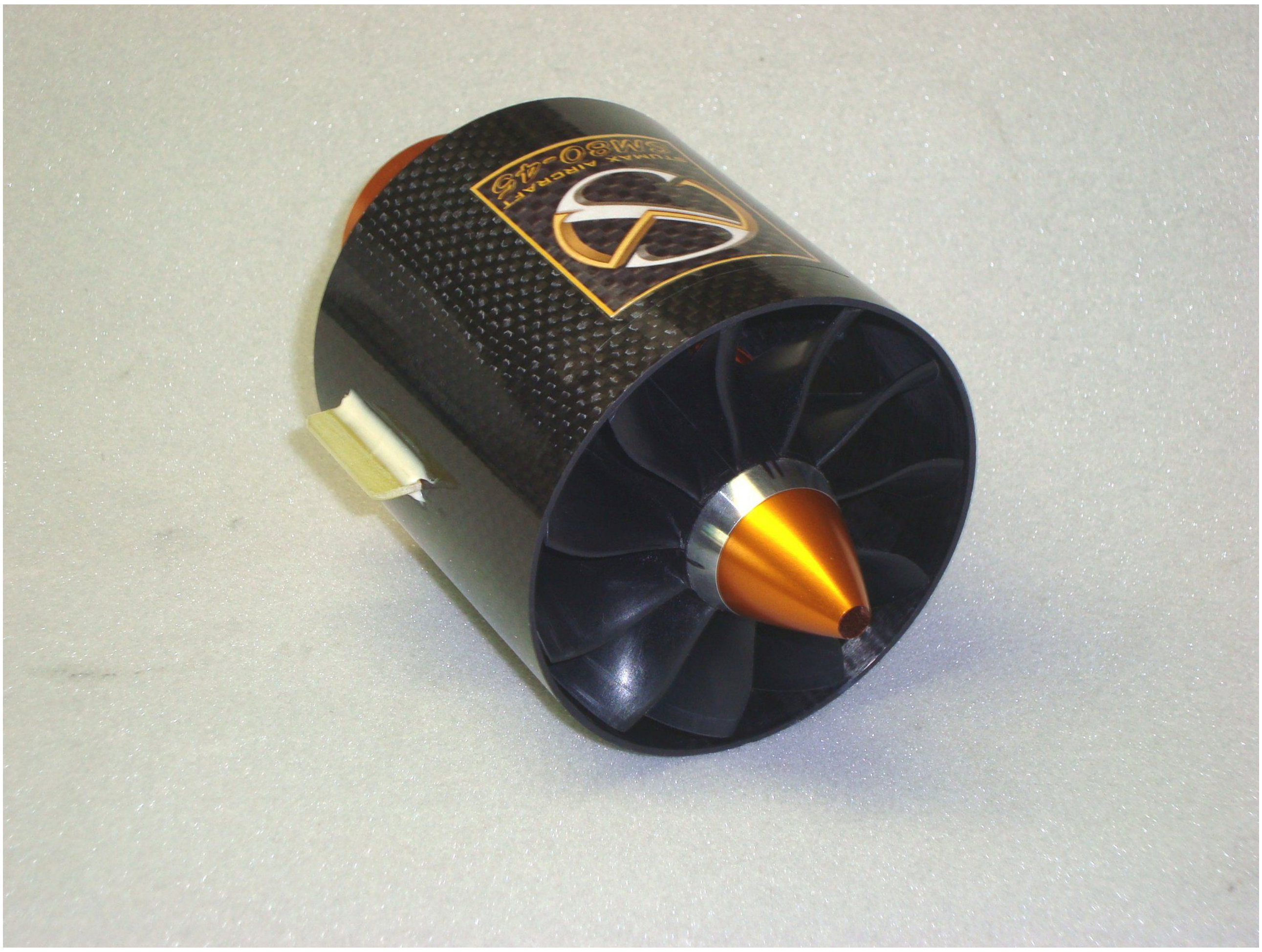
STUMAX AIRCRAFT
SM80-45
EDF Unit Owner's Manual



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Safety Warning!

