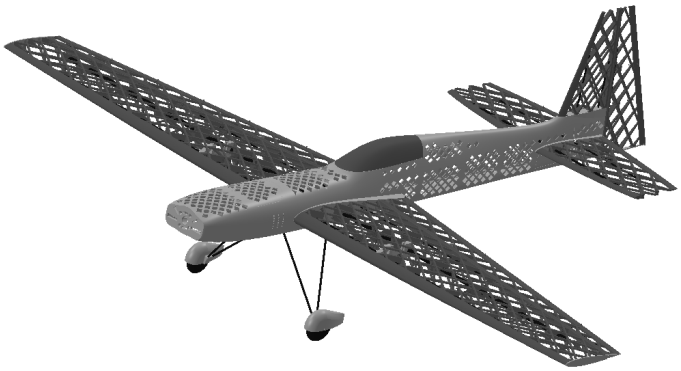
KRAGA

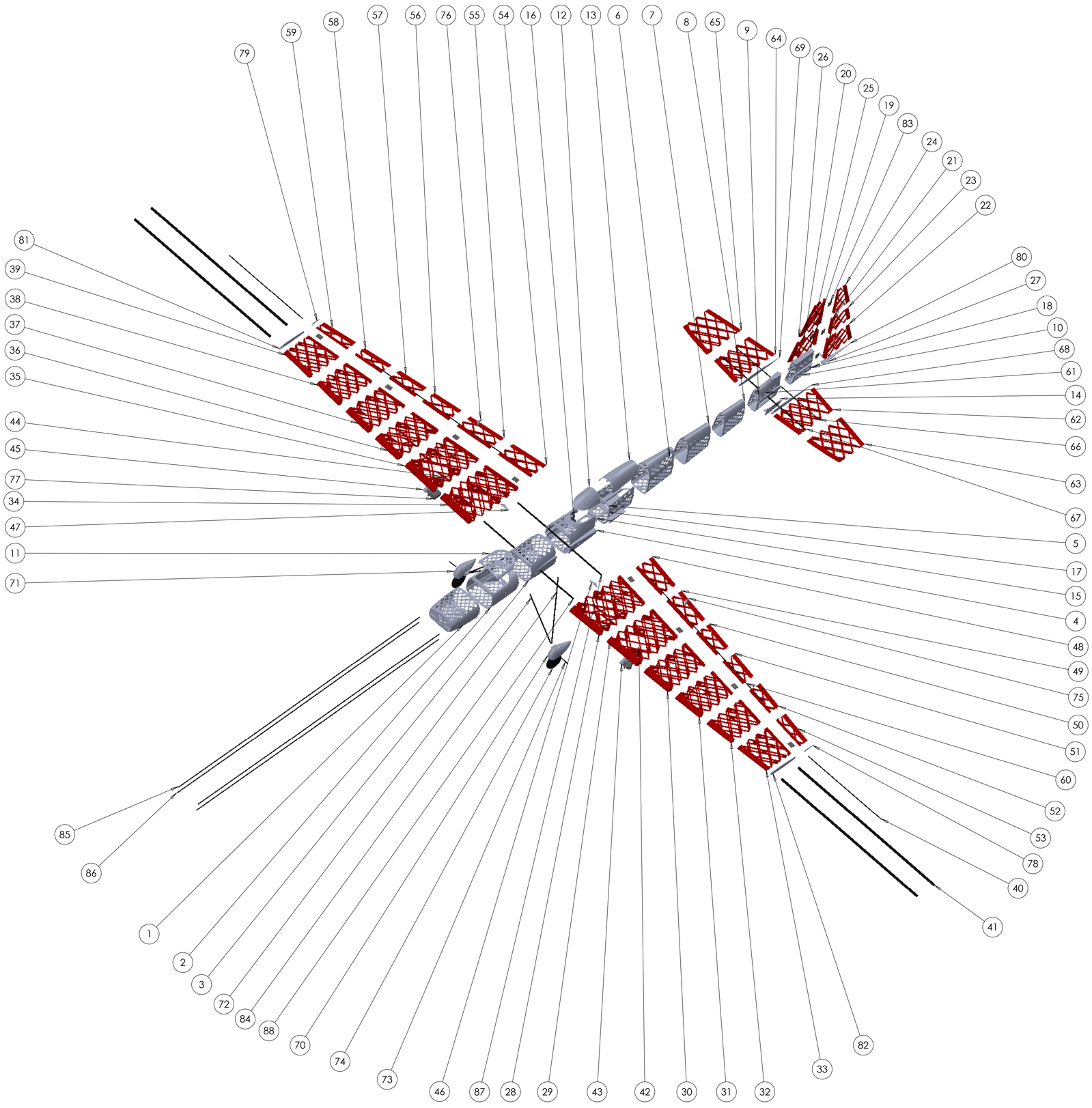
Maripi build guide 1.3



Please do not share files that you bought

Development of a new plane and support of the old ones is very time consuming. Only with your help I can focus fully on this project and spend some quality time with my family.

