TUD Modelltechnik Herrig & Demmler GbR
www.tud-modelltechnik.de

Instructions on Completion and Operation of the

SALpeter

Version 1.02

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Contents

1. The SALpeter – a top-performance DLG

1.1. Introduction

With the SALpeter you have chosen a Discus Launch Glider of the highest category. The design target was to further increase the very high flight performance of our Aspirin and make a plane for the F3K class with superior capabilities.

Compared to the Aspirin the SALpeter is kept more slim. The main changes are not directly visible in the outline, but are of aerodynamic and constructive nature. Due to this the SALpeter provides improved performance in all flight ranges except inverted flight.

Small compromises to the Aspirin's gentle handling were definitely accepted for the benefit of pure performance. However, it must be clear we talk about minute changes, giving the pilot just a better feeling for the air.

Therefore, the SALpeter is not only an ideal platform for competition pilots, but also brings a lot of delight to the commited leisure pilot. Basic experience in building and flying three-axis controlled composite planes is a prerequisite for a high-end device like the SALpeter, though.

1.2. Aerodynamic concept

Starting from the Aspirin, improvements were strived for in the following points (in order):

- dear air sink rate
- glide ratio against the wind
- launch height

- thermalling capability.

A set of 5 different airfoils along the span was designed, adapting to the local Reynolds numbers, lift range and height requirements. Previously, the Aspirin airfoil had been intentionally designed for a larger relative thickness of 7.3% to allow integration of reasonable servos without protruding parts and to achieve an excellent stiffness-to-weight ratio of the wing. With the AH160_9 series the luxurious reserves in the negative lift range provided by the AH84 were reduced for the benefit of specialization of the airfoils on the positive lift range. Relative thickness was reduced in the major part of the wing and only maintained where necessary for mounting the servos.

Again, the airfoils were made with a kink in the contour, focussing on two main flap settings (0/-2°). In slower glide with 'neutral' flap the suction side is smooth, avoiding big transitional bubbles on the flap. The kink in the lower surface doesn't lead to transition then and the thin laminar bubble reduces friction drag somewhat. In fast flight the bottom side is made smooth and the boundary layer stays laminar 100% here.

With a too strongly ballasted Aspirin and too negative flap settings sometimes a drop of glide ratio could be noted in returning from thermals against the wind. Careful selection of flap, ballast and speed was necessary to find the 'sweet spot'. The SALpeter offers a slightly wider optimum, with less off-design performance drop.

The outer wing has been made a bit more narrow and less swept compared to the Aspirin. For our taste, the Aspirin tended a bit too much to stall in the middle of the wing and rotate nose down subsequently. A little too much for the experienced pilot. Still, care was taken that stability and turning behaviour of the SALpeter allow the competition pilot to focus on other important things during contests.

An intermediate aspect ratio is a compromise of stiffness, Reynolds number and weight-to-drag ratio in the launch.

New tail airfoils were developed with the target of reducing core weight. Furthermore, hardly noticable waggles around the vertical axis sometimes occuring on the Aspirin in slower flight were to be diminished. Still, the vertical tail airfoil is strongly oriented on the HT23, being asymmetrical for providing good maximum lift in the first yaw excursion after release. The slightly bigger sized fin and longer tailboom are an admission to many people's requests about more forgiving launch behaviour. The elevator airfoil was made a tiny bit unsymmetrical as well, extending the low-drag range of the polar in the desired regions.

1.3. Construction

Like for the Aspirin "As simple as possible, but as complicated as necessary." was the motto. To fully exploit the aerodynamic potential of an airfoil, a very accurate reproduction of the contour on the real wing is necessary, indeed. With the CNC machined negative moulds the SALpeter is built in, this is guaranteed in the best possible way, especially in the leading-edge region. The analytically described wing geometry was transferred into CAD data with self-programmed tools. Airfoil distortions in the tip region, often occuring when using standard tools, could be avoided this way.

The wing is built in hollow sandwich technology, Rohacell foam is the standard. It allows very good surface quality and much stiffer and shape accurate shells compared to balsa sandwich. The optional addition of a lattice of UHM rovings (disser wing) allows exceptional torsional rigidity.

To compart the servos in the wing without any extending parts, they were shifted to the middle of the wing, were airfoil thickness is larger. This also saves rotational inertia. Why not earlier this way? Fear of flutter problems. . . But with our stiff RDS system we were certain to handle that.

The fuselage is made as a single part in special technology. The elevator pylon is integrated, assuring absolute repeatability of decalage. Hiding the elevator horn behind the pylon and taking it out of the flow saves drag. The tailboom cross section is made oval, for higher lateral bending stiffness without increased weight. Cross section of the front fuselage was adapted to current developments in RC component size.

1.4. Recommended RC-Components

Tab. 1.1.: Suggestions for RC-Components.

component	specificity
receiver	SMC-16 scan (w/o case), Schulze alpha
battery	4 × AAAA NiMH 300 mAh
servos HT, VT	5g class (C141, D47)
flaperon servos	DS281, DS285, C261

Source of supply for the cells: GP – see Reichelt (www.reichelt.de) or Batt-Mann (www.batt-mann.de) for example.

2. Completion of the kit

2.1. Canopy

If not already performed in-factory, fix the 2 mm carbon rod centered in the canopy with CA, protruding 1-2 mm at the front and rear end. Check the fit and if ok glue the rod with small patches of glass cloth (12x12) using 5-min Epoxy. Distance about 50 mm front and 40 mm rear, depending on the desired contact pressure. To avoid slipping in hard throws and when catching the plane in a contest, the addition of a stopper made of thin ply-wood is recommended (compare Fig. 2.1).

Fig. 2.1.: Fixing rod and stopper on canopy rear end.

