Testing the AVA Pro-e Flapped

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Fig. 1: The author very proud of his new AVA Pro-e Flapped

Introduction

I am a long time modeler, but I have always flown models that I was building from balsa kits. And I love RC gliders. On my flying field, a few of my fellow modelers were flying ARF made from composite, and those were beautiful. I wanted to fly one of these! I also wanted a model with spoilers or flaps. I had discovered painfully that with RC gliders, some days when there are a lot of thermals, it is a real problem to succeed to lose altitude safely if you do not have spoilers of flaps.

I discovered the AVA Pro-e from Vladimir models in Ukraine on the web site of Hyperflight in UK, and was seduced by the look and performance data of the plane. After a lot of thinking (it is not inexpensive), I decided to go for it. With such a nice glider, you want also a variometer, and I decided to order also from Hyperflight the “sky assistant” from Pitlab in Poland, that I had already tested successfully on other gliders. And I took also a nice bag to carry the wings. After my web order, I received an e-mail inviting me to select the color of the wings and took red and white.

Opening the box

After just a few days, I received a sturdy cardboard box in perfect condition. When I opened the box, I was amazed by the quality of the glider. The wings leading edges are made of carbon-kevlar-epoxy composite and are very strong, very light and almost perfect aerodynamically. The wing ribs are balsa with a carbon fiber – epoxy reinforcement on top and bottom. The elevator is made in a similar way, and is incredibly light (26 gr.) and stiff for its size.

The fuselage is in two parts. The front part is in fiberglass-epoxy composite, with carbon fiber reinforcements around the canopy and around the wings pod. The use of fiberglass composite allows keeping the receiver and variometer antennas inside the fuselage (but see more on that at the end). The rear part of the fuselage is a quite long, very light carbon fiber-epoxy conical tube, ending in a hexagonal section receiving the rudder section. The two parts of the fuselage could possibly be kept easily demountable to facilitate transport, but I selected to glue them together.

The total weight of the glider parts provided is just less than 900 gr. This is really light for a glider which has a wingspan of 3175 mm and a fuselage length of 1656 mm.

A bag containing a quite complete set of accessories is also provided. The only part that was missing in my package was an instruction sheet, but I called Hyperflight and they e-mailed me a quite complete instruction sheet for the AVA Pro-e, in the version with spoilers. Doing the modification for the version with flaps was quite easy.

Installing the servos in the tail

The first job is to install the two servos in the rudder. The rudder fixed part is a thin shell of carbon-epoxy composite with internal reinforcements. The instruction sheet received from Hyperflight is recommending the use of Hyperion servos. But all my radio gear is Futaba, so I decided to stick with Futaba. For the tail, I decided to use the Futaba S3114. This micro-servo has a high torque, small dimensions and a small weight (7.8 gr.)

Fig. 2: the Futaba S3114

The next question was to find the right method to attach the servos in the rudder cavity. Unlike the Hyperion servo recommended, the Futaba servo does not have fixation holes that could attach directly in the rudder cavity.

The servo fixation method had to be very light, strong (a loose elevator servo is a sure way to crash a glider – I know because it happened to me on an earlier model) and reversible. Gluing the servo directly in the rudder cavity did not seem a good idea: if for any reason I had to remove a servo, it is likely that I would break the composite from the rudder, not the glue joint.

So I decided to make a small support in carbon-kevlar-epoxy composite, and to glue the servo on this support. The servo-plate assembly would then be attached in the rudder by M2 metal screws and nuts. So I cleaned and scratched the surface of the servos to provide a good adhesion, and I prepared the support by wetting with epoxy a layer of thin carbon-kevlar fabric. I pushed the servos in the wet composite to glue it. The result can be seen below. It certainly looked good!

But when I tried to move the servos after, I found them to be completely blocked. The thin, slow curing epoxy had found its way inside the servo case at the joints by capillarity and so not only the servos were glued, but the gears inside the servo as well!! ☹

