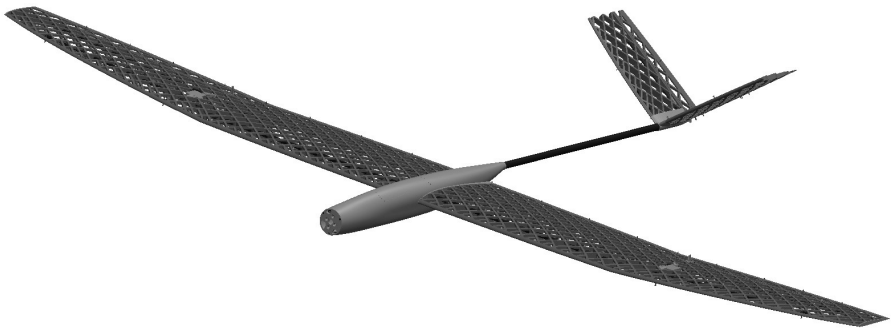
KRAGA

Kodo build guide 1.4.1

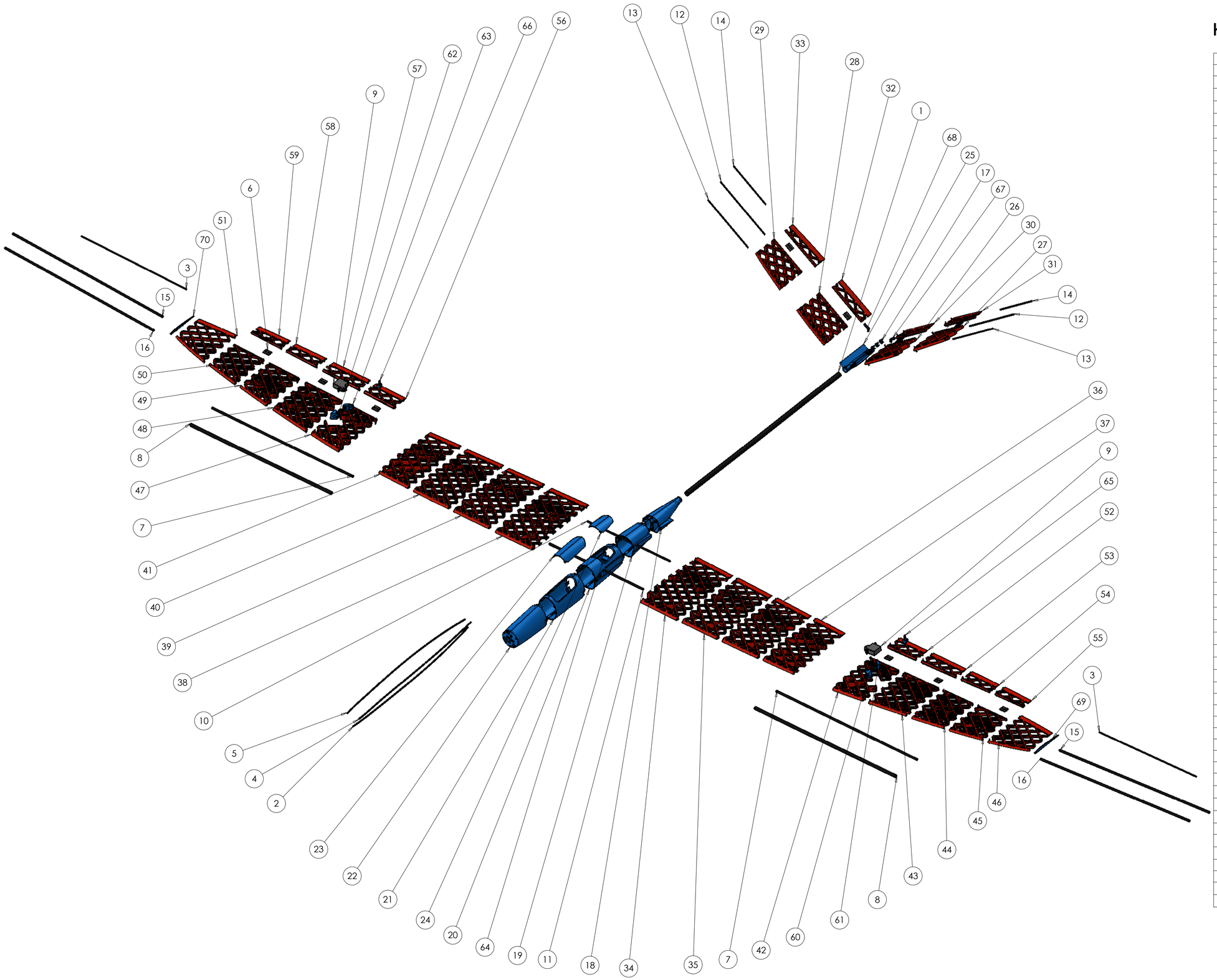


Please do not share files that you bought

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 KODO

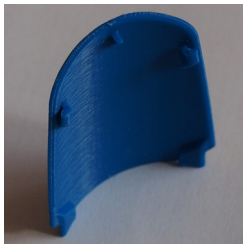


ITEM NO.	PART NUMBER	PRINTED AS	QTY.
1	boom_10x9_520	-	1
2	fuse_bottom_spar_2x1_425	-	1
3	aileron_spar_2x1_270	-	2
4	fuse_left_spar_2x1_407	-	1
5	fuse_right_spar_2x1_407	-	1
6	hinge	-	10
7	main_wing_spar_4x3_375	-	2
8	main_wing_spar_6x4_375	-	2
9	servo_common	-	2
10	spar_joiner_3_220_b	-	1
11	spar_joiner_4_250_f	-	1
12	tail_main_spar_2x1_b_145	-	2
13	tail_main_spar_2x1_f_132	-	2
14	tail_mov_spar_2x1_105	-	2
15	tip_wing_spar_4x3_b_400	-	2
16	tip_wing_spar_4x3_f_397	-	2
17	boom_lines_holder	SOLID	3
18	fuse_0	SOLID	1
19	fuse_1	SOLID	1
20	fuse_2	SOLID	1
21	fuse_3	SOLID	1
22	fuse_4_sk3_2836	SOLID	1
23	canopy_front	SOLID	1
24	canopy_rear	SOLID	1
25	tail_boom_mount	SOLID	1
26	tail_main_L_0	SHELL	1
27	tail_main_L_1	SHELL	1
28	tail_main_R_0	SHELL	1
29	tail_main_R_1	SHELL	1
30	tail_mov_L_0	SHELL	1
31	tail_mov_L_1	SHELL	1
32	tail_mov_R_0	SHELL	1
33	tail_mov_R_1	SHELL	1
34	center_wing_L_0	SHELL	1
35	center_wing_L_1	SHELL	1
36	center_wing_L_2	SHELL	1
37	center_wing_L_3	SHELL	1
38	center_wing_R_0	SHELL	1
39	center_wing_R_1	SHELL	1
40	center_wing_R_2	SHELL	1
41	center_wing_R_3	SHELL	1
42	tip_wing_L_0	SHELL	1
43	tip_wing_L_1	SHELL	1
44	tip_wing_L_2	SHELL	1
45	tip_wing_L_3	SHELL	1
46	tip_wing_L_4	SHELL	1
47	tip_wing_R_0	SHELL	1
48	tip_wing_R_1	SHELL	1
49	tip_wing_R_2	SHELL	1
50	tip_wing_R_3	SHELL	1
51	tip_wing_R_4	SHELL	1
52	aileron_L_0	SHELL	1
53	aileron_L_1	SHELL	1
54	aileron_L_2	SHELL	1
55	aileron_L_3	SHELL	1
56	aileron_R_0	SHELL	1
57	aileron_R_1	SHELL	1
58	aileron_R_2	SHELL	1
59	aileron_R_3	SHELL	1
60	servo_common_mount_wing_front_L	SOLID	1