Flying R/C aircraft can be dangerous. Use this product at your own risk. If you are not willing to accept this risk, please return the unit to the vendor. Electric ducted fans may seem somewhat safer than propellers, however be warned that misuse of this product may result in serious injury. Always wear eye protection when you are close to a running fan, hearing protection is also advisable. Never touch any moving part, never throw anything into the fan when it is running and secure anything within a few metres of the unit when it's running, it can suck items in from quite a distance. Always inspect the fan before and after a day's flying for any damage which may have occurred due to stone chips etc. Please do not continue to operate this EDF unit if there is visible damage to any part of it. Replacement rotors are available, please contact your vendor or StumaxAircraft if you require one.

NEVER RUN THE UNIT WITH THE SPINNER REMOVED! The spinner locks the front of the rotor blades into the rotor, it's an essential part of the rotor's structural integrity.

Please Note:
The rotor blades are quite small so some care is required when handling the rotor. The rotor blades are moulded from long glass fibre filled Nylon and are very tough. They also have very sharp trailing edges, so please be careful when handling the rotor, as you may find out just how sharp they are. When removing the rotor, try not to exert too much force on the rotor blades, instead, follow the directions later on in this manual.

Introduction

Congratulations on your purchase of your Stumax Aircraft SM80-45 EDF unit. This unit features state of the art aerodynamic design and several unique design features which set them apart from the rest. The motor tube features cooling fins which follow the curved flow path through the stators. This reduces turbulence whilst increasing the thermal capability of the unit and reduces the weight. The rotor is constructed from eleven individual blades assembled onto a 7075-T6 aluminium hub assembly. The unique wedge action of the rotor blade retaining plates ensures the blades are always captured and preloaded against the hub. A single nut holds the rotor assembly together, creating an assembly which is 100% axi-symmetric. The stator blades are moulded from carbon fibre using a high temperature epoxy, and bonded to the motor tube and shroud with an aerospace grade methyl-methacrylate adhesive. The shroud of the SM80-45 is solid carbon fibre which is very stiff and strong.

Assembly of the SM80-45 EDF unit

If you've purchased a unit with motor installed, you can skip the next two sections. Plug and play units come with the motor installed, rotor installed and trued up to run smooth and the unit is test run to approximately 3kW. After running a new fan at full rated power, there may be slight evidence of rotor blade scuffing inside the shroud due to blade stretch. The rotors are sized to have minimum tip clearance at full rated power, and achieving this sometimes means that the rotor tips may lightly scuff inside the shroud whilst the optimum rotor tip clearance is being achieved during setup and testing.

Installing the motor

As the unit comes pre-built, assembly is limited to installing the motor, fixing the rotor and fixing the tailcone. The units are designed around 39mm dia case motors with 5mm shafts. The inside diameter of the motor tube is machined 39.10mm, the extra 0.1mm being an allowance for the motor's case being slightly out of round or bulged at the end caps, as well as providing space for some thermal grease to reside to provide better thermal conductivity between the motor and the motor tube. When inserting the motor, be careful not to try and force it in if it doesn't want to go – it will get stuck and give you a big headache getting it out. It should slide in nicely. You may find that the front of the motor's case has expanded slightly due to the bearing caps being pressed in. If so, get some masking tape and tape up the front and rear of the motor to protect the bearings and cover the cooling holes. Get a smooth file and file lengthways just touching the case, and taking material off the front or rear surface of the case. You will notice that you will be removing material from the bulged end of the case only until you have filed it flush, then stop. Then get some 400 wet and dry paper and smooth it off. Leave the tape on the motor and try inserting it into the motor tube again. This time it should slide in nicely, but may stop as you reach the other end of the motor. If so, repeat the process, file and sand the end of the case smooth. The motor should now insert smoothly.

You will need to grind a small flat on the motor shaft for one of the rotor grubscrews to lock onto. The rotor has four M4 grubscrews to secure it to the motor shaft, which is plenty to hold the rotor on and transmit the torque of the motor, the flat is there as a safety feature to prevent the rotor from sliding forwards should the grubscrews lose their bite. The flat only needs to be about 6mm long and should be ground using a Dremel motor tool or similar, with the tool's axis perpendicular to the motor shaft. This will give you a flat which is actually a radius, ie it doesn't have a stepped front or rear edge. This is quite important from a stress concentration point of view, as well as preventing the edge from biting into the aluminium shaft adapter if the grubscrews are incorrectly tightened. Ensure you cover the bearing with masking tape whilst grinding the flat.