Well, that's how you learn

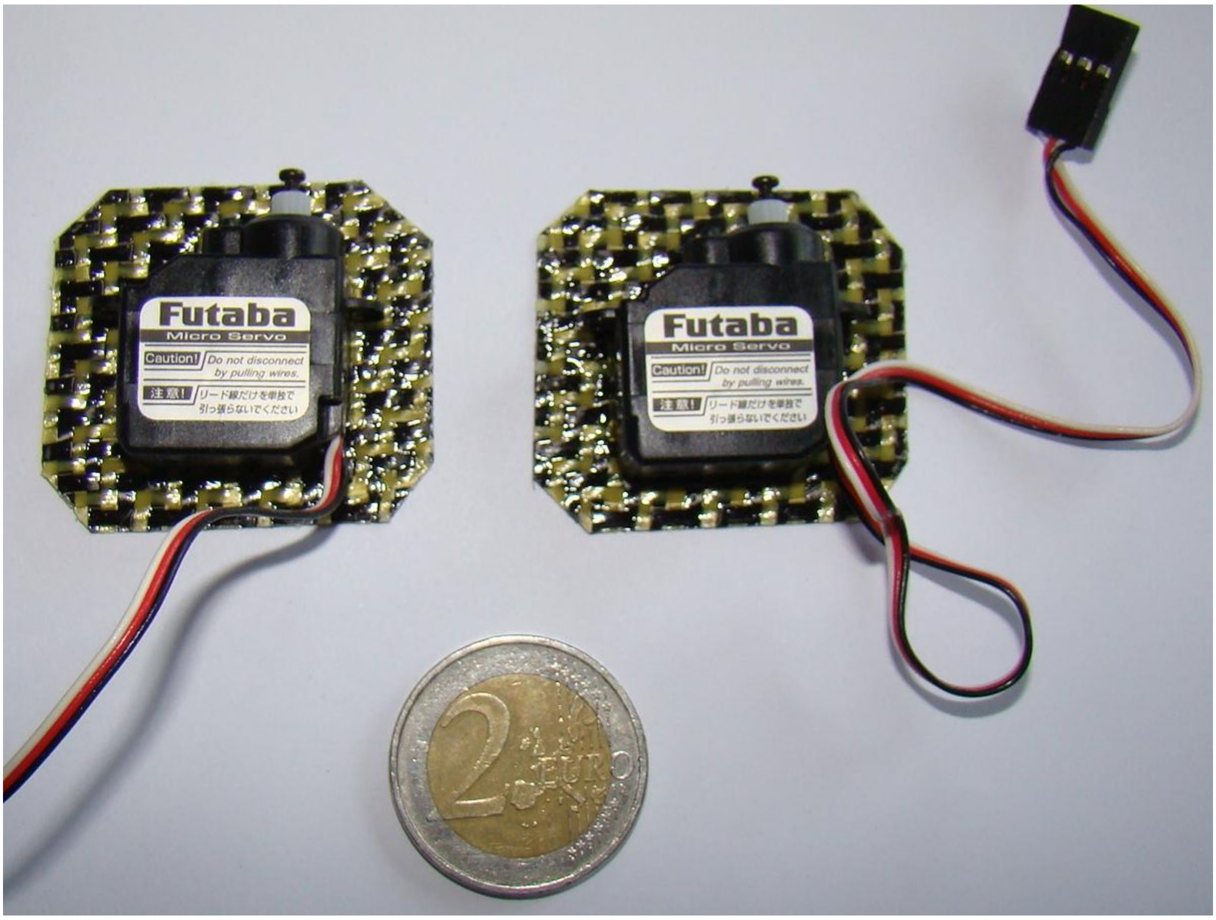


Fig3: Futaba S4114 servos glued to a piece of carbon-kevlar-epoxy composite and blocked by the epoxy

So instead, I formed a L-shaped profile in carbon-kevlar-epoxy composite to form a more classical servo support where the servo is attached by its usual support legs. The L-shaped servo composite servo supports were then epoxied in place in the rudders. When all was dried, the servos were attached to the servo supports by M2 metal screws.

Following the advice from Neil from Hyperflight, the rudder was attached to the tail boom by a single M3 screw, rather than by the fin quick-release accessory provided.

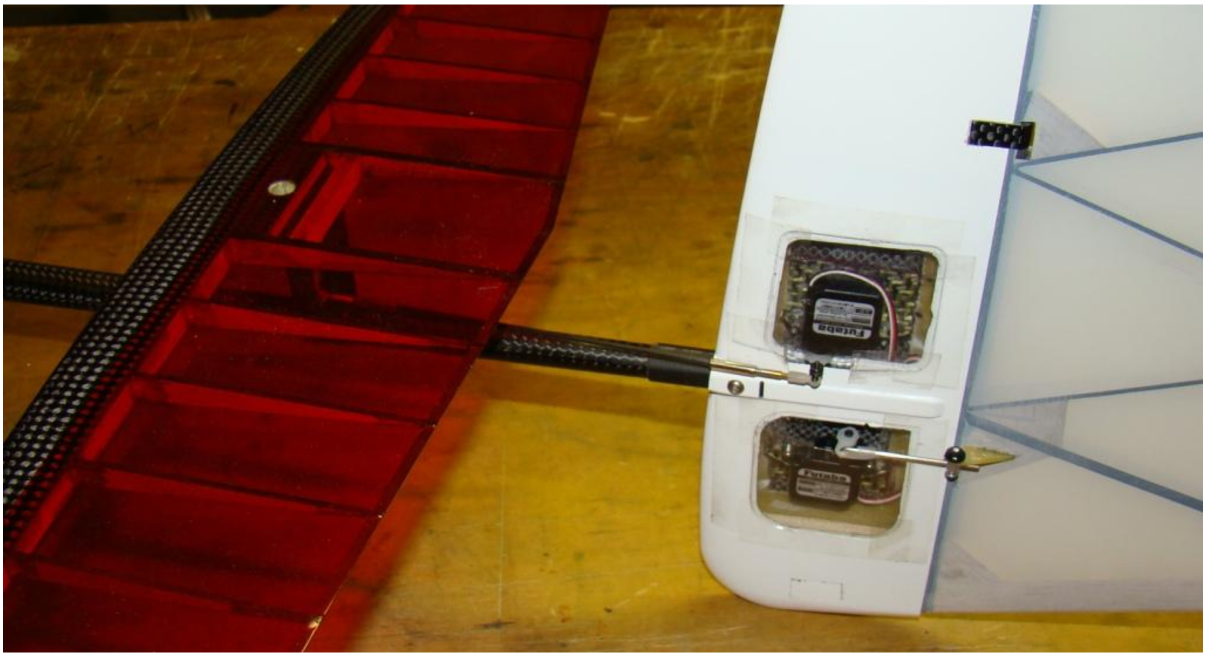


Fig. 4: The rudder and elevator servos are installed in the fixed part of the rudder

Fitting the long extension cables was not obvious. The cross section of the male connector on the extension cable was larger than the inside dimension of the tail boom. I had to cut away the external plastic jacket of the male connectors. Then the female connector from the servo and the male connector of the extension cable were secured together with heat-shrink sleeve.

After installation, the servo cavities are closed with clear plastic covers, provided with the glider. I attached these with adhesive tape.