2.2. Servo cables and plugs

As a simplification compared to the previous MPX-plug solution, the servo connectors present at the servos can be used directly for the electrical connection of the wing. Glue the plugs together and place in the wing with the servo signal lines oriented towards the leading edge (Fig. 2.2). We recommend, to glue only the plug to the wing. The opposite connector is not glued to the fuselage. With the fuselage hole done with excess space this allows for easy part exchange in case of a necessary replacement. The fuselage servo wiring should allow to pull the plug approx 40-50 mm outside to allow easy connection during wing mounting/unmounting. See also Fig. 2.3 and Fig. 2.4.

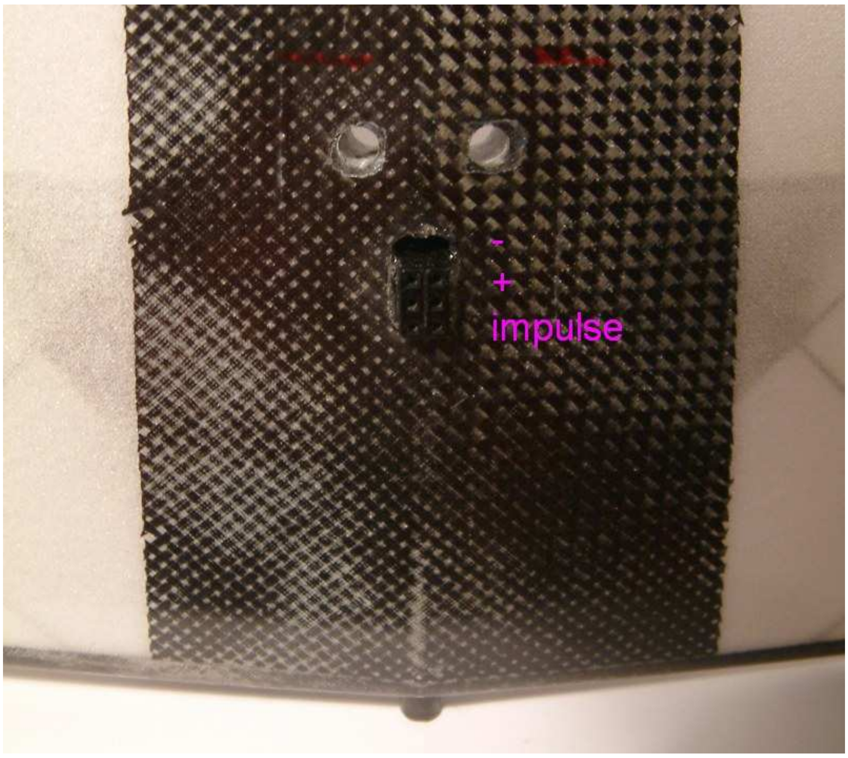

Fig. 2.2.: Positioning and pin assignment of the servo plugs in the wing seen from below.

2.3. Tailplanes

When glueing the vertical tail to the boom, getting the correct alignment (zero lift angle parallel to boom axis) is important. Use the template Fig. A.5 for this task. Sand the boom and put on some 5-min epoxy and slide the tail over it. Also put

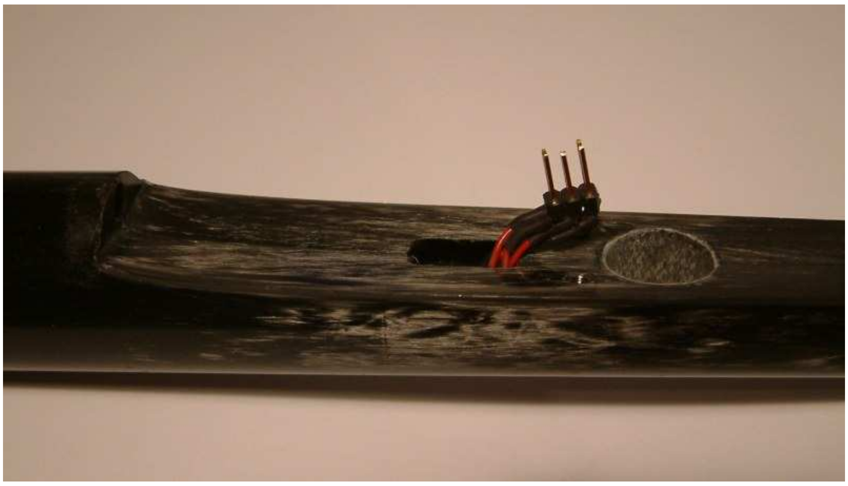

Fig. 2.3.: Servo plug in the fuselage made from 2.54 mm PCB header.

a little epoxy from the outside to the joint between boom and tail to fill all gaps. If necessary use paper *lightly* soaked with acetone to wipe of excess epoxy. Double check the alignment, both vertical and the zero lift angle and then let the epoxy cure. The advantage of using epoxy here is, that in case of a mishap at landing, the vertical tail will get off the boom with almost no damage.

To fix the horizontal stab on the pylon, use M3 counter-sunk nylon screws.

2.4. Rudder linkages

2.4.1. Tailplanes

For rudder and elevator, single pull lines made from ≈ ø 0.4 mm Kevlar or Dyneema strings are used. The counter-movement is provided by torsion springs at the tail side, that are delivered with the kit and have to be installed by the customer. When installing the springs, make sure, they are sitting near the horns in the movable parts, no more than 1 cm distance from the horn to avoid twisting the thin flaps between horn and spring (compare Fig. 2.7).

Do not directly apply the springs into the foam or they will work themselves towards the glass laminate after some time. Put the wire ends into small plastic or carbon tubes or into small balsa filling pieces approximately ($2 \times 2 \times 10$ mm) in size to spread the load of the springs over a few more square millimetres. Glue these into the tails, where the springs are supposed to go. Take off the foam with some fine drill or grinder. For better looks, the filler should not sit at the laminate directly, but inside the foam.

