



Instruction manual

JetCat SPH5



JetCat USA, LLC

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MADE IN GERMANY

PURCHASE AGREEMENT, FULL ASSUMPTION OF LIABILITY AND INDEMNITY AGREEMENT

Buyer purchases from JetCat USA, a Limited Liability Company ("JetCat USA") or from one of JetCat USA's authorized dealers, a MINIATURE TURBOJET ENGINE for model aircraft, cars or boats ("Model Engine") for the invoice price, accompanying this sale, and Buyer and JetCat USA agree to all of the following terms and conditions:

1. Buyer's Representations. Buyer represents that he/she is very experienced in model airplane operation, and that all of the information set forth in the Purchase Application is true and correct. JetCat USA relies on such representations, and would not enter into this sale but for these representations.

2. Buyer's Acknowledgment of Risks and Dangers. Buyer recognizes that operation of the Model Engine may be dangerous, and that under certain circumstances, its handling will be dangerous. As set forth in Paragraph 3 below, Buyer accepts full responsibility for all of these risks and waives all liability as against JetCat USA.

(a) Buyer's Acknowledgment of Danger. Buyer expressly acknowledges that use of the Model Engine is dangerous if improperly handled, and could inflict injury if attempts are made to handle it properly, if the user does not fully acquaint himself/herself with the Model Engine's operation procedures. The Model Engine may cause burns to the user, or the user's assistant, particularly in the start-up procedure, and Buyer agrees to use extreme caution. The Model Engine exhaust is extremely hot, and will burn someone or something placed directly behind the exhaust tube. Highly flammable liquid is used to operate the Model Engine, and it or its fumes will ignite easily and flare up rapidly. The Model Engine itself remains extremely hot, after it is shut off, and requires a cooling down period. Improper use of the Model Engine, or failure to follow Academy of Model Aeronautics ("AMA") guidelines and rules will result in injury to the user, the user's assistant, or bystanders. Operation of the Model Engine in any location other than an approved location, and under safe circumstances could lead to injury to bystanders. A risk exists from explosion, in the event of tampering, modifications leading to over-speed or extreme metal fatigue.

(b) Buyer's Obligation to Become Fully Acquainted With Operation Procedure. Buyer acknowledges receipt of operating instructions for the Model Engine which depicts its handling and operation. Buyer agrees to thoroughly acquaint himself/herself with these materials, and to require his/her assistant to become equally familiar with them. Buyer expressly agrees not to allow any person to assist in the start-up procedure of the Model Engine, who has not become thoroughly familiar with these materials.

(c) Agreement to Use Qualified Assistant in Start-Up Procedure. Buyer acknowledges that the start-up procedure for the Model Engine cannot be safely done, without an assistant. Buyer expressly agrees to use an assistant, who is thoroughly familiar with the Model Engine and its operation as set forth above, on each occasion when the Model Engine is started up.

(d) Warning to Bystanders. Buyer acknowledges that injury or burns to bystanders could occur, during the start-up procedure or when operating the Model Engine. Buyer expressly agrees to take all steps necessary to assure that no bystander will be in a position to receive injuries during the start-up procedure, or while the Model Engine is running.

3. Full Assumption of Liability; Waiver and Release of JetCat USA. Buyer assumes all risk of injury, harm and damage, of every nature whatsoever, to himself/herself and his/her property. Buyer fully and completely waives and releases any and all claims which he/she might have at any time arising out of the purchase, handling, or operation of the Model Engine. This assumption, waiver and release is complete, full, and comprehensive.

(a) Release Even If JetCat USA Is Negligent. The waiver and release contained herein releases JetCat USA from all conduct, no matter how it could be characterized or alleged. JetCat USA shall not be liable for its own negligence, whether active, passive, primary, or secondary. JetCat USA shall not be liable for its sole negligence. JetCat USA shall not be liable for its willful misconduct. JetCat USA shall not be liable based on any theory in strict liability in tort. JetCat USA shall not be liable for any alleged breach of warranty, whether express or implied, of any nature whatsoever, whether a warranty of fitness for a particular use, merchantability, or otherwise. There is no warranty of merchantability; there is no warranty of fitness for a particular purpose; and there are no warranties which extend beyond the description on the face hereof or JetCat USA's One Year Limited Warranty.

(b) Waiver Effective for All Time. The waiver and release contained herein is effective, without regard to the passage of time. It is effective indefinitely. It will not be changed by any modification to the Model Engine, to any later sale, or other changes in circumstances.

(c) Release Extends to JetCat USA and All Its Associates. The waiver and release contained herein protects JetCat USA, and all of its employees, officers, principals, owners, designers, and agents ("Associates").

(d) Waiver of Civil Code Section 1542. Buyer acknowledges the existence of, and fully and completely waives the provisions of California Civil Code Section 1542, which provides:

"A general release does not extend to claims which the creditor does not know or suspect to exist in his favor at the time of executing the release, which if known by him must have materially affected his settlement with the debtor."

4. No Modifications to Model Engine. Buyer agrees to make no modifications of any kind to the Model Engine. This Agreement pertains to the entire life of the Model Engine.

5. Sale By Buyer to Other Party. Buyer agrees to fully inform any person to whom he/she sells or transfers the Model Engine, concerning the handling, use, and operation of the Model Engine, and agrees to give all operating instructions to such person, at or before the time of sale or transfer. The indemnity and hold harmless agreement contained in Paragraph 3 continues in effect, following such sale or transfer.

6. Severability. In the event any clause, provision, or term of this Agreement is held to be ineffective, void or otherwise unenforceable for any reason, that clause, provision, or term shall be severed from this Agreement, and the Agreement shall otherwise remain binding and effective. If any portion of Paragraph 3 is found to be unenforceable, then the parties agree that the fullest and most complete waiver and release which is permitted by law, shall be effective.

7. California Law Applicable. The law of the State of California shall apply to any and all controversies which may arise out of or relate to this Agreement, the sale of the Model Engine, or its ownership, use, or operation.

8. Arbitration. ANY CONTROVERSY OR CLAIM ARISING OUT OF OR RELATING TO THIS AGREEMENT, OR THE BREACH THEREOF, OR THE OWNERSHIP, USE, OR OPERATION OF THE MODEL ENGINE, SHALL BE SETTLED BY ARBITRATION ADMINISTERED BY THE JUDICIAL ARBITRATION AND MEDIATION SERVICE/ENDISPUTE, AT ITS LOS ANGELES OFFICE, UNDER ITS THEN APPLICABLE RULES AND PROCEDURES. THE ARBITRATION SHALL BE BINDING, AND JUDGMENT ON THE AWARD RENDERED BY THE ARBITRATOR MAY BE ENTERED IN ANY COURT HAVING JURISDICTION. BUYER EXPRESSLY ACKNOWLEDGES AND WAIVES THE RIGHT TO FILE A LAWSUIT IN A COURT OF LAW, TO HAVE THE MATTER DETERMINED BY A JURY, AND TO APPEAL. BUYER'S AGREEMENT TO THIS ARBITRATION PROVISION IS VOLUNTARY. THE PARTIES HAVE READ AND UNDERSTAND THE FOREGOING AND AGREE TO SUBMIT DISPUTES ARISING OUT OF ALL MATTERS TO NEUTRAL ARBITRATION.

9. This Document Is the Full Expression of Parties' Agreement. This Agreement contains the full and complete agreement of the parties. There is no representation, term, or provision which is outside this Agreement. Any and all discussions, oral agreements, and representations are merged into this single written Agreement. This Agreement cannot be modified or amended in any way, except by written Amendment, signed by the parties.

10. Paragraph Headings Not Controlling. The heading to any paragraph, or subparagraph of this Agreement, shall not be dispositive, but may be used to interpret the parties' intentions.

11. No Interpretation of Agreement Against Either Party. Buyer understands and expressly acknowledges that he/she has the right to have an attorney read and review this Agreement, before execution. This Agreement shall not be interpreted against either party, but shall be interpreted as if it was drafted mutually by the parties.

12) If the Buyer is not prepared to fully accept the PURCHASE AGREEMENT, FULL ASSUMPTION OF LIABILITY AND INDEMNITY AGREEMENT, the Buyer is advised to return this Model Engine immediately in new and unused condition to the place of purchase.

JetCat USA, LLC One Year Limited Warranty

JetCat USA, LLC, a Limited Liability Company, ("JetCat USA") warrants that this MINIATURE TURBOJET ENGINE for model aircraft, cars or boats ("Model Engine") enclosed with this warranty statement is free from defects in materials and workmanship during normal usage, according to the following terms and conditions.

- 1) The limited warranty extends to the original purchaser ("Buyer") of the Model Engine and is assignable or transferable to any subsequent purchaser / end-user.
- 2) Warranty coverage begins the day you buy the Model Engine. For 1 year or 25 hours of measured use by the Electronic Control Unit (which ever comes first), all parts except for batteries, electric motors, glow plug and frictional materials will be repaired or replaced free of charge. All parts, including repaired and replaced parts are covered for the original warranty period. When the warranty on the Model Engine expires, the warranty on all replaced and repaired parts also expires.
- 3) **Buyer must fully accept all conditions of the PURCHASE AGREEMENT, FULL ASSUMPTION OF LIABILITY AND INDEMNITY AGREEMENT**
- 4) The limited warranty extends only to Buyers who purchased the Model Engine in the United States or Canada and includes this written warranty statement.
- 5) During the limited warranty period, JetCat USA will repair or replace, at JetCat USA's option, any defective parts with new or factory rebuilt replacement items if such repair or replacement is needed because of Model Engine malfunction or failure during normal usage. No charge will be made to the Buyer for any such parts. JetCat USA will also pay for the labor charges incurred by JetCat USA in repairing or replacing the defective parts. The limited warranty does not cover defects in appearance. JetCat USA shall not be liable for any other losses or damages.
- 6) Upon request from JetCat USA, the Buyer must prove the date of the original purchase of the Model Engine by a dated bill of sale or dated itemized receipt.
- 7) The Buyer must bear the cost of shipping the Model Engine to JetCat USA in Paso Robles, California. JetCat USA shall bear the cost of shipping the Model Engine back to the Buyer, within the continental United States, after the completion of service under this limited warranty. The Buyer must pay for any other shipping charges.
- 8) The Buyer shall have **no** coverage or benefits under this limited warranty if any of the following conditions are applicable
 - a) The Model Engine has been subject to abnormal use, abnormal conditions, improper storage, unauthorized modifications, unauthorized repair, misuse, neglect, abuse, accident, alteration, improper installation or other acts which are not the fault of JetCat USA, including damage caused by shipping.
 - b) The Model Engine has been damaged from external causes such as crash damage, foreign object damage, weather, Act of God, improper electrical connections, or connections to other products not recommend for interconnection by JetCat USA.
 - c) **The Model Engine is operated for commercial or institutional use.**
 - d) The Model Engine serial number has been removed, defaced or altered.
- 9) If a problem develops during the limited warranty period, the Buyer shall take the following step-by-step procedure:
 - a) The Buyer shall ship the Model Engine prepaid and insured to JetCat USA.
 - b) The Buyer shall include a return address, daytime phone number and / or FAX number, complete description of the problem and proof of purchase.
 - c) The Buyer will be billed for any parts or labor charges not covered by this limited warranty.
 - d) If the Model Engine is returned to JetCat USA during the limited warranty period, but the problem with the Model Engine is not covered under the terms and conditions of this limited warranty, the Buyer will be notified and given an estimate of the charges the Buyer must pay to have the Model Engine repaired, with all shipping charges billed to the Buyer. If the estimate is refused, the Model Engine will be returned freight collect. If the Model Engine is returned to JetCat USA after the expiration of the limited warranty period, JetCat USA's normal service policies shall apply and the Buyer will be responsible for all shipping charges.
- 10) The Model Engine consists of newly assembled equipment that may contain used components that have been reprocessed to allow machine compliance with Model Engine performance and reliability specifications.
- 11) JetCat USA shall not be liable for delay in rendering service under the limited warranty, or loss of use during the period that the Model Engine is being repaired.
- 12) JetCat USA neither assumes nor authorizes any other person or entity to assume for it any other obligation or liability beyond that is expressly provided for in this limited warranty.
- 13) This is the entire warranty between JetCat USA and the Buyer, and supersedes all prior and contemporaneous agreements or understandings, oral or written, and all communications relating to the Model Engine, and no representation, promise or condition not contained herein shall modify these terms.
- 14) If the Buyer is not prepared to fully accept the liability associated with the use of this Model Engine, the Buyer is advised to return this Model Engine immediately in new and unused condition to the place of purchase.
- 15) This limited warranty allocates the risk of failure of the Model Engine between the Buyer and JetCat USA. The allocation is recognized by the Buyer and is reflected in the purchase price of the Model Engine.
- 16) Questions concerning the warranty may be directed to:

JetCat USA, LLC
4250 Aerotech Center Way, Building G
Paso Robles, CA 93446

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SOME OTHER NUMBER. THIS IS THE HEAD SPEED AND TAIL ROTOR SPEED IN THE COMPUTER AT THE MOMENT. TO CHANGE THE HEAD SPEED TO THE DESIRED VALUE, PRESS AND HOLD THE CHANGE VALUE AND PRESS THE + OR – KEYS. THIS WILL CHANGE THE SHAFTHiR1 VALUE WHICH WILL IN TURN ALTER THE ROT VALUE. SET THE SHAFTHiR1 VALUE SO THAT THE ROT VALUE EQUALS THE HEAD SPEED YOU WANT. IF YOU ONLY WANT A SINGLE HEAD SPEED SETUP THEN THE AUX CONNECTION IS NOT USED. 51

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Introduction

Welcome to the Jet Age of model aircraft! **JETCAT USA** is pleased to sell, support and service the **JetCat** turbine engine and greatly appreciates your purchase. We hope the **JetCat engine** brings you many days of pleasurable flying.