61	servo_common_mount_wing_rear_L	SOLID	1
62	servo_common_mount_wing_front_R	SOLID	1
63	servo_common_mount_wing_rear_R	SOLID	1
64	servo_mount_fuse	SOLID	1
65	wing_horn_L	SOLID	1
66	wing_horn_R	SOLID	1
67	tail_horn_L	SOLID	1
68	tail_horn_R	SOLID	1
69	end_cap_L	SOLID	1
70	end_cap_R	SOLID	1

Printing

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

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



2. Shell parts (wings - all orange 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: 0.4mm
Layer thickness: 0.19mm
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. There are only two parts from whole plane which require support, these are from plane fuselage and are printed as solid. The rest of the plane should be support-free.

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 moving parts on the plane tail. 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.

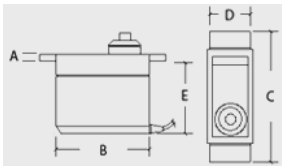
Parts choices

For some parts there are more options and it is up to you what you will choose depending on what motor and servos are you going to use.

Choices based on used motor:

- no motor (pure sailplane variant): print fuse_4_no_motor and fuse_5
- Turnigy Aerodrive SK3 - 2836 brushless outrunner motor: print fuse_4_sk3_2836 (fuse_5 not needed)
- other motor: print fuse_4_uni, for this option you need to drill motor screw holes manually (fuse_5 not needed)

Choices based on used servo in the wing:



- servo_hxt_900_mount: will fit HXT900 servo A = 2.4 mm, B = 23 mm, C = 32 mm, D = 12 mm, E = 16 mm
- servo_common_mount: will fit A = 2 mm, B = 23 mm, C = 32 mm, D = 12 mm, E = 19 mm
- servo_custom_mount: you can cut out slots yourself based on your needs

Most important dimension is A, if that one fits you but the other ones not try to print the mounts anyway and test-fit your servo.

