Discus Launch Glider Build

by FlyingDrMike

The thought that one can hand launch a model glider to 100-200ft altitude seems amazing – but is possible with Discus Launch Gliders (DLGs). To launch one holds the glider by a finger grip on a wing tip and then one spins around as throwing a discus. In order to get to 200ft the glider needs to be launched at >80mph, and the g force in the rotation is over 25g. This is a little faster than a discus (~55mph) but the glider is 6 times lighter. With the gliders weighing around 300g (11oz) the 25g force comes out at 7.5kg or 17lbs – easy to take on a straight arm. For some great demos search for 'DLG glider' on youtube. Also look at my flight later in this instruction.

The need for high strength, light weight and clean aerodynamics means that a composite built model is needed. I had started with a cheap HobbyKing model with conventional covered balsa wings which was great for testing interest but was higher drag and hence gave poor launch heights. It was also around 40% heavier and so came down faster. Hence shorter flights and less time to find some lift.

The instructable here shows my build of a 'Blaster 2'. The kits comes with the moulded wings and fuselage complete and with hardware to build the control linkages. The rudder also has to be attached to the fuselage - that was a bit more difficult with my kit. The mount for the all moving tail has to be glued in place. However the major activity is installing the radio gear and control hardware.

I did several things differently to the instructions in order to save weight and make a neat installation. I hope some of these will be useful to other builds of DLG kits. In particular I mounted all 4 servos in the nose to reduce the nose weight required and hence reduce the overall weight. I also used a neater, more maintainable and lighter servo mounting system. The control horns were all replaced with lighter carbon ones and their length was carefully set to match the servo arm length and movement that was possible within the confines of the nose cone.

This model is the most expensive in my fleet by some margin and hence the approach to the build was 'If a job's worth doing it is worth doing right'. Hence it took longer and required a fair bit more planning/checking with the changes implemented.

In broad terms I followed the sequence of starting at the tail and worked forward:

1. Elevator
2. Rudder
3. Tail control rods
4. Servo arrangement
5. Radio installation

Before starting I weighed and found the centre of gravity (COG) for each of the parts, plus servos, radio and battery. I put these into a spreadsheet so I could see where the final model COG was likely to be. From this it became clear that I would need less nose weight if I put the aileron servos in the nose rather than the wings. I had seen comments on doing this but no examples– a gap that I hope this instructable fills.

Step 1: Elevator

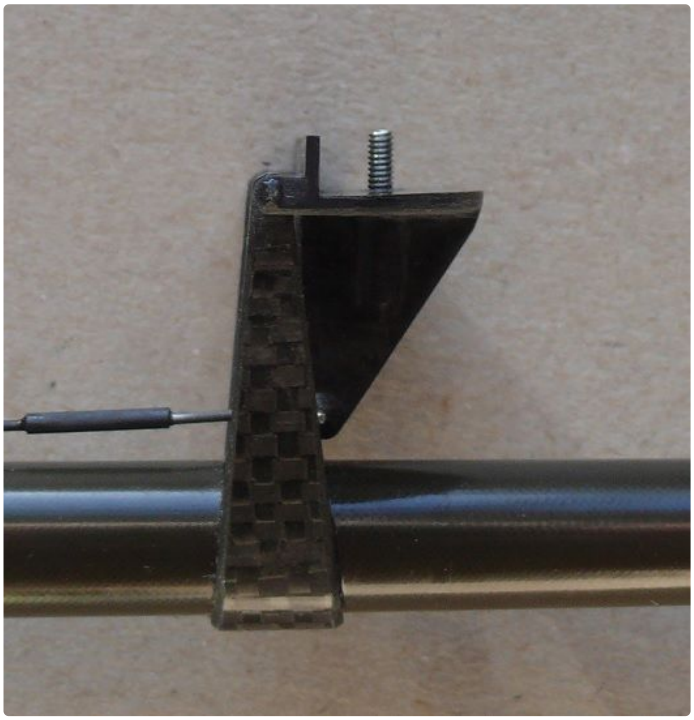
The Blaster 2 has an all moving tailplane mounted on a carbon V mount. The mount has to be fitted before the rudder as it slips over the boom.