Now is a good time to check the fit of the rotor on the motor shaft. The bore of the rotor is precision machined to be a size for size fit on the shaft. Unfortunately, some motors will come with, a 4.970mm dia shaft (Chinese made), and some with a 4.990mm dia shaft (such as Neu or Lehner). Whilst 20 microns may seem pretty small, it is enough difference to make the rotor too loose if it were sized for a 4.990mm dia shaft and placed on a 4.970mm shaft. So, you may find the rotor is a bit tight going onto the motor shaft. If so, try warming it up under hot tap water (no hotter!), drying it off thoroughly, and then try it on the shaft again. Ideally, it should slide on without having to be pushed too hard. If it's still too tight then you'll need to get some 600 wet/dry paper and run the motor whilst sanding the motor shaft down a bit. Always protect the motor bearings and cover the cooling holes with masking tape whilst doing this. Make sure that the shaft has a slight chamfer on its front edge, and make sure that the lack of a chamfer wasn't the reason it wasn't going into the rotor bore smoothly. It doesn't take much to make a big difference, so stop and check constantly. If the shaft gets too hot, let it cool off before test fitting it to the rotor. When you're happy that you can slide the rotor on smoothly without it being too loose or too tight, you're ready to install the motor. Right after you solder some wires to the motor, of course.

Before installing the motor, get some thermal grease and sparingly wipe inside the motor tube and around the outside of the motor case. The grease is sticky stuff and doesn't like to flow so make sure you wipe it everywhere you want it to go. Be warned that it contains silicone, so make sure you clean it off your fingers thoroughly with warm soapy water before you touch anything. You only need a thin coating of grease, too much and you'll make a big mess when you insert the motor. When inserting the motor, it helps to keep it moving – if you stop moving it will tend to grab, so rotate it during insertion and push it in until it hits the mounting lugs. Grab a tissue or cotton bud and wipe off any excess thermal grease and go and wash your hands very thoroughly. Use the M3x6mm long screws provided to screw the motor in place, thread locker is good practise here.

Installing the Rotor

Now it's time to fix the rotor in place. Note there is a small hole in the shroud. This is for inserting a 2mm Allen key to tighten the rotor's M4 grubscrews. Remove each grubscrew and apply a small amount of Loctite or thread locker. After screwing them back in, wipe away any excess, you don't want this spitting inside the shroud, as it will degrade the shroud material. Turn the motor shaft so that the flat lines up with the hole in the shroud. Line up a grubscrew with the flat on the motor shaft and push the rotor on until it won't go on any further. The rear of the rotor hub/ shaft adapter should make contact with the front bearing inner ring. Like most things, there is a right and a wrong way, so please follow this to the letter for smooth running. There are four grubscrews, which means two opposing pairs. When you tighten one up, then its opposite, the two screws will fight each other. It is possible to distort the shaft adapter and kick to rotor off sideways if you get it wrong. To tighten it up, nip grubscrew 1, turn the rotor 180 degrees and nip grubscrew 3. Turn the rotor 90 degrees and nip grubscrew 2, then turn it 180 degrees and nip grubscrew 4. When I say “nip” only just nip, using your thumb and first finger on the diameter of the Allen key, not even on the short end. The idea here is to take up the clearance. Now go back and nip the grubscrews again in the same order, this time just a light tweak of the short and of the Allen key. Repeat, just a bit tighter this time. Now, let the unit sit for an hour for the Loctite to grab.