Fig. 2.4.: Mounting of the wing.

As horns at the tail feathers 0.5 mm thin carbon sheets cut to shape (see Fig. A.7) are used. Cut a narrow strip of laminate to get the horns into the core. It is crucial to have the horns being glued to both laminate sides of the flaps to spread the load. Use 5-min epoxy or foam safe CA for glueing the horns, normal CA dissolves the foam of the standard Depron tails.

The vertical rudder line is meant to exit the boom through an oval hole near the leading edge of the horizontal stabilizer pylon. *It is important to have the horn for the vertical rudder at the opposite side of the launch peg!* Having the rudder pull line at the outside during the throw is necessary to keep the line under tension and avoid flexing of the flap.

The horn for the elevator goes into the boom behind the pylon (Fig. 2.5). To keep the horizontal removable, the pull line can be connected with a thin spring steel hook. However, like on the rudder, it can be connected directly to the carbon horn. Then the elevator can at least be rotated parallel to the rudder in case of transport problems.

After the connections at the tail ends are done, thread the lines through their servo horn holes (length of the arms should be about 7.5 mm), pull towards the tail end adjusting length such that the tails are neutral, twist once around and glue with a drop of CA.

Fig. 2.5.: The elevator horn is hidden inside the pylon.

2.4.2. Wing

Standard linkages: Mount the servos just beside the stiffening ribs, at the fuselage side of the ribs and *infront of* the spar shear web. The horn should point outwards and be near the rib. This ensures maximum stiffness. Place the servos in front of the spar, because the airfoil has its max thickness there. Cut the hole with a very sharp cutter blade. The spar shear web needs to get a hole for the linkage of approx 5-6 mm diameter. Reinforce around the hole with some glass and CA.

For the flaperons linkages, 1-1.2 mm dia steel works fine. As flaperon horn, a 3 mm aluminium tube pressed flat can be used (Fig. 2.8). Positioning of the flaperon horns and the hole in the wing is sketched in Fig. 2.9.

At the servo side, the horn must be shortened to fit within the airfoil contour and if necessary, a new hole near the servo shaft can be melted in the horn with hot steel (Fig. 2.11). With the flap neutral, the servo horn should point 15-20° forwards. At the flap side, the interconnection should be approx. 1 mm behind the hinge line. *Be sure to get both linkages similar (symmetry of both flaps).*

Cover the hole with adhesive film. Be sure, that the only thing outside the wing contour is the flap horn - no fat and bulky linkages please.

RDS linkages: Nothing to do in this case than to connect the servo plugs.

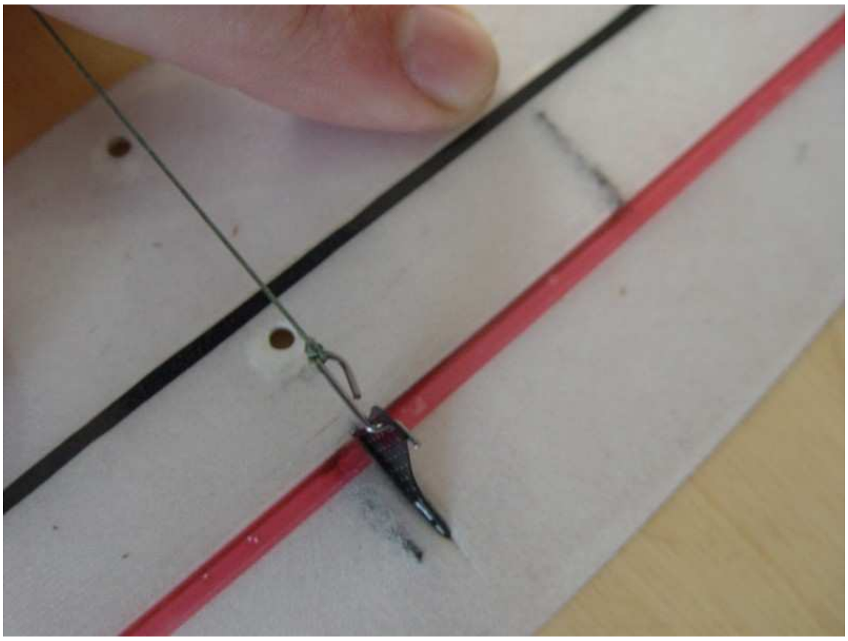

Fig. 2.6.: Removable connection of pull line to elevator horn.

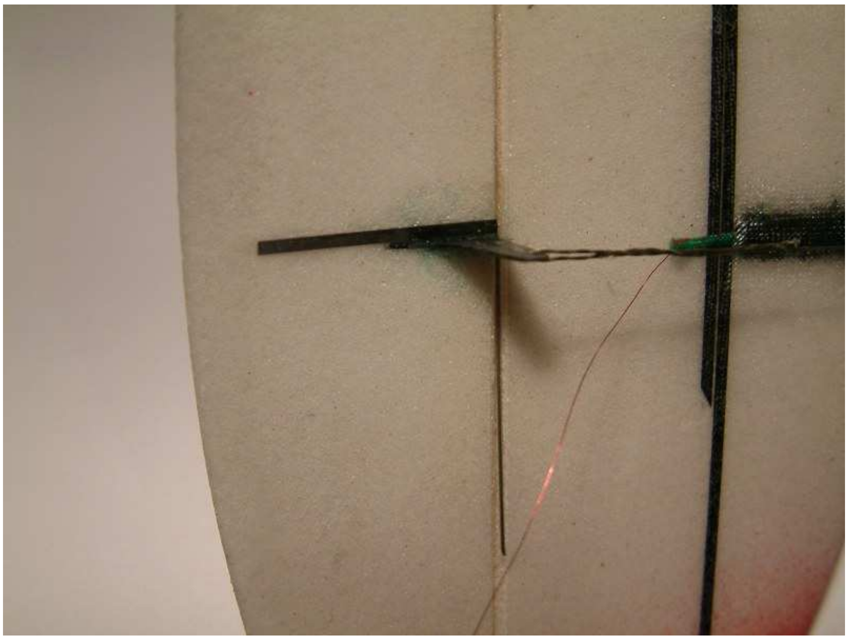

Fig. 2.7.: Rudder horn and torsion spring of the vertical tail. Optionally, a carbon strip can be added for reinforcement.