The finished fuselage is quite long, and the mobile surface of the rudder is at the end of it. I realized that I was often bumping the mobile surface of the rudder in transport. All these shocks are transmitted to the servo gears, and after a couple of trips to the flying field my rudder servo was dead with stripped teeth’s in the gears. So I replaced it, but to protect it from future shocks I installed a servo saver with two metal springs in the linkage, as illustrated below:

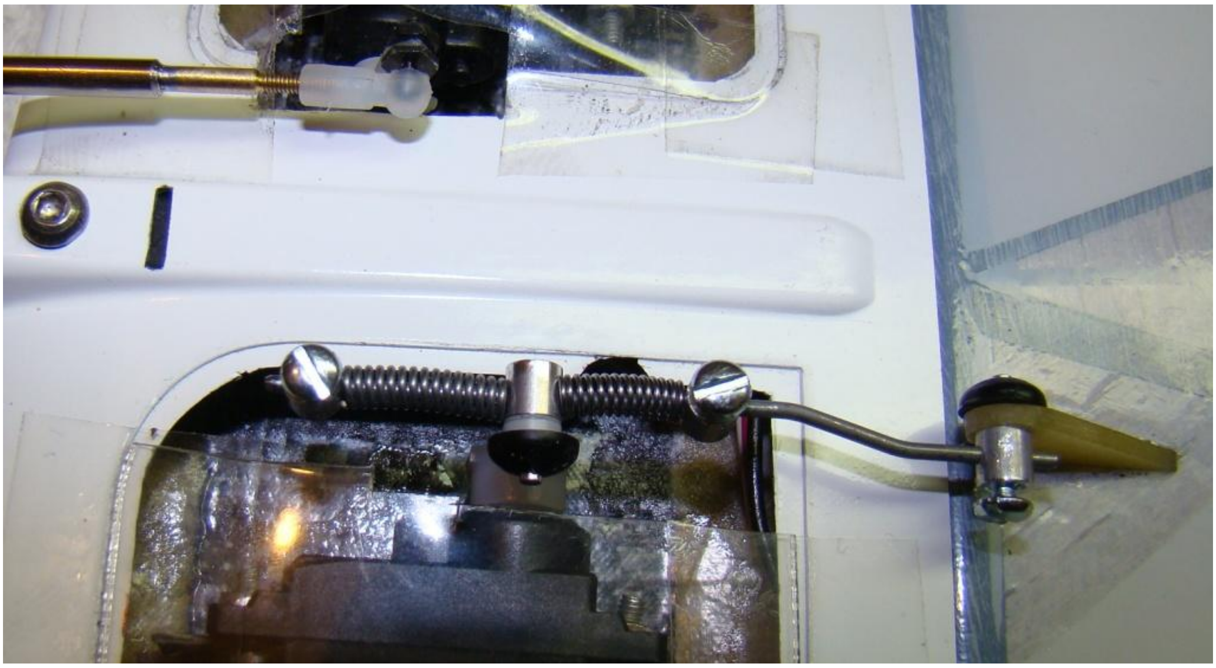


Fig. 5: Rudder servo saver to protect the servo from the shocks in transport.

Installing the servo for the flaps

A normal size servo was installed in the wing to control the flaps. Due to the limits of my transmitter, the flaps are controlled in all or nothing by a switch. Obviously, I selected the flaps in line with the rest of the wing for the OFF position, and the flaps deflected around 75° in the ON position.

The linkage between the servo and the flaps presents no special difficulty. However, there is always some play in the flaps position, amounting to + or – 2 mm at the trailing edge of the flaps. This is undesirable, especially when the flaps are in the OFF position. The reason of this play is not the servo nor the linkage, but a play in the flaps rotation axis. The flaps are mounted on a carbon fiber tube. At the center of the wing, this tube is held in position by a U-shaped part made of carbon-epoxy composite. There is around 0.5 mm play between the carbon fiber tube and the U-shaped guide. Considering the short length of the flaps control horn, this results in about 2 mm play at the trailing edge of the flaps.

