

JetCat BMS-system V1-0



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JetCat Three Year Limited Warranty.

Ingenieurbüro CAT, M.Zipperer GmbH, Etzenbach 16, 79219 Staufen, Germany hereafter called JetCat warrants that this MINATURE 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) Upon request from JetCat, the Buyer must prove the date of the original purchase of the Model Engine by a dated bill of sale or dated itemized receipt.
- 3) Warranty coverage begins the day you buy the Model Engine. For 3 (three) years all labor and parts except for the glow plug and battery 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.
- 4) During the limited warranty period, JetCat will repair or replace, at JetCat'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 will also pay for the labor charges incurred by JetCat in repairing or replacing the defective parts. The limited warranty does not cover defects in appearance. JetCat shall not be liable for any other losses or damages.
- 5) The Buyer must operate and maintain the Model Engines in accordance to the Model Engine manual. The Model Engine must be returned to JetCat for maintenance on or before the TBO (Time Before Overhaul) interval of every 25 hours. If Buyer fails to return the Model Engine within the TBO interval, any damaged parts affected by this negligence will be subject to additional repair costs.
- 6) 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, 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.
 - c) The Model Engine is operated for commercial or institutional use.
 - d) The Model Engine serial number has been deliberately removed, defaced or altered.
- 7) 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.
 - b) The Buyer shall include a return address, daytime phone 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 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 after the expiration of the limited warranty period, JetCat 's normal service policies shall apply and the Buyer will be responsible for all shipping charges.
- 8) The Buyer must bear the cost of shipping the Model Engine to JetCat, Germany. JetCat shall bear the cost of shipping the Model Engine back to the Buyer after the completion of service under this limited warranty. The Buyer must pay for any other shipping charges.
- 9) 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.
- 10) JetCat 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.
- 11) JetCat 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.
- 12) This is the entire warranty between JetCat 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.
- 13) Buyer must fully accept all conditions of the PURCHASE AGREEMENT, FULL ASSUMPTION OF LIABILITY AND INDEMNITY AGREEMENT
- 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. 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:

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Safety, meaning of symbols

| | |
|---|---|
|  | ATTENTION! This symbol highlights the following points which must be strictly observed by the user! Any violation of the corresponding restrictions may impair the safe operation and the safety of the user. |
|  | ATTENTION! This symbol highlights restrictions which must be strictly observed by the user! Any violation of the corresponding restrictions may impair the functional efficiency and severely compromise user safety. |
|  | ATTENTION! This symbol highlights information that should be heeded by the user to ensure safe operation of the device |
|  | ATTENTION! Fire or explosion hazard! |
|  | ATTENTION! This symbol warns of hot objects and surfaces. Any violation of the corresponding restrictions may affect the health of the user. |

Safety Precautions

| | | | | | | | |
|---|--|-------------------------|-----------|----------------------------|-----------|--------------------|-----------|
|  | WARNING! Errors and / or defects in the construction or operation of a jet model can lead to personal injury or even death. | | | | | | |
|  | ATTENTION! Before you put a model aircraft in operation, you must learn about the law. Legally, a model aircraft is a real aircraft and is subject to applicable laws which must be strictly adhered to. The rules of other countries are to be observed accordingly. | | | | | | |
|  | WARNING! It is your responsibility to protect others from injury. The minimum operating distance of residential areas to ensure the safety of people, animals and buildings must be at least 1 mile. Never operate model turbine jet aircraft in or around residential or heavily populated areas. Keep a safe distance away from power lines. Do not fly the model in bad weather with low clouds or fog. Never fly into direct sunlight, otherwise you might lose sight of the model. To avoid collisions with manned or unmanned aircraft, land your model immediately if a plane approaches. Persons or animals must comply with the following minimum safety distances from a turbine model: <table style="margin-left: auto; margin-right: auto;"> <tr> <td>In front of the turbine</td> <td>= 15 feet</td> </tr> <tr> <td>On the side of the turbine</td> <td>= 25 feet</td> </tr> <tr> <td>Behind the turbine</td> <td>= 15 feet</td> </tr> </table> | In front of the turbine | = 15 feet | On the side of the turbine | = 25 feet | Behind the turbine | = 15 feet |
| In front of the turbine | = 15 feet | | | | | | |
| On the side of the turbine | = 25 feet | | | | | | |
| Behind the turbine | = 15 feet | | | | | | |
|  | WARNING! The construction and operation of the model and / or turbine under the influence of alcohol, drugs, medicines, etc. are strictly forbidden. These activities must take place only in the best physical and mental health condition. This applies to both the operator and any assistants. | | | | | | |
|  | WARNING! The <i>JetCat</i> model jet turbines were designed exclusively for model aircraft and are NOT suitable for any other purpose. Never use for any other purpose except for the flight of the model. Any other types of uses may result in personal injury or death. | | | | | | |
|  | WARNING! Any deviations from these instructions or the instructions of the manufacturer, the use of other parts or materials or changes to the system may have an adverse effect on the functionality and reliability of the turbines and therefore must be avoided at all costs. | | | | | | |
|  | WARNING! The operation of a model jet turbine can only be done under strict accordance of the model, remote control and turbine operation manual. Before flying the model, all control functions and surfaces as well as the range of the remote control system must be checked in the accordance of the manufacture. The checking of these operations must be repeated with a running turbine engine including the remote control system range. | | | | | | |

