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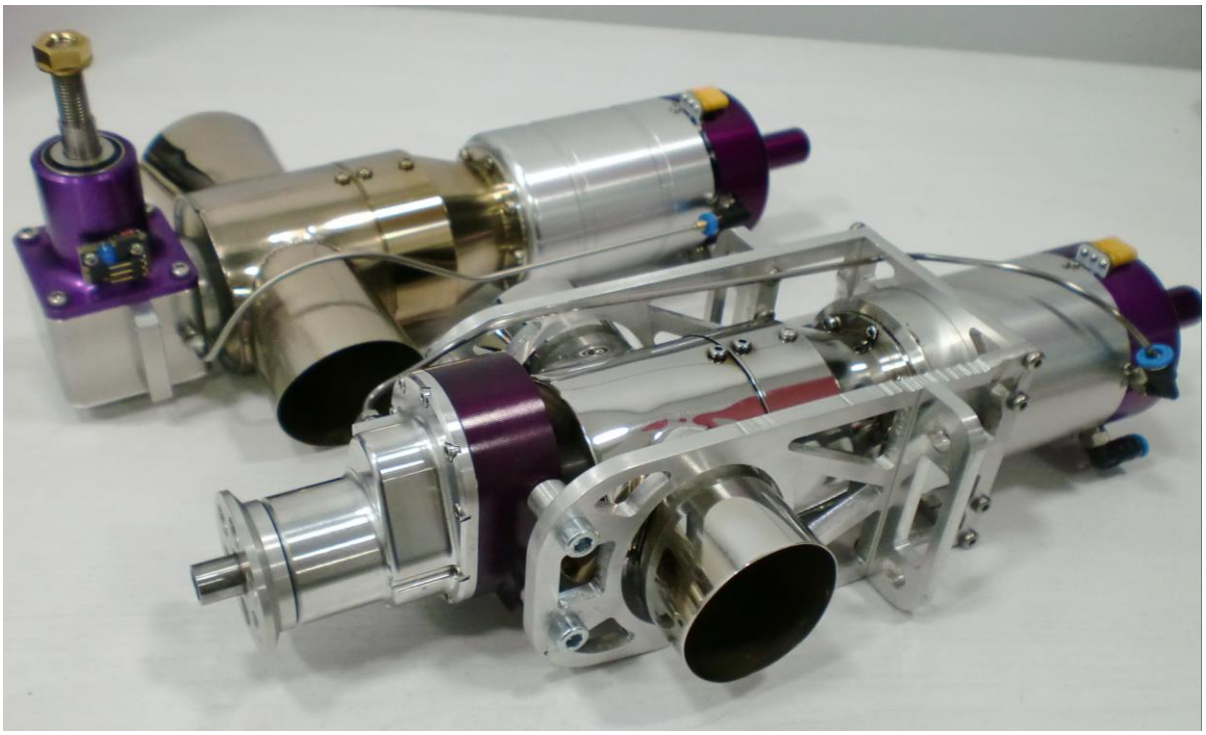

Xicoy X45Helicopter
X45TurboProp

User Manual

Version 2.0 Feb/2024

Congratulations on your purchase of this new generation Xicoy X45 two stage gas turbine engine. We are confident you will be delighted with your purchase and your new engine will give you excellent service and maximum enjoyment to your hobby.

The X45Heli and X45TurboProp are a new extension of the development programme by Xicoy Electronica, supported by the latest fluid dynamics and analysis software to bring you these miniature gas turbine power units of unrivalled performance and versatility, in amazingly small packages. New electronics design and digital programming sets a new high bar standard for this new generation of small turbine engines.

Much of the installation and operation of these engines is common to both units so we have combined the instruction notes to a single manual to aid currency and completeness. Where instruction is specific to one unit it will be stated.

Important: This manual only covers the particularities of the second stage; please refer to the turbojet manual for the relevant instructions on how to operate the associated turbojet engine.

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Web site: www.xicoyturbines.com Email: sales@xicoy.com

See our new turbine webpage at: www.Xicoyturbines.com

Xicoy X45H, two stage helicopter engine

It is 2stage gas turbine helicopter drive unit to power 0.90cu in (15cc) size R/C helicopters. The unit features a miniature gas turbine engine producing up to 4kw/ 5hp driving a 2nd stage turbine linked to a gearbox just like standard full size practice. This offers a powerful, smooth and vibration free power plant that can run on regular kerosene. The sound is totally different from any piston engine, being smooth and steady with a gentle rush of expanding air to provide a unique driving system unlike any other.

The unit is designed to interchange comfortably with standard 0.90 glow Heli engines with considerably more power available. Standard mountings, shaft attachments, fan and clutch parts may be reused with minimal modification. The output rpm range matches closely with the benefit of a much higher reserve torque and broader power curve making it easy match to any similar airframe.

The engine and gearbox unit is extremely small and light and easy to install and operate. It uses the latest digital control with many additional safety functions developed specifically for this application.

Helicopter Conversion Kits

Currently the Miniature Aircraft Whiplash helicopter can be ordered ready to use for the X45H engine.

Xicoy X45TP, two stage TurboProp engine

This unit benefits is of very small size and light weight and can use the full power of the X45 engine up to 5.5kw / 7.4hp. This is equivalent to piston engines of about 80cc piston engines making it ideal to power planes up to 2.5m/98” wingspan and up to around 20kg/44lbs.

We have introduced this power plant complete with a sturdy mounting enabling it to easily fit standard firewalls of airframes intended for bulkhead mounted 50 to 100cc petrol (gas) engines.
The Xicoy 45TP is available in two reduction ratings, High and Low:

High ratio (HR) is for swinging large props (24” to 28”) at lower rpms for high wing Pilatus PT6 glider tug type applications.

Low ratio (LR) is for fast flying sport “Tucano” type models with limited ground clearance. (20” to 24” props)

Depending on your planned airframe simply select the reduction rating for the propeller you plan to use. Choice is if you plan to fly light and fast, or heavy and slow, a bit like the KV value for electric motors. The gearboxes have been optimised to ideally match each application. This enables us to optimise the performance of the unit to the power curve of the 2nd stage and maximise your enjoyment of the unit.

Features and Functions

- Tiny 60mm case 2 stage engines developing up to 5.5kw of shaft power
- Very low installed weight and bulk
- Heli gearbox outline and shaft matches standard 90 size heli glow engine

- Turboprop version comes complete with bulkhead mounting
- Turboprop option of two reduction ratios: HR = max 6.000 RPM and LR = max 7.500RPM
- Integrated Propeller/Rotor over speed protection.
- Gearbox Rpm and temperature included in telemetry feedback
- Accommodates wide presettable range of helicopter reduction ratios
- Peak power user presettable
- Valves and ECU installed on-engine
- Internal ignitor and thermocouple for clean exterior
- Fast start to idle of about 30secs
- Fast spool up to flight rpms
- Automatic cooldown after run, even with receiver power turned off
- Automatic battery disconnection after cooldown
- Brushless high speed starter
- Tiny digital brushless fuel pump
- High speed digital control of all components
- Gearbox uses lubrication from engine, no separate oil required
- Choice of display options.
- Telemetry options available for most modern transmitters

New options and features are being added from time to time,
Keep watching on: www.Xicoyturbines.com for details

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Package Contents

Helicopter engine:

Engine unit including f.o.d. protection screen
Fuel pump
Hub Light + colour display + 300mm signal cable, OR / Compact Hub
Engine cable 250mm
Battery cable
Servo type cable 300mm x 2
Fuel filter
4mm tubing, 1mtr
Instructions USB card

TurboProp engine:

Engine unit inc mounting and fod filter screen
Fuel pump
Hub Light + colour display + 300mm signal cable, OR / Compact Hub
Engine cable 500mm
Battery cable
Servo type cable 300mm x 2
Fuel filter
4mm tubing, 1mtr
Instructions card

New Owners

If you sell or pass on this engine to a 2nd or subsequent owner please also pass on this User's Manual or its link, so they can enjoy a safe and fulfilling ownership too.

The Xicoy Electronica SL responsibility is limited exclusively to the repair of the engine and accessories which are outlined in the conditions of warranty you can find in the turbojet manual.

Before unpacking the engine, please read through these notes and agree to the conditions of warranty.

Customer satisfaction is important to Xicoy Electronica. Technical support is readily available through your local dealer and via email:

Xicoy Electronica SL, Plaça Pere Llauger Nau 18, 08360, Canet de Mar, Barcelona, Spain

Web site: www.xicoyturbines.com Email: sales@xicoy.com

Legal

Disclaimer

This engine is a very sophisticated piece of machinery. Great care should be taken at all times when using the engine. It should only be operated installed in an airframe and by those with appropriate skills and knowledge to do so. The engine is not a toy. Incorrect operation or misuse can cause damage to property and serious bodily harm to operators, spectators or animals. Xicoy Electronica SL accepts no liability any damage which may occur.

Xicoy Electronica SL assumes no responsibility for any errors contained in this document and is not liable for any damages resulting from such errors.

It is forbidden to use this engine outside radio control applications, especially those that power vehicles to carry people.

Performance, weights and measures

	X45Heli	X45 TurboProp
Nominal power at sea level	4kw / 5hp	5.5kw/7.4hp
Typical Idle shaft rpm	4,000rpm	1400 (low ratio) 1200 (high ratio)
Max shaft rpm	20,000rpm (limited)	7,400 rpm (LR)/ 6,000 rpm(HR)
Torque at max rpm	1.5Nm (13 lb ins)	6.25Nm (55.3 lb ins) (low ratio) 8.33Nm (71.2 lb ins) (high ratio)
EGT at max power	500ºC-600ºC	550 – 700ºC
Fuel consumption at max power	100ml/min / 3.4oz/min	180ml/min / 6oz per min
Restart capability	Off and manual	Off, manual & automatic
Fuel	Kerosene only	Kerosene only
Oil mix required	4%, see turbojet manual for details.	
Overall length:	280mm/11”	320mm/12.6”
Width across exhausts:	120mm/4.75”	120mm/4.75”
Width main body:	60mm / 2.35”	72mm / 2.83” (inc.mounting)
Firewall to rear of prop distance	n/a	160mm / 6.3”
Gearbox output shaft:	Clutch portion 9.5mm / 3/8”, threaded 5/16” UNF	Dia 10mm plain portion, threaded M8x1.25 internally for M8 cap bolt
Gearbox mounting holes:	4 off dia 4.1mm W52mm x H25mm (0.164”, 2.05” x 0.98”)	4 off dia 5mm, W90mm x H50mm (0.2”, 2” x 3.54”) Firewall cutout required: W72mm x H70mm (2.83”x 2.75”)
Unit weight bare	1170g/41oz	1470g/51.7oz (inc mounting)
Ancilliaries + Compact Hub Hub Lite + display Hub Lite, no display	70g/2.5oz 86g/3oz 62g/2.2oz	70g/2.5oz 86g/3oz 62g/2.2oz
Airborne weight	1232g – 1261g 43.3oz – 44.3oz	1532g - 1556g (inc mounting) 53.9oz – 54.7oz (inc mounting)
Suitable ECU battery:	2S Lipo, min capacity 1200mAh	

Installation – X45H Helicopter engine

Please read through the section on Safety as there are many areas to consider that may differ from those pertaining to other forms of helicopter power plant.

Helicopters have a special form of vibration due to asymmetrical gyrations of the rotor head. We recommend using a locking compound on any critical screws likely to loosen in service. Use only blue type as the green type can be impossible to loosen later. If you need to return your unit for service, **please remove clutch and fan assembly** and any mountings, return the engine as supplied.

The unit is designed to operate with the output shaft uppermost. A side and plan view and 3D STL file can be downloaded from www.Xicoyturbines.com.