The propulsion system

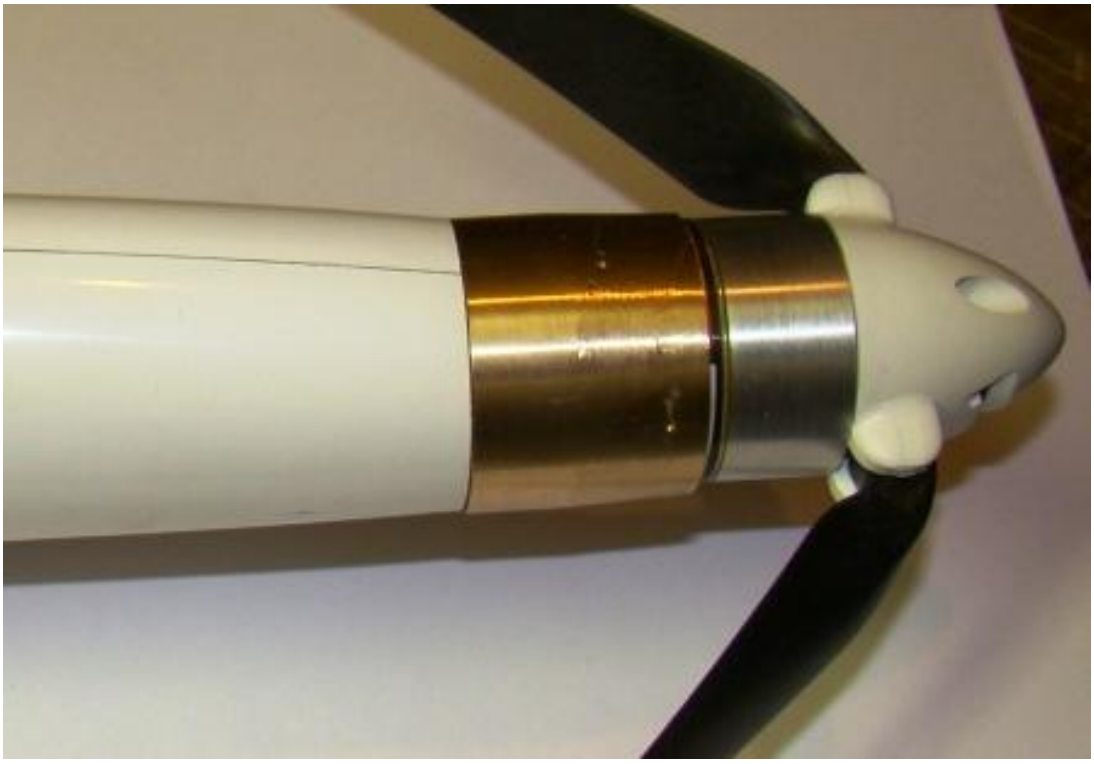


Fig. 6: Propulsion system: the motor is attached in front of the fuselage, rather than installed inside. The brass adaptor is fixed and surrounds the motor. The aluminum adapter rotates with the propeller.

Fig. 7: Propulsion system selected for the AVA Pro-e. A second motor is pictured besides the one already installed on the glider

When reading the manual, I saw that a pretty heavy motor was recommended. And even with this, it seemed unavoidable to add lead in the nose to achieve the desired CG. In my airplanes, I use outrigger brushless motors from Electrifly (distributed by Great Planes, available through Tower Hobbies). I buy my ESC and Li-Po batteries from the same source. I did some calculation, and decided that the Electrifly 15 outrigger motor (35 mm OD, 36 mm long, K=1200) with a 9 x 6” Multiplex folding propeller, a 3 cells, 2200 mAh LiPo and a 45 A ESC would be a fine combination, developing a bit more than 1000 gr. of thrust at launch. However, this combination is not heavy enough to balance the glider if the motor is placed at the expected location in the fuselage. In addition, the relatively large diameter of the motor made the installation in the fuselage somewhat difficult. So I decided to put the motor outside, in front of the fuselage, screwed to the front bulkhead. This is good to balance the plane, but if nothing else is done it is ugly from an esthetical viewpoint, and a sure way to ruin the very high aerodynamic performance of the plane.

So, to improve the aerodynamics and esthetics, I machined on my lathe two adapter pieces. One fixed around the motor and connecting to the fuselage made of brass to balance the CG. The other one rotating with the front part of the motor and attached with the propeller spinner.

Internal setup and balancing the CG

The next step was to finish the installation to reach the right location of the CG without having to add lead weight. The wing weights 604 gr. and its center of gravity is 10 mm forward of the recommended CG for the plane. The fuselage weights 808 gr. with everything on board. This means that to get the plane CG on the right spot, the CG of the fuselage must be 7.5 mm behind the plane CG. A small jig was built to balance the fuselage on its required CG

Fig.8: Suspension jig used to balance weights in the fuselage

Using this jig, I found that my fuselage had a tendency to be nose heavy, and not the opposite as I expected. As a result, I had to push the battery quite to the rear of the canopy opening. The battery is prevented to move forward by a balsa block glued to the epoxy composite. This is less likely to injure the battery in case of hard landing. On the two sides, the battery is pressed between foam pads also glued to the fuselage

The layout inside the fuselage is illustrated by the next picture.

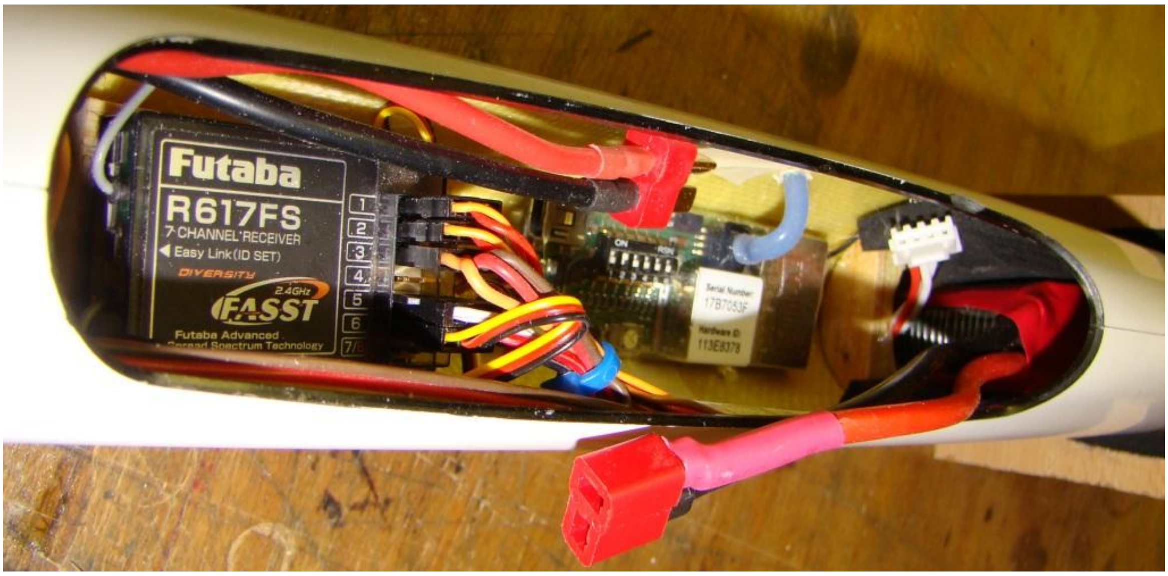


Fig. 9: Layout of elements in the front of the fuselage. The front of the plane is on the left.