| | |
|---|--|
|  | <p>WARNING! In case of a mishap, fire extinguishers should be on hand at all times. <i>JetCat</i> recommends the CO/2 variety. Powdered extinguishers will corrode the precision components inside the turbine and void your warranty.</p> |
|  | <p>WARNING! 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 an instant exists in this area. Always be aware of this source of danger! 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. If your installation allows, we highly recommend using a "Jet Net" to protect the intake.</p> |
|  | <p>WARNING! 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 <i>JetCat</i> turbine in restricted fire zones.</p> |
|  | <p>WARNING! The overflight of people, especially at low altitude, is strictly prohibited</p> |
|  | <p>Attention! Always exercise caution around the hot parts of the turbine, to avoid burns. The outer case at the turbine stage and nozzle reaches 450-600° (Celsius), while the exhaust gas may exceed 800 °C.</p> |
|  | <p>WARNING! Assure that the fuel is mixed with approximately 5% synthetic oil. Use only synthetic turbine oils available at local airport fuel suppliers. Synthetic turbine oils are dangerous and should only be handled as per the manufacturer's MDS sheets. <i>JetCat</i> has available a compatible oil that is less harmful that also contains an antistatic ingredient. Contact <i>JetCat</i> for more information.</p> |
|  | <p>WARNING! To avoid hearing damage, always use hearing protection when you are near a running turbine engine!</p> |

BMS-System V 1.0 description

The JetCat BMS (Battery Management System) system solves several necessities when charging the engine and receiver batteries from an engine powered generator system:

- 1) Precise measurement of the cell voltages of the engine battery, and forwarding of this information to the ECU and generator charging system.
- 2) Balancing of the engine battery cells.
- 3) Output control and current measurement of the two charging outputs to the receiver batteries.
- 4) Reporting of all charge currents / voltages and charged capacities to the ECU.

Principal of operation

The engine side starter/generator is used to charge the engine supply battery once the engine is running.

The charge current into the engine battery depends on the type of engine battery used (i.e. 3cell LiFe or 2 cell LiPo) and the actual rpm setting of the engine. The charge current provided (generator current) is used for all connected devices like ECU, fuel pumps, valves etc. as well as for charging of the engine and receiver batteries. The charge current into the supply battery can reach up to approximately 6.5A; this is necessary to replace the energy used up during startup and cooling within a short period of time.

Once the engine battery has reached its “full level”, the charge current is automatically reduced to stay within the allowed margins of the engine battery.

To replace the battery energy used up during engine startup and cooling, about two minutes of engine run time above 45,000 rpms are typically required. This time will increase depending on how much energy is needed for buffering/recharging of the optional connected receiver batteries or other equipment (i.e. smoke pump).

If the BMS should not be connected/used in conjunction with an engine with integrated generator and charging system (like i.e. P220-RXi), the charging of the engine supply battery will still work, however the engine battery will not be balanced in this configuration and will only be charged to about 90% of the maximum allowed voltage.

The ECU will monitor/memorize the capacity taken from or restored back into the engine supply battery.

All of this information can be checked/displayed by connecting the GSU to the ECU.

With the BMS connected and powered up, the cells of the engine battery will be monitored/balanced automatically.

Furthermore, the system will supply two independent output channels to suitable receiver batteries (receiver batteries must contain an onboard charging/balancing system, i.e. batteries from PowerBox Systems).

The charging system inside these receiver batteries will accomplish the charging and balancing of the receiver battery cells. The BMS system V1.0 will currently “just” supply a switched and current monitored output to these subsystems.

Charging of the receiver batteries happens independent to the charging of the engine supply battery.

Charging of the engine supply battery is made via the engine generator or via an external connected battery charger in case the system should require a manual recharge.

