CARF MODELS

# Instruction Manual

# *Embraer T-27 Tucano, quarter-scale*

TAVS Technology

version 1.0

# Instructions for Embraer T-27 Tucano

Thank you very much for purchasing our CARF-Models Embraer T-27 Tucano (quarter-scale) all composite aircraft, designed for Turboprop power, made with the revolutionary Total Area Vacuum Sandwich (TAVS) technology.

It is based on the original molds from JetPower.at, with several changes to improve the assembly and structural characteristics. This manual shows the installation of both the Jetcat SPT5 and Wren MW66 turboprops.

This Instruction Manual is freely dowloadable from our website (www.carf-models.com), with all the hi-resolution photographs in full color. Please note that you might see a few small differences between some the wood parts shown in the photos here, as they are prototypes, and the final cnc milled parts supplied in your kit.

Before you get started building and setting-up your aircraft, please make sure you have read this instruction manual several times, and understood it. If you have any questions, please don't hesitate to contact us. Below are the contact details:

***Email:*** **info@carf-models.com**

***Website:*** **http://ww.carf-models.com**

# Liability Exclusion and Damages

You have acquired a kit, which can be assembled into a fully working R/C model when fitted out with suitable accessories, as described in the instruction manual with the kit.

However, as manufacturers, we at CARF-Models are not in a position to influence the way you build and operate your model, and we have no control over the methods you use to install, operate and maintain the radio control system components. For this reason we are obliged to deny all liability for loss, damage or costs which are incurred due to the incompetent or incorrect application and operation of our products, or which are connected with such operation in any way. Unless otherwise prescribed by binding law, the obligation of the CARF-Models company to pay compensation is excluded, regardless of the legal argument employed.

This applies to personal injury, death, damage to buildings, loss of turnover and business, interruption of business or other direct and indirect consequent damages. In all circumstances our total liability is limited to the amount which you actually paid for this model.

**BY OPERATING THIS MODEL YOU ASSUME FULL RESPONSIBILITY FOR YOUR ACTIONS.**

It is important to understand that CARF-Models Co., Ltd, is unable to monitor whether you follow the instructions contained in this instruction manual regarding the construction, operation and maintenance of the aircraft, nor whether you install and use the radio control system correctly. For this reason we at CARF-Models are unable to guarantee or provide a contractual agreement with any individual or company that the model you have made will function correctly and safely. You, as operator of the model, must rely upon your own expertise and judgement in acquiring and operating this model.

# Supplementary Safety Notes

**Pre-flight checking:**
Before every session check that all the model's working systems function correctly, and be sure to carry out a range check.

The first time you fly any new model aircraft we strongly recommend that you enlist the help of an experienced modeller to help you check the model and offer advice while you are flying. He should be capable of detecting potential weak points and errors.

Be certain to keep to the recommended CG position and control surface travels. If adjustments are required, carry them out before operating the model.

Be aware of any instructions and warnings of other manufacturers, whose product(s) you use to fly this particular aircraft, especially engines and radio equipment.

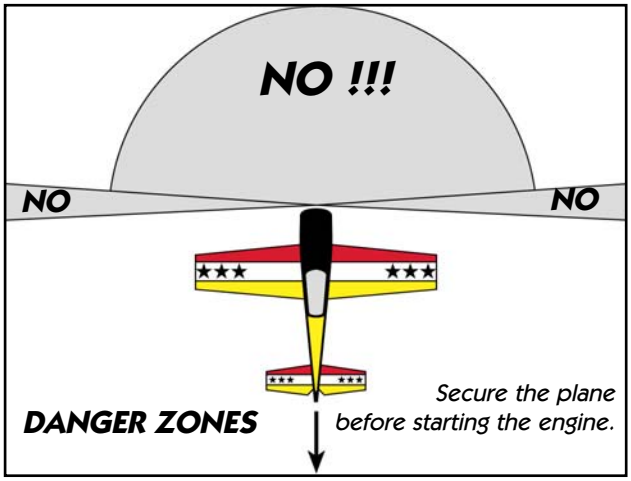
Please don't ignore our warnings, or those provided by other manufacturers. They refer to things and processes which, if ignored, could result in permanent damage or fatal injury.

# Attention !

This large-scale turboprop aircraft is a high-end product and can create an enormous risk for both pilot and spectators, if not handled with care, and used according to the instructions. Make sure that you operate your Extra according to the AMA rules, or those laws and regulations governing the model flying in the country of use.

The engine, servos and control surfaces have to be attached properly. Please use only the recommended engines, servos, propellers, and accessories supplied in the kit.

Make sure that the 'Centre of Gravity' is located exactly in the recommended place. If you find that you need to relocate your batteries or even add weight in the aircraft to move the CG to the recommended position, please do so and don't try to save weight. A tail heavy plane, in a first flight, can be an enormous danger for you and all spectators. Fix any weights, and especially heavy items like batteries and fuel tanks, very securely to the plane.




Make sure that the plane is secured properly when you start the engine. Have at least 2 helpers hold your plane from the tail end, or from behind the wing tips, before you start the engine. Make sure that all spectators are behind, or far in front, of the aircraft when running up the engine.

Make sure that you range check your R/C system thoroughly before the first flight. It is absolutely necessary to range check your complete R/C installation first WITHOUT the engine running. Leave the transmitter antenna retracted, and check the distance you can walk before 'fail-safe' occurs. Then start up the engine, run it at about half throttle and repeat this range check with the engine running. Make sure that there is no range reduction before 'fail-safe' occurs. Only then make the 1st flight. If you feel that the range with engine running is less then with the engine off,

please contact the radio supplier and the engine manufacturer and DON'T FLY at that time. Please follow the law in the country of operation for turbine engine failsafe settings; usually this must be set to shut-down after 2 seconds of 'failsafe' condition.

Check for vibrations through the whole throttle range. The engine should run smoothly with no unusual vibration. If you think that there are any excessive vibrations at any engine rpm's, DON'T FLY at this time and check your engine, spinner and propeller for proper balancing. The low mass of all the parts results in a low physical inertia, so that any excess vibrations could affect the servos and linkages.

Make sure that your wing tubes and stab tubes are not damaged. Check that the anti-rotation pins for the horizontal stabiliser are located correctly in their holes, and are not loose. Check that all linkages and clevises are securely connected to their respective servos and control horns. Check that the M6 wing retaining bolts are tight, that the M3 bolts retaining the horizontal stabilisers on to the carbon tube are installed and tight, and that the hinge tubes for the rudder and elevators cannot come out.

If you carefully checked all the points above and followed our advice exactly, you will have a safe and successful first flight - and many hours of pleasure with your CARF-Models Tucano.

# General information about fully-composite aircraft structure and design

All the parts are produced in negative molds, manufactured using vacuum-bagged sandwich construction technology. All parts are painted in the moulds, either single colour or designer colour schemes. A new production method, called TAVS (Total Area Vacuum Sandwich), enables us to present this aircraft with incredible built-in strength, while still being lightweight, and for a price that nobody could even consider some years ago. This production process has huge advantages, but a few disadvantages as well. These facts need to be explained in advance for your better understanding.

## Description of Parts

### The Wings:

Both wing halves are made in negative moulds, fully vacuum-bagged, using only 2 layers of cloth in combination with a hard 2mm foam sandwich to form a hard and durable outer skin. Because of this TAVS technology no additional structural parts are needed except for the main spar tubes, and the integrated landing-gear mounts.

The ailerons and flaps are already hinged for you. They are laminated in the wing mould and are attached to the main wing with a special nylon hinge-cloth, sandwiched between the outer skin and the foam. This nylon hinge is 100% safe and durable. You never have to worry about breaking it, or wearing it out. There is no gap at all on the hinge-side surface, and there is a very narrow slot on the opposite side, where the control surface slides under the wing skin. This hinge method is the cleanest you can ever obtain, but you have to take some care during assembly for proper installation and servo set-up. The aileron is top-hinged, and the flaps are bottom-hinged - with the molded flap gloves already attached, trimmed and painted for you at the factory.

Having the aileron hinge axis on the top surface of the wing, rather than on the centreline, is not

a disadvantage, if you set in about 10% NEGATIVE aileron differential in your transmitter. This means that the 'down' throw needs to be about 10% more than the up throw.

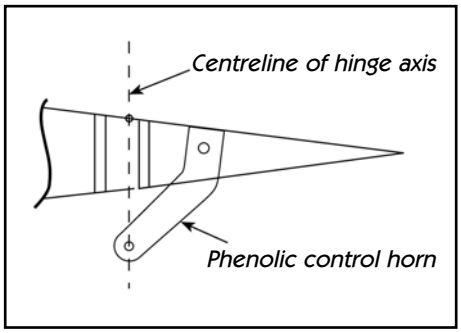
Why? Because the axis of the hinge is not at the centreline of the aileron, so it moves slightly in and out when it travels, and the aileron gets a little "smaller" when moving downwards. This is why you have to set the negative differential in your transmitter to compensate for the size changing. 10% is a good starting point, and you will find out the exact setting during the first flights, doing fast vertical rolls and watching the fuselage rolling in a perfect line. You can set it perfectly, this is guaranteed.

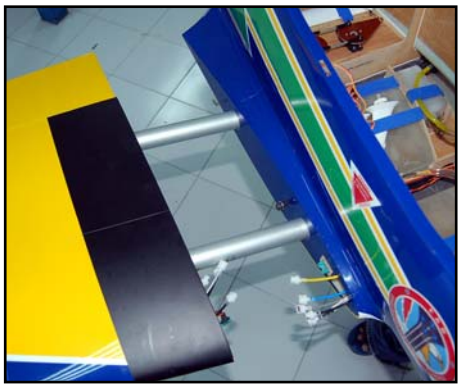
The bottom slot needs some explanation, too. The cut line is exactly in the correct position so that the aileron slides under the wing skin smoothly. If the cut was a few mm forward or back, it would not work properly. So, make sure that the lip is not damaged, and that the aileron slides under this lip perfectly. It will NOT lock at any time, as long as the lip is not damaged. If damage occurs to the lip, you can cut off 2-3 mm, but you should NEVER need to cut off more than this.

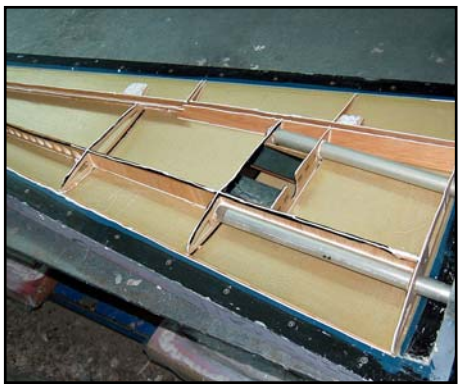
The wings are manufactured with recessed servo covers and hatches for 1 servo per aileron. The flap servos are installed in milled plywood mounts that are screwed to the plywood rib, in the back of the main wheel bay. We recommend a high-torque digital servo (eg: JR D8411 or 8511/8611) for both the flaps and ailerons in each wing. Our servo hatches and milled plywood mounts make both installation, and exchange if necessary, very quick and easy and provide a rock solid servo mounting and linkage system. Both Flap and aileron control surface horns are pre-installed .

The main landing gear mounts are constructed from milled carbonfibre plates and plywood, and are fully integrated into the spar tube system during the molding process, providing an extremely rigid system.

The wings are attached to the fuselage with 2 x 30mm diameter aluminum alloy tubes each, and retained with a single M6 x 30mm socket head bolt that is screwed through the plywood wing root rib into a T-nut in the fuselage - accessed through the main wheel bay with a ball-ended allen wrench. This dual wing tube spar system is extremely strong, and already tested during a very hard emergency landing of the prototype - so please do not modify it in any way !





*(top) Dual 30mm alloy wing tubes give excellent structural integrity.*
*(above) Internal wing structure showing spar and carbon composite landing gear mounts.*
*(below) All main structural bulkheads are factory-installed.*

**The Fuselage:**
The fuselage is also made in negative moulds, and is all constructed using TAVS technology. All the loadbearing internal parts are installed during manufacture, to ensure accurate location and reduce your assembly time. The molded carbon tubes in the fuselage that receive the wing tubes, the carbon stab spar tube, and the holes and reinforcement plates for the anti-rotation dowels, are already installed and aligned. There is no need to even check the incidences - you can be assured that these are already set in the molds so that no adjustment is necessary.

The molded carbon motordome is already trimmed for you at the factory, and provides a rigid mount for the current turboprop motors. Please mount your chosen motor to the mount using the instruction in included in the motor section here - and follow the latest motor manufacturers recommendations about this exactly.

The nosegear mount is also pre-assembled for you, bonded into the bottom of the carbon motor mount and is more than strong enough for even less-than-perfect landings !

The 2 part cowling is also pre-assembled during manufacture, with the main of the fixings already completed.

*(above) The lightweight fin-post has the phenolic hinge posts already installed and aligned for you. Just slide in the 4mm brass tubing for a perfect 'scale' hinge.*
*(below) The elevator hinging also uses 4mm diameter tubes, with phenolic posts and slots all factory-finished and aligned.*

**The Stabilisers:**
The stab parts are also vacuum bagged sandwiched construction, with the control horns and hinging completed for you. The rudder is hinged with a 4mmØ brass tube, and the elevator control surfaces are hinged with 4mmØ aluminum tubes, all fitted through phenolic hinge bearing plates which are jig-installed during manufacture for perfect alignment.

All the structural parts are preinstalled. The horizontal stabs are mounted with a 16mm diameter carbon tube and one 8mm carbon anti-rotation pin each.

## Servo Screws:
Fix the *all* the servos into the milled plywood servo mounts using the 2.9 Ø x13mm sheet metal screws provided in the kit, ***not*** the standard screws normally supplied with servos by the servo manufacturer. This is because all the holes in our milled servo mounts are 2mm diameter, due to our CNC manufacturing process, and this is too big for the normal screws.

## Take Care:
Composite sandwich parts are extremely strong, but fragile at the same time. Always keep in mind that these contest airplanes are designed for minimum weight and maximum strength in flight. Please take care of it, especially when it is being transported, to make sure that none of the critical parts and linkages are damaged. Always handle your airplane with great care, especially on the ground and during transport, so you will have many hours of pleasure with it.

# Accessories

Below are the things you may need to get your CARF-Models T-27 Tucano into the air. Some of them are mandatory, some of them can be chosen by you. What we list here are highly recommended parts, and have been thoroughly tested.

1. Power servos (min. 8 req'd). We highly recommend JR DS8411 or 8511/8611/8811 for all flight control surfaces. For Futaba users, we recommend that you use S9351's for all flight control surfaces. Please do not use inferior quality servos, or servo arms, in this plane. It will result in an aircraft that does not fly accurately, reliably or safely.

2. Servo output arms & discs (9 pieces total). We recommend that you use full metal servo output arms on ailerons and and elevator servos (4 pieces req'd), for example the 1" SWB 'Double-Loc' type which we use on all our high-performance aircraft. These are available from C-ARF as an option (# 630301)

   For Flaps and Nosegear steering you should use heavy-duty plastic servo arms. (eg: JR #JRPA215, or Graupner #3544). 3 pieces required.

   For the Rudder servos we also strongly recommend that you use metal output discs (eg: 'Hangar 9' #HAN3526 or HAN3520) 2 pieces required.

3. Nosegear steering servo. Any standard sized servo with at least 5kg torque, and preferably with a metal final output gear.

4. Retractable Landing Gear set: Behotec have designed and manufactured a special scale set for our Tucano, which includes the 3 retract units, oleos, wheels, air tank and filler valve, air tubing, main gear door cylinders, and airline connections. Available from C-ARF as an option (product # 690500). Gear/brake and door valves are not included (see below)

5. Gear/Brake and Door valves etc. In both prototypes we used the standard Behotec 'combined' valve for the retracts and brakes, and a Jet-tronics 2-way valve for controlling the inner main gear doors - in combination with a Jet-tronics door sequencer. This set-up works perfectly and all items are available from C-ARF as options. (products #320569, #961100, and #961160)

6. Engine: These instructions show the installation of both the Wren M454 turboprop and the Jetcat SPT5 turboprops, and the carbon engine mount is designed for these 2 units. Both engines can be purchased from C-ARF. (# 850005 and # 850010)

7. Propeller: We recommend the Biela 24 x12" 3-blade carbon prop for both the Jetcat and the Wren. Maximum propeller RPM on the ground will vary between 6300 and 6500 depending on core engine RPM.

8. Exhaust outlets: The Wren comes with these already attached to the motor, but for the Jetcat you will need to purchase these, or fabricate them. Available as an option from C-ARF, product # 690600)

9. High quality heavy-duty servo extension cables, with gold connectors. High quality receiver and ignition switches, etc.

10. Batteries. We used the Powerbox 2800mAH Lipo packs for the receiver (product # 960550) and the standard Jetcat 6-cell 2400mAH Nicad for the ECU/pump/kerosene start.

11. Powerbox 40/24 Competition and sensorswitch for dual batteries (available from C-ARF, product # 960500)

# Tools

This is a relatively easy plane to assemble, not requiring difficult techniques or special equipment, but even the building of CARF-Models aircraft requires some suitable tools! You will probably have all these tools in your workshop anyway, but if not, they should be available in all good hobby shops, or hardware stores like "Home Depot" or similar.

1. Sharp knife (X-Acto or similar)
2. Allen key set **(metric)** 2.5mm, 3mm, 4mm & 5mm.
3. Sharp scissors
4. Pliers (various types)
5. Wrenches **(metric)**
6. Slotted and Phillips screwdrivers (various sizes)
7. M3 tapping tool **(metric)**
8. Drills of various sizes
9. Small spirit level, or incidence meter.
10. Dremel tool (or Proxxon, or similar) with cutting discs, sanding tools and mills.
11. Sandpaper (various grits), or Permagrit sanding tools (high quality).
12. Carpet, bubble wrap or soft cloth to cover your work bench (most important !)
13. Car wax polish (clear)
14. Paper masking tape
15. Denaturised alcohol, or similar (for cleaning joints before gluing)

# Adhesives and Solvents

Not all types of glues are suited to working with composite parts. Here is a selection of what we normally use, and what we can truly recommend. Please don't use inferior quality glues - you will end up with an inferior quality plane, that is not so strong or safe.

High performance models require good gluing techniques. We highly recommend that you use either a slow (minimum 30 minute cure) epoxy resin and milled fibre mixture, or a slow filled thixotropic epoxy for gluing highly stressed joints (eg: Hysol 9462). The self-mixing nozzles make it easy to apply exactly the required amount, in exactly the right place, and it will not run or flow onto places where you don't want it! It takes about 1 - 2 hours to start to harden so it also gives plenty of time for accurate assembly. Finally it gives a superb bond on all fibreglass and wood surfaces. Of course there are many similar glues available, and you can use your favourite type.

1. CA glue 'Thin' and 'Thick' types. We recommend ZAP, as this is very high quality.
2. ZAP-O or Plasti-ZAP, odourless, or ZAP canopy glue 560 (for clear canopy)
3. 30 minute epoxy (we use ZAP for many of the important joints in this aircraft).
4. Loctite Hysol 9462 or equivalent (optional, but highly recommended)
5. Epoxy laminating resin (12 - 24 hr cure) with hardener.
6. Milled glass fibre, for adding to slow epoxy for stronger joints.
7. Micro-balloons, for adding to slow epoxy for lightweight filling.
8. Thread-locking compound (Loctite 243, ZAP Z-42, or equivalent)

We take great care during production at the factory to ensure that all joints are properly glued, but of course it is wise to check these yourself and re-glue any that might just have been missed.

When sanding areas on the inside of the composite sandwich parts to prepare the surface for gluing something onto it, do NOT sand through the layer of lightweight glasscloth on the inside foam sandwich. It is only necessary to rough up the surface, with 80/120 grit, and wipe off any dust with acetone or de-natured alcohol (or similar) before gluing to make a perfect joint. Of course, you should always prepare both parts to be joined before gluing for the highest quality joints. Don't use Acetone for cleaning external, painted, surfaces as you will damage the paint.