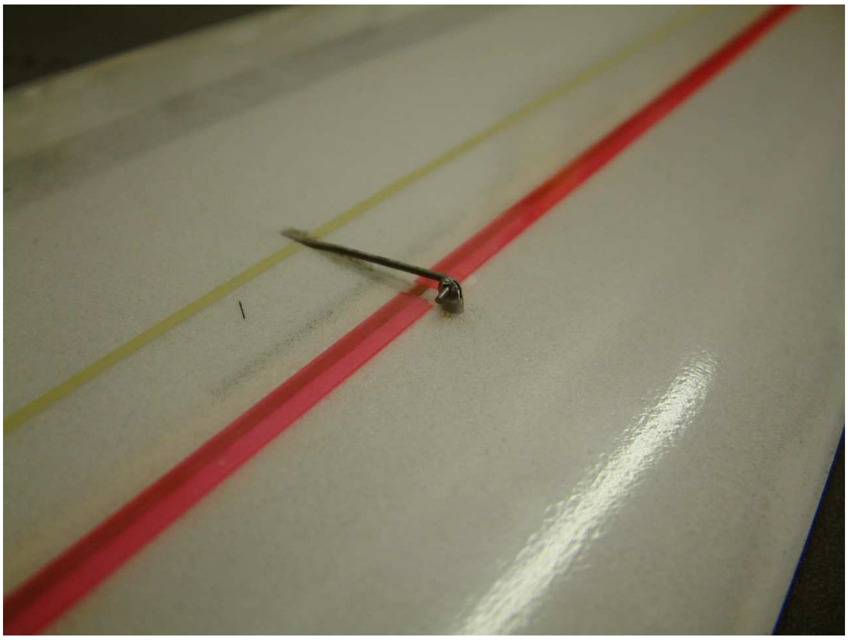

Fig. 2.8.: Standard version of flaperon linkages.

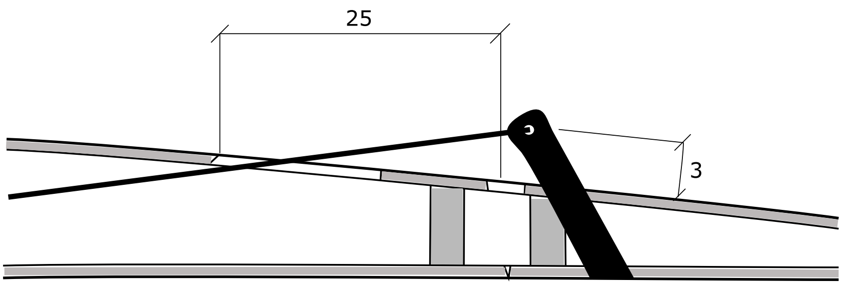

Fig. 2.9.: Positioning of the flaperon horn and measures for the pushrod hole.

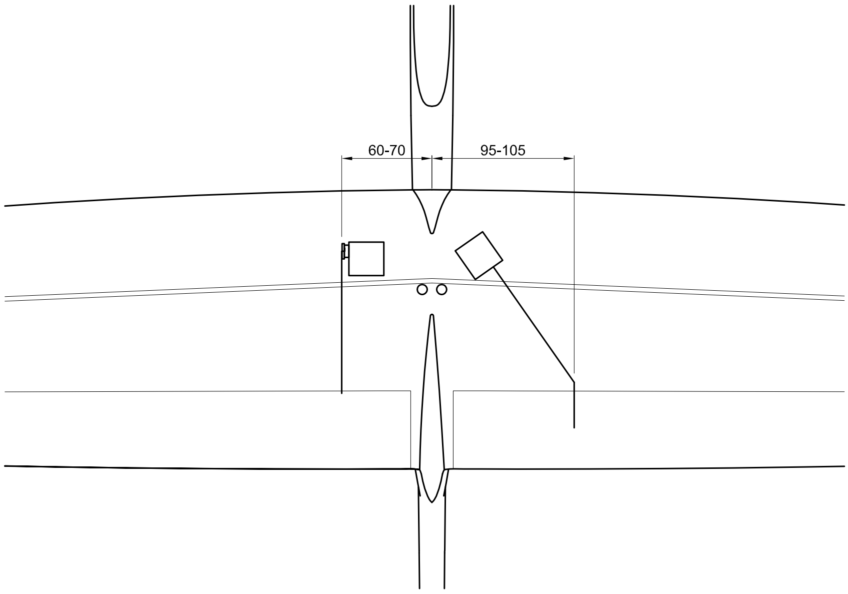

Fig. 2.10.: Servo position in the wing for standard and RDS linkage.