Charging of the up to two receiver batteries will happen from the engine supply battery independent to the state of the engine. That means the receiver batteries will always be charged up to the maximum possible level. The “charging until full” of the receiver batteries will only be terminated if the engine battery should go flat unexpectedly.

A charging cycle of the receiver batteries will be always triggered as soon as:

The ECU is switched on (model being switched on), and/or as soon as the engine should have been started up.

The charging/buffering of the receiver batteries will only terminate if the ECU is switched off and the charge current into the receiver batteries is below 50mA (or the engine battery is empty). This means that charging of the receiver batteries will continue even after the model (ECU) has been switched off!

In a typical usage this will result in always fully charged receiver batteries upon the next power-up/flight.

In a worst case scenario this could mean that all the engine battery capacity has been transferred into the receiver batteries, leaving an empty engine battery (engine cannot be started anymore).

In this unlikely case, this then will result in a situation where the engine battery needs to be externally recharged via a suitable charger system.

This should only happen if either empty receiver batteries are connected for the first time to the system and/or if the power of the RC system has been left turned on for a longer period of time without running the engine (without charging of the engine battery).

In all of these cases, to resolve the low power situation of the engine battery, it is preferred to hook up a charging system to the engine battery, then start the charging cycle on the external charger, and then once power up/down the ECU. As laid out above, the power up/down of the ECU will then also trigger the charging cycle of the receiver batteries. That means the external connected charger will charge the engine battery and via the BMS also both of the receiver batteries!!!

Also: If powered on, the BMS will take care of balancing the engine battery cells even in this charging condition (via external charger, no balancing cable connected to charger).

After the charging of both of the receiver batteries has terminated, the BMS will shut down itself.

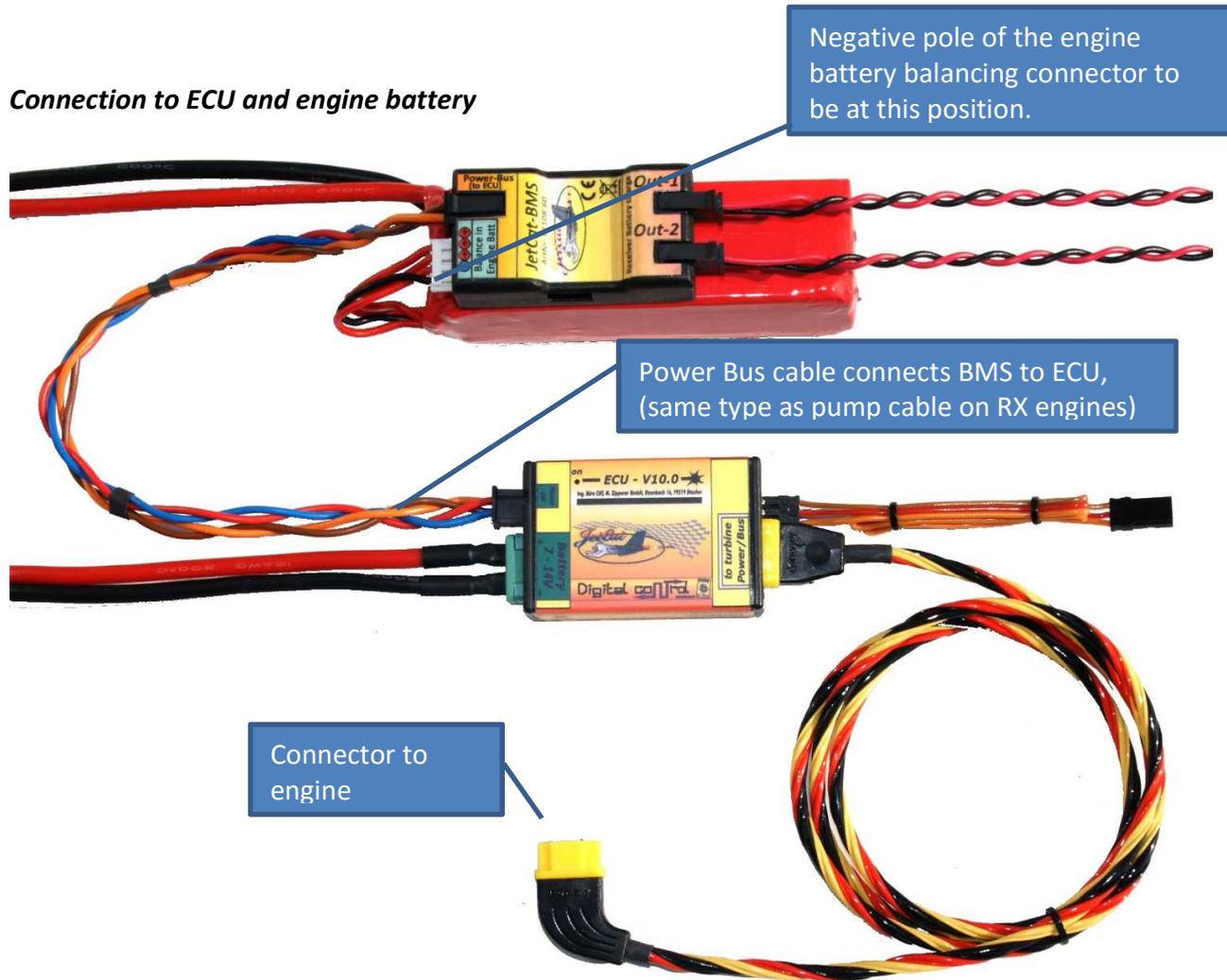
Engines suitable to be used with the JetCat BMS system