support@kragamodels.com



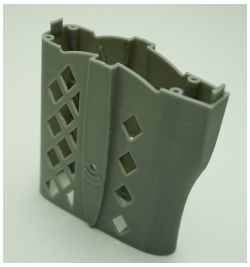
KRAGA MARIPI

ITEM NO.	PART NAME	PRINT AS	QTY.
1	fuse_0_SK3_35xx	SOLID	1
2	fuse_1	SOLID	1
3	fuse_2	SOLID	1
4	fuse_3	SOLID	1
5	fuse_4	SOLID	1
6	fuse_5	SOLID	1
7	fuse_6	SOLID	1
8	fuse_7	SOLID	1
9	fuse_8	SOLID	1
10	fuse_9	SOLID	1
11	canopy_front	SOLID	1
12	canopy_middle_0	SOLID	1
13	canopy_middle_1	SOLID	1
14	canopy_tail	SOLID	1
15	servo_plate_hs_65	SOLID	1
16	fuse_servo_plate_spar_2x1_68	-	1
17	fuse_servo_plate_spar_back_2x1_51	-	1
18	tail_leg_spar_2x1_80	-	1
19	ver_stab_main_b_spar_2x1_80	-	1
20	ver_stab_main_f_spar_2x1_97	-	1
21	ver_stab_mov_spar_2x1_165	-	1
22	ver_stab_b_0	SHELL	1
23	ver_stab_b_1	SHELL	1
24	ver_stab_b_2	SHELL	1
25	ver_stab_f_0	SHELL	1
26	ver_stab_f_1	SHELL	1
27	ver_stab_horn	SOLID	1
28	wing_L_0	SHELL	1
29	wing_L_1	SHELL	1
30	wing_L_2	SHELL	1
31	wing_L_3	SHELL	1
32	wing_L_4	SHELL	1
33	wing_L_5	SHELL	1
34	wing_R_0	SHELL	1
35	wing_R_1	SHELL	1
36	wing_R_2	SHELL	1
37	wing_R_3	SHELL	1
38	wing_R_4	SHELL	1
39	wing_R_5	SHELL	1
40	back_wing_spar_2x1_245	-	2
41	main_wing_spar_6x4_454	-	4
42	servo_mount_wing_L_B	SOLID	1
43	servo_mount_wing_L_F	SOLID	1
44	servo_mount_wing_R_B	SOLID	1
45	servo_mount_wing_R_F	SOLID	1
46	wing_hook_L	SOLID	1
47	wing_hook_R	SOLID	1
48	aileron_L_0	SHELL	1
49	aileron_L_1	SHELL	1
50	aileron_L_2	SHELL	1
51	aileron_L_3	SHELL	1
52	aileron_L_4	SHELL	1
53	aileron_L_5	SHELL	1
54	aileron_R_0	SHELL	1
55	aileron_R_1	SHELL	1
56	aileron_R_2	SHELL	1
57	aileron_R_3	SHELL	1
58	aileron_R_4	SHELL	1
59	aileron_R_5	SHELL	1
60	aileron_spar_2x1_436	-	2
61	hor_stab_ctrl_arm	SOLID	1
62	hor_stab_L_0	SHELL	1
63	hor_stab_L_1	SHELL	1
64	hor_stab_R_0	SHELL	1
65	hor_stab_R_1	SHELL	1
66	hor_stab_control_spar_2x1_284	-	1
67	hor_stab_pivot_spar_3_284	-	1
68	hor_stab_inner_endcap_L	SOLID	1
69	hor_stab_inner_endcap_R	SOLID	1
70	shoe_L	SOLID	1
71	shoe_R	SOLID	1
72	landing_leg_spar_3_145	-	2
73	wheel_shaft_23	-	2
74	wheel_45	-	2
75	aileron_horn_L	SOLID	1
76	aileron_horn_R	SOLID	1
77	servo_common	-	2
78	aileron_endcap_L	SOLID	1
79	aileron_endcap_R	SOLID	1
80	ver_stab_endcap	SOLID	1
81	wing_L_endcap	SOLID	1
82	wing_R_endcap	SOLID	1
83	hinge	-	11
84	landing_leg_back_spar_3_161	-	2
85	fuse_spar_2x1_8582	-	2
86	fuse_spar_2x1_8622	-	2
87	wing_joiner_rod_4_280	-	1
88	wing_joiner_rod_4_300	-	1

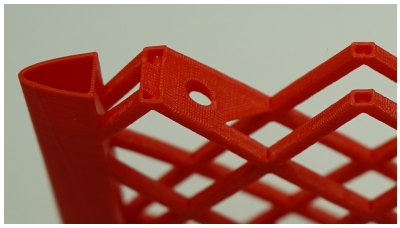
Printing

You need to use two printing methods to print all parts:

1. Solid parts (fuse and accessories - all grey parts). Use dense (100%) infill. This is common way of printing objects and these parts should be printable on every printer.



2. Shell parts (wings - all red parts). Use 0% infill and no horizontal surfaces (thickness of the shell is one layer). Only this way you can achieve required weight of the plane.



You can check what method to use on what part in bill of materials table.

Nozzle size: 0.4 mm
Layer thickness: 0.19 mm
Rafts: yes

You can use any material you like, only limitation is high temperature from ironing when covering assembled parts. Heat from the iron can deform the parts. Although I was not able to damage any part and I tried to cover many materials (ABS, PLA ...), please test film covering on your testing part.

One of the goals when designing KRAGA models was to use minimal or no support during printing. Removing support after printing is big pain and you can easily destroy your part. That is the reason why you should use default orientation of all parts during printing.

I strongly recommend to mark every printed part with it's name (I'm using masking tape for that). There are many parts in this plane and from each part there is also mirror side which can easily cause confusion during assembly.

I also recommend to print parts in bulks, especially smaller parts like ailerons or horns. Otherwise there is not enough time for material cooling in each layer and you might end up with rough layers, ugly edges or print fail.

Parts choices

For some parts there are more options and it is up to you what you will choose depending on your preferences. All options can be found in Options directory.

Choices based on hinge. You can use two kinds of hinges, both have same length and width (roughly 28mm x 16 mm) but thickness is where they differ. European style is 1.2mm thick and Du-Bro 117 is roughly 0.3 inch thick:

- parts in main directory have slots for European hinge
- parts under Options directory ending with suffix _dubro.STL have slots for Du-Bro 117 standard hinges

Choices based on wheel size:

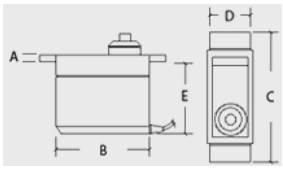
- shoe_L.STL and shoe_R.STL will accommodate 45mm wheel
- shoe_L_50mm.STL and shoe_R_50mm.STL from Options directory will accommodate 50mm wheel

Choices for motor mount. In first version of Maripi files part fuse_0_SK3_35xx.STL had some design issues that caused firewall breaking and complete motor separation from the fuselage after rough landing or after longer use due to the motor vibrations. In version 1.1 this part was improved. Namely carbon spars are protruding more into firewall and some small fillets were added. This fix was still not good enough. That is why I improved it much more in this version. I added more fillets on all critical places. Air inlets are much smaller and moved away from motor mount holes to prevent cracks around motor screws. Also motor mount screw holes have now smaller countersink. Despite all my changes some of you felt that it is still now enough and that is why added heavy duty version of fuse_0 with thicker firewall and no countersinks for motor screws:

- fuse_0_SK3_35xx.STL in main directory is strong enough to withstand serious abuse
- fuse_0_SK3_35xx_heavy_duty.STL is even stronger but requires you to use your own longer screws with flat bottom.

