ASSEMBLY INSTRUCTION MANUAL

Aero-Persistence Research

WARNING: THIS PRODUCT IS NOT A TOY

WING SPAN: 1060 mm

TYPHOON 4D

R/C ELECTRIC POWERED HYBRID AIRPLANE

SPECIFICATIONS

Wingspan: 1060 mm (41.7 in) **All-up weight:** 1578 g (3.5 lb) **Battery**: Li-Po 3 cells, 3000 mAh
Wing Loading: 76.2 g·dm^{-2} (24.98 oz·ft^{-2}) **Primary motor:** 450/360 class heli, max. 650 W
Radio: 9 proportional channels or more **Target user:** Intermediate / expert

IMPORTANT

Read through this manual before starting construction. It contains important instructions and warnings concerning the assembly and use of this model aircraft.

Table of Contents

1. Introduction

Thank you very much for purchasing the zip file which contains the 3D-printable parts and other useful resources for constructing the Typhoon 4D.

The Typhoon 4D is an advanced 4D flyer that can be built using a combination of additive manufacturing, the Gaui X3 rotorhead mechanics and other components available from hobby shops. With its patent pending design, the innovative electric-powered Typhoon 4D gives you the joy and thrill of hovering nose-down with precision roll control.

The typhoon 4D is a suitable platform to explore the realm of the unexplored 4D aerobatics including tic-tocs around the lateral and vertical axes. You may also try the 'bomberang' maneuver in which the aircraft performs a flat pirouette while traveling forwards. The flying wing with straight-wing configuration has zero flight control surfaces which makes building the kit quick and easy. A wing span of 1060 mm makes it adequately compact to be transported without having to remove and re-install the wings, giving the convenience of essentially plugging in the battery and fly.

The 3D-printable files supplied in the zip file are in the popular STL format that you can readily send to your printer. The kit has been ingeniously designed so that you can successfully 3D-print the components using single material without having to resort to supporting material or worrying about overhangs. The delight of building the kit doesn't just stop there. The wings are to be constructed with ease and high degree of accuracy using our ezWingLoft™ technique.

Last but not least, we hope the Typhoon 4D will rekindle the joy of the good old days that comes from building a quality kit except this time with the advent of 3D-printing.

2. Model specifications*

Wingspan: 1060 mm (41.73 in)

Wing chord: 230 mm

Wing area: approx. 20.7 dm^2 (320.85 in^2)

All-up weight (AUW): 1578 g (3.5 lb)

* In Line with our continuous improvement policy, specifications are subject to change without notice.

Wing loading: approx. approx. 76.2 g·dm^{-2} (24.98 oz·ft^{-2})

Overall width: approx. 1500 mm (59.06 in), incl. wingtip rotors

Overall length: approx. 328 mm (12.91 in)

Battery: Li-Po 3 cells, 3000 mAh

Target user: Intermediate / expert

Main motor: Requires a motor designed for 450/360 class heli, max. 650 W

Radio requirements: Requires 9 to 10 proportional channels, or 8 proportional channels with an Arduino® signal processor (refer to the Arduino® folder for details)

Gyro system: Futaba CGY750 is recommended (this would require a S-Bus receiver). Alternatively, any FBL gyro system with 3 independent gains can be used

3. Liability Disclaimer

This product should not be considered a toy and it is intended to be assembled and operated by experienced radio controlled (RC) aircraft pilots with intermediate to expert level of experience.

Whilst every effort is taken to avoid errors, Aero-Persistence Research cannot accept responsibility for the accuracy of any statement, extract or information contained within the pages of this manual. Mention of any other organization or website does not imply approval or warranty as to their standing or capability.

We shall have no liability for any losses or damages which may be suffered by you whether the same are suffered directly or indirectly or are immediate or consequential in connection with the zip file purchased from our website in any way or in connection with the use or inability to use the digital content of the zip file including but not limited to loss or damage due to viruses or any other malicious code.

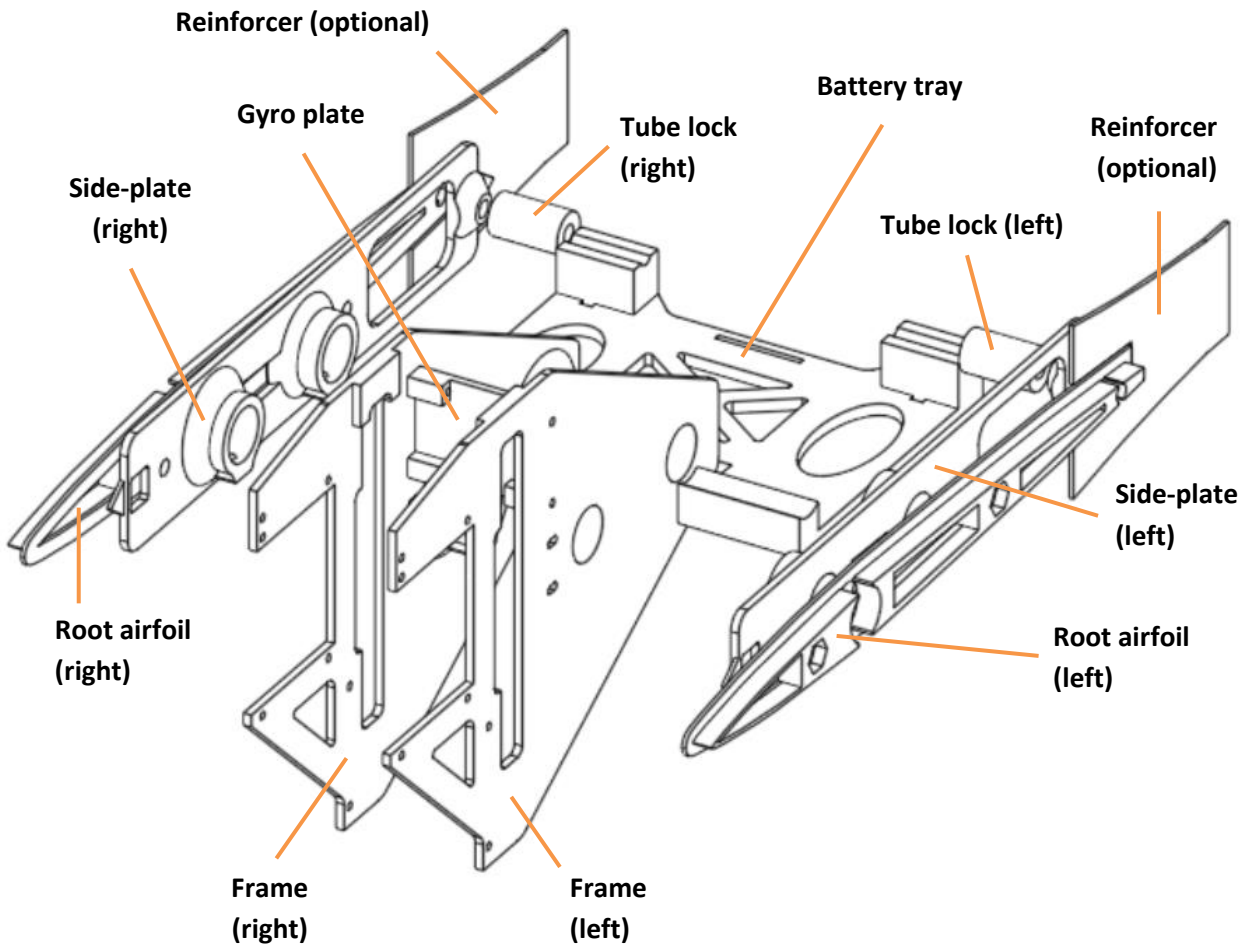
The purchase and download of the zip file entitles you to unlimited personal use of all digital files contained therein. Unauthorized copying or distribution of the digital file(s) including its/their derivative(s) is prohibited. Derivative(s) of the digital file(s) include tangible entity manufactured by any means including additive manufacturing and CNC machining.