Following engines can currently be used in conjunction with the BMS system:

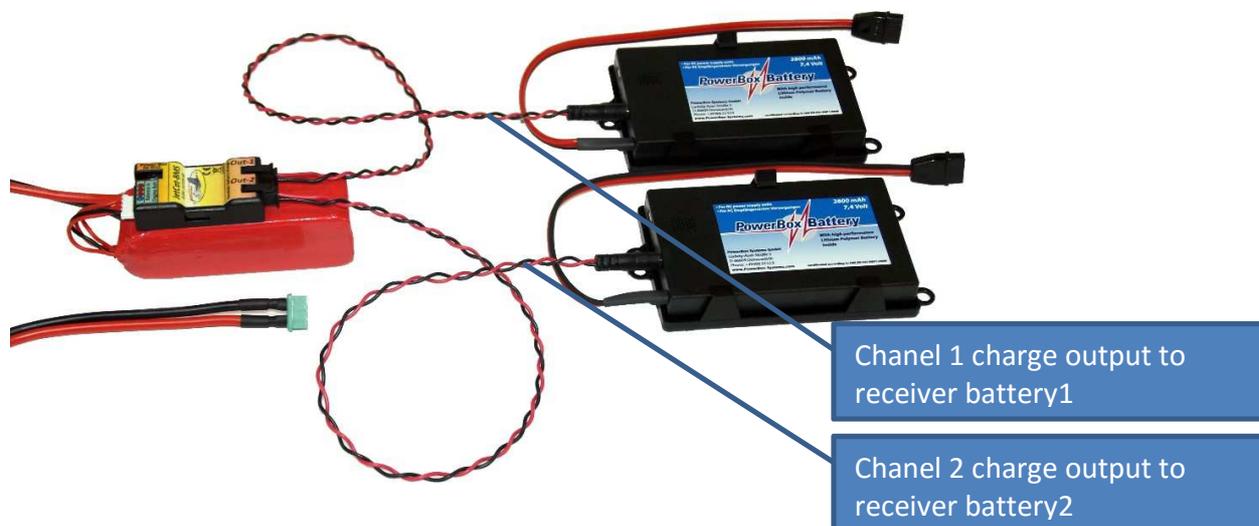
- **JetCat P220-RXi**

Electrical Connection

Connection to ECU and engine battery



Connection to receiver batteries



Necessary adjustments/settings of the ECU

There are two settings you need to adjust/verify and set correctly in the ECU

- 1) Type of engine battery used
- 2) Capacity of engine battery

Both settings are found in the "Setup menu" of the ECU.

Power up ECU, after the boot screen disappears, and the normal Run menu is displayed, press the blue "Limits" button on the GSU. This will call up the Limits menu.

In the Limits menu using the +/- keys, navigate to the parameter: "Battery Type".

Verify/adjust the correct Battery Type. Currently usable options for the battery type are:

"LiFePo3Cell 9.9V"

Or

"LiPo2Cell 8.4V"



Do not use/select other battery types than these allowed types.

Per default "LiFePo3Cell 9.9V" are supplied with the engine.

It is essential that the correct battery chemistry and cell count is selected here. The system uses this information to select the charge termination voltages as well as cell balancing voltages.

An incorrect setting can lead to an overcharge of the battery and lead to a fire!



After the battery type has been correctly set, navigate to the parameter “Battery Size (mAh)” and set to the capacity of the engine battery. Per default “LiFePo3Cell 9.9V” with 2100mAh are supplied with the engine.



The battery capacity is used to calculate the charging level/remaining energy of the engine supply battery.

This value will only affect monitoring information provided by the system and has no impact on function of the charging system.