Obviously, model turbine aviation - despite all the apparent fun involved - is serious business. The **JetCat engine** has undergone extensive testing and redesign, in order to ensure it is a safe and reliable model engine; however, it is **not** a recommended power source for the average model builder. It requires a good background in model flying and a working understanding of the principles of turbine engines, along with a disciplined commitment to correct and safe operation, in accordance with these instructions.

To begin, read this manual thoroughly. Develop an overall impression of the engine and its operating procedures, measuring equipment and accessories. Study the material step-by-step and ascertain how to install, operate and maintain your turbine engine. If you are unsure about anything, re-read it again.

DO NOT OPERATE THE *JetCat engine* BEFORE YOU HAVE READ THE MANUAL AND FULLY UNDERSTAND EVERY PROCEDURAL DETAIL

Should you still have doubts or questions, do not hesitate to contact **JETCAT USA** for further assistance.

Once you are accustomed to handling the **JetCat engine**, you will observe that it is a very reliable engine. Some experienced operators have expressed their belief that it handles better than many piston engines. However, always remember this is a **REAL JET ENGINE**, requiring knowledge, discipline and maintenance.

In order to learn more about the development of the model turbine engine and understand its function, we highly recommend reading **Gas Turbine Engines for Model Aircraft** by Kurt Schreckling and **Model Jet Engines** by Thomas Kamps. These books are available through:

Traplet Publications

Traplet House

Severn Drive

Upton upon Severn, Worcestershire

United Kingdom WR8 0JL

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Safety Precautions

If other persons or animals are present while operating the **JetCat ENGINE**, **ALWAYS ENFORCE THE PROPER MINIMUM SAFE DISTANCES FROM THE TURBINE!**

The recommended minimum safe distances are:

In front of the turbine	= 15 feet
On the side of the turbine	= 25 feet
Behind the turbine	= 15 feet

In case of a mishap, fire extinguishers should be on hand at all times. **JETCAT USA** recommends the CO/2 variety. Powdered extinguishers will contaminate the precision components, upsetting the integrity of the turbine.

To avoid hearing damage, always use hearing protection when you are near a running turbine engine!

When the turbine is running, never place your hands closer than six inches into the area of the intake. An **extreme** suction - which can grasp a hand, fingers or other objects in a flash - prevails in this area. Be aware of this source of danger, always!

Prevent foreign materials from entering the intake or exhaust when working with the turbine. Before operation, make sure there are no loose parts or debris near the turbine. Objects being sucked in can cause severe damage.

Always exercise caution around the hot parts of the turbine, to avoid burns. The outer case at the turbine stage and nozzle reaches 450-500° (Celsius), while the exhaust gas may exceed 720 °C.

Assure that the fuel is mixed with approximately 5% synthetic oil. Use only synthetic turbine oils available at local airport fuel suppliers or from **JETCAT USA**.

Never run the turbine in a closed room, or an area near any kind of flammable matter. Do not fly turbine-powered aircraft near flammable materials, nor in forested tracts or areas experiencing drought or dryness. Obey all forest fire regulations and warnings by refraining from operating the **JetCat ENGINE** in restricted fire zones. Never operate model turbine jet aircraft in or around residential or heavily populated areas.

After running the turbine, briefly point the nose upward to assure that there is no fuel left in the engine.

Installation of unauthorized parts from another manufacturing source may also result in engine failure. Do not introduce engine or electronic components other than those delivered by **JETCAT USA**, unless you are willing to risk destroying your turbine! **JETCAT USA's** parts are designed and engineered specifically for the **JetCat SPH5**. Accept no substitutes, unless you are prepared to sacrifice your helicopter.

The Checklist

Before Running the Turbine

- Charge ECU Battery
- Prepare fire extinguisher
- Check fuel lines and filter. Make sure they are clean with no restrictions
- Check that the fuel tank vent is unobstructed
- Mix 5 % oil in fuel (i.e.: 1 quart per 5 gallons of kerosene)
- Fill fuel tank(s). Make sure the main and header tanks are full
- Be certain the starting gas release valve is closed, before filling the starting gas tank
- Turn on receiver switch
- Place the model with nose into the wind
- Start turbine

After Stopping the Turbine

- Turn model into the wind. Stop turbine
- After the cooling process (approximately two minutes), turn off receiver switch
- After each flying session, open starting gas release valve, to empty the tank, before storing the model. This should be executed in a safe area

Fuel / Fuel Care

The **JetCat** engine can use deodorized kerosene, 1-K kerosene or Jet-A1 for fuel. Fuel must be mixed with 5% synthetic turbine oil.

Example formula: 1 quart of oil in 5 gallons of fuel.

JetCat recommends Aeroshell 500 turbine oil.

Fuel System

The input and output fuel tubing must be connected to the electronic shut-off valve as per the drawing. The tube from the pump, fuel in, is towards the heat shrink tubing covered coil. The tube to the engine, fuel out, is towards the edge of the valve. **It will not shut off if connected incorrectly!**

When installing the fuel lines on components with nipples, slightly warm the tubing before connecting. This will soften the tube, making it easier to install. When installing tubing on a metal tube, secure the tubing by placing a tie-wrap around the connection. To remove tubing from nipples, you must cut the tubing off. Be careful not to damage the nipple when cutting off tubing. To insert tubing into Festo quick release fittings, use firm pressure until you feel the tube snap in. To release, press in on the front ring, while pulling the tubing out.

ALWAYS use a gasoline-compatible stopper. Silicon stoppers swell and leak. Check your fuel filters every ten (10) flights. You may be surprised how rapidly they can clog up! The filter is installed with the **O-ring located toward the fuel pump**.



Extremely Important:

Use caution not to pinch o-ring when assembling filters. **Clean any aluminum dust off and lubricate threads before assembling.**

We recommend mounting the fuel filter vertically. This will limit the possibility of air being trapped inside and then coming out at an inopportune time. It is also better not to affix it but to leave it free to slightly move.

When running the engine at full power, check the fuel line from the pump to the engine. If there is a large quantity of air bubbles flowing with the fuel, there is probably a restriction in the fuel system or an air leak in a fitting.

Be careful not to over-pressurize the kerosene tanks and the kerosene shut off valve during refueling operations. You might pump a bit of raw fuel past the valve and into the turbine, and subsequently have a wet (hot!) start. We are now requiring a manual shutoff valve downstream of the automatic kerosene shutoff valve, as an additional precaution.

Hopper Tank

A hopper tank is recommended, between the main fuel tank and the engine. **JetCat USA highly recommends the BVM UAT for the hopper tank!**

Always use the filter between the fuel pump and the solenoid valve as shown in the diagram. This is true even when using the BVM UAT! The pump will emit small particles that can block the solenoid valve from completely closing!

Prime the pump and system.



To prime the fuel pump and fuel lines (or for fuel pump test purposes), it is necessary to open the fuel shutoff valve and run the fuel pump manually. For this purpose, use the **Test-Functions Menu** selection, **Pump TestVolt**. This test opens the fuel valve and acts as a speed control for running the pump.



Extremely Important:

Pump Test allows the fuel pump to operate without the turbine running. However, if the fuel feed line is not removed from the turbine during this procedure; it will become flooded with fuel. When this occurs, the next turbine start can become highly combustible!

Before activating the pump test mode, ALWAYS remove the fuel feed line connected to the turbine.

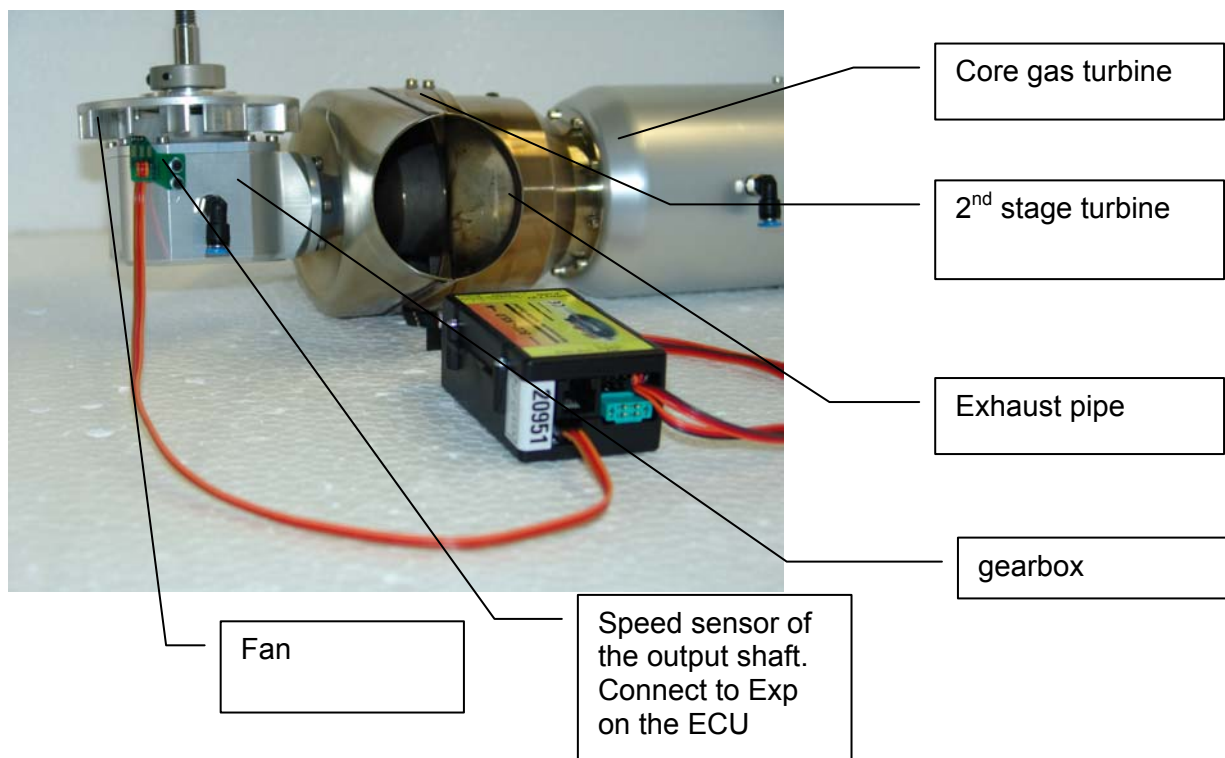
Press the **Change Value/Item** key to run the pump. If you want to change the voltage the pump runs at, press either the  or  while pressing the **Change Value/Item** key.

SPH5 Introduction

Helicopters with glow and gas engines will no longer have to miss the advantages of turbine engines. The generally available high energy or torque power band of turbine engines, is now accessible through the SPH5 turbine reduction gear.

Therefore, as in the full scale industry, turbine engines will play a more prominent role in the RC scale helicopter world.

These turbine engines have the same working principles as the full scale turbine systems.



The ECU controls the unit partially through the measurement of the rpm of the second stage turbine. If the sensor for the second stage turbine is defective or not connected, the engine can be started (up to 65 k rpm limited) but it will not reach its full rpm of 165 K rpm.

Checking of RPM sensor for the second stage turbine:

As soon as the sensor for the second stage turbine has been connected to the Exp connector on the ECU it is ready to be tested.

Connect the GSU with LED- Board and switch the radio on. You will see the voltage of the turbine battery indicated on the lower left side.

Rotate the fan rapidly and the display will switch to indicate the fans rpm. If you wiggle the fan blade with the magnet in it above the sensor it will show a fan rpm reading. It is a good idea to check **BOTH** magnets are being detected by the sensor.