As Aero-Persistence Research has no control over the assembly or material used for the manufacturing, no liability shall be assumed nor accepted for any damage resulting from the use

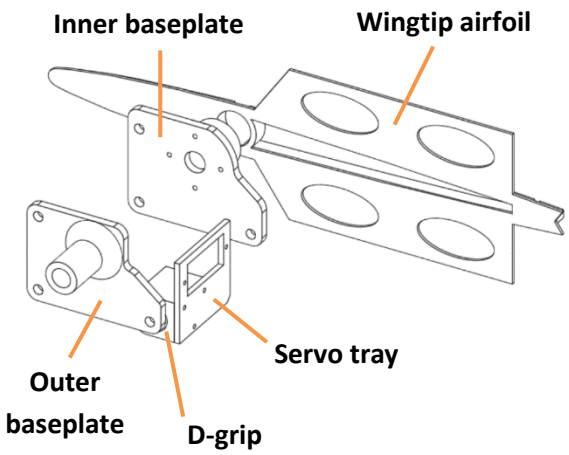
by the user of the user-assembled product. By the act of accessing the digital content of the zip file or using the user-assembled product, the user accepts all resulting liability.

4. Content of the zip file

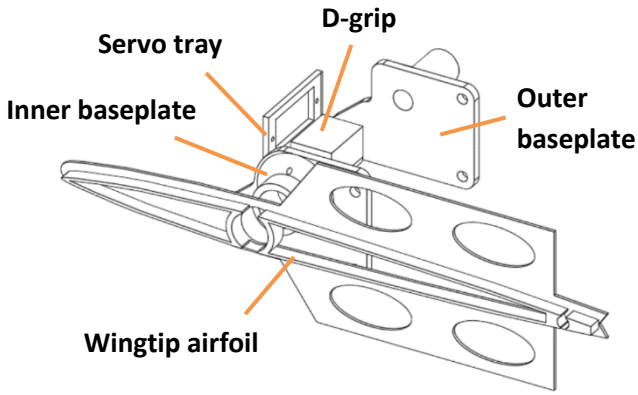
4.1 Fuselage section



4.2 Wingtip sections

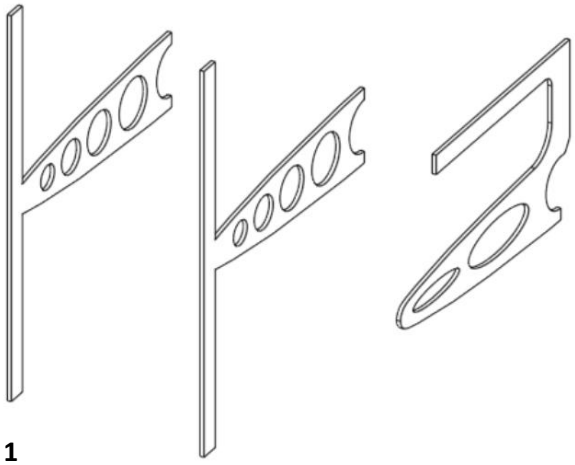


(Left)



(Right)

4.3 Alignment tools

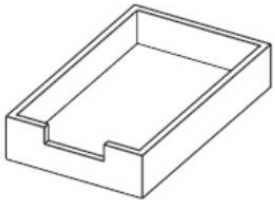


1

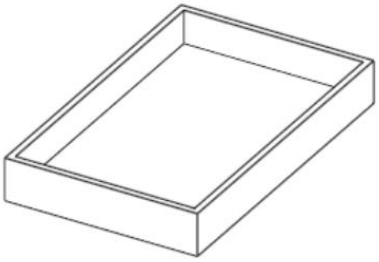
2

3

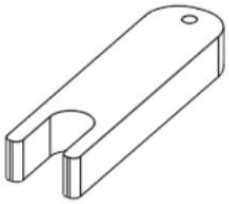
4.4 Miscellaneous



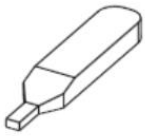
Protective tray for Teensy 2.0



Protective tray for Maestro

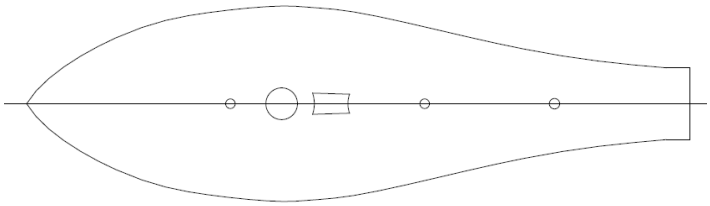


APR swashplate leveler for X3

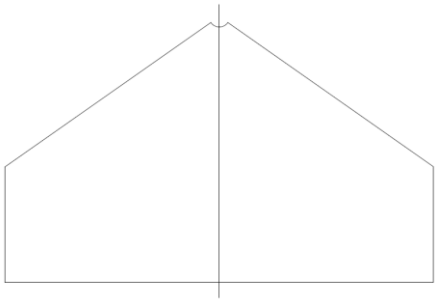


APR custom screwdriver for CGY750

4.5 Templates in PDF and DXF formats



Fuselage sidewall



Winglet

4.6 Arduino source code (only required for 8-channel receiver)

The model aircraft requires at least 9 proportional channels. If using 8-channel radios, the included Arduino source code can be uploaded to Teensy 2.0 board to obtain the necessary number of channels. See the Arduino folder for details.

5. Items required to complete the model (based on the prototype)

Fuselage:

- □ Parts listing for the Gaui X3 rotorhead mechanics:
  - Servo Mount Bearing Cap http://www.gaui.com.tw/product/x3-body/servo-mount-bearing-capfor_x3/
  - Bearing(2x5x2.5) http://www.gaui.com.tw/product/bearing/bearing2x5x2-5x3/
  - X3 Main Shaft Servo Mount **(quantity required: 2)** http://www.gaui.com.tw/product/x3-body/x3-main-shaft-servo-mount/
  - X3 Main Shaft Third Bearing Mount http://www.gaui.com.tw/product/x3-body/x3-main-shaft-third-bearing-mount/
  - X3 Front Bevel Gear Mounting Block http://www.gaui.com.tw/product/x3-body/x3-front-bevel-gear-mounting-block/
  - X3 CF Divider http://www.gaui.com.tw/product/x3-body/x3-cf-divider/
  - X3 Main Gear Hub http://www.gaui.com.tw/product/x3-body/x3-main-gear-hub/
  - X3 Crown Gear Hub with One Way Sleeve http://www.gaui.com.tw/product/x3-body/x3-crown-gear-hub-with-one-way-sleeve/
  - X3 131T Main Drive Gear http://www.gaui.com.tw/product/x3-body/x3-131t-main-drive-gear-x2pcs/
  - X3 Swashplate Guide http://www.gaui.com.tw/product/x3-body/x3-swashplate-guide/
  - 9T Aluminum Pinion Gear (for 3.17mm shaft) http://www.gaui.com.tw/product/x3-body/9t-aluminum-pinion-gearfor-3-17mm-shaft/
  - X3 Motor Mount (Silver) http://www.gaui.com.tw/product/discontinue-list/x3-motor-mount-silver/

    OR

    - X3 Motor Mount (Type B) http://www.gaui.com.tw/product/x3-upgrade/x3-motor-mount-type-b/
  - GS-311 Metal Gear Digital Servo **(quantity required: 3)** http://www.gaui.com.tw/product/special-sale/guec-gs-311-metal-gear-digital-servo/
  - RJX FBL 363mm Carbon Fiber Main Blades https://hobbyking.com/en_us/rjx-fbl-363mm-carbon-fiber-main-blades-for-flybarless-heads.html