NOTE. *To accommodate the housing expanding with temperature, the top bearing next to the fan is allowed to slide against a strong internal load spring. Please note therefore that on installation, you need to ensure there is no downward pressure on the output shaft which could overcome the spring and cause the gears to bind which causes noise and excessive and rapid gear wear.*

Use the standard clutch. Retain and use the clutch supplied for the piston engine for the airframe. It enables the engine to start and run to idle without powering the rotors. It also provides a valuable slipping point in event of rotor being overloaded or forcibly stopped in a crash, or the helicopter being blown over by strong gust of wind.

Keep gearbox cool. The gearbox unit *must* be cooled in operation. Being connected to a gas turbine producing up to 100kw of heat energy, it will otherwise quickly overheat in use. DO NOT remove the helicopter fan, nor run the engine without the cooling fan or an equivalent cooling system of similar power.

Use the standard fan. The standard fan included with glow engine helicopters is suitable if used with supplied shroud which can be trimmed to clear any areas of contact and direct the cooling flow downwards onto the centre of the exhaust and gearbox. With an effective cooling setup the gearbox temperature should seldom exceed 50C in operation, though may climb to 80C or more when engine is stopped due to heat soak from the hot 2nd stage.

If the fan cooling is not effective enough, the exhaust will begin to turn a darker brown shade. Aim to keep at least 6mm of shroud clearance to any hot surface. Consider the possibility that the fan shroud may need to be fitted 1st, before the fan and clutch assembly.

Exhaust extensions

In normal operation, the engine exhaust flow is continually expanding as it leaves the 2nd stage. Adding extra exhaust ducting to the exhaust outlets inhibits the exhaust expansion and causes local restrictions to the free flow, increasing the back pressure on the engine. This reduces the power available to run the engine and has to be made up by burning more fuel. This significantly increases the running temperature and spoils the starting and running characteristics of the unit, so is strongly discouraged.

Where the standard exhaust outlet does not quite reach beyond the ends of a particular body shell short simple push-on straight exhaust stubs up to 75mm/3" are acceptable as they cause minimal disturbance to the engine flow. It is the longer lengths or changes in direction which cause back pressure and must be avoided.

Fitting the clutch

1. Fitting clutch. To fit the fan and clutch to the gearbox output shaft you need to lock the output shaft. ***Do not attempt to do this by jamming the 2nd stage turbine*****.**
2. Remove the four M3 screws from the ***bottom*** cap of the gearbox to reveal access to the lower output shaft nut which you can hold stopped using an 11mm socket wrench or ring spanner.
Be extra vigilant not to allow grit or dirt to enter while the cap is removed. Be aware there may be some loose fuel in the gearbox so best not does this on unprotected best dining table…

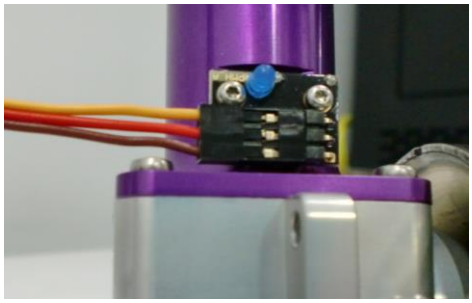
3. Place the supplied 3/8" thin washer onto the output shaft first ***before*** the fan to ensure running clearance to the top bearing.

4. A 12mm socket or box spanner can be used to nip the brass nut onto the fan. You can use a washer if one was supplied in the heli kit but it is not usual. Do not use locking compound (Loctite etc) on the brass nut. Do not substitute the brass nut; the shaft is stainless steel to prevent rusting as is the brass nut.

5. Tighten the side nip screws on the split collet if used. Check fan rotates freely. Fit the clutch parts and ensure everything is tracking true.

6. Refit bottom cap on gearbox (note orientation of cut-out to clear input gear) using a small drop of blue locking compound on the screws.

7. Fit a good quality silicon or Teflon (heat resistant) 3 wire type servo type cable from the small gearbox output pcb to connect to the auxiliary socket on the small Hub board. It may be difficult to do this later. *Note orientation.*



When all is installed and powered up you can see a blue light on the small gearbox electronic board which when the shaft is rotated flashes twice per revolution to show gear output shaft rpm signal present. When the gearbox is running fast the flashes indicate the bus updating rpm signal every second.

8. Offer up the gearbox to the helicopter mountings following the special notes of your helicopter manufacturer kit and carefully aligning the clutch into its bearing. Fit the gearbox securing screws but not tight yet. Be very careful not to disturb or damage the lubrication feed pipe going to the gearbox from the engine. If you have to remove it for any reason the 6mm gland nut on the gearbox should be unscrewed to allow the pipe and gland to be removed as one. Note there is an small Oring fitted onto the pipe which the gland nut presses down upon to provide the seal. When refitting ensure the Orings are in position and the gland nut gently nipped up, don´t over tighten it not needed.

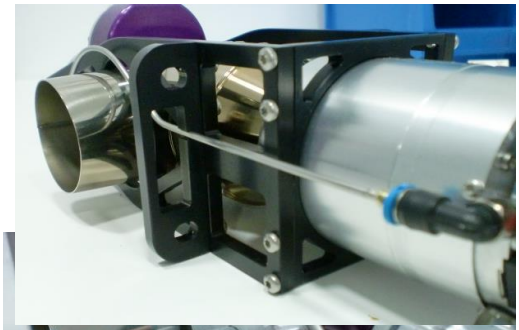
9. The engine section should be supported by its special mounting in the airframe and the clutch assembly checked for free rotation at this point. If all ok the mount screws can be fully tightened. Never fly the Heli without the engine properly supported in a sturdy mount, else even a gentle landing can very expensively bend the 2nd stage unit in the middle due to the unsupported engine weight.

10. Always use the FOD screen, Helis throw up all sorts of ground debris, the small engine parts need all the protection they can get.

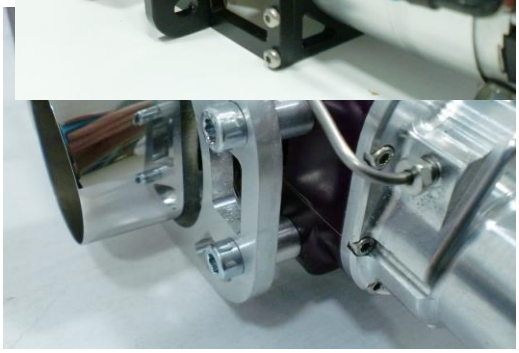
Be careful to ensure no downward pressure load is placed on the output shaft when fitted to airframe as this will jam the gears together and drastically shorten the life.

Don´t forget to fit the FOD screen

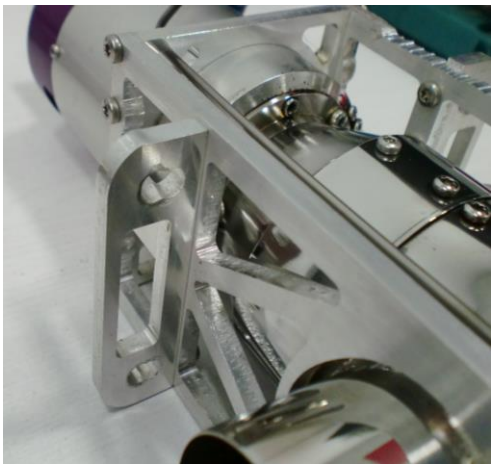
Installation – X45TP TurboProp engine



The engine unit is designed to operate horizontally with the engine markings upwards. A side and plan view and a 3D stl file can be downloaded from www.Xicoyturbines.com.



The special mounting is supplied as part the engine. It provides critical support at the important positions required and aids heat dissipation from the small gearbox. It also gives the engine section gentle support and allows for expansion lengthways as the unit warms up in operation. It also provides some limited shielding from the hot interstage part between the engine and 2nd stage.



Note the solid fixing of the gearbox to the mounting and through to the firewall, critical in providing a stiff, yet load sharing pathway. This simple but rigid framework provides a lot of engine protection in event of a nose over or crash, however this stress will be passed directly to the firewall so must be a secure point in the airframe.

Without such a system any significant prop-strike or nose over could bend the 2nd stage, a very expensive repair.

A template is provided to place over and position mounting holes and cut-out for the firewall. It can also be downloaded from www.Xicoyturbines.com.

The engine requires a flow of cool air to its intake to operate. This is ideally forward facing to take advantage of prop and airframe airflow. Make provision for this **separate** from any airflow used for cooling in the cowl area, perhaps passing underneath a separator. If this flow passes through the front undercarriage area place a fine mesh similar to the one used on the fod screen to prevent stones, grass etc being pushed into the engine area during ground manoeuvres.

Make sure that the engine can't breathe his own hot exhaust, this will cause a significant reduction of power or/and cause unexpected shutdowns.

Cooling

In operation the 2nd stage radiates a lot of heat. The engine produces the equivalent of 100kw of heat, most goes straight out the exhaust after giving up energy to the propeller shaft but some is retained by the 2nd stage parts, meaning it get very hot in the immediate area inside the cowl at the front of the airframe.

Allow plenty of propeller and forward flight airflow to be directed into the cowl area via openings and vents just as you would a petrol or glow engine and this will keep the area well ventilated and help prevent damage to surface finishes and/or paintwork. The ideal exit for this air is via side or lower vents and a large clearance around the exhaust outlets of at least 6mm/1/4” is ideal to allow good outflow and afford a limited amount of exhaust cooling. Be careful not to close off vent flow by the use of large spinners or back plates.

It is important as noted earlier to minimize this hot cowl air reaching the engine intake as it raises the engine running temperature significantly (an extra 1C at intake = approx 4C extra EGT), which is detrimental to reliability and sensitive electronics are housed in the front of the engine.

Any required side or down-thrust for the powerplant is usually built into the firewall, so once the engine unit has been positioned to place the propeller shaft in the centre of the cowl, the engine clearance hole and bolt mounting holes can be cut out using the template. Protect any exposed wood using fuel proofer.

Allow around 3mm/1/8” clearance between the end of the cowl and the back of the propeller. Add a spacer to the mounting position on the firewall if required, do not add a washer behind the propeller.

Exhaust extensions

As is also for the Heli engine, in normal operation the engine exhaust flow is continually expanding as it leaves the 2nd stage. Adding exhaust ducting beyond the exhaust outlets inhibits the exhaust expansion and causes local restrictions to the free flow, increasing the back pressure on the engine. This reduces the power available to run the engine and has to be made up by burning more fuel. This therefore significantly increases the running temperature and spoils the starting and running characteristics of the unit, so is strongly discouraged.

However, where the standard exhaust outlet does not quite reach beyond a particular cowl or where you want to turn the exhaust slightly to the rear for scale effect or streamlining, short simple Xicoy approved push-on exhaust stubs are acceptable provided they cause minimal disturbance to the engine flow. It is the longer lengths or significant changes in direction which cause back pressure and must be avoided.

Installing the TurboProp

1. Cut out holes for the exhaust, ideally positioned on any horizontal cowl split if there is one. Allow 6mm/1/4" clear all round.

2. Use M5 / no.10-32 nuts and bolts to fix the unit to the airframe, captive nuts are ideal. **Do Not** fix the engine unit in place with woodscrews, it is impossible to ensure they cannot loosen or pull through the firewall without warning.

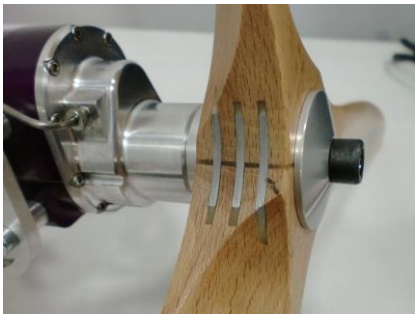
3. Fit a good quality (heat resistant) 3 wire type servo type cable from the small gearbox output electronic board to connect to the auxiliary socket on the small Hub board. It may be difficult to do this later.