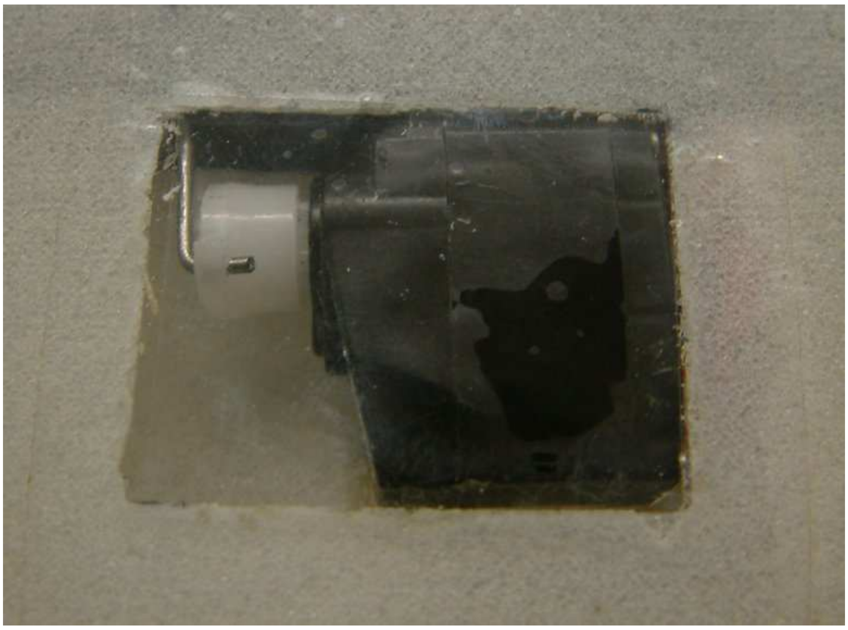

Fig. 2.11.: Glue in the flaperon servo with 5-min-Epoxy and cover the hole with adhesive film.

2.5. Throwing peg

Mill the hole for the launch peg at the marked position or according to Fig. 2.12. If you have very short fingers, you may install the peg slightly shifted outwards, but this will somewhat compromise strength as the forces need to travel a longer path to the spar and the airfoil gets thinner. Use a small cylindrical grinder in the beginning and a small file for finalising the hole. Work very carefully, the hole should provide a snug fit for the peg to maximize strength. The peg may be angled somewhat to provide easier slipping off the fingers (TE of peg pointing outwards by about 2-5°). Glue with thin or medium CA. Make sure, that there are no gaps between peg and wing and that the CA is soaking into the Rohacell too, to harden it around the peg area. Use only a small amount of CA-kicker, if any.

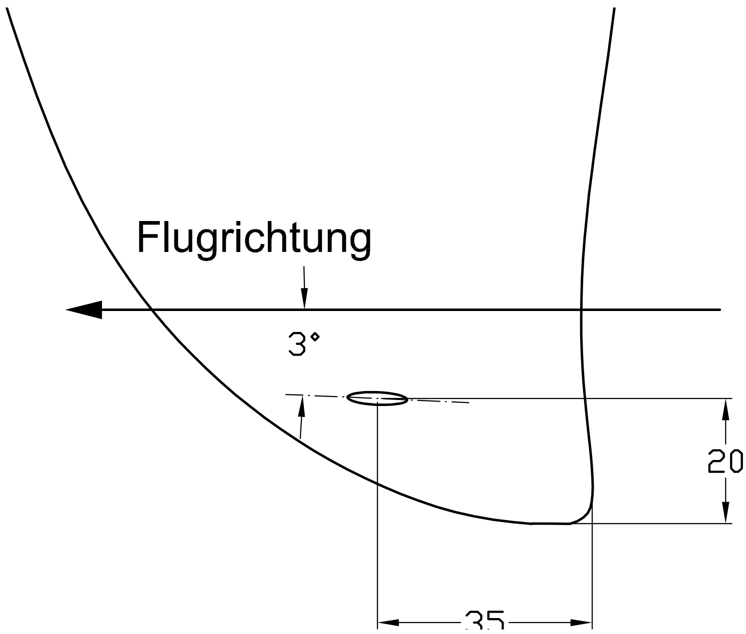

Fig. 2.12.: Positioning of the launch peg.

2.6. Radio gear

Fig. 2.14 shows the recommended radio gear installation with two servos in the fuselage. The servos are just put into shrink tubing and glue to the fuse with thick CA. Be careful, that no CA gets into a servo. Alternatively, you can make a servo tray from 1.5 mm plywood as in template Fig. A.3. Do not forget to roughen all surfaces with 240-400 grit sanding paper before gluing the servo tray with five minute epoxy. Fig. 2.15 shows the fuse finished and the canopy installed.

Fig. 2.13.: Glue in the launch peg with thin CA.

2.7. Antenna

We recommend to route the antenna inside the fuselage and exit the boom just before the fin. There should be at least 400 mm hanging free in extension of the boom. If the original antenna is too short to provide the necessary free length, solder the delivered piece of copper wire (0.1-0.2 mm diameter) to get the proper length. If you want to save weight, replace the heavy original stranded wire completely with the monofil wire. For exchangable connection at the receiver small 0.8 mm gold plugs (e.g. Nessel Elektronik) are very well suited.