Attaching the Tailcone

The tailcone is an optional extra. They look pretty and provide a nice neat way for the motor wires to exit the exhaust duct. They do, however, make the motor run a little bit hotter, so if you're pushing things perhaps think about leaving the tailcone off. Hot motors are less efficient, the 2-3% gain in aerodynamic efficiency may be lost in reduced motor efficiency. The tailcone slides onto the rear of the motor tube. There are some strips of aluminium tape included, these are for fixing the tailcone onto the motor tube. The tape sticks very well, and can be peened down by rubbing with a stick of balsa. The motor wires will pass through the wire fairing of the motor tube. The fairing will pass through a cut-out in the exhaust tube. It's a good idea (it's essential, really) to tape around this cut-out to secure the exhaust tube, as well as tape over the wire opening to seal everything off, as the pressure inside the exhaust tube will be greater than the pressure inside the fuselage. It's best to mount the esc somewhere where it can receive a small amount of cooling air (don't forget to allow somewhere for this air to escape), or you can keep it cool with a small CPU type cooling fan powered by the Rx battery. These tiny fans draw only 10-50mA so they won't flatten the Rx battery. One day, all esc manufacturers will mount small fans to their escs. Some manufacturers like to put the esc in the tailcone. The motor temperature will rise by 15-20degC if you do this as the air enters the end of the tailcone and exits in the gap between the rotor and motor tube. This is because the pressure in between the rotor and motor tube is lower than the pressure after the fan. Think carefully about this. The two hottest items in the aircraft are the motor and esc. Does it really make sense to have them almost touching each other?

Mounting the Unit

The SM80-45 is designed to be simply screwed to ply or hardwood mounting rails using standard servo mounting screws. The SM80-45 may be soft mounted if desired. For this you may use standard servo grommets/eyelets & screws, but you will need to enlarge the holes to suit the grommets. Install the eyelets with the face of the eyelet facing down, so that it contacts the fan mount. The mounting screws will then clamp down onto the eyelet, and the eyelet will limit the amount of compression of the grommet. It's not essential to use grommets, you can just screw the unit directly to the fan mounts, but the grommets do provide a degree of sound dampening of the motor noise, which is more significant with these units as the fan noise is very quiet. They also allow for mounting rail misalignment, which is very important, as screwing the fan down hard to mounts which are not parallel will induce some distortion into the unit, possibly affecting the roundness of the shroud.

Test Running the Unit.

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Ideally, mount the unit to a test stand. This can be as simple as a piece of 6mm plywood clamped to your workbench, with a rectangular cut-out to screw the fan into. The idea of the initial testing is to determine if the unit is running as smooth as it should. All rotors are dynamically balanced to a very fine level but because of the slight clearance in the fit of the rotor on the motor shaft, it's possible that the rotor can be kicked slightly off centre by uneven tightening of the grubscrews. You may also find the motor doesn't run as smooth as it perhaps could, and sometimes the motor's slight imbalance adds to the rotor's slight imbalance, creating a noticeable imbalance. It's possible, and very easy to tune the balance of the unit by tweaking the torque applied to opposing pairs of grubscrews, ie loosen one and tighten its opposite, and the result is well worth the 10-15 minutes it may take. Run the unit up on say 6 cells, ideally with some sort of inlet lip (to make it quieter) and feel how smooth it is, being very careful not to place your fingers in front of the fan whilst it's running, just touch the shroud from behind. There shouldn't be any noticeable vibration, nor should there be any resonance occurring during throttling up or down. If it's not as smooth as it should be, loosen off grubscrew #1 and tighten #3, then nip up #1. Run the fan and feel for vibrations. If it's improved, try a bit more or a bit less torque on this pair of grubscrews until you find the smoothest running. If it's worse, loosen #3 and tighten #1, then nip up #3 and repeat. With this pair sorted out, repeat this process for #2 & #4 grubscrews then repeat the whole process again.

Removing the Rotor

If you need to remove the rotor for any reason, simply loosen all four grubscrews and the rotor should slide off. If it doesn't, it may be because the grubscrews have kicked up a burr on the motor shaft, or some Loctite from the grubscrews has found its way onto the motor shaft. The solution is to remove the spinner, noting its location on the rotor. There is an M3 tapped hole in the front of the rotor hub. A long piece of M3 threaded rod can be screwed down into that hole until it hits the motor shaft. On the other end of the threaded rod, screw an M3 nut followed by another M3 nut and tighten these two nuts against each other. These nuts lock onto the threaded rod and provide something to turn the threaded rod with. Use a spanner on the last M3 nut to screw the threaded rod down, it will hit the end of the motor shaft, keep screwing it down and the rotor will be driven off the motor shaft. Replace the spinner, noting its location is the same as before it was removed. This is important, as the rotor was balance with the spinner in this location. Now check the motor shaft for burrs, run it up on 3S and hit it with some 600 wet/dry to remove the burrs.