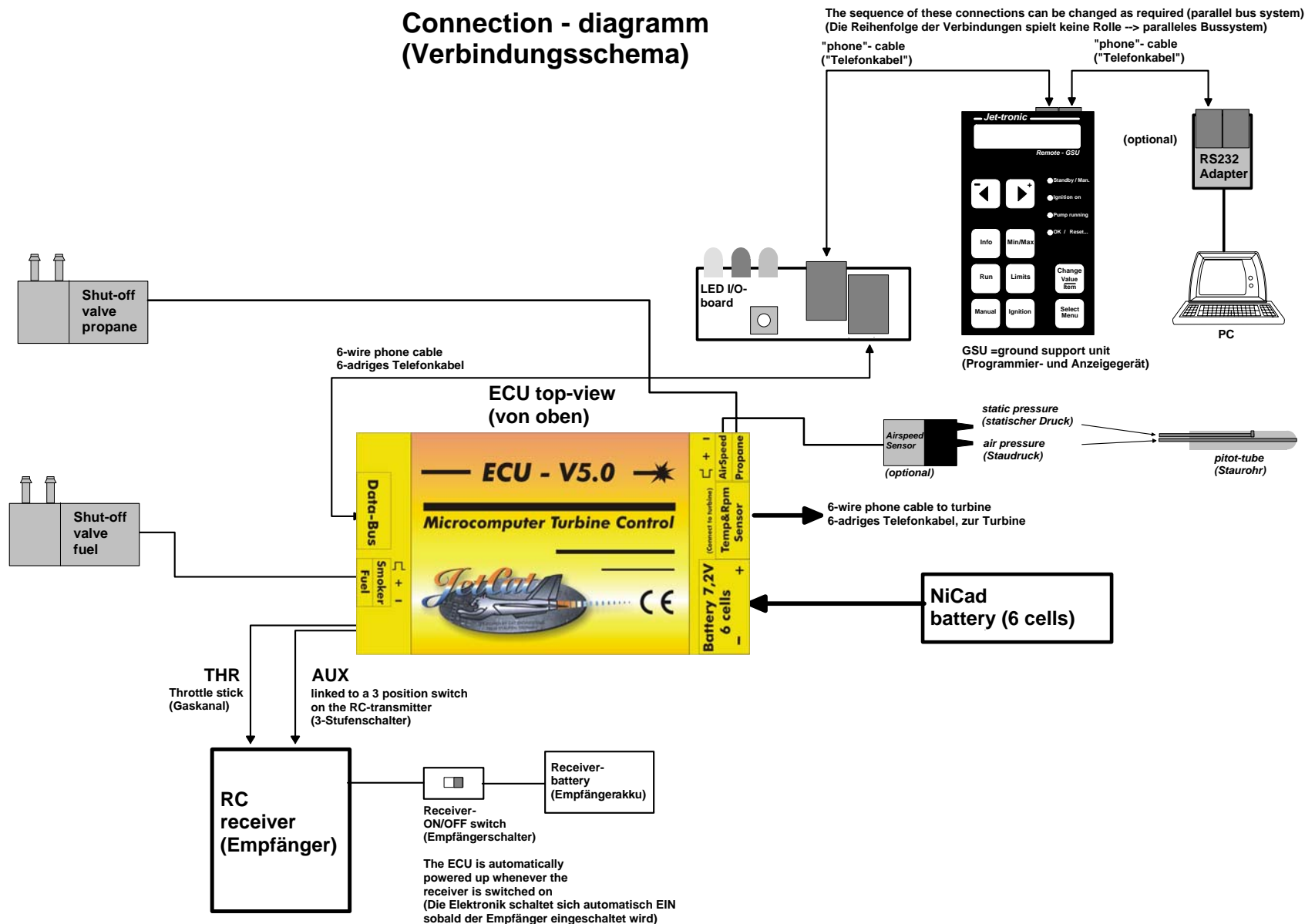
Turbine battery
voltage/fan rpm

Attention: Please never run the engine under an unloaded condition. It should be installed and drive the main rotor head with the blades.

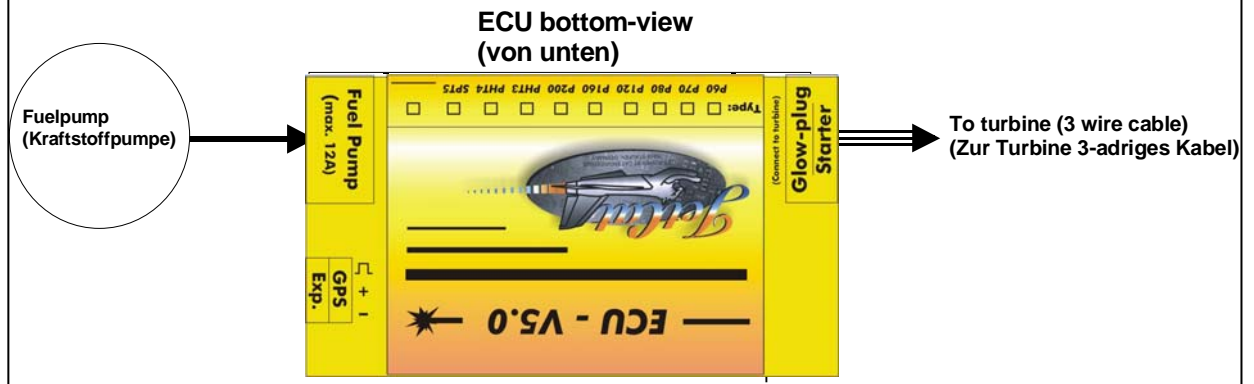
The maximum rpm of the turbine engine can be set in the "Limits-Menu

Should the rpm sensor fail during flight, the rpm will be limited to the maximum rpm the engine has had during that flight.

Connection - diagramm (Verbindungsschema)



Connection - diagramm (2/2) (Verbindungsschema)

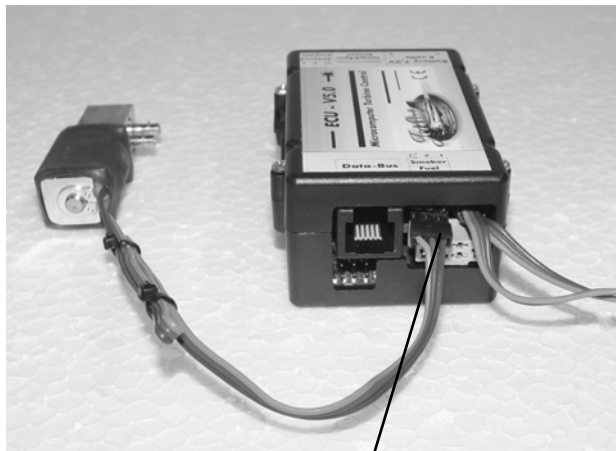


Gas valve
(Propane)

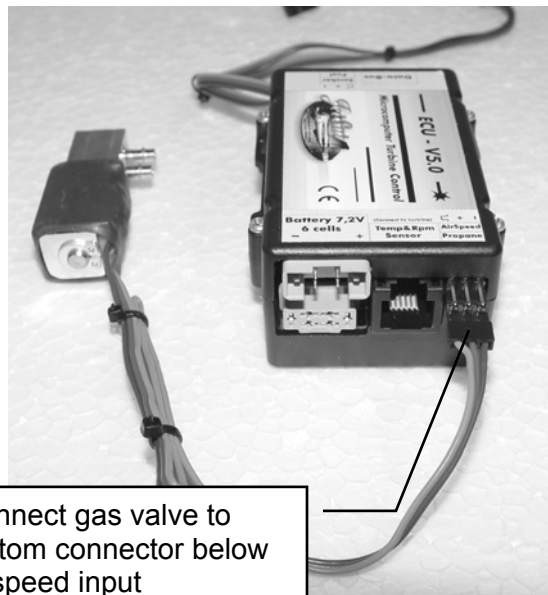
1 or 2 connections
to the Rx

Fuel valve

Fuel pump



Connect fuel valve to bottom connector



Connect gas valve to bottom connector below airspeed input

Turbine battery

All the components (starter, glowplug, ECU, fuel pump etc) are powered by a single 6 cell battery which is connected directly to the ECU.

Caution It is not permitted to under any circumstances to fit a switch in the battery cable.

The ECU power supply is switched on automatically when the receiver is powered on. During each flight (duration 10 minutes or so including start up and cool down sequences) the battery has to supply 300-400mAH. On the early 1250 mAH batteries, a recharge every 3 flights is necessary. Later batteries are of 2400mAH capacity and can power 5-6 flights maximum. More often is preferable for safety.

Charging the turbine battery

Under normal circumstances the turbine battery should be disconnected for charging, however, leaving it connected and using a Y-lead is acceptable as long as the charger does not reverse the supply for testing the batteries charge level.. Under no circumstances should the charger be connected to the ECU without a battery being present.

Attention: As of the ECU Software version 5.00J you can, within the Limits Menu, select the type of battery. The available options are NiCad (minimum of 2400 mAH) or LiPo (minimum of 3300 mAH). The standard setting is NiCad

Fuel/fuel supply

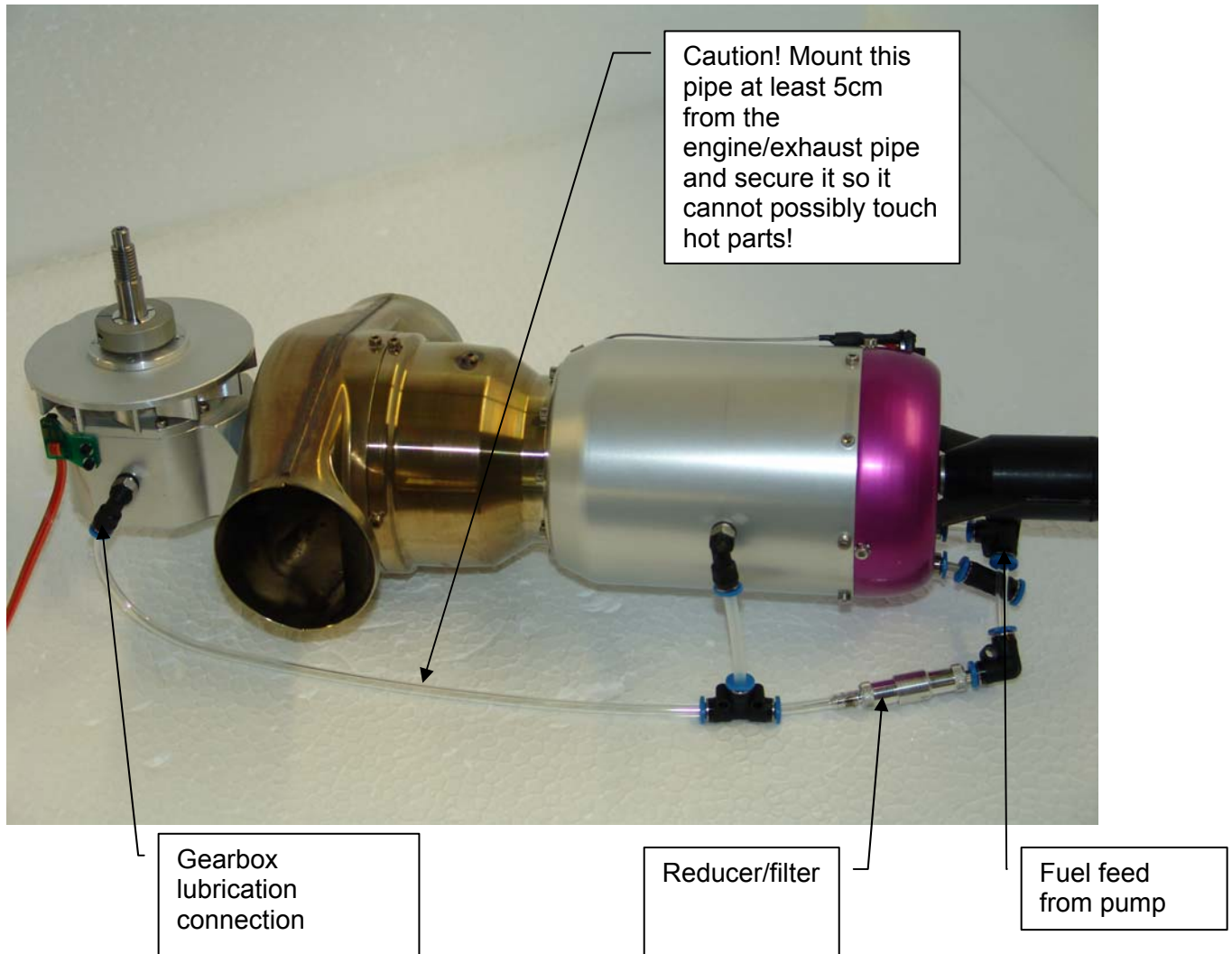
Suitable fuels are Kerosene or Jet A-1 aviation fuel to which turbine oil must be added at the rate of 5%.

Approximate formula 1 quart oil to 5 gallons kerosene.

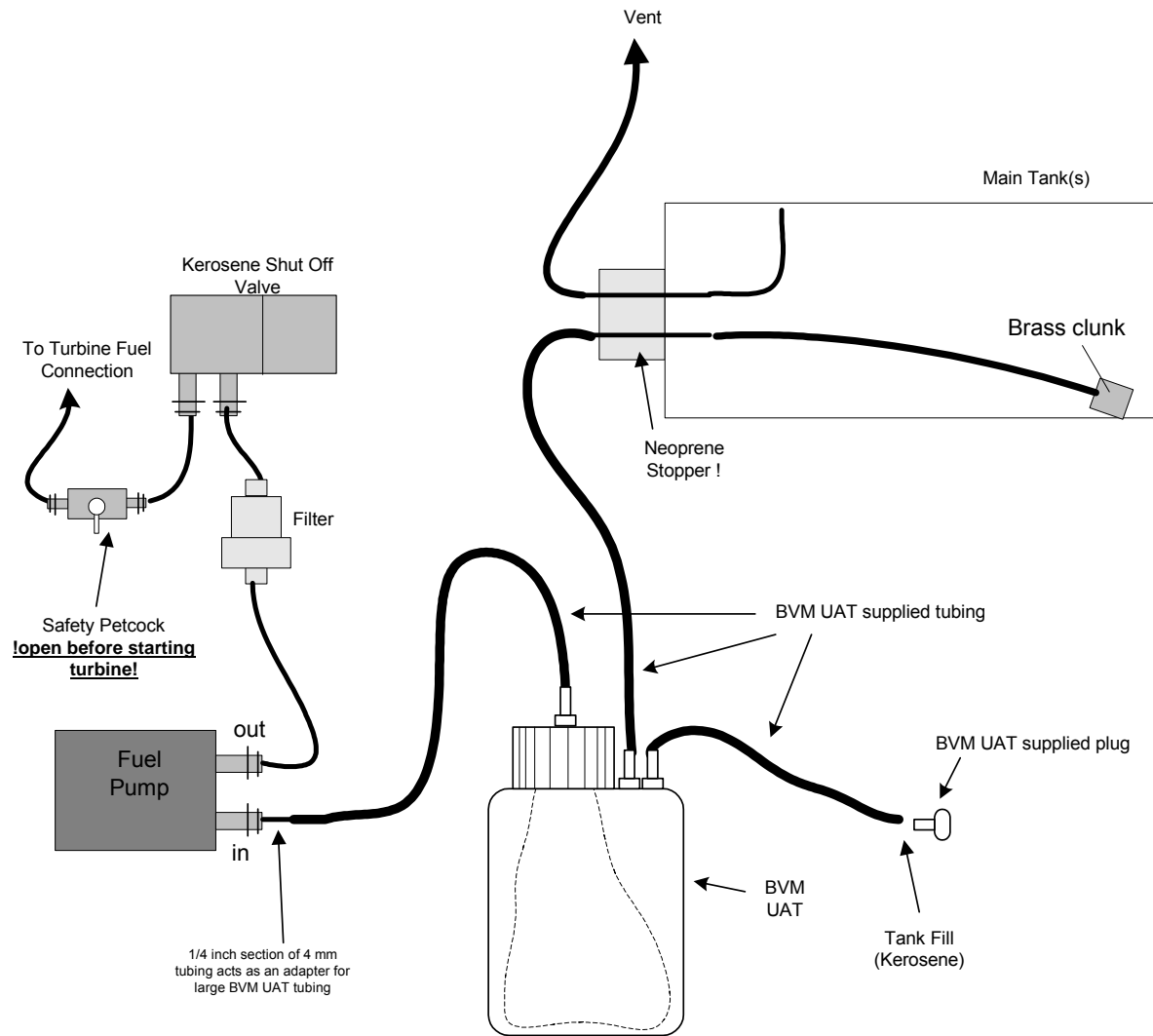
Special turbine oil should always be used as lubricant e.g Aeroshell 500 or Exxon turbine oil.