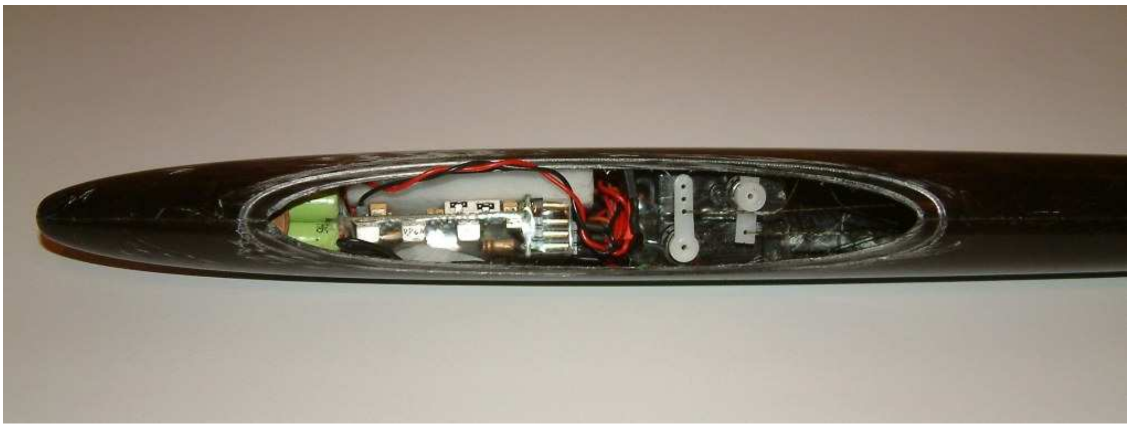

Fig. 2.14.: Example for installation of radio gear with servos in shrink tube.

Fig. 2.15.: Completed fuselage.

Be sure to provide protection against bending by using some heat shrink tube where the antenna exits the boom. Visually inspect the free dangling part now and then to make sure, that it was not damaged by earlier landings.

2.8. Ballast system

The SALpeter can be fitted with an optional ballast system, that will enhance flight performance in windy conditions and will make it easier to return to the field after a downwind run. The ballast system as provided will add 30 g, which is sufficient for practically all conditions.

As shown in Fig. 2.16, grind a circular hole in the fuse, centred at 79 mm from the LE of the wing. Make it snug fit with the glass fibre tube, not any larger. The bottom of the ballast will need some trimming to fit to the inside bottom of the boom. Place tube and ballast into the fuse, remove the ballast and glue the tube with five minute epoxy. Be sure to keep the pull lines for the tails away from the glue. After the epoxy has settled, trim off the tube to fuselage level and adjust ballast piece length to fit.

Fig. 2.16.: Installation of a ballast system in the fuselage.

3. Flying the SALpeter

3.1. Center of gravity

Recommended CG range for the SALpeter: 75 ± 1 mm from the wing leading edge.

CG position will affect both flying characteristics and performance at decisive measure. Qualitatively CG shifts will result in the following tendencies:

Forward CG: The plane is "ploughing" through the air very stable. Gentle flight characteristics and smooth response to elevator input. Higher than normal elevator throws needed. Fast recovery from a dive. Reduced signaling of lift, but easier circling in turbulent air.

Rearward CG: Indifferent flight characteristics - the plane will keep the angle of attack it was pointed to. No/slow recovery from a dive and reduced directional stability. Sensitivity to small elevator control inputs. Better signaling of light lift, but difficult to fly in gusty conditions.

The SALpeter wings should also be balanced laterally (compensation of the throwing peg weight). If this is not done, unwanted couplings of rotational movements will affect flight characteristics.

3.2. Control surface throws

If your transmitter offers the possibility of flight phases, we strongly recommend to use this feature and program at least three different phases. Tab. 3.1 lists the recommended throws at the control surfaces at full stick input and also the different trim settings at zero stick input. The deflections are meant as guidelines and can be adapted to your preferences. Positive numbers in Tab. 3.1 refer to downward deflections, negative numbers to upward deflections. All throws in millimetres at the root.

Tab. 3.1.: Recommended trim settings and throws of the control surfaces in mm.

	trim			throw			
flight phase	**QR**	**HR**	**SR**	**QR**	**HR**	**SR**	**Combi-sw.**
thermal	+2.0	0	0	+14/-15	+10/-9	+11/-11	+5/-5
normal	0	0	0	+14/-14	+10/-9	+11/-11	+3/-3
launch/speed	-2.5/-1.5	-0.5	0	+14/-14	+10/-9	+10/-10	+2/-2

QR = flaperon, SR = vert. rudder, HR = hor. rudder, combi-switch = mix aileron to rudder.

It is extremely important to decamber the wing during the launch. This will result in better launch heights due to lower drag and also lower the burden of the elevator, which would have to provide a large amount of downforce otherwise.

Snap-Flap mix is also recommended in during phases launch and normal. Snap-Flap should camber the wing an additional +3 mm if the elevator stick is fully pulled.

For braking, downwards deflection of the flaps by 30-35 mm is used. Add about +5 mm down elevator (fine tune in flight test). The SALpeter will then go nose down and drastically reduce speed. It can be safely landed or catched this way. To compensate for the bad aileron response with brakes deployed, add a large amount of aileron to rudder mix (combi switch) with the brake activated.

3.3. First flight and trimming

Start with a CG position at the front end of the recommended range (section 3.1).

Before making the first throws, make sure that the RC system is functioning correctly. Do not only check that the rudders move, but also that they move in the correct direction.

It is best to start on a meadow with long grass. Put the SALpeter into the air horizontally after some steps of run. The following glide should be straight on a path with flat angle and without stalling tendencies. Correct your elevator and aileron trim if not the case.

3.4. Launch technique

Then the first throws can be made. It is important not to cramp oneself. Only increase your force when the technique is sure. The heights will increase, when you don't have to think about your correct movements.

Set the launch phase for launching (Tab. 3.1). Grab the wing at the peg, the typical posture is shown in Fig. 3.1. In the rotation the plane will stabilize with the correct incidence by itself. Do not try to actively rotate the model upwards on the tip – overloading of the laminate could be the result.

Fig. 3.1.: Only the fingertips of fore and middle finger grab the launch peg.

The launch can be divided in the following sequence (compare Fig. 3.2).

Initial position: Hold the plane behind the body, tip hanging on the ground. Right handed persons have the left leg infront, view is in the planned direction of launch. Throwing arm is stretched and turned behind the shoulder line with little tension. In wind the SALpeter can also be held horizontally.