Choices based on servo in the wing:

- servo_mount_wing_[position]: will fit Hitec HS-65 (mg or hb) servo A = 2 mm, B = 24 mm, C = 32.5 mm, D = 11.6 mm, E = 17 mm
- servo_mount_wing_generic_[position]: there are included both STL and STEP file, you can customize it in software or manually after the mount is printed out



Choices based on servo in the fuselage:

- servo_plate_hs_65: will fit Hitec HS-65 (mg or hb) servo A = 2 mm, B = 24 mm, C = 32.5 mm, D = 11.6 mm, E = 17 mm
- servo_plate_generic: there are included both STL and STEP file, you can customize it in software or manually after the plate is printed out

Preparation for assembly

KRAGA Maripi plane consists of parts that are printed and parts that you need to buy separately (they are not included in the sold product) – carbon tubes, carbon rods, wheels, pinned hinges ...

List of required parts:

	dimensions	count
carbon tube	↕ 2x1 mm ↔ 1 m	7
carbon tube	↕ 6x4 mm ↔ 1m	2
carbon rod	↕ 3 mm ↔ 1 m	1
carbon rod	↕ 4 mm ↔ 1 m	1
covering film	↔ 2 m	1
wheels	⌀ 45 mm or ⌀ 50 mm (max thickness 16 mm)	2
pinned hinge	↕ ↔ 16x28x1.2 mm or Du-Bro 117	11
propeller	↔ 10 inch	1
spinner	⌀ 40 mm	1
clevis	thread M2	6
threaded coupler	⌀ 2 mm thread M2	6
twine/cord	↔ 1.5 m	1

⌀ 2x1 mm – means tube with outer diameter of 2mm and inner diameter of 1mm
⌀ 3 mm - means rod with diameter of 3mm

And of course you need electronics (motor, esc, 4 micro servos, battery).

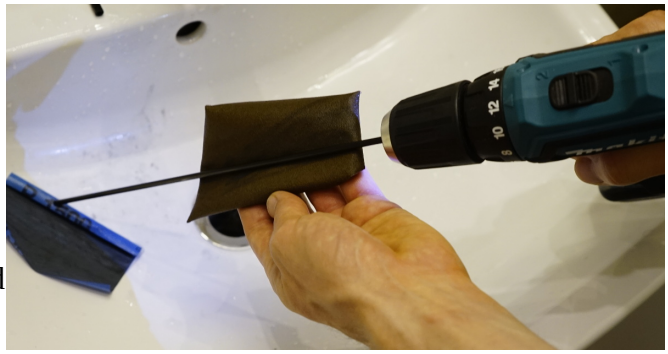
Next step is to cut carbon tubes and rods into smaller pieces, which will be used as spars, joiners or boom support of the plane. Don't forget to mark name on every piece to avoid confusion during the assembly.

part	dimensions	count
main wing spar	↕ 6x4 mm ↔ 454 mm	4
back wing spar	↕ 2x1 mm ↔ 245 mm	2
aileron spar	↕ 2x1 mm ↔ 436 mm	2
horizontal stab. control spar	↕ 2x1 mm ↔ 284 mm	1
horizontal stab. pivot spar	↕ 3 mm ↔ 284 mm	1
vertical stab. main front spar	↕ 2x1 mm ↔ 97 mm	1
vertical stab. main back spar	↕ 2x1 mm ↔ 80 mm	1
vertical stab. mov spar	↕ 2x1 mm ↔ 165 mm	1
fuse top spar	↕ 2x1 mm ↔ 858 mm	2
fuse bottom spar	↕ 2x1 mm ↔ 862 mm	2
fuse servo plate spar front	↕ 2x1 mm ↔ 68 mm	1
fuse servo plate spar back	↕ 2x1 mm ↔ 51 mm	1
wing joiner rod front	↕ 4 mm ↔ 300 mm	1
wing joiner rod back	↕ 4 mm ↔ 280 mm	1
landing leg spar front	↕ 3 mm ↔ 145 mm	2
landing leg spar back	↕ 3 mm ↔ 161 mm	2
wheel shaft	↕ 2x1 mm ↔ 23 mm	2
tail leg spar	↕ 2x1 mm ↔ 80 mm	1
aileron linkage carbon tube *	↕ 2x1 mm ↔ 44 mm	1
horizontal stab. linkage carbon tube	↕ 2x1 mm ↔ 286 mm	1

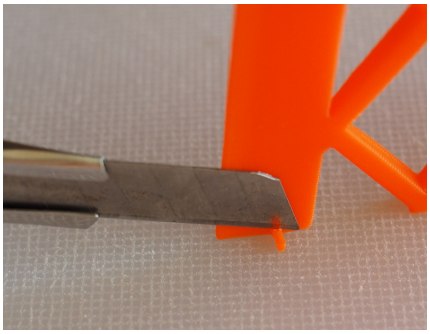
* needed only if you will be making custom carbon pushrods for aileron linkage

TIP: How to cut carbon spars. Wrap masking tape around carbon spar and mark cut position. Use rotary tool or X-ACTO fine saw to cut the spar. Work outside or in room with good ventilation. Use breathing mask to avoid inhaling carbon dust! After cutting wipe out carbon dust from the spars using wet tissue.

TIP: Joiner rods on the fuselage have diameter of 4 mm, carbon spars in wings have inner diameter of 4 mm. They should fit into each other but sometimes the fit is too tight or you cannot insert joiners rods into wing spars at all. You can use drill and wet sandpaper to make joiner rods thinner. Use breathing mask to avoid inhaling carbon dust!