**Tip:** For cleaning small (uncured) glue spots or marks off the painted surfaces you can use old-fashioned liquid cigarette-lighter fuel, like 'Ronsonol' or equivalent. This does not damage the paint, as Acetone and many other solvents will, and this is what we use at the factory.


*TIP: Lighter fluid is excellent for cleaning small marks, uncured glue, or similar off the painted surface of the plane - without damaging the colour finish.*

At CARF-Models we try our best to offer you a high quality kit, with outstanding value-for-money, and as complete as possible. However, if you feel that some additional or different hardware should be included, please feel free to let us know.

Email us: ordersupport@carf-models.com

We know that even good things can be made better !

***Did you read the warnings above and the complete instructions carefully?***

***Did you understand everything in this manual completely?***

***Then, and only then, let's start assembling your CARF-Models Tucano.***

# Building Instructions

**General Tips:**
We recommend that you follow the order of construction shown in this manual for the fuselage, starting at the back of the fuselage and working towards the nose - as it makes access to everything easier and saves time in the end.

The first thing to do is protect the finished paint on the outside of the model from scratches and dents during building - so cover your work table with a piece of soft carpet, cloth or bubble-plastic. The best way to stop small spots of glue getting stuck to the outside of the fuselage is to give the whole model 2 good coats of clear car wax first, *but* of course you must be sure to remove this 100% completely before adding any decals or markings. Additionally you can cover the majority of the fuselage with the bubble-plastic used to pack your model for shipping, fixed with paper masking tape, which also protects it very well.

When sanding any areas of the inside of the fuselage to prepare the surface for gluing something onto it, do NOT sand right through the layer of glasscloth on the inside foam sandwich !
It is only necessary to rough up the surface, with 60/80 grit or equivalent, and wipe off any dust with alcohol (or similar) before gluing to make a perfect joint.

Before starting construction it is a good idea to check inside the fuselage for any loose glass fibres that could cut your hands, and a quick scuff over any of these with a coarse Scotchbrite pad will remove them.

**Note:** It is very important to prepare the inside of the fuselage properly, by roughing up and cleaning the surface, before gluing *any* parts to it.

## Horizontal Stabs

The stabilisers only need the servos and linkages installing. The stabs are secured to the 16mm Ø carbon tube spar with a pair of M3 x 16mm bolts, that pass thru the holes in the bottom of the stabs into T-nuts that have been aligned and glued into the ends of the carbon tube at the factory. 8mm diameter carbon rod anti-rotation dowels are factory-installed at the leading edge. The dual phenolic elevator horns are also jig-installed for you.

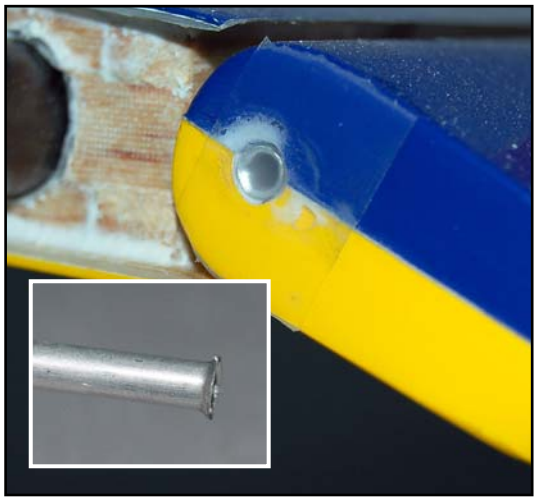
*(above) Horizontal stabiliser parts.*
*(below) 1.5mm ply triangles must be glued inside stab for the hatch screws.*

Insert the 16mm carbon tube spar in the fuselage sleeve, and slide on both stabs. The tube is marked left and right, so that you can get the correct alignment of the stab retaining bolts. When assembling the model at the airfield make sure to add a small piece of clear tape over the heads of the bolts to make suer that they cannot come loose.

**TIP:** Try to always leave the stab tube fixed into one stab, and never remove that one bolt, as it is difficult to find the right position for the stab tube again if it is removed from both stabs!

The elevators are hinged to each stab using the 4mm Ø aluminium tubes provided, which pass thru' phenolic hinge posts glued into the stab during factory assembly. Make sure there is no burr on either end of the tubes, and chamfer the ends slightly with fine sandpaper to make it easier to get them through the holes in the phenolic hinge plates. Be careful inserting them, and if they are a bit stiff, then use a little grease on the tubes. Leave the tubes a bit too long during assembly, and cut them to exact length when the model is finished. During final assembly, retain both ends of the tubes with small pieces of clear tape on the root and tip ends of the elevators.

Alternatively you can 'mushroom' or 'splay' the inner end of each tube with a tapered rod or 5mm ballwrench, counter sink the 4mm hole in the stab slightly, and slide the hinge tube in from the root end. Then you only need to retain the inner end with tape - which gives a nicer appearance (see photo right)



*(above) Either secure the hinge tubes with clear tape at both ends, or splay one end of the tubes, countersink the 4mm hole in the control surface a little, and then secure with tape.*

## Servos

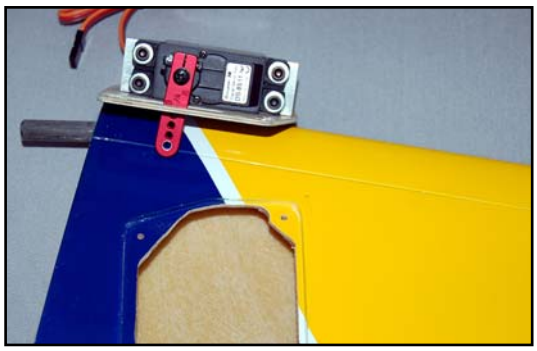
We strongly recommend that you fit a high-power digital servo (eg:JR DS8411/8511/8611/8811) in each stab as shown here, and the servo mount is specifically designed for these servo types.

## Servo arms

We highly recommend that you use metal servo output arms on the servos for the elevator servos. The extreme torque of the current hi-torque digital servos can strip the splines from the inside of plastic servo arms - which will result in immediate flutter. Several reputable accessory companies make aluminium servo arms, but you should check that the CNC machined splines fit onto the servo output shaft tightly, with a minimum of lost movement. At CARF-Models we only use the 'Double-Loc' arms from SWB, and we highly recommend them. These arms clamp onto the servo output shaft with no lost movement (play) at all. They are high quality, properly engineered arms, and are available as an optional item from us, or from good hobby stores.

The stab servos are secured to the CNC milled composite servo hatches using the aluminium angles and bolts supplied. Check the fit of both servo hatches in the moulded recesses in the stab, and sand the edges a little if necessary for a perfect fit. Glue the milled 1.5mm plywood triangles under each corner of the servo bay (where the fixing screws will be) to reinforce the area for the screws, using thick CA. Sand and trim the inside edges of the servo bays as needed for the hatches.

Fit the rubber grommets and brass eyelets into the servos, and *loosely* bolt them to the angles with the M3 x 10 allen bolts and washers (with the servo output shafts towards the trailing edge of the stabs). Using the M3 x 6mm button-head bolts secure the ali. brackets to the hatches, with a small drop of Loctite on each. The milled holes in the hatch for these bolts are 2.5mm diameter, and the bolts will cut their own thread in the composite plywood.



*(above & below) Stab servo installed in the hatch using the aluminum angles & hardware supplied, and fitted with 1" metal SWB servo arm.*

Check that the upper face of the servos is completely flush against the inside of the servo hatches, and then tighten the securing allen bolts. (see photo P1)

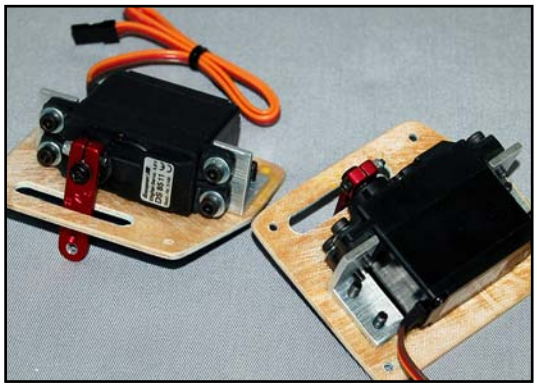
Centre both servos with your R/C, and fit 1" (25mm) metal servo arms (SWB shown here) at 90 degrees to the servo hatch surface, using a drop of Loctite on the servo arm bolts for safety. With the servo hatches in place, drill Ø 2mm through the milled fixing holes in each corner, and secure the hatches with the Ø 2.9 x 10mm sheetmetal screws.

Make up the linkages from the 65mm long M3 all-threaded rod provided, with an M3 aluminum clevise and M3 nut to connect to the outer hole of the servo arm, and an M3 ball-link bolted between the dual phenolic elevator horns with an M3 x 16mm bolt and M3 lock nut. See photo P2.

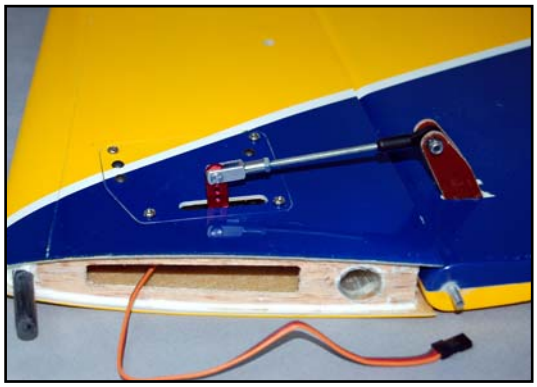
You will need to re-drill the outer hole of the SWB arms to 3.0mm Ø for the clevise pins, and we recommend that you apply a little grease to these (and all similar) linkage connections to prevent any binding of the aluminum pins in the metal arms.

### Leading Edge Extensions

Included in the kit are a pair of 'handed' (left & right) lightweight stab leading edge extensions to represent those parts on the full-scale plane. These should be glued onto the fuselage as shown, using thin CA, leaving a small gap between the back edge and the stab leading edge for easy stab removal.



*(above) Stab servos (8411/8511/8611) installed in the stab servo hatches.*
*(below) Completed stab servo hatch and M3 linkage.*




## Rudder

The rudder is completed at the factory, with the dual phenolic control horns already glued in position, and the hinging is the same as for the elevators - except that it uses a 4mm brass tube. Secure this hinge tube for flight in the same manner as for the elevators.

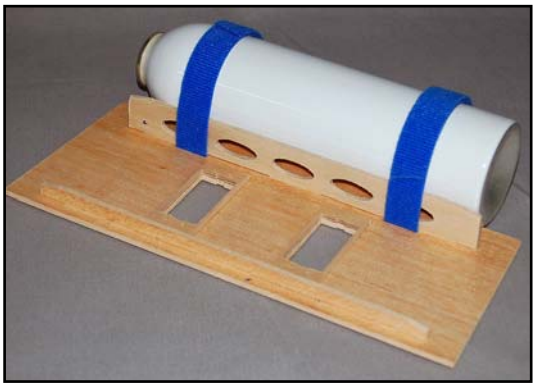
The rudder is operated by a pair of servos, mounted in a composite balsa/glass plate with plywood reinforcements, that must be glued to the back of the rear main former under the cockpit area. This rudder servo plate also has provision for mounting the Behotec air tank under the back edge of it. (see installation section)

## Servos

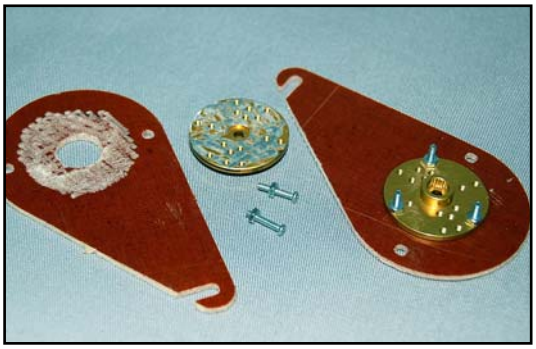
The recommended choice of servos for the rudders is either a pair of JR DS8411/8511/8611, or Futaba S9351's, and the milled mounting plate suits these.

## Servo arms

The supplied 'pear-shaped' phenolic rudder servo output horns must be bolted to 1" or 1.25" diameter *metal* servo output discs. Please do not use the standard plastic output discs, as there is a chance that the internal plastic splines can be stripped by the current hi-torque servos - causing instant rudder flutter, and probable loss of your plane. We used 'Hangar 9' metal output discs (part number # HAN3526 or HAN3520) for the JR8511 servos used here.



*(above) Rudder servo tray assembled from milled balsa & plywood parts. The slots allow you to secure the airtank under it with the supplied velcro. (below) Phenolic rudder servo output arms must be secured to metal servo discs, with at least 2 small bolts & nuts.*



Prepare and glue the 2 milled plywood reinforcing pieces underneath the servo cutouts in the balsa plate, the balsa reinforcing strip at the front, and also the 3mm milled plywood strip at the back, using thin CA glue. Check the fit in the fuselage with the top surface of the plate 6mm (1/4") below the top edge of the rear cockpit bulkhead, and sand the ends if a little bit long. Don't glue the plate into the fuselage until after the servos and phenolic arms have been completed.

Install the 2 rudder servos in the plate, with the output shafts nearest the front edge, using the Ø 2.9 x 13mm sheetmetal screws. Fit the metal servo discs, and centre both servos your R/C. Rough sand and clean the bottom surface of the 2 phenolic horns, and the top surface of the metal discs.

With the R/C still switched 'ON' place the phenolic servo horns on top of the output discs, with both 'hooks' facing forwards. Align them carefully so that both horns are centred exactly on the metal discs, and they both angle backwards by the same amount (photo P3). This angle is so that the rotation axis of the horns is close to 90 degrees to the line of the rudder pull-pull cables, which must be crossed - so that they exit under the stab.

Tack glue the phenolic arms on top of the output discs with a couple of drops of thick CA. When the glue has cured, remove the arms and discs, drill through both and secure with at least 2 small bolts, washers, locknuts and Loctite (M2 bolts & nuts included). Finally add a drop of Loctite to the bolts that secure the discs to the servos.

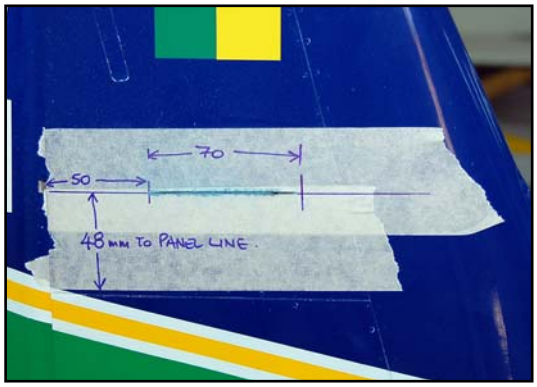
Make up the linkages between the servos from the M3 ball-links and threaded rod included, as shown. Secure just one of the linkages between the phenolic arms, with the M3 x 16 bolts through the milled holes, with lock-nuts underneath. Adjust the length of the 1st linkage very carefully until there is no buzzing or humming from the servos at idle, or at full throw. When satisfied, add the other linkage and follow the same method of adjustment. (photo P3)

Glue the competed rudder servo tray into the fuselage, with the top surface about 6mm below the top edge of the rear cockpit bulkhead, using 30 minute epoxy and micro-balloons mixture.

Make the pull-pull wires from the hardware supplied, with a loop at the front that goes over the hooks on the output arms, and an M3 clevise with threaded end (turnbuckle) and locknut at the rudder end. Pass the closed loop cable through the supplied 'crimping tubes' 2 times before squashing flat with pliers (photo right). Make sure that the wires are tight, and check and adjust after the first few flights as the cables straighten out. You can glue a very small scrap of ply or balsa across the front of the slots on the servo arms with a drop of CA to prevent the wires coming out of the slots accidentally.

*(above) The pull-pull linkage to the rudder horns is made up from the 1.0mm cable, threaded-ends and M3 steel clevises as shown. Pass the cable thru' the crimping tube 2 times for safety, before squashing them flat.*

With the servo tray fitted in the recommended position, then the centre of the slots that you must cut for the parallel pull-pull cables to the rudder is 130mm (5.25"") forward of the back edge of vertical fin, and 40mm down from the panel line under the stab fairing. Cut out a small slot first with a very sharp knife, check the position using the pull-pull wire, and then adjust and open up the slots with a small file as needed. The slots need to be about 2mm high and 25mm long. (see photo P4)



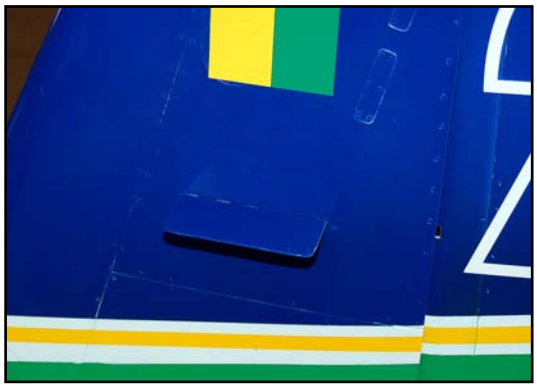

*(above) Cut the slot for the fin antenna with a Dremel and cutting disc as shown. (below) Secure the milled plate in position in the slot in the fin with a little thin CA or 5-minute epoxy.*

The pull-pull cable is plastic-coated, which should prevent any metal-to-metal contact, but if you can also insulate them with a length of small diameter heat-shrink tube over each.

## Antenna

Included in the kit is a milled and painted sheet to represent the antenna in the fin of the full-scale aircraft.

Cut a 70mm long matching slot in both sides of the fin, 50mm from the trailing edge and 48mm above (and parallel to) the molded-in panel line that is below it, as shown here. A dremel cutting disc is suitable for this as the slot only needs to be 1.5mm wide. Push the milled sheet thru' the fin, check from the front and rear that it is perpendicular the fin centreline, and glue into position.



# Wings

The wings have already been installed on your fuselage to check fit and alignment. Each wing slides onto a pair of Ø 30mm alloy tubes (the front tube is 5 - 6mm longer than the rear tube), which locate in carbon sleeves in the fuselage, that are factory-bonded to the bulkheads. The wings are retained by one M6 x 30mm allen bolt each, which passes thru' the milled hole in the plywood wing root rib (in the wheel well) into the factory-fitted T-nuts in the fuselage (see P46). You will need to use a 5mm ball-driver to tighten the wing bolts because of the angle.

The aileron servos fit into molded hatches in the underside of the wing, and the flap servos are installed in milled plywood mounts that you need to fix inside the wing. The phenolic aileron and flap control surface horns are pre-installed and jig-aligned for you.

The main landing gear is bolted to strong composite carbon/plywood mounts that are jig-installed during manufacture, and this mount is specially designed to fit the (optional) Behotec C-50 landing gear set exactly. Molded and painted inner and outer gear doors are included, with the hardware needed to install them. The pneumatic cylinders and extension shafts used to operate the inner gear doors are included in the optional landing gear set.

## Servos

The choice of servos for the flaps and ailerons is similar to that for the rudders. We recommend a pair of JR/Graupner 8411/8511/8611's or a pair of Futaba S9351's in each wing. If using 8511/8611 servos you will need to sand the inside of the plywood servo mounts about 0.5mm bigger all round for a good fit. The aileron servo is installed with the output shafts towards the wing trailing edge, and the flap servo has the output shaft towards the leading edge.

## Servo arms

We highly recommend that you use metal servo arms for the ailerons, like the 1" (25mm) SWB type shown here. If you use the standard plastic output discs on JR 8511/8611 servos, or stronger, there is a chance that the internal plastic splines can be stripped by the current hi-torque servos - causing instant flutter.