Please note that not all types of turbine oil mix with petroleum.

Fuel system / lubrication system connection diagram



Fuel System Connection Diagram



Note: All tubing 4mm(except as noted)

The UAT is available from JetCat USA,LLC or Bob Violett Models, Florida (407) 327-6333.

Fuel pump adjustment

After the turbine has ignited on propane, the starter motor further accelerates the turbine. At approx. 5000 RPM, the fuel pump is automatically started at minimum power by the ECU. Beginning from this first pump start voltage, the fuel flow is then slowly increased by increasing the pump voltage.

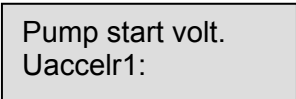
The initial pump voltage that the pump is supplied immediately after ignition has been factory adjusted. If the fuel pump is changed or after several turbine runs the pump is breaking in thus delivering too much fuel at start-up causing long flames behind the turbine exhaust, it might be necessary to readjust the pump start voltage.

For adjustment of the pump start voltage, the ECU incorporates a special adjustment function, which can be accessed as follows:



Interrupt fuel supply to the turbine. If the fuel supply to the turbine is not disconnected / interrupted the turbine can be "filled" with fuel during the following adjustment procedure!!! → Danger of a "Hot Start"

Switch off ECU and plug in GSU (RC transmitter is not being used)
Press and hold the key "Change Value/Item" on the GSU and switch on the ECU

Release the "Change Value/Item" when the display of the GSU shows the following:



Pump start volt.
Uaccelr1:

By pressing the "Run" key will run the pump at the current start voltage value.
To increase the pump start voltage by one increment, press the + key.
To decrease the pump start voltage by one increment, press the - key.

The pump start voltage should now be adjusted in such a manner, that the pump just begins to steadily turn and that the fuel is delivered in a thin fuel stream (a little bit more than just dripping out of the tubing). To test this, press the "Run" key several times to check that the pump starts steadily running on different pump rotor positions.

Normal values for the pump start voltage are between 0.100 and 0.325V.

Important:

At the end of the adjustment procedure press the "Manual" key to store the new setting and resume to normal operation.

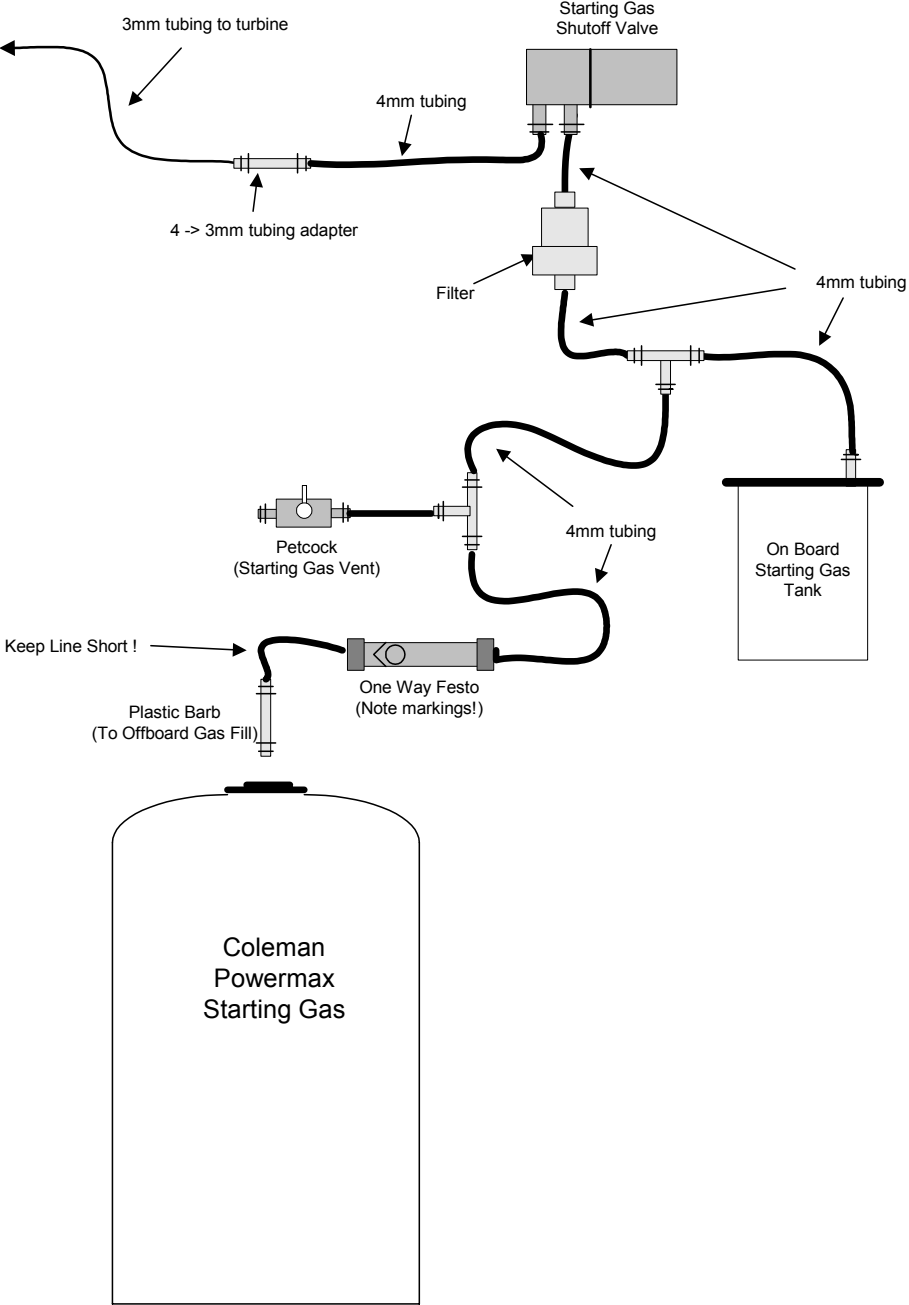
Pump start voltage is adjusted too low:

If the pump start voltage is adjusted too low, the pump may not start to turn (→ the red “pump running” LED is illuminated, but the pump is not turning). This can result in the turbine, after ignition on propane, running an unusual long time and not picking up RPM. If this time is too long (>10sec.), the ECU will terminate the start and show an Error message “AccTimOut” or “Acc. Slow” (=acceleration too slow).

Pump start voltage is adjusted too high:

If the pump start voltage is adjusted too high, the turbine maybe supplied with too much fuel during start up. This could result in heavy flames behind the turbine (→ turbine RPM too low compared to fuel being supplied).

Starting Gas Diagram



Important:

The input and output starting gas tubing must be connected to the electronic shut-off valve as per the drawing. The gas in is towards the heat shrink tubing covered coil. The gas out is towards the edge of the valve. **It will not shut off if connected incorrectly!**

Keep the tubing length short from the one/way valve to the black nylon starting gas probe. This will minimize the amount of excess gas released when the probe is removed from the **POWERMAX** can. Be careful to identify the proper end of the starting gas probe. The probe has a barbed nipple on one end and a smooth nipple on the other. The smooth end is inserted into the **POWERMAX can**.

The starting gas tank can be mounted vertically or slightly horizontally. Whether the tank is mounted upright or slightly on its side, the nipple must always be towards the top. This will limit the amount of liquid propane entering the turbine during startup. After every flying session, open the release valve to empty the tank, before storing the model. Perform this procedure in a safe area.

The propane filter is installed just before the starting gas valve.

If you are using the engine in a bypass, and it produces a bang when the starting gas ignites, or if it is too rich and not igniting immediately, you must limit the amount of starting gas flowing to the turbine. This is accomplished by changing the **Gas Flow** percentage to a lower value in the **Limits** menu. Start by lowering it in 10% increments until it smoothly ignites. This should be adjusted with a full tank of gas each time. Watch the exhaust gas temperature each time you make an adjustment. The turbine will over heat if the amount of starting gas is too low. When a good adjustment is achieved, it should work unless there is a broad change in outside temperature.

Filling the Starting Gas Tank:

Only use a propane/butane mix for starting gas. **JETCAT USA** recommends **Coleman POWERMAX** fuel (or a mix of propane butane 60/40%). **POWERMAX** is available at sporting goods stores or from **JETCAT USA**. Use the 10.6-ounce size.

Do not use 100% propane from torch refill bottles. The pressure is too high and will cause the tubing to rupture.

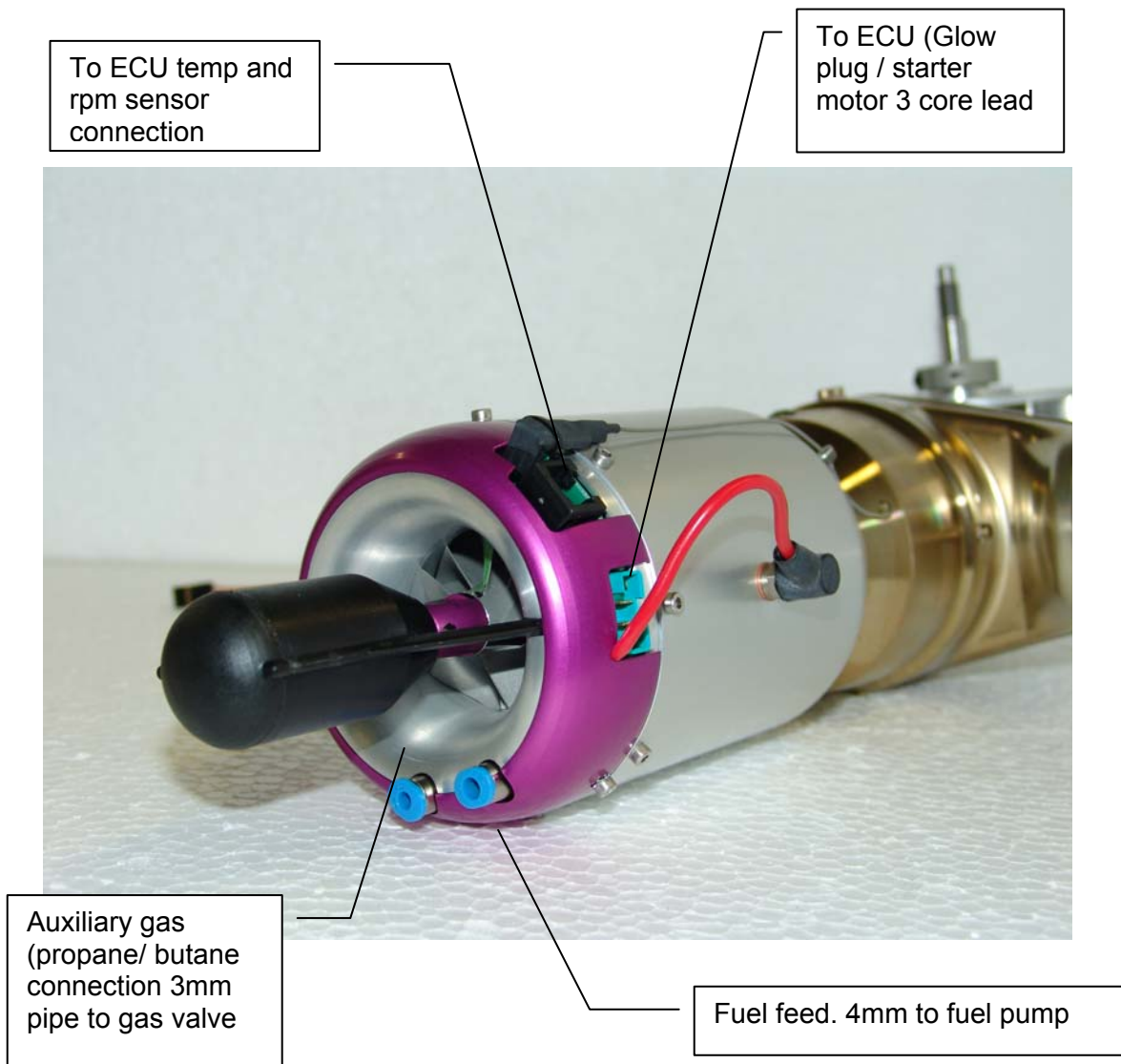
To fill the tank, insert the starting gas fill probe into the valve on the **POWERMAX** can. Make sure the can is vertical since it has a clunk at the bottom. Verify that the fluid is flowing into the tubing. Continue filling, until the fluid slows. Just before the liquid stops flowing, remove the probe from the **POWERMAX** can. Although several starts are attainable with a full tank, **JETCAT USA** recommends refilling before every flight, establishing a routine that is not overlooked.