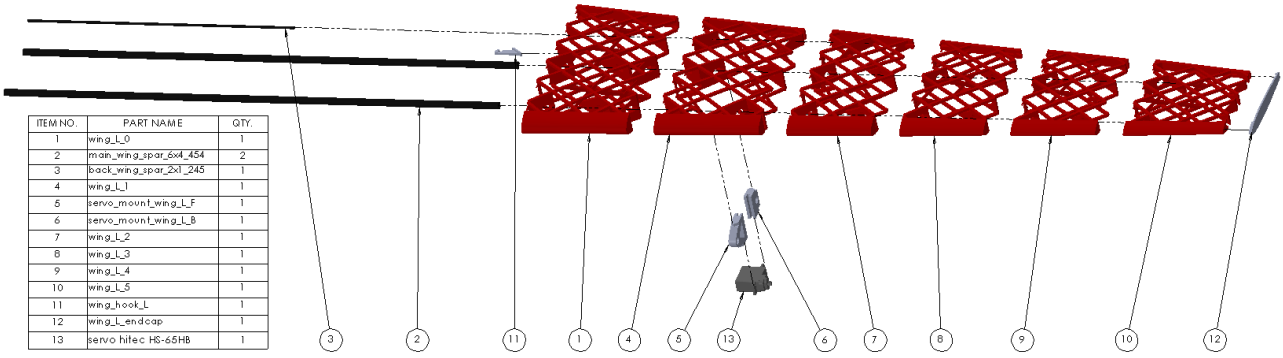
Remove support legs from all parts. Also sand all sharp edges and printing imperfections to avoid covering foil damage.



Assembly

This assembly will describe always left side of the plane when it comes to symmetric parts. It is recommended to use medium viscosity CA glue. You can use CA glue accelerator for faster curing time. Dry fit all the parts before gluing them together.

Wing



ITEM NO.	PART NAME	QTY.
1	wing_L_0	1
2	main_wing_spar_6x4_454	2
3	back_wing_spar_2x1_245	1
4	wing_L_1	1
5	servo_mount_wing_L_F	1
6	servo_mount_wing_L_B	1
7	wing_L_2	1
8	wing_L_3	1
9	wing_L_4	1
10	wing_L_5	1
11	wing_hook_L	1
12	wing_L_endcap	1
13	servo hitec HS-65HB	1

Assembly left wing as sketched above.

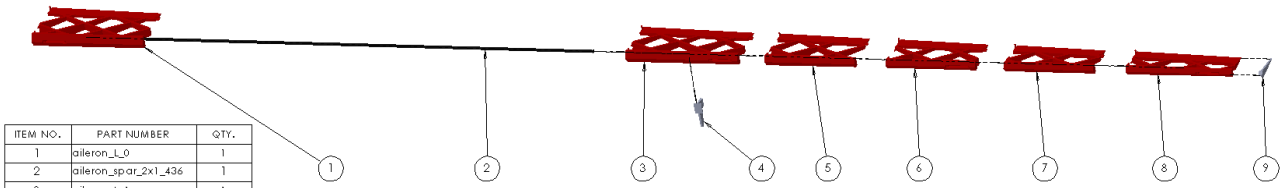
You have an option here to use default servo mounts for Hitec HS-65 series servos (or other with similar dimensions) or to customize included generic servo mounts. Don't forget to insert servo mounts into wing_L_1 part when leading spars through.

Both main wing spars (main_wing_spar_6x4_454) should be aligned flush with base of wing_L_0 part. Back wing spar (back_wing_spar_2x1_245) should protrude 0.5 cm. It's purpose is to fix back side of the wing on the fuselage and also to protect wing hook during transportation.

Do not forget to center your servos before gluing them in. Check also that your clevises fit servo arm holes, drilling them when servo is in place could damage the wing. Lead servo cable through the wing. The servo cable should come out of the wing near leading edge to meet servo cable hole in the fuselage.

When all the parts are on their position, put glue on contact points where carbon spars are touching printed parts.

Aileron

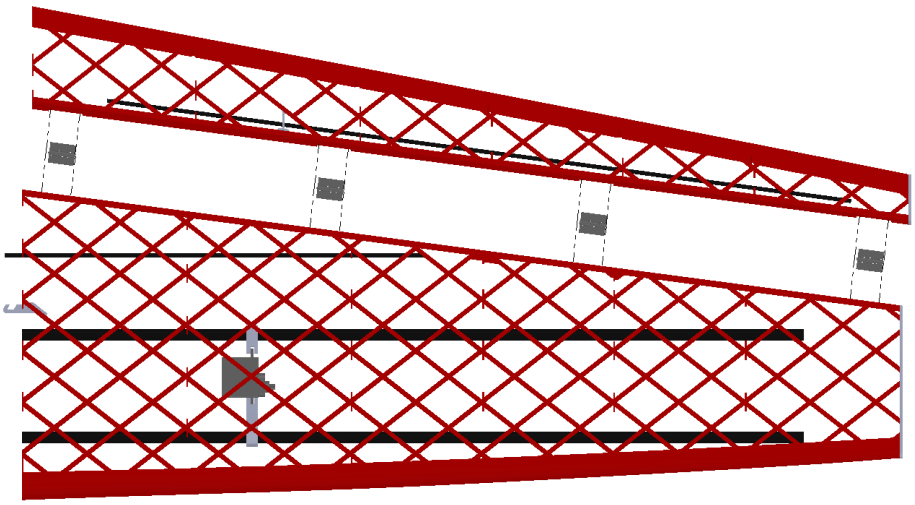


ITEM NO.	PART NUMBER	QTY.
1	aileron_L_0	1
2	aileron_spar_2x1_436	1
3	aileron_L_1	1
4	aileron_horn_L	1
5	aileron_L_2	1
6	aileron_L_3	1
7	aileron_L_4	1
8	aileron_L_5	1
9	aileron_endcap_L	1

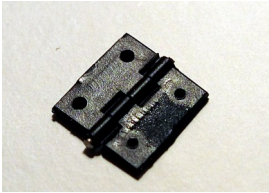
Assembly left aileron as sketched above. Carbon spar should be centered in the middle.