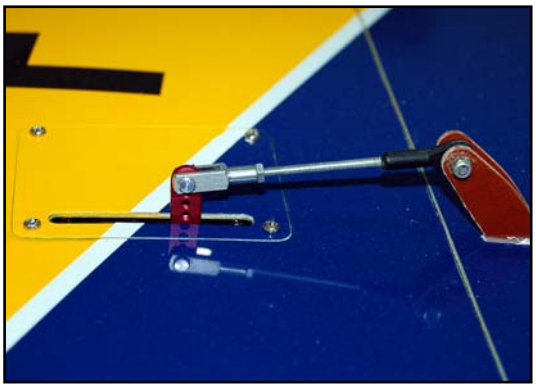
The Flap servos should have heavy duty plastic servo arms as the throws and travels are very short, there is very limited space, and due to the travel axis of the servo arm in relation to the flap horn.

## Aileron servo mounting

Assemble the aileron servo mounts from the 3 CNC milled plywood parts supplied for each servo, using thin CA, as shown in the photo P5. Sand the inside surface of the servo hatch covers with 80 grit paper, to make sure you have a good gluing surface. This is very important ! Fix the servos into the mounts with the Ø 2.9mm x13mm screws provided in the kit. Secure your chosen type of servo output arm to the servos, and centre in the usual way with your R/C.

Place the servos (in their mounts) on the inverted hatch covers to check the alignment so that the servo output arms are in the centre of the milled slots. Tack the plywood mounts onto the hatch covers with a cou-

*(below) Completed aileron servo hatch and linkage, using the supplied M3 aluminum clevises and ball-links.*



ple of small drops of thin CA. Remove the servos carefully, and glue the mounts to the hatch covers permanently with thin CA, and then reinforce the glue joints between the servo mount and the hatch with slow (at least 30 minute) epoxy and milled fibre, with a nice glue fillet all around. Re-install the servos. If using SWB 1" arms you will need to redrill the outer hole Ø 3.0mm for the pins of the M3 aluminum clevises. Route the servo lead, and extension cable as needed, forward thru' the holes in the wing spar to the opening in the front of the ply root rib. Don't forget to tape any slack cable to the inside of the wing skin so that it cannot foul the servo linkages.

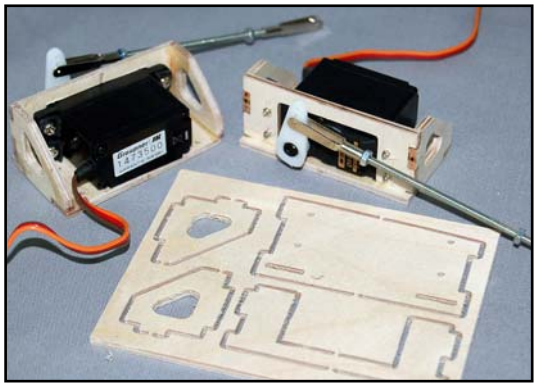
Finally secure the completed aileron servo hatches to the underside of the wing using 4 of the sheet-metal screws provided, Ø 2.9 x 10mm. Make up the aileron linkage from the supplied hardware, using the M3 aluminum clevise and an M3 nut at the servo end of the all-threaded rod, and an M3 ball-link sandwiched between the dual phenolic control horns - retained with an M3 x 16mm bolt and locknut. (see photo above)

## Flap servo mounting

The flap servo mounting and linkage is a little unusual, because the axis of the clevises are at 90 degrees to each other, but this works perfectly due to the small travels, and has been fully tested with many flights of both prototypes.

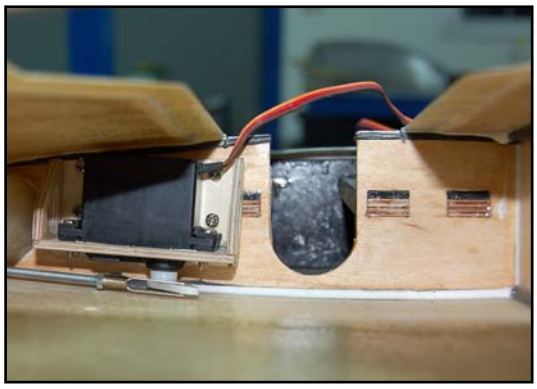
Assemble the flap servo mounts from the 3 CNC milled plywood parts supplied for each servo, using thin CA, as shown in the photos right and P6. Then reinforce all the joints with a bead of 30 minute epoxy.

Install the servo with the output shaft nearest the *front* of the wing, using the Ø 2.9 x 13mm screws. Of course, because the servos are mounted inverted in the mounts you should insert the brass eyelets in the rubber grommets form the opposite side from usual. Centre the servos using your R/C and screw the plastic heavy-duty servo arm into place at 90 degrees to the servo case side. Set the flap servo travel/ATV to 110% in your transmitter (JR).



*(above) Flap servo mounts are assembled from the milled plywood parts supplied, glued together with thin CA and then reinforced with 30 minute epoxy.*
*(below) Flap servo mount installed in the wing, and secured to the plywood rib with sheetmetal screws. The plastic servo arm & clevise must be very close to the top skin of the wing, as shown here.*

Make up the 2 linkages from the M3 threaded rods, with a steel clevise and M3 nut at each end. Make the length of both linkages (clevise pin to clevise pin) exactly the same, to ensure identical flap throws, anywhere between 127 - 130mm (5 - 5.1") is fine. Loctite the clevise and nut on *only* the servo ends of both linkages now. Fit the linkage to the 2nd hole out from the centre of the servo, so that the side of the steel clevise with the pin will be only about 0.5 - 1mm away from the top skin of the wing. This ensures that the clevise cannot come off the servo arm accidentally.



Install the completed servo mount and linkage into the wing, so that the servo mount is flat against the plywood rib, and inserting the linkage thru' the pre-cut hole in the trailing edge of the wing. (see photo above and P5). You can enlarge this hole a little if needed, and note that it needs to be right against the top surface of the wing skin. Connect the clevise to the phe-

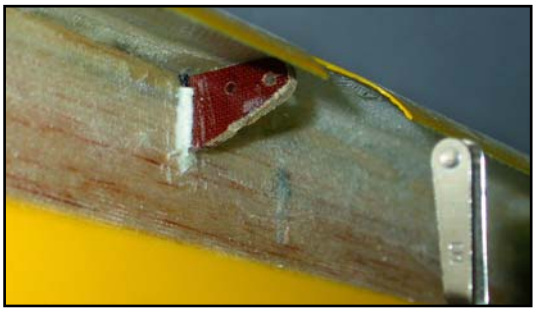
nolic flap horn.

Switch on your R/C and set the flap control the fully 'up' position, so that the servo arm is angled forward at about 45 degrees. You should find that the front edge of the plywood servo mount is about 6 - 9 mm behind the back edge of the 'U-shaped' cutout in the landing gear mount. Fine adjust the linkage length and transmitter ATV's until this is achieved, and check that you can get 75 - 80mm of full deflection (measured at root trailing edge) of the flap.

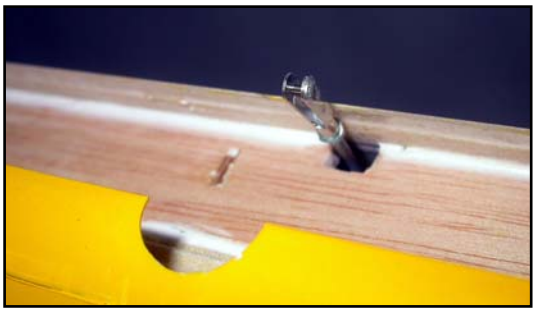
When satisfied, tack the plywood servo mount to the plywood rib with a drop of thin CA to hold it in position temporarily while you drill holes for the 4 sheetmetal screws that secure it to the rib. Make up a long drill bit by gluing a 2mm drill into the end of a piece of 3mm brass tube with CA, and drill thru' the 4 milled holes in the servo mount into the plywood rib (photo right). Secure the mount to the rib with the included Ø 2.9 x 16mm sheetmetal screws using a long PZ2 or PH2 screwdriver.

Note: The first few kits had 4 holes milled in the rib for the flap servo mount, but these are not correctly positioned and should not be used.

The servo cable is routed above the main landing gear cylinder, taped to the wing skin, and then forward through the slot in the wing spar to exit at the front of the wing root rib. (see photo on page 47)



*(above) Clevise connects to factory-installed phenolic horn in front of flap.*
*(below) Enlarge hole for flap linkage in wing trailing edge a little, if needed.*
*(bottom) Use a long 2mm drill to make the pilot holes in the rib for the Ø 2.9 x 16mm sheetmetal screws.*



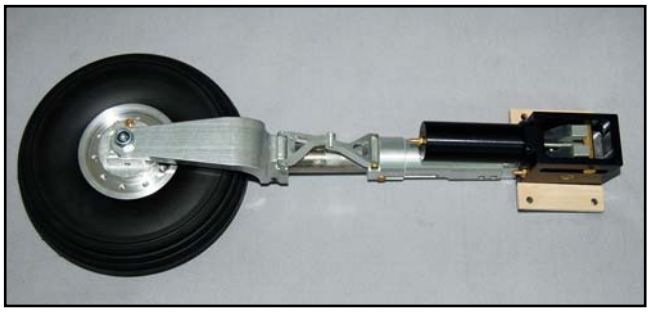
## Main Landing Gear

The main landing gear (Behotec C-50 custom set), and the inner and outer gear doors are very easy to fit. Assemble the main landing gear oleos and wheels to the retract units as shown here, using the 8mm diameter steel connecting pins and set screws. Don't forget to grind *small* 'flats' on the connecting pins for the 2 set-screws that secure it into the retract unit which you should do now, and the 4 that secure it into the oleo leg which must be done after the gear is installed and aligned for correct tracking.

* **NB:** These flat spots should only be a maximum of 0.5mm (1/32") deep - otherwise you will create a weak point in the connecting pins.

Cut 2 plywood spacers for each retract from the 3 x 12mm wide plywood strips supplied, to raise the retract unit off the carbon mounting plates. Tack them to the back of the retracts with a drop of CA, and drill thru' the four Ø 4mm holes.

With the wings upside-down, trial fit the retract unit on the mounting plate. You will need to sand the bottom of the 'U-shaped' cutout in the plywood rib a little, so that it clears the cylinder by about 1mm, because we cannot cnc mill it deep enough without it falling apart. (arrowed on photo P6)



**Important:** Position the retract unit towards the outer edge of the mount and the back of the slot, so that there is 20mm between the inner end of the wheel and the inside of the ply root rib, and at least 10mm between the front of the wheel and the wing spar. This space is needed for installing the linkage from the cylinder to the inner door. (photo P7 & P8)

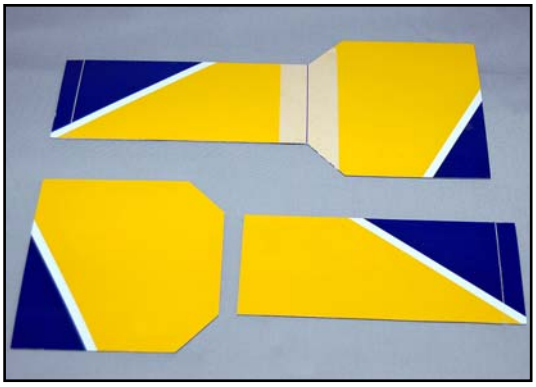
*(above) Behotec C-50 Tucano main gear assembled, with 3mm ply spacers under mounting flanges.*
*(below) Position retracts towards outer edge of carbon mounts, with 20mm clearance between wheel & root rib. Secure with M4 x 25 bolts and T-nuts.*

Drill Ø 4mm through one of the mounting holes in the retract unit, and insert one of the M4 x 25 allen bolts to hold it in position. Then drill the other 3 holes, also inserting a bolt to maintain the correct alignment after each hole is drilled. Remove the retract unit and open up all the holes to Ø 5.5mm for the M4 T-nuts. Using one M4 bolt and a large washer, pull the spikes of each T-nut into the top surface of the mounting rails *just a little*, with a drop of 30 minute epoxy on each. Quickly re-install the retract units and tighten all four bolts tightly, which will make sure that the T-nuts are perfectly aligned when the glue has cured.

You will need to trim the flanges around the wheel well for clearance of the tire, especially at the rear edge. (see photo at bottom of page 19)

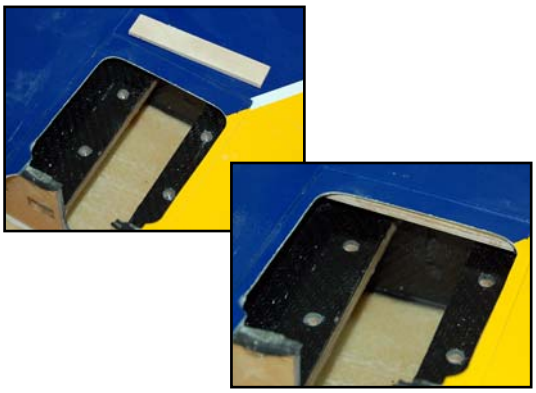
## Outer Gear Doors

The carbon composite inner and outer gear doors are laminated and milled from one sheet, and need to be cut apart as shown right. The outer door has the elastic hinge inserted during the laminating process.



*(above) Separate inner & outer doors.*
*(below) Plywood strip glued in place under skin for outer door screws.*

Sand the edges of both the inner and outer doors for a perfect fit in the molded recesses in the bottom of the wing, and radius the back edges slightly so that they fit completely flush.



Cut a small piece of ply from the 12mm wide strip supplied and glue it under the wing skin at the outer end of the retract bay, for the outer door securing screws. Fix the outer door in place using 3 small sheetmetal screws (Ø 2.2.x 10mm). see photo P10.

The outer door is held to the oleo leg with a short link of 2mm steel wire, in 2 bushings made from Ø 3mm

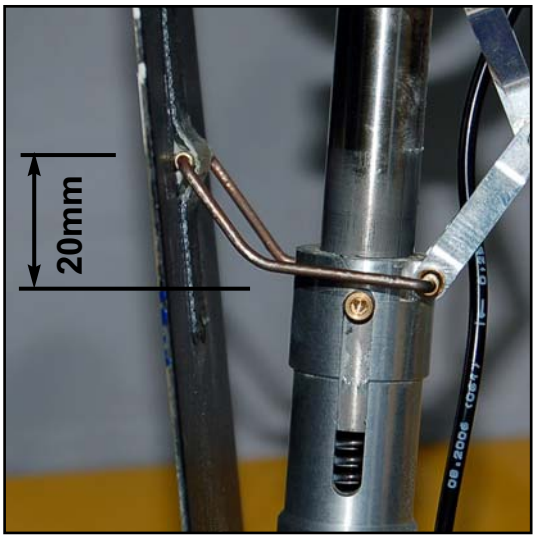
brass tube. Cut 2 lengths of the 3mm tube, each 28mm long, for each outer door. Slide one of these into the 3mm I.D. sleeve in the oleo leg at the top of the scissor-link, as shown.

Cut a 170mm length of the soft 2mm wire, and bend as shown in photo P9, threading the other tube onto it during the bending. The dimension between the centres of the brass tubes should be approx. 48mm. The shallow bend in the middle of the long sides is used for fine adjustment of door closing.

Insert the short ends of the wire into the brass tube in the oleo leg. Apply a piece of masking tape to the inside of the outer gear door so that you can tack the brass tube to the tape with CA to find the exactly correct position. You will find that the brass tube on the door needs to be approx. 20mm above the tube on the oleo.

Adjust the position of the tube, tack in place with a drop of CA, and retract the gear by hand to check that the door almost closes flush with the wing - with just a 1 or 2mm gap. Mark the position of the tube on the inner door, remove the paper tape and sand the area ready for gluing. Glue the brass tube to the door with 30 minute epoxy and milled fibre, and then cover the joint with a short length of the 20mm wide fibreglass tape - applied with laminating resin (photo P11). When the glue has cured you can make the final adjustment of the door, for perfectly flush closing, by adjusting the bend in both sides of the wire 'drag-link'.

*(above) Use masking tape on door to check for exact position of brass tube. No bend made for fine adjustment yet. (below) Brass tube on door is approx. 20mm above tube in scissor link. Adjust side bends for perfect closing.*




*(below) Trim 15mm long notches at back and front of the door openings.*

## Inner Gear Doors

Trim and sand the inner edge of the wheel well exactly straight, right up to the edge of the recessed flange. Trim and sand the front and back edges, adjacent to the inner edge of the wheel well, for a length of approx. 15mm, also right up to the edge of the recessed flange (photo right).

Sand both sides of all the phenolic door hinges *before* removing them from the main sheet, using 240 grit sandpaper. Lightly sand the inner (carbon) surface of the gear doors to prepare for gluing. Tack glue the front and rear phenolic hinge plates to the inner surface of the gear doors as shown, with a couple of small drops of thin CA. Make sure that the ends of the phenolic plates are exactly in line with the inner edge of the doors for best operation. Both hinge plates should be 6mm from the front/back edges of the doors.

Cut 2 pieces of the white plastic 3mm tube, each 30mm long, and glue onto the door on the inside of the phenolic plates. Use the 2mm hinge wire passed through both hinge plates and the tubes to make sure everything is in line while you tack these in place with a drop of thin CA. See photo P12.


*(above) A 90 degree attachment makes it easier to drill the hole for the front hinge tube.*

Trial fit the door in the wing recess and transfer the positions of the hole needed at the front for the plastic tube, which is about 6mm from the edge. You will need to maintain about 1 - 1.5mm gap between the inner edge of the door and the edge of the opening.

Mill a Ø 3mm hole right thru' the balsa wing spar for the front hinge wire and tube, in line with the plastic tube on the doors (approx. 6mm from the inner edge of the door). The hole *must* be right up against the skin of the wing for the door to close properly. A Dremel moto-tool with a 90 degree attachment makes this easy! When the hole has been drilled, use a small round file to enlarge the hole to about Ø 5mm, and sand into the foam sandwich by about 0.5 - 1mm. Be careful not to go through the outer fibreglass surface of the wing skin! Sand the inside surface of the wing sandwich at the rear of the door in the same way to prepare for gluing in the plastic tube.

Cut 2 lengths of the Ø 2mm hinge wire 65mm long, and make a short 90° bend at the end of each. Wax these hinge wires with some clear car wax to make sure they cannot be glued in permanently in the next steps! Cut 2 more pieces of the plastic tube, each 25mm long. Install the door in the wing, with the hinge wires in place and the 25mm lengths of plastic tube over them, and check alignment and door operation by hand. When satisfied apply a thick mixture of 30 minute epoxy and microballoons into the hole if the wing spar, and a drop on the wing skin for the rear hinge. Quickly install the door, hinge wires and plastic tubes, close the door to set the correct position, and tape it flush with the wing surface until the glue has cured. When cured, check that the glue joints are filled properly and add a little more epoxy if needed.

When the doors are completed, fix al the plastic tubes and phenolic hinge plates properly with a fillet of 30 minute epoxy and micro-balloons, and also secure the small bends at the ends of all hinge wires with a very small drop of 5-minute epoxy, so that you can remove them for maintenance if necessary. See photos P11, P12 and P14 for completed door.

*(above) Slot the inner hole in the door cylinder brackets.*
*(below) Door cylinder fixed to mounting block with 2 small sheetmetal screws.*

## Door Cylinders

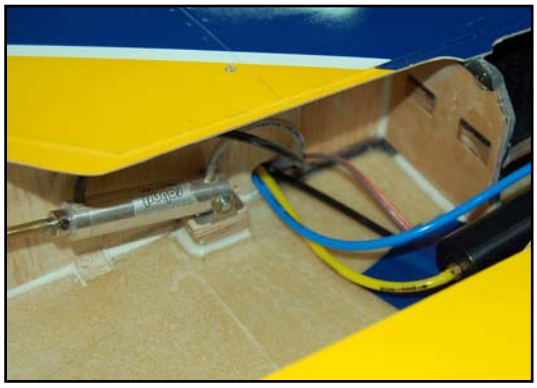
The inner doors are operated by a Robart pneumatic cylinders that are screwed to a small plywood blocks in the front of the wheel well, and connected to the front phenolic hinges with brass extension shafts that are included with the cylinders (in the optional landing gear set).