- □ Screw Grub Hex M3x3mm https://hobbyking.com/en_us/grub-screw-set-m3x3-10pc.html
- □ Screw Grub Hex M3x4mm https://hobbyking.com/en_us/grub-screw-set-m3x4-10pc.html
- □ Depron® sheet (5 mm thick)
- □ Nylon XT60 Connectors Male/Female https://hobbyking.com/en_us/nylon-xt60-connectors-male-female-5-pairs-genuine.html
- □ RotorStar Brushless Outrunner Helicopter - 2839-3600kv https://hobbyking.com/en_us/rotorstar-brushless-outrunner-helicopter-2839-3600kv-450-size-heli.html
- □ Nylon Thumbscrew Wing Bolt M4x20 https://hobbyking.com/en_us/nylon-thumbscrew-wing-bolt-m4x20-10pcs.html
- □ .156'' (4mm) OD x 48'' Carbon Fiber Solid Rod (SKU: R-10A) (required length: approx. 122 mm) https://store.acpsales.com/products/2372/carbon-fiber-solid-round-rods

  OR

  - K&S Precision Metals Aluminum Stock Tube 4mm OD x 0.45mm x 1000mm (required length: approx. 122 mm) https://hobbyking.com/en_us/round-alum-tube-4mm-od-x-45mm.html

Wings:

- □ Depron® sheets (3 mm thick, dimensions: 450 x 462 mm) **(quantity required: 2)**
- □ Depron® sheet (5 mm thick)
- □ Hex-nuts M4 10pc https://hobbyking.com/en_us/hex-nuts-m4-10pc.html
- □ .156'' (4mm) OD x 48'' Carbon Fiber Solid Rod (SKU: R-10A) https://store.acpsales.com/products/2372/carbon-fiber-solid-round-rods

  OR

  - K&S Precision Metals Aluminum Stock Tube 4mm OD x 0.45mm x 1000mm https://hobbyking.com/en_us/round-alum-tube-4mm-od-x-45mm.html

Wingtip rotor units:

- □ HexTronik 24gram Brushless Outrunner 1300kv **(quantity required: 2)** https://hobbyking.com/en_us/hextronik-24gram-brushless-outrunner-1300kv.html

- □ YEP 30A (2~4S) SBEC Brushless Speed Controller **(quantity required: 2)** https://hobbyking.com/en_us/hobbyking-yep-30a-2-4s-sbec-brushless-speed-controller.html
- □ 3M Gyro Mounting Pad (3pcs/bag) https://hobbyking.com/en_us/3m-gyro-mounting-pad-3pcs-bag.html
- □ M3.5 x 65mm Stand-offs With Clearance **(quantity required: 2 packs)** https://hobbyking.com/en_us/m3-5-x-65mm-stand-offs-with-clearance.html
- □ Screw Socket Head Hex M3.5 x 15mm (10pcs) **(quantity required: 2 packs)** https://hobbyking.com/en_us/m3-5-x-15mm-hex-head-screw-10pcs.html
- □ Self Tapping Screw M2x8mm Phillips Head **(quantity required: 1 pack)** https://hobbyking.com/en_us/self-tapping-screw-m2x8mm-phillips-head-100pcs.html
- □ Copper Drive Shaft Connector http://www.sdshobby.com/rc-boat-accessories/drive-system/cooper-drive-shaft-connector-motor-shaft-collect-2-2-3-3-4mm-to-2-3-3-17-4-5mm-with-screws-for-rc-electric-boat-car-and-robot.html
- □ Turnigy High Quality 18AWG Silicone Wire 2m (Red) https://hobbyking.com/en_us/turnigy-high-quality-18awg-silicone-wire-2m-red.html
- □ Turnigy High Quality 18AWG Silicone Wire 2m (black) https://hobbyking.com/en_us/turnigy-18awg-siliconewire-black-2m.html
- □ 45cm Servo Lead Extension (JR) with hook 26AWG (5pcs/bag) **(quantity required: 1 pack)** https://hobbyking.com/en_us/45cm-servo-lead-extention-jr-with-hook-26awg-5pcs-bag.html
- □ 10cm Servo Lead Extension (JR) 26AWG(10pcs/bag) **(quantity required: 1 pack)** https://hobbyking.com/en_us/10cm-servo-lead-extention-jr-26awg-10pcs-bag.html
- □ Assault 450L Flybarless 3D Helicopter Complete CNC Tail Rotor Gearbox Assembly **(quantity: 2)** https://hobbyking.com/en_us/assault-450l-flybarless-3d-helicopter-complete-cnc-tail-rotor-gearbox-assembly.html
- □ PolyMax 3.5mm Gold Connectors https://hobbyking.com/en_us/polymax-3-5mm-gold-connectors-10-pairs-20pc.html
- □ ES08MD 13g Mini Metal Digital Servo **(quantity required: 2)** https://www.emaxmodel.com/es08md.html

- □ Linkage Stopper **(quantity required: 1 pack)** https://hobbyking.com/en_us/linkage-stopper-m3x2xl11-2mm-10pcs-set.html
- □ Assault 450 DFC - Tail Blade (4pcs) **(quantity required: 1)** https://hobbyking.com/en_us/assault-450-dfc-tail-blade-4pcs.html
- □ Assault 450L TT Flybarless 3D Helicopter Torque Tube **(quantity required: 1)** https://hobbyking.com/en_us/assault-450l-450dfc-tt-flybarless-3d-helicopter-torque-tube.html
- □ Assault 450DFC TT & Belt Flybarless 3D Helicopter Tail Rotor Control Pushrod https://hobbyking.com/en_us/assault-450dfc-tt-belt-flybarless-3d-helicopter-tail-rotor-control-pushrod.html

Radio equipment:

- □ FrSky TFR8 SB 8ch 2.4Ghz S.BUS Receiver FASST Compatible https://hobbyking.com/en_us/frsky-tfr8-sb-8ch-2-4ghz-s-bus-receiver-fasst-compatible.html
- □ Futaba 3-Axis Flybarless Control System (CGY750) https://www.futabarc.com/gyros/futm0836.html
- □ If using 8-channel RX: Teensy 2.0 https://www.adafruit.com/product/199 ()
- □ Optional: Micro Maestro 6-Channel USB Servo Controller (Assembled) https://www.pololu.com/product/1350

Battery pack:

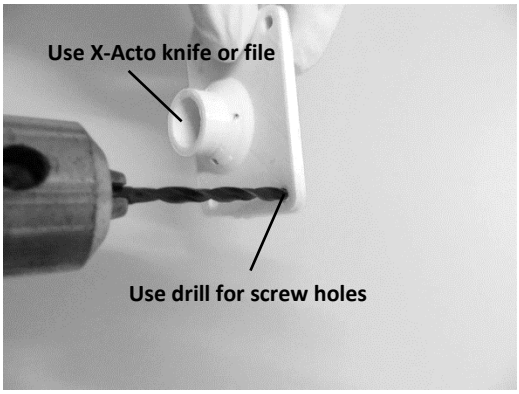
- □ ZIPPY Flightmax 3000mAh 3S1P https://hobbyking.com/en_us/zippy-flightmax-3000mah-3s1p-20c.html

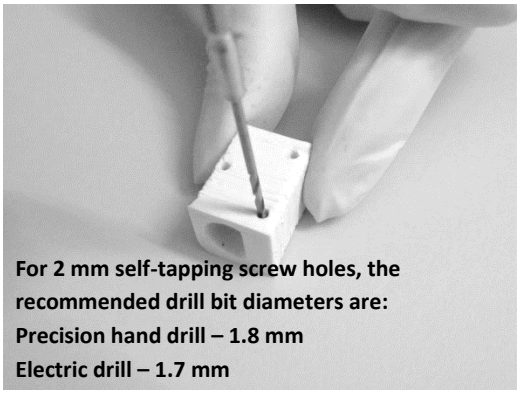
6. Essential things to know before starting to build

In a few instances the parts shown in the photos may be slightly different from those described in the instructions. In those cases, please follow the written instructions.

6.1 Refinement of 3D printed parts prior to use

Unlike CNC machining, there is often a need to "touch-up" 3D printed parts prior to use. It probably a good idea to tidy up screw holes using drill bits, and for parts involving tubing inserts use an X-Acto knife or a rounded file. **Warning: wear protective gears** e.g. **eye protection** and **gloves** when performing this task. Screw holes for M3 grub screws can be tidied up using 2.6 / 2.7 mm drill bits prior to use.