Don't forget to insert aileron_horn_L part into aileron_L_1 when leading spar through. When all the parts are on their position, put glue on contact points where carbon spars are touching printed parts.

Wing

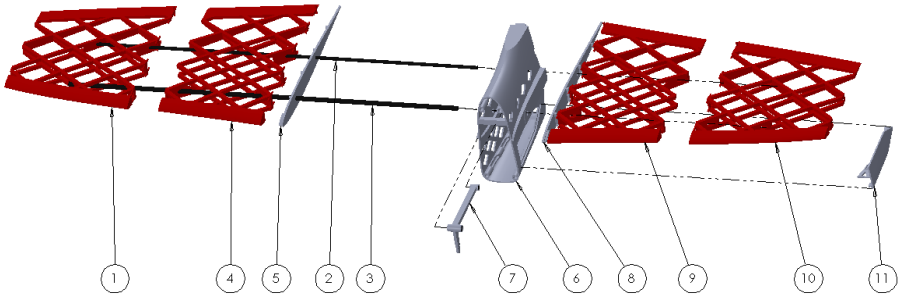


Some hinge slots are not deep enough to fit whole hinge length. Shorten all hinges as shown on the picture. It has no benefit in terms of added stiffness of rigidity to use whole hinge arm length as only small hinge area is in contact with the wing.



Be careful when using glue near pinned part of the hinge. First insert the hinge into hinge hole and then apply the glue from inner side of the wing. Do the same when gluing aileron to hinge. First insert all hinges into hinge holes on aileron and then apply glue from inner side of aileron. Make sure that aileron has enough space for moving from every side.

Horizontal stabilizer

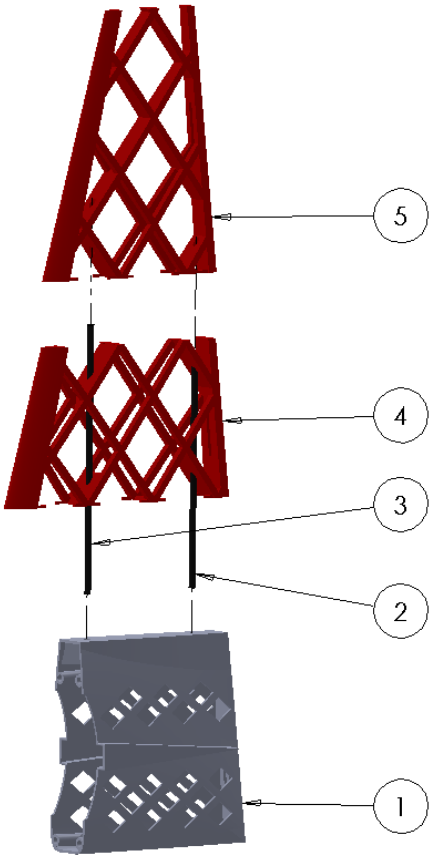


ITEM NO.	PART NAME	QTY.
1	hor_stab_R_1	1
2	hor_stab_control_spar_2x1_284	1
3	hor_stab_pivot_spar_3_284	1
4	hor_stab_R_0	1
5	hor_stab_inner_endcap_R	1
6	fuse_8	1
7	hor_stab_ctrl_arm	1
8	hor_stab_inner_endcap_L	1
9	hor_stab_L_0	1
10	hor_stab_L_1	1
11	canopy_tail	1

Assembly the stabilizer as sketched above.
Carbon spars should be centered in the middle.
I recommend to install the clevis on the control arm before gluing it in. That saves you the hassle later, installing it through service opening when the fuselage is assembled is more difficult.

When all the parts are on their position, put glue on contact points where carbon spars are touching printed parts.
Canopy_tail has printing support which should be removed (triangle shape in the middle of the canopy). Canopy_tail provides service access to the linkage mechanism and should NOT be glued to the fuse_8 part.

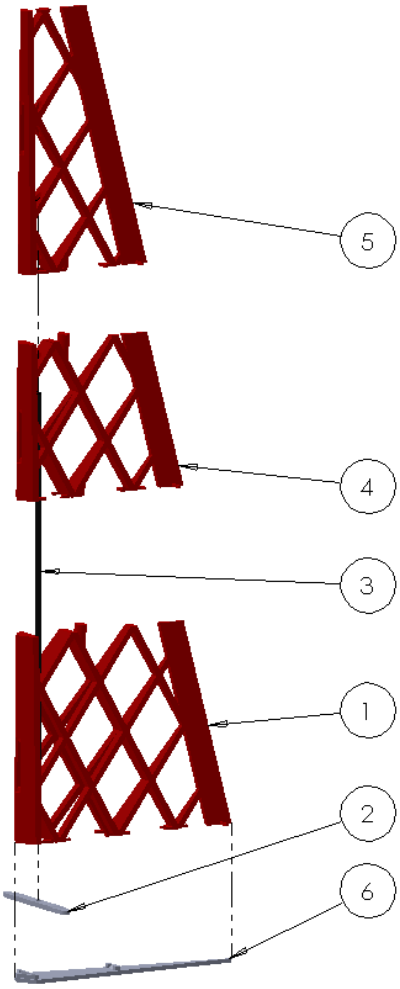
Vertical stabilizer main



ITEM NO.	PART NAME	QTY.
1	fuse_9	1
2	ver_stab_main_b_spar_2x1_80	1
3	ver_stab_main_f_spar_2x1_97	1
4	ver_stab_f_0	1
5	ver_stab_f_1	1

Assembly the stabilizer as sketched above. Carbon spars protrude 1 cm from base of ver_stab_f_0. When all the parts are on their position, put glue on contact points where carbon spars are touching printed parts.