Make up the cylinder mounting blocks by gluing 3 pieces of 3mm plywood together (12mm wide and 20mm long) with CA. Cut these from the 12mm wide

plywood strip provided in the kit. Because you cannot access the inner screw when the cylinders are installed in the wing, you need to 'slot' the inner hole in the metal mounting bracket with a small file, as shown here. Don't tighten the inner screw fully, so that you can remove the mount and cylinder by sliding it outwards towards the wing tip (after removing the other screw), for maintenance. Secure the cylinder mount to the blocks using the Ø 2.2 x 10mm sheetmetal screws provided.

Attach the 80mm long extension shaft to the door cylinder. This is a brass tube with a 2 x 56 UNC thread at one end (to screw into the cylinder shaft), and an M3 thread at the other end for the supplied M3 steel clevis, to connect to the phenolic door hinge plate. Add a drop of Loctite to the 2 x 56 thread before screwing it into the cylinder shaft.

*(above) Extension shafts are included in the optional LG set.*
*(below) Cylinder installed, and all air tubes and flap servo cable routed thru' the slot in the spar/balsa shear web.*



Connect the cylinder to the phenolic hinge with the M3 clevis (and locknut) and mark the position where the block will be glued against the wing spar and skin. Sand and prepare the area. With the door closed and taped firmly in position and the cylinder fully extended, glue the block onto the upper wing skin and the back surface of the wing spar as shown, using 30 minute epoxy. When the glue has cured adjust the clevis on the M3 thread a couple of turns longer to give a positive 'closed' lock. Supplied in the hardware are Ø 4mm wheel collars, which can be secured onto the cylinder shaft if needed to limit the opening angle of the door (see photo right and P13), which should be a little less than 90 degrees - just enough for the wheel to clear the door when operated.

When installed as described, the extension shaft clears the front of the retracted wheel by at least 2mm.

# Cockpit Canopy

The fibreglass canopy frame mountings are already completed for you at the factory. It is secured to the fuselage with four M4 x 12mm allen bolts, fitted from the outside of the fuselage, through the plywood tabs that are glued to the canopy frame, into M4 T-nuts. There are also a couple of small ply location tabs in the middle to maintain correct alignment. This system has been very well proven on all of our aerobatic planes, and is a strong rattle-free solution.

*(above/below) The canopy frame fixings are completed at the factory for you.*

Fitting the clear canopy into the frame is a little bit tricky, because the canopy is so long and the canopy frame is quite flexible because it is so narrow, but this is a step by step guide of how we do it.

**TIP:** To make the installation of the clear canopy easier, we suggest that you do it *after* you have fitted the plywood plate to the front of the fibreglass fuselage firewall and cut the hole for the air inlet duct. Then it is possible to put your arm into the fuselage, thru' the inlet hole, and push the clear canopy against the frame while tack gluing it into place.

* You will find that this job is much easier if you have the assistance of one more person, as you need to hold the canopy in the correct position while gluing it into place.

Sand and prepare the inside edges of the canopy frame carefully with 120 grit sandpaper, especially the fibreglass joining tapes, to ensure a perfect fit of the canopy. Fit the canopy frame on the fuselage and secure with all 4 bolts. Cut the clear canopy from the vacuum molding, staying 2 or 3mm outside the molded-in cut lines. Lay the clear canopy on top of the frame and view from the front and back to check that it is centred and symettrically positioned. Mark the centerlines of the canopy at the front and back on small pieces of masking tape, in line with the joint seams of the canopy frame, to make sure that you glue it in centrally.

Remove the canopy frame, and insert the canopy inside the frame, keeping it centred using the lines you marked. Mark the final shape with a wax crayon or white-board felt pen. Trim the edges of the clear canopy a little at a time until it is about 6 - 8mm (1/4 -3/8") bigger than the frame, clean the outside surface of the clear canopy with lighter-fluid (see page 9) to remove any grease, and then tape it in position inside the frame with small pieces of strong tape. Do this in a warm room to make sure that you do not crack or split the canopy. Carefully reinstall the canopy frame and canopy on the fuselage, and bolt it in position. Secure the front and back edges of the frame to the fuselage with tape.

Apply some wide strips of paper masking tape to both sides of the canopy frame and glue 2 long strips of medium/soft balsa (approx. 10mm x 20mm wide) onto the masking tape with a few drops of thin CA to stiffen the edges of the canopy frame whilst gluing the clear canopy in position (see photo below and P15).

Reach thru' the hole in the firewall and push the back of the canopy firmly up inside the frame, using a strip of plywood or similar. Then secure the lower back 2 corners of the canopy to the

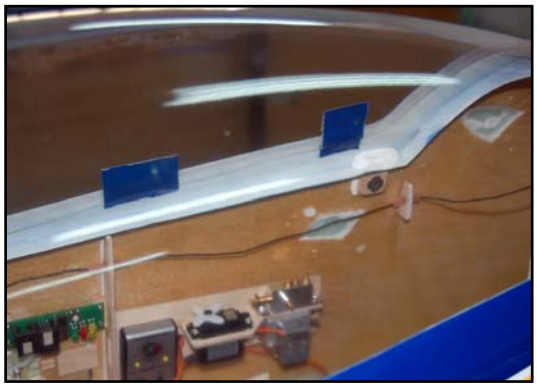
frame using 2 small drops of odorless CA (ZAP-O recommended). Check alignment. Secure the lower 2 front corners to the frame in the same way, *making sure* that the long sides of the canopy stay in contact with the frame for the whole length. Check alignment again.

Then, using the long strip of 3mm plywood to hold the canopy against the inside of the frame, apply 3 or 4 more small drops to fix each long side to the frame. See photo P16.

**Note:** Do NOT use any CA accelerator/kicker - you will immediately 'fog' the clear canopy!

Now that the canopy is fixed in position and cannot twist or warp anymore, you can very carefully remove the canopy frame from the fuselage, and use a 30 minute or 24hr epoxy and micro-balloon mixture for gluing all the edges to the frame on the inside surface.

It is most important that the canopy cannot come off in flight, so make sure that the bead of glue traps the clear canopy firmly in place. Re-secure the canopy frame onto the fuselage with all 4 bolts while the epoxy-microballoons mixture is curing to prevent any warps or twists.



*(above) Tape the clear canopy in position while gluing it into place.*
*(below) Temporarily stiffen the narrow canopy frame sides by gluing soft balsa strips to masking tape.*

# Cowling

The 2 piece cowling is already 95% completed and aligned for you at the factory. The lower part is secured to the fuselage using five M3 x 10mm button-head bolts, into T-nuts that are already installed inside the fuselage. The top part is secured to the lower part using a similar method to the canopy frame, with four M4 x12mm bolts that pass thru' plywood tabs into T-nuts. This is a very secure system, but still allows the upper cowling to be removed very quickly for motor inspection. The cowling is used to align the motor correctly, so that the spinner backplate is exactly parallel with, and centred on, the front of the cowling - ensuring the correct thrustlines.

**Note**: Some of the steps below need the carbon engine mount at least temporarily installed, so please read the engine installation section before starting the cowl assembly.

Install the lower part of the cowl on the fuselage, using the button-head bolts included. If the outer surface of the lower (or upper) cowl is not exactly flush with the fuselage you can adjust it as described below. The photos here show this method applied to the upper part of the cowl.

Apply a layer of brown parcel tape to recessed lip on the front of the fuselage, and give it 2 good coats of clear car wax. Lightly sand and clean the inside of the back of the cowling, and then apply a thick bead of clear silicone (bath sealant). Quickly bolt the cowling in place, making sure

that the cowl and fuselage surfaces are flush. Leave to cure for at least 24 hours, and then remove it, and trim off any excess sealant with a sharp modelling knife. If you need to add more than about 0.5mm (1/32") thickness, then first glue a narrow strip of 0.8mm (1/32') plywood to the inner edge of the cowl, with CA, and then apply the bead of silcone to the plywood strip.

During the motor installation you will need to make semi-circular cutouts in the upper and lower parts of the cowl to clear the turbine exhausts. Make sure that the edges of these cutouts are at least 9mm (3/8") from the exhausts at the front, and about 12mm at the back. (photo P18)

We advise you to apply a layer of aluminum tape to the inside surface of the upper cowl, as shown in the photo right, to protect the paint from residual heat after the engine has been shutdown (photo P17)

You can open up the NACA vents and other small louvres in the cowl if you wish, and they do provide a little extra cooling airflow.

When the motor installation is completed, you must install 1 extra M3 x 15mm button-head bolt in each side of the lower cowl, which passes through the molded 'bumps' on the carbon motor mount, into M3 T-nuts glued onto the inside surface.

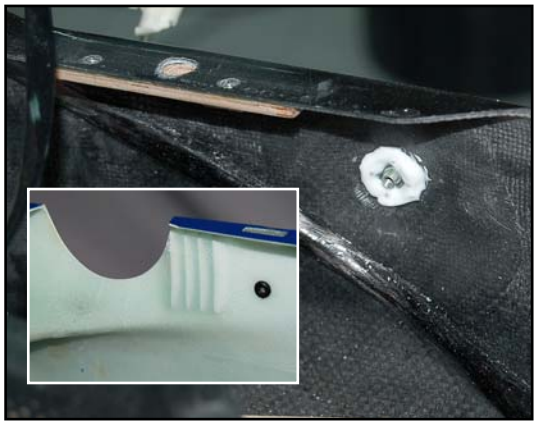
Drill the 3mm holes thru' from the inside of the carbon motor mount, thru' the middle of both molded 'bumps' to ensure correct alignment. Wax the M3 bolts and insert them from the outside of the cowl. Screw on the T-nuts, with the spikes pointing inwards, and glue in position with a bead of 30 minute epoxy and micro-balloons as shown below.

When the glue has cured, remove the bolts and glue half of a small rubber grommet, or small piece of rubber sheet, onto the inside surface of the cowl around the hole to act as a spacer. See inset photo right

Installation of the nosegear doors is described in the 'Nosegear' section below, and should be completed after the motor installation is completed.

*(above) Apply brown parcel tape to the fuselage and wax twice.*
*(below) Apply a thick bead of silicone to cowling and bolt in place until cured.*

*(above) You can mill out the vents in the cowling to provide extra cooling airflow.*
*(below) M3 T-nuts glued inside the motor mount for the M3 cowl bolts later.*
*(inset) Half a small rubber grommet is glued to cowl with CA to act as spacer.*



# Engine Installation

*(above) The carbon motor mount is trimmed, and the plywood parts for the nose gear unit are factory-installed.*

Included in the kit is a molded carbon motor mount, which is designed to suit both the JetCat SPT5 and Wren MW54 turboprop motors. Both motors are similar in size and weight, but have slightly different mounting methods and dimensions. This carbon motor mount also provides the mounting for the retractable nose gear unit, and the plywood parts for this are pre-installed at the factory.

**Important:** Turboprops are at the leading edge of today's miniature turbine technology and it is most important that you read, and follow exactly, the manufacturers *latest* instructions when installing their motor in this airframe. The manufacturers instructions *must* be regarded with priority over the instructions below.

To ensure reliable and safe operation of these 2-shaft turboprop motors, it is most important that they are are mounted very accurately and rigidly - paying special attention that the vertical mounting surface for the 2nd stage turbine is exactly perpendicular to the horizontal mounting plane of the rear (core) engine. Any misalignment could cause 'bending' between the 2 parts of the turboprop, resulting in engine damage or failure. The first few steps of the engine installation are almost identical whether you have chosen to use the Jetcat or the Wren turboprop.

Cover the front of the fuselage with masking tape, and mark a vertical line, exactly in line with the fuselage joint seam. Mark another vertical line exactly 5mm to the right (pilots left view) of it. This line is the centreline of the engine mount, and is offset to the side to take account of the side-thrust needed. (P19)

*(above) Wren MW54 turboprop, showing vertical front mounting ring for the 2nd stage turbine & mounting strap for the core (rear) turbine. The exhaust outlets are integral part of the motor.*
*(below) Exhaust outlets are available for the Jetcat as an option from C-ARF.*

Measure 55mm down from the top of the fuselage and mark a horizontal line, using a set-square to make sure that it is at 90 degrees to the vertical line. Hold a steel ruler on this line and visually check to see that it is exactly parallel with the horizontal stabilisers. This horizontal 'datum' line is the top edge of the plywood firewall that you will glue onto the fuselage, and also the top edge of the carbon mount.

Now check the alignment of the motor mount *before* drilling the mounting holes, as follows:

Temporarily tack glue the 3mm milled plywood firewall to the back of the carbon mount with 2 or 3 small drops of CA, aligning the top edges carefully. Make marks on the top and bottom edges of the plywood in line with the joint seam of the carbon mount. Using 2 sheetmetal screws, temporarily fix the complete assembly to the front of the fuselage, carefully aligning the top of the plywood with the horizontal datum line, and the centre joint seam of the carbon mount

with the vertical line that is 5mm offset to the side of the fuselage joint seam line. Install the lower cowl on the fuselage with all five M3 bolts.

Fix a 1.5mm thick spacer to the back face of the Ø 120mm spinner backplate with double-sided tape to maintain the correct gap between it and the front face of the cowl (photo P20). You can use the milled 1.5mm plywood 'U' shape front motor mount for this. Install the backplate onto the propeller shaft, and secure it with a nut. The cnc machined hole in the centre of the backplate is Ø 10mm, which fits the Wren prop bolt. If using a Jetcat you will need to accurately drill this hole out to 12mm, keeping it exactly centred. Bolt the turbine mounting strap onto the core engine and carefully lay the engine into the carbon mount, with the spinner spacer tightly against the front of the cowl. Correct engine alignment is assured when the spinner is exactly concentric with, and parallel to the front face of the cowling.

*Cowling front face is engineered so that perfect engine alignment is assured when the spinner backplate is exactly concentric with, and parallel to, it.*

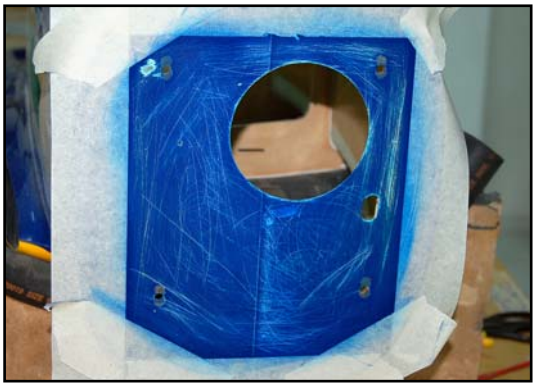
**NB:** The motor ***must*** be parallel with the top surface of the carbon mount during this alignment check, and you will need to add some packing pieces under the front of the 2nd stage engine to ensure this.

Now check that the the bottom of the spinner backplate is 1mm *above* the bottom edge of the front of the cowling, and exactly parallel to it (viewed from the side), to confirm that the vertical position of the carbon mount is correct on the fuselage. (The spinner backplate is 120mm diameter, and the front face of the cowling Ø122mm). Note that the bottom surface of the Wren mounting straps is exactly on the axis of the core engine, but on the Jetcat SPT5 it is about 1.5mm above the centre - which may need a small adjustment of the carbon mount height.

If the bottom of the spinner backplate is 2mm too *high*, for example, then you will need to reposition the horizontal datum line of the front of the fuselage *lower* by the same amount. This check is *only* for the vertical position of the motor mount, and side-to-side alignment will be set when you bolt the core turbine mounting straps to the top surface of the carbon mount later. You can also install the upper cowl at this time to check the alignment.

When satisfied, remove the motor, carbon mount and cowl. Remove the ply firewall from the back of the carbon mount and place the top edge of it on the correct horizontal datum line and the 5mm offset vertical centreline, and mark thru' the four mounting holes. Drill the 4 holes thru' the fuselage bulkhead Ø 6mm (P21). If you make a mistake, and drill the holes incorrectly, just plug the holes with some hard wood dowel, glued in with epoxy, and re-drill (see P19).

Protect the remainder of the front of the fuselage bulkhead with masking tape (photo right), and sand/prepare the area where the ply firewall will be glued. Glue the firewall to the front of the fuselage with 30 minute epoxy, mixed with a little microballoons, and



*(above) Sand the front face of the fuselage and prepare for gluing the 3mm plywood firewall to it.*

hold it in the correct place while the glue cures with the four M6 x 20mm allen bolts, large washers and the T-nuts on the front face. Don't forget to wax or grease the threads of the bolts first, other wise you will not be able to remove them! When the glue is hard, remove the bolts, align the carbon mount exactly with the plywood (hold in place with the 2 sheet-metal screws again), and drill through the 6mm holes from the back.

*(above) M6 T-nuts are glued inside the carbon mount with a thick epoxy and microballoon mixture.*
*(below) For the Wren only you need to use 2 milled plywood discs in each corner of the firewall for correct spacing.*

Sand and prepare the surface inside the carbon mount where the T-nuts will be fixed, insert the M6 bolts (oiled or waxed) with large washers under the heads, and glue the T-nuts in place with a thick mixture of 30 min. epoxy and microballoons. Note that the spikes on the T-nuts face forwards.

**Wren MW54:** Because the distance between the front (vertical ring) engine mount and the back face of the spinner backplate is 6mm shorter than the Jetcat, the carbon engine mount needs to be packed off the plywood firewall using two 3mm thick x 30mm diameter milled plywood rings in each corner, and secured with the M6 x 30mm allen bolts.

**Jetcat SPT5:** Use the M6 x 20mm allen bolts to secure the engine mount.

Remove the carbon mount and mill the Ø 90mm hole in the front of the fuselage, using the milled hole in the firewall as a guide. Reinstall the carbon mount and mill the hole thru' the back face of the carbon mount also. Adjust the diameter to match the fibreglass inlet duct in the kit.

Sand and prepare the inside front vertical face of the carbon mount carefully. Glue the 1.5mm thick milled plywood 'U' shape onto the back face, aligned with the U-shaped cutout in the carbon, using slow epoxy and microballoons (photo P22). Trial fit the lower cowl and motor again and use the spinner backplate to check the space between the front (vertical) engine mount and the back of the 1.5mm plywood. You should find that there is about 4mm between the front face of the engine mount and the back of the 1.5mm plywood. Adjust the shape of one of the milled 3mm thick plywood' U-shaped' parts to fit in the space. You may need to chamfer the edges. Do not glue in place yet.

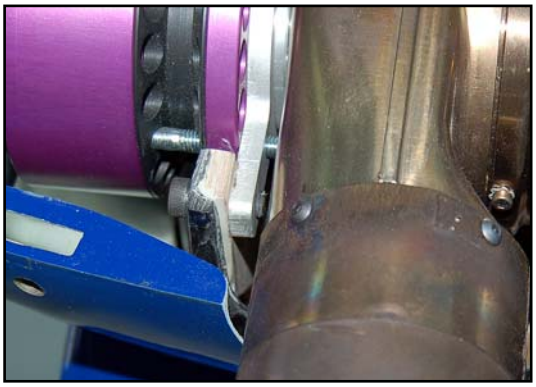
**Wren MW54:** Wren advise that their motor should be rigidly fixed, using three M5 bolts to fix the front mount, at the 3, 6 and 9 o'clock positions, thru' the Ø 5mm front mounting ring, with washers and nylock nuts on the back face. This advice is based on at least 2 years experience of customer engines in similar airframes.

**Jetcat SPT5:** The latest advice from Jetcat (Germany) is that you should *only* secure the front mount with two M5 bolts, at the 3 and 9 o'clock positions, making sure that the lower (6 o'clock position) mounting bracket does *not* touch the plywood mount. This is to reduce the chance of misalignment distorting their motor. The mounting brackets are threaded M5 and therefore you do not need any nuts.

The M5 mounting bolts for the motor front mounts are not included in the kit hardware.