Choices based on used servo in the fuselage:

- servo_mount_fuse: will fit servos with B = 23 mm, D = 12 mm
- servo_mount_fuse_common: you can cut out whatever hole you need

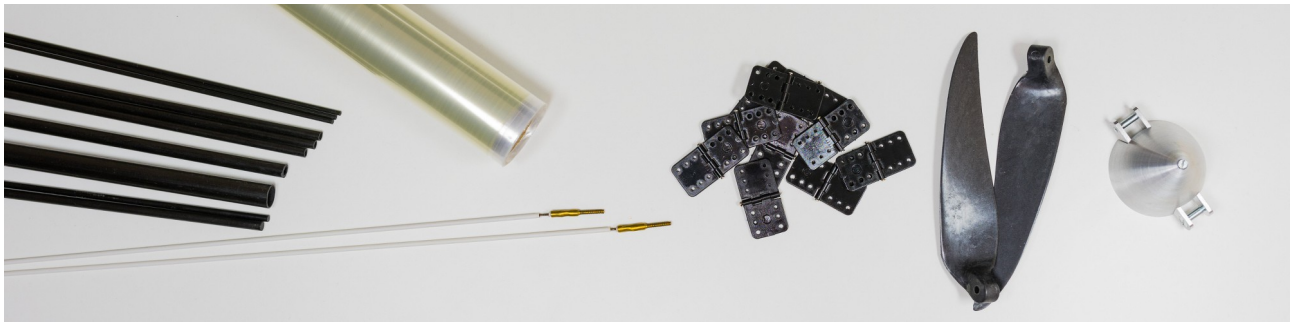
Preparation for assembly

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

List of required parts:

	dimensions	count
carbon tube	⌀ 2x1 mm ↔ 1 m	3
carbon tube	⌀ 4x3 mm ↔ 1 m	3
carbon tube	⌀ 6x4 mm ↔ 1m	1
carbon tube	⌀ 10x9 mm ↔ 520 mm	1
carbon rod	⌀ 3 mm ↔ 220 mm	1
carbon rod	⌀ 4 mm ↔ 250 mm	1
covering film	↔ 2 m	1
push rod *	↔ 80 cm	2
pinned hinge	↕ ↔ 16x28 mm or smaller	10
folding propeller	up to ↔ 10 inch	1
spinner	⌀ 40 mm	1

⌀ 2x1 mm – means tube with outer diameter of 2mm and inner diameter of 1mm
⌀ 3 mm - means rod with diameter of 3mm
* you can use other linkage system than flexible push rod (push rod made from carbon tube ...)



And of course you need all the common accessories like clevises, push rods for ailerons, (horns are printed so you don't need those) and electronics (motor, esc, 4 micro servos).

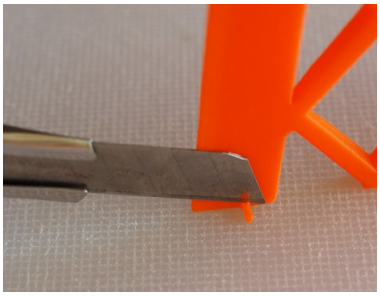
Next step is to cut carbon tubes and rods into smaller pieces, which will be used as spars, joiners or boom of the plane. Don't forget to mark every piece to avoid confusion during the assembly.

part	dimensions	count
aileron carbon spar	⌀ 2x1 mm ↔ 270 mm	2
fuse bottom carbon spar	⌀ 2x1 mm ↔ 425 mm (*438 mm)	1
fuse side carbon spar	⌀ 2x1 mm ↔ 407 mm (*420 mm)	2
tail main carbon spar front	⌀ 2x1 mm ↔ 132 mm	2
tail main carbon spar back	⌀ 2x1 mm ↔ 145 mm	2
tail mov carbon spar	⌀ 2x1 mm ↔ 105 mm	2
tip wing carbon spar front	⌀ 4x3 mm ↔ 397mm	2
tip wing carbon spar back	⌀ 4x3 mm ↔ 400 mm	2
center wing carbon spar back	⌀ 4x3 mm ↔ 375 mm	2
center wing carbon spar front	⌀ 6x4 mm ↔ 375 mm	2
carbon boom	⌀ 10x9 mm ↔ 520 mm	1
wing joiner carbon rod back	⌀ 3 mm ↔ 220 mm	1
wing joiner carbon rod front	⌀ 4 mm ↔ 250 mm	1

* dimensions for pure sailplane variant

TIP: How to cut carbon spars. Wrap masking tape around carbon spar and mark cut position. Use rotary tool 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.