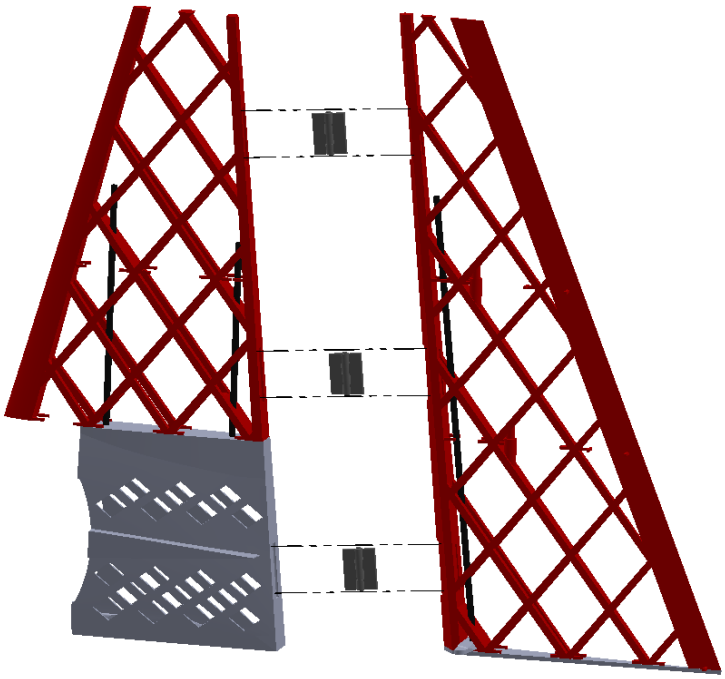
Vertical stabilizer mov



ITEM NO.	PART NAME	QTY.
1	ver_stab_b_0	1
2	ver_stab_horn	1
3	ver_stab_mov_spar_2x1_165	1
4	ver_stab_b_1	1
5	ver_stab_b_2	1
6	ver_stab_endcap	1

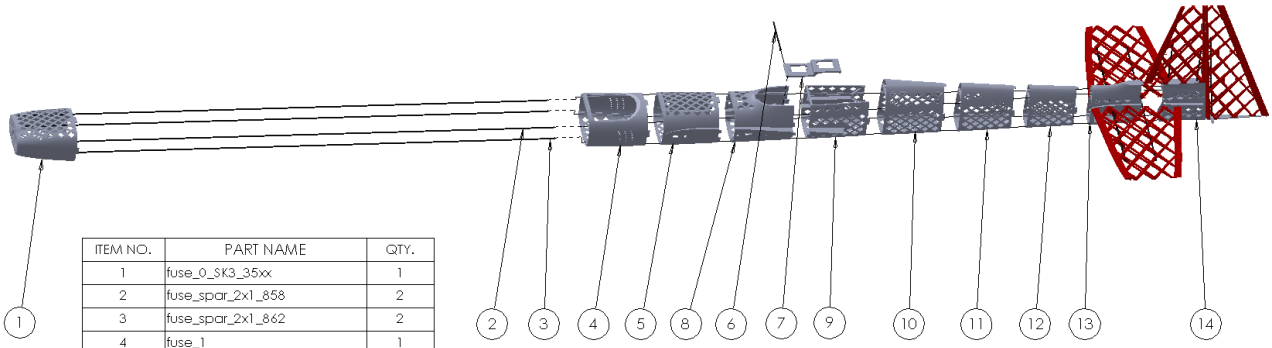
Assembly moving part of the stabilizer as sketched above. Carbon spar should be centered in the middle. When all the parts are on their position, put glue on contact points where carbon spars are touching printed parts.

Vertical stabilizer



To complete vertical stabilizer assembly first shorten all hinges and then insert the hinges into hinge slots and apply the glue from inner side of the main part. Then insert all hinges into hinge slots on moving part and put the glue from inner side of the moving part.

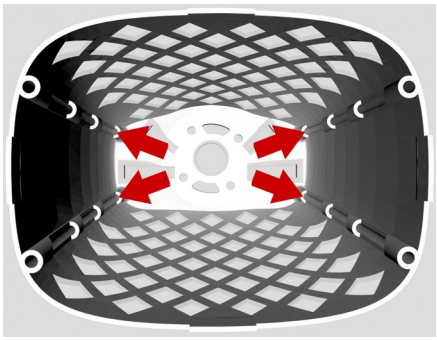
Fuselage step 1



ITEM NO.	PART NAME	QTY.
1	fuse_0_SK3_35xx	1
2	fuse_spar_2x1_858	2
3	fuse_spar_2x1_862	2
4	fuse_1	1
5	fuse_2	1
6	fuse_servo_plate_spar_2x1_68	1
7	servo_plate_hs_65	1
8	fuse_3	1
9	fuse_4	1
10	fuse_5	1
11	fuse_6	1
12	fuse_7	1
13	fuse_8 & horizontal stab.	1
14	fuse_9 & vertical stab.	1

Remove Y-shaped printing support from fuse_4 part.

Round the ends of carbon spars to make them slide easily into spar leading holes. Remember to use breathing mask to avoid inhaling carbon dust whenever sanding carbon! Test fit all 4 spars into fuse_0. It is important to push them all the way in. The longer spars (fuse_spar_2x1_868) should be on the bottom side.

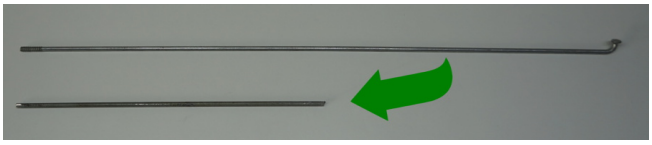


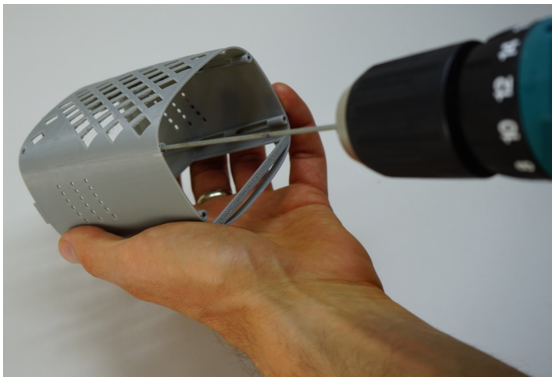
Now take out all 4 spars and put glue into spar leading holes that are touching motor mount plate (as shown on right picture). Quickly insert spars back into fuse_0. This is the only time that glue is used before carbon spars are on their position and it has to be done to make motor mount as strong as possible.
When spars are on their position apply more glue from inner side of fuse_0. There are spaces along spar leading tubes where you can put the glue and let it leak further into places which are hard to reach.