Re-install the lower cowling. Install the motor (with spinner backplate and spacers) in the carbon mount. Glue 2 strips of the 12mm wide plywood under the carbon flanges where the core engine mounting holes will be. Align the side-to-side position so that the spinner backplate is centred exactly, and parallel to, the front face of the cowl. Drill the four Ø 3mm mounting holes thru' the carbon flanges and plywood strips below, using the mounting straps as a guide. For the Wren you will also need to drill 9mm diameter clearance holes in the carbon for the M4 nuts under the centre of the mounting strap. Remove the motor and enlarge the 3mm holes to Ø 4.5mm, and install the four M3 T-nuts supplied, using a drop of 30 minute epoxy to secure them. Before the epoxy has fully hardened, re-install the motor, and tighten the M3 bolts (with washers under the heads) fully to ensure perfect alignment of the T-nuts. (see P23 and P24)

*(above) Glue plywood strips under the carbon flanges for the core mount strap T-nuts, using epoxy.*
*(below) Side-view showing the M5 bolts installed thru' the brass tubes for the front engine mounting.*



*(below) Close-up view of one of the brass tubes glued into the front mount.*

The front fixing bolts are fitted thru' brass tubes, that are glued into oversized holes, to ensure that there are no bending forces on the motor, as follows:

Remove the motor and carefully apply 2 coats of clear wax to the vertical front engine mount, and bottom surface of the gearbox. Apply a very thick mixture of 30 minute epoxy and micro-balloons to the front face of the prepared 3mm thick plywood 'U-shaped' part, and place it against the back of the 1.5mm ply U-shape. Quickly re-install the motor (with spinner backplate and 1.5mm spacers), and tighten the core engine mounting bolts firmly. Check that the motor is parallel to the top face of the engine mount, and add packers below the gearbox at the front if necessary. Clamp the plywood 'U' in position so that it is tightly against the vertical front engine mount until the epoxy has cured. The thick epoxy and micro mixture must fill the space between the 3mm and 1.5mm plywood pieces completely. Any excess glue will be squeezed out of the joint, and can be cut or sanded off later. (see P25 and P27)

When the glue has cured, transfer the position of the holes (2 for Jetcat and 3 for Wren) in the front mount to the plywood 'U-shape' as accurately as possible. Remove the motor and drill these holes Ø 3 or 4mm. Install the motor, check alignment of the holes, and adjust as necessary with a small round file. Then redrill the holes Ø 7mm. Cut 2 (3 for Wren) short lengths of the 5mm I.D. brass tube supplied, exactly the same length as the total thickness of the front face of the carbon mount and plywood U-shapes (approx. 9mm). Sand and clean the outside of the tubes to prepare for gluing. Re-wax the front engine mount and oil or wax the thread of the M5 mounting bolts carefully. Coat the outside surface of the brass tubes with a very thick mixture of

30 minute epoxy and micro-balloons and insert them into the mounting holes. Quickly re-install the motor, tighten the M3 bolts, and screw the M5 mounting bolts (with washers under the heads) into the engine mount and just tighten them a little - *not too tight*. When the glue has cured you will have perfectly aligned front engine mounts, with no bending stresses on the motor. Remove the motor and carefully cut off any excess glue that has squeezed out of the joints with a sharp knife before it has fully hardened. You can trim off any excess plywood that projects above the carbon 'U' at the front of the motor mount. (see above, and P26 and P27)

**Important:** Make sure that the gearbox section of the 2nd stage turbine clears the plywood and carbon 'U-shape' mount by 1 - 1.5mm everywhere, sanding as necessary. This is to prevent any chance of mis-alignment, and to protect the carbon and plywood from the hot gearbox section.

**Jetcat only:** Check that there is clearance between the bottom (6 o'clock position) front engine mount and the back of the plywood 'U', and sand there if necessary (photo above right).

Cut the rounded slot (shown in photo P27) in the lower front of the carbon mount to allow cooling air to circulate under the turbine. The size should be approx. 25mm high and 55mm wide.

**NB:** We *strongly* recommend that you don't finally secure the motor into the carbon mount at this time, but instead complete the nosegear retract and doors first, as access for these is much easier.

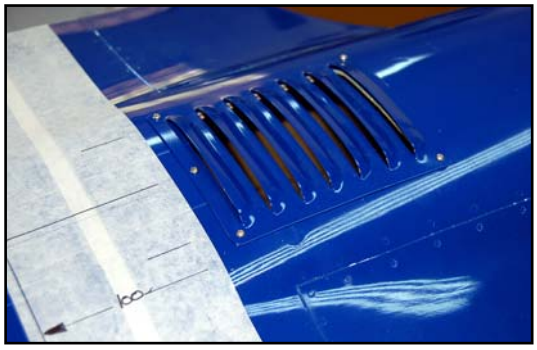
During final installation of your turboprop motor, we advise you to add a little Loctite to all the the M3, M5 and M6 engine mounting bolts - and check that these are tight after every couple of flights.

## Air Inlet Duct

So that the engine does not suck in the warm air from around the 2nd stage turbine, we have included a short Ø 90mm fibreglass tube inlet which must be glued into the back of the carbon mount and aligned with the core engine inlet. This ensures that the core engine sucks in clean and cool air from the fuselage. Glue in place to the carbon mount only, and trim the back flush when the epoxy has cured. The diameter of the Wren and Jetcat are slightly different, because the Wren has an integral FOD guard. Glue the split

*(above) For JetCat, make sure that the bottom engine mount clears the plywood surface by sanding a small groove. (below) Glue the inlet duct to the carbon mount, and trim the end flush. Glue on split silicone tube to minimise any gap between the duct and turbine.*

*(above) For the JetCat it is important to fit a FOD-guard to make sure no small items are sucked in from the fuselage. (below) Completed air inlet louvre secured in with 6 sheetmetal screws.*



Ø4mm silicone tube around the front edge of the inlet duct with thin CA to reduce any gap between the duct and motor to the absolute minimum for the greatest efficiency of this duct.

**JetCat only:** We strongly recommend that you either fit a FOD-guard to the motor inlet, or a suitably sized mesh guard to the fuselage end of the inlet duct, as shown here. In this case it is a 100mm diameter tea-strainer with the handle removed, secured with 3 small sheetmetal screws.

## Air Inlet Louvre

To ensure enough inlet air for the turbine, we have included a pressed aluminium louvred grille (painted to match your fuselage) which must be installed under the fuselage, just behind the rudder servo tray. Additional air also enters the fuselage thru' the fin post (and any of the grilles and NACA inlets that you chose to open up). From our experience with the 2 prototypes just the area of the louvre and the fin post is sufficient - even in very high ambient temperatures. The front edge of cutout (100 x 78mm) in the bottom skin of the fuselage should be 100mm behind the back edge of the rear wing tube. Radius the corners to prevent tearing of the sandwich skin. (see P28)

Glue 4 strips of the 12mm wide ply strip around the opening inside the fuselage and secure the grille with at least 4 of the small 2.2 x 10mm sheetmetal screws provided.

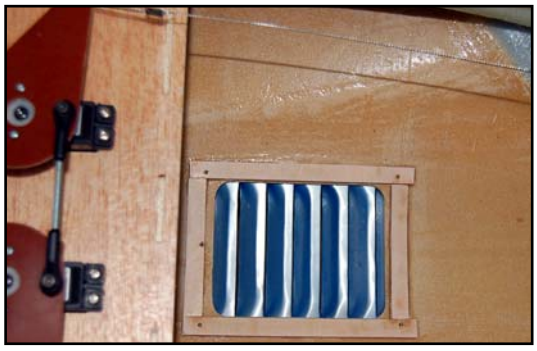
## Turbine Connections

Fuel, gas (or kero-start) and electrical connections are very well described in the Instruction manuals for both the turboprops shown here.

However please make sure that all services are adequately protected from the very abrasive (and electrically conductive) carbonfibre, and sharp fibreglass or wood parts, using either the rubber grommets included in the kit for this purpose - or silicone tube sleeves through all bulkheads and composite parts.

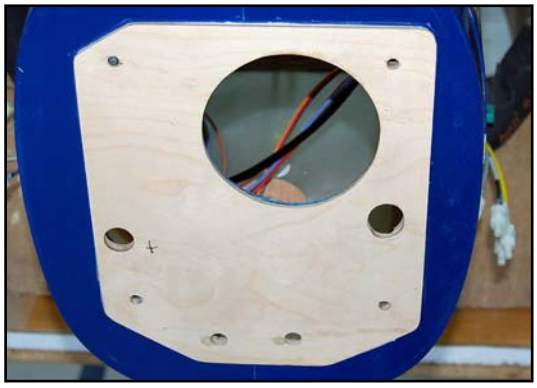
Install one of the large grommets into a long slot milled in the air inlet duct to protect the main fuel feed to the core turbine, as the thin fibreglass can cut the tubing very quickly!

You will need to make 2 holes (Ø8mm) in the bottom of the firewall for the nosegear steering cables, and



*(above) Glue 4 small strips of plywood around the cutout, inside the fuselage for the sheetmetal screws.*
*(below) Protect all fuel, gas and electrical services where they pass thru' any composite or wood parts*

*(below) You will need to drill holes in the plywood firewall and the back of the carbon motor mount for the tubes and electrical connections to the turbine, and also for the air tubes and steering cables for the nosegear.*



also a hole for the air tubes to the retract. The larger hole of the right of the photo here is for the 2 cables from the turbine ECU, and the various fuel, kerosene-start, and lubrication tubes.

Photo P29 shows a top view of the completed set-up of the Jetcat SPT5, and all services connected. Photo P30 shows the milled plywood ECU board that is included in the kit, with the ECU, fuel pump, solenoid valves and filter all secured to it. The board is held into the fuselage by 2 tabs at the back that fit into milled slots in the bulkhead, and an M6 plastic nut on a plastic bolt at the front. This makes it very quick and easy to remove for access or maintenance. Photo P31 shows a typical Jetcat SPT5 installation, with the kerosene-start, pressure, and lubrication tubes and propeller RPM sensor cables attached securely to the side of the motor mount and all electrical connections taped together for safety. Wren installation is similar, although the ECU is a little smaller.

### Spinner and Propeller

Included in the kit is a 120mm diameter molded carbon-fibre spinner, painted to match your fuselage. This has been pre-balanced at the factory for your convenience, but please check the balance carefully after cutting it for your chosen propeller.

Mark the cut-outs for the propeller carefully on masking tape to ensure that they are similar in size and shape, before milling them, and then fine sanding to shape. Leave at least 2mm clearance between the cutouts in the spinner and the propeller blades. The spinner backplate is cnc machined from T6 alloy, and is perfectly matched to the spinner cap.

Also included is a spinner bolt, M5 x 90mm. You might need to sand the head of it a little to make the outside diameter match the recess in the spinner cap exactly, and this can easily be done by spinning it against a sanding belt with the bolt shaft held in a battery-drill, or similar.

*(above) Make the cutouts in the spinner for the prop blades very carefully, ensuring that they are the same size and shape. Check the balance of your prop and spinner before running the motor.*

For both the Wren MW54 and Jetcat SPT5 we highly recommend the carbon 3-blade Biela 24 x 12” prop, which gives at least 6300 rpm on the ground.

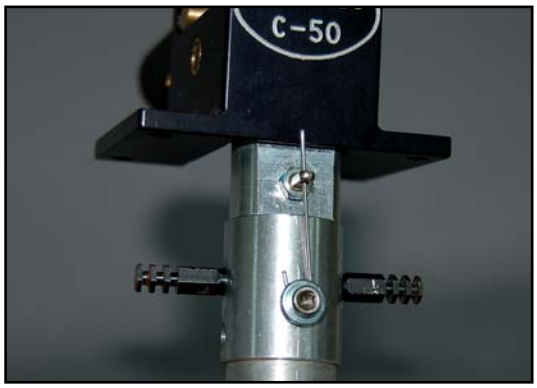
## Nose Gear Installation

**Note:** This section should be completed, and operation of the gear and doors checked, ***before*** the final installation and connection of your turboprop engine, because access is much easier.

The Behotec C-50 nose retract fits into the milled plywood parts that have been factory-installed in the bottom of the carbon motor mount. It has a 105 degree retract angle, and has been specially engineered for our Tucano. Note that the retract mount is offset slightly to the (pilot’s) right, to centre it in the fuselage due to the sidethrust of the motor. (See photo on page 25).

The oleo leg is connected to the retract unit with a Ø 8mm hardened steel pin. Grind a very small flap spot at the top of the pin for the M3 set-screw in the included wheel collar, and tighten firmly with a little Loctite. The wheel collar must be right at the (chamfered) end of the 8mm pin so that the retract can pivot freely.

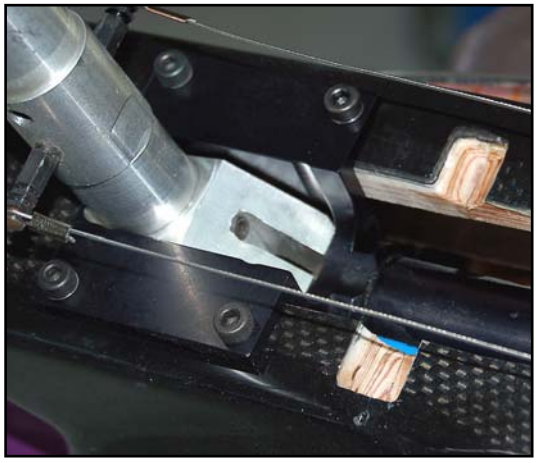
Shorten both the black metal steering arms by 5mm, and sand the ends smooth. Install the assembled oleo onto the connection pin, and accurately mark the position of the 2 set-screws and the steering arms through their holes onto the pin. Remove the oleo and grind 4 small (max 0.5mm or 1/32" deep) flats on the pin. reassemble the oleo onto the pin and tighten the 2 set screws and the 2 steering arms firmly, with a drop of Loctite on the threads.




*(above) The noseleg incorporates a small music wire that locates in an eye in the trunion block to keep it centred during retraction and extension.*
*(below) Detail of the recesses you need to mill to clear the steering arms in the carbon & plywood. Radius all the edges.*

On the front face of the top of the oleo is a short music wire, bolted to the leg, which engages in an eye in the trunion block to keep the noseleg centred during retraction and extension. The photo here shows the prototype of this set-up, and the system on your noseleg might look slightly different.

The carbon motor mount already has a slot milled in the bottom of it for the retract, but this must be extended for the oleo leg and wheel as shown in photo P32. The slot for the oleo leg should only be 25mm wide, and the cutout for the wheel and oleo fork should be about 44mm wide and 100mm long, ending just about 6 - 12mm from the back face of the carbon mount (depending on whether you are installing the Wren or the Jetcat motor).



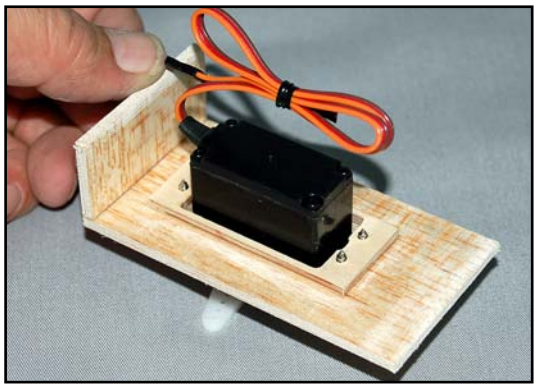
*(below) Nosegear servo mount is assembled from composite balsa and plywood parts with thin CA, and then all joints are reinforced with 30 minute epoxy.*

Now install the retract unit in the same way as the main landing gear, drilling one Ø 4mm hole at a time and inserting an M4 x 20 bolt to keep it aligned while drilling the next. See photo P33. Install the 4 T-nuts in the same way also. Note the correct position of the retract as below:

**Wren:** Install the retract unit 6mm back from the front of the 'U-shaped' cutout in the plywood mount.

**JetCat:** Install the retract unit at the front of the 'U-shaped' cutout in the plywood mount.

Mill and sand the recesses thru' the carbon and into the plywood for the 2 steering arms so that the oleo leg retracts completely. (photo right)



While the glue is curing on the T-nuts, assemble and install the nosegear steering servo mount into the fuselage. Glue the 2 milled composite balsa parts together with thin CA, and the plywood reinforcement

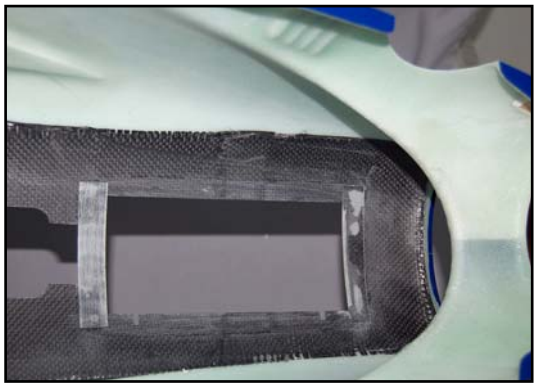
on the bottom - and then reinforce the joints with epoxy. Prepare for gluing, and then glue the complete assembly onto the fuselage centreline. See P34. Install the servo using the Ø 2.9 x 13mm sheetmetal screws provided, with the output shaft towards the tail of the plane. Any good 5kg servo will do for the nose steering, but we prefer one with a metal final output gear to better withstand any shocks during landings. Fit a heavy-duty plastic servo arm as shown.


*(above) The slots for the steering tubes should be about 20mm long, & 8mm away from the milled slot for the oleo. (below) Scrap balsa holds tubes apart while glue dries for wheel clearance.*

With the motor mount installed on the fuselage, drill a Ø3mm hole in line with each outer hole in the servo arm, right thru' the fuselage, firewall and carbon mount. Remove the carbon motor mount from the fuselage now, and then redrill the holes in the fuselage and firewall only to Ø 7mm. This is to give enough clearance for the clevises on the steering cables for removal of the motor mount, so don't omit this step!

Now install 2 lengths of the Ø 3mm white plastic tube as guides for the steering cables. Grind 20mm long slots in the bottom of the motor mount as shown in the photo right, about 8mm out from the slot for the oleo. Use a piece of scrap balsa with notches in the ends to hold the tubes as far apart as possible either side of the where the wheel will be when it is retracted, and another to set the front of the tubes at the correct angle so that they are in line with the steering arms on the oleo leg when it is extended. See photo P35. Glue the tubes in position with 30 minute epoxy and micro-balloons and, when cured, trim off the excess length of tube flush with the back of the carbon mount with a sharp knife.

Secure 2 lengths of the Ø 0.8mm steering cable to the steering arms with the crimp tubes, making sure that they are very close to the steering arms. With the motor mount installed on the fuselage, pass the cables thru' the tubes into the fuselage, and fit the M3 threaded extenders, nuts and steel clevises in the same way, using the crimp tubes. You can add a short length of heat-shrink tube over the connections to make sure that nothing catches on the edges of the holes in the firewall during operation. See photo P36 for completed nosegear view.



*(above) Glue 2 strips of the thin fibreglass sheet at the front & back of the door opening with thin CA, leaving a 4mm overlap as shown here.*

## Nose Gear Doors

The nose gear doors are very simple, just using a U-shaped piece of music wire to keep them open when the gear is extended, and the oleo pulls on this wire to close the doors behind it when it is retracted. The door is supplied as a separate painted fibreglass molding in the kit, and opening in the bottom of the cowling is already cut for you. Cut the door exactly in the middle to make the 2 doors. There is a panel line molded into the door, at the front, which should be matched with the panel line on the fuselage.

Cut 2 pieces of the thin clear fibreglass strip about 90mm long. Sand the inside surface all around the door cutout in the cowl carefully, and glue these strips in place at the front and back with thin CA - leaving about 4mm overlapping inside the door cutout.

Sand and prepare the inner surface of the nosegear doors for good glue adhesion now. Tack glue the 4 phenolic hinge plates to the doors with a drop of thin CA, exactly as shown in photo right and P37. Each plate should be 18 - 20mm from the end of the door.