Battery Choice, Charging and Maintenance.

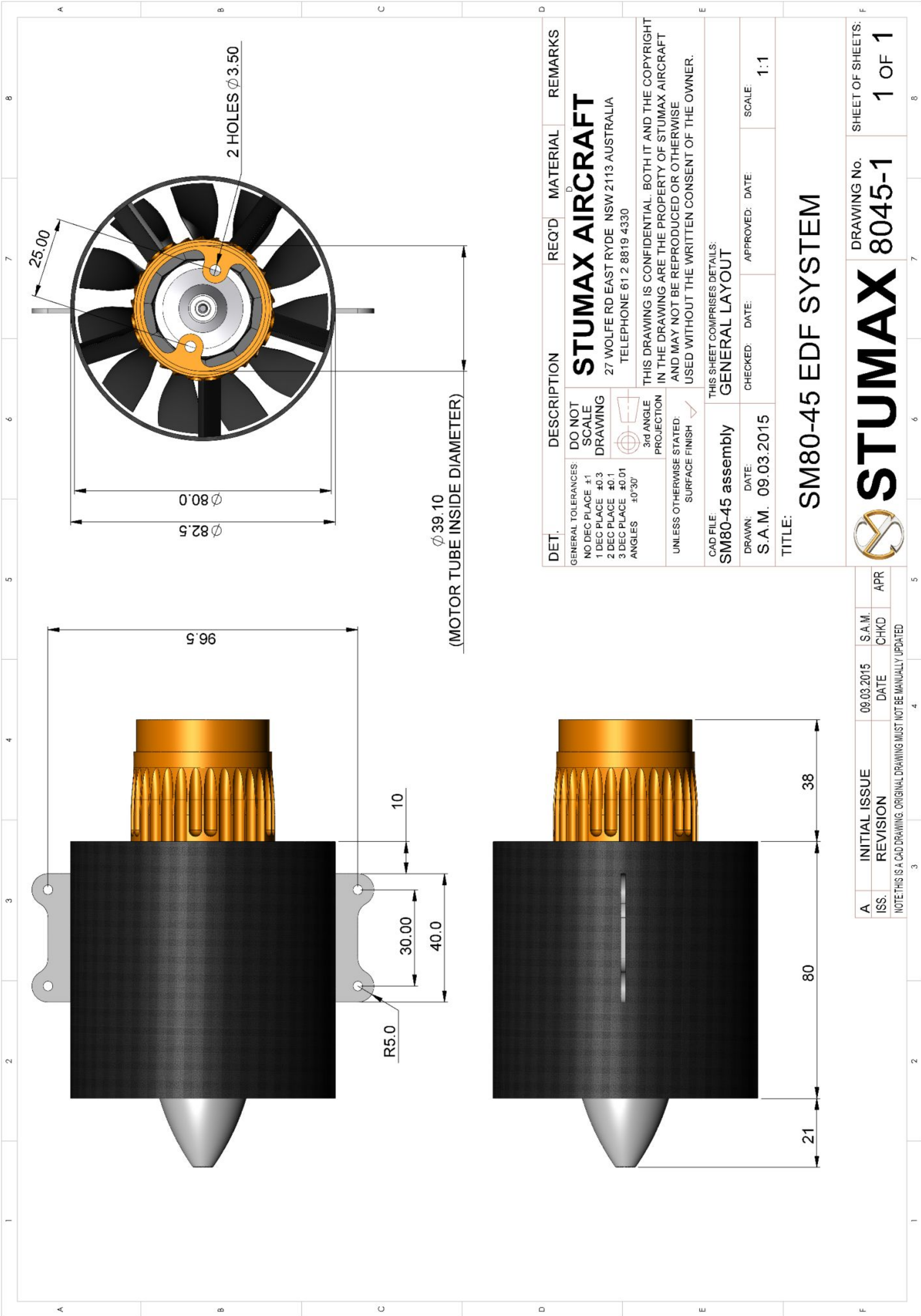
Battery choice is always a contentious issue. Customer loyalty is strong in this field, with many customers swearing by a single brand, unwilling to try anything else. Whatever brand is your favourite, you must ensure that the battery chosen is suitable for the task. Be wary of manufacturer's claims about their cell's performance. Also, remember that for long cell life you can only use 80% of the capacity of the pack at the discharge rate you are operating at. Lipo cell have a capacity which is rated for a 1C discharge. When you start discharging at higher rates, such as 20C the capacity drops, so your actual capacity is based on the capacity available at your discharge rate, and then you should only use 80% of that capacity. Remember that cell manufacturers will hype their product and get away with it as not many people have the capability or technical knowledge to test their product in accordance with the correct test methods.