As illustrated above, the cross section of the fuselage is not large. It helps the aerodynamics, but makes the inner layout a bit more challenging. I located the Futaba R617FS FASST receiver in the front, and located behind it the Pitlab Sky Assistant variometer. The variometer antenna had to be folded to go forward, because behind the canopy opening the fuselage is reinforced with carbon fibers. As carbon fibers are electrically conductive, they absorb and block radio waves. The result is that the transmitting antenna of the variometer is very close to the receiving antenna of the receiver, a situation that I do not like too much, but there was no space to do otherwise.

Actually this layout gave a good ground range with the transmitter on low power, and the first flights were fine. But on a later flight, when the glider was both very high and very far, it made once or twice some unexpected moves that I attributed to radio transmission glitches, but without being sure. That made me uncomfortable. Now, I have drilled two very small holes in the fuselage on both sides of the receiver, and I have directed the active part of the two 2.4 GHz antennae radially out of the fuselage. The active part is the unshielded outer 30 mm of each antenna. So my bird has now two thin flexible whiskers coming out of his nose, 30 mm long and less than one mm in diameter. Since I did that, I have seen no indication of radio glitches, but honestly I am not sure that what I had observed before was really radio glitches, and not a sudden effect of local air turbulence.

When you work on the fuselage in your shop or prepare it for the flight at the field, it is nice to have a support to prevent it rolling. The following picture illustrates the very simple support I made.

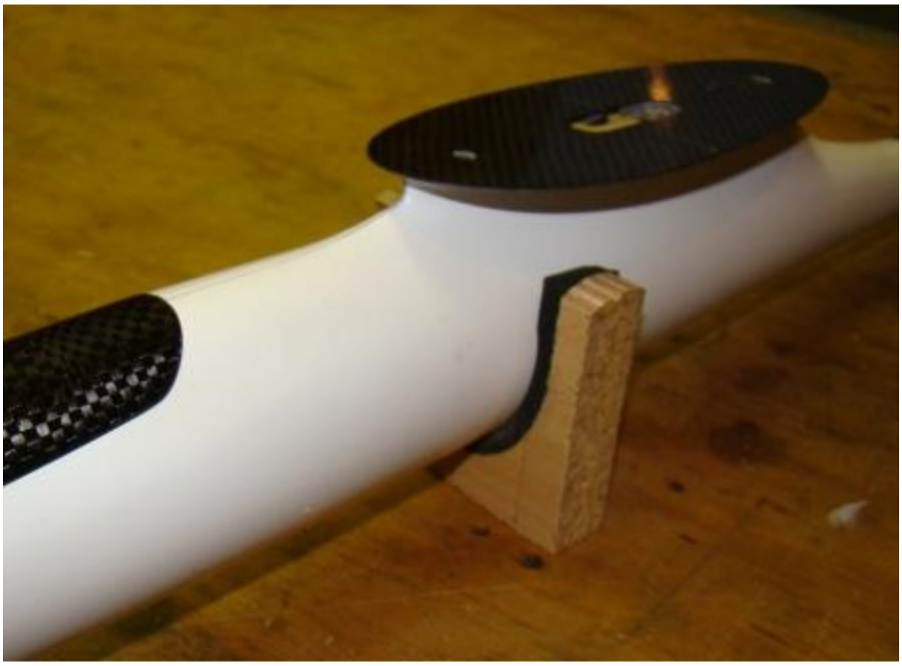


Fig. 10: Rectangular wood fuselage support

Adjusting the control throws

The control throws of the tail were adjusted according to the recommendations of the instruction sheet:

- Rudder: 50 mm each way
- Elevator: 15 mm up, 10 mm down
- Flaps: 75°down deflection

Two mixings were also programmed in the transmitter. The first one is some amount of elevator down when the motor is turned ON, and the second is a lot of elevator down when the flaps are lowered. The exact amount of mixing was tuned during the test flights, and here are the final values:

1. Mixing 1: 2 mm of down elevator when full throttle is applied
2. Mixing 2: 10 mm of down elevator when the flaps are lowered to -75°

I found convenient to make a small tool to check the elevator tuning and the mixings. It is just a thin blade of aluminum with a ruler which snap-fits onto the carbon composite tail boom. It is illustrated in the following picture:

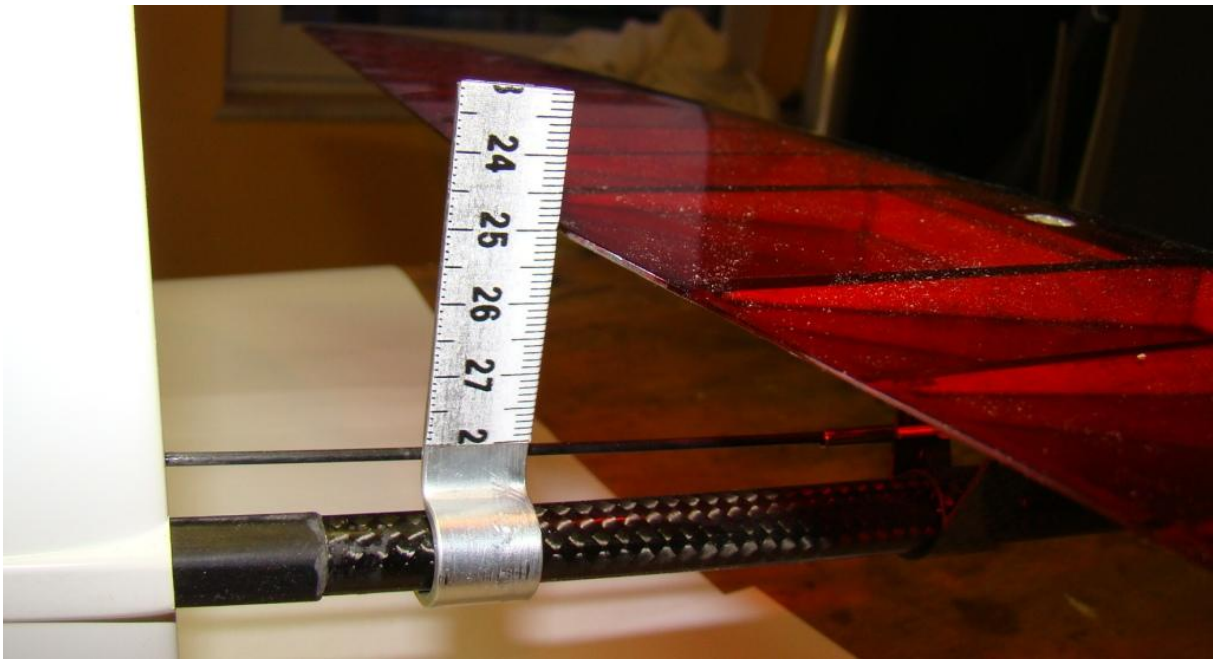


Fig. 11: Small tool to check the elevator settings

Flight tests

I selected a nice day with low wind to test the AVA Pro-e at my club flying field. I started by a few hand launches without motor to tune the elevator and rudder trim, then I applied motor. This motor/propeller/battery combination develops a powerful thrust, and the AVA climbs very rapidly. I had carefully calibrated the altimeter of my Sky Assistant variometer, and after calibration my altitude readings are accurate to 1..2 meters. In a few seconds, the AVA was above 150 m, and I gradually stopped the motor. The AVA flies really fast with the motor ON. At the end of the climb, it is better to bring the glider to a level flight and to slow it gradually to do a smooth transition to the glide flight which is much slower.

Fig. 12: Hand launching the AVA Pro-e

Fig. 13: The AVA Pro-e climbing away

In glide mode, the AVA Pro-e is a pure delight to pilot. It is very stable, but responds well to the controls. When properly trimmed it has a very low sink rate, and will go up at the slightest trace of a thermal.

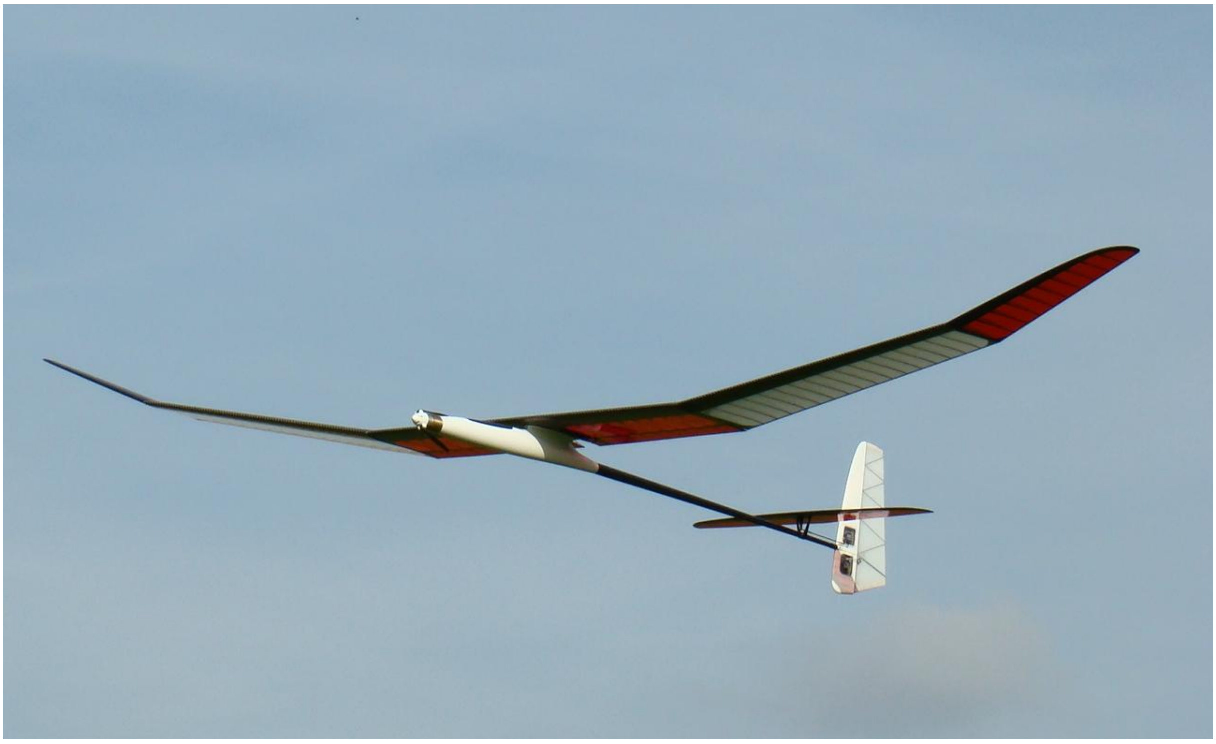


Fig. 14: The AVA Pro-e, gracefully gliding

The flaps action

After a couple of flights, I decided to test the flaps action. In my transmitter, I have only a switch for the flaps, so it is all or nothing. I actuated first the flaps at a safe altitude. The glider stalled violently! It was quite spectacular, and I had to apply a lot (really a lot) of down elevator to make a smooth descent on the flaps. But when the mixing was well adjusted, the result was excellent. When the flaps are actuated, the AVA goes into a rather steep dive, but without increasing speed. The transition from normal flight to flaps and back goes smoothly without hiccups, so the flaps can be used up to very close to the ground. However, I am convinced that it is not a good idea to land with the flaps down, because the flaps will hit the ground first and the flaps linkage or the servo could be destroyed.

