HWDMAC SPAD Combat (30/06/2007)
"Viper" MK4 Plan (Minimal Version)
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1) Introduction

As some members have built and thrashed KT4 and are a little past the Combat "Trainer" stage, I gave some thought to an out and out no compromise performance design. It had to be lighter than KT4 and succeeded in coming out at 3.5lbs which is 1/2lb lighter than KT4. 8ozs makes a large difference to a .40 and even larger to a .46 ! This was achieved by the use of a lighter fuselage (20mm pipe) and wing (3mm Correx)).

Aileron and Elevator width were increased to give a very tight loop and bank radius as well as speed, while retaining a certain Combat "groove". A "groove" means it goes where you put it and stays there. Very important when you take your eyes off it to check out the opposition !

Note that due to the speed of this device, stronger servos are required than the standard 3.0Kg standard variety. Testing showed a loss of aileron control at full speed with .40 or .46 engine.

Experimentation with a "V" tail was relatively unsuccessful, so was reverted to a more standard configuration.

The Pilot needs quick reactions with this machine as things happen fast above half throttle !

2) Specifications

a) Engine size : .40 - .46
b) Tank Size : 9oz (9-10mins. is more than adequate as most competitive bouts last 5mins.)
c) 3mm Correx based.
d) 3CH (Ailerons/Elevator/Throttle) only.
e) 4 standard servos. ((JR 591's (5.1Kg) or Cirrus CS601/BB.s (5.5Kg) – not Futaba 148's (3.0Kg))
f) 1.3mm drain pipe and 20mm waste pipe.
g) Symmetrical aerofoil.
h) Build Time = Approx. 4hours.
i) Airframe Cost = £10.00 approx.
j) A.U. Weight – 3.5 lbs approx.

3) Characteristics Required

a) A thoroughbred. Sensitive and responsive - tight turning circle and roll.
k) Fast but stable enough to fly hands off.
l) Faster than KT4.
m) Materials to be easily and cheaply available.
b) Tough and withstands abuse.
c) Hand Launch stable.
d) Easy to build and repair.

4) Materials Required

a) ½ sheet (48" x 48") 3mm Correx (sizes on plan).
b) 1.3m Drainpipe (20"minimum) (sizes on plan). (Hunter Squareflo PVC 65mm x 1.3mm)
c) Pine Spar 18mm x 8mm (44") or glue two 4mm thick pieces together.
d) 20mm PVC Waste Pipe.
e) Pine Firewall 61mm x 61mm for engine.
f) Two Pine Firewalls with 20mm holes drilled at bottom to mount pipe.
g) Pine Servo mount.
h) 3/8" Dowel for wing (5" long x 2).
i) 4mm dowel for Tailplane & Elevator bracing.
j) 4mm Correx for Ailerons.
k) 8 x ¾" screws for Firewall.
l) 4m Allen bolts and nuts/lock nuts.

Model Shop Bits

a) Throttle rod; plastic outer ; plastic screw-on clevis.
b) 2mm Aileron and Elevator rods and 2mm metal clevises.
c) Radio Active 30-45 Engine Mount or similar.
d) 9oz SLEC (yellow) Tank.
e) Combined charging and On/Off switch.
f) 700ma Rx Battery. (lighter the better)
g) "Y" lead and 2 wing extension leads (if needed).
h) Rx and 4 servos.
i) Lead weights (or pennies) for Lateral balance.
j) Fuel Tube.

5) Material Suppliers

a) 1.3m Drainpipe – Homebase or Wickes (8ft length – around £8.00)
b) 3 &4mm Correx - (8ft x 4ft sheet – around 7.50 each) - Paperco on 0161-8648000 for "Euroflute" 3mm & 4mm sheets (8' x 4') – Companies only – £7.41 each.
c) Spar – Homebase – (Pine strip 18mm x 8mm x 5ft length approx. £1.20) or glue two 4mm thick pieces together.
d) Firewall – Homebase – (18mm shelf pine – around £4.00)

6) Building Instructions

A) Fuselage

1) Cut drainpipe to a 18"length with Dremel or similar, making sure it's square.
2) Cut waste pipe section to 18" size.
3) Cut Radio access rectangle in top (9" long)
4) Mark 4 pilot Firewall holes on Fuse. depending on Firewall thickness, at half depth of firewall. In my case, the Firewall is 18mm thick, so mark at 9mm depth.
5) Cut out elevator servo mount (ply) and test mount servo in it. Cut out fuselage hole for servo and mount so that the height is determined by the rod path and glue initially to the fuselage side. Then when dry, use four small screws to hold the ply plate to the fuselage. Note glue is not strong enough on it's own, hence the screws.