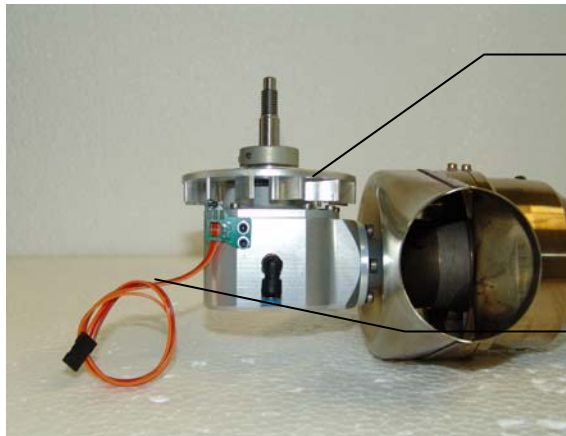
Do not over fill the on-board starting gas tank. When you notice the liquid flow into the tank start to slow down, stop filling. You will prevent any tendency to "pop" on start up, while still having enough gas for 2 to 3 auto starts.
--

Mounting the Turbine

A two-piece, aluminum mounting bracket is included with the turbine. Place the bracket around the turbine, with the glow plug situated within the slot of the smaller bracket piece. This will help stabilize the engine along the thrust axis. The glow plug must be in the vertical position, when mounted in your model ($\pm 75^\circ$ of engine rotation, from the glow plug at top dead center, is the allowable deviation). Secure the engine, using four metric mounting screws and lock washers that are provided with brackets.

Connections to the Turbine





Transmission fan. There are 2 magnets in opposing fan blades

Connection cable for fan rpm. Connect to Exp input on the ECU

The fan should be mounted on the main shaft first. Secure it with the collar. Fasten the rpm sensor with the hex bolts to the gear housing using blue loctite. Make sure that clearing between the sensor and the fan is not more than 1mm.

Power Supply

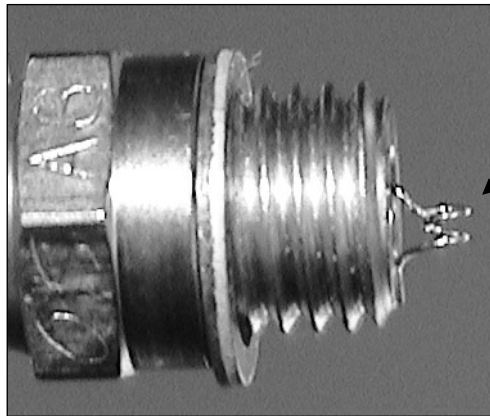
Power for all electrical components of the turbine (starter / glow plug / ECU / fuel pump / fuel and gas valves) are supplied by the six-cell, 1250 mah ECU battery. The amount of battery capacity used per flight is approximately 300-400 mah. This includes starting and cool down. The ECU NiCad battery **must** be recharged after two (2) flights! **JETCAT USA** recommends recharging after every flight, making it a routine that is not overlooked. The battery should be cycled periodically, to prevent NiCad memory problems that lower the battery's capacity. If you use Lithium batteries, we suggest unplugging the ECU at the end of the day to prevent over discharging.

Charging the Battery

Do not charge the battery, with a quick charger using negative discharge pulses, when connected to the ECU. This will destroy the electronics of the ECU. The only recommended method is to disconnect the battery from the ECU and charge it directly. If you are absolutely sure that this is not the case with your charger, the battery can be charged using a Y cable.

Glow Plug

A modified, (non-idle bar) glow plug (McCoy 9) is appropriate. The glow plug is installed on the turbine with the washer. Do not over-tighten or you may damage the threaded bushing. Light torque is fine; there is no vibration to loosen it. The glow plug is modified, so that two turns of the element extend beyond the bottom of the plug. With a pin, pull out two turns of the element. Make sure the plug glows brightly red. The limits menu features an adjustment for glow plug voltage. If high voltage plugs are used (Rossi R8), a higher value than the default will be required. This adjustment is described later.



Note: 2 coils pulled out 90° from the body

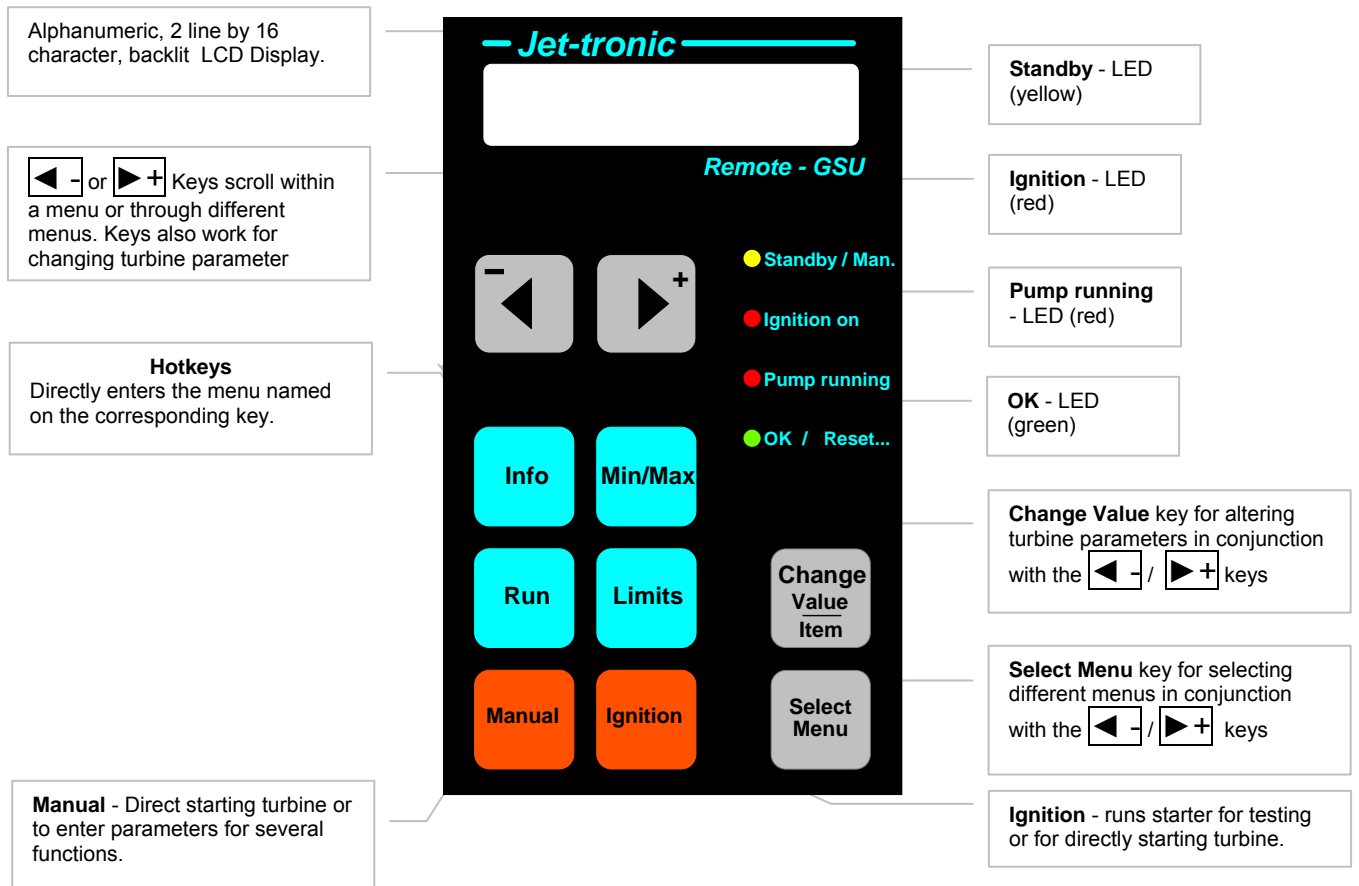
If you have been enjoying good auto starts, and suddenly you notice that your turbine does not start immediately on the first starting gas cycle, check the glow plug. The plugs last so long that we sometimes forget that they can finally wear out!

Ground Support Unit (GSU)

The GSU serves as a terminal for displaying and programming turbine parameters. It may be connected or disconnected at any time. The real time nature of the ECU allows the operator to adjust the turbine's parameters, even when the turbine is running.



GSU Control Panel Descriptions



GSU Switch Descriptions

Key	Explanation
Info	Directly displays the Info menu (Hotkey).
Run	Directly displays the Run menu (Hotkey).
Limits	Directly displays the Limits menu (Hotkey).
Min/Max	Directly displays the Min/Max menu (Hotkey).
Select Menu	When the Select Menu key is pressed and held, the ◀- / ▶+ keys are used to select another menu. When a desired menu is reached, release the Select Menu key, and your selection becomes the currently displayed menu.
Change Value/Item	When the Change Value/Item key is pressed and held, the ◀- / ▶+ keys are used to change the indicated value. If the value is admissible to change, a small arrow appears in the display before the value. If the indicated value cannot be changed (e.g.: current RPM or temperature), the display will indicate that the “Value/Item cannot be changed”.

GSU LED Descriptions

Color	Name	LED On	LED Blinks
Yellow	Standby/Man.	Starter Motor engaged	
Red	Ignition On	Glow Plug is on	---
Red	Pump Running	Fuel pump is on	Glow Plug is defective
Green	OK / Reset...	Turbine running: throttle control active	<ol style="list-style-type: none"> 1. If the turbine is running, the EGT is exceeding the maximum temperature. 2. If the turbine is off, SlowDown mode active

Special function:

If the yellow **Standby** and green **OK** LED's blink simultaneously, the battery is low and must be recharged.

The LED I/O Board

The LED I/O (Input/Output) board is a connection point for the data bus and a display for the current status of the ECU. The board should be mounted with the LED's visible and the data bus connector accessible for plugging in the GSU. The connector facing opposite of the LED's is attached to the ECU. The LED I/O board also features a pushbutton switch function to learn your R/C system, calibrate EGT probe or reset all parameters back to default (when powered up). These procedures are described later.

Illustration 1:

Explanation of the Lights on the LED I/O board. These LED indicators are identical to the **GSU** LED's (excluding the red "ignition on").

Color	Name	LED On	LED Blinks
Yellow	Standby	Starter Motor engaged	
Red	Pump Running	Fuel pump is on	Glow Plug is defective
Green	OK / Reset...	Turbine running: throttle control active	1. If the turbine is running, the EGT is exceeding the maximum temperature. 2. If the turbine is off, SlowDown mode active

Special function:

If the yellow **Standby** and green **OK** LED's blink simultaneously, the battery is low and must be recharged.

JetCat ECU version 4.0 introduction

This is the most significant update for the American market since our introduction of the JetCat engine, December 1998. This update replaces the processor board in the ECU with a new, totally redesigned board, utilizing the Hitachi H8 16 bit micro-controller. This very fast and powerful micro-controller allowed us to expand our already rich set of features and has a much larger capacity to expand in the future. Further updates will only require a new program to be "Flashed" in through the serial port without opening the ECU and reprogramming the chip as its predecessor required.

This update includes many new operating and safety features but still retains the basic menu structure and operation similar to the previous ECU. The most significant new features include

- Programmable failsafe time out.
- Starting gas purge.
- Optional Windows™ compatible computer interface.
- Expanded set of test functions.
- Expanded set of diagnostic functions.
- Ability to start the engine directly from the GSU without the transmitter.

The Hitachi H8 micro-controller is the latest technology in its class and features very quiet operation. By utilizing this micro-controller, our updated ECU has very low Radio Frequency and Electro Magnetic Interference yet is much more powerful than **any** other ECU on the market today. The low emissions from this new ECU allows for much easier installation in your aircraft and has very little to no effect on the receiver's range operating on the American frequencies (50, 53 and 72 MHz).

Setting up the ECU

These are the first steps you need to complete before operating the v4.0 ECU. Make sure your batteries are charged, the ECU is off and the GSU is connected.

Do not perform the calibration of the temperature probe if this is a new engine. Temperature probe calibration is for ECU updates only.

Calibrate the temperature probe.

To compensate the differences from engine to engine there is an offset number that is used to correct the temperature displayed. This offset is derived by sampling the actual temperature read from the engine compared to the ambient room temperature.

Your engine should be at approximately room temperature, 21 °C.

Press and hold the **Select Menu** key on the GSU, then switch on the power.

 Remark:

Instead of pressing the **Select Menu** key on the GSU, the little key on the LED board can be use instead.

The three LED's first show the following blinking sequence:

LED	Blink Sequence
Standby/Man.	Yellow ☉ ○ ○ ☉ ○ ○
Pump running	Red ○ ⇨ ☉ ⇨ ○ ⇨ ○ ⇨ ☉ ⇨ ○
OK	Green ○ ○ ☉ ○ ○ ☉ ...

The Display of the GSU will also show the message:

Release key to:
- learn RC -

Keep the Select Menu key pressed during this blinking sequence. It takes up to 10 seconds!

Only release the key when the 3 LED's are showing the following sequence:

LED	Blinking sequence
Standby	Yellow ☉ ○ ☉ ○ ☉ ○
Pump running	Red ○ ⇨ ☉ ⇨ ○ ⇨ ☉ ⇨ ○ ⇨ ☉ ⇨
OK	Green ☉ ○ ☉ ○ ☉ ○ ...