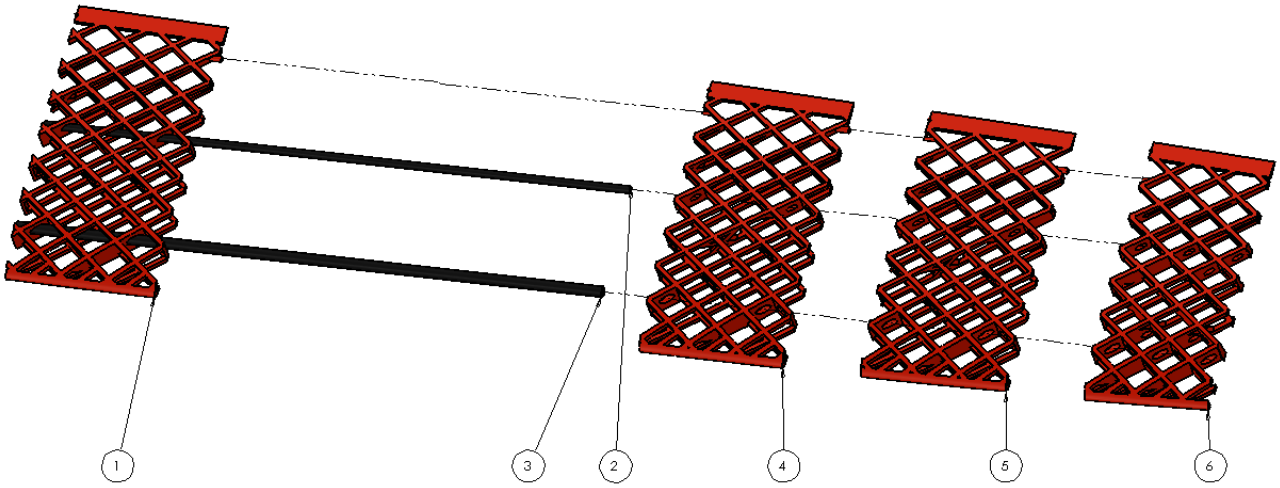
Remove support legs from all parts. Also sand all sharp edges and printing imperfections to avoid covering foil damage.



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.

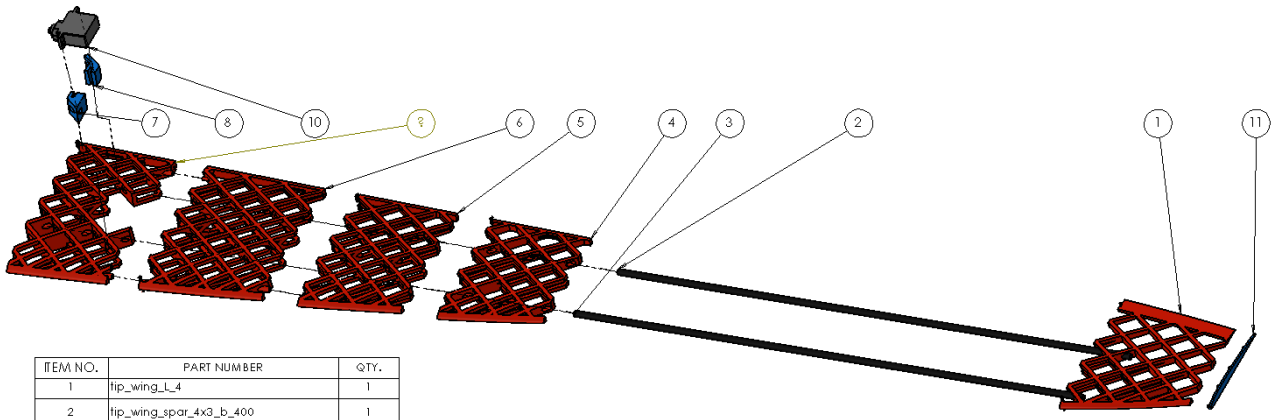
Center wing



ITEM NO.	PART NUMBER
1	center_wing_L_0
2	main_wing_spar_4x3_375
3	main_wing_spar_6x4_375
4	center_wing_L_1
5	center_wing_L_2
6	center_wing_L_3

Assembly left center wing as sketched above. Carbon spars should be aligned flush with base of center_wing_L_0 part. When all the parts are on their position, put glue on contact points where carbon spars are touching printed parts.

Tip wing



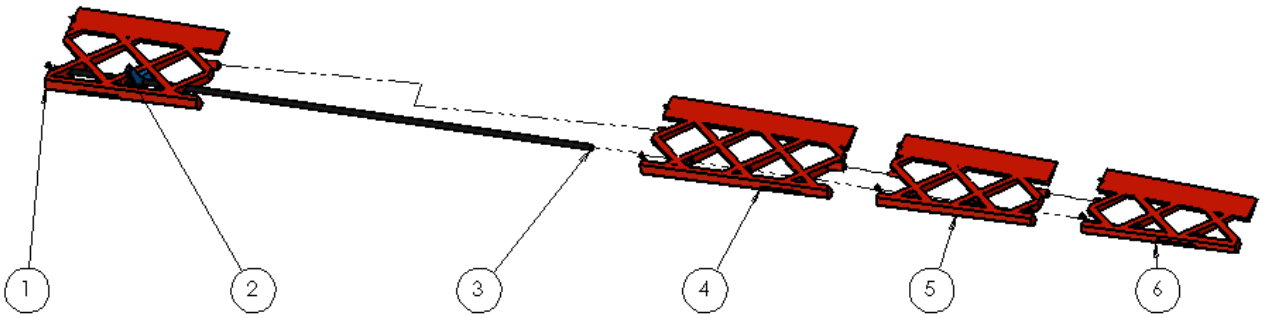
ITEM NO.	PART NUMBER	QTY.
1	tip_wing_L_4	1
2	tip_wing_spar_4x3_b_400	1
3	tip_wing_spar_4x3_f_397	1
4	tip_wing_L_3	1
5	tip_wing_L_2	1
6	tip_wing_L_1	1
7	servo_common_mount_wing_front_L	1
8	servo_common_mount_wing_rear_L	1
9	tip_wing_L_0	1
10	servo_common	1
11	end_cap_L	1