B) Engine/Mount/Firewall/Tank/Throttle servo

1) Select mount and drill engine holes for 3mm bolts. Use nuts plus lock nuts.
2) Cut Firewall to size, round off corners and test fit. Drill 3 holes vertically to allow fuel tank pipes through. File to size. File cut-out in Firewall rhs. for plastic outer to fit in. Fit engine mount to Firewall with 4 screws.
3) Insert Firewall in Fuse. and keeping Firewall/mount square, drill firewall through fuselage pilot holes. No upthrust or downthrust is required.
4) Make plastic horizontal mount for Throttle servo. CA small ¼" balsa lengths to both horizontal sides, where the screws will go. Fit servo and mark holes for drilling. Drill holes and mount servo to mount. CA mount to Fuse. sides making sure height of arm is under normal Fuse. height. Arm height should match the cut-out in the Firewall.. Leave enough space under the mount to allow the battery to be moved forward if necessary.
5) Fit servo arm, make Z bend in throttle rod and fit outer plastic tube.
6) Put Tank (SLEC 9oz (yellow)) and Firewall plus feed tubes together and fit to Fuse. , making sure the plastic outer fits the path cut for it in the Firewall.
7) Make Fuse. screw holes larger to allow screws to go through the Fuse. easily.
8) Use 4 x ¾" screws to secure Firewall to Fuse.

C) Tailplane/Elevator

1) Cut Tailplane and Elevator to size. (from plan)
2) Cut flute at 2" mark as per plan.
3) Drill holes for 4mm allen bolts through pipe and test fit tailplane/elevator leaving enough space for elevator movement. Cut spacers for either side of 4mm Correx to prevent crushing and drill 4mm holes.
4) Mount Tailplane to pipe and CA nuts when in final position.
5) Insert 4mm dowel both side of the elevator hinge to prevent flutter.
6) Leave bolts sticking up for Fin attachment.

D) Fin

1) Cut Fin from 4mm Correx (flutes vertical) and temporarily line up with pipe. Fin should be mounted on the bolts leaving enough space for full up Elevator movement.
2) CA bolts to Fin.

E) Wing & Aileron Servos

1) Cut wing to 44 x 22" size, 44" flutes horizontal. Folding is easier in this direction and it looks better.
2) Mark 11" flute at each end of 44" length.
3) Score with screwdriver and fold carefully in two, so fold and chord length is the same on both sides. (Correx does not always fold straight !)
4) Mark and cut the servo holes at approx. the 12" positions or as far as the servo leads will reach, as per plan. Cut plywood plates as per plan. Rough up Correx wing around servos. Glue to the wing. Cut 4mm ply plates to the same shape as the ply and rough up.
5) Cut the Ailerons as one piece to size and mark the flute to be cut so it's obvious how much will disappear inside the wing halves. Cut hinge at the 2" mark as per plan. Note that the Aileron has to be aligned straight with the wing TE. Glue the aileron to the wing bottom. Clamps can be used here. (rough up both the areas on the aileron and the wing with sandpaper so the CA has something to stick to. I use a piece of wire to help spread the glue evenly over the area.
6) When dry, run servos but do not finalise mounting yet. Attach the extensions inside the wing. Note that small zip ties should be use to secure the servo leads to both the "Y" lead and the extension leads. Make a hole in the wing bottom central to allow the single side of the "Y" lead to exit the wing bottom. Prior to wing completion, test that the "Y" lead and servos work by attaching them to the Rx and Tx.
7) Rough up the other inside side of the wing and the aileron top.
8) Glue the same way and clamp the whole TE to hold the wing straight.
9) The spar should be cut to 44" length and tapered 2" at both ends.
10) Measure and mark the proposed CG point on the wing. (27.5% of 11")
11) Insert the spar flat and twist into it's final vertical position.
12) Place the wing vertically on a flat surface (make sure this surface is not required as the CA will run down the wing onto it !) and run some CA down between the spar and the wing.
13) This has to be done on all 4 spar joins after each has dried.
14) When dry, drill servo holes and mount both permanently with the horn end nearest to the ailerons.
15) Mark wing ends shape as per plan , rough up the inside wing ends, and glue and clamp.