When all is installed and powered up you can see a blue light on the small gearbox pcb which when the shaft is rotated flashes twice per revolution to show gear output shaft rpm signal present. When the gearbox is running fast the flashes indicate the bus updating rpm signal every second.

4. Offer the engine unit up to the firewall and secure in place with four screws, cap head type are ideal as access is challenging.

5. Fit a previously carefully balanced propeller with 10mm bore onto the shaft stub. See the chart on propeller selection to determine a suitable size. If you plan to use a spinner backplate, fit this 1st. For spinners Xicoy recommend "Truturn" prop backplates and spinners for their accuracy and careful balance. (bob@truturn.com). They have a wide range of adapters to suit the unit – just mention you have an M8x1.25 prop bolt and they should be able to help.

Important - *No attempt should be made to add material, lead shot or coloured sticky tape to balance the prop as this is sure to fly off later and if you are lucky it might not hurt someone, but the resulting out-of-balance running could cause major engine damage. If this happened in the air you would not know until it was too late. The warranty will not cover you for such damage.*



1. Fix prop (bore 10mm) in place using the supplied washer and prop bolt. If the prop bolt is too long or short an alternative standard M8 cap head type can be substituted. The shaft is threaded internally for a distance of 30mm (1-1/4") and it is best to have as much thread engaged in this as possible. This helps steady the retaining bolt and prevent wobble.

2. Rotate the propeller gently and eyeball the tips from the side to ensure tracking is precise, and correct if not. Any run-out of the tips while under power will generate severe unwanted vibration which can damage the engine.

3. Do the same with the propeller bolt, make sure its running true for the same reasons. Investigate any wobble and cure.

Propeller Selection (TurboProp)

The Xicoy TurboProp unit is useable to power in a wide variety of aircraft. Being available in two ratios enables users to select the most appropriate for the intended application. The turboprop unit has been tested in a range of situations and loads. The main indicator of the performance of the unit from the users point of view, is the rpm that can be achieved with a given propeller load. Larger propellers and/or more blades produce higher torque figures but not always the highest thrust figures.

We always recommend good quality wood props. Carbon are very nice but very unforgiving in a crash or nose-over. Make sure the propeller it is well balanced and the tips are visible (paint a strong colour) when running, they can bite hard.

As the Turboprop has two reduction options there are optimum propeller size ranges for each ratio.

High reduction, up to 6000rpm, ideal props 0.61-0.71m / 24-28".
Low reduction, up to 7400rpm, ideal props 0.51-0.61m / 20-24".

Higher rpms are achieved with smaller diameter propellers and / or shallow pitches. It is most important that propellers significantly smaller than listed are not used or if they are, maximum engine rpm should be lowered to prevent over speeding and possibly of overstressing (the propeller). In all cases follow the propeller manufacturer's recommendations for preparation and use.

Tipspeed

Most propellers are designed for a maximum tip speed around 200m/s or 655ft/sec. Above this the tips start to make that familiar howling noise. This can be just in a dive or most of the time if a prop with shallow pitch is fitted to a fast airframe with a powerful engine.

A rough guide to optimum tipspeed is calculated by 3820 / prop dia in mtrs.
So for example a 560mm (22") prop, max rpm would be 3820 / 0.56 = 6822rpm (low ratio gearbox)

For imperial measures 12,510 / prop dia in feet, or 150,100 / prop size in inches.
So for example a 26" (660mm) prop max rpm would be 150,100 / 26" = 5773 rpm. (High ratio gearbox)

In practice the best performance comes from *slightly* overloading the engine with a slightly over-sized or over pitched propeller. This gives lower rpm on the ground but this is recovered as soon as the plane has forward airspeed and enables the full power of the engine to be used. Of course it is perfectly possible that some props will not reach their maximum rpm in which case they are inherently self-limiting and quiet in operation.

General notes on propellers

All sizes are for 2 blades. If you want to use 3 or 4 blades, reduce by 50mm/2" on diameter:

Slow planes (Pilatus PC6 / Cessna high wing types) could ideally have a 28x10 or 28x12 pitch with 2 blades, and high ratio. Slow flying aerobatic planes can use the same.

Medium sports and scale plane like Pilatus PC7 / PC21 / Tucano needs a smaller diameter but larger pitch, a 24x14 or 26x12 with high ratio, or 22x12 or 24x12 on low ratio. The larger diameter and pitch enables plenty of thrust for good forward speed with a quiet operation and scale appearance.

Fast sleek plane needs a 20x18/20 or 22x14 pitch to get good forward airspeed with the low ratio gearbox. The larger pitch and smaller diameter allows a higher propeller rpm and corresponding high forward airspeed.

Prop-hanging requires large diameter and small pitch for high static thrust. Around 28x8 pitch is about right with high ratio gearbox. The forward speed will not be high but take-offs and climb outs should be brisk.

The dynamic thrust (when the aircraft is in flight) will reduce as aircraft airspeed increases and is a function of all propeller driven aircraft. However, it is worth reminding that the thrust on an unrestricted turbo-prop falls off more gradually than an I/C engine due to the fact that as the propeller load reduces due to forward speed ("unloading") the propeller rpm rises 15-20% to balance the torque supplied. This feature enables turbo-prop powered aircraft to achieve a higher forward speed than the static rpm suggests, or the same speed achieved for a reduced throttle setting, saving fuel.

As indicated, in the air the prop will unload quickly with rising airspeed so there is no need to push for maximum rpm on the ground. For example, a prop on the ground might give 5000rpm but rise to over 6,000rpm in the air. A propeller set to 6,000rpm on the ground may rise quickly above the point to which the overspeed limiter kicks in in the air and thus not give as good a performance as expected. The limiter action is soft and will gently ease back the max throttle as the rpm passes the threshold.

Adjusting engine power to limit maximum propeller rpm
When using a prop in the smaller sizes or pitches, there is the possibility the maximum rpm will come close to limiting in which case it is preferable to reduce the engine power slightly to match this smaller prop.
In the RUN menu there is a screen shown the propeller rpm together with the engine rpm. You can gently rev the engine to the prop rpm limit you have calculated and read off the engine speed required. You can then re-enter the RUN menu and reduce the maximum engine speed to that which gave you your optimum propeller rpm. You can then fly with confidence knowing the prop is operating safely.

Maximum forward airspeed is mainly a function of forward thrust against airframe drag. A sleek and slippery airframe will result in far greater airspeed on even modest power levels, whereas a large draggy airframe may fly slowly on even exceptional power. Different brands of prop also add their own differences, some appear draggier than others or appear to make less thrust on the ground, but work well in the air.

Ground Clearance.

If your plane has limited ground clearance then you can always go to 3 or 4 or even 5blade propellers. Is also a way to enable the engine to use all available power without rpm limiting. More pitch may not be ideal with a slower flying model however where shallower pitch will give better results.

Protections

The ECU has four protection functions to protect the 2nd stage components from overspeed: gentle overspeed, sudden excess overspeed, no rpm reading from start, loss of rpm reading during run.

1. Gentle overspeed
With a propeller slightly too small or pitch too shallow for the power used, the propeller rpm will rise either at standstill or during level flight or dive until it reaches an overspeed threshold. At this point

the ECU will gently ease back on the throttle signal to reduce engine power back to the rpm threshold. Higher speeds beyond this will result in a stronger reducing action.

2. Sudden drastic overspeed
A catastrophe like a nose over, striking of an obstruction resulting in prop breakage or sudden loss of propeller load at high or maximum power (perhaps during takeoff), can cause instant loss of load resulting in the 2nd stage to run unloaded and quickly overspeed. This sudden rpm increase will be seen by the ECU and will trigger immediate return of the throttle to idle and show an error message onscreen.

3. No rpm reading from start
In case of no gearbox rpm reading (RPM cable not connected, RPM cable damaged, RPM plug fallen out, rpm pcb misaligned due to damage) the ECU will prevent acceleration of the engine rpm above idle after the start, and shows an error.

4. Loss of rpm reading while running
If there is a loss of gearbox rpm reading while running, (rpm plug fallen out, rpm cable damaged, rpm pcb failed or misaligned due to obstruction) the ECU will return the engine to idle, prevent acceleration and show an error.

Full-size “Pilatus PC7” – an ideal modelling subject for your new turbo-prop – who will be the first?!

Component Installation Notes – All versions

Do NOT try to run the engine on its own. There is no need nor do we recommend attempting to run the engine outside of the airframe by way of functional test. With care, the turboprop can be run on a sturdy test stand with suitable propeller but there is no safe way to do so with the helicopter unit, and there is no need. The engine has already completed a programme of test cycles at the factory in controlled conditions. As this is not easy to do safely for your sake and can damage the engine unit by overheating or overstress we strongly recommend you don´t.

1) You should have a clear idea how to arrange all the components needed to run the engine inside the model. The main issues are fuel tank (locate centre of tank to CofG), bubble trap position (if used), locating the fuel pump in close proximity to the source of the fuel (bubble trap or tank) and adjusting the receiver and ECU batteries to achieve optimum location for balancing the model.

2) The 3-wire heavy connecting cable from the engine to the Hub should be carefully routed away from the engine intake so there is no possibility of the wire being accidentally ingested if the FOD screen should be displaced for any reason. This is 250mm (10”) on the Heli and 500mm (20”) on the Turboprop. Please do not modify it if not quite right, ask for a longer or shorter one if required. Avoid placing the cable close to the engine rpm sensor which is located at approximately 4 O´clock when viewed at the intake of the engine with the cable entry plug at 12 O´clock. A cable too close can cause some rpm interference at start-up. The same goes for any servo wires or servos passing near.

3) The 4mm fuel feed pipe should be routed similarly clear of the intake. Try to have at least 200mm/8” of fuel feed pipe to the engine. Note the connector is indicated with an “F”.

4) The metal lubrication feedpipe to the gearbox, exits the engine via the connector marked “L”.

Be sure NOT to accidentally connect the fuel feed to this if removed.

5) The other end of the engine cable should plug into the small Hub connector unit sited at a convenient (cool) location for access. You can use the regular small Hub (Hub Lite) or the Compact Hub with the screen built on, both have same function. This is also the location to connect the ECU battery.

6) If you plan to use telemetry adapter it should plug into the outlet marked “Data” on either Hub unit. Mount it somewhere away from heat, and visible if desired. If also using the colour display you can connect both using a Y lead.

7) The signal cable from the gearbox rpm sensor should be plugged in alongside the pump outlet with the same orientation. On the Compact Hub it is marked “Aux”. There is no specific marking on the Hub Lite but it should go below the pump outlet.

8) If the ECU battery has to be sited at some distance perhaps in the tail for a heli, please contact Xicoy and ask for a longer cable in one piece. Please don´t cut it and splice in a couple of old bits of wire to make it longer as this is surely a recipe for troubles and is a regular candidate on engines presented for service. A heavy duty extension can be used but check polarity before plugging in. It’s always better to have a longer single piece cable for minimum volt drop and maximum reliability.

9) The ECU battery should ideally be sited somewhere it can be easily accessed. It is good practice to disconnect after flight or before travelling anywhere with the model.
Note it is extremely important to disconnect the battery whilst charging, *as the usual pulse type charger can easily destroy the ECU, and is in any case a sensible precaution with rechargeable batteries*.

10) The centre of the fuel tank should be located as close to the centre of gravity (CofG) of the model as possible. This will minimize the effects of the CofG shifting as the fuel is used during the flight.