The Display of the GSU will change to the message:

Release key to:
Calibrate Temp

→ now release the key

- The display should return to the default showing RPM and temperature. The temperature should be 21 °C.

Setup failsafe mode and “Learn RC”.

The updated ECU has the unique ability to shut-off your engine if you have a radio failure. This is accomplished by detecting that the signal from the receiver’s throttle output is either missing or outside the values that were learned during setup.

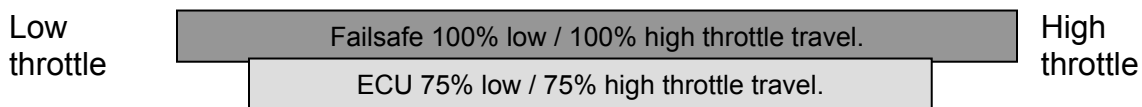
YOU ARE REQUIRED TO USE THE FAILSAFE!

This will not instantly shut off the engine. A timer is started when the failsafe condition occurs and the engine will immediately go to idle. After 3 seconds (2 seconds after V5.0A for AMA requirements as of March 1, 2004) the engine will then shut off. This 2 second timer is reset back to zero anytime a non-failsafe condition is met. Your R/C signal must be broken for at least 2 continuous seconds before the engine is shut off.

The following is for PCM receivers only. Users of FM (PPM) receivers bypass the failsafe instructions and go to the ["Learn R/C"](#) section in the manual. (FM Receivers are not allowed under AMA rules.)



Setting the failsafe for JR PCM receivers – Call JetCat USA for failsafe setup procedures for other radio brands.

If you look at the following servo travel graph, you can see how the ECU detects a failsafe condition. The dark gray bar is the transmitters throttle channel for low throttle, low throttle trim and full throttle set to 100% travel. This is the value that is set into the transmitter’s failsafe. The light gray bar is a reduced low throttle, low throttle trim travel and full throttle set to 75%. This is the value that will be taught into the ECU. If the throttle input to the ECU is between 75% for low throttle, low throttle trim and 75% for full throttle, then this would be within the normal range taught into the ECU and will operate normally. If a failsafe condition exists, the transmitter’s pre-programmed 100% low throttle, low throttle trim will be outputted by the receiver and this value would be outside of the ECU’s taught in range. The ECU will now automatically set the engine to idle (after the **FailSafe delay**) and start a programmable timer. The timer is set to 2 seconds by default. If the timer times out, the ECU will shut-off the engine. If at anytime during this countdown the receivers signal is reacquired, the ECU timer will be reset and the engine will go back to the speed the throttle stick is currently at.



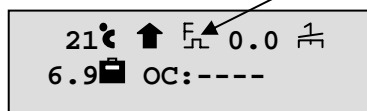
To accomplish this, you must execute the following steps. It is VITAL that these steps be preformed in this order for the failsafe feature to operate properly! Review your transmitter’s manual on how to set the failsafe. Examples are given for the JR 10X with S style receivers. **YOU MUST PERFORM THESE STEPS!**

IMPORTANT: IF YOU CHANGE YOUR TRANSMITTERS FAILSAFE AGAIN IN THE FUTURE, YOU MUST REDUE THE FOLLOWING INSTRUCTIONS AGAIN.


- First, set your transmitters travel parameter to 100% for low throttle and 100% for high throttle. On the JR 10X transmitter, use function 12 to access the throttle travel.
- Set your transmitters failsafe for low throttle, low throttle trim. On the JR 10X transmitter use function 77 to access the failsafe. Enable the throttle channel for a failsafe (select  so the bar is in the top position ) and then set the throttle stick and throttle trim to their minimum positions. Save this minimum position by pressing **STORE**.
- Return to the travel menu and now set the minimum and maximum throttle travel to 75%.
- Now you must teach in these values into the ECU. Refer to ["Learn R/C"](#) section in this manual for this procedure.

You can verify the failsafe function in the default GSU screen.

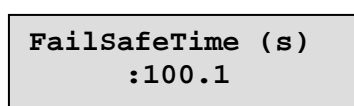
Default Display  This symbol will appear when in failsafe.




If you turn-off your transmitter, the default display will indicate a failsafe by displaying an E_{FL} . If you turn the transmitter back on, the E_{FL} will disappear. If the E_{FL} does not appear when you turn-off your transmitter, the fail-safe is not programmed properly!

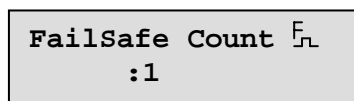
You can verify the failsafe parameters by accessing the **RC Check Menu**. Press and hold the **Select Menu** key on the GSU and by pressing the  key until the **RC-Check Menu is displayed**. Now release the **Select Menu** key.


Time in Failsafe (seconds)



If you press the  in the RC-Check Menu until you see FailSafeTime: the display will indicate the number of seconds the reciever was in failsafe. This is a total time for all the failsafe counts. If you turn-off your transmitter, it will increase every second. This is a great tool for diagnosing the quality of the RC systems RF link by checking this after each flight.

Number of Failsafes



If you press the  again you see Failsafe count: the display will indicate the number of times the receiver went into failsafe. If you turn-off and turn-on your transmitter, it will increase this count by one. This is a great tool for diagnosing the quality of the RC systems RF link by checking this after each flight.

Refer to the Limits menu for the following parameters.

Failsafe delay

FailSafe Delay
:0.1

Setting for the period before the ECU will go into the Failsafe mode and reduce the throttle to the preset **FailSafeRPM**. After the **FailSafeTimeOut** below, the engine would then shut off.

This maybe programmed from 0.1 to 20 seconds (Default = 0.1 seconds).

Failsafe timeout

FailSafeTimeOut
:3.0

Setting for how long the turbine will run in a failsafe condition before the engine shuts off. This may be programmed from 0.1 to 20 seconds (Default = 3 seconds).

Failsafe RPM

FailSafeRPM
:33000

Setting for the RPM the engine will run at durring the **FailSafeTimeOut**. This maybe programmed from Minimum RPM to Maximum RPM (Default = Minimum RPM).

If the engine is shutdown because of a failsafe, in the **Info Menu** the **LAST-OffCond** :**FailSafe** will be displayed. The **Info Menu** has selections for **LastFailsafeCnt:0** and **Last FailSafeTim:0.0**. This is the number of times the ECU went into failsafe and the actual time period it was in failsafe during the last flight.

“Learn R/C”. Teach the ECU to the R/C System

Before the Jet-Tronic ECU can be used for the first time you must program the failsafe and learn the throttle stick and optionally the auxiliary control positions of your R/C system.

To accomplish this, complete the following steps:

1. Connect the ECU servo cable to the receiver. The “**THR**” cable connects to an auxiliary knob or switch channel. The turbine runs in a “governor mode” that automatically compensates for pitch loads. **Do not connect the ECU throttle control input to the receiver pitch control channel.** Make certain that all other connections are made in accordance with the **Electrical Connection Diagram**.
2. Inspect the transmitter programming, to ensure that dual rates and exponential functions are disabled, travel is set at 100% (75% if failsafe is active) and sub trim is set at zero.
3. While pressing the “**Select Menu**” key on the GSU, switch on the receiver.

Helpful hint:

Instead of the **Select Menu** key on the GSU, the small switch on the LED I/O board may be pressed instead. This key can also be used to advance through the “**learn R/C**” sequence (described below). This feature is useful when the GSU is not available. Keep in mind that the LED’s on the I/O board are the same as the GSU for “**Standby**”, “**Pump running**” and “**OK**”.

Release **Select Menu** only after the three LED's display the following blink sequence:

LED	Blink Sequence
Standby/Man.	Yellow ☉ ○ ○ ☉ ○ ○
Pump running	Red ○ ⇨ ☉ ⇨ ○ ⇨ ○ ⇨ ☉ ⇨ ○
OK	Green ○ ○ ☉ ○ ○ ☉

The GSU display will simultaneously read:

Release key to:
- learn RC -

- This procedure enables a system mode, whereby the control positions can be learned by the ECU. When **Select Menu** is released, only the green **OK** LED should illuminate.

The GSU display will read:

Set Throttle
control channel
to minimum:

→ “Off” position

- Now the ECU can memorize the positions of the throttle control channel. First, place the throttle control channel to low. Next, press **Select Menu** or the LED I/O board switch, again. This will store the R/C system's pulse width for immediate shutdown of the turbine. The green **OK** LED will turn off and the red **Pump running** LED will illuminate. This indicates that the shutdown data has been set correctly.

The GSU display will read:

Throttle Trim to
maximum:

→ Throttle channel “Idle” position

- Advance the throttle control channel to the center position. Press **Select Menu** or the LED I/O board switch again, to store the R/C system's pulse width for the turbine idle position. The red **Pump running** LED will turn off and the yellow **Standby** LED will illuminate. This indicates that the turbine idle data has been set correctly.

The GSU display will read:

Set Throttle to
maximum:

→ Throttle channel “Full Power” position

7. Advance the throttle control channel to maximum. Press **Select Menu** or the LED I/O board switch again, to store the R/C system's pulse width for the turbine full power position. The yellow **Standby** LED will turn off and the green **OK** LED will illuminate again, indicating that the turbine full power data has been set correctly. This completes the learn mode for throttle and initiates the learn mode for the three-position AUX channel.
8. ECU Version 5.10E will ask for the 3 positions for the AUX switch which will allow 3 different head speeds. It will automatically set up the 3 options on R0, R1 and R2. See page 50 for full details on this set up. Right now, you need to have a 3 position switch set to give 3 different servo positions eg, for normal, idle up 1 and idle up 2. Connect the Aux wire to the receiver output which is activated by this switch.
9. Once this is done the ECU will revert to Run mode and is ready for use after inputting gear ratios and head speed selections as described on page 50

Test Functions

The new Test Function Menu

For owners of our previous ECU, the Manual mode is no longer implemented. Instead, a new expanded set of test functions are available from the **Test-Functions Menu**. This menu is selected while pressing the **Select Menu** key, press the ◀- or ▶+ key until the menu is displayed. To test the selected component, press the **Change Value/Item** key. To change the fuel pump or glow plug voltage when testing, while pressing the **Change Value/Item** key, press the ◀- or ▶+ key. The following functions are available ->

- Run the fuel pump with a programmable voltage. This is principally used to prime the fuel system.
- Test the glow plug and/or set the voltage.
- Test the starting gas valve.
- Test the fuel valve.
- EGT offset information.

Turbine Starting / Running

1. Prepare to start by completing the startup checklist (previously described on **page 10**).
2. Briefly hold the model upward, to ensure there is no residual fuel in the turbine.
3. Move the throttle trim lever to idle (maximum) position.
4. If the throttle stick is not at the idle position, the LED's will blink in a continuous sequence of yellow to red to green. Bring the throttle stick to the idle position, changing the LED blink sequence to green to red to yellow, continuously. The turbine is now ready to start!
5. Advance the throttle stick to its maximum setting and the turbine will start.
6. Once the turbine begins to accelerate, the throttle stick can be returned to idle position. As soon as the turbine stabilizes at idle speed, the green **OK** LED will illuminate, indicating that thrust control is now handed over to the pilot. The throttle stick must be in the idle position for the green **OK** LED to illuminate.

When the throttle stick is set to the maximum position (Step 5 above), the ECU will begin a fully automatic starting sequence. This starting sequence can be immediately stopped at anytime by moving the throttle to the **Off** position.

After the start process is initiated, the following occurs:



1. The starting motor spins the turbine rotor up to approximately 2,500-3,500 RPM - then the starting motor is stopped.
2. Next, the glow plug is switched on and the starting gas valve opened.
3. The speed of the turbine begins to fall slowly, while ignition normally occurs during this period. Should ignition not occur, the starter will automatically make two more

attempts. If the turbine does not ignite, during a 30-second period of attempts, the process is aborted and the green **OK** LED will blink.

4. As soon as ignition occurs, the yellow **Standby** LED will illuminate and the starting motor is re-engaged to accelerate the turbine. At approximately 5000 RPM, the fuel pump switches on and the red **Pump running** LED illuminates.
5. Turbine speed will progressively increase until achieving stable speed. When the turbine speed surpasses the idle RPM value, the starter motor disengages and the yellow **Standby** LED goes out.
6. As the turbine approaches approximately 55,000 RPM, it will briefly stabilize, before automatically decelerating to idle RPM.
7. When the turbine attains idle speed and the throttle stick is placed at idle position, the green **OK** LED will illuminate, indicating that thrust control is now handed over to the pilot.

Manual startup without using the transmitter directly from the GSU

The former **Manual Mode** has been removed in the v4.0 ECU. Therefore, a new **Manual Control Mode** with the following features are included:

- The turbine can be started directly from the GSU. While pressing down the **Manual** key, press the **Ignition** key to start.
- While pressing down the **Ignition** key, press the  or  key to incrementally increase or decrease the turbine's RPM.
- While pressing down the **Ignition** key, press the **Run** key to set the RPM directly to idle.
- While pressing down the **Ignition** key, press the **Min/Max** key to set the RPM directly to maximum.
- While pressing down the **Manual** key, press the **Ignition** key to stop the engine.

The engine control can be switched from **Manual Control Mode** over to **RC control** and back while the engine is running. While pressing down the **Ignition** key, press the **Select Menu** key to switch control.

Note: Switching from **Manual Control Mode** to **RC control** is only possible if the throttle stick is in the idle position and, if the AUX channel is used, it must be in the center position. When switching from **RC control** to **Manual Control Mode**, the engine will be set initially to idle.

Turbine Stopping / Cool Down

To shut off the turbine, there are two methods:

Manual Off

Turbine immediately turns off!