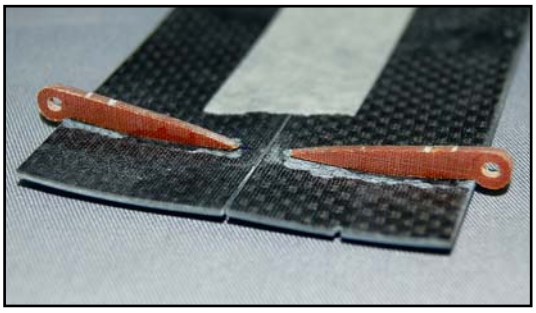
With the cowling inverted, lay the doors in position and mark the position of the 4 narrow slots that you must file in the cowl for the phenolic plates. (see photo right). As the cowl is quite curved in this position you must leave a 1 - 1.5mm gap between the outside edge of the door and the cowl for proper operation. File these slots accurately, and then lay the doors in place and tape into final position.

Cut 4 lengths of the soft Ø 2mm hinge wire @ 35mm long each, and make a small 90 degree bend in one end. Sand a point on the other end for easy insertion. Cut 8 lengths of the Ø 3mm white plastic tube @ 15mm long each.

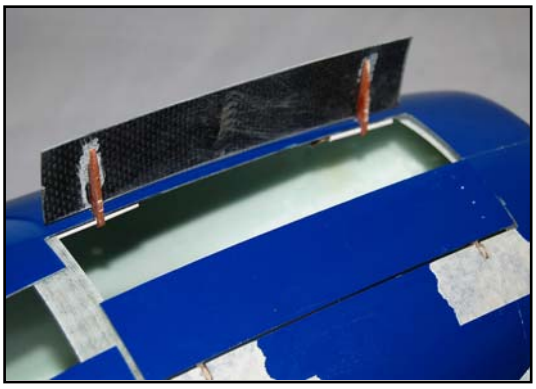
Turn the cowling over and install the 8 short lengths of tube and the 4 hinge pins as shown on photo P37, tacking the tubes in place with just one small drop of CA on each. Remove the tape from the doors and carefully check operation. The doors should open a bit more than 90 degrees each, see photo P40. When satisfied, glue the tubes and phenolic hinge plates permanently in position with another drop of thin CA on each, and then a small fillet of 30 minute epoxy and micro-balloons.

Using thin CA, glue a couple of small scraps (10 x 10mm) of the 3mm thick ply strip to the back sides of the phenolic door closing plates (as shown right), centred on the milled Ø 1.5mm holes - not forgetting to make a 'left' and right' side! Drill the 1.5 hole thru the plywood squares. Glue the phenolic plates to the doors 15mm in front of the rear phenolic hinge plates, as shown in P38.

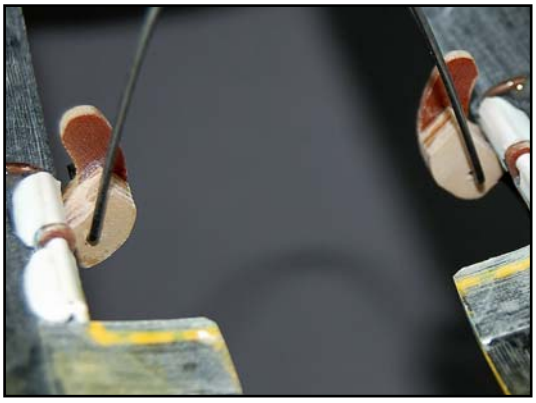
Install the cowling on the fuselage, and carefully measure the vertical distance between the holes in these plates and the top surface of the oleo directly above them, when the doors and oleo are retracted. It will be approx. 65mm (2.5"). Make up the door closing hoop from the Ø 1.5 music wire, shaped as shown



*(above) Tack glue the phenolic hinge plates onto the door 18 - 20mm from each end, with a drop of thin CA.*
*(below) File 4 slots in the cowl to match the positions of the phenolic plates.*



*(below) Add 6mm thick scrap ply blocks to back face of phenolic door closers, and glue in position 15mm in front of the rear phenolic hinge plates.*



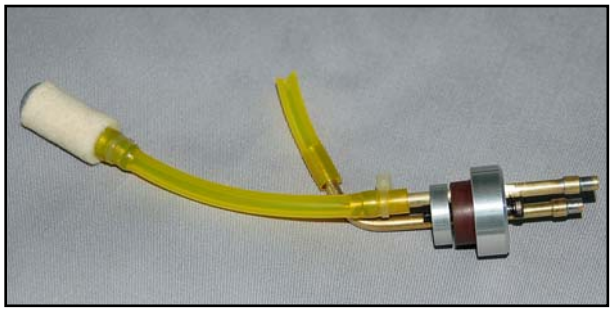
in the photos, with a short 90 degree bend on each end which passes through the holes in the phenolic plates and plywood squares.

With the cowl secured on the fuselage, operate the nosegear by hand to check that the leg contacts the wire hoop and pulls both doors fully closed - and that when the leg is extended the wire has enough tension to keep the doors held fully open when the plane is in flight. This is a little tricky, but we have included enough of the Ø 1.5mm music wire for you to have a few attempts at this if needed!

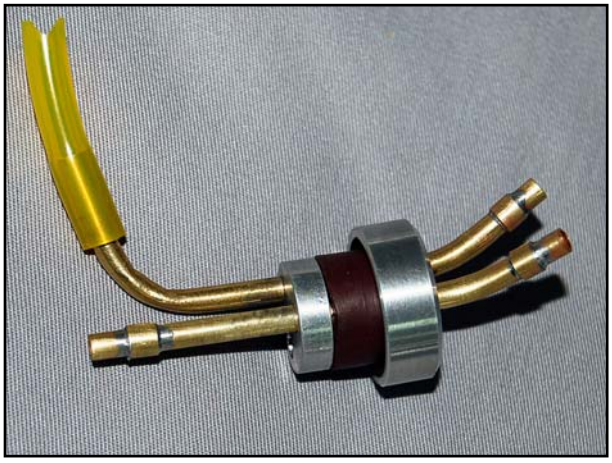
When you have finalised the wire hoop, solder two of the M2 nuts (included) onto the ends of the 90 degree bends to prevent the wire coming out (photo P39). The bends on the ends of the 4 hinge wires should be secured to the door with one small drop of 5 minute epoxy, in the same way as main gear doors.

## Fuel System Installation

The fuel system consists of two identical 1.3 litre (approx) molded fibreglass main fuel tanks, which are installed in front and behind the front wing tube sleeve and connected in parallel, to ensure that there is minimal CG change during flight. These main tanks feed into a plastic hopper tank, which is connected to the fuel pump as per the engine manufacturers instructions. All 3 tanks and the complete hardware (except for the Tygon tubing used inside the tanks), is included in the kit. See photo P41, and photo of complete set on page 50.



*(above) 2-tube set-up for the front and rear tanks. Secure the main feed tubes with small cable-ties behind the brass tube 'barbs'.*
*(below) The outlet tubes also need bending upwards a little on the rear tank, to clear the plywood bulkhead.*



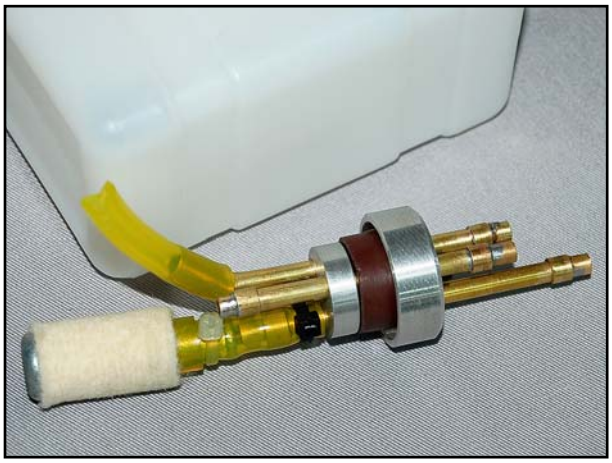
Assemble the aluminum caps, kerosene stoppers and 2 brass tubes (Ø 4mm) for both main tanks in the normal way, as shown here. Included in the hardware pack are some very short lengths of Ø 5mm brass tube that should be soldered on the outside of the ends of all the 4mm tubes to act as 'barbs' - preventing the fuel tubes coming loose, or allowing air into the system. Use 3.5mm I.D. Tygon tube for all internal fuel tank connections.

The 'vent' tube must be bent upwards at quite a large angle in the main tanks to reach the top surface, and the easiest way to do this without kinking the tube is to cover it with a tightly-fitting

spring (eg: available from K & S metal centres in many hobby stores) before bending it around another tube of about 12mm diameter.

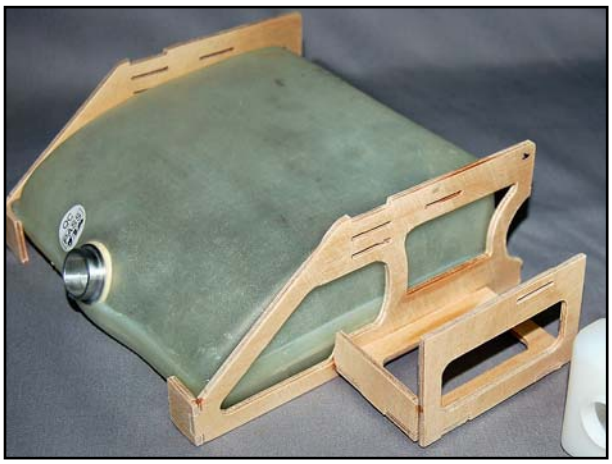
The supplied felt clunks should be used in all 3 tanks, and must be securely fixed to the Tygon tube with a cable tie as shown. A short length of larger diameter tube between the cable-tie and the felt sleeve prevents it sliding forward. Ensure that the length of Tygon tube allows the clunk to reach to within 20mm (3/4") of the back of the fuel tank when the plane is upright and level.

The felt clunk in the Hopper tank must be fixed in the 3-dimensional centre of the tank, so that it is as far away from any small air bubbles as possible - which will always collect on the outside, upper surface.



*(above) The hopper tank has a 3-tube set-up, with the extra tube used for filling the fuel system. Make sure that the felt clunk is fixed as close to the 3-D centre of the tank as possible. (below) The rear tank and hopper tank mounts are assembled as shown here.*

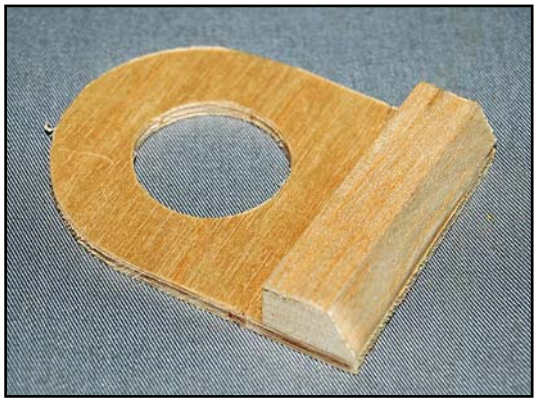
Included in the kit are milled plywood and composite balsa parts for securing the 2 main and hopper tanks in the fuselage, together with double-sided velcro straps. The photo right should make the assembly details clear. Sand and clean all the joints, and assemble with thin CA - then reinforce the joints with a mixture of 30 min. epoxy and micro-balloons.



The rear tank is held in position by the 2 milled plywood side-plates which are glued to the carbon sleeve behind it, and the fuselage floor, and they have milled slots for the velcro straps to secure the main and hopper tanks. With the tank in place, tack the plywood plates in position with a couple of drops of CA, remove the tank and reinforce the joints to the bottom of the fuselage with 30 min. epoxy and micro-balloons.

The Hopper tank fits into the milled plywood mount, which is glued to the side of the rear tank side plate.

The front tank is secured with the 2 milled plywood tabs on each side, glued against some 10mm balsa cut from the 10 x 25 x 200mm strips included in the wood pack. Glue these 2 in position, tightly up against the sides of the tank, about 55mm (2") in front of the carbon spar tube sleeve.



*(above) Front mount for front fuel tank is assembled from the milled plywood part and a piece of the 10mm balsa strip. (below) The side mounts for the front tank are milled plywood parts with balsa blocks glued to the inside of them.*

Make up the angled front mount as shown below, from the milled plywood part and another block of the 10mm strip balsa glued to the back of it. Sand an angle on the bottom as needed. Sand and prepare

the inside surface of the fuselage where the mount will be glued. Place the tank in position and weight it down firmly.

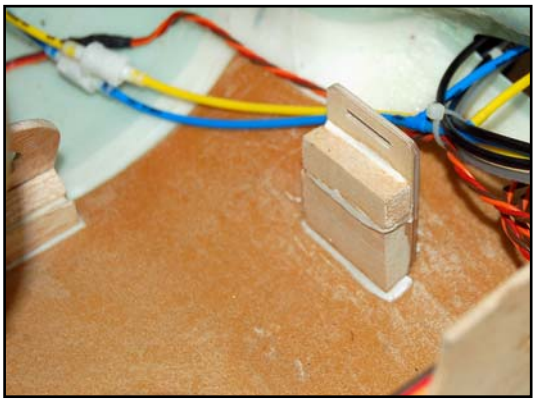
Install the mount over the aluminum cap, at the same angle as the front of the tank - and spaced off the front of the tank with a scrap of 3mm balsa. (photo right). The pair if pliers is just to keep the mount in position while the 30 minute epoxy and micro-balloons cures!

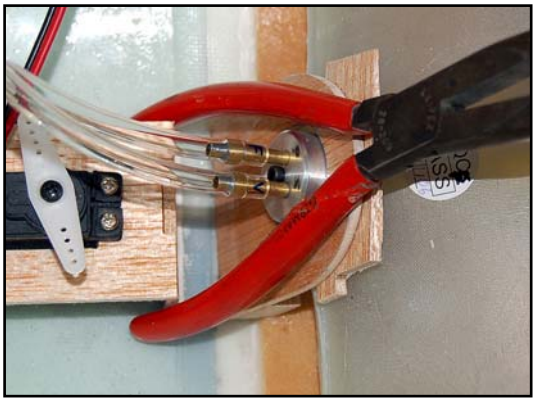
When the glue is hard you will find that you can slip the tank out backwards, at an angle, over the plywood bulkhead - and in this way it only needs 1 velcro strap to hold it in position.

The fuel tanks are connected together in *parallel* using the 4mm I.D. clear tubing supplied in the kit, and the two Festo Tee pieces. Connect the tubes from both main tank clunks together, and Tee to the vent tube of the hopper tank. Connect the vent tubes from both main tanks together, and Tee to the overflow tube that exits under the fuselage. Try to make the lengths of the feed tubes between each tank and the 'T' as equal as possible, so that both tanks will empty equally.

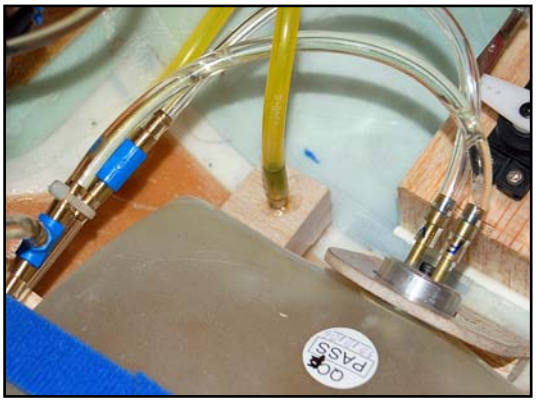
It is your choice where to install the overflow tube. We glued the 4mm brass tube into a block made from the 10 mm balsa, and glued it to the fuselage floor just in front of the front tank, with the brass tube extending about 10mm below the fuselage. (photo right)

Please wash out the complete fuel tank system before connecting it to your turbine engine, by flushing it thru' with some clean kerosene to clean out any manufacturing debris - and then discard this fuel. Even very small particles can partially block the extremely small fuel injectors inside your turbine, resulting in incorrect combustion - and possibly an expensive repair.





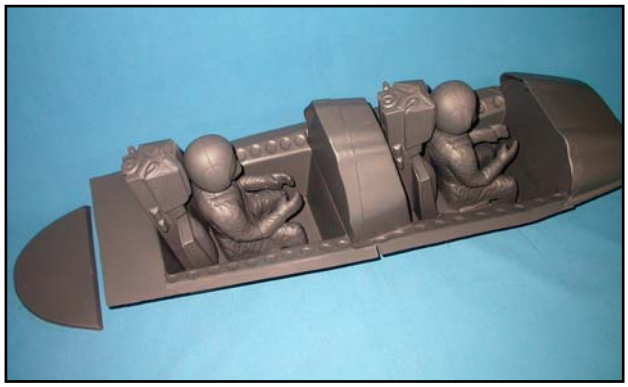
*(above) Space the mount off the front of the tank with a scrap of 3mm balsa until the epoxy has cured properly.*
*(below) Overflow tube glued into a balsa block, extending thru' the fuselage floor about 10mm.*



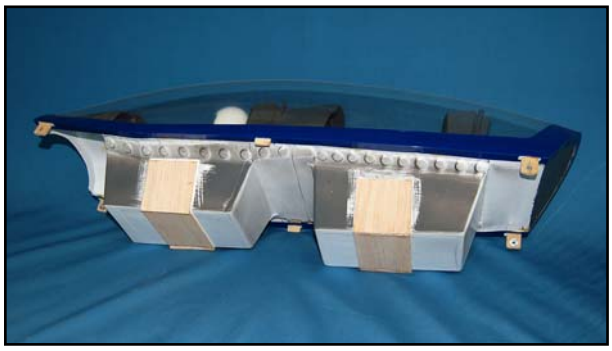
## Cockpit tub set

Included in the kit is basic set of vacuum-formed parts which you can use to assemble a cockpit tub, 2 ejection seats and 2 pilots. Also included are 2 color photo sheets that can be cut out and used on the instrument panels. With a little time, imagination and paint you can produce a cockpit that looks quite good from a few metres, and very realistic in flight.

Cut the parts out using small curved scissors, and glue together with Plasti-ZAP or equivalent. Most spray paints can be used on the vac-formed parts, but test on a discarded part first. When the cockpit is completed it must be glued into the canopy frame securely enough so that it will not come loose during flight. Add a couple of strips of 3mm balsa around the bottom of the tub to transfer the weight of to the bottom edge of the canopy frame.



An optional scale cockpit set will be available, which installs in the fuselage, and then you could make a 'scale' side-hinged cockpit canopy frame if you wish. See our website for details.



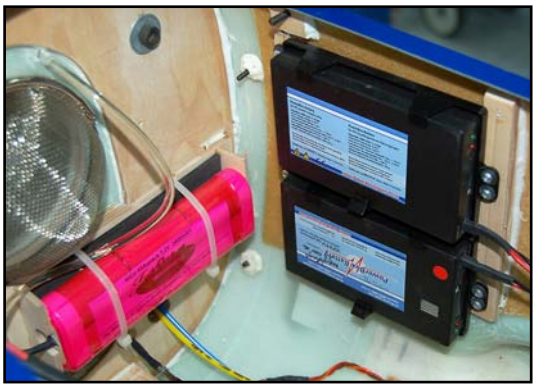
## Markings

Included in the kits for the Brazilian Red and Blue schemes are a set of high-quality full-color pressure sensitive markings. The larger items are plotted on very thin self-adhesive vinyl, and the smaller items are silk-screen printed on clear carrier film that is peeled off after they are positioned on the plane. The photo on the right shows the set for the Brazilian Blue scheme. There are some good photos of the full-size aircraft on www.airliners.net for location reference.