We understand that a given 3D printed part may come out slightly differently depending on the materials used, possible thermal effects and characteristics of individual 3D printer. The prototype of this model was built using PLA. If you find that the diameters of the parts are too small (or too large) for the wing / fuselage sleeves to go through and substantial amount of material needs to be removed, you may like to first verify the calibrations of your 3D printer. If the problem still persists, do feel free to email us at rc@aero-persistence.com, stating the required offsets and we will do our best to accommodate your requests and send you the updated files.

6.2 Templates for the fuselage sidewalls and winglets

The templates for the fuselage sidewalls and the winglets are included in the zip file and can be conveniently printed out on a piece of A4 paper whenever needed. Make sure to select "actual size" during printing in order to obtain the correct dimensions. The templates in DXF format are also included.

6.3 Choice of material for the wing tubes / sleeves

Both fiberglass or aluminum tubings can be used as the wing sleeves for this model aircraft, each offering its own advantages. Thus, a decision should be made prior to the start of building. Fiberglass has greater strength, but it is also heavier in general. Another significant difference is that aluminum is much easier to be dented and so that joints involving sleeve tubings can be held in place with grub screws. For the harder fiberglass tubings, grub screw would have to be used to make a mark on the surface of the tubing and the required recess can be made by drilling. The prototype used fiberglass sleeves on its wings and fuselage together with a matched fiberglass wing tube. The tubings were held in place with M3x4 mm grub screws for the first couple of flights after which, CA adhesive was applied to critical joints. While use of CA ensures a reliable joint with very little inspection required, it also means that these parts cannot be taken apart easily. In short, use of grub screws enables practical serviceability but also requires a more frequent inspection for mechanical integrity.

The followings are the recommended wing tube-sleeve pair that can be used to build the model aircraft based on either fiberglass or aluminum:

Fiberglass

.417'' (10.59mm) ID x.505'' (12.83mm) OD x 54'' (SKU: TU-04B)

.337" (8.56mm) ID x .414" (10.52mm) OD x 54" (SKU: TU-03B)

https://store.acpsales.com/products/2347/filament-wound-fiberglass-tubes

Aluminum

K&S Precision Metals Aluminum Stock Tube 13mm OD (SKU: 815000073-0) https://hobbyking.com/en_us/round-alum-tube-13mm-od-x-45mm.html

K&S Precision Metals Aluminum Stock Tube 12mm OD (SKU: 815000072-0) https://hobbyking.com/en_us/round-alum-tube-12mm-od-x-45mm.html

7. Building the wingtip rotor units

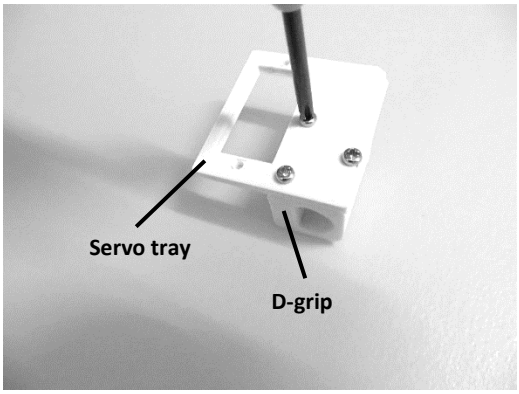


Fig. 7.1

Join the servo tray to the D-grip using three self-tapping screws (size: 2 x 8 mm).

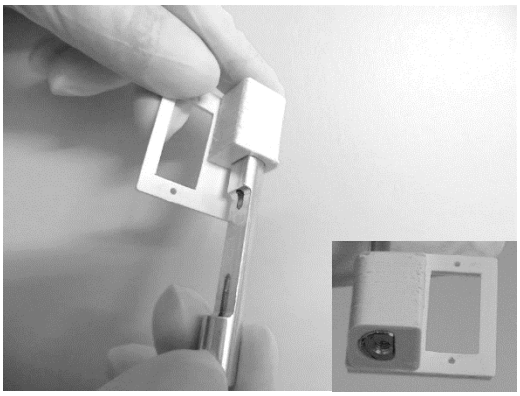


Fig. 7.2

Insert a 65 mm standoff into the D-grip, making sure that their surfaces are flush (as shown in the inset).

Fig. 7.3

Glue the D-grip to the standoff using CA or epoxy resin.

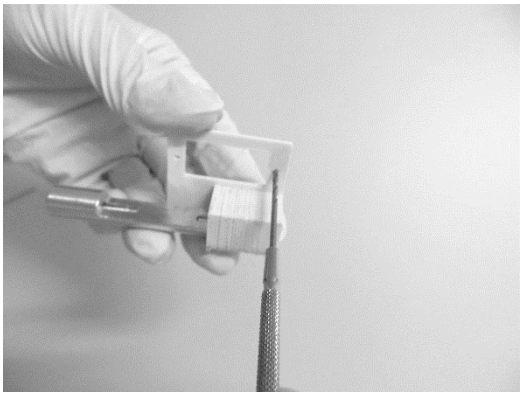


Fig. 7.4

Refine the screw holes on the servo tray using 1.8 mm drill bit. It is recommended to use 1.7 mm drill bit if you are using electric drill.

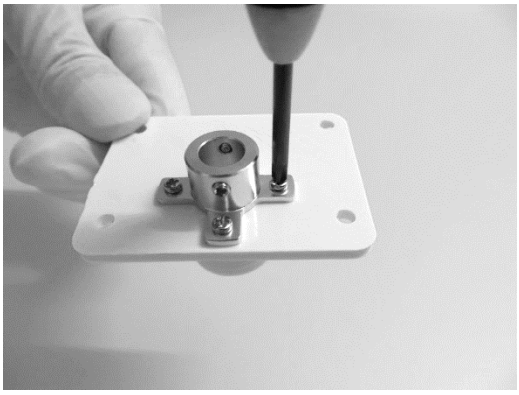


Fig. 7.5

Secure the motor mount onto the inner baseplate using self tapping 2 x 8 mm screws.

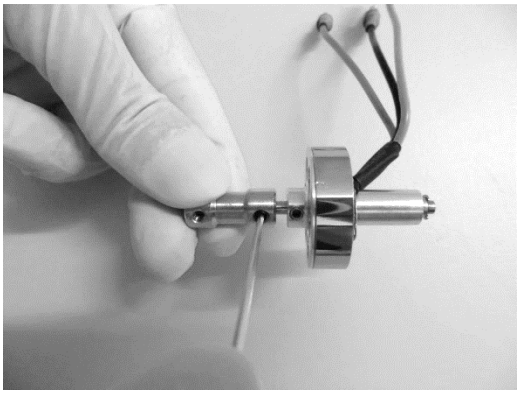


Fig. 7.6

Secure the coupler to the motor shaft. **NOTE:** coupler of coaxial collet type with suitable length and diameters may also be used.

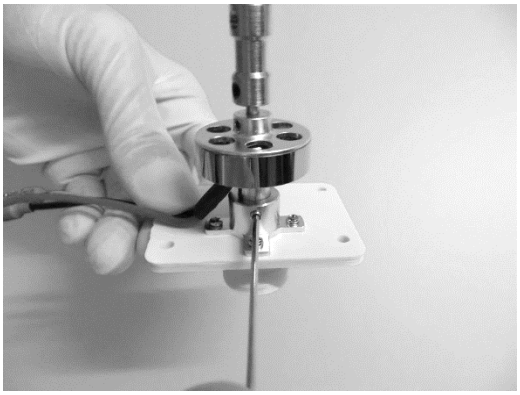


Fig. 7.7

Secure the motor to the motor mount. It may be a good time to check for undesirable vibration at this stage. Exercise excessive care while the motor is running.

Fig. 7.8

Install the 65mm stand-offs (3 pieces) and secure them using the M3.5 x 15 screws.

