Birdbone Plus Instructions

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Updates:

V1.1: Added requirement/link to carbon fiber drill bit in parts list and step #7 (ordinary drill bits delaminate and weaken the tubing).

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The Birdbone Plus is a very fast, lightweight, rugged, 3d printable, plus configuration freestyle/race FPV quadcopter frame that can accommodate 4", 5", and 6" props. It uses standard 8mm O.D. carbon tubing for arms. Cut the tubes to length as-needed for your props.

I developed the frame using ABS and SemiFlex. Other materials will likely work very well. Typical weights for a 6" prop configuration are 75 grams for the printed components and tubes, and around 25 grams for all the mounting hardware.

Much of the hardware below is available at hardware stores.

PARTS LIST:

Arris 8mm O.D. 3K tubing (Amazon ASIN: B00TF8UY9A)
Fine toothed hacksaw blade (and a hacksaw)
(Qty=8) #4 x 3/4" length thread forming screws (McMaster P/N 92295A109)
(Qty=20) M3 x 12mm length screws (McMaster P/N 92095A183)
A 3/32" drill bit specific for drilling carbon fiber (McMaster P/N 2828A71)
(Qty=8) 4 x 3/8" pan head sheet metal screws (McMaster P/N 90190A108)
35mm long standoffs (Amazon ASIN: B071NFCP8W)
(Qty=4) M3 x 22mm (McMaster P/N 92095A473)
(Qty=4) M3 x 8mm (McMaster P/N 92095A181)
Optional (depends on electronics:
Nylon standoffs (McMaster P/N's 94639A702 and/or 94639A706)

INSTRUCTIONS:

1. Print the lower frame components. I currently use Hatchbox ABS (Amazon ASIN: B00J0H1QNY) with 2 layer walls and 15% honeycomb infill.

2. Print the camera mount. I currently use NinjaTek Semiflex with 2 layer walls and 20% honeycomb infill. SainSmart TPU may also work well (Amazon ASIN: B00TI3JUTM) - I'll try it soon.

3. Use a fine toothed hacksaw to carefully cut 8mm O.D. carbon tube to the desired lengths for your props. I highly recommend Arris 3K tubing (Amazon ASIN: B00TF8UY9A). For 6" props and a mild-stretch configuration, I cut a 500mm Arris tube into two pieces (240mm for the spanwise tube, and 260mm for the forward/aft tube).

4. Center the tubes within the upper and lower body components, and screw them together using (qty=8) #4 x 3/4" length thread forming screws (McMaster P/N 92295A109). Only moderate torque is required for these - do not overtighten.

5. Mount your motors. Note the difference between the upper and lower motor mounts (the upper has a larger hole in the center to accommodate the motor spindle). I developed this frame using some old SunnySky X2207S-14, 2100 kV motors. Sandwich each tube end between the upper and lower motor mounts, and use (qty=4 per motor) M3 x 12mm length screws to attach the motor (McMaster P/N 92095A183). Torque bolts evenly and use only a moderate amount of torque - do not overtighten.

6. IMPORTANT: Before drilling (steps 7 and 8), double check that all motors are perfectly aligned and snug, and all tubes are centered with respect to the body components. Think twice, cut once.

7. Use a 3/32" drill bit specific for drilling carbon fiber to drill holes through the center of each lower motor mounts, and into the tubes. Do not drill all the way through the opposite sidewall of the tube. Just drill through the near sidewall of the tube. FYI: A typical drill bit will wear out very quickly and cause delamination when used to drill carbon fiber.

8. Use the 3/32" drill bit to drill holes through the four inner-most holes in the lower body, and into the tubes. Same as step 7: Do not drill all the way through the opposite sidewall of the tube. Just drill through the near sidewall of the tube.

9. Secure the lower motor mounts and lower body to the tubes using (qty=8) 4 x 3/8" pan head sheet metal screws (McMaster P/N 90190A108) into all the drilled holes. Use moderate torque - do not overtighten.

10. Mount four M3 standoffs to the upper body corners using (qty=4) M3 x 12mm length screws (same screws as the motors: McMaster P/N 92095A183). I currently use 35mm long standoffs (Amazon ASIN: B071NFCP8W), but adjust length as needed for your own electronics stack.

11. Add your FC/PDB/4-in-1 ESC stack. I currently use a Sunrise Cicada 4-in-1 30a BLHeli_S ESC with a Matek Mini Power Hub PDB and an RMRC Dodo v3b FC. For mounting I currently use (qty=4) M3 x 22mm (McMaster P/N 92095A473) and a bunch of nylon standoffs (McMaster P/N's 94639A702 and sometimes 94639A706). Alter as needed for your electronics.

12. Add your VTx. I currently use a TBS Unify Pro HV with NinjaTek Semiflex mounts by Thingiverse user CamCopter (thing:2468587). Screw your antenna onto the camera mount. I currently use Anbee antennas (Amazon ASIN: B00LGMTTPI).

13. Add your FPV camera. I currently use a RunCam Swift 2 (Amazon ASIN: B01N9ZJX9N).

14. Configure your electronics, and mount your props, etc. For a receiver I currently use a LemonRx diversity unit, mounted to the underside of the camera mount, with two zip ties extending on either side of the aft portion of the camera mount (see pics). Fasten the camera mount to the standoffs using (qty=4) M3 x 8mm (McMaster P/N 92095A181).

15. Go Fly.