16) Mark Aileron mid point of wing and measure and mark 2.5" on either side. Cut Ailerons vertically at this point to allow movement around the fuselage and room for wing wrap.
17) Test fit the 22" wing wrap. Mark end points so both are equal (roughly) on the underside of the wing. Bend LE and TE portions to shape. Rough up both mating surfaces and glue flat part first, (top side) then each under side portion. When dry, use 4mm dowel inserted in the top and bottom of TE and LE's, to prevent elastic band crush. Make sure the elastic bands (at least 6) are very tight or the wing will lift. I use 4" stretched ones from Staples.
18) Mark aileron ends cut-offs and cut to shape/size as per plan.
19) Clamp wing ends down and staple together.

F) Radio Installation
1) Position Rx temporarily under radio hatch so that all servos leads can reach it.
2) You may have to use an extension on the aileron lead, so don't forget the zip tie(s).
3) Check that the Elevator servo proposed position (on lhs) is a) the servo lead can reach the Rx b) the control rod length is enough to reach the elevator.
4) Make sure Elevator rod is free to move in pipe and has full throws.
5) Mark servo outline and cut hole in Fuse. Fix servo to Fuse.
6) Zip tie the Rx to the rhs of the Fuse.
7) Battery should also be mounted on the lhs of the fuselage to counteract the silencer weight on the rhs.
8) Mark Switch position vertically on fuselage side and cut with Dremel.

G) Security & Setting Rates
1) Secure all servo connections, especially the Battery, with zip ties. Make sure the Battery cannot move - zip tie Battery to fuse with two ties.
2) Set rates on Elevator to full. (hole 4 on Futaba servo horns)
3) Set Aileron rates to hole 2 of 4 (this can be adjusted later after the test flight if required)

H) Control Surface Connection
1) Make 3 Horns (2 left hand and 1 right hand) and Plates as per plan.
2) Use 9" 2mm threaded rods, Z bent at servo end and metal clevises at the control surface end.
3) Secure clevises with fuel tube.
4) Horns have one hole at the top only for both ailerons and elevator.
5) Set all surfaces to mid-points on Tx (trims at neutral). Elevator flat. Ailerons flat and parallel with fuselage top.
6) Set throttle up (servo arm at mid-way point should correspond to ½ carb. opening movement.

I) CG and Lateral Balance

1) The CG can be anywhere between 27.5 and 30%. I prefer around 28%. Moving the CG further backwards will make the plane more sensitive to elevator movement and thus less able to fly "hands-off". It will however, roll quicker and loop/bunt tighter but be harder to fly. Lateral balance is very important to it's flight characteristics, and ensures an as designed performance – it also ensures a flat stable glide without power.

a) CG Balance
1) Make sure all components are in place. (switch banded also)
2) Cut two pieces of dowel about 5" long and rubber band them to fuselage. Rubber band wing to the fuse via the two dowels and test the CG already marked.
3) Move Battery to obtain balance. Mark Battery position and zip tie.
4) Mark edge of win LE and TE on top of fuse.
5) Mark holes for 3/8" dowel ½" before the wing LE and TE marks, and ½" below Fuse. edge.
6) Drill holes for dowel rods, making sure they do not foul anything like the tank etc.
7) Drill hole on side of fuse. for switch and mount vertically.

b) Lateral Balance
1) Screw a hook into the fuse. at the rear mid-point of the fuse (where the streamer mount will be).
2) Suspend the plane at the front and rear with (nylon) rope over the washing line or similar.
3) First line goes around the engine front, second to the rear hook.
4) Balance the plane so that the left and right wings are horizontal. Add weight to the higher side until this is obtained (usually the side opposite the silencer). The plane will now take-off and glide straight without dropping a wing -important in a hand-launch plane.

7) Test Flying

1) Get an experienced Pilot to take-off and trim the plane for you.
2) The plane should be trimmed at half-throttle initially.
3) Hand-Launch should be done by a second helper until the plane is trimmed.
4) Once trimmed, the plane is stable enough to be self hand-launched.

8) Independent Testers Comments

K.Hitchen
Stability :- "very good"
Speed :- "very good"
Loops and Rolls :- "very good"
Glide :- "very good"
Hand-Launch stability :- "very good"
Overall Impression :- "very good"

R.Stephens
Stability :- "good"
Speed :- "enough"
Loops and Rolls :- "quick loops"
Glide :- "superb"
Hand-Launch stability :- "fine"
Overall Impression :- "excellent"

9) Fine Tuning the Design (Expert only)
Not necessary.