11) The fuel tank should have an effective fuel pickup, like a felt clunk or felt bag over a weighted clunk to ensure no air is pulled into the fuel feed. A UAT or similar can be used.

A bubble-trap type hopper tank system is highly recommended (and available in the Xicoy Jet Shop). The bubble-trap outlet feeds direct to the inlet to the filter. If using an air trap which has a fine bag type filter then the external filter *CAN* be omitted but beware the pump is vulnerable to particles getting in between bubble trap and pump inlet, so aim to be squeaky clean with the installation.

12) A tank capacity of around 800cc/30oz to 1000cc/35oz is suitable for 6-10mins flying for helicopters, and 1200cc/40oz to 1500cc/50oz suitable for the same times on turboprops.

13) The fuel pump should be located close to the fuel tank as convenient. The pump has two 3mm screw fixing holes provided for mounting to the airframe. Try not to mount the pump in close proximity to the front of the engine as being a brushless motor it might interfere with the rpm reading. If you want to fit a manual shutoff, fit a Festo 4mm ball valve type in the suction side and locate it somewhere easy to see and get to.

14) To prime the fuel system, disconnect the fuel pipe at the engine and route it into a suitable container. Run the fuel pump for a few seconds using the Pump Prime function accessed via the INFO menu. Note the ECU battery must be connected to do this. This will help clear any air and particles that could have entered the fuel system during installation.

15) If refitting a quick release “Festo” connection, trim the last 6mm (1/4”) from the end of the tube to expose a fresh area for the connector to seal onto. To release a “Festo” type connection, push the blue ring inwards with one hand and gently pull the tube out with the other hand, whilst holding the collar in its retracted position.

16) If using “Tygon” flexible piping from fuel tank push on a short (12mm/1/2”) length of the supplied 4mm pipe onto the pump suction port and push the “Tygon” over the top to provide a tight leak free fitting. A double wrap of lock-wire will ensure secure connection. Otherwise, use the 4mm piping supplied. *DO NOT use nylon tie wraps anywhere on the fuel system. Be aware Tygon gradually softens in use so should be replaced annually.*

17) DO NOT use “Tygon” flexible piping anywhere for the pressure (delivery) side; it is only suitable on the suction side. Also DO NOT use silicon tube anywhere in the fuel system as the fuel will melt it.

18) Any air inlet openings to the engine intake should have area equivalent to 60mm x 60mm / 2”x2”“.

19) Extreme care should be taken to avoid the possibility of foreign objects, loose parts or debris being allowed to enter the engine either during installation or while flying. Always use the supplied FOD screen but regard this as a last line of defence and not as a reason not to practice good housekeeping. Before filling the tank and starting the engine for the first time, turn the model upside down and give it a good shake and hoover out to loosen and clear any small bits and pieces.

20) Always use the supplied FOD screen, it protects the engine from sucking in small objects that could damage the delicate high speed compressor blades.

21) We recommend test flying the engine in the airframe without bodyshell or cowl fitted for 1st test flights.

22) *Do not* under any circumstances try to run the fuel pump by plugging it into any other brushless controlller or similar type 3-phase driver. It does not work like that and you will destroy its internal electronics in the process.

The supplied FOD screen is essential to protect the engine, USE IT!

Safety Notes

Please remember that though this engine is small and compact it is most definitely NOT a toy and has the potential to hurt you or others around you if misused. The engine unit is a very high performance machine in miniature and must always be treated with a high level of care and safety when in your operation.

It is your responsibility as owner, to ensure safe and considerate operation at all times and conforming to the word and spirit of this User Manual. By running this engine you agree to assume full responsibility for its safe operation.

If you sell or transfer this engine, please pass this User Manual or web link to the new owner.

The following guidelines should be read carefully and followed:

- Before attempting any engine starting, set up your transmitter to the ECU carefully. Confirm you have full control of the ECU and engine before attempting any flying.
- Never try to run the engine in an indoor or enclosed environment.
- In event of any problem requiring engine stopping, stick down, trim down immediately.
- Always keep a C02 or similar gaseous fire extinguisher of at least 2kg contents close to hand when starting and operating the engine. Do not use a powder extinguisher unless of last resort as the abrasive powder will ruin the engine if it used.
- Just before starting, perform a visual check to ensure the immediate area is clear of spectators and that anyone nearby knows of your intention and to stand clear.
- Safest place to stand to start the engine for either heli or turboprop is to the rear.
- Be especially aware this engine is fast to start, stand well clear, initiate only when in a safe position with the aircraft restrained if turboprop, or on a heli to be ready to correct any tail swing that could develop if clutch starts to engage suddenly.
- Note this engine is fast to spool to maximum power, use the throttle control smoothly and gradually on raising from idle.
- Do not start the engine whilst restraining the rotor blades or propeller.
- If any problem develops during starting, stop the engine immediately before investigating.
- The engine, exhaust and gearbox WILL be very hot while running and immediately after, so please don´t touch.
- Keep clear anything affected by heat away from the engine, especially the exhaust area.
- Don´t run the engine anywhere near a source of flammable gases, liquids or materials.
- Don´t run the engine or fly the engine in wooded or crop or other high fire risk areas.
- Keep spectators, children and animals clear of starting area (10mtrs (30ft) radius away).
- Always handle turbine fuel and oil with care as they are flammable and can cause a reaction with sensitive skin. Store them in clearly marked containers and always dispose appropriately. Use protective gloves when mixing and decanting fuel and oils. Avoid all skin, eye, mouth or ingestion contact with the liquids and ensure any spillage is wiped up immediately. Clean any affected area with warm soapy water. Wash hands and any effected part immediately after any contact.

❿ Excess priming or failing of the starter burner can result in pooling of fuel inside the engine which could cause excess flaming in event of subsequent ignition. The only method to clear the engine is to remove the fod screen and tip it to allow excess to escape through the front of the engine. Mop up with a rag. Tipping it backwards will not work as the internal construction of the engine prevents any liquid draining out to the exhausts.

❿ The engine has its own internal starting system and does not require any assistance or priming to operate. So please do not try to assist it to start quicker or easier by administering any flammable agents, sprays or similar, into the engine in the belief it will start better. It won´t.

General Notes

Unauthorised opening of the engine will void the warranty. The engine also features an internal thermocouple. This avoids the danger to this delicate component being outside the engine from the usual knocks and bumps associated with engine install and refit. If the thermocouple needs attention please refer to nearest Service Agent or direct to Xicoy Electronica SL.

The engine starter is a high speed brushless unit. The power driver for this is part of the ECU. You cannot replace this with anything else. You can power the starter separately using the “starter test” function. If engine has just been run you need to reset the engine before any starter test. The starter is accessible in event of attention can be easily replaced. The small clutch fitted to the starter motor has a small O-ring which may wear in service. It is also easily replaced if required.

Please note that the accessories used for this engine use the simple 3-wire servo type cable connection. This includes the fuel pump, display, sensors, telemetry adapters etc. In all cases the third wire (usually orange or white) is a digital signal line so DC power should not be applied to this line or attempts made to read the voltage on this line for fault-finding purposes.

ECU Battery

The engine has been designed to use a 2s Lipo battery for power and all factory tests on all engines are performed at a nominal 8v.

3S LiFe batteries are allowed in the case that 2s Lipo can’t be used, but if possible use 2s Lipo to lengthen the glow plug service life. Using a higher battery voltage than 10V will damage the ECU.

Use at least 25C batteries, there is no upper limit. Do not use other battery types like LiIon, these batteries cannot deliver the peak amperage (20A) necessary for starting.

Consumption
In mAh battery use, on average the engine uses:

About 100mAh for startup,
About 20mAh for each minute running,
About 40mAh for cooling after a run.

A typical eight minute flight consisting of a start, normal flight and shutdown will consume:

100+(8x20)+40 = 300mAh

Be sure to always disconnect the battery for charging. Most chargers use a high voltage pulse system which can destroy the ECU.

Auto battery disconnect
The receiver may be turned off as soon as the aircraft is retrieved from flight, the Hub unit will ensure the cooldown continues until the end. The Hub will then disconnect the battery after the end of the cooldown.

When the receiver is turned back on, the Hub unit will reconnect the battery. At the end of the flying day it is good practice to disconnect the ECU battery *just in case*.

Fuel

The engine use Kerosene fuel only.
Recommended Kerosene fuel is the odourless refined Kerosene (some countries call it ”Paraffin”) used in home stoves, there are different commercial brands like “keroclair”, “Ptx200”, “Petroleum” as it is very clean and burns without smell.

JetA1 will work the same but should be carefully filtered before use, but its odour can be offensive during model storage.

Oil

The engine requires oil for lubricating bearings. This should be mixed at 4% with the fuel and all lubricating is then automatically metered and applied by the engine internal components.

If you use a 20ltr fuel bottle then add 0.8l of oil. For every 3 gallons of fuel add 1 pint of oil.

Recommended commercial oil is **Deluxe Power Model Jet Oil.** Other commercial turbine oils like Kingtech oil, Fuchs… can be used. Don’t use Jetcat oil or Jackadofsky oil on the X45. These cause a lot of bearing drag when cold causing difficult or impossible start-up.
Also it can be used a mix of 3% of ISO32 type of oil, (commercial brands like Mobil DTE Lite, Shell Tellus 32, Igol 32, Cepsa Turbine 32, etc) *plus 1% of 100% **synthetic** 2 stroke oil*. Plenty of commercial brands 2T oil are available locally, just check in the bottle that the oil is JASO FC or JASO FD compliant.

It is allowed to use a 5% of oil contents for compatibility with other engine brands; this will cause a higher fuel consumption and increased possibility of internal carbon building. Use 4% if not using the recommended oil.
Full size turbine oils can be used, but are not recommended because these oils are not intended to be burned; they are irritant and contain neurotoxic chemicals such as tricresyl phosphate that in long term could impact negatively on the health of operators and other persons breathing the exhaust fumes.
Aeroshell 500 should not be used at all due to high residues left on bearings.
Do not use 2 stroke oil alone (4%). This will gum the bearings causing difficult or impossible start-up when engine is cold.

Please refer to the Xicoy Office for guidance in the first instance in event of any issue or concern.

Engine Description

Engine

The heart of the engine is a miniature turbojet designed produced specifically to produce a gas flow to drive a 2nd turbine to generate a shaft drive to power small model aircraft. It has a single stage billet machined centrifugal compressor and single stage cast Inconel axial flow turbine. The engine is fitted with an internal ceramic glowplug which enables the engine to initiate combustion directly on liquid fuel after which further fuel is gradually introduced into the main part of the combustion chamber to provide combustion heat to operate the engine.

A high speed brushless electric starter motor fitted with a clutch mechanism provides drive to the rotor all the way up to 60,000rpm idle for starting the engine. The starting sequence is controlled by an electronic system fitted to the engine (ECU) which initiates the start sequence and controls the parameters of the engine within design limits.

The engine rotor shaft is supported by ceramic bearings, lubricated by a small percentage bleed off the pressurized main fuel supply, which is added a small percentage of oil for this purpose. The rotor discs are separately balanced and then 2-stage dynamically balanced on assembly to the engine. Disturbing the rotor will lose this delicate balance and the engine will need to be returned to a service unit for rebalancing.

2nd Stage

The 2nd stage is the part which converts the fast gas flow from the engine to a shaft drive to power an external load. It has three major parts, the interstage stator, the power turbine and the support. The interstage and support are high temperature stainless and the power turbine is of Inconel and is blown round at high speed by the gas flow which is angled in direction by the interstage vanes. The support holds the power turbine bearing in the centre.