Assembly left tip wing as sketched above. You have an option here to use common servo mounts or servo mounts for HXT900. Don't forget to insert servo mounts into tip_wing_L_0 part when leading spars through. Carbon spars protrude from base of tip_wing_L_0 so that they can be inserted into empty leading spar holes on the center wing. 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.

You can choose to use end cap for the wing tip. It is not mandatory, but it makes film covering a little bit easier.

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

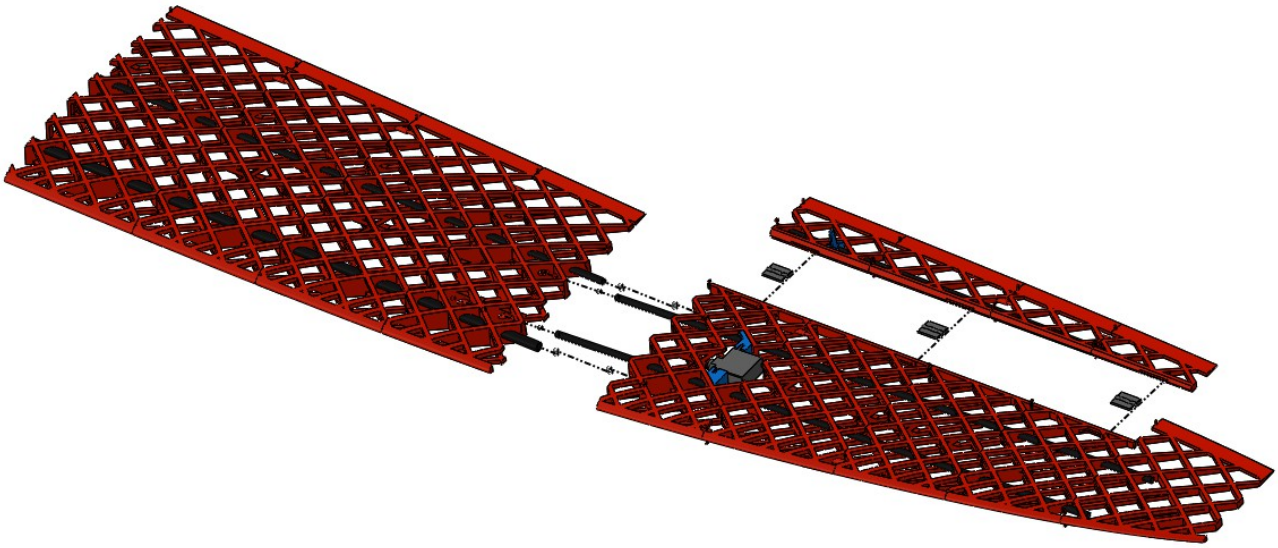
Aileron



ITEM NO.	PART NUMBER
1	aileron_L_0
2	wing_horn_L
3	aileron_spar_2x1_270
4	aileron_L_1
5	aileron_L_2
6	aileron_L_3

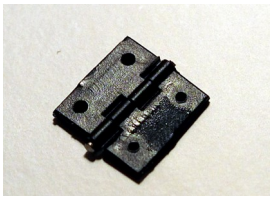
Assembly left aileron as sketched above. Don't forget to insert wing_horn_L part into aileron_L_0 when leading spar through. Carbon spars should be aligned flush with base of aileron_L_0 part. When all the parts are on their position, put glue on contact points where carbon spars are touching printed parts.

Wing



To complete wing assembly first glue together center wing and tip wing. Only then continue with gluing hinges and aileron.

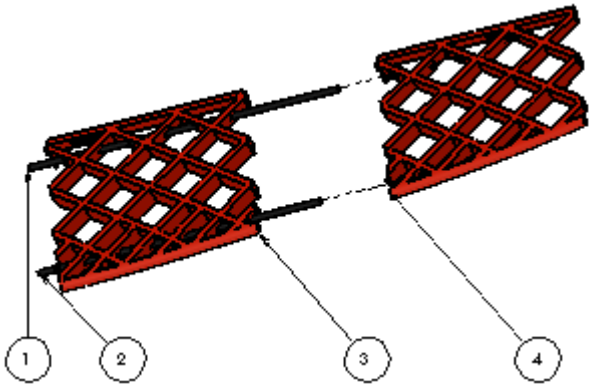
Some hinge slots are not deep enough to fit whole hinge length. Shorten all hinges as shown on the picture. It has no benefit in terms of added stiffness of rigidity to use whole hinge arm length as only small hinge area is in contact with the wing.