When selecting a battery always think about how long you want to fly on a given pack. Sure, you can get cells which will deliver 60C constant discharge, but do you really only want <1 minute of full throttle flight? Models large enough for these units should be able to handle the extra weight of a pack large enough to give you 3-4 minutes of full throttle flight. A 16C discharge equates to 3.75minutes. With an 80A current draw, 16C means 5000mAh usable capacity will be required. You will probably use at least 30 seconds for takeoff, so there's only 3.25minutes left. With careful flight tactics you should be able to achieve 6-8 minute flights using a pack this size. Efficient flying is the key, don't waste power. When pulling out of loops or split S's bring the throttle back to about ¼ or less and apply it smoothly when pulling out to maintain speed. If you've just done a fast pass there's no need to keep it fast when it's past your viewpoint – you can't really see how fast it's going as it flies away anyway. All these little tricks add up to quite a saving in energy which means longer flights.

For long battery life, always let the pack cool down before recharging it. A good rule of thumb is to let them cool to below body temperature. The cells in the centre of the pack will always be warmer than the cells on the outside, so take this into account. Cell voltage is very dependent on temperature, so having all the cells at the same temperature is very important when recharging as it helps ensure that the individual cells all have the same voltage. Balance charging is a good way to keep your pack in good shape, however, if the individual cells are at different temperatures the balancer will be struggling to get it all balanced out. Some brands of modern lipos claim to be able to be charged at higher rates than what we are used to for lipos. The cell manufacturers rarely provide any information as the to effect of faster recharging with regards to cell life. Don't forget that they want to sell more batteries. At the end of a day's flying don't leave your batteries lying around in a highly discharged state, bring them up to about 50% capacity. Some chargers have what is called a “storage” charge mode for lipos, this will bring them up to about 50% capacity, which is the level recognised to be best for longevity. If your charger can't do it for you, then fully charge them then perform a timed discharge.

Flying Techniques

Flying EDF models is no more difficult than a prop driven model of the same size and weight, however ducted fan models have their own peculiarities which must be respected otherwise you'll end up with a very sorry looking pile of bits. Jets tend to be heavier and have smaller wings than most models, so you will need to allow for this in your flying style. You can't treat them like a sport model and yank them around the sky. Be smooth with your flying and the model will perform that much better. Ducted fan models rely on airspeed for control authority, as there is no prop wash over the tail. Remember this when you are flying slow, and don't get so slow that the controls become sluggish, as it's all too easy to over control in such a situation, usually resulting in a tip stall into the ground, something a lot of inexperienced pilots will blame on radio lockout or interference. Any sudden pitch changes may upset the flow into the intakes temporarily, causing a loss of thrust, so no snap pylon racing turns please. The thrust to weight ratio of most ducted fan models will be lower than for a similarly powered prop driven aircraft. This will mean that acceleration will be slower, so plan ahead if you need to abort a landing and give the aircraft time to build up sufficient speed before climbing out and turning downwind. If landing with full flaps, keep the flaps down whilst accelerating away from an aborted takeoff, only raising them until sufficient speed has been achieved. Putting flaps up at low speed is a good way to make the model dump itself onto the ground due to the sudden loss of lift. Takeoffs will be longer, especially on grass, so you need to allow the model sufficient time to accelerate to flying speed before breaking ground. Some jets have their intakes in a position which will tend to suck them onto the ground, such as an F18. Be wary of this, and always give the model a slightly positive angle of attack when sitting on its wheels and make sure the main wheels are no so far aft that the model is difficult to rotate. Overall, remember that you're flying a performance aircraft, not a trainer, so fly it like a jet, fast and smooth, big manoeuvres, graceful rolls and lots of fast fly-bys.