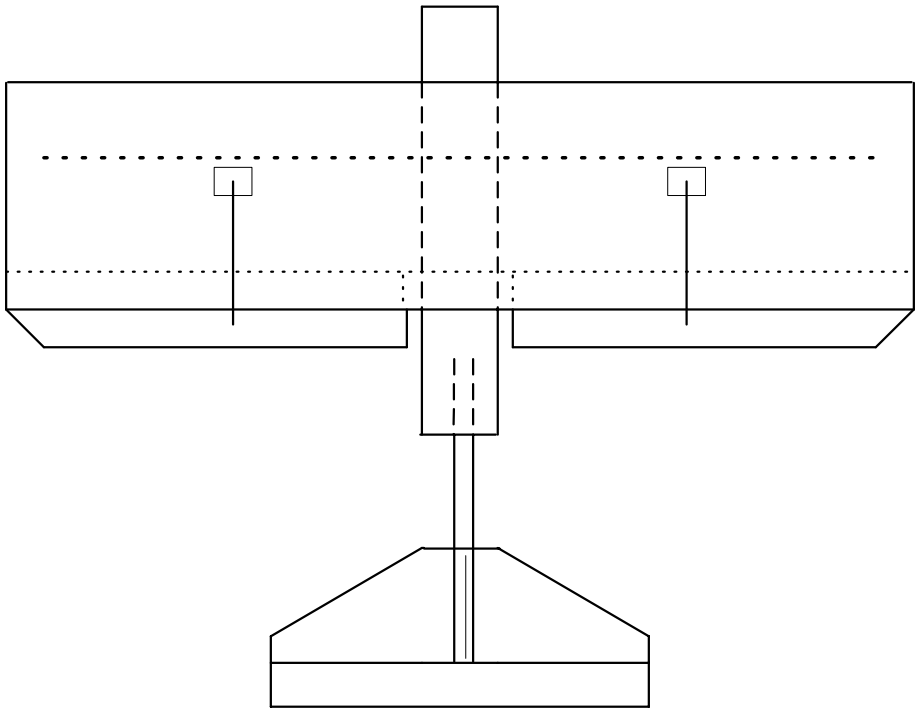
10) Design Don't's
a) Change firewall to HPDF – the fuselage breaks instead of the firewall in a crash and it's too heavy.
b) Change the wing / tailplane positions – this ruins the stability performance.
c) Use a single servo for the Ailerons – this bends the ailerons (warps) out of shape, necessitating constant trim adjustments every time you fly. Only one flute cut-out is fine for dual servos.
d) Zip tie the throttle servo to the fuselage – this causes excessive friction on the throttle wire due to the bend and ruins fine control.
e) Fly with all settings on full throws, especially ailerons – the plane will be uncontrollable in a wind.
f) Reduce the spar thickness. The spar must be at least 8mm thick.
g) Use standard servos. At least 5-6Kg of torque is necessary due to the speed and the aileron area, even with a .40 engine.

11) Plans

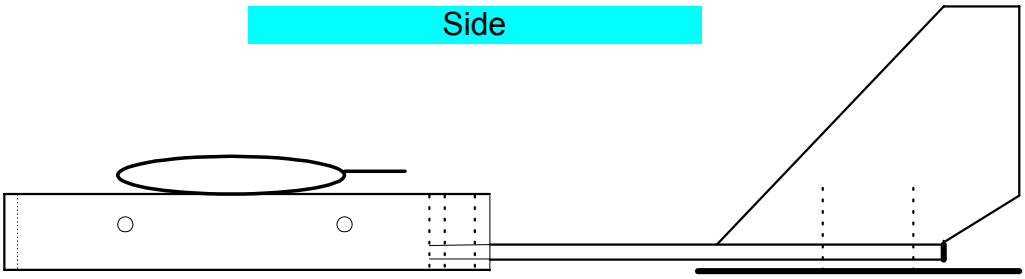
Designed by I. Scottow
No copywright applies
for further ideas see
www.ianscottow.wingers.co.uk or
www.spadtothebone.com