At anytime, the turbine can immediately be switched off manually by bringing the throttle stick and trim to their minimum positions

Automatic Cooling Process

After the turbine spins down from **Manual Off**, the starter motor will periodically spin the turbine rotor, if the **Exhaust Gas Temperature** is above 100° C. This happens at regular intervals, for about one minute or longer.

Turbine Running States

The **JetCat turbine** progresses through several operating states, from ignition to the cool down process. The transitions of these states are automatically controlled by the ECU and by user commands. The current value is always displayed on the GSU, under the **STATE** selection in the **RUN** menu.

Explanation of the Turbine States

Table 1

Value	Explanation
Standby / START	AUX switch positioned to the Start / Standby position, throttle trim at maximum and throttle stick at idle. The LED chase sequence is started from green to red to yellow, continuously. When throttle stick is advanced to the maximum position, the starter motor engages to spin the rotor. When RPM reaches a pre-programmed value, the starter motor's voltage is removed and the turbine is ready to ignite .

Ignite...	<p>Glow plug is switched on and the starting gas valve is opened. The GSU's red Ignition LED is illuminated when the glow plug switches on.</p> <p>The ECU now pauses until ignition occurs and will remain in this condition until at least one of the following criteria is met:</p> <ul style="list-style-type: none"> • The measured EGT exceeds a pre-programmed value • The measured EGT rises faster than a pre-programmed time <p>If one of these conditions exists, turbine proceeds to the next operant condition (Acceleration Delay).</p> <p>If the turbine doesn't ignite after several attempts (within the pre-programmed time), the ignition state is discontinued and the turbine will shift to the Slow Down state.</p>
Acceleration Delay	<p>Voltage for the starter motor is re-engaged. Fuel valve opens and the fuel pump will run at a steady minimum voltage (a level where the pump just begins to operate), for approximately two (2) seconds. During this state, the turbine operating system purges air from the pump and fuel lines, while warming the combustion chamber in preparation for acceleration.</p> <p>Glow plug turns off.</p> <p>The red Pump running LED turns on and will stay illuminated as long as the pump operates.</p>
Accelerate	<p>In this condition, the fuel pump and starter motor voltages ramp up to accelerate the turbine to idle. The yellow Standby LED will illuminate during this period.</p> <p>Starting gas is shut off.</p> <p>Under normal circumstances, the turbine will ascend to idle RPM. The starter motor then disengages and the yellow Standby LED turns off. Here, the turbine progresses to the next state (Stabilize).</p> <p>During the following error conditions, the acceleration is discontinued and a jump to the Slow Down state occurs:</p> <ul style="list-style-type: none"> • Turbine does not reach idle RPM after a pre-programmed period of time • The change in turbine speed is less than a pre-programmed amount, during a 0.1 second interval
Stabilize	<p>Turbine successfully accelerates to the idle RPM, then automatically increases speed to about 55,000 RPM. When this speed is maintained consistently for at least one second, the turbine will proceed to the next state (Learn LO).</p>
Learn LO	<p>In this state, the turbine automatically decreases RPM to the idle speed. As soon as idle speed is attained, with the throttle stick in the idle position, the turbine will proceed to the next state (RUN (reg.)).</p>

Slow Down	<p>During this state, the fuel shut-off valve is closed and the fuel pump is stopped.</p> <p>The green OK LED blinks, indicating Slow Down</p> <p>This condition will continue, until all of the following parameters are met:</p> <ul style="list-style-type: none"> • Turbine speed less than 800 RPM • EGT is less that 100 degrees C. <p>Once these conditions are met, turbine proceeds to Off.</p>
Run (reg.)	<p>Turbine in the normal running state; the throttle will regulate turbine rpm.</p> <p>During this operant condition, the green OK LED will illuminate, indicating that pilot has control.</p> <p>RUN (regulated) continues, until the turbine is switched off.</p>

Explanation for Turbine Shut Down

In the run menu, state selection, are the following explanations for the last shut down condition of the turbine.

Code	Value	Explanation
1	R/C Off	Throttle stick and throttle trim moved to the minimum position.
2	OverTemp	Turbine running over temperature. Exceeded high temperature parameter and time out.
3	IgnTimOut	Turbine did not ignite within programmed time interval.
4	AccTimOut	Turbine achieved ignition, but did not accelerate within programmed time interval.
5	Acc.Slow	Turbine achieved ignition, but acceleration was less than the programmed value, during startup.
6	Over-RPM	Turbine exceeded the maximum RPM, by 5% and a delay of 0.5 seconds.
7	Low-RPM	Turbine running under the minimum RPM, by 10% and a delay of 3 seconds. Usually triggered by a flame out.
8	BattryLow	Battery pack is dead. Cell voltage is < 1.0V.
9		
10	LowTemp	EGT dropped below the minimum value. A dislodged EGT sensor can trigger this shut down.
11	HiTempOff	EGT exceeded the maximum range (~950 °C).
12	GlowPlug!	Defective glow plug.
13	WatchDog	ECU processor was locked out usually from static discharge or voltage spike in power supply.
14	FailSafe	Turbine was shut down from a failsafe timeout condition.
15	ManualOff	Turbine was shut off by using the GSU.
16	PowerFail	The power failed to the ECU when the turbine was running. This will occur if the power was lost because of a defective battery, connection or if the switch is turned off before the engine is shut-down. Note: If this state is displayed the Info, Min/Max and Statistics menus retain information from the previous run.
17	TempSensor Fail	EGT sensor failed. Note: This could happen only during startup.

Menu Structure

All similar data and running parameters are grouped in separate menus. Menus can be displayed and their values modified (where accessible), by using the GSU.

Menu Selections

- Run menu
- MIN/MAX menu
- RC-Check menu
- Info menu
- STATISTICS menu
- Test Functions
- Limits menu
- Rotor speed Menu

Selecting a Menu

The corresponding keys (hot keys) can directly select the “Run”, “Info”, “MIN/MAX”, or “Limits” menus. An alternate method is to press and hold the **Select Menu** key and use the ◀- / ▶+ keys for selecting. **Note:** this method is the only access to all menus.

Change Values / Items

In order to change an indicated value, press and hold the **Change Value/Item** key while using the ◀- / ▶+ keys to alter its value. An arrow (→) will appear in front of the value, if it can be changed.

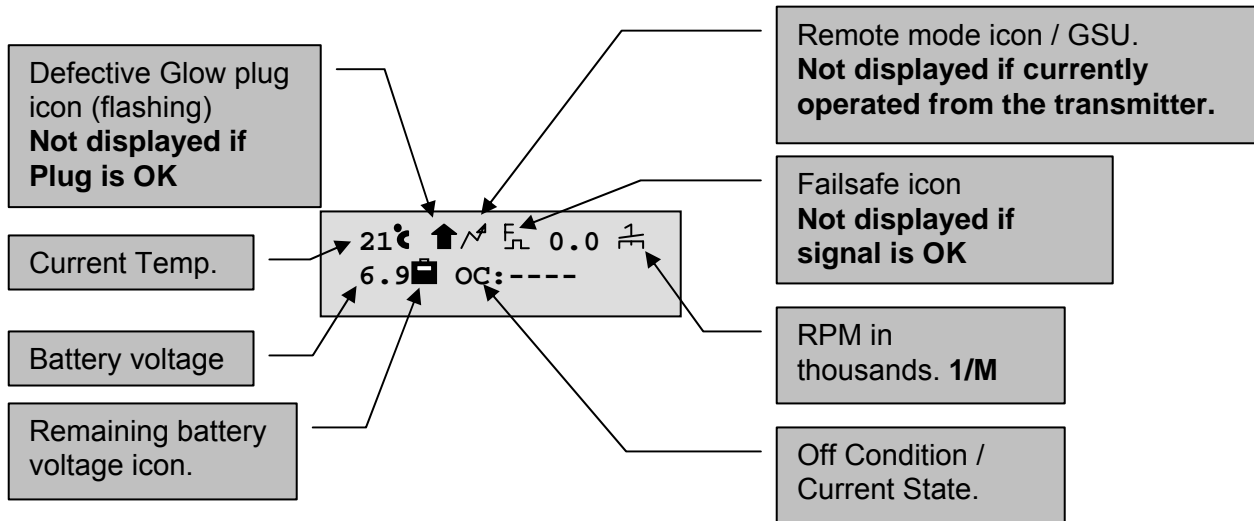
Important Note for Min/Max and Info values->
--

1. After the turbine has started and stabilized, the Min/Max values are reset. This makes the Min/Max values correct for the actual run time of the turbine not including the startup values.
2. When the turbine stops, the Min/Max values are copied to the Info menu’s “Last values”.

The RUN Menu

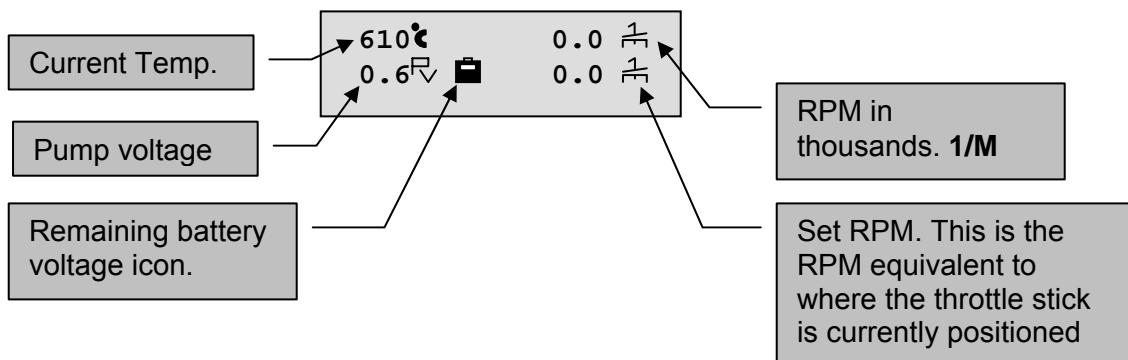
As soon as the ECU is switched on, the default run menu is displayed.

Before starting the engine, the default display appears like this. The first line displays the temperature in degrees Celsius, glow plug bad icon (flashing), remote mode icon, failsafe icon and RPM in thousands. The second line displays battery voltage, remaining battery voltage icon and the “OC:” Off Condition.



During the start sequence of the engine, the “OC:” will be over written with all the different states during the start process until the engine is at idle (green LED is on). The battery voltage will change to pump voltage as well.

When the engine is in the RUN State, the display will be as follows ->



The pump voltage display is useful to monitor the voltage under full power. If this value begins to increase over time, it may be an indication that the fuel filter is clogging. Make note of the maximum voltage at full power for future reference.

When the engine is shut-off, the display changes back to the pre-start version. The Off Condition can then be checked for why the engine was shut-off. **R/C Off** is the normal state when the user stops the engine.

In addition to the default display, the following selections can be monitored on the upper display line. Use the ◀- / ▶+ keys alone for selecting the different parameters.

Value	Explanation
Default Display	See above for description.
U-Pump / RPM	Current pump voltage. Current RPM.
Temp. / RPM	Current EGT (Exhaust Gas Temperature). Current RPM.
OffCnd SetRpm / Set RPM	Last Off command (reason for shut down). See table on page 43. Commanded RPM.
State / RPM	Current turbine state. Current RPM.

The Min/Max Menu

The Min/Max menu is used primarily for diagnostics purposes. All of the following variables may be reset manually by pressing the **Change Value/Item** key on the GSU. Although the display will indicate that the values cannot be changed, it will reset the Min/Max values.

Value	Explanation
Upump-Max Upump-Min	Maximum pump voltage. Minimum pump voltage.
MaxTemp MinTemp	Maximum EGT. Minimum EGT.
AvgPump AvgTemp	Average pump voltage Average temperature
MaxRpm MinRpm	Maximum turbine RPM. Minimum turbine RPM.
AvgRpm MaxRTmp	Average RPM Average temperature at maximum RPM during the last run.

The R/C Check Menu

All parameters in this menu are for informational purposes only and will vary in accordance with R/C input.

Value	Explanation
StickPuls F_{NL}	Position of the throttle stick (by percentage, 0-100%). An 'F' signals a failsafe condition.
Throttle%	Position units of the throttle stick.
FailSafe Count F_{NL}	Displays the number of times the receiver went into failsafe during the flight.
FailSafeTime In seconds	Displays the time the receiver was in failsafe.

The INFO Menu

Info menu displays the following information:

Value	Explanation
BattCnd	<p>The condition of the battery is indicated in the upper line:</p> <ol style="list-style-type: none"> 1. --OK-- 2. !WEAK! 3. --EMPTY-- <ol style="list-style-type: none"> 1. If the battery voltage is 1.1V/Cell or higher "--OK--" will be displayed. 2. If the battery voltage drops under 1.1V/Cell, the display will read "!WEAK!". Red Standby and green OK LED's will blink simultaneously (at a rate of twice per second). Starting the turbine is not possible, until the battery is recharged. If the turbine is already running and the battery warning function is enabled, the warning function will be activated. 3. If the battery voltage drops under 1.0V/Cell "--EMPTY--" is displayed. Starting the turbine is not possible until the battery is recharged. If the turbine is running, it will be immediately shut off, to avoid a malfunction of the ECU.
Ubattery	Current voltage of the battery. Displayed on bottom line.
Last Run Time	Last turbine run time.
Last-Off PmpVolt	Volts applied to the pump when it was switched off.
Last Off RPM	RPM of the turbine, when it was switched off.
Last Off TEMP	Temperature of the turbine, when it was switched off.