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.

When the wing is assembled lead servo cable through the wing. The cable should come out of the wing near servo cable hole in fuselage.

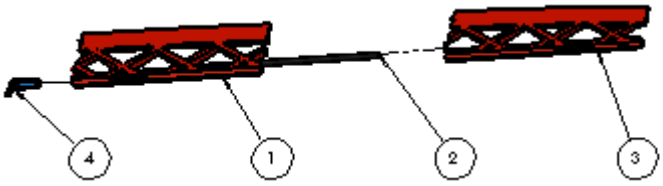
Tail main



ITEM NO.	PART NUMBER
1	tail_main_spar_2x1_b_145
2	tail_main_spar_2x1_f_132
3	tail_main_L_0
4	tail_main_L_1

Assembly left main tail as sketched above. Carbon spars protrude 1 cm from base of tail_main_L_0. When all the parts are on their position, put glue on contact points where carbon spars are touching printed parts.

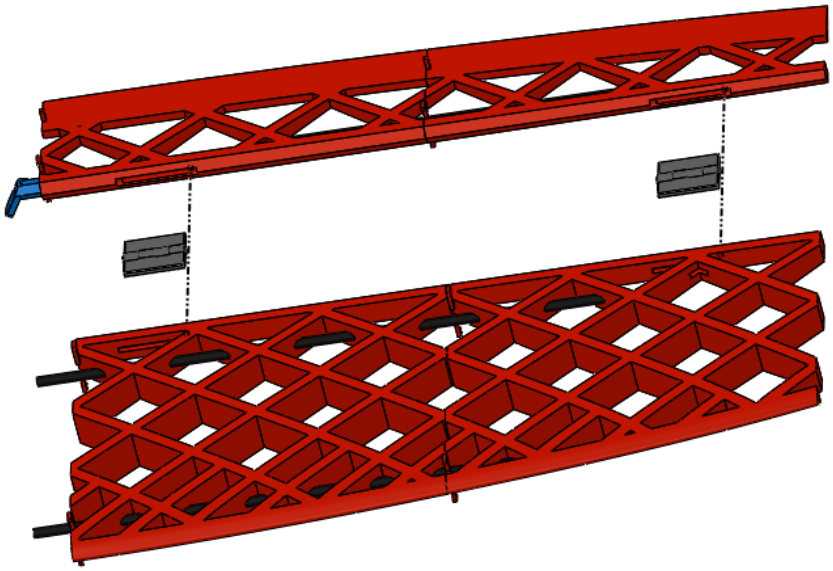
Tail mov



ITEM NO.	PART NUMBER
1	tail_mov_L_0
2	tail_mov_spar_2x1_105
3	tail_mov_L_1
4	tail_horn_L

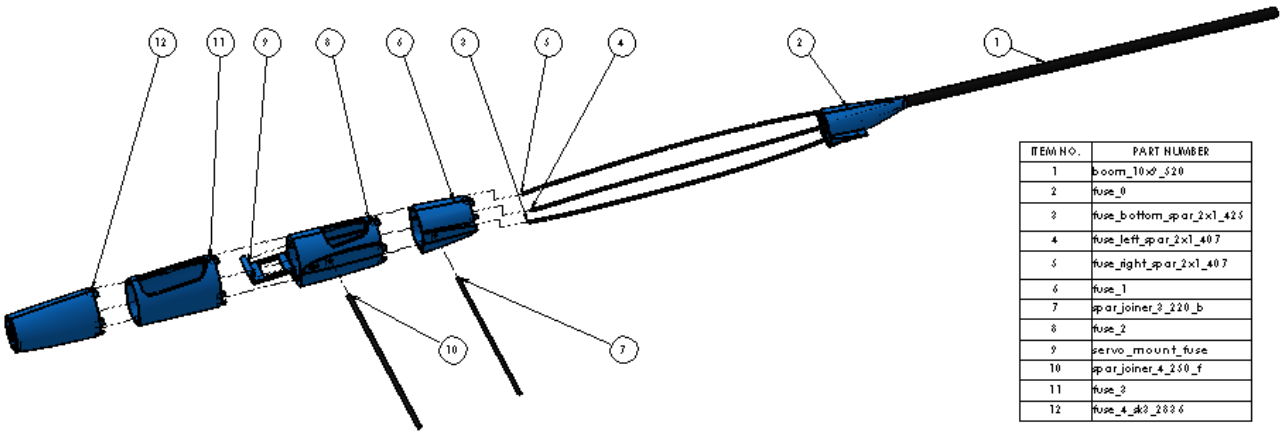
Assembly left tail as sketched above. Carbon spar should be centered in the middle. When all the parts are on their position, put glue on contact points where carbon spars are touching printed parts.

Tail



To complete tail assembly first shorten all hinges and then insert the hinges into hinge slots and apply the glue from inner side of the main tail. Then insert all hinges into hinge slots on moving part of the tail and put the glue from inner side of the moving part. Tip of the moving part should be aligned flush with main part.