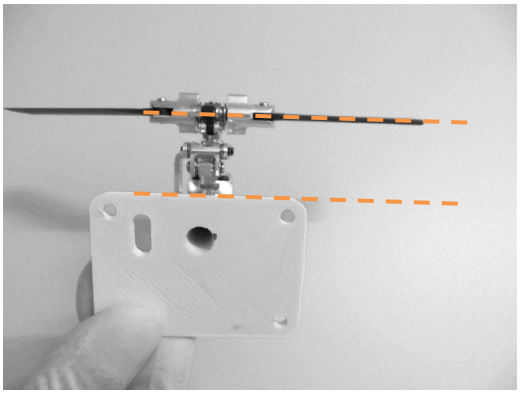


Fig. 7.9

Insert the Assault 450 tail rotor assembly into the outer baseplate. The fitting should be snug for a secure fit when the screws are fully tightened. Also, make sure that the rotor is parallel with the edge of the outer plate as shown. Refer to the Assault 450's manual for proper installation and maintenance of the tail rotor assembly.

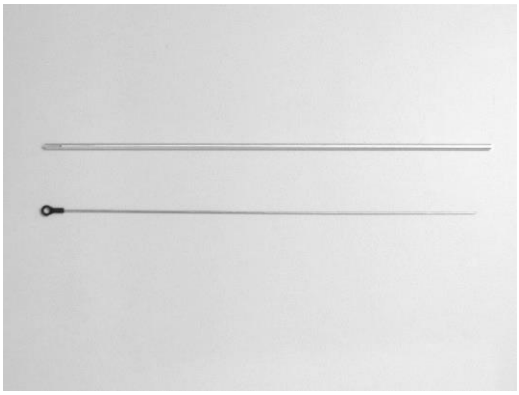


Fig. 7.10

Cut the drive shaft and the pushrod to the correct lengths.

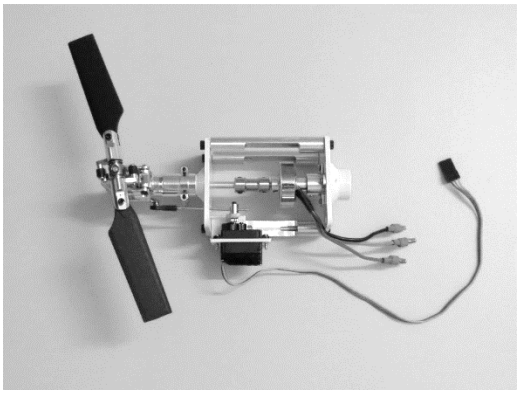


Fig. 7.11

The completed wingtip rotor unit with the servo installed. The pushrod is connected to the servo using the link-stopper. Temporarily power up the unit to make sure that everything is working fine. If excessive vibration is present, verify that the drive shaft is co-axial with respect to the coupler.

8. Building the wings

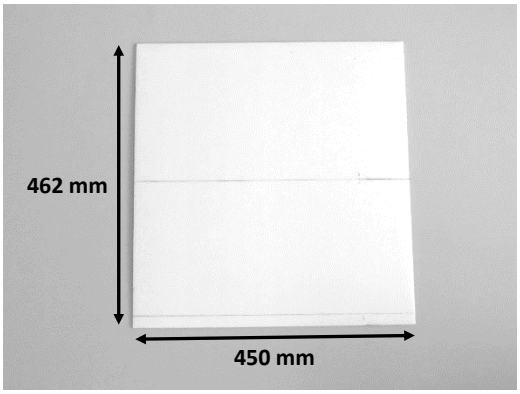


Fig. 8.1

Cut out the wing skin on a 3 mm thick Depron®. See the supplied DXF file for measurement details. The centerline is where the leading edge is going to be. The 15 mm width region along the trailing-edge is for gluing purpose.

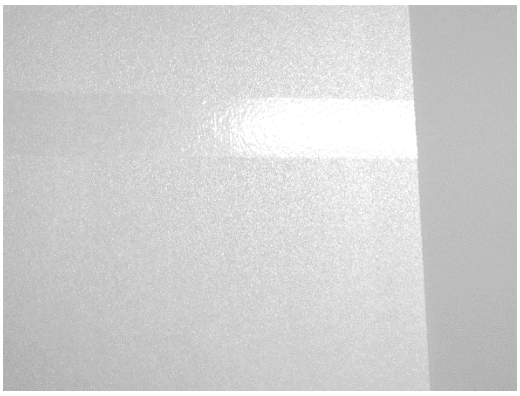


Fig. 8.2

You may wish to reinforce the region along the centerline prior to folding especially if the foam sheet is non-Depron®. To do so, turn the wing skin over and apply masking tape (width: about 40 mm) along the leading-edge line.

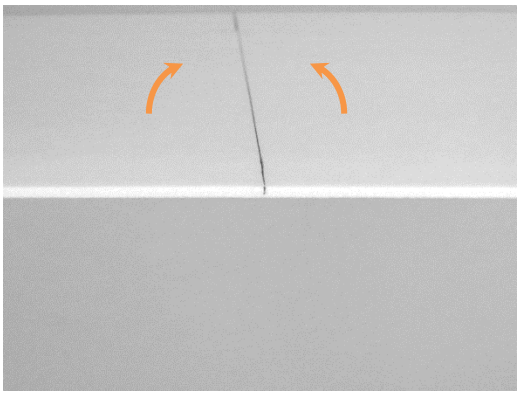


Fig. 8.3

Use a pizza roller and make a groove along the leading-edge line as shown. Now, fold the foam sheet inwards along the line as indicated by the arrows. It should fold cleanly and symmetrically along the line.

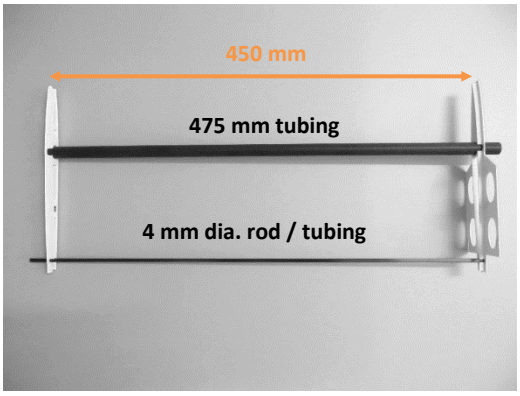


Fig. 8.4

This is the right wing. Arrange the main components as shown. As the Depron® skin is 450 mm in width, use a ruler or the skin itself to get the correct placement of the wingtip rib.

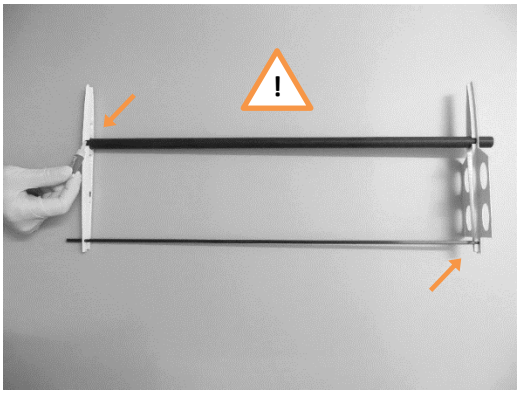


Fig. 8.5

Once the dimensions are correct, apply small amount of CA glue at positions indicated by the orange arrows to lightly hold the ribs in position.

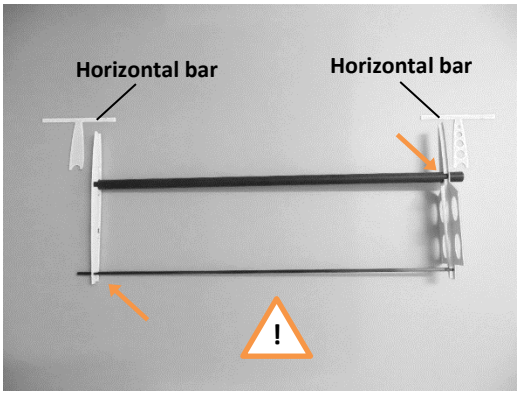


Fig. 8.6

You may use the supplied alignment tools to fine tune the angular positions of the two ribs so that both the horizontal bars are parallel to each other when viewed across the wing. This helps ensure that the wing is warp-free. Once done, use the wing skin to do a final check to make sure that the lengthwise dimensions are accurate and apply CA glue at positions indicated by the orange arrows.