I noticed that the attachment screw did not rest flat on the upper surface of the tailplane/elevator. This was because the V mount assumes parallel top and bottom surfaces and the elevator was essentially triangular in cross-section from the mounting plate to the trailing edge. To correct this I filed a piece of 0.5mm carbon sheet to make a wedge and glued this onto the mounting plate bottom surface. See photo above. I rounded all the edges of the V mount to hopefully lose a tiny bit of weight and drag (I don't suppose very much).

After the mod the screw presses more evenly on the top of the elevator:

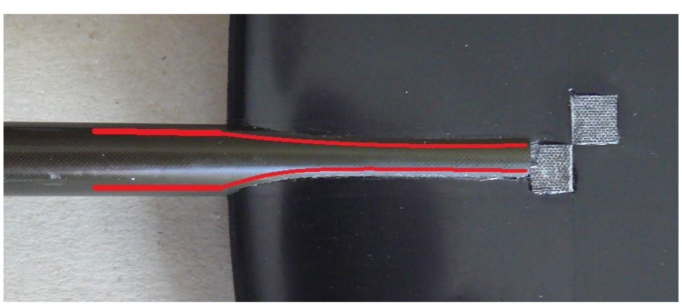
The target is to have the trailing edge of the elevator 5mm in front of the leading edge of the rudder. This position was found with rudder fitted loosely. Masking tape was wound around the boom forward of the mount so it could be positioned easily with adhesive applied. I prefer epoxy to cyano as it gives a longer handling time and a stronger joint. I had also sanded the mating surfaces for a good joint.

In order to get the elevator flat relative to the main wings the mount was fitted with the main wings in place and the elevator attached to the mount. The alignment was checked carefully before leaving for the epoxy to set.



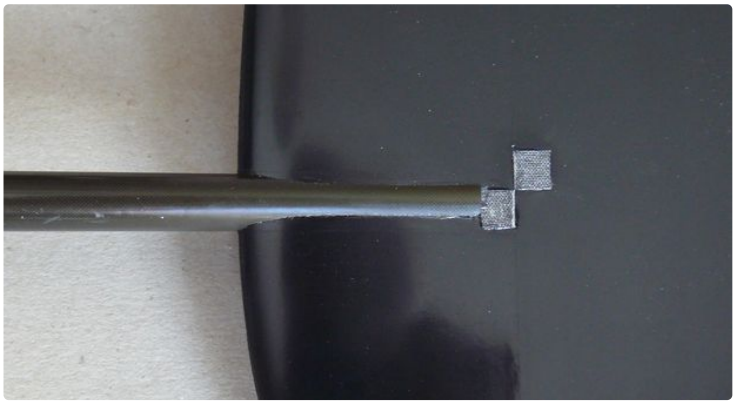
Step 2: Rudder

The rudder glues into a slot the rear of the carbon tail boom. Unfortunately the slot in my kit was not vertical. I explored options, including getting a replacement fuselage, but the rudder was also a little thicker than design and it looked like careful trimming could lead to a fit. So I decided to proceed. This would leave the tail a little weaker with thinner pieces of the carbon boom either side of the rudder. So I added two 60mm lengths of 1mm2 carbon tow starting inside the top and bottom of the boom and the splitting each of these so half ran down each side of the rudder, still inside the boom. Tricky but worked OK. See photo below for the positioning of the carbon tows.



I again used epoxy. I had masked off the rudder around the joint and the outside of the boom before assembly to aid removal of a small amount of surplus adhesive. This also helped giving a minimal sanding of the rudder side of the joint to remove the gel coat and get a better joint.

I have described this as if done after the elevator mount. However given the uncertainty on whether I would get the rudder vertical I did the filing of the rudder slot first and then fixed the elevator mount, followed by gluing the rudder in place. Hence in order to sand the rudder slot vertical I had to use a straight edge on the main wing mount as a reference – having also checked that this was representative of the main wing position. It would have been easier to have fixed the elevator mount first and used this as a reference to get the rudder upright.