Fuselage front



ITEM NO.	PART NUMBER
1	boom_10x8_520
2	fuse_0
3	fuse_bottom_spar_2x1_425
4	fuse_left_spar_2x1_407
5	fuse_right_spar_2x1_407
6	fuse_1
7	spar_joiner_3_220_b
8	fuse_2
9	servo_mount_fuse
10	spar_joiner_4_250_f
11	fuse_3
12	fuse_4_sk2_2836

Start by gluing together boom and fuse_0. Boom should be aligned flush with base side of fuse_0. When these two parts are aligned apply glue from both sides of fuse_0.
Then insert all three spars into fuse_0. Apply the glue from inner side of fuse_0. There are spaces in spar leading tubes where you can put the glue and let it leak further into places which are hard to reach.

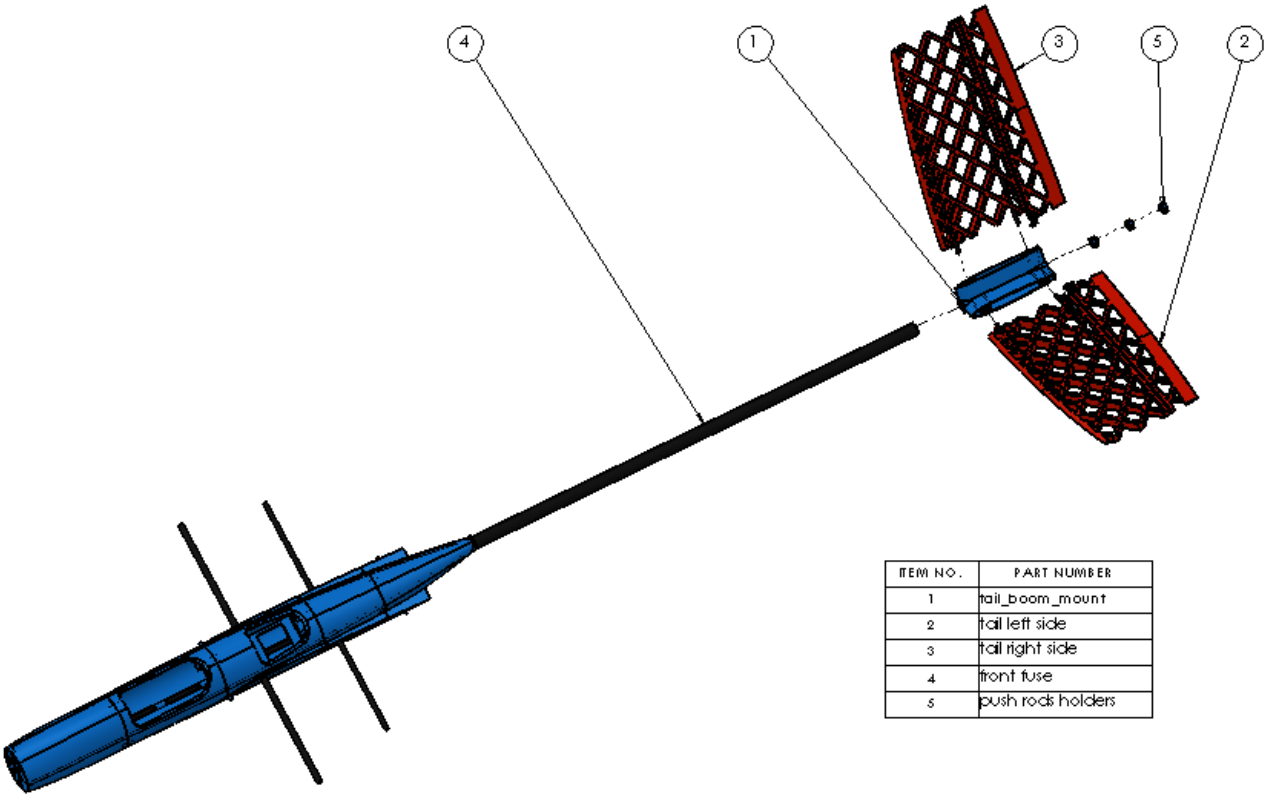
Insert and center back joiner rod into holes in fuse_1. Glue it in the place from inside of the fuselage. Then insert carbon fuse spars into spar leading tubes in fuse_1 and slide it all the way until it is touching fuse_0. Then apply glue from inner side of the fuselage.

Put servo mount plate (optionally you can drill servo mounting holes into the plate beforehand) into fuse_2 part and lead front joiner rod through holes in fuse_2 and hole in servo plate. Apply the glue to secure servo plate and joiner rod in place. Insert carbon fuse spars into spar leading tubes in fuse_2 and slide it all the way until it is touching fuse_1. Then apply glue from inner side of the fuselage.

Now you can continue with rest of fuse parts. Always put each part on their position and only then apply the glue from inner side.

If you opted for sailplane without motor then fuse spars are protruding 13 mm from the fuse_4_no_motor and you can glue fuse_5 to these. Otherwise fuse spars should be aligned flush with fuse_4_* when you are done with all parts.