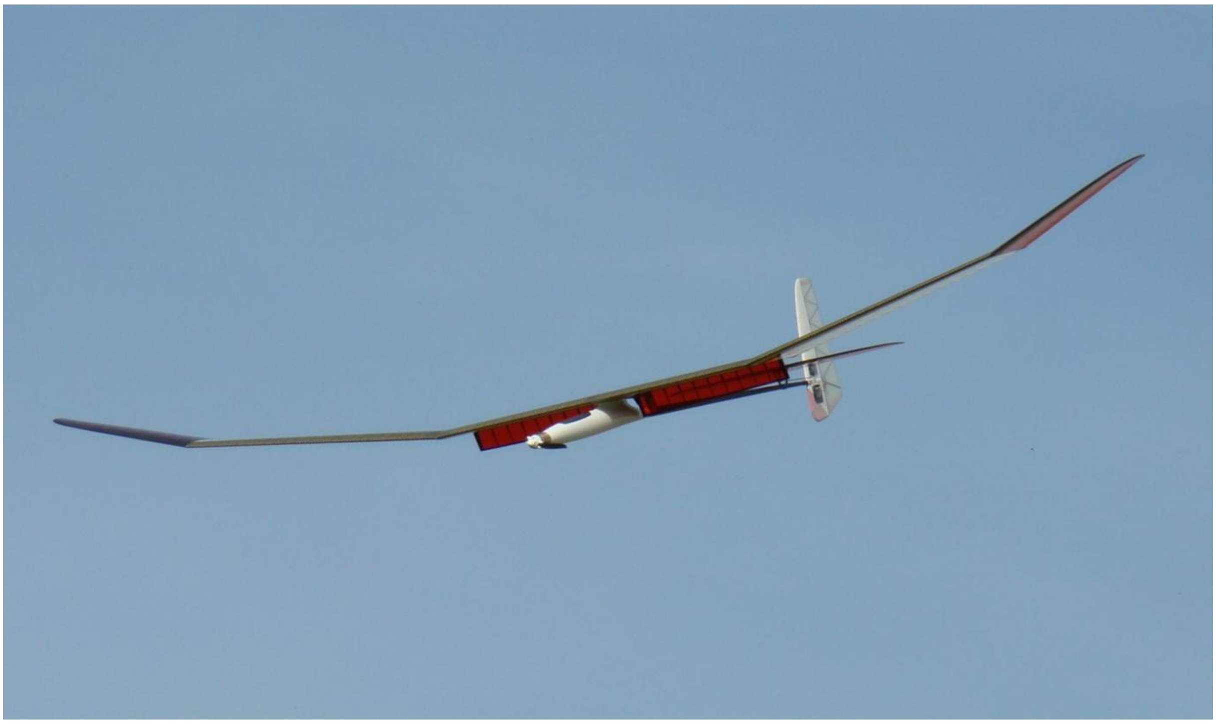
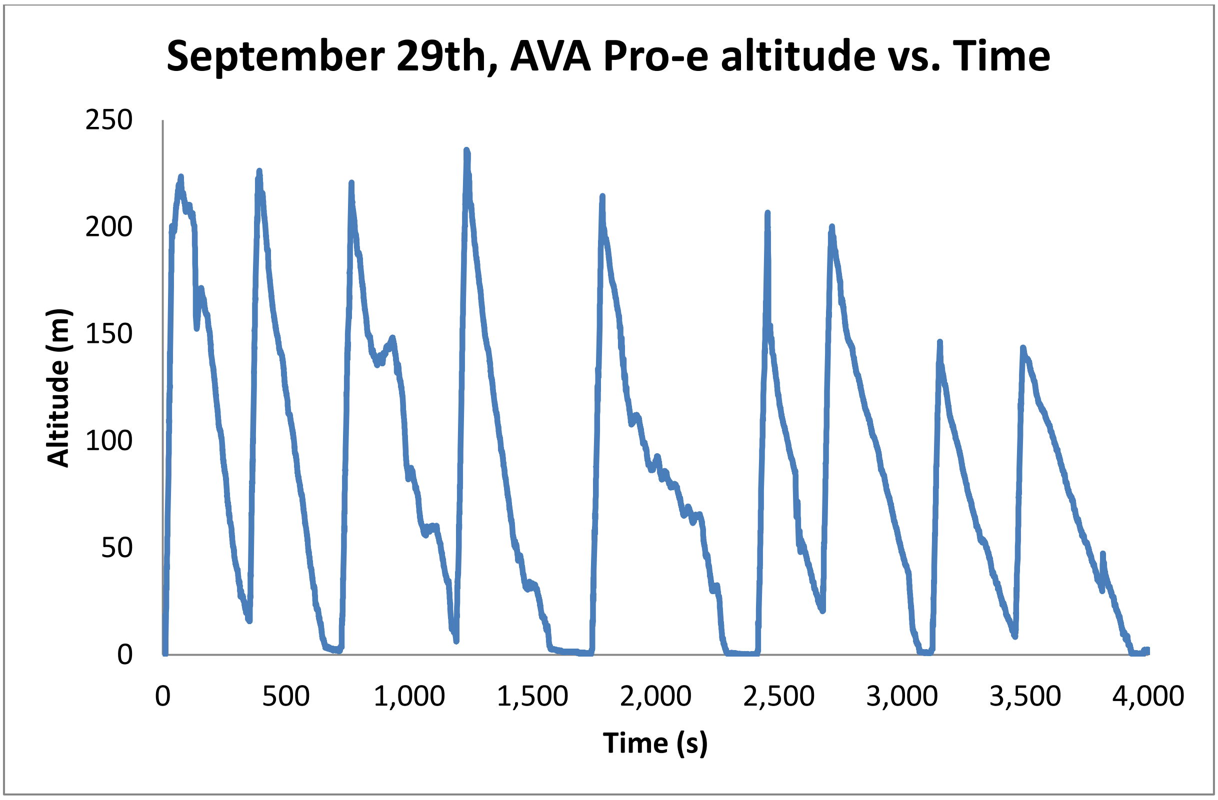