Fig. 8.7

Press the M4 nuts into the root airfoil rib. Apply a small amount of CA or epoxy to securely hold the nut in position.

Fig. 8.8

Test fit the skin to the wing to verify that everything fits well. Next, apply 5 to 10 mins epoxy to **ONLY one side** of the wing surface (**either** top or bottom). Apply epoxy along the two ribs, on the primary and secondary tubings. **NOTE: DO NOT** apply adhesive to the **trailing-edge region** at this time.

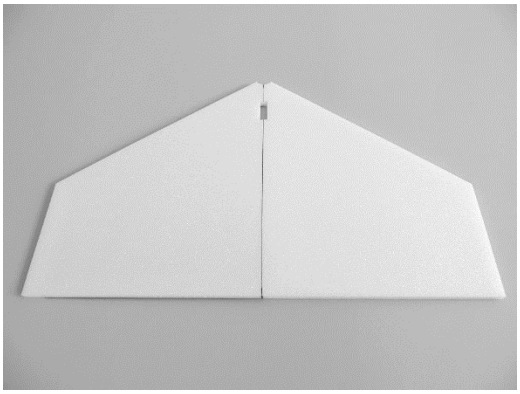


Fig. 8.9

Cut out the winglet on 5 mm Depron® using the supplied PDF template (in A4 paper size) and preferably include the centerline for easy alignment purpose, though it does not need to extend all the way to the front.

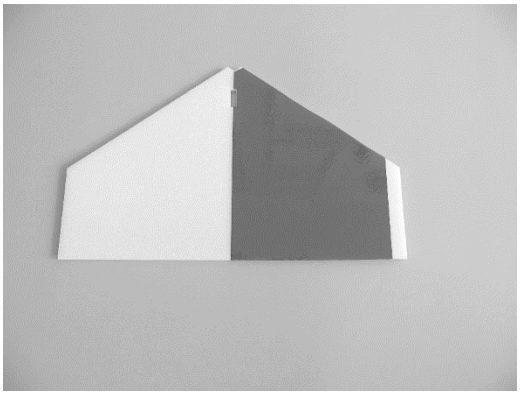


Fig. 8.10

You may find that it is easier to apply decal to the winglet before joining it to the wing. Apply decal on the winglet surface without the centerline.

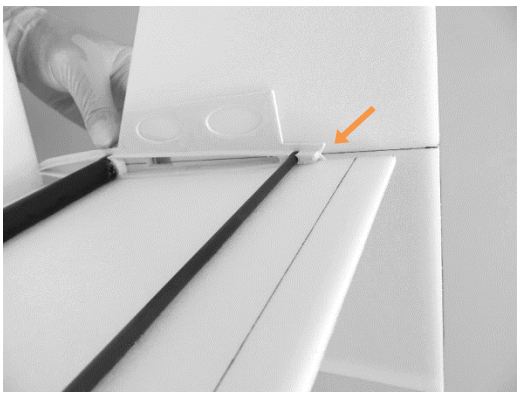


Fig. 8.11

Mount the winglet onto the wingtip using 5-minute epoxy resin. Push the winglet against the tubing and use the V-shaped marking on the trailing edge of the 3D printed rib (indicated by an arrow) and the centerline on the winglet for easy alignment.

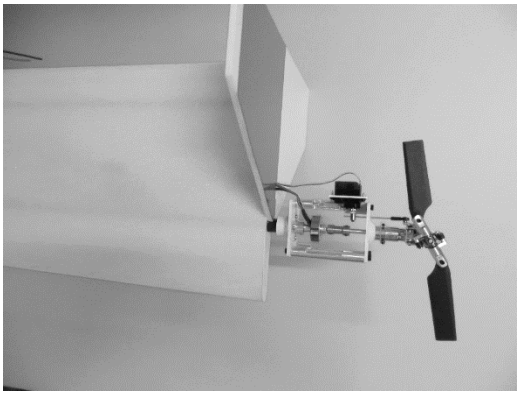


Fig. 8.12

Temporarily attach the wingtip rotor unit to the wing and route the wires through the winglet (**left wing** is shown).

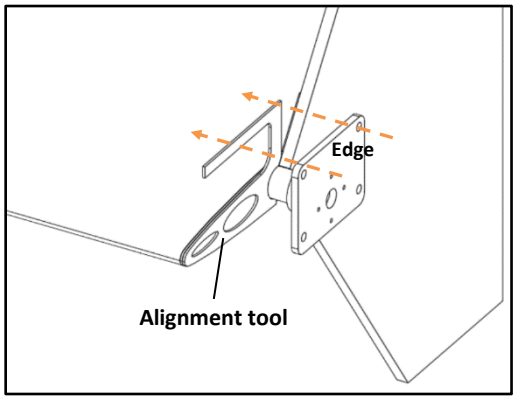


Fig. 8.13

Place the supplied alignment tool against the wingtip and visually align the long edge of the inner baseplate so that it is parallel with the horizontal bar of the alignment tool.

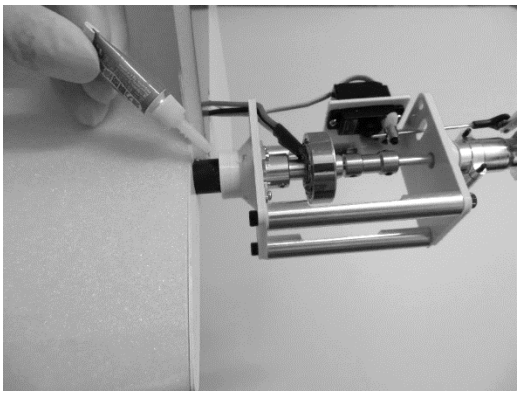


Fig. 8.14

Apply CA glue to the joint of the inner baseplate once alignment is done.

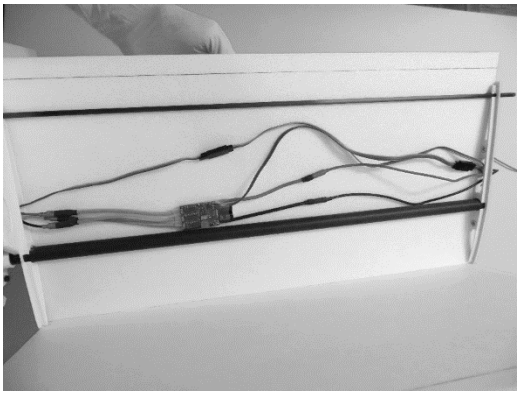


Fig. 8.15

Route the wires through the root rib, arrange the wires neatly and mount the ESC and extension connectors to the inner surface of the foam skin using double-sided tape.

Fig. 8.16

Apply epoxy resin to the ribs, wing tubes, and within the trailing edge region enclosed by the line. **IMPORTANT:** make sure to apply epoxy to the **joints** between the **ribs** and the **wing tubes** (primary and secondary) otherwise structural failure during flight may result. Apply gentle pressure to the wing surface while the epoxy cures. This completes the construction for one wing. Repeat the same process to complete the other wing.

9. Building the Fuselage

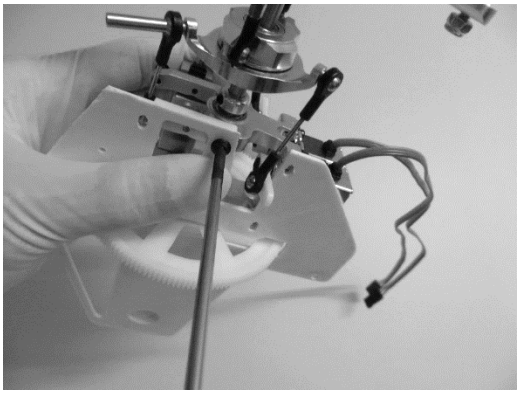


Fig. 9.1

Assemble the rotorhead mechanics according to the manufacturer. In this model, we are using the Gaui X3's. Please refer to its user manual. **NOTE:** the **crown gear** should be **omitted**. Attach the 3D printed right frame to the Gaui X3 mechanics as shown using the 2 x 8 self tapping screws that come with the X3, but do not fully tighten them yet.