HWDMAC Combat "Viper"MK4 Overview

Plan



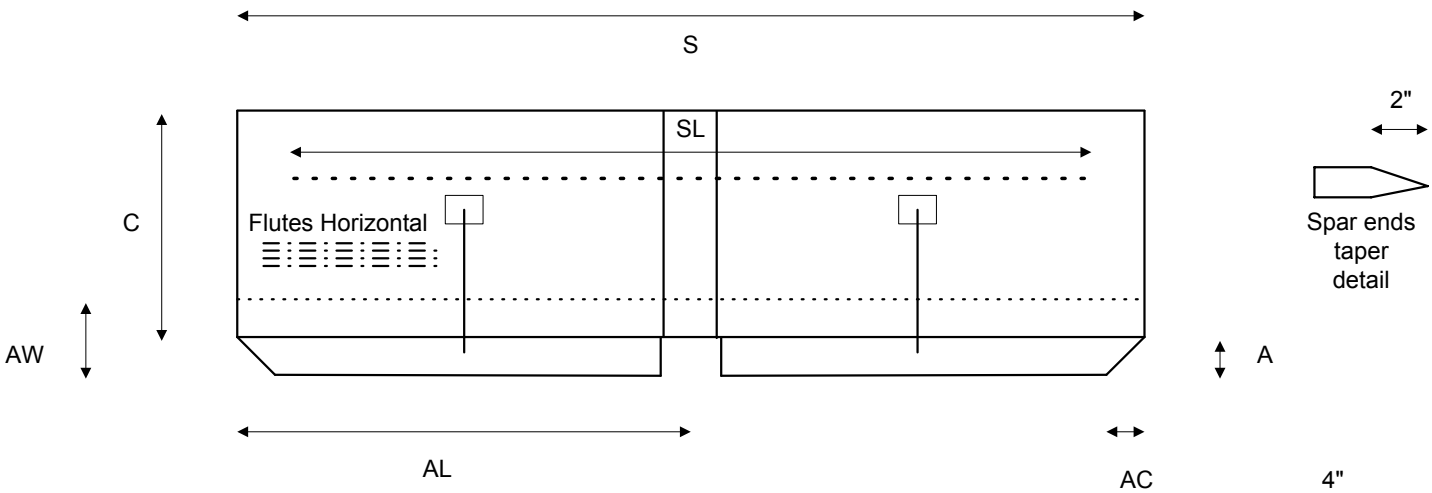
Side



Notes

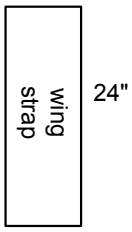
1) Wing on top of fuse.; Tailplane under boom.
2) Dowel holes and final wing position are determined by final CG position.
3) Fin mounted on 2 x 4mm fixing bolts and is cosmetic.
4) Preferred position for Elevator servo and Battery is lhs of fuse to offset weight of silencer.
5) Dual servos used to prevent aileron warp.
6) Use servo wheel screwed to fuse to tie on streamer.

Wing Dimensions



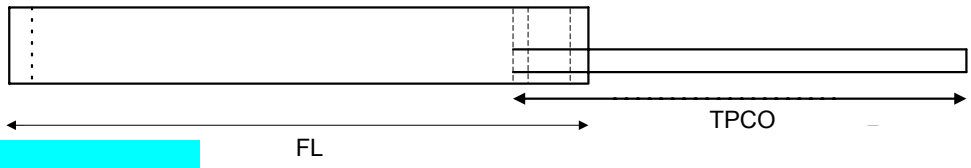
S = Span = 44"
C = Chord = 11"
AW = Aileron Width = 4"
A = Aileron = 1.5"
SL = Spar Length = 44"
AC = Aileron Cut = 1.5"

Notes
1) Spar (CG) is 27.5% of C (77mm from LE)
2) Servos at 12" points.



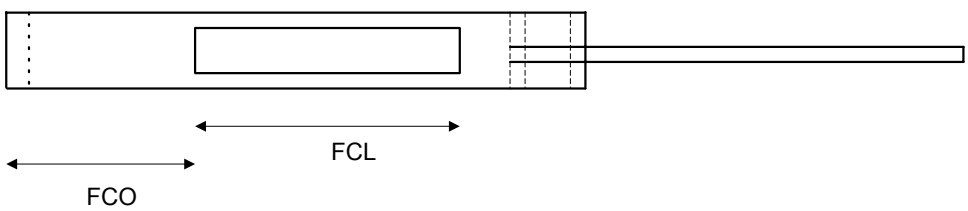
Fuselage Dimensions

Side

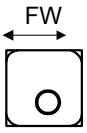


FL (Fuselage Length) = 18"
FCO = 5.5"
FCL = 8.5"
FW = 61mm
TPCO (pipe length) = 18"