The power turbine is mounted on a shaft with substantial ceramic bearings and drives the gearbox to which it is connected. The orientation and reduction in the gearbox is dependent on the application. The heli unit uses a right angle single stage spiral bevel reduction; the turboprop uses a horizontal 2 stage spur gear reduction. All gears are fully hardened for long life. The 2nd part of the turboprop gear reduction is available with two ratios to facilitate large or small reduction ratios for different prop drive regimes.

The gearbox of both versions uses a magnetic pickup to read output shaft rpm. This rpm signal is connected to the ECU via the Aux input on the Hub and used to monitor shaft speed conditions and detect potential anomalies which either require some limiting or protection function or action, a constant speed function or some protection function.

These conditions and adjustments which can be made to them are described in more detail later. The rpm pickup receives signals from magnets embedded in the prop driver rear face (TP) or internally mounted collar (Heli).

Lubrication for the 2nd stage and gearbox is taken from a bleed off the main fuel supply, plus a small air pressure feed to maintain a positive pressure in the gearbox. These are mixed and output via the 2nd 4mm swivel fitting on left side of the engine. A small pipe conveys this mixture to an injection point on the gearbox.

Never run the engine without this pipe properly in position as 2nd stage bearings and gears will be severely damaged within a short time (30secs) running.

Engine Control

The fuel for the engine is provided from a fuel tank and fed through a small pump driven by a 3-phase (brushless) motor that has its own intelligent control. The engine speed between idle and maximum is controlled by varying the speed of the fuel pump rotor by command from the electronic device called an ECU (Electronic Control Unit), a small computer that is mounted under the front cover of the engine.

This sends commands to the fuel pump via a connector board (Hub) to turn at a certain rpm (and therefore flow rate) to deliver a precise amount of fuel and the fuel pump automatically adjusts itself to this rate.

The communication between the ECU and fuel pump and all other function accessories, display, telemetry etc is via a single wire bidirectional digital data link, no analogue voltages are used and operation is not voltage sensitive as long as sufficient voltage is maintained for digital signals to be read.

To control the admission of fuel to the burner and main combustion chamber there are two miniature electric valves attached to the front of the engine under the cover and also the 4mm quick-release fuel feed connection. The valves are connected to and controlled by the ECU as required by the starting sequence.

The 2nd 4mm fuel feed connector is the fuel/air connector to gearbox and should already have the lube pipe installed. PLEASE NOTE: This is NOT interchangeable with the main fuel connection, so do not swap them.

Component Description

ECU (Engine Control Unit)

The electronic controller is in the form of a small C-shaped circuit board fitted under the front cover of the engine. It directly controls the two fuel valves, the brushless starter motor and internal glowplug. Two of the three wires in the 3-cable are the power for these. It is connected via the 3-wire cable which plugs into the engine and a small connector board called the “Hub” externally (also available with built in display called the “Compact Hub”). The Hub acts as a clearing house for ECU data and the outside world. The three wires are just plus (+) minus (–) and data. The signals in and out of the ECU are via bidirectional digital data link, no analogue connection to the outside world is required, or possible.

Flight data can be stored by using a regular micro SD card plugged into the small colour display mounted in the aircraft to store many additional hours of operation which can be reviewed using a simple PC viewer.

The ECU is programmed specifically with the engine operating characteristics, start parameters, throttle curves and operating routines. Some of these are user settable like the radio setup and maximum power settings which are accessed or modified via a menu system on a display. The display can be the full colour backlit version (Hub “Lite”) which plugs into the Hub, or directly on the Compact Hub black and white display. Both have adjuster buttons and can be mounted in your model to eliminate the need to plug in anything. The colour screen is very bright making it easy to observe the start-up on the display from a short distance through a canopy, for instance.

Connector board, the “Hub Lite” and “Compact Hub”

To enable connection of the power supply and signals to and from the outside world to the ECU, a small component which we call the “Hub” is provided. There are two types, the “Hub Lite” is a small shrink wrapped flat board, the “Compact Hub” is housed in a small box and includes a small integrated LCD backlit display.

Both Hubs form the connecting point for:
The receiver throttle signal (max voltage 10v)
ECU battery (volts 7.4 – 9.9v)
Fuel pump
ECU on the engine
Any additional display used separately plugged in
Additional input sensors such as rpm from a 2nd stage
Additional output devices such as telemetry.

Auto Power-Off

The Hub has intelligence of its own in that it can take a signal from the ECU and isolate (power down) the ECU battery after a cooldown has completed and the receiver turned off. The ECU will complete the cooldown process even if the receiver is turned off, it does not need a radio signal to do this. This saves the battery in the transmitter and receiver and helps stop the possibility of leaving them on for long periods accidentally.

Ambient Sensors

The Hub unit (Compact and Lite) contain ambient sensors to measure temperature and pressure and use these to provide the ECU with data to enable it to automatically adjust for ambient air density conditions. These include automatically adjustment of starting parameters, acceleration and deceleration rates, and idle rpm setting. Where an “Auto” option in any menu is offered, the ECU will use the Hub data to adjust the setting to the most appropriate for the conditions.

Positioning the Hub Lite or Compact

Site the Hub unit in a location away from direct exhaust or sunlight heating as otherwise its ambient sensors will tell the ECU it is a hot day and moderate settings appropriately.

The Hub communicates via digital link to the ECU, there are no analogue signals used. The Hub has a printed panel showing where each cable goes and the orientation of each plug. For all cables, if you need a longer or shorter version than supplied, please contact Xicoy. Do not cut or splice in extra wire. If you are using the full colour plug-in display this is also plugged in here. The gearbox rpm sensor is also plugged in here.

The ECU battery should be connected directly to the Hub, no switches, electronic regulators, diodes etc. Multiple battery operation using “Y” lead is possible but at least one battery must be directly connected.

Auto battery recognition
A new addition is automatic detection and accommodation for 7.4v LiPo (recommended) and 9.9v 3-cell LiFe batteries. The ECU detects the battery voltage at plug in, and automatically adjusts the functions to reduce the additional voltage available.

Fuel Pump

As mentioned previously, the fuel pump has been specially designed for this application and is unique in many ways. It is extremely small in size and weight but is much more sophisticated than its looks suggest. There is not the usual fixed cable with socket but a small plug built into the pump which enables a regular high quality JR type servo cable to be used as the pump cable (socket at both ends). This way its easy to get just the right length you need without cutting or extending the wire.

Note: the three wires are NOT the 3phases usually used for a brushless motor. The three wires are for the plus and minus power supply, and a single wire bidirectional digital link.

Construction A solid aluminium housing encloses the motor and pump elements. A pair of nipples provide a secure connection for 4mm piping at inlet and outlet. Two tapped M3 holes in the body provide a secure mounting location for a neat and tidy installation. Never disassemble the pump, it has an extremely delicate internal structure and you will void its warranty.

Operation The difference between this pump and most other turbine pumps is that it also has its own tiny brushless 3-phase driver included within the pump housing. The motor is not a slave to an external driver or an open loop dc motor driven by an external voltage, but has its own sophisticated controller and driver built in.

Please note, you must not try to run the pump by plugging this 3-wire cable into any brushless (3-phase) driver, the controller will be immediately destroyed.

Pump pre-setting The pump initial flow rate is set at the factory with the engine by simply setting the minimum rpm it produces sufficient heating from the burner for a start. This is the only required adjustment. Once set, the user needs make no adjustment to pump commands. Being based on a powerful brushless motor it does not suffer from sticky seals or variable speeds due to atmospherics or fuel densities unlike regular DC motor based pumps, so it no need any regular adjustment.

Applying a DC voltage to the fuel pump will not make it run so please do not try it. Modifying the cable and reverse connecting the polarity of the power supply wires will also not make it run but may destroy the internal pump controller, so don´t risk ruining your pump by modifying your cable, just get the right length you need.

ECU Display

There are two display options depending on which package you select, Compact or Lite.

The Compact Hub is a Hub and screen combined in one box. It has its own buttons and is backlit. This type does not record flight data.
It weighs 22g/0.77oz.

The Lite option includes the small shrink-wrapped Hub and separate colour display connected via a servo type lead. This can be plugged into the Hub as required for making adjustments and then unplugged, or can be connected and permanently installed in the airframe where it will record flight data (see below).
The small Hub and screen together weigh 28g/1oz

Both displays include dedicated screens for engine operation, radio checking, last shutdown cause and other special turbine operations.

Hub Lite data record / playback

(Note, this function requires the Hub Lite colour display to be mounted in the model)

One innovative and useful function is the internal recorder/playback function which is contained in the Hub Lite colour display. If mounted on the airframe the colour display continuously stores all the data received from the ECU, keeping in its permanent memory all the data of last 66 minutes of engine run, without the need of a memory card.

After flight the display can be removed from the airframe and be powered up with a receiver type battery and the data stored can be played back in real time, same presentation as if the engine was running.

Playback mode can be still, forward or reverse, speed x1, x 10 and x100 in both directions, so can be easy to view the engine operation or investigate any issue at the field without the need of a computer or any other type of reader.

All the data, including all engine parameters, can be saved later to a memory card, where it can be read using a text editor, or our viewer software. Also this data can be sent to Xicoy to be studied.

The function of the buttons is described later in the “ECU setup”

Plug-In backlit display

Display Screens available on the Plug-in backlit colour display:

Initial Screen

Initial screen with Xicoy logo.
Button Tools, to visualize menu.
Button HDT, to visualize fadec data.

HDT Screen

Button Back x , to go initial screen.
Data from FADEC.
Buttons to navigate through FADEC menus.

Tools Screen

ButtonBack x, to go initial screen.
Button Player to go Player.
Radio Check to go Radio Check.
Button Last Shutdown to go Last Shutdown.
Button File to go File.

Radio Screen

ButtonBack x, to go initial screen.
Radio Check Screen to visualize the set points: Full Power, Stop & Idle.

File Screen

ButtonBack x, to go initial screen.
Button Save Data to export the data to uSD.
Button Update to update the firmware of the display.

Player Screen

ButtonBack x, to go initial screen.
Button Play Last Run to visualize last run.
Button Play From to visualize stored data.

Last Shutdown Screen

ButtonBack x, to go initial screen.
Last Shutdown screen to visualize the last shutdown cause, RPM, Temperature and pump on shutdown.

Navigating Menu Screens

The screen display is straight forward to navigate once you get the hang of it. We use the backlit display but the Compact Hub display is very similar, just follow the buttons.

	Start by plugging in the display to see the open screen. Note there are four buttons underneath the dials, < > - +. Navigate through menus by following the prompts on the screen and pressing the button beneath the prompt.
	Press the > button, 2nd in from left. You will then see a screen showing 4 items: the radio signal (Pulse 0 xxxx uS), the throttle stick percent (x %), the battery voltage (vb=x.x V) and the current draw (Ib x.x A) “x” = any number
	Press the > button again. You now see the four main menu root choices: **Start Info Radio Run** Press the button beneath the START label
	You now enter the stream which covers the starting functions. Press the > button to enter.
	You now see the fuel choice option. Your choice here is Kerosene only. Press the > button to continue

	Next is the setting for minimum pump speed during the start. Only adjust this if the combustion is slow to get going. 125 is the default and it increments at 25 a time with + and – buttons. Too high a setting will make flames at the starting. Press the > button to continue
	Now we come to Glow Plug Power. It should be set as low as possible to still function. *Default is 6 / 6.2v* Only adjust this +/- if the glowplug is not able to ignite the fuel. This could be seen by a hissing sound at the start and white smoke from exhaust. In this case, adjust upwards by 0.2v Having too high a setting shortens the life of the glowplug.
	There are no more functions to adjust in this branch so exit by pressing > until you return to the opening screen. Press the > button twice to get back to the main navigation Menu. Press the button under the INFO option
	Timer screen. TimerServ shows the total runtime on the engine. Last shows the duration of the last run in secs, and (Cy) the total number of times the engine has reached idle on a start.
	RX Errors screen This shows any time when the receiver signal has been lost or outside the normal range, glitches etc, during the last run. Normally shows 0 or low number. Is reset each new start.

	Total time counter. This screen shows the total runtime in hours of the engine since last reset. It also shows engine serial number and software version.
	Test starter screen. This screen is used to test the action of the starter by pressing the button under the “On”. Note the ECU should be in stick-down, trim down position. If engine has just completed a cooldown the ECU needs to be reset to re-enable this function. Use sparingly as it can cook the starter motor and electronics.
	Test Glow-plug screen. Use this function to check the glowplug operation by pressing button under the “On”. Use only briefly, you can normally hear a small squeek when activated and a hissing sound from inside the engine. Beware sometimes a “woomf” of small flame can appear at the exhausts if any residual fuel left. Again, use only a few seconds.

	Test/Prime Pump screen. Use this function to fill the fuel line on a new installation of after the feed pipe has emptied. Disconnect from engine and prime into a rag to clear any particles, and then connect. Do not prime into the engine, it is not needed and can make a flame on start-up.
	Test Gas Valve. We don´t use gas any more but this screen refers to the valve supplying the kero burner used to start the engine. The only test you can do is press the button beneath the “On” and you hear a click from the front of the engine, to signal all is ok. Is a rarely used function.
	Test Fuel Valve. This test refers to the valve supplying the main fuel supply to the combustion chamber of the engine. The only test you can do is press the button beneath the “On” and you hear a click from the front of the engine, to signal all is ok. Is a rarely used function. Return now to the main navigation menu.

	Choose now the RADIO option. You have a choice now to enter the menu for setting up the transmitter, or proceeding to other options. The transmitter setup is show in the relevant section in detail, so now choose the “No” option.
	THRUST CURVE. You now get to the setting for thrust curve (as indicated in the chart). This is used for Turboprops or Helis (with the governor turned off). You have three choices: Linear Half Expo Full Expo Choose the one you prefer after tests.
	The last item in the Radio menu options is Restart. Use the +/- buttons to toggle. *Default is OFF.* For Helis you can select Off or Manual For TurboProps you can select Off, Manual or Automatic ***Read the section on Restart carefully before enabling this function.*** Return now to the main navigation menu and choose RUN
	RUN Menu. This menu is used to access all adjustable settings used for when the engine is running.
	Full Power Screen. This shows the maximum power setting corresponding to full throttle to the engine. It shows shaft output power in Kw and HP and nominal engine rpm for that setting. You can reduce or increase the maximum setting within the application limits, by using the +/- buttons. For helis, be careful to set a maximum power slightly higher than might be requested by the governor or headspeed won´t be maintained.

	Idle Speed screen. This is preset at Auto, normally 60,000rpm, which allows the ECU to modify the setting in response to atmospheric conditions. In hot or conditions of high altitude or low air pressure the ECU will raise this value. You can see any change the ECU has made by checking this screen.
	Ambient Acceleration. This is a setting which decides the rate of acceleration of the engine. Default is Auto. ECU decides optimum for current conditions. In case of acceleration problems, the setting can be switched to manual preset of Cold, Mild, Warm or Hot. Each is a slightly longer acceleration ramp.
	Ambient Deceleration. This is a setting which decides the rate of deceleration of the engine. *Default is Auto.* ECU decides optimum for current conditions. In case of acceleration problems, the setting can be switched to manual preset of Cold, Mild, Warm or Hot. Each is a slightly longer deceleration ramp.
	***(HELI ONLY)*** Governor. The next screen is for the and shows the governor setting for rotor head RPM. ***Default is 0 meaning OFF.*** The governor is disabled with a setting of 0, when rotor speed will track the throttle stick movement. The governor is enabled when you preset a value between 800 and 2400. The throttle should be increased until this rpm is reached when the governor will lock in. Lower the throttle stick to regain unlock governor control.
	***(HELI ONLY)*** Heli Gearbox Ratio. ***Default preset is 8.2:1*** This setting is where you input your reduction ration used on your heli between the gearbox output shaft and rotor head. For many helis it is around 8.2 so this is the default, modify with */- buttons to suit your application.

(TurboProp Only) Combined Propeller / Engine RPM Screen

Instead of the Heli Governor screen there is a split screen showing PropSpeed and gearbox temperature, and below that is engine RPM.

Is used to compare engine speed to prop speed for information or performance comparisons.
Can also be used to determine max engine speed for a given prop size and give an RPM derating if required. *Buttons not used.*

Engine Installation: Electrical connections

All versions of the X45 are very simple to install but main thing to be very careful of is any cable or battery connector which is not standard or has been modified in some way, as this can risk reverse connection of power supply which will easily destroy ECU and other components, so please be extra vigilant before using junkbox cables and/or adapters.

For the heli engine we have supplied a short engine cable of 250mm (10”) as there is usually just a short distance to go in any direction in a helicopter airframe. All the servo type connectors are just double end socket type as available in many outlets. Be careful to select JR type compatible leads as the pin sizes for Futaba can be smaller, thus making a looser and troublesome connection.

It´s always best to use those supplied in the engine package which have been used in setting the engine up for its factory tests.

Please don´t give in to temptation. If you don´t have the recommended type battery, please obtain one of the recommended types (2S LiPo recommended) Do not risk ruining your engine by trying to get it going by using a mains type power supply which makes no sense anyway with a helicopter. Such a power supply would have to be very smooth (regulated) and capable of very high peak current at the exact recommended output voltage and such units are rare. A battery charger or similar will almost certainly be unregulated and have high voltage peaks which will destroy the components of the engine, and such use invalidates your warranty.

Just order yourself a good, high quality battery of the recommended type and use the wait for it to arrive by checking through your installation and these notes.

When it does arrive **please double check the polarity of the connector supplied before plugging in.**

A reverse polarity battery connection WILL destroy the ECU and engine components.

The very briefest of puffs of smoke is all the notice you will get you have killed the ECU

Shared ECU battery

With small and light installations there may be the temptation to dispense with the receiver battery and run the receiver using a regulator from the ECU battery.

This is an absolute No-No, strongly discouraged and is surely an incident/accident waiting to happen sooner than later.

The receiver needs to be able to power many servos at once and its supply voltage will vary considerably as the servos are driven. It would be so easy for the varying supply to subsequently cause what is known as a “brown-out”, a short dip in supply voltage that causes the ECU to suspend operation or reset itself.

In either case it will shut off the engine, which is very bad news for heli fliers in particular as an impromptu autorotation practice will result, so please don´t do sharing the battery, keep receiver and ECU powered securely and separately.

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ECU Setup

The ECU is contained on the engine. All the operating parameters relating to the starting and running of the engine are contained in its memory. All communications with the outside world occurs through the cable connected to the external Hub unit. The signal from the user's radio receiver throttle channel is used to initiate and control all functions relating to engine operation.

Interaction with the ECU and modifying or adjusting of any parameter or setting is done via buttons on a display unit, also plugged into the Hub or on the Compact Hub.

The ECU on the engine and all its components have been carefully programmed and tested together at the factory. They are then subject to rigorously testing together to ensure they all operate as expected so there is very little for the user to do to get the engine operational beyond the installation process and align the transmitter to the ECU

Once the engine is correctly installed and the components of the fuel system are fitted and connected up, the ECU should be aligned to the radio system. This is a simple procedure which should be done whenever your radio is programmed for a model, or the engine is new or returned from service or repair.

Heli Radio Special Notes

On a Heli *without* a head speed governor, throttle and pitch functions would be mixed together as a throttle/pitch curve in transmitter and maximum power may correspond to maximum pitch.

If the control is a manually controlled knob or slider this can be operated smoothly and gently by the operator to avoid tail-swing as rpm increases. If it is a switch the action needs to be slowed to enable a smooth throttle up to flight power, say over 10seconds, the same for the switch-down function back to idle which should also be gentle. This is usually easy to arrange on modern helicopter radios.

Without this gentle transition the heli will show excessive tendency to uncontrolled tail-swing or pirouette on the ground as to perform a satisfactory governor function the engine must be able to act on control inputs very fast.

The slow ramps up and down of the Idle-Up switch should be disabled for the purposes of setting the transmitter to the ECU.

So for a heli radio your three functions for setting to the ECU are:

1. engine cut set to off, idle-up control set to full idle-up, *equivalent to "trim up, stick up"*
2. engine cut set to on, *equivalent to "stick down, trim down"*
3. engine cut set to off, idle-up control set to idle, *equivalent to "stick down, trim up"*

Follow the graphic over the page to enter settings.

Turboprop radio setup

There are no special conditions needed for the turboprop as it uses the regular throttle stick in the normal way. Follow the graphic below.

Pre-setting Radio to ECU

Confirm you have connected the ECU signal input to the throttle channel on your receiver.
Confirm you have connected the gearbox cable to the HUB and have a blue light which flashes on rotation of the gearbox shaft or prop.

Connect the display to the Hub if your system is a Hub Lite or use buttons on the case for Compact Hub.

To navigate through the menus the two left buttons move up and down the menus, the two right buttons increase and decrease the value set. When setting up transmitter setting use the plus button to confirm. On all other adjustments there is no need to confirm any change of setting as changing a value automatically updates it.

Connect the ECU and receiver batteries and note the display screen illuminates.
Remove rates, mixes, and throttle travel settings in the transmitter.

Before doing any adjustment on the ECU check your transmitter is sending correct signal by checking the reading on the display:

From the opening screen, press the 2nd button from left once to show an information screen.
Note at top left a number showing the received radio signal shown as “Pulse = xxxxuS”.

It should be between 900-1050uS at ENGINE STOP position,
It should be between 1100 and 1300uS at IDLE position
And between 1800 and 2200uS at Full Power position.

Ignore the % reading to the top right for the moment.

Please note these readings are measured directly from the signal received from your R/C system, so you should readjust your transmitter if the values read are outside that the ones suggested.

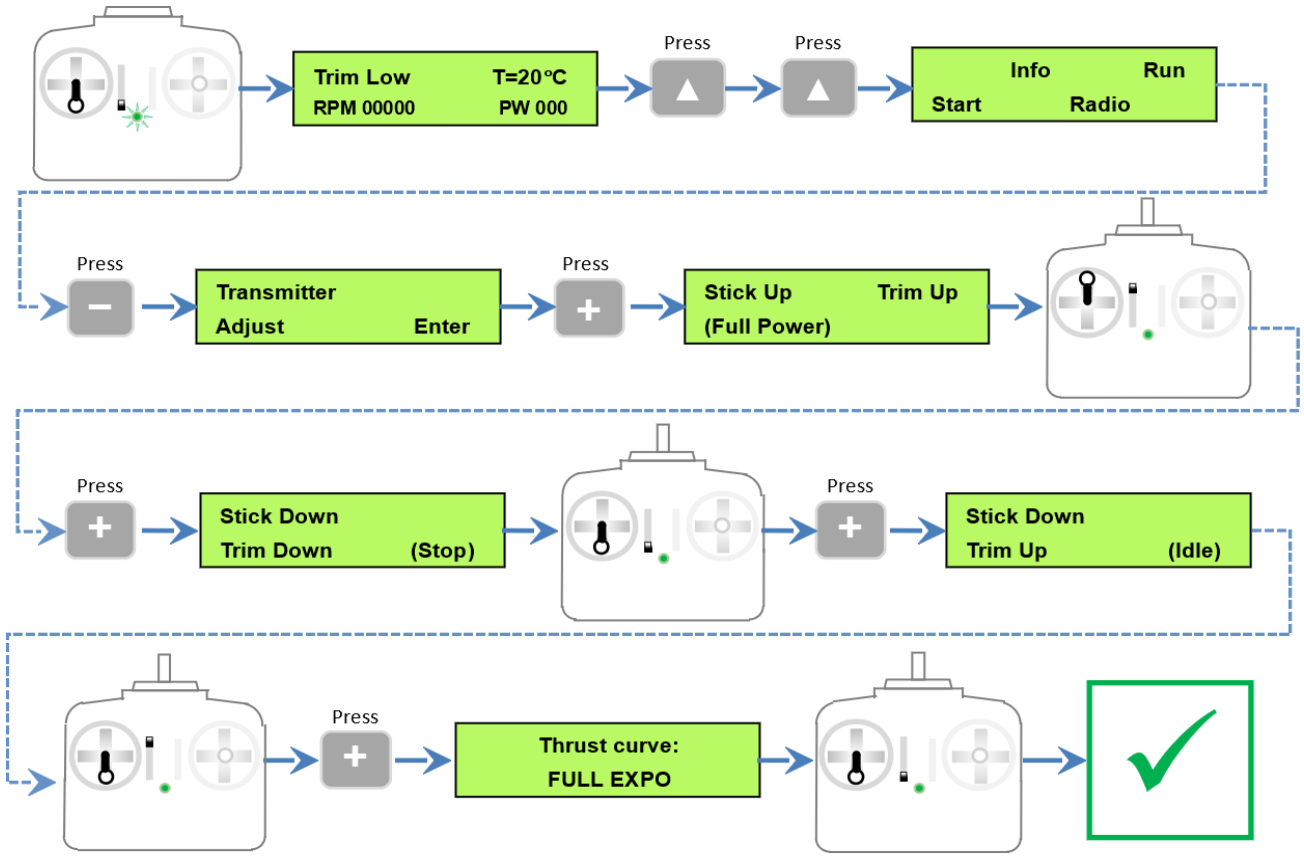
On some Futaba transmitters, it has been found that the throttle channel the sense of movement may require reversing (servo reverse) and to repeat the transmitter alignment. The setting up assumes the use of a transmitter (TX) with manual trims.

If you use a TX with digital trims, is essential to use the switch in the TX programmed for the function "Throttle cut", or “engine cut” which normally has the effect of producing the “trim-down” function. Using a digital trim cause unstable idle, and delay in shutting off the engine in emergency.

Check your radio manual for this before you start. Avoid using the digital trim if at all possible.
Be careful not to use a spring loaded “Throttle Cut” switch as it will prevent the engine carrying out the cooldown function. It must be a switch that stays in the position it is moved.

Aligning transmitter with ECU

Turn on the transmitter and receiver. The opening screen should show as below. Follow the steps shown to set your radio:



The correct adjustment of the throttle adjustment on the ECU can be verified in the second screen of the display as used before. The percentage of the throttle position should read 0% at the position of engine stop (trim and stick down), 100% with stick/trim full up and between 10% and 30% at idle.

Note the setting seen in the “Thrust Curve” above, could be Half Expo, Full Expo or Linear. Will change depending on what has been set up.

This now completes radio setup and only needs doing again if the radio settings are changed.

Failsafe

Never fly with the failsafe set to "hold". It is strongly recommended that you setup your radio system with the correct failsafe settings. In some countries is mandatory that the engine stops in 2 seconds in the case of a failure of the radio link.

To program correctly the failsafe on your radio:

1) Adjust the travel of the throttle channel from -100% (stop position) to +100% (full power)
2) Adjust the ECU to your radio as described above.
3) Adjust the failsafe position of the throttle channel in your radio to -125%.

If all is correctly adjusted, the ECU will stop the engine immediately when receive the "STOP" signal (-100%), but if the signal received is Failsafe (-125%) the ECU will set Idle power for 2 seconds, and if after these 2 seconds the Failsafe condition persists, will shutdown the engine.

Once you have the radio programmed, check it with the engine OFF, by setting the throttle to any position, then switching off the transmitter; after two seconds the "failsafe" reading should be displayed.

Preparing the engine for running

Important notes for kerostart engines. **PLEASE READ**

The kerostart system used on this engine is a reliable and well tested system that produces very smooth and trouble free starts. However, extra care and attention must be paid when starting a kerostart engine.

With kerosene, in the case of a failed ignition, Kerosene is liquid and if unburned, will pool inside the engine and stay there forever. The engine can hold a big quantity of kerosene inside. This kerosene will be ignited on next successful start-up and will be pushed to the exhaust as soon as the airflow inside the engine is sufficient, then it will be ignited in the exhaust, causing a hot start (in extreme cases a big fireball) that surely may not hurt the engine, but can destroy the model.

- Keep a CO2 fire extinguisher handy. VERY IMPORTANT. Do not use a powder extinguisher, it will ruin the engine.
- Fill the fuel tank. Do not forget to filter the fuel, and to mix the oil.
- Confirm all batteries are freshly charged and connected up.
- Check there is a temperature reading on the display.
- Ensure the running area is clear of onlookers
- Verify that the fuel tube is full of fuel and purged of all air, if not; carry out the fuel system prime sequence as described here. ***BUT do not prime fuel into the engine.***

Priming/purging the fuel system

Fuel system needs purging of all air after initial installation and also to clear any small particles picked up during installation:

1. Disconnect the fuel feed to engine.
2. Place a small container, cloth rag etc that the fuel feed pipe to the engine can be pointed into.
3. Set the trim to low and go to “Info” menu and then travel to “Pump test”.
4. Click on “on” /”off” to start/stop the pump manually.
5. Observe fuel line to engine very carefully and push the off button to stop a couple of seconds after fuel reaches the rag or container.
6. Now connect the pipe to the engine.

IMPORTANT: The prime procedure should be done only to fill the fuel tube and filter in the case of a first installation or in case of disassembling of the tubes. It does not need repeating. Pushing fuel directly into the engine will cause an uncontrolled fire at next startup.

Starting Notes

- During the start-up ignition phase listen to the engine sound to check for positive sound of ignition, check looking from the exhaust that the kero is burning, or check for an increase in exhaust temperature in the display. A small plume of white smoke from the exhaust means that the fuel is not burning. The fuel is pooling inside the engine. Abort immediately the start.

- Double check that the engine is not flooded. An extra security measure is to place a manual valve between the fuel tank and the pump, so during the process of filling the tanks or during storage, fuel cannot arrive to the engine.

- After a failed start, or whatever condition that could cause that fuel be collected inside the engine (ie accidental priming), ALWAYS empty the engine of fuel by placing a rag at the engine intake and tilting the engine nose down. Fuel will exit through intake. Due to the internal engine construction the fuel cannot exit out through the exhaust.

- Kerosene can keep burning slowly for a long time inside the engine. This situation can happen during an aborted start; the start-up sequence is aborted by the user or automatically before the engine arrives to idle. This can cause the kerosene inside the engine keep burning for long time, and could destroy the engine or the model.

- IF START-UP SEQUENCE IS NOT COMPLETED, CHECK FOR FLAME INSIDE THE ENGINE.

- If there is flame, then set full throttle for over 3 seconds to engage the starter and blow out the flame. USE SHORT BURSTS OF STARTER. Using the starter for long time can overheat and destroy the starter motor. In the case that the start-up procedure has been aborted due to starter failure or the engine has jammed, then it will be necessary to apply the CO2 fire extinguisher.

- A white smoke plume from the engine is a good indication here; mean that there is no fire inside.

Starting the engine

1. Manually check the gearbox output shaft is free from restriction, ie turn the heli fan a small distance or rotate the prop to make sure both are free. After a shutdown and cooling the output shaft can stick slightly from the main with main housing cooling, this small turning normally unclicks it and runs free.

2. Set the throttle stick down and the trim up (“Idle”). Confirm that the screen shows "Ready" ie *Ready to start!*

3. In the case that the exhaust temperature is over 100º, the ECU will power the starter to cool down the engine. Wait until the cooling sequence finishes.

4. Move the stick to full throttle and immediately back to idle again within 2 seconds. The ECU will begin the startup sequence as described below:

5. First the internal glow plug will be energized. Soon after, the starter will be powered up to have the engine turning at slow speed (around 5000 RPM).

6. Once the engine is at correct speed, the fuel pump and solenoid valves will be energized. A few seconds later (depending if the fuel is already at the engine or not) the fuel will ignite and the exhaust temperature will begin to increase. The rpm and pump power will increase automatically. During this phase the display will display “IGNITION”.

7. When the ignition is detected, the display will change to “Preheat”, during this phase fuel is also routed to main injectors and speed of the rotor will be progressively increased to about 8,000RPM. You may hear some clicking coming from the engine, this is the valves pulsing.

8. Once this phase is finished, the RPM rises to 10,000RPM and the reading will be “FUEL RAMP”. In this phase the ignition system is switched off. The fuel flow and starter power will be increased automatically to increase the RPM quickly up to idle at 60,000RPM. At arriving to idle the ECU will automatically disconnect power to the starter. When the rotor speed reaches idle, the screen will change to “Run IDLE” and the engine speed is adjusted to the idle RPM.

The engine is running!

Helicopter engine running

You may now see the fan spinning around or just a whirring sound if it is enclosed. It should be slow enough not to engage the clutch so little or no power will be going to the main rotors. But sometimes there is a small drag and the rotors gradually begin to turn slowly.

Hot gas will be coming out of the exhausts so be careful.

If you have telemetry fitted you should see an rpm reading for the gearbox output shaft divided by the rotor reduction, even if the rotor is not turning yet. This is because the reading takes account of the heli reduction ratio so you see only the equivalent rotor rpm, which is the most useful value, even before the clutch has engaged.

The gearbox blue light should be flashing to indicate it is reading rpm from the output shaft. If there is no signal you will not be able to increase the throttle beyond idle and you will get a flashing warning display.

With the rpm pickup is working correctly it will be possible to gently increase the throttle and the clutch will start to engage. Be ready for any tail-swing that may develop.

Quick Test?
If your intention was just to functional test the engine you can shut off now, lower the throttle to idle and lower the trim to off, or switch your Throttle Cut switch to “off” to turn off the engine. The engine should now go into cooldown mode. You may see a puff of smoke from the exhaust, this is normal (good) and shows lubrication is reaching the gearbox. Same goes if you pick up your heli and tilt it nose down, lube can run into the hot power turbine area and there is another puff of smoke. Again, normal don´t panic.

TurboProp engine running

The power is enough to spin the prop up to its idle rpm. If exposed, you should see the gearbox light flashing to indicate shaft rpm and if you have telemetry fitted it will show on the screen.

If there is no prop rpm signal you will not be able to increase the throttle. If you have telemetry fitted you will see gearbox rpm reading and if no gearbox rpm reading there will be a flashing error message.

If the gearbox rpm reading is working correctly it will be possible to gently increase the throttle and the propeller speed will increase.

Control of engine power/rpm is now handed back to the transmitter and controlled by the position of the throttle stick. Initially Increase/decrease the throttle slowly, verifying that the engine accelerates/decelerates following the throttle command. Take special care and maintain a safe distance from the rotating propeller.

Engine shut down procedure

To shut down the engine lower the trim and the stick.
After the shutdown the ECU will keep the starting motor running to cool the engine under 100ºc.
The receiver can be switched off before the cooling procedure is complete. ECU will keep going until finished. The ECU will shutdown itself when the procedure is complete.

WHAT TO DO IN THE CASE OF AN EMERGENCY

During the start sequence the ECU will be in charge of everything, controlling temperature and RPM. The only thing the user can do is to abort the sequence by lowering the trim in the case that something abnormal (scraping noise, excessive flames in the exhaust, etc).

If a problem is detected, first: move the trim to the low position to abort the sequence.

If there is a fire in the engine and the problem is because the starter has failed or the engine is seized (not turning), **IMMEDIATELY APPLY THE FIRE EXTINGUISHER** through the intake side of the engine, never through the exhaust as it can blow any flame to inside the airframe.

If there is a fire, but the rotor remains free to spin and the starter is OK, raise the trim and stick to the full power position for 3 seconds, this will connect the starter manually to ventilate the engine and extinguish the fire.

The throttle channel acts as a starter switch as long as the engine has not reached idle.

If the engine had reached idle and stopped, lower the trim and the engine will go into cooldown mode.

Adjusting the engine maximum power

The X45Heli and X45TP engine comes from factory adjusted for optimum power settings. It is possible to change the maximum power setting if needed. To do so, go to RUN menu and scroll the menus up to “Max RPM” and you can see the equivalent maximum shaft power setting.

Using the + and – buttons, you can change the power setting for full throttle in Kw and HP.

Please note that these figures are calculated based on an ambient temperature of 15ºC at sea level.

Hotter ambient/higher altitude will reduce the power output.

AutoRestart function

X45 engines include an AutoRestart function. This function can quickly restart an engine automatically, but it should be understood that such a system may cause damage to people and property if triggered inappropriately and in certain installations is not appropriate (like helicopters). By default this function is disabled in the ECU, the user should expressly enable it. By enabling this function, the user agrees that they have understood the working principles and understands its limitations.

Restart options and how to enable them:
Within the “Radio” menu, a selection defines the restart operation. The ECU offers 3 choices:

- **Standard operation (off):** After the shutdown the ECU should be reset (power cycled off then on) to enable another start-up cycle. Engines are supplied in this mode from factory.

- **Manual Restart : Heli and TurboProp.**

User can normally shutdown the ECU through the transmitter (by lowering the stick and trim). The ECU will execute the normal shutdown and post run cooling cycle.

Once the cooling is finished (temperature below 100ºC), the ECU will return to power-up state allowing the engine to be restarted through the normal procedure (Trim-up, cycle stick). The time to shut down and later start is exactly the same as standard operation.

This mode is useful for motor gliders, where the engine is used to climb to height, shutdown, soaring, restart, climb, etc.
In a Helicopter this function enables the engine to be restarted without having to approach the helicopter to manually reset the ECU.

This mode does not normally pose any additional safety hazard besides the fact that the engine can still be started inadvertently if the start procedure is executed in the transmitter after the flight.

- **AutoRestart :TurboProp only.**

In particular case of a fuel bubble that momentarily stops the combustion, the ECU will detect this condition by monitoring the rpm, temperature and pump power, and then the ECU triggers the auto-restart sequence. This sequence is done with the engine hot, so the power is restored quickly.

This restarting function can help save the plane in few limited circumstances.

But it can also greatly increase the risk of fire, so before to enable this function, please read and understand the following:

What the auto-restart function does do

It automatically tries to restart the engine quickly and restore the power setting that is being asked by the transmitter. To trigger this function, the ECU checks:

- The radio signal is valid, no failsafe condition.
- The readings of the RPM are consistent with a flameout condition (the speed of the RPM coasting down is between preset limits).
- The readings of the exhaust temperature are consistent with a flameout condition.
- The battery voltage is good.
- No other faults detected.

Once the ECU is satisfied that the shutdown/flameout was most likely caused by an interruption of combustion, usually caused by an air bubble, the ECU triggers the quick restart function, where the ignitor is energized to full voltage and the pump is started at a power dependent of the current engine status (RPM and EGT).

Once the ECU detects that the combustion has reassumed, the starter power is set to full power to reach the idle rpm as quickly as possible, and the pump power is increased accordingly to the real RPM increase, allowing for delays caused by bubbles arriving to the engine.

If after 10 seconds of restart the ECU doesn't detect a stable combustion, the procedure is aborted and the normal cooldown initiated.

What the AutoRestart function will not do

- It will not restart the engine if the shutdown was caused by any fault other than a typical flame out caused by air in the fuel system.
- It will not monitor and confirm flight conditions are optimum for a restart. Leaving the restart to progress is the pilot responsibility and decision, depending on each particular case.

When should AutoRestart function be enabled?
Auto-Restart is fast but still takes an average time of 10s to establish restored level of pre-shutdown power. It is highly recommended that Auto-Restart only be used on airframes capable of sustaining enough flight for the re-start to be completed. Some aircraft examples include: lightly loaded planes, gliders, or multi engine planes.

It is highly advised that a shutdown simulation be done before selecting Auto-Restart option in the ECU RADIO menu. Do it during a normal flight at a high altitude, throttle down to idle then begin a 10sec count down. From this try to gauge if the aircraft can maintain controlled flight during this time at idle setting.

If your plane cannot maintain flight for a minimum of 10sec without engine power, do not enable the Auto Restart function.

"I'm flying my (turboprop) plane and the engine has shutdown with restart enabled, what should I do":

Think that the chances of that the engine restart are slim. You don't know why it has shut down, so likely it will not restart, DO NOT RELY on it.

1. **Fly your plane.** Leave the throttle at mid setting and fly your plane keeping airspeed in aft for a dead stick landing. Be ready for the sudden torque effect as prop power returns.
2. **In case you see the plane begins to stall** or an uncontrolled landing is most likely, ***IMMEDIATELY set the trim and stick to STOP*** position to abort the restart function. A crash with the engine running normally ends with a fireball; a crash with the engine off is not likely to catch fire.

Do not use the "digital trims" to shut down the engine, always use a dedicated Throttle Cut switch to be operated quickly.

3. **If the engine restart is initiated while on approach**, evaluate if the speed/position of the plane is still good for a safe landing, if so, land immediately, you don't know why the engine stopped and may stop again during a "go around" but this time the aircraft may not be in an as favourable position. If the position/speed of the plane is not convenient, use the engine power to go around and plan for a normal landing, BUT land as soon as possible. Be ready for the sudden torque effect as prop power returns, best is to lower throttle stick to reduce the torque reaction.

4. **Once the plane is on the ground**, even in normal landing or crash landing, set the transmitter in the STOP position. The engine could restart and go to full power on its own; the ECU does not know when or if the plane is on the ground.

"Can I use the restart function many times"?

NO!

Restart function is an *emergency* procedure and places a high stress on the engine ancillary components. The starter and ignitor are fed with extra power that is not used in normal startups, this places considerable more wear on them, also the engine is subjected to abrupt temperature changes that could shorten its life.

Restart function is not the replacement of a poor fuel system. It can save a plane in particular circumstances, but it can do much more harm than good. A belly landing or landing gear damage due to a flameout induced heavy landing is more favourable than a similar landing arrival with the engine in start phase that can possibly cause a fire and result in total destruction of the model and or property.

Please consider carefully before enabling the auto-restart feature.

Restart Disclaimer

There are no circumstances Xicoy Electronica SL or any of its Service Agents and employees will accept or be held responsible for any losses or damages the Auto Restart feature causes should the owner operator choose to enable this function.

Throttle curves (TurboProp)

The ECU controls the RPM in linear way, i.e., at half stick position the engine produces power at half of the RPM range. However, jet engines develop shaft power in exponential way, meaning half RPM means approximately ¼ of shaft power.

On small engines with a high idle to full power rpm ratio, or in a high drag/low power planes, often only the last 1/3 of the throttle stick produce significant power, with the low half stick travel being not much used.

Although with current digital TX the pilot can modify the throttle curve to suit needs, three throttle curves have been added to simplify the setup for most of the installations.

These curves are selected under the RADIO menu:

FULL EXPO: Means power is linear to RPM, it is the default setting. Power develops exponentially, and it is the recommended curve for high power/weight ratio planes as it eases the control in low power used during taxi.

LINEAR: Means that the power develops linearly with the throttle setting. Could cause difficult taxi, as it would be difficult to fine adjust the power at low settings.

HALF EXPO: An intermediate setting between the other two modes.

Throttle stick position chart

		Stick Position				
MODE	0% (Idle)	25%	50%	75%	100%	
FULL EXPO	Idle thrust	6%	25%	56%	100%	**% of total thrust**
HALF EXPO	Idle thrust	16%	38%	66%	100%	
LINEAR	Idle thrust	25%	50%	75%	100%	

Throttle curves can be changed while the engine is running, so you can leave the throttle at a given position and switch between the curves to see the difference.

Acceleration and Deceleration settings

In the “RUN” menu it is possible to change the acceleration and deceleration settings. The engine is supplied and tested from factory ready to use and usually these settings should be correct for normal use. However the user can modify these default settings to allow the engine to run optimally in different conditions.

On Heli and TurboProp engines, acceleration setting are set to AUTO which gives the engine a good response but tries to minimise the risk of over-fuelling in a sudden acceleration. In AUTO mode, the ECU adjusts itself for optimum running at the current ambient conditions reported by the sensors built into the Hub, and in extreme cases it also raises the idle speed accordingly.

Leave always your ECU in AUTO for optimum trouble free performance.

ECU message codes

Here is a list of possible messages shown on the data terminal screen and their meaning.

1. **TrimLow**: Indicates that the signal received from the transmitter corresponds to the lowered trim, that is to say, engine OFF.
2. **Ready**: Indicates that the engine is ready for starting, and that the transmitter signal corresponds to IDLE, (LED lit twice)
3. **StickLo**!: This indicates that the throttle stick is in a position above IDLE, the engine will not start with the stick in this position.
4. **Glow Test**: Verification of glow plug continuity
5. **StartOn**: Test of the starter and rpm sensor
6. **Ignition**: Ignition phase
7. **SwitchOver**: Phase of heating of the combustion chamber after detecting the ignition.
8. **FuelRamp**: Phase of acceleration until idle speed.
9. **Run Idle**: Engine working correctly, pilot have full control of engine power, command received from transmitter is IDLE.
10. **Running**: Engine working correctly, pilot have full control of engine power, command received is an intermediate throttle setting between Idle and Full Power.
11. **Run-Max**: Engine working correctly, pilot have full control of engine power, command received is Full Power
12. **CalPump**: Pump is being calibrated, usually at full rpms. Hold throttle steady a few seconds until it is finished.
13. **Stop**: Engine off.
14. **Cooling**: Starter is operating to cool the engine.
15. **GlowBad**: Defective glow plug.
16. **StartBad**: Defective starter, insufficient RPM reached during start, RPM sensor damaged, too thick oil used on previous run, no cooling sequence done in previous run, no rpm signal seen by ECU.
17. **Low RPM**: Engine had been shutdown because the speed has fallen below the minimum. Usually lack of fuel (bubble)
18. **HighTemp**: Excessive temperature
19. **Battery!**: battery voltage out of limits, or not connected.
20. **Pump Overload**: There is a restriction in the fuel path from the pump to the engine, or in the engine itself.
21. **No Data**: Means that the data terminal is not receiving any data from the engine. Usual causes are battery disconnected, Data Terminal in wrong port, throttle lead connected in wrong port, pump lead reversed.

Diagnoses

In order to access these measures, it is necessary to shut down and power-up the ECU. Set the trim down (TrimLow) and push the left button on the display. The ECU will show the cause of last shutdown and the parameters value at the moment of shut down. These are as follows:

Diagnosis messages

1. UserOff: The engine has been shut down because it has received the shut down command from the transmitter.

2. FailSafe: The engine has been shut down because of loss of the control signal from the transmitter. After 0,5s of detecting a loss or invalid RC signal, the ECU sets engine power to idle, and if after another 1,5seconds a valid signal is still not received the engine is shut down.

3. LowRPM: The engine has been shut down because the RPM has dropped below a minimum. Cause could be lack of fuel, air bubbles, problem with the batteries, or defective RPM sensor.

4. RCPwFail: Lack of power from the radio receiver.