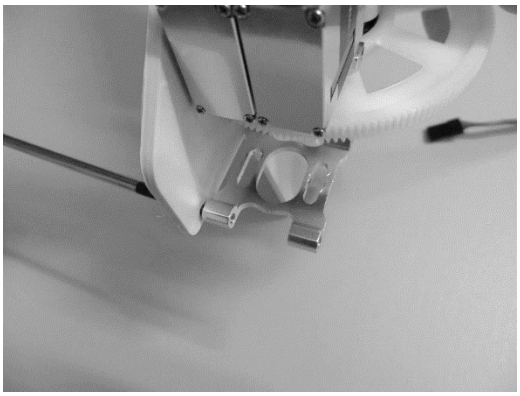


Fig. 9.2

Install the motor mount, motor, and pinion gear.

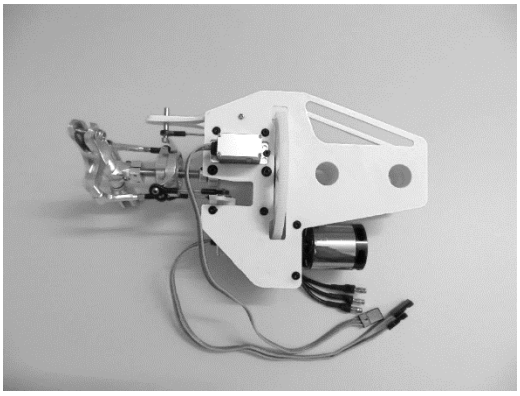


Fig. 9.3

Attach the left frame and the X3 swashplate guide to the assembly, and fully tighten the 2 x 8 self tapping screws on both sides of the hub including the M2 screws holding the motor mount. At this stage, it may be a good time to verify that the servos and power system are working properly.

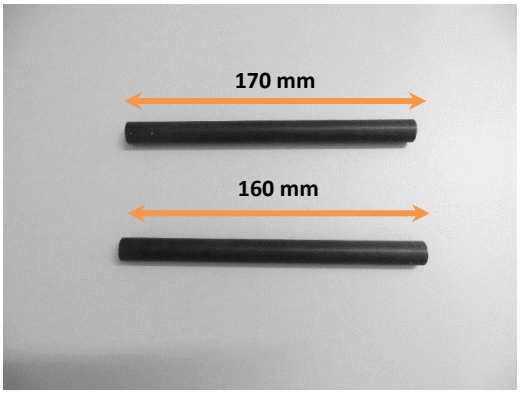


Fig. 9.4

Cut two tubes (outer diameter: 13 mm) to make the fuselage sleeves. The tube in front is to have a recommended length of 170 mm (i.e. flush with the outer fuselage surface) while the one behind is 160 mm. The 170 mm tube can be made slightly shorter to avoid interfering with the wing sleeves.

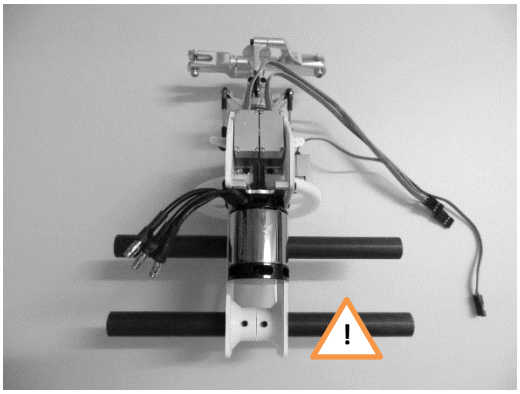


Fig. 9.5

Insert the fuselage sleeves through the frames. Once the frames have been verified to be mounted on the **center** of the sleeves, tighten the M3x4 mm grub screws. See **Section 6.2** for installation details and precautions.

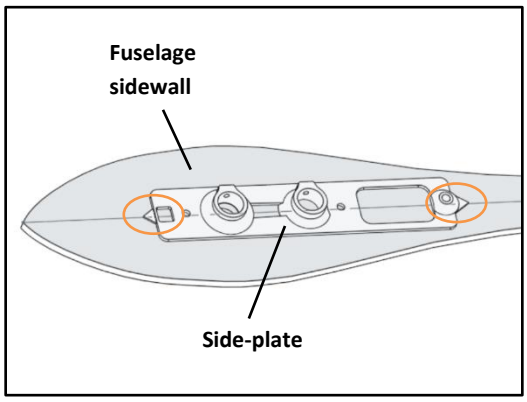
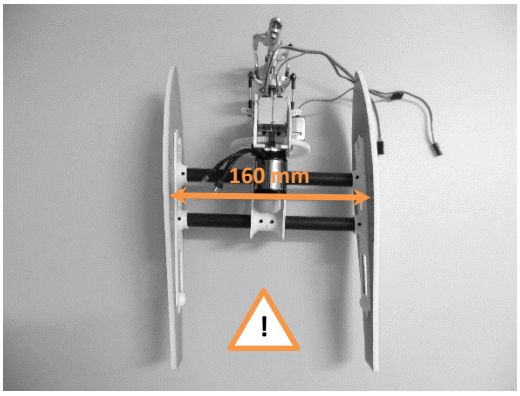


Fig. 9.6

Use the supplied PDF template (in A4 size) to cut out the fuselage sidewalls on 5 mm thick Depron® and marking the centerline.

Attach the 3D printed side-plates to the fuselage sidewalls with epoxy resin and using the two triangles on the side-plate for alignment with the centerline as shown. The distance from the tip of the triangle to the front of the fuselage is 63 mm.

Fig. 9.7



Join the frames and the fuselage sidewalls together and secure them with M3x4 mm grub screws. For added security, use CA (**see Section 6.2** for details). The distance between the fuselage sidewalls is **160 mm**, measured within the **inside** of the fuselage as shown.

WARNING: If the fuselage sleeves were to separate from the side-plates in mid-flight, catastrophic failure will result.

10. Putting them together

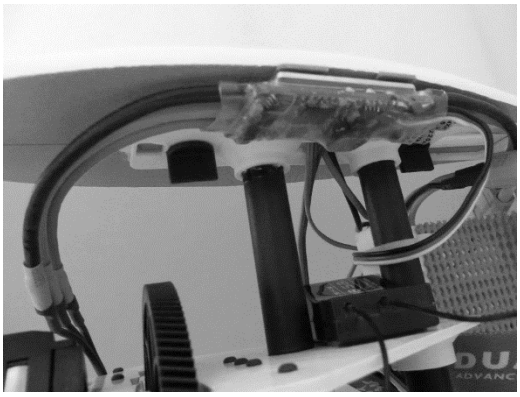


Fig. 10.1

Insert the wing tube and secure the wings to the fuselage with the wing bolts, two on each side.

The RX may be placed in the space between the sleeves depending on the dimensions of the RX. The fuselage sidewall may be a suitable place to mount the ESC.

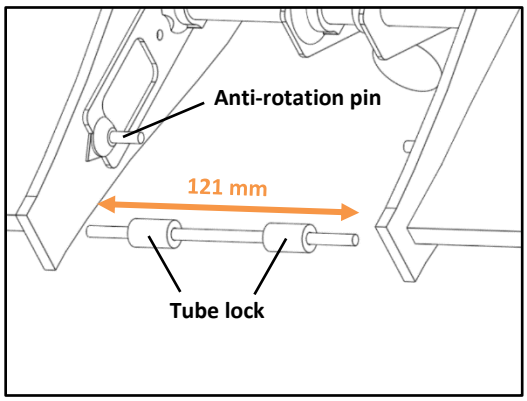


Fig. 10.2

Measure the gap between the anti-rotation pins and cut the 4 mm diameter rod / tube to fit within the gap. The length of the **rod** should be approx. **121 mm** with overall free play of about **1 mm**. Put the tube locks through the rod / tube. Each tube lock holds two M3x3 grub screws.