Rotation and build-up of tension: When the mental preparation is finished, begin with the acceleration phase. With a step forward, start rotating the upper body. Try to accelerate from the feet and twist your body letting the plane hang behind. This sets the basis for the final acceleration boost with the arm. Foot work is very important in this phase. But control your rotation from the head and do not concentrate on the feet. The plane moves on a nearly horizontal path. If you hold it too high in the beginning, the ground clearance might be too small in the end.

Acceleration and release: When the upper body is pointed in the opposite direction of the planned throwing direction, it is time to initiate the release of the model with a further increase of rotational speed in the last half rotation. By rotating the upper body from the hip and pulling the shoulder forward the throwing arm is accelerated like a pendulum. The plane is released when it is in direct extension of the shoulder line. Don't bend your arm or hold your head back. A good release is almost without a large peak of centrifugal force on the peg. The feeling is that the plane was released too early, but then the plane will not show excessive yaw after release. This also reduces loads on the plane and the fingers.

Two different variants of the technique can be distinguished. Either it can be more concentrated on the rotation. Or it can be tried to gain significant energy from a fast run. Which one is better in the end everybody has to find out for himself...

Fig. 3.2.: Picture series of launch.

3.5. Maintenance and care

Despite the SALpeter withstands extreme loads in the launch, one should always be aware that it is a sensitive device because of the necessary lightweight construction. Especially at transport damages can quickly occur if you do not handle your plane with care. For long lasting enjoyment in the exceptional flight performance avoid dents in the wing by putting them in the protection covers whenever possible.

Besides the general integrity the following points should be checked regularily:

- bonds of launch peg, vertical tail and rudder horns
- mounting of wing and elevator
- presence of the antenna elongation.

Rapid glue (CA) should be used carefully. The foam of the tails is not resistant to it (the Rohacell of the wing is).

For cleaning use a moist (not wet) piece of cloth and some detergent. The balsa wings can show wood structure for a short time, which is normally reversible. Insistent contaminations can be removed with solvent like cleaning grade petrol or acetone (the latter not on the tails, as the foam is not resistant to it).

Dry your wings quickly after they have become wet and store in a dry place.

At storage there should be no forces or moments acting externally on wing and tails. Epoxy is a viscoelastic material which deforms under long enduring loads. The wing can be stored standing on one tip.

Finally TUD Modelltechnik wishes you a lot of fun with your SALpeter and that you keep the enjoyment for a long time.

Andreas, Franz und Martin

A. Appendix

A.1. Parts list

Tab. A.1.: Parts list SALpeter

Pos.Nr.	amount	designation	material	size
1	1	fuselage	CfK	n.Z.
2	1	wing	GfK, CfK, Rohacell or Balsa	n.Z.
3	1	horizontal tail	GfK, CfK, Depron or RHC	n.Z.
4	1	vertical tail	GfK, CfK, Depron or RHC	n.Z.
5	1	canopy with mounting	CfK	n.Z.
7	1	linkage lines	Kevlar/Dyneema	ø 0.4 × 2000
8	2	torsion springs	spring steel	ø 0.5 × 45
9	1	rudder horn material	carbon sheet	25 x 25 x 0.5
10	1	antenna elongation	copper wire	ø 0.15 × 1000
11	2	nylon screws M4	nylon	ø M4 × 15
12	2	nylon screws M3	nylon	ø M3 × 10