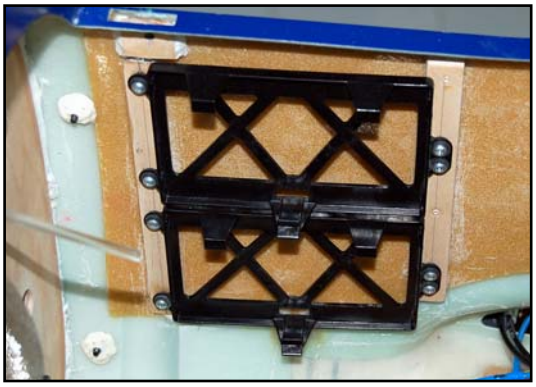
# R/C and Equipment Installation

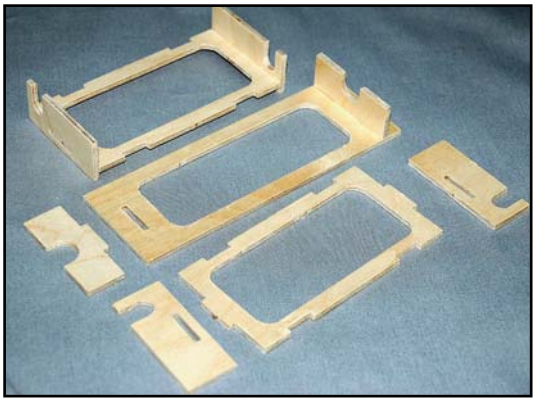
Everyone has their own favourite methods, items and layouts when fitting the R/C, turbine ECU and equipment, and batteries etc - but the installation shown here can be used as a guide. However, it works perfectly, gives good access to all the important items, and provides a perfect Centre of Gravity position. If you chose to use Nicad or NiMH batteries, instead of the LiPo's that we used for the Rx, then you will probably need to install them either side of the rear fuel tank for correct CG location.

We prefer to keep all the turbine equipment (ECU, fuel pump, solenoid valves etc) on the opposite side to the RX, to prevent any possible chance of RF interference, and in this installation we used a separate plywood board for all of the pneumatics equipment for the landing gear, gear doors & brakes. The milled plywood board used for the turbine & pneumatics installations are included in the kit, and can be modified as necessary to suit your motor and equipment choice.



*(above) Rx Lipo's and Turbine Nicad were mounted in the front of the cockpit area for correct CG location.*
*(below) Quick-release mounts are included with the 2800 mAH lipo packs from Powerbox.*
*(bottom) Milled plywood parts are included to assemble 5 and 6 cell Sub-C sized NiCad or NiMH battery packs.*





**Batteries.**
Included in the milled wood parts are 3 plywood battery trays, 1 for a 6 cell sub-C sized pack (turbine) and 2 for 5-cell packs that can be installed in your chosen location.

The dual 2800mAH Powerbox Lipo batteries we used for the Rx are installed in their plastic mounts on 6mm thick strips of the 12mm wide plywood glued directly to the side of the fuselage with slow epoxy and microballoons mixture, using the rubber grommets and screws included with the batteries.

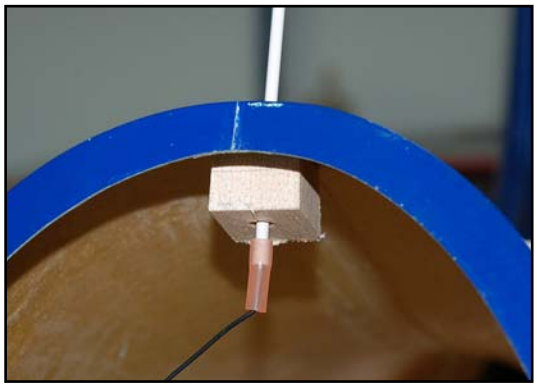
For safety we *strongly* recommend that the Lipos are removed from the fuselage for storage, and they must definitely be removed for charging. The quick-release mounts included with the Powerbox packs make this quick and easy.

The turbine/pump battery is a 6-cell sub-C 2400 mAH pack, supplied with the Jetcat SPT5, and this has sufficient capacity for at least 3 (kerosene) starts and flights before recharging is needed. It is secured to the milled plywood battery mount on a rubber pad with cable-ties, and then glued to the inside of the front of the fuselage - or other location to set the correct Centre of Gravity.

Make sure that all batteries, and other heavy items, are very securely fixed in the plane - remember how much they will effectively weigh when subjected to 4 or 5 G's!

## Receiver and Antenna.

The receiver is cable-tied to a 3mm balsa plate on a foam pad, spaced off the fuselage side with 3mm thick ply strips, and has an extension at the bottom of it which acts as a support for all the extension cables and services. Remember the forces on all items in the airframe when you are performing aerobatics and make sure that you support all wires, tubes and services adequately. See photo P43.



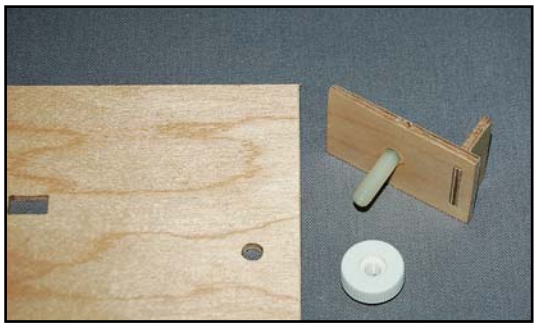
*(above) All hardware is included to make up this external antenna sleeve, which is quickly removable for transport.*

We prefer to have an external 'whip' antenna on all our turbine powered aircraft. Route the antenna rearwards from the Rx, securing and protecting it with short sleeves of silicone tube where it passes thru' any bulkheads or composite parts. Glue 2 short lengths of the 10mm balsa strip together with CA to make a block approx. 20 x 20 x 20mm and sand top surface to match the fuselage shape behind the cockpit. Drill Ø 4mm hole centrally thru' the block.

Squash a 20mm length of Ø 4mm aluminum tube just a little, with pliers, so that the Ø3mm white plastic tube slides tightly inside it. Then glue the alu. tube into the hole, projecting about 2mm out of the top of the balsa block. Drill a Ø 4mm hole in the top of the fuselage behind the cockpit, and glue the block up against the inside surface with 30 min. epoxy - with the aluminum tube in the hole in the fuselage. Push a suitable length of the plastic tube through the aluminum tube and block, and add a short length of the silicone tube to the bottom end, inside the fuselage, to ensure that the antenna wire cannot be abraded by the end of the plastic tube. The plastic tube (and antenna) is easily removed for transport, and cheap to replace if necessary.

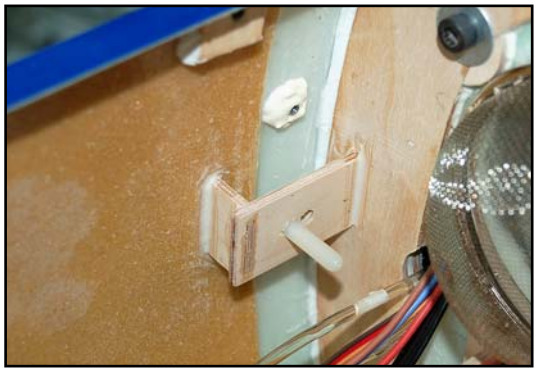
## Turbine Board etc.

Included in the kit is a milled plywood board that we used for the installation of the ECU, Pump, 2 solenoid valves, filter etc. It has milled slots for securing the ECU to the board, and you can modify it as needed to suit your equipment and preferred layout. There is more than enough space on this board for all the usual turbine equipment, and when finished you can trim off the excess area as required.



*The Turbine/ECU board is secured with a plastic bolt & nut, glued into the milled parts included. The back has tabs that fit into slots in the adjacent bulkhead.*

The board is held in place with the 2 tabs on the back edge, that fit into milled slots in the plywood bulkhead, and a single M6 plastic bolt and nut at the front - for quick and easy removal. Glue the plastic bolt to the inside of the milled plywood part (photo right) and secure to the completed board with the plastic nut. Locate the board in the 2 slots at the back, add some epoxy and micro-balloons to the back of the bolt plate and tape into position until the glue has cured.



## Powerbox and Switch.

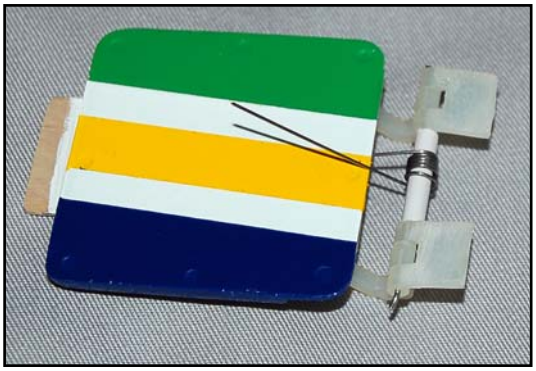
We highly recommend that you fit some sort of 'servo powerbus' system in this high-performance aircraft. We prefer the Powerbox units as they are designed

especially for large models and provide dual battery inputs with hi-amp connectors, multiple outputs for 7 channels/24 servos (no 'Y' leads needed), automatic voltage regulation and stability, built-in servo amplifiers for long servo cables, as well as dual LED battery level displays. They come complete with hi-current connectors and are fitted with anti-suppression chokes on all channels. The full 'PowerBox' range is available from C-ARF as an option. Please visit our website for more details.

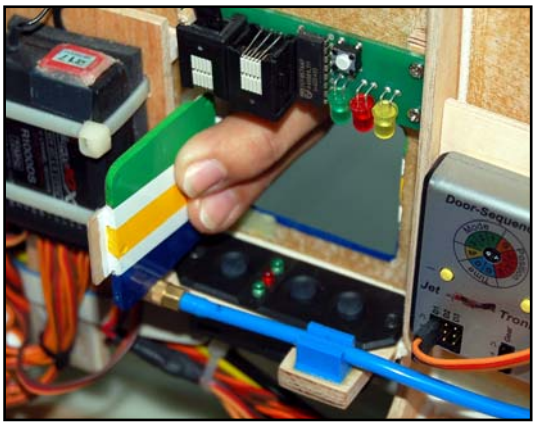
The Powerbox 40/24 'Competition' and 'Champion' (shown here) models include an electronic (fail 'ON') switch as shown in photo P43. Using the screws and grommets provided, we installed it on two 6mm thick pieces of the 12mm ply strips glued directly to the side of the fuselage.

**Access Hatches.**

To save having to remove the cockpit for switching 'ON' and 'OFF', re-fuelling, refilling the air tank and connecting your turbine Ground Support Unit, etc, etc, we made a small spring-loaded hatch, which opens inwards and needs no hatch-catch. All the parts are included in the hardware pack to make 2 hatches, and we recommend that you install the 2nd one on the opposite side of the fuselage to keep the re-fueling connection separated from the electronics.



*(above) Detail of the access hatch, with assembled offset hinges and spring - viewed from the outside.*
*(below) Just enough space to operate the switch, pull out the air filler tube, and plug in the GSU cable.*



Cut the hatch out carefully, using a very sharp modelling knife or fine coping saw, following the of the panel lines molded into the fuselage. Push out the hinge pins on a pair of the plastic offset door hinges. Make up a coil spring using the 0.8mm music wire, of about 5 turns wrapped around the shaft of a Ø 3 or 4mm tube or shaft of a screwdriver - held in a vice. Replace the hinge pins of the 2 hinges with a length of the 1mm steel wire, adding a short sleeve of the plastic tube over it to keep the hinges apart, with the spring slipped over the plastic tube.

Prepare the inside surface of the fuselage and hatch carefully, removing the foam sandwich with a small chisel or sharp knife, and gluing the hinges directly the inside surface of the fibreglass skin. Align the hatch and tape in place firmly, and tack glue the hinges in position with a drop of thick CA. When satisfied with hatch operation, 'trap' the hinges in position permanently with a fillet of 30 minute epoxy/micro-balloons. Add a small plywood 'stop' to make the hatch close flush with outside fuselage surface.

See photo P45 for the completed hatch, which also shows the Powerbox electronic switch and air filling point installed.

**Pneumatic system**

No pneumatic valves or door sequencers are included in the kit or landing gear set as we know that most customers have their own preferences for these important items.

We used a standard 'combined' valve from Behotec (# 320569), controlled by a mini servo, to

operate the retracts and the wheel brakes. The inner main gear doors (which are be closed when the gear is extended and retracted), are connected to a 2-way jet-tronic valve, which is plugged into outlet D1 on a jet-tronic door sequencer unit to set the timing for door opening and closing only.

The mini-servo for the retract/brake valve and the door sequencer are connected together with a 'Y-lead' and plugged directly into a single channel on the RX. The 'Gear' output on the sequencer unit is not used.

We highly recommend this set-up, which has proved simple and reliable, and all these items are available as accessories from C-ARF.

The outer main doors & nose doors are mechanically operated, and remain open when the gear is down.

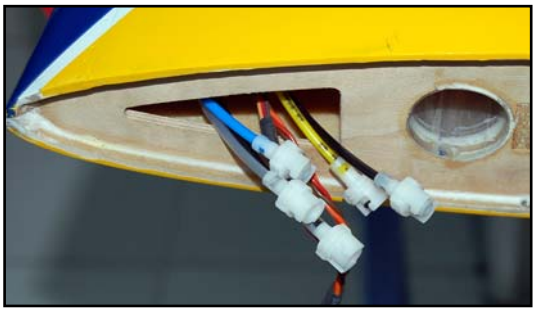
Included in the kit is a milled plywood board for the pneumatics equipment, whihc you can modify as you wish to fit your chosen equipment. We fixed it into the fuselage by filing a slot in the bulkhead to match the single tab on the front of the board, and using an M3 bolt at the back, into a T-nut glued onto the back face of a scrap plywood block - glued to the fuselage side (similar method to turbine/ECU board).

The Behotec valve is mounted on the milled plywood plate (included, with 1.5mm ply packers for height adjustment), and connected to the servo with an M2 threaded rod and steel clevise, with a 'Z-bend' in the servo end. Photo P42 shows the details.

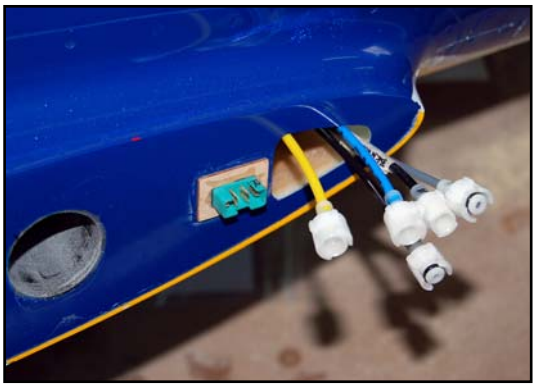
**Extension cables etc.**

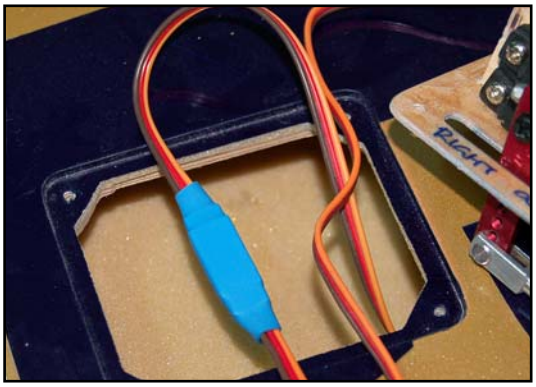
Please use good quality twisted-cable extension leads, of heavy gauge wire with gold-contact connectors, to all the servos. Certainly we recommend that all servo leads and extensions longer than about 30cms (12") are fitted with ceramic chokes (ferrite rings) to prevent RF noise, at the receiver end - normally within 100mm (4") of the receiver. Of course, if you are using a 'Powerbox' this unit is already fitted with all the ceramic chokes.

At C-ARF we hard-wire all our servos with twisted cable leads of the exact length required and Multiplex 6-pin connectors. For the aileron and flap servos you can use 1 pin for each wire, and for the elevators you can gently squeeze pairs of adjacent pins together and use a pair of pins for each cable. We glue the

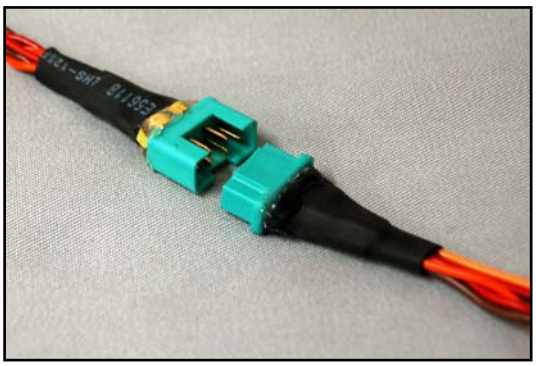


*(above/below) All 5 air tubes (doors, retracts & brakes), along with the flap & aileron extension cables, exit at the front of the wing. The Robart quick-connectors are included in the Landing Gear set.*





*(above) Secure all hidden servo plugs/socket connections with heat-shrink tube or tape. (Extra 300SX shown) (below) 6-pin MPX connectors are used for extension leads, with one half mounted in the fuselage sides.*

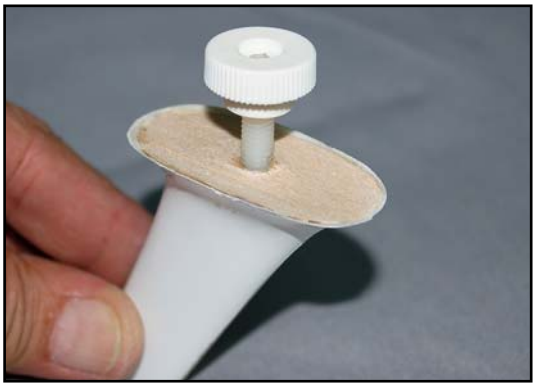


female connectors into small 1.5mm thick plywood plates in the sides of the fuselage for connecting the stabs and ailerons when assembling the plane.

Making up the proper extension cables and connectors is only a little work, if you are proficient with a small soldering-iron, and makes assembly of the model at the airfield very quick and easy! Once all wires are soldered to the pins, fit a short length of heat-shrink tube over each one. Finally protect all the connections from vibrations etc with a blob of glue from a hot-glue gun. Job done.

Make sure that any plug/socket servo cable connections that cannot be easily seen and regularly checked, for example the servo connections in the wings, are secured together with strong tape - or a short length of heatshrink tubing. Also tape down any loose cables that could get trapped in linkages.

*(above) Multiplex connector mounted in plywood plate, glued into stab root for elevator servo cable.*
*(below) Fuselage antenna's are simply mounted with M6 plastic bolt and nut.*



### Fibreglass Antennas

Included in the kit are 2 white molded fibreglass antennas, to represent the large antenna's on the top and bottom of the fuselage, behind the cockpit, of the full-size aircraft.

A simple way to make these removable, for transport and storage, is to glue the M6 plastic bolts into a shaped piece of 6mm scrap balsa - glued into the base of each antenna with a little epoxy or thick CA. Drill Ø 6mm holes on the fuselage centreline in the required positions, and secure each antenna with one of the large plastic nuts included in the hardware.

## Final Check

Now check that you have fixed all components securely. Keep in mind that all the components inside the aircraft are loaded with the same G's as the wing and the wing spar during aerobatic maneouvers. Check engine, cowling, wing and stab mounts carefully again.

- Are all extension leads, cables & fuel tubes securely fixed to the airframe and cannot come loose when subjected to high 'G' forces during flight.
- Are all tubes and wires protected from chafing where they pass thru' carbon or fibre glass parts or bulkheads with rubber grommets, or short lengths of split silicone tubing?
- Check very carefully that no tubes or wires can possibly come into contact with hot sec tions of the turbine or exhaust stacks. Check that all tubing for the fuel system is secured properly onto the tanks and pump, safety-wired where necessary, and cannot possibly leak or suck air into the fuel system.
- If using the easily-available cable-tie plastic fixing plates, please do not trust the double-sided tape that they usually have on them which will fail it it gets even 1 drop of kerosene on it. Peel it off, rough up the back face with coarse sandpaper and glue them in place with 5 or 30min. epoxy.