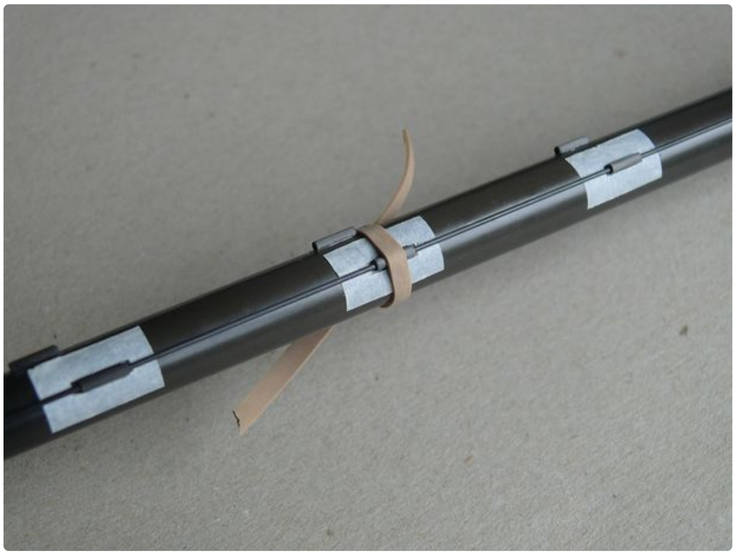


Step 3: Tail Control Rods

The tail control rods are 0.8mm diameter carbon rods. The design has these running on the outside of the tail boom. It would look much neater if these were inside. However after much thought I stuck with the outside as the internal option would end up heavier and weaken the boom where the rods exited. The design has the rods guided by a series of 10mm long tubes at around 50mm spacing. I was however not happy with using the supplied plastic guides as my experience of gluing to plastics is poor. So I decided to use 2mm OD carbon tubes (1mm ID) and file a flat on one side to both get the rods closer to the boom and provide a flatter surface to glue and hence save a tiny bit more weight. I also reduced the guide length to 8mm and increased the spacing to 55mm to save a bit more weight.

In order to get these guides aligned I cut pieces of masking tape with a hole just bigger than the guides and carefully placed these on the boom before gluing the guides in place. I also used a piece of 1mm carbon rod to aid alignment. I started by fitting the guides next to the elevator mount. I could then use a straight edge from here to the tubes at the front of the boom to place the pieces of masking tape. I then progressed fitting one guide at the front and one at the back and then, after waiting to set, moving on to the next pair, gradually getting to the middle. The photo above shows the last of the main rudder control rod guides being fitted. I then made up an offset guide to give some support between the elevator mount and the rudder horn. This was fitted later when I knew what pushrod movement I could get from the servo and hence the size of the rudder horn, and hence the amount of offset required:

The all moving elevator link was straightforward (well something had to be!). I raised the last guide 0.5mm to help give a smooth run to the horn:



Step 4: Servo Arrangement

This took quite a while to design. The aim was to have the servos as far forward as possible to minimise the need for nose weight.

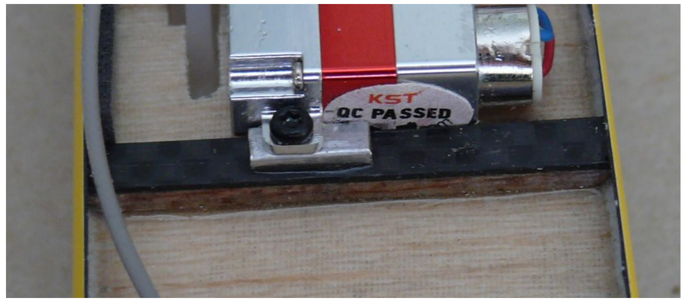
The battery would be furthest forward. So the first question was ‘which battery was I going to use?’. A 380mah 2 cell lipo would be big enough. I had already decided that I would use high voltage servos. This avoids the need for a voltage regulator – that then saves space and weight and also means a smaller capacity battery can be used (no energy loss from the regulation).

I had also already bought the servos and had opted for the version designed for mounting flat rather than upright (KST X08H v3 HV). These are designed for mounting in wings – that was no longer my plan! However mounting servos horizontally rather vertically also makes good use of the space in a nose cone.