A.2. 3-view

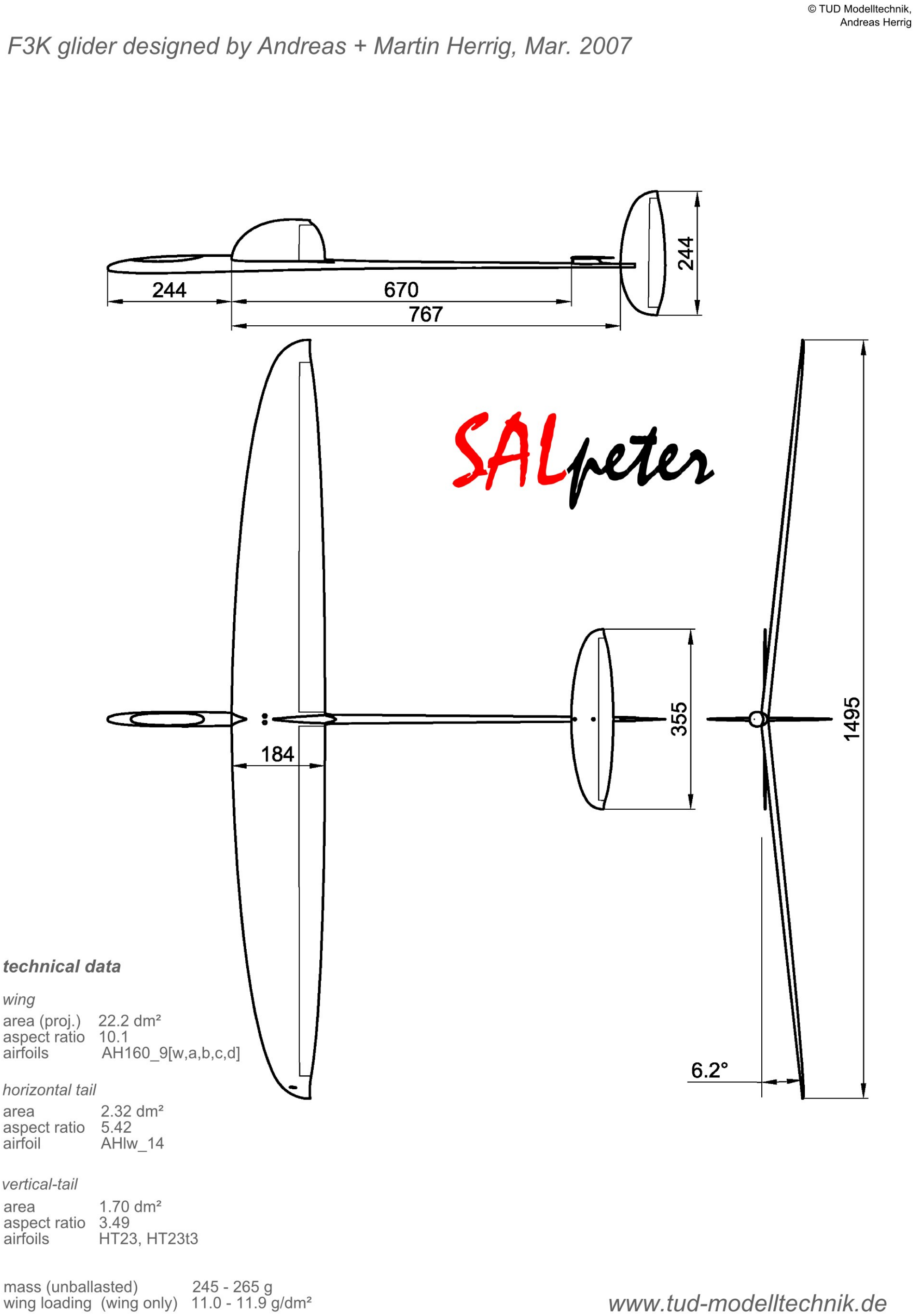

Fig. A.1.: 3-view of the SALpeter.

A.3. Templates

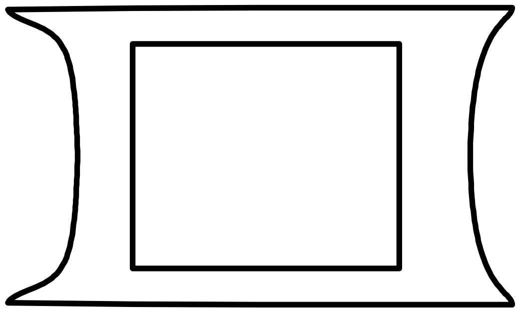

Fig. A.2.: Servo tray. For printout in size A5.

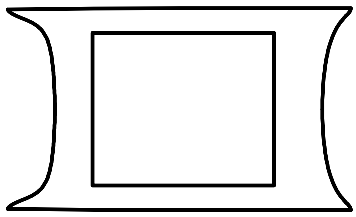

Fig. A.3.: Servo tray. For printout in size A4.

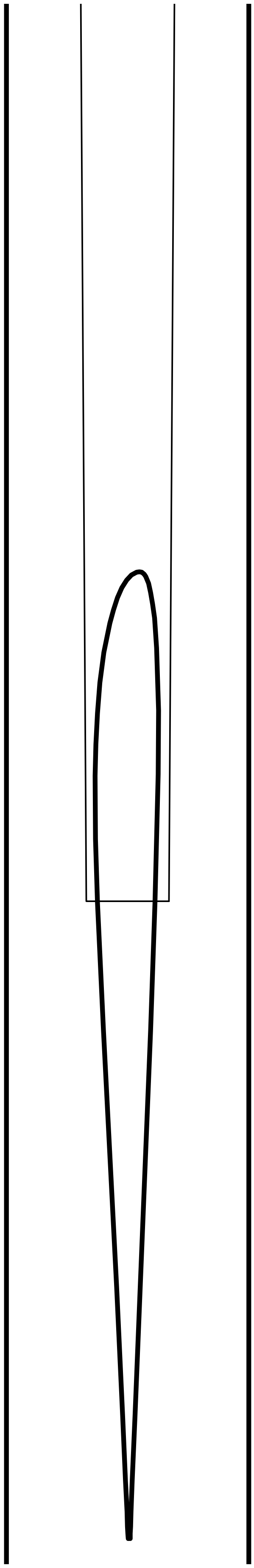

Fig. A.4.: Alignment of vertical tail. For printout in size A5.

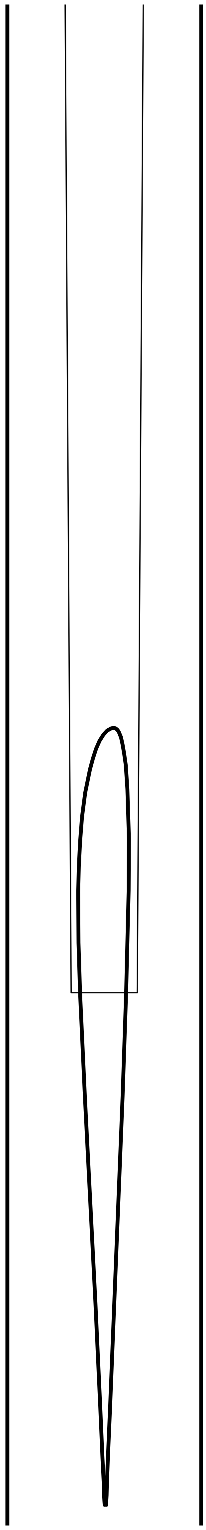

Fig. A.5.: Alignment of vertical tail. For printout in size A4.

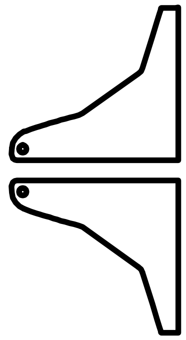

Fig. A.6.: Templates for rudder horns. For printout in size A5.

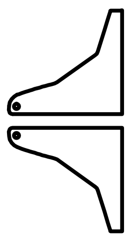

Fig. A.7.: Templates for rudder horns. For printout in size A4.