2 HOLES Ø3.50
25.00
Ø80.0
Ø82.5
Ø39.10
(MOTOR TUBE INSIDE DIAMETER)
96.5
10
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80
21
DET.
DESCRIPTION
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REMARKS
GENERAL TOLERANCES:
NO DEC PLACE ±1
1 DEC PLACE ±0.3
2 DEC PLACE ±0.1
3 DEC PLACE ±0.01
ANGLES ±0°30'
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DATE:
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DATE:
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TITLE:
SM80-45 EDF SYSTEM
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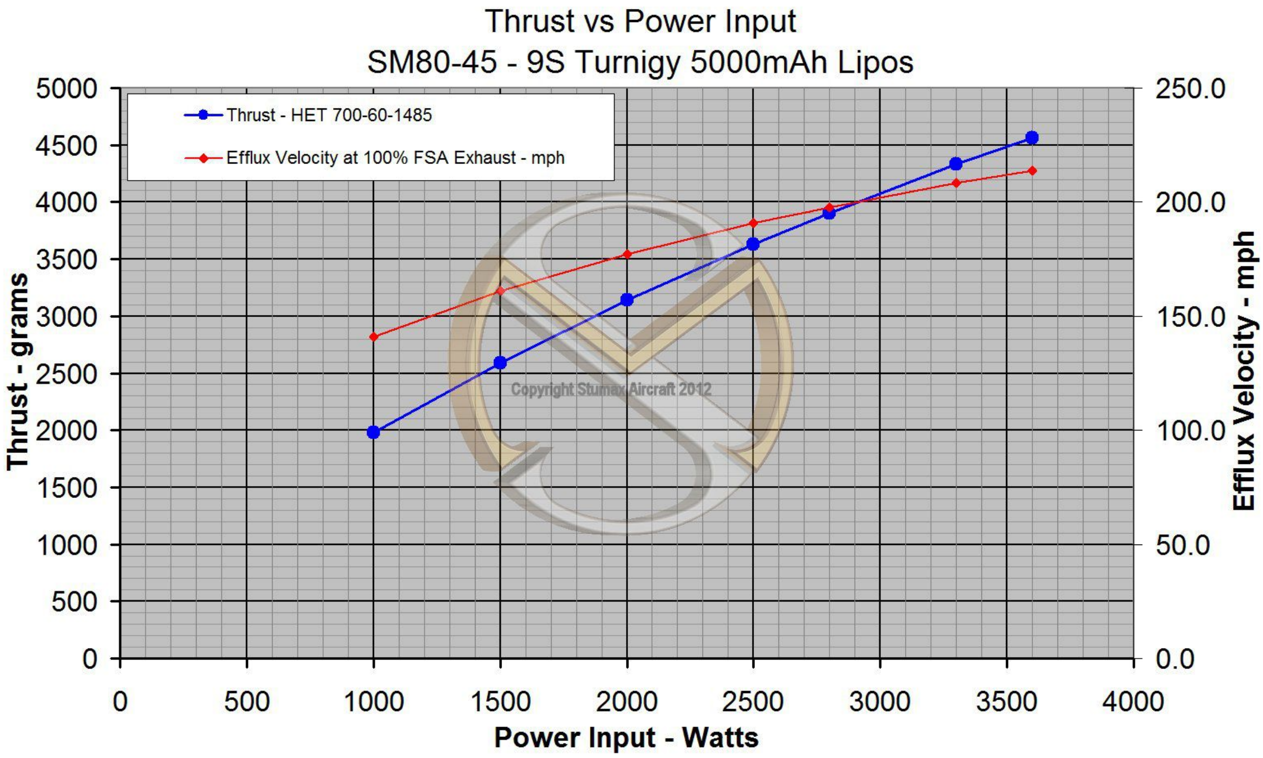

Thrust vs Power Input
SM80-45 - 9S Turnigy 5000mAh Lipos
Thrust - HET 700-60-1485
Efflux Velocity at 100% FSA Exhaust - mph
Copyright Stumax Aircraft 2012
Thrust - grams
Efflux Velocity - mph
Power Input - Watts
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