Fig 15: The AVA Pro-e in a steep but slow dive with the flaps down

Fig. 15: The AVA approaching landing with the flaps down. It's time to put the flaps back up to avoid damage when the flaps hit the ground

Measuring quantitatively the flight performance

The Sky Assistant variometer has a built in logger, recording a number of parameters versus time. As the altitude of this Sky Assistant was carefully calibrated, I could use the file describing the altitude versus time to assess quantitatively the fly performances of the AVA Pro-e, both during the climb and during the glide. Of course, it is necessary to select a day when the air is very calm and when there are no thermals, or at least very little. In this case, the loss of altitude versus time is very regular. This was the case on September 29th 2011, in the late afternoon. The weather was nice, the wind was very low, and as we were nearing the sunset, the thermals were dying. Here is the plot of the altitude versus time:



The first observation is that I could fly a quite long time (more than one hour) on a single battery, a 3 elements Li-Po of 2200 mAh capacity. As can be seen, I could climb 9 times out of this single battery. In climb, the motor uses around 25 Amp. so the time to discharge the battery is around 5 minutes, or 300 seconds.

With the selected motor/propeller combination, the climbing speed is quite good. It is slightly above 7.5 m/s for the first climb, when the battery is fully charged. As expected, the climbing speed decreases when the battery gets discharged, and for the last climb it is only 5 m/s. So, in the beginning, it takes only around 30 seconds of motor to reach 200 m and at the end it takes around 40 seconds. I generally stop the motor around 200 m because the glider becomes less visible if I climb too high. Lifting a mass of 1.4 kg (this is the mass of my AVA Pro-e in flying condition) against gravity at a speed of 7.6 m/s represents a power of 105 W. The electrical power used by the motor when the battery is fully charged is 11V x 24.8A = 275 W. So the total efficiency of the propulsion system during climbing, including the propeller efficiency and the glider drag is around 38%, which is very decent!

The next logical step is to look at the rate of descent during the glide. This rate of descent is very dependent of the trimming of the elevator. Generally, the lowest rate of descent will be observed if the elevator is trimmed for a low speed, but of course not too close to the point of stalling. It can be observed that the lowest rate of descent was observed in the 3 last descents, where the elevator trimming was optimal. This rate of descent is around 0.35 m/s. This is really impressively low for a model glider, and is the lowest rate of descent I ever observed on any of my gliders. This shows that the weakest thermal will be sufficient to gain altitude with the AVA Pro-e.

Finally, it is interesting to note that while the AVA Pro-e is extremely stable in flight, it will not recover automatically from a stall without some correction of the pilot on the elevator. I induced a stall on the AVA Pro-e, and then observed his behavior without applying corrections. I observed that the glider engaged in a series of stalls, followed by diving and climbing again almost vertically, with increasing amplitude. There was no sign of a spontaneous stabilization. But when I acted on the elevator, it was very easy to restore a level flight and a smooth glide. So, clearly, the AVA Pro-e is not a trainer. You cannot take your hands off the transmitter and expect that the glider will return to a level flight from any condition. It needs a pilot.

Conclusions

The AVA Pro-e is Flapped certainly the best flying and most beautiful RC glider I ever owned. The quality of the parts is outstanding, and the level of finish is perfect. The sales service from Hyperflight was excellent, with fast responses to my questions. The packing was very sturdy and well made, and the glider was delivered in perfect condition.

Assembling the AVA Pro-e Flapped raised no special issue. Flying this glider is a fantastic experience. With the power pack I selected, the climbing is extremely fast and stable. 30 to 40 seconds only are needed to reach an altitude of 200m. With a Li-Po battery of 3 elements and 2200 mAh, 8 to 9 climbs are possible, allowing more than one hour of flight, even in the absence of any thermal.

When gliding, the glider is extremely stable but very responsive to the control. When the elevator is properly trimmed, the rate of descent was measured to be only 0.35 m/sec. This less than any other glider I know, and this means that the AVA will gain altitude even with the weakest thermal activity.

The only minor criticisms I could express was that an instruction sheet for the AVA Pro-e Flapped was missing from the package, and that the attachment of the flaps has some play, which results into a slight play of the finished flaps.

Weights table

	gr
Wings	**604**
Central panel	274
Outer panel right	167
Outer panel left	163
Tail	**109**
Carbon boom + elevator support	44
Elevator	26
Rudder fixed + mobile panel	39
Fuselage	**226**
Fuselage without lead weight	151
Motor covers	35
Canopy	7
Various accessories	33
Weight of glider structure	**939**
Radio equipment	**76**
Receiver	9
2 tail servos + base plate	14
Extension cables	20
Flaps servo	23
Various hardware	10
Propulsion equipment	**381**
Motor Rimfire .15 35-36-1200	123
ESC SS-45	55
Battery LiPo 11,1V 2100 mAh	171
Folding propeller 10 x 6	22
Spinner	10
Telemetry equipment	**16**
Sky assistant	16
Fuselage ready to fly	**808**
Total weight ready to fly	**1412**