- Did you fit small Tygon or silicone tube pieces, or ‘keepers’ over all the steel clevises?
- Did you tighten the M3 locknuts against all the clevises to make sure they cannot turn?
- Are the crimp tubes squashed up tightly on the rudder and nosegear steering cables?
- For added security add one small drop of loctite/thread locking compound on all the bolts that hold the servo arms to the servos, especially important with digital types.

Then you can go on set up all the linkages, control throws and R/C system as described below.

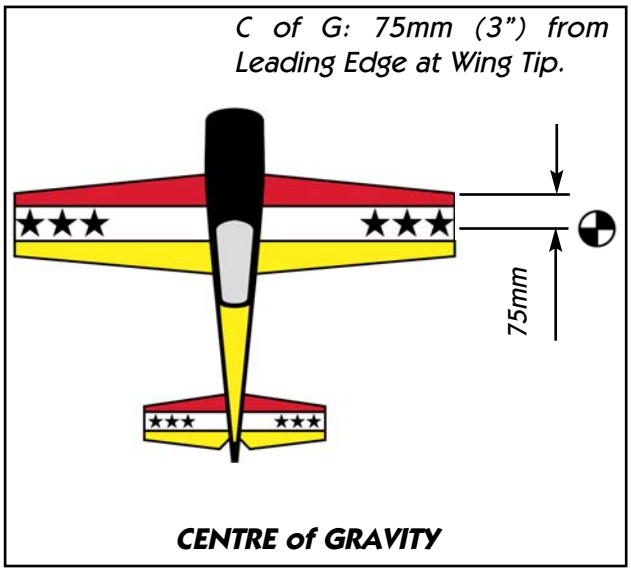
# Setting Up Your Aircraft

## Centre of Gravity:

The Centre of Gravity should be set at 12mm (1/2”) *in front of* the spanwise panel-line at the tip of the wing. This is the same as 75mm (3”) back from the leading edge at the wing tip.

With a helper, support the plane at both wing tips in this position and make sure the plane balances horizontally, and adjust the positions of your batteries (or other heavy items) if necessary to set it exactly.

Don’t forget to balance the plane laterally, holding the spinner central bolt and a fingertip under the rudder and, if necessary, add a small weight to the light wing tip to make it track correctly.




## Engine Thrustline:

The engine thrustline is perfectly set when the spinner backplate is exactly parallel with the front surface of the cowling.

## Control Throws:

All measurements are at the root/trailing edge position. The throws listed below have been used for all flights, and we have not found it necessary to use dual rates at all.

### Elevator

The elevator throw should be 40mm up and down. If you like you can add up to 20% exponential as well.

### Rudder

The rudder throw should be about 90mm both ways, measured at the lower trailing edge. You can add a little exponential if you prefer.

Make sure to set a lot of expo on the nosegear steering, perhaps as much as 80 %, so that it is not too sensitive during takeoff and landing.

### Ailerons

Aileron throw should be set to 25mm ‘up’ and 28mm ‘down’. You can add a little expo if you like.

### Flaps

Take-off position is about 25mm down (at root trailing edge), and landing position is 70 - 80mm down.

## Flying the Tucano

We must say that Flying the Tucano is a real joy. No bad habits at all, and it flies like it’s on rails. Take off and landing are easy and uneventful, and the flying speed is very scale. The slow flight characteristics, due to the huge flaps, are very good and the plane is extremely stable through its entire speed range.

If you have set the control throws and CG as recommended in this manual, you take off with full throttle, and Flaps in take-off position. That's about 1” (2.5 cm) down at the root trailing edge. Steering on the ground is easy. Set a lot of expo on the nosegear steering, so that you are maneouverable in the tight turns at the end of the runway, and have a less-sensitive control during takeoff and landing.

The plane does not need any trim for level flight, as incidences are perfect. The flaps do not change the trim much either; they might need 2-3% down elevator trim mix, but this is up to how you prefer it. For the first takeoff, no trim at all should be applied.

Put the gear up immediately after the wheels leave the ground, and do not wait until the plane is too fast. The huge outer gear doors do hold the gear out a bit, and at too high speed the mains might not want to go all the way up. Also the spring-loaded nose gear doors might flip closed at too high speeds.

Put the flaps up after the first turn, and then fine trim the plane. You will immediately realise that that the plane feels “just right”, and you can start a few aerobatic maneouvers, if you feel like it. The one and only slight disadvantage is the very high ‘scale’ dihedral, which causes some weird knife edge feeling… If you start a nice four point roll, and during the first quarter, when applying a bit too much rudder during the first knife edge, you will find yourself in the opposite knife edge right away, this is nothing spectacular… but the rudder has quite a lot of roll coupling, and since this is the characteristic of the plane, we haven't really tried to mix it all out. It helps if you add

about 10% opposite aileron to the rudder, but it does not cure the habit totally. It is important to fly slow and point rolls a little bit “ballistic” and not use too much rudder during rolling.

Inverted flight is very uneventful, and the Tucano just needs a very little bit of down elevator. We have managed to set the thrust lines quite accurately, and you will notice that right away. Slow flight with full flaps is easy, too. Even if you get too slow, you don't have to worry about tip stalling. The plane just gently noses down, and then picks up speed again.

Landing approach with full flaps and quite a good amount of power will end in a very nicely controllable landing. Put full flaps down when you put the gear down, and then fly it to the runway touch-down point with the with the engine power. Do not throttle down too much, otherwise you will notice the throttle lag of the turboprops too much. Never reduce power below 30% on your stick during the approach, as this lets you go around within 2 seconds of spool up time. Only when you are 100% sure that the approach is perfect, just before touch down, reduce the throttle to idle. Sometimes even this is not necessary, and you idle when you hit the wheel brakes. It looks and sounds unbelievably scale. The large flaps allow these kind of “power-on landings”, and with a little bit of practice you will do it perfectly every time ... and you will love it !!

With the supplied fuel tanks you have 7-8 minutes safe flying time. The plane glides quite well even after an engine flameout, but you should not risk anything. And a last warning: Take very good care of nose gear and doors. Check it regularly and make sure its working perfectly. A nose gear ‘up’ landing will damage the propeller *and* the engine, and you MUST have your engine checked by the manufacturer before you run it again.

If you follow this advice, your Tucano will conquer a place in your heart, and you won't want to miss it anymore…

Have fun!

**Note:** Please let us know if you think that any hardware is missing or inadequate. We tried to make this airplane as complete as possible, and with constructive feedback from customers you will help us to continue making good things even better. We appreciate your comments very much.  Email: info@carf-models.com

*The original prototype Tucano in flight at Superman 2006.*

# Appendix:

## Embraer T-27 TUCANO, quarter-scale kit kit (version 1.0)

## Kit Contents

| *Quantity* | *Description* |
|---|---|
| 1 | Fuselage |
| 1 | Wing, right (aileron servo hatch taped in position) |
| 1 | Wing, left (aileron servo hatch taped in position) |
| 1 | Stab, right (servo hatch taped in position) |
| 1 | Stab, left (servo hatch taped in position) |
| 1 | Elevator, right |
| 1 | Elevator, left |
| 1 | Rudder |
| 1 | Cowling, upper part |
| 1 | Cowling, lower part |
| 1 | Nose gear door (painted to match cowling, taped to fuselage) |
| 1 | Canopy Frame |
| 1 | Clear Canopy |
| 1 set | Cockpit tub, seats, dash, pilots etc (white vac-formed plastic,10 sheets) |
| 1 | L.E. extension, for right stab (painted to match stab color) |
| 1 | L.E. extension, for left stab (painted to match stab color) |
| 1 | Rudder antenna (milled sheet, color to match fin) |
| 2 | Fuselage antenna, fibreglass (white) |
| 1 | Motor mount, carbon.(plywood LG parts installed) |
| 1 | Inlet duct, fibreglass tube, (Ø 90 x 125mm long) |
| 1 | Spinner, carbon, Ø 120mm, (painted to match cowling) |
| 1 | Spinner backplate, Ø 120mm, T6 alloy. |
| 1 | Main gear door set for right wing |
| 1 | Main gear door set for left wing |
| 2 | Wing tubes, front, aluminium Ø 30mm x 565 mm |
| 2 | Wing tubes, rear, aluminium Ø 30mm x 560 mm |
| 1 | Stab tube, carbon, Ø 16mm x 510mm(T-nuts installed) |
| 2 | Elevator hinge, aluminum tube Ø 4mm x 570 mm (packed in elevators) |
| 1 | Rudder hinge, brass tube Ø 4mm x 625 mm (packed in rudder) |
| 2 | Fuel tanks, fibreglass (1.3 litre capacity) |
| 1 set | Protection bag set (wings, stabs and rudder) |
| 1 | Milled wood/Phenolic parts bag |
| 1 | Fuel system hardware bag |
| 1 | Hardware bag |
| 1 set | Instrument panel gauges (color copy) |
| 1 set | Self-adhesive markings (for Brazilian red and blue schemes only) |
| 1 | Instruction Manual, English. |

## Hardware List

### Fuselage Pack

| *Quantity* | *Description* |
|---|---|
| 3 | Plastic nut, M6 (ECU board & antenna fixings) |
| 3 | Plastic bolt, M6 x 25mm (turbine board and antenna fixings) |
| 4 | T-nut, M6 (engine mount) |
| 14 | Allen bolt, M3 x 16mm (rudder linkage and servo arms, engine mount) |
| 6 | Lock-nut, M3 (rudder linkage and servo arms) |
| 6 | Ball-link, plastic, M3 (rudder linkage and servo arm links) |
| 2 | Nut, M3 (rudder linkage) |
| 2 | All-thread, M3 x 60mm (rudder servo connection) |
| 6 | Sheetmetal screw, 2.2 x 9.5mm (to fix louvre vent to fuselage) |
| 4 | Sheetmetal screw, 2.9 x 16mm |
| 12 | Sheetmetal screw, 2.9 x 13mm (nose steering & rudder servo mounting) |

| | |
|---|---|
| 4 | Threaded-end for pull-pull cable, M3 (rudder & nosegear steering) |
| 1 | Pull-Pull cable, 1.0mm x 3 metres (rudder linkage) |
| 4 | Crimping tubes, 2.6mm ID (rudder linkage) |
| 4 | Allen bolt, M6 x 20mm (Jetcat turboprop mounting |
| 4 | Allen bolt, M6 x 30mm (Wren turboprop mounting) |
| 4 | T-nut, M4 (nose retract mounting) |
| 7 | T-nut, M3 (lower cowl, pneumatic board and engine mounting) |
| 3 | Grommet, plastic, I.D 6mm (tube and cable protection) |
| 3 | Grommet, plastic, I.D 14mm (tube and cable protection) |
| 2 | Tube, plastic, Ø 3 x 250mm (nose steering cable guides) |
| 1 | Tube, plastic, Ø 3 x 400mm (RX antenna & hatch hinges) |
| 1 | Music wire, Ø 1.5 x 500mm (nose door spring) |
| 1 | Music wire, Ø 0.8 x 300mm (hatch springs) |
| 1 | Steel wire, Ø 1.0 x 125mm (hatch hinge pin) |
| 6 | Bolt, M2 x 12mm (secure phenolic arms to metal discs on rudder servos) |
| 8 | Nut, M2. (as above, and nosegear spring fixing) |
| 4 | Washer, steel, I.D 6mm, large (engine mounts) |
| 1 | Silicone tube, Ø 4mm x 400mm (inlet duct) |
| 4 | Allen bolt, M4 x 20mm (nose retract mounting) |
| 8 | Allen bolt, M4 x 8mm (canopy frame & upper cowl mounting) |
| 5 | Button-head bolt, M3 x 10mm (lower cowl mounting) |
| 2 | Button-head bolt, M3 x 15mm (lower cowl mounting) |
| 4 | Offset door hinge, plastic (hatch hinges) |
| 1 | Pull-pull wire, Ø 0.8mm x 1 metre (nose gear steering) |
| 4 | Crimping tubes, 2.4mm ID (nose gear steering) |
| 2 | Clevise, steel, M3 (nose gear steering) |
| 2 | Nut, M3 (nose gear steering) |
| 1 | Louvre vent, aluminium (painted to match fuselage bottom) |
| 2 | Grommet, plastic, I.D. 4mm (lower cowl mounting) |
| 1 | Tube, brass, OD 6mm, I.D 5mm x 40mm (engine front mounts) |
| 1 | Tube, aluminum, Ø 4mm x 30mm (Rx antenna sleeve) |
| 1 | Allen bolt, M5 x 90mm (spinner bolt) |
| 1 | Fibreglass strip, 0.5 x10mm x 200mm (nosegear doors) |
| 4 | Washer, M3 (engine mounting) |

## Wing Pack (2 sets)

| *Quantity* | *Description* |
|---|---|
| 3 | Clevise, steel, M3 (flap linkage and inner gear door cylinder) |
| 1 | Ball-link, Plastic, M3 (aileron linkage) |
| 4 | T-nut, M4 (retract mounting) |
| 1 | Allen bolt, M6 x 30mm (wing retaining bolt) |
| 1 | Washer, M6 (for wing retaining bolt) |
| 1 | Allen bolt, M3 x 16mm (aileron linkage) |
| 1 | Lock nut, M3 (aileron linkage) |
| 3 | Nut, M3 (aileron/flap linkage) |
| 1 | Clevise, M3, aluminum, with pin and E-clip (aileron linkage) |
| 8 | Sheetmetal screw, Ø 2.9 x13mm (servo mounting) |
| 4 | Sheetmetal screw, Ø 2.9 x16mm (flap servo mount to rib) |
| 5 | Sheetmetal screw, Ø 2.2 x10mm (outer gear door & cylinder attachment) |
| 4 | Sheetmetal screw, Ø 2.9 x10mm (aileron servo hatch) |
| 1 | All-thread, M3 x 60mm (aileron linkage) |
| 1 | All-thread, M3 x 120mm (flap linkage) |
| 4 | Allen bolt, M4 x 25mm (retract mounting) |
| 1 | Wheel collar, I.D 4mm with set screw (door cylinder throw adjustment) |
| 1 | Tube, plastic, Ø 3 x 120mm (inner gear door hinges) |
| 3 | Hinge wire, Ø 2 x 300mm (inner door hinge & outer door connection) |
| 2 | Brass tube, Ø 3 x 35mm (outer door connection) |
| 1 | Fibreglass tape, 20mm x 70mm (outer door connection) |

## Stab Pack (2 sets)

| *Quantity* | *Description* |
|---|---|
| 4 | Button-head bolt, M3 x 10mm (servo angle mount fixing) |
| 4 | Allen bolt, M3 x 12mm (servo fixing to angles) |
| 1 | Allen bolt, M3 x 16mm (elevator linkage) |
| 1 | Allen bolt, M3 x 20mm (stab securing to carbon spar tube) |
| 1 | Lock nut, M3 (elevator linkage) |
| 4 | Washer, M3 (servo fixing to angles) |
| 1 | Ball Link, plastic, M3 (elevator linkage) |
| 1 | Nut, M3 (elevator linkage) |
| 1 | Clevise, M3, aluminum, with pin & E-clip (elevator linkage) |
| 1 | All-thread, M3 x 70mm (elevator linkage) |
| 2 | Aluminium angles, drilled, 1 x left & 1 x right (servo mounting) |
| 4 | Sheetmetal screw, Ø 2.9 x 10mm (servo hatch fixing) |

## Fuel System pack

| *Quantity* | *Description* |
|---|---|
| 3 | Felt Clunk |
| 1 | Hopper tank, plastic, rectangular |
| 1 | Fuel tubing, clear, Ø 6mm x 1.5 metres |
| 7 | Brass tubes, Ø 4 x 90mm |
| 12 | Brass tubes, Ø 5 x 5mm (barbs for brass tubes, solder on) |
| 3 sets | Fuel tank cap sets, aluminum (cap and disc only) |
| 3 | Kerosene stoppers (Dubro #400) |
| 3 | Allen bolt, M3 x 25mm |
| 1 | Velcro strap, double-sided, 18mm x 2.5 metres |
| 2 | Festo Tee connector (T-PK-4) |

## 'Spare' hardware pack

** This bag contains a few extra items that might be useful in the event of maintenance or repair.*

| | |
|---|---|
| 2 | Ball-links, M3 |
| 2 | Phenolic control surface horns |
| 2 | All-thread, M3 x 120mm |
| 2 | Allen bolt M3 x 20mm |
| 2 | Allen bolt M6 x 30mm |
| 2 | Allen bolt, M4 x 20mm |
| 2 | Stop Nut, M3 |
| 2 | T-nut, M4 |
| 2 | T-nut, M3 |
| 1 | Plastic nut, M6 |

## Available Accessories:

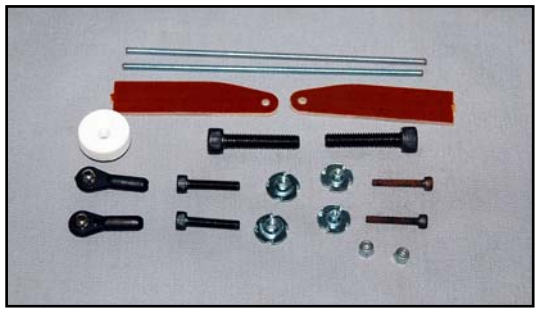
Landing gear set (#690500)
Jetcat SPT5 and exhaust outlets (#850005 and #690600)
Wren MW54 TBP (#850010)
Jetronic valves, 1 and 2-way (#961100 and 961150)
Behotec combined brake retract valve (#320569)
Jet-tronic door sequencer (#961160)
SWB servo arms (1") for JR/Graupner servos only (#630301)
PowerBox 40/24, Competition (#960500)
Powerbox 2800mAH Lipo packs & charger (#960550)
Scale cockpit set (*see website*)

* *Please check our website : www:carf-models.com, for current availability of options and accessories.*

*(above) Contents of Fuselage hardware pack*

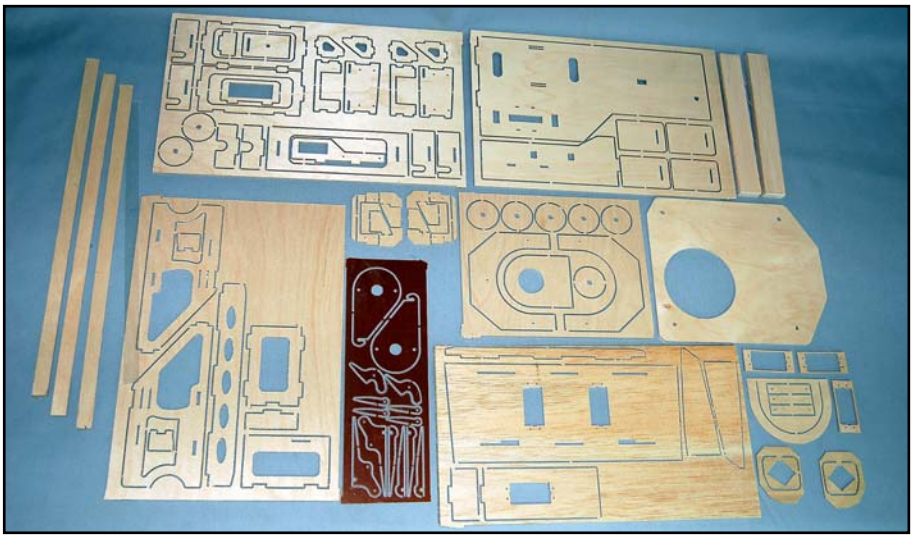
*(above) Contents of Wing Hardware pack (2 sets)*

*(above) Contents of Stab Hardware pack (2 sets)*



*Contents of Spare Hardware pack*

*(above) Contents of Fuel system pack, and also showing the main and hopper tanks for reference.*



*(above) Contents of Milled wood and Phenolic pack*

*(above) Main contents of the kit (prelim)*

*(above) Contents of the vacuum-formed cockpit tub set*

*(above) Optional landing gear set*