You can continue with rest of fuse parts. Always put each part on its position and only then apply the glue from inner side. If glue is applied before carbon spar is inserted into the part glue could cure before the part is on its position.

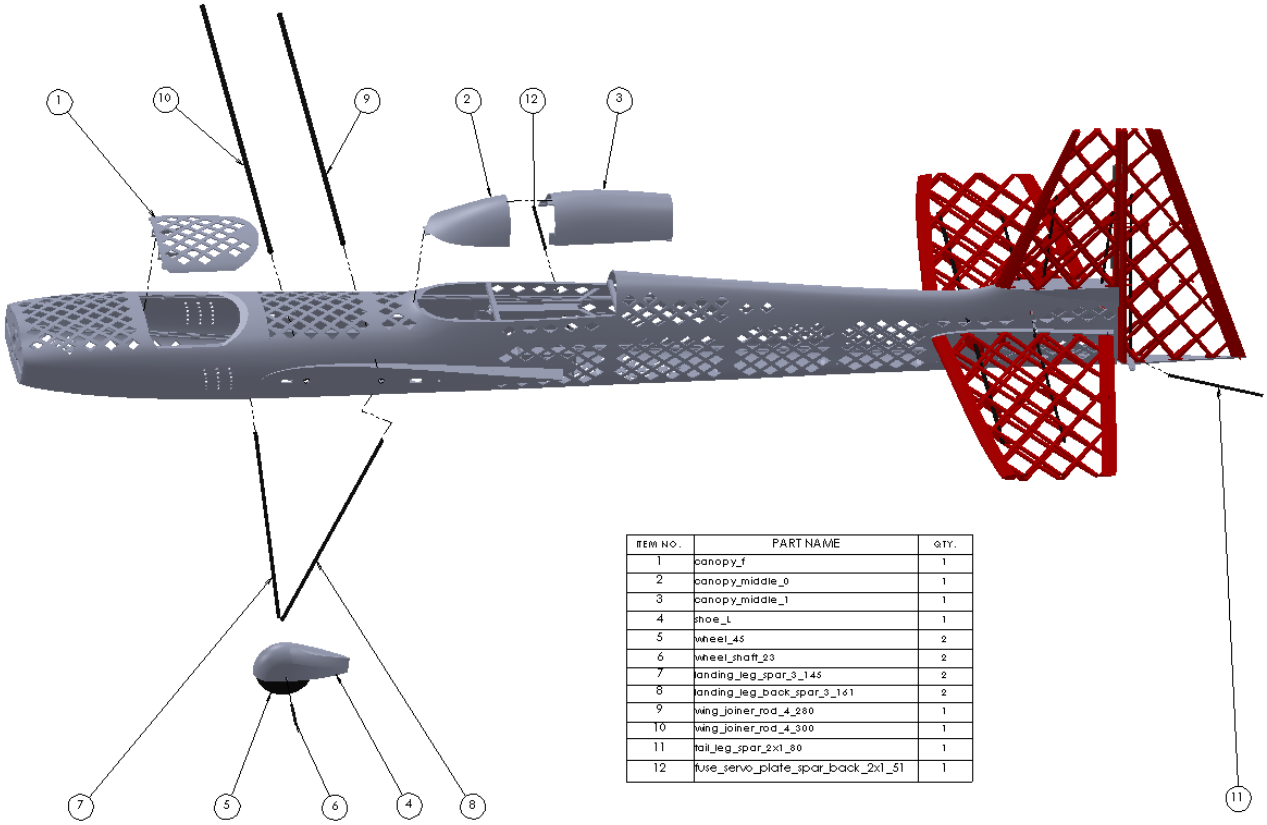
Depending on your servo choice use servo_plate_hs_65 or customized servo_plate_generic part.
First insert fuse_servo_plate_spar_2x1_68 into servo_plate, center it and glue it in place.
Put servo mount plate into fuse_3. Apply the glue also to the servo plate leg to secure it in place.

It can happen that spar leading tubes are too tight and it is difficult to insert carbon spars into them. One option is to use ordinary bicycle steel spoke (2mm thick). Cut the head and the thread off, make some kind of sharp edge and mount it into a drill. This way you can drill through all spar leading holes to remove all printing imperfections. Another option is to use metal cable which you can straighten and use in the drill.





Fuselage step 2



ITEM NO.	PART NAME	QTY.
1	canopy_f	1
2	canopy_middle_0	1
3	canopy_middle_1	1
4	shoe_L	1
5	wheel_45	2
6	wheel_shaft_23	2
7	landing_leg_spar_3_145	2
8	landing_leg_back_spar_3_161	2
9	wing_joiner_rod_4_280	1
10	wing_joiner_rod_4_300	1
11	tail_leg_spar_2x1_80	1
12	fuse_servo_plate_spar_back_2x1_51	1

Part canopy_f has printing support which should be removed (two triangle shaped legs). This canopy provides service access to the motor and should NOT be glued to the fuse_1 part.

Glue together canopy_middle_0 and canopy_middle_1. These two parts work as cockpit canopy and provide service access to the servos.

When assembling landing gear, consider using some kind of spacer if your wheels are narrow and have too much space in shoe. It is enough to secure wheel_shaft_23 to the shoe only from one (outer) side with the glue. First attach landing leg spars to the shoe_L part and only then attach the landing gear to the fuselage.

Insert and center wing_joiner_rod_4_300 into holes in fuse_2 and wing_joiner_rod_4_280 into holes in fuse_3. Glue it in the place from inner side of the fuselage.

Glue tail_leg_spar_2x1_80 to the fuse_9 part.

Finally insert fuse_servo_plate_spar_back_2x1_51 from right side of the fuselage and lead it through hole in servo plate. Fix it in place with glue.

Covering

Covering of 3D printed planes is done the same way as you would do with common balsa RC plane. It is important to test film covering on testing part before you start.

