the camera doesn't over expose highlights
- In broad daylight I would recommend using an ND16 and in the afternoon/evening an ND8. I would recommend the type that replaces the front glass element of the GoPro.

Advanced settings
The more advanced user will want to control the shutter speed of the camera. This ultimately gives you control over the amount of motion blur in the final footage, but also makes sure that the camera doesn't use super fast shutter speeds, which can lead to jitter or even worse, jello footage. This gets worse if any of the props or motors are damaged.
1/60th shutter speed will give you a very strong amount of motion blur, while 1/480th will give a sharp image, while avoiding jitters.
You will probably need an ND16 during daytime, and an ND8 in the evening/morning to expose the shot correctly..

As with all things, I would recommend testing your different settings before actually going out on a shoot!

○ Stabilization

While fpv drones have come a long way in terms of improved flight handling in the past years, the only reliable way to obtain cinematic footage in all conditions is to stabilize the footage. Having a great PID tune or setup helps a lot in creating great raw footage, but at the end of the day, the camera is directly mounted to a piece of carbon with 4 props spinning at tens of thousands of rpm. Uses in wind, different pressures, humidities and altitudes makes it impossible to have 1 settings to make raw footage perfect. So here are a few solutions:

- **GoPro hero 7 + Hypersmooth** The hero 7 black's hypersmooth is very impressive, even very shaky footage comes out very clean, with minor issues. Out of all the solutions, it is the only one where great stable footage comes straight out of the camera ready to be used in an edit, and you can usually rely on it no matter the conditions. One main drawback, is that it crops in a constant 10%, which means it uses less of the sensor, lowering the final quality. It also isn't available in all the resolution/framerate combinations that you may need, and sometimes introduces slight jitters in very slow panning motions. A tiny amount of warp stabilizer can usually fix anything coming from hypersmooth though.
- **Reelsteady** Reelsteady is the absolute best stabilization software for fpv drones. Its smoothness and tunability is absolutely unmatched among other options. The output videos compensate for the fisheye effect in the Gopro, and only crop in a minimum amount, leaving a result that is wider angle and smoother than Hypersmooth. It does unfortunately come in a bit pricey, requires an after effects license, takes a lot of time to work with and also has a bit of a steep learning process. The expert user will pull great benefits from it though.
- **Gopro hero 6 + ReelsteadyGO** New on the market, ReelsteadyGO outputs footage that's as amazing as Reelsteady, for a fraction of the price and a fraction of the render time. It looks at the gyro trace stored in each file recorded by GoPros. The stabilization is done by a standalone program which is super fast and fairly tunable. Its main drawback at the moment is that the gyro traces aren't consistent across different GoPro models. The GoPro 5 and 7's gyro traces are much more sensitive to high frequency noise from drones and requires a lot of dampening. The Hero6 works great on the Ichabod though. My current go-to solution.
- **Warp stabilizer and similar** Stabilization softwares that are built into video editors are usually fairly simple to use and give good results for some things. While they won't be as smooth as reelsteady, they can help take out some of the edge off rough control inputs. I'd recommend setting the stabilization mode to

position/rotation/scale, and stick to stabilization amounts below 10%.

9. Betaflight dump

```
# version
# Betaflight / RADIX (RADIX) 3.5.1 Sep  9 2018 / 14:02:06 (bae853125) MSP API: 1.40

board_name RADIX
manufacturer_id

# name

# resources

# mixer

# servo

# servo mix


# feature
feature -RX_PPM
feature RX_SERIAL
feature AIRMODE

# beeper

# beacon
beacon RX_SET

# map

# serial
serial 2 64 115200 57600 0 115200

# led
```

```
# color

# mode_color

# aux
aux 0 0 0 1700 2100 0 0
aux 1 1 1 1700 2100 0 0
aux 2 13 2 1300 1700 0 0
aux 3 35 2 1700 2100 0 0

# adjrange

# rxrange

# vtx

# rxfail

# master
set baro_hardware = NONE
set rssi_channel = 8
set serialrx_provider = CRSF
set motor_pwm_protocol = DSHOT1200
set ibata_scale = 175
set yaw_motors_reversed = ON
set small_angle = 180
set osd_vbat_pos = 2456
set osd_rssi_pos = 2394
set osd_tim_1_pos = 376
set osd_tim_2_pos = 2424
set osd_flymode_pos = 65
set osd_crosshairs_pos = 205
set osd_current_pos = 2432
set osd_mah_drawn_pos = 2400
set osd_craft_name_pos = 362
set osd_warnings_pos = 265
set osd_avg_cell_voltage_pos = 76
set brainfpv_hd_frame_mode = 1
set brainfpv_hd_frame_width = 155
set brainfpv_hd_frame_height = 74
set brainfpv_hd_frame_h_offset = 2
set brainfpv_hd_frame_v_offset = 2
```

```
# profile
profile 0

set dterm_notch_cutoff = 0
set anti_gravity_gain = 8220
set p_pitch = 71
set i_pitch = 80
set d_pitch = 32
set p_roll = 52
set i_roll = 65
set p_yaw = 86
set i_yaw = 90

# rateprofile
rateprofile 0

set roll_rc_rate = 50
set pitch_rc_rate = 50
set yaw_rc_rate = 50
set roll_srate = 80
set pitch_srate = 80
set yaw_srate = 80
```