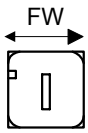
Top



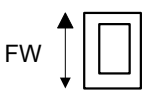
Servo Mount
Elevator



tube mount x 2

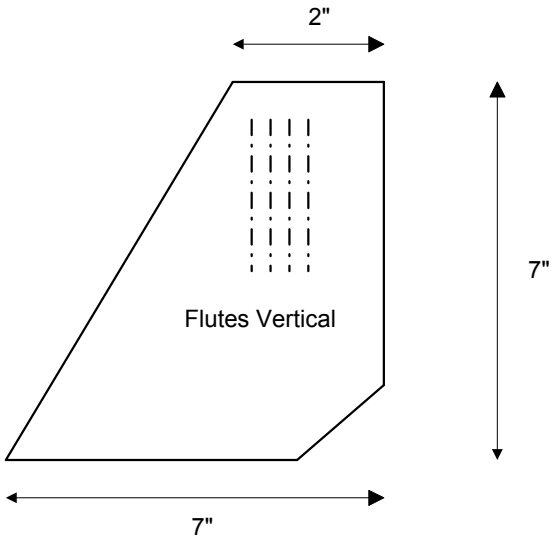


Firewall

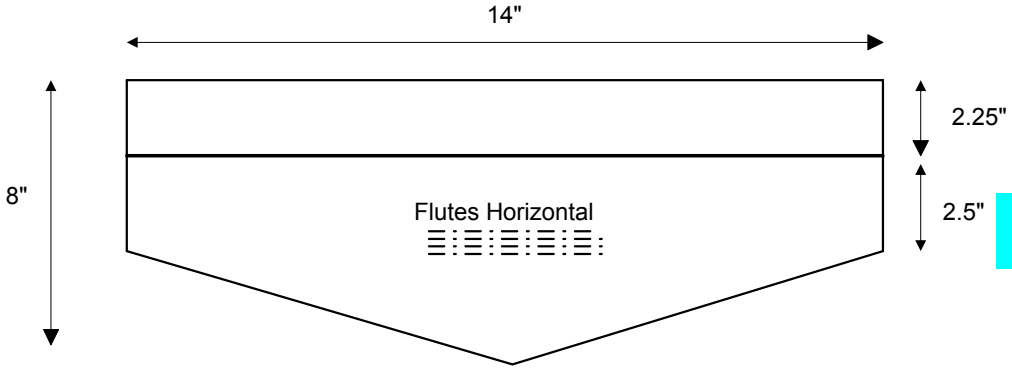


Throttle
Servo Mount

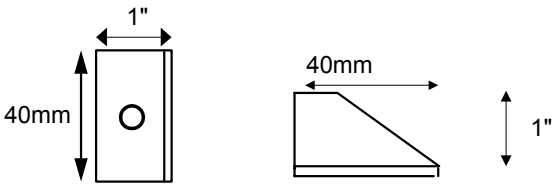
Tailplane/Elevator and Fin



Fin



Tailplane/Elevator

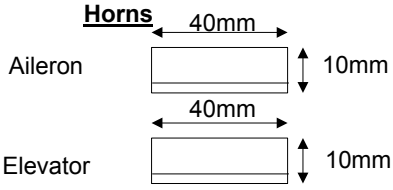


Notes

1) A single flute is used for the elevator hinge.
2) Fin flutes are vertical.
3) Tailplane flutes are horizontal.
4) Bolts have plastic washers above and below correx

Plates

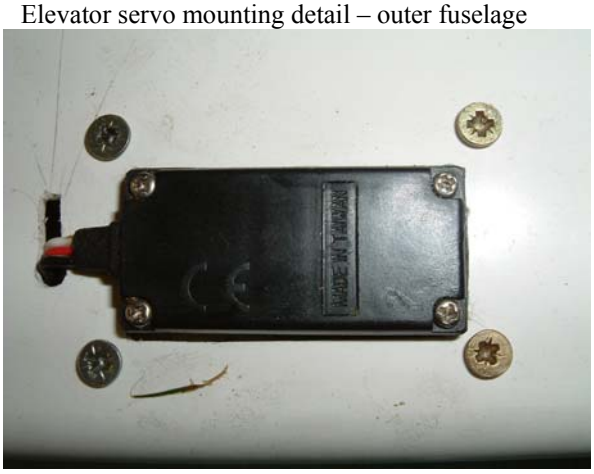
Horns



12) Helpful Pictures

Elevator servo mounting detail

Elevator servo mounting detail – outer fuselage



Throttle servo mounting detail

Tailplane & Tail mounting detail

Switch mounting detail (vertical & shutter forward) to avoid accidental switch off.