Information readout via GSU

Checking the calculated remaining supply battery capacity

This information is found in the "Info-Menu"

To access the "Info-menu" press the blue "Info" button on the GSU to call up the menu. Then using the +/- keys, navigate to the parameter: "Battery capacity". This value cannot be adjusted/changed and is for information purposes only.

This value actually reflects the remaining calculated battery capacity, based on the maximum capacity programmed/set in the previous step (Parameter "Battery size" in the Limits menu), and the actual energies taken or restored from/to the engine battery.

This value acts like a level indicator for the energy remaining in the engine supply battery.



40% = 848mAh of 2100mAh

The above value will be reset to its maximum every time the parameter "Battery size" in the Limits menu is set or modified. → After change/modification of this parameter the ECU assumes a fully charged battery is now connected to the system.

There is an intelligent tracking function implemented which detects when a battery is actually fully charged. This function will reset the Battery capacity automatically to 100% as soon as a fully charged battery is detected during run/charging.

Checking generator currents and battery charge/discharge currents

This information is found in the "Run-Menu"

To access the "Run-menu" press the blue "Run" button on the GSU to call up the menu.

Then using the +/- keys, navigate to the screen shown below:

Generator current in Amps. Generator current will only flow if engine is running (generator is driven by engine shaft). In this example currently 4.98A of current are being generated/supplied.

Capacity in mAh recharged or used by the engine battery from power up until current .

Positive values mean battery has been charged, negative values indicate battery has been discharged. In this example 689mAh have been charged into the engine battery.



Charging current into or out of the engine battery in Amps.
Charging current will only flow if the engine is running and generator power is high enough.
In this example the engine battery is currently charged at 4.48A from the onboard generator system.
Negative numbers will indicate a battery discharge (e.g. during startup). Battery charging current typically is the generator current minus the other on board current demands like i.e.:the fuel pump/ ECU and charging currents into the receiver batteries etc...

Voltage of the supply battery. Voltage will climb when battery is charged. Charge voltage will be limited automatically once battery is close to fully charged.

Checking charge currents into receiver batteries and cell voltages of engine battery

This information is found in the "Run-Menu"

To access the "Run-menu" press the blue "Run" button on the GSU to call up the menu.

Then using the +/- keys, navigate to one of the screens shown below.

Info: the 3 screens shown below will rotate every second, to stop the "rotation" press and hold the red "Set" button on the GSU.

Last capacity charged into receiver battery #1 in mAh. In this example 2mAh had been charged last time.

Actual charging current into receiver battery #1
In this example, currently 0.31A are flowing into receiver battery #1

Actual capacity (in mAh) charged into receiver battery #1 since power up of the ECU. This value moves to the left, once a charging cycle has been finished and ECU has been powered down. In this example 4mAh had been



Last capacity charged into receiver battery #2 in mAh. In this example 1mAh had been charged last time.

Actual charging current into receiver battery #2
In this example, currently 0.35A are flowing into receiver battery #2

Actual capacity (mAh) charged into receiver battery #2 since power up of the ECU. This value moves to the left, once a charging cycle has been finished and ECU has been powered down. In this example 5mAh had been charged.



Cell1 voltage of engine battery

Cell2 voltage of engine battery

Total voltage of engine battery

Cell3 voltage of engine battery



Power

The operating power for all components of the turbine (starter/glow plug/ECU/fuel pump/valves) is from a 3-cell 9.9V 2200 mAh LiFePo battery. Alternatively, a 2 cell 25C or better LiPoly battery can be used.

The battery plugs directly into the ECU and the ECU powers on automatically when the receiver is switched on. If you plan to store the model for more than a few weeks, the battery should be disconnected.



Do not disconnect the battery after engine has been started up or is running!
The onboard charging system always requires the system battery as a buffer/load.

Do not operate the engine from purely a DC/DC or AC/DC power supply, this will not work and might result in a damage of the on board charging system!!!

Important:

If the BMS-System is used, this must be connected to the 4pin balancing connector of the supply battery. Also make sure that this connection is present before you power up the ECU!



Attention!

Fire! A LiPo/LiFePo battery can explode if incorrect charge parameters are used. You should therefore always refer to the manufacturer's charger instructions. **NEVER** charge the batteries unattended. **Do not exceed the batteries maximum allowed charging current. READ AND OBEY WARNINGS ON BATTERY BEFORE CHARGING!**



Always ensure the batteries are at their optimal charge state before use. The battery is heavily loaded because of the kerosene start. Please also note that at very low ambient temperatures, LiPo/LiFePo batteries have lower capacities. **IMPORTANT: DO NOT INSERT A SWITCH BETWEEN THE BATTERY AND