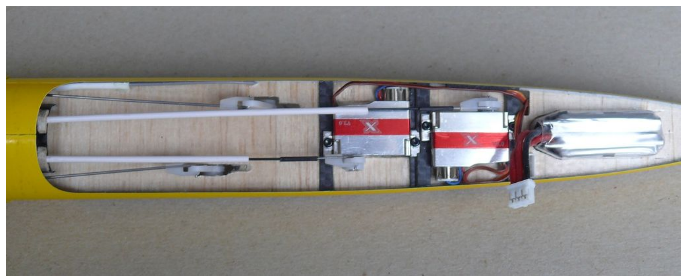
I then did a bunch of drawings with servo positions, potential servo arm lengths and push rod routes. I double checked space using pieces of card with different diameter holes for nose diameters at the servo positions. At first I had the rudder servo most forward as this would enable the pushrod to pass over the elevator servo. The rudder servo arm needs to be fairly long for the large rudder movement while the elevator servo arm is short with the small movement of the all moving elevator. I disbanded this when I realised that the pushrod would need to be more than the standard 1m length. So the elevator servo had to go in front and the rudder servo set into the 2mm thick servo tray (but not through it) so the elevator pushrod could pass over it.

The aileron servos needed arms as long as possible and hence could be installed underneath the servo tray with their arms going upwards through holes in the tray.

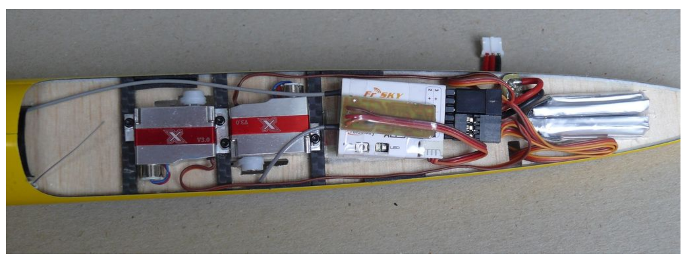
DLG servos are traditionally mounted by wrapping in tape and then gluing in place. This looked too messy and heavy to me, plus not easy to remove the servos if they fail. So I decided to use 4mm wide strips of 0.5mm carbon sheet to span the servo tray at each mount and then epoxy small aluminium blocks tapped for a #0 UNF screw that was the right size for the servos. I had the screws from a 250 size helicopter. The carbon strips had pieces of balsa underneath to raise them to the height required. See photo below:



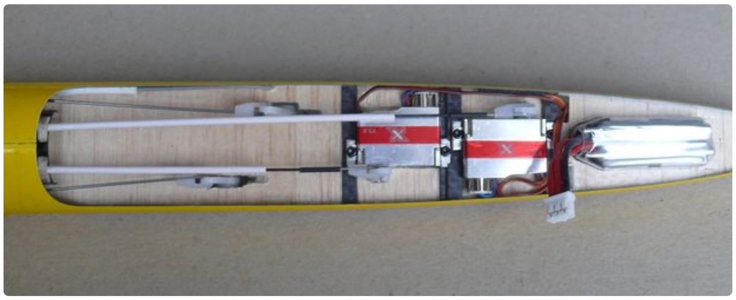
The elevator and rudder servos where mounted on top of the servo tray, behind the battery:



The aileron servos were mounted in the underside of the servo tray:



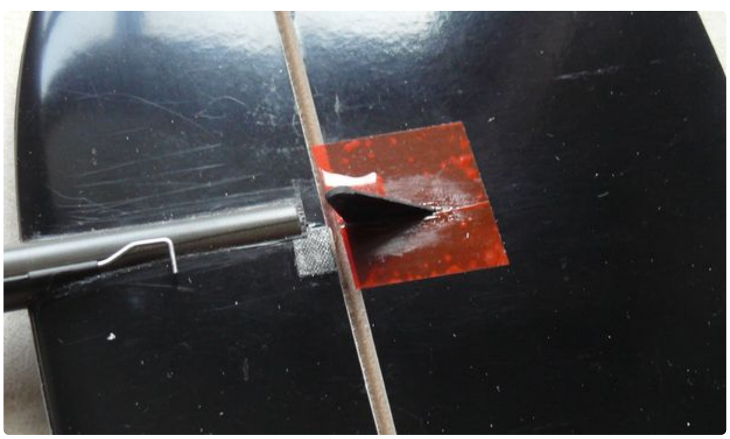
Here is a horizontal view:

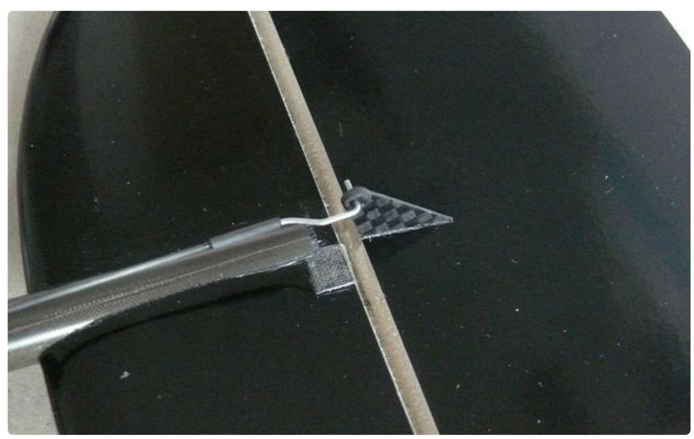


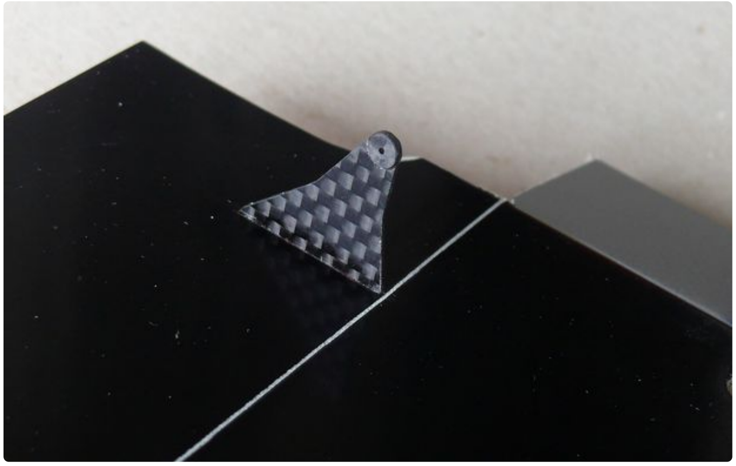
Step 5: Control Horns and Aileron Control Rods

With the servo positions set and the maximum arm lengths known I could set the lengths for the rudder and aileron horns. In both cases I used slightly longer horns. I made the slots in the moving surfaces using a 0.7mm drill and chain drilled against a straight edge. The horns were made from 0.5mm carbon sheet with doublers to give extra strength where the push rod attaches. The aileron horns supplied were 1mm thick which is overkill. 0.5mm carbon is plenty strong enough.

For the aileron control rods I decided to use 0.8mm piano wire - the same as at the ends of the tail control rods. I considered using carbon rods but these would have needed to be a bit bigger diameter (longer free run) and then needed joints to the piano wire ends. So the weight saving would be small, if any. Finding the place to drill the exit slots in the nose cone was a bit scary. I assembled the wings and used a straight edge to mark the line between the rod ends in the horizontal and vertical planes. Where they crossed was the place for the hole - that was elongated as required for the shallow angle of exit. See below. I have marked the servo arm position for clarity. It is not vertical as the ailerons need more down movement than up when being deployed as flaps:

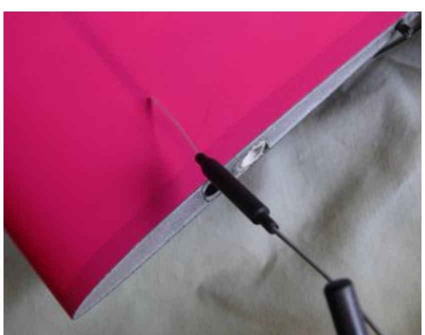


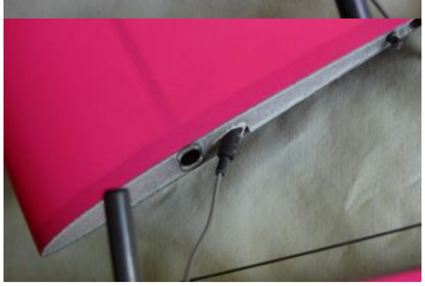




Step 6: Radio Installation

I had already fixed the battery location and there was space for the receiver on the underside of the servo tray, below the rudder and elevator servos. There was also room for my very small altimeter/variometer next to the receiver. I use FrSky radio with their excellent telemetry system. The question then was where to place the aerials. I could place one behind the aileron servos pointing away from the carbon parts of the nose. See above. The only option for the other was to get a long aerial lead and place it in the wing. I made a paper tube the right diameter and epoxied it in at an angle so it would be 90 degrees to the aerial in the nose:

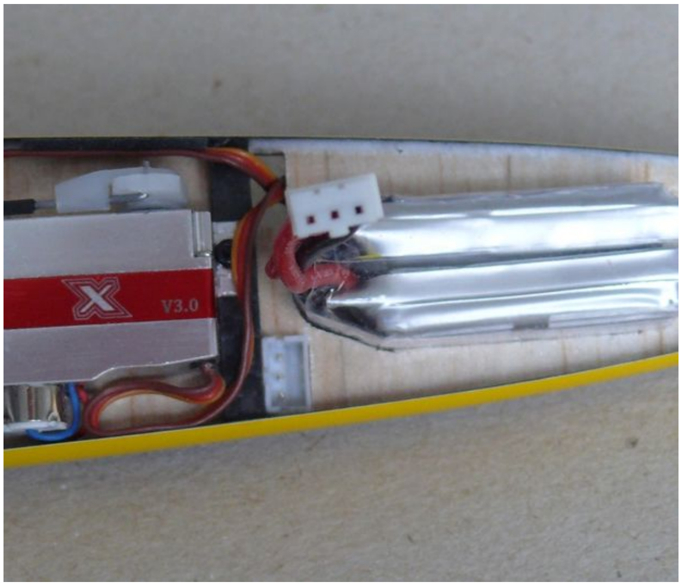


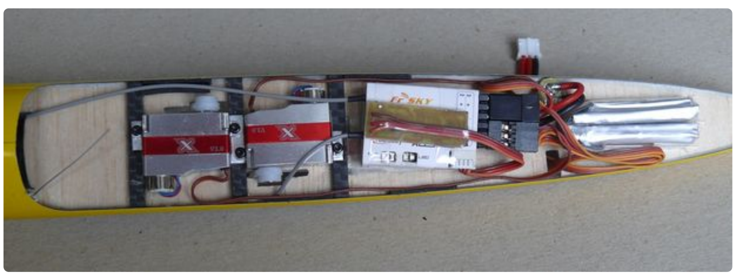


The radio setup was the most complicated I have ever done. I have 5 flight modes (trim settings), two for launch and three for normal flight. The first launch mode has a slight up elevator to rotate the glider from the horizontal discus launch to a climb. The second launch mode maintains the glider in a straight climb. The top of the climb is detected by a script running on the transmitter that monitors the altitude. This switches the flight mode from the launch modes to the selected normal flying modes of cruise, speed and thermal (set via a 3 way switch). I will be happy to supply the setup file if anyone would like to use it. The throttle stick can also be used to give extra flap down, with a custom curve providing trim correction to the elevator. There is also a switched link from elevator to flap to give better aerobatic performance if required. Rudder movement has a small coupling to the ailerons to make turns easier. This is switched out on aerobatic mode. This is on top of the voice alarms for low battery and low signal strength and the telemetry that gives spoken altitude, vario sounds for lift and spoken confirmation of mode changes. I also have a script that records launch height, max height and flight duration plus a graph of altitude vs time to inspect after the flight. Things have come on a bit from my first transmitter that just had one button!

I made up the battery from a couple of single cells and fitted a balance plug that could be used both for charging and for supplying power the radio.

Rather than use an on/off switch I glued a socket into the servo tray. Hence powering up is just a matter of removing the nose cone and plugging the battery in:





Step 7: Flight

I got a member of our club to do a gentle hand launch for the first flight. This enables immediate action if the model is not quite setup correctly. It flew perfectly, and kept on going right to the end of our long mown strip. So next was a proper discus launch. This went well and the video above shows the following flight. Obviously I was delighted to see it fly so well. I now need some more fine days to learn how to get the best out this great plane.

I hope this instructable helps others building their first DLG. I expect some will feel my approach has been too finicky. There is always the option of following the instructions! You can adopt as much or as little of what I have done as you wish. I am however very happy and in retrospect would not have done anything differently.

Happy flying.

Mike

https://www.youtube.com/watch?v=1bwMLFgpwB8