If you have no experience with film covering my advice is to try more brands of covering film before you get frustrated. It is easier to work with some than with other. I tested couple of brands and in my opinion *solarfilm lite* is the best option for this kind of plane.

My recommendation is to cover wings after they are fully assembled (center wing, tip wing and aileron are glued together). It is a little bit more demanding but it is definitely worth it. Otherwise you are risking that when gluing aileron to hinges and hinges to wing tip, glue might leak and spread all over hinge pin which will block the hinge and aileron would get stuck.

The same is valid for vertical stabilizer covering. Cover it after you glued on the moving part with hinges.

Fuselage has holes in order to reduce weight and make printing easier (smaller chance of cracking or warping). These have to be covered as well (except for side vents near front canopy).

Electronics

This is by no means the best way possible how to setup your plane. It is just a brief overview of possible options.

Motor

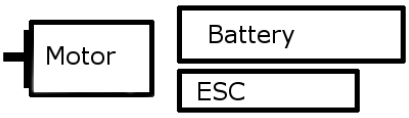
To avoid problems when setting correct CG, it is recommended to use motor weighting 110g. You should be able to fit inside motors with diameter up to 35mm.

Good option is *Turnigy Aerodrive SK3 - 3536-1200kv Brushless Outrunner. This motor provides plenty of power even for hovering figure.*

ESC

If you opted for above mentioned motor option, you need 40A speed controller for brushless motors ideally with SBEC, for example this one: *HobbyKing 40A BlueSeries Brushless Speed Controller*.

Battery



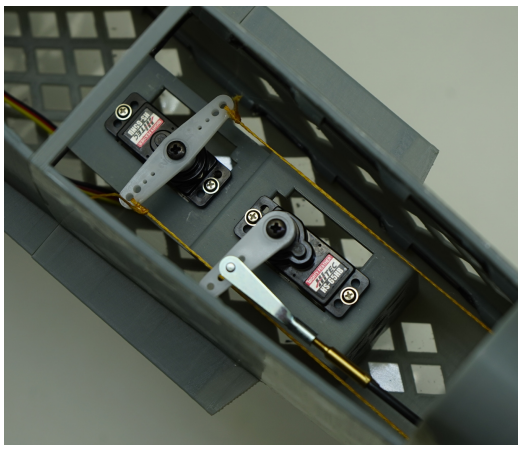
Although there is plenty of space in the fuselage, to be able to set correct CG, you have to place ESC and Battery next to each other right behind the motor. In this configuration ideal battery weight is between 120g and 140g. *Turnigy nano-tech 1500mah 3S 25~50C Lipo Pack* is one of many options.

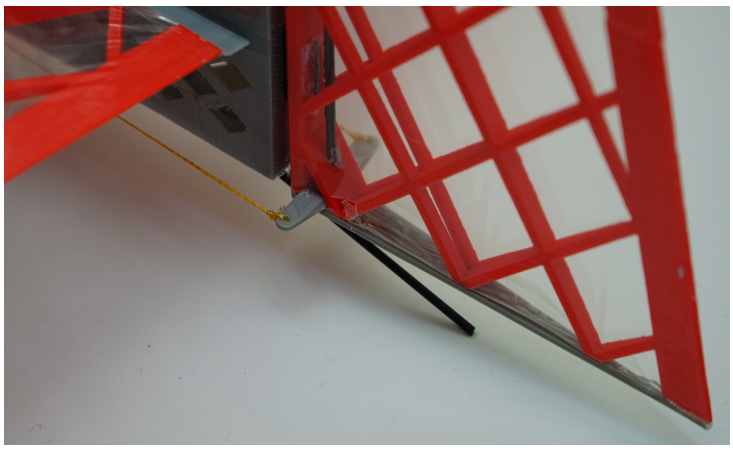
Receiver

This depends on your transmitter. Only requirement is to have 5 channels.

Servos

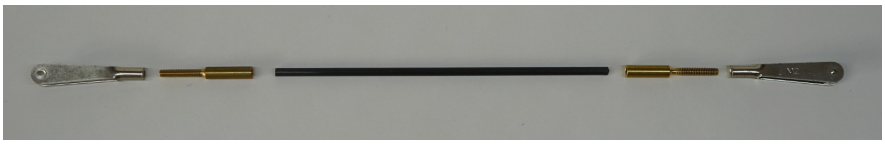
In this type of plane it is important to use strong, fast and light micro servos especially the ones used in the wing. I opted for Hitec HS-65hb. It is an analog servo with karbonite gears.





Rudder has pull pull system as shown on the pictures above.

All the linkages except for the rudder use 2x1mm carbon tube glued into threaded couplers and screwed into metal clevises.



Settings and flying

Throws

Use maximal possible throws on ailerons and rudder. Movement of horizontal stabilizer is limited by rudder linkage cord.

CG

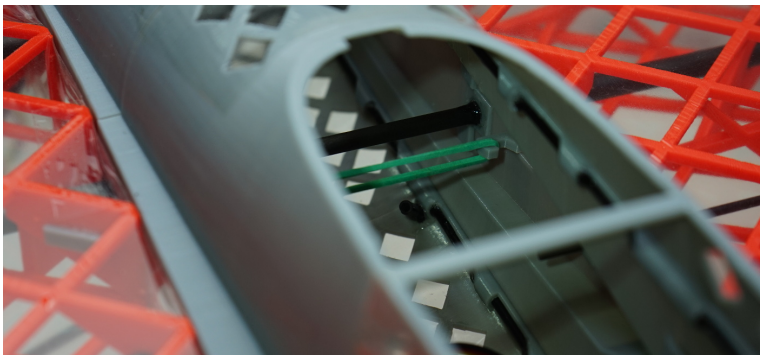
73 mm – 84 mm from wing leading edge measured next to the wing root.

I recommend to use 74 mm for first flight. Setting your CG exactly is very important!

Wings to fuselage attachment

Wings should not be attached too firmly to the fuselage. It also helps to absorb the energy during landing or crash when the wings can detach easily.

To attach wing to the fuselage insert joiner rods into wing spars. Use small rubber band to secure the wing in place by attaching it on the wing hooks from inner side of the fuselage.



Happy flying

Tomas

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