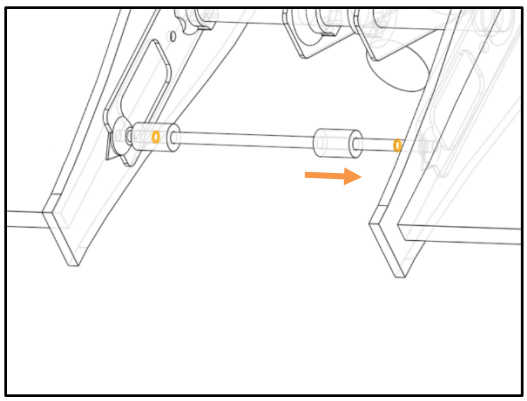


Fig. 10.3

Place the rod in the position as shown and slide the tube locks outwards so that they are centered over the gaps (highlighted in orange).

Tighten the four M3x3 mm grub screws on the tube locks.

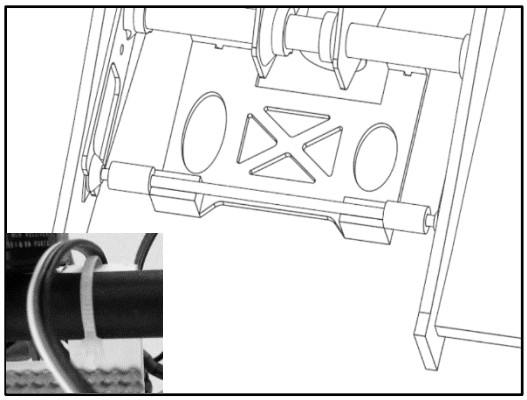


Fig. 10.4

Install the battery tray as indicated and fasten it in position using four cable ties as shown in the inset.

Fig. 10.5

Insert a Velcro strap for the battery through the slot on the battery tray, and include an anti-slip mat if preferred.

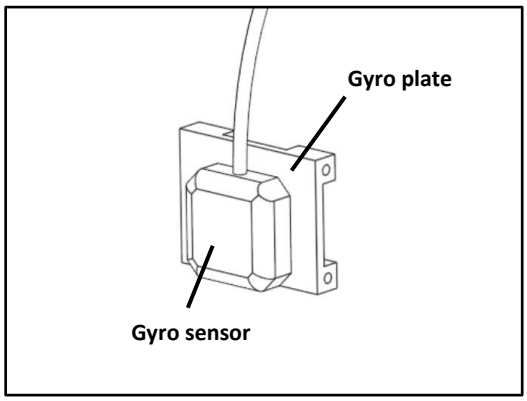


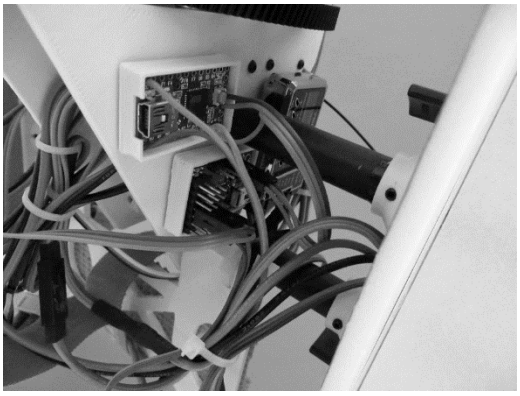
Fig. 10.6

Mount the CGY750 gyro sensor onto the gyro plate. You may find it much more convenient and accurate to mount the gyro sensor onto the plate first before bolting the assembly to the frames.

Accurate positioning of the gyro sensor can be obtained by:

1. Affix double-sided tape to the gyro plate.
2. placing both the gyro plate and the gyro sensor vertically on a table and bringing them together.

Fig. 10.7



If 8-channel proportional RX is used, a Teensy 2.0 with the supplied Arduino® source code can be used as a processor to provide the remaining one or two proportional channels. In the prototype, the Teensy 2.0 was linked with a 6-channel Maestro servo controller to reliably control the wingtip ESCs. 3D printed protective trays for the PCBs are included in the zip file. On the prototype, they were mounted on the left frame using double sided tape as shown. The control box for the Futaba CGY750 can be mounted nearby. 3D printed custom screwdriver needed to make adjustment to the control box is included.

Bundle the wires neatly using cable ties and fasten them to the frame by making use of the cable tie slot on the right frame.

11. Setup and safety precautions

11.1 Balance the model

While aircraft equipped with gyros are more forgiving in terms of their flight performance and stabilities, it is still imperative to get the balance right. To balance the model vertically, simply lift it by the rotor hub. Ideally, the base of the winglet should be parallel with the ground surface. The battery tray has been specifically designed to accept the 3000 mAh battery in the part listings or other similar form factor battery packs such that the center of mass of the battery coincides very closely with the centerline of the aircraft. With the recommended hardware and equipment as per this manual, the vertical balance should be good and the model should lift practically straight up into a hover. As for the horizontal balance, the C.G of the model should be within ±10 mm of the wing tube. Attempting to fly the model outside this range can have unpredictable characteristics.

11.2 Guides on setting up the Futaba CGY 750

Setup style (StupStyl): F3C

Swash rate (SWS.Rate), amount of base cyclic: 7 degrees

Pitch AFR (PIT.Rate): +15 degrees

IMPORTANT: The settings below for the rotations about the principal axes (i.e. **roll**, **pitch**, **yaw**) refer to those of **conventional airplane** (see https://en.wikipedia.org/wiki/Aircraft_principal_axes). If you intend to test hover the model as a helicopter, please translate them accordingly.

Dual rates

	High	**low**
Roll	55	45
Pitch	65	65
Yaw	65	50

Exponentials (negative means softer around stick center)

	High	**low**
Roll	-30%	-30%
Pitch	-30%	-30%
Yaw	-30%	-30%

Idle-up settings:

Normal: -4 to +11 degrees

Idle up 1: -11 to +11 degrees

Idle up 2*: -4 to +15 degrees

***NOTE:** to be used only for high-cruising speed

Gain (AVCS mode)

Yaw 92

Pitch 43

Roll 59

11.3 RPMs for the main propulsion and wingtip rotor units

For initial flight test, set the rpms to be as follow:

Main propulsion unit – 2300 to 2500 rpm (it is recommended to start with 2300 rpm) **Wingtip rotor units** – 9000 rpm (if using Arduino® processor, please refer to setup guidelines in the Arduino folder)

11.4 Preflight check and maintenance

Check for any damaged parts on main rotor, fuselage, wings and wingtip rotor units. Make sure that all screws are securely tightened and all parts, especially the 3D printed components are in good condition. Damaged or worn out parts should be replaced. Inspect the pinion and main gears to ensure correct gear meshing before and after each flight.

You are strongly advised to obtain membership of the governing body of model aviation in your country, such as the MAAA in Australia or AMA in the US, if you have not done so. Please abide by the safety code. This is a way to preserve the wonderful aero-modeling hobby.

12. The maiden flight

Tips for a successful first VTOL flight

Consider whether you would like to hover your Typhoon 4D as a helicopter or an aerobatic airplane for the first couple of flights. Some who frequently fly helicopters might feel more at ease to hover it as a helicopter to gain familiarization, while others might prefer to fly it as an airplane. The choice is yours. Radio transmitters such as the Futaba 10CG allow stick mode to be easily changed, which involves swapping channel 1 (ailerons) with channel 4 (rudder). After the stick mode has been changed, it is **important** to check for possible channel **reverse**. If so, reverse the channel on the transmitter.

Flight test with the prototype suggested that there is a tendency for the rotating main blades to induce a resonance prior to reaching the operating rpm. Thus, when spooling up the main rotor, spend as little time as possible around that region to avoid the resonance. If resonance does occur, throttle back and try again. With the recommended gain settings in **Section 11.2**, your Typhoon 4D should lift off smoothly into a hover.

Wishing you an awesome 4D experience and happy VTOL!

Best regards

Aero-Persistence Research