Fuselage back

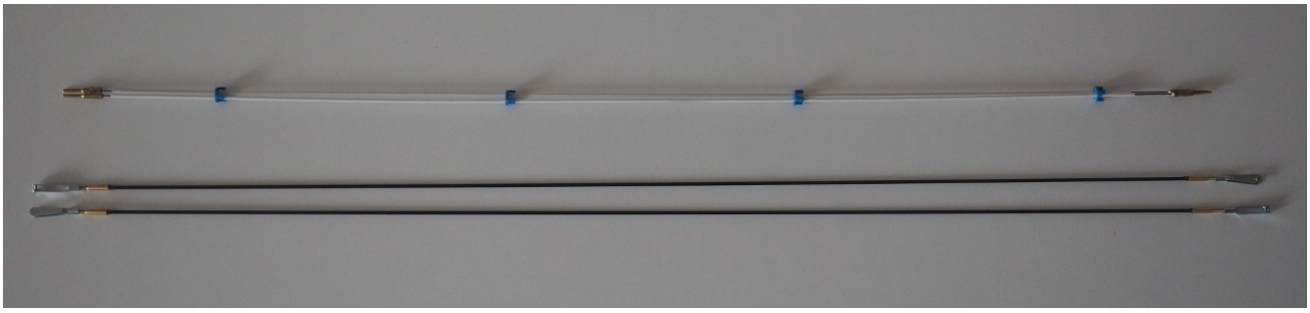


ITEM NO.	PART NUMBER
1	tail_boom_mount
2	tail left side
3	tail right side
4	front fuse
5	push rods holders

Glue together both sides of the tail with tail_boom_mount. Apply the glue only after tail parts are joined with tail_boom_mount.

Insert boom into tail_boom_mount. Aline the tail correctly with rest of the fuselage (use joiner rods as helping guide). Then you can put the glue from inner side of the tail_boom_mount where it is touching the boom.

There are multiple ways how to make linkage to the tail moving surfaces. If you opt for flexible type (the white one on the pciture), you can use printed push rods holders to restrict their bending in boom.
Linkage made of 2mm carbon tube is a bit more time consuming to make, but offers superior movement control and as a result of that, plane feels more responsive.



Covering

There is nothing special about covering 3D printed planes. It 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 tail covering. Cover it after you glued on the moving part with hinges.

Electronics

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

Motor

To avoid problems when setting correct CG, it is recommended to use motor weighting 80g. Inner diameter of the fuselage is 38mm. You should be able to fit inside motors with diameter up to 30mm.

Good option is *Turnigy Aerodrive SK3 - 2836-1040kv Brushless Outrunner* – with this motor Kodo will be no rocket. But it is enough for a little bit of fun. Part fuse_4_sk3_2836 has prepared mounting holes for this motor.

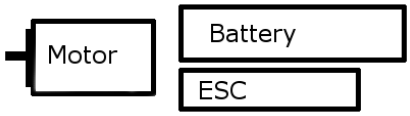
ESC

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*.

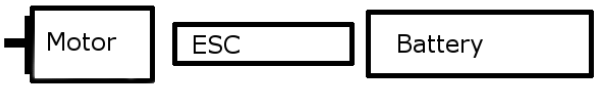
Battery

There are two basic setups:

- If you want to have small wing loading to do more thermal flying - install battery and ESC next to each other (in parallel) into the front area of the fuselage. To fit the battery into fuselage in such config it needs to be maximally 20mm thick, 30mm high and 80g heavy. Good options are: Turnigy nano-tech 950mah 3S 25~50C Lipo Pack or Turnigy 1250mAh 3S 30C Lipo Pack (Long).



- For more flying under power – install battery behind the ESC (in series). In this configuration bigger and heavier battery will fit inside of the fuselage. *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 or 4 if you are going for pure glider (no motor).

Servos

Good and affordable option which will fit nicely into Kodo is *Turnigy TGY-9018MG MG*. It is an analog servo with metal gears. You can use 4 of these (2 in the wings, 2 in the fuselage).

Settings and flying

CG

61mm – 64mm from wing leading edge measured next to the wing root.

I strongly recommend to use 61mm for first flight. Setting your CG exactly is very important!

Template for tail zero position

You can print this template, cut it out of the paper and use it for setting zero position of the tail.

Settings for maiden flight

Ailerons: 15mm up, 9mm down (measured closer to the fuselage)

Tail: 10mm up and down (measured closer to the fuselage)

Wings to fuselage attachment

There are no or only very little forces acting on the wings in horizontal direction. There is no need to attach wings too firmly to the fuselage. It also helps to absorb the energy during landing when the wings can detach easily.

Joiner rods on the fuselage have diameter of 3 and 4 mm, carbon spars in wings have inner diameter of 3 and 4 mm. To attach wing to the fuselage insert joiner rods into wing spars. Use tape to secure the wing where trailing edge of the wing is touching the fuselage.

Happy flying

Tomas

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