Last Off Cond	Last stored Off condition.
Last MaxTemp	Maximum temperature during the last run.
Last MinTemp	Minimum temperature during the last run.
Last AvgTemp	Average temperature during the last run.
Last MaxR AvgTmp	Average temperature during the last run at maximum RPM.
Last StartTemp	Maximum temperature during startup during the last run.
Last MaxRPM	Maximum RPM during the last run.
Last MinRPM	Minimum RPM during the last run.
Last AvgRPM	Average RPM during the last run.
Last MaxPump	Maximum pump voltage during the last run.
Last MinPump	Minimum pump voltage during the last run.
Last AvgPump	Average pump voltage during the last run.
Last FailSafeCnt	Number of failsafe conditions during the last flight.
Last FailSafeTim	Time in a failsafe condition.

The Statistic-Menu

Menu parameters are for informational purposes only and cannot be changed.

Value	Explanation
Totl Run-Time	Total turbine running time (excluding startups).
Runs-OK	Number of successful turbine runs, without errors.
Runs aborted	Number of turbine shut downs, caused by the ECU's safety system.
Ignitions OK	Number of successful ignitions.
Ignitions failed	Number of failed ignitions.
Starts failed	Number of failed starts.
LoBatt Cut-Outs	The number of low battery shutoffs.

The Test Functions Menu

The Manual mode is no longer implemented. Instead, a new expanded set of test functions are available from the **Test-Functions Menu**. To test the selected component, press the **Change Value/Item** key. To change the fuel pump or glow plug voltage when testing, while pressing the **Change Value/Item** key, press the ◀- or ▶+ key. The following functions are available ->

Value	Explanation
Pump TestVolt	Opens fuel valve and runs the pump. Default = 0.500 volts. Note: Can be used to prime the pump and fuel system. Make sure the fuel line is disconnected from the turbine.
GlowPlug Power	Test and / or change glow plug voltage. Default = 2.100 volts.
GasValve Test	Test starting gas valve.
FuelValve Test	Test fuel valve.
Temp AD	Temperature value and offset. Analog Converter value and offset

The LIMITs Menu

The LIMITs menu allows the operator to adjust the following parameters of the turbine, within the allowable values, according to the performance requirements of a particular model.

Value	Explanation
Minimum RPM	Turbine idle speed
Maximum RPM	Turbine maximum speed
LowBat Warning	Battery warning function, Enabled/Disabled Default = Disabled (OFF)
GlowPlug Power	Glow plug voltage, The glow plug will glow with the selected voltage when the Change Value/Item key is pressed. Default = 2.100V
Gas Flow	Sets the amount of starting gas that will flow when the turbine is started. The range is from 10 to 100% adjustable in 10% increments.

Limits Menu, continued

Value	Explanation
FailSafe delay	Delay before the failsafe function is activated. Range = 0.1 to 20.0 seconds.
FailSafeTimeOut	Delay before turbine shuts off because of a failsafe. Range = 0.1 to 20.0 seconds
FailSafeRPM	RPM the turbine will throttle to during a failsafe time out period. Range = Minimum RPM to Maximum RPM
Drain GasTank	If enabled, after turbine is started and throttled up, the starting gas valve will open, draining the tank. Default – Disabled (Off)

Limits Menu, continued

StartUp Mode	This function allows for different engine start procedures for multi engine models. The possible methods are: Sequence <ul style="list-style-type: none"> Start the engine by moving the throttle trim to maximum and then moving the throttle stick to maximum.
---------------------	--

Helicopter Head speed control menu

There is a sub menu in the turbine limits menu for altering the gear ratio of the helicopter so as to set the head speed. Access it by entering the turbine limits menu as before, then press limits and + simultaneously and release.

U-accel R1	:0.225	
U-idle R1	:0.45	
U-accel R2	:0.60	
U-idle R2	:0.45	
Nicad cells	6	Number of nicad cells powering the ECU. Leave at 6 if using 2 LiPo cells
Ratio Turb -> Rot	9.73	Main gear to motor ratio. Adjust by pressing +/- keys while holding down change value. Set this value for your helicopter
Ratio Tail-> Rot	4.53	Main gear to tail rotor ratio. Adjust by pressing +/- keys while holding change value key down. Set this value for your helicopter

Once the gear ratio is set press menu key to return to turbine limits menu. Scroll through with + key until you reach maximum rpm. Set this at 165,000. The governor will control the engine rpm but if you load the rotor head up the turbine may need to reach this rpm.

Press the + key to scroll through until you reach ShaftHiR1:55,000 or some other number. The 55,000 is the rpm of the secondary turbine and will be reduced by the gearbox. Below that you will see ROT=1650 or some other number and Tail = 7422 or some other number. This is the head speed and tail rotor speed in the computer at the moment. To change the head speed to the desired value, press and hold the change value and press the + or – keys. This will change the ShaftHiR1 value which will in turn alter the ROT value. Set the ShaftHiR1 value so that the ROT value equals the head speed you want. If you only want a single head speed setup then the AUX connection is not used.

The V5 ECU has a 3 speed option for the head speed and this requires the addition of a connection to the AUX lead on the ECU which needs to be connected to a 3 position

switch. This should be programmed to give low, medium and high output pulses to one channel and the Aux lead from the ECU should be plugged into that channel.

Set up the head speed as normal for R1 as above. Press and hold the LIMITS button and press the SELECT MENU button until you get to TURBINE LIMITS.

Release the LIMITS button and then press the + button to step through the menu. Keep pressing it until you get to the AUX CHANNEL FUNC menu

Press and hold CHANGE VALUE and press + repeatedly and the AUX CHANNEL FUNC will eventually read RPM-SWITCH ON. Release the CHANGE VALUE button

Repeatedly press the + button until you get back to the SHAFT HI R0. When you press it again you will see SHAFT HI R1 and again it will show SHAFT HI R2.

Turn on the transmitter and put the switch selected for the speed change control in either the slow, medium or high speed position. By Using the CHANGE VALUE and the + and - buttons you can alter the values of the slow, medium and high rpms. You must have the TX switch in the position of the speed you want to alter or the GSU will say THIS VALUE CANNOT BE CHANGED

Troubleshooting

Most frequent errors. Cause and remedy:

Problem	Cause	Remedy
Turbine doesn't ignite	<p>Starting gas system has a leak or bad connection.</p> <p>Starting gas pressure is low. May be caused by insufficient quantity of gas or low outside temperatures.</p> <p>Glow plug is not glowing bright enough.</p> <p>Glow plug defective or glow plug element not sufficiently extracted.</p>	<p>Check starting gas system for leaks and poor connections.</p> <p>Fill starting gas tank; fly in warmer conditions (e.g. Southern California)</p> <p>Adjust glow plug voltage. Glow plug must be bright red!</p> <p>Replace defective glow plug. Glow plug element must be extracted by at least 1/8 inch (two coils)! See page 25.</p>
Starting process fails	<p>Turbine is still too warm; Cool Down not yet completed.</p> <p>Low battery or faulty connection.</p> <p>Glow plug defective (red Pump running LED blinks).</p> <p>Three-conductor cable for starter motor and glow plug disconnected.</p>	<p>Wait until SlowDown sequence is finished. The green OK LED will stop blinking.</p> <p>Charge battery. Check ECU's battery connection.</p> <p>Replace defective glow plug.</p> <p>Check cable. Check for proper connection from ECU to the turbine.</p>
ECU doesn't follow full commands from the throttle stick	<p>Programming alteration in R/C transmitter</p>	<p>Check alignment with RC-Check menu. Re-align ECU to the R/C system. See page 34.</p>

Turbine ignites, but the start process is discontinued.	Air in fuel feed lines.	Air leaks in fuel system. Examine all Festo fittings, nipples, clunk, filter, etc. Check for fuel filter clogs.
	Fuel pump not running.	Test the pump in manual mode (as soon as the red Pump running LED illuminates, the fuel pump must run!). See page 37.
	Starting gas tank nearly empty.	Fill starting gas tank.
Starter unit slips, makes noise.	Dust and oil sediment on the compressor nut and O-ring.	Clean O-ring and compressor nut periodically, with cotton swab and solvent.
EGT giving erratic temperature or RPM readings.	Transmitter antenna too close to the model.	Keep the antenna away from the model. It may cause false readings.
Turbine quits with Watchdog Failure	Static discharge reset the ECU.	Do not mount ECU directly to the fiberglass body of the plane. Use a plywood mount with a layer of foam tape and Velcro between the body and the ECU. If the plane has a glossy finish and the failure happened directly after the wheels left the ground, spray the tires with an anti-static spray available from electronic or hardware supply stores.

Reason for Shut-Down

There are three ways to diagnose why the engine flamed out.

1. In the info menu the "LAST OFF-COND" variable will tell you why. For example, low RPM, high temp, fail-safe etc. **This parameter is non-volatile and will be available until the engine is run again.**
2. With V4.0g and later ECU you can view the last 4 seconds of the flight before it shut-down. This data is updated every 0.2 seconds. This allows you to see the trend leading up to the shut-down. This mode is entered by pressing the "+" key of the GSU while powering up the ECU. You can scroll through the data using the (+ or -) keys and scroll forward and backward through time using the (info or min/max) keys. **This parameter is non-volatile and will be available until the engine is run again.**

3. As long as you do not power-down the system, you can down view the entire flight using the RS-232 adapter and a PC.

If the off condition is "POWER-FAIL" then the data is not valid. This occurs if the ECU or receiver battery was disconnected or was intermittent or if the receiver power goes lower than 3 volts. In this case, the data in the system would be for the previous run.

Sample of displayed values

Tim: Time	R: RPM	S: Set- RPM	EGT: Temp	Pmp: Pump V	Sta: State	Th: Thr. pulse	Au: Aux. pulse	Bat: Batt volts	AirS: Air Speed	SetS: Set Air speed
-4.0	0	0	0	0.0	0	0	0	0	0	0

See the **Explanation for Turbine Shut Down** for a description of each state code.

How to diagnose a shut-down from the saved data

Symptom	Engine shut-off state	Possible Reason
Engine quits with a trail of white smoke.	Low RPM or Fuel Fail Code 7	<p>99 times out of 100 times this is caused by air in the fuel system. Make sure there is no leaks in the fuel system and most importantly, get all the air out of the fuel filter. The fuel filter should not be hard fixed to the plane but allowed to hang free. It is best mounted vertically. When you purge the fuel system, tap the filters while the pump is running to get all the air out them.</p> <p>You will see the pump voltage rising rapidly before it shuts off because the ECU is trying to maintain the RPM. The temperature and RPM will be decreasing. The ECU will turn off the pump when the RPM is approximately less than 24,000 RPM.</p> <p>USE A BVM Ultimate Air Trap!!!!!!!!!!!!</p>

Maintenance



Occasionally, the starting unit clutch may slip or not grip properly, the result of dust and oil sediment on the compressor nut. The O-ring and compressor nut should be cleaned periodically, with a cotton swap and solvent. When the turbine is not running, the starter may be tested by pressing the **IGNITION** key on the GSU.

Check your fuel filters every ten (10) flights.

Each **JetCat** has a prescribed maintenance interval. After approximately 25 hours, the engine should be returned to **JETCAT USA** (along with the ECU and fuel pump), for service. The total running time of the turbine can be accessed and monitored through the **STATISTIC** menu.

Reset the ECU to the factory default values.

NEW FOR ECU V4.9R and later!

After resetting, the display will prompt you if you want to “**learn R/C**”. Press the  key for NO or the  key for YES. After teaching the R/C system, the ECU will automatically calibrate the EGT sensor.

To reset all the user parameters back to the factory default, perform the following steps.



















This will put the ECU back to the “before delivery state”. You will need to recalibrate the EGT probe, re-Learn R/C and set the fuel pump voltage for startup.

Press and hold the **Select Menu** key on the GSU, then switch on the power.

 Remark:

Instead of pressing the **Select Menu** key on the GSU, the little key on the LED board can be use instead.

The three LED’s first show the following blinking sequence:



















LED	Blink Sequence
Standby/Man.	Yellow      
Pump running	Red      
OK	Green       ...

The Display of the GSU will also show the message:

Release key to:
- learn RC -

Keep the Select Menu key pressed during this blinking sequence. It takes up to 10 seconds!

Next the 3 LED’s are showing the following sequence:

LED	Blinking sequence
Standby	Yellow      
Pump running	Red      
OK	Green       ...

The Display of the GSU will change to the message:

Release key to:
Calibrate Temp

Keep the Select Menu key pressed during this blinking sequence. It takes up to another 10 seconds!

Next the 3 LED's are showing the following sequence:

LED	Blinking sequence							
Standby	Yellow	⊙	○	⊙	○	⊙	○	
Pump running	Red	⊙ ⇒	○ ⇒	⊙ ⇒	○ ⇒	⊙ ⇒	○ ⇒	
OK	Green	⊙	○	⊙	○	⊙	○

The Display of the GSU will change to the message:

Release key to:
Reset system !!!

→ now release the key

The display will indicate that it is saving system data and then will return to the default showing RPM and temperature.

Parts List

- 1 – Turbine engine
- 1 – ECU
- 1 – GSU
- 1 – PUMP
- 1 – Battery Pack
- 2 – Fuel / Starting Gas Solenoid
- 1 – Cable Set
- 1 – Fuel Line Set
- 1 – Starting Gas Tank
- 2 – Fuel / Starting Gas Filters
- 2 – Ball Cock Valves
- 2 – “T” Nipple Connectors, (White Nylon)
- 1 – 4 to 3mm Nipple, (Brass)
- 1 – Starting Gas Probe, (Black Nylon)
- 1 – Charge Connector
- 1 – Standard Engine Mount
- 1 – Manual

Optional Accessories

- A1029 -- RS-232 Adapter with Windows™ software
- A1045 -- FOD Screen / static shield
- A3011 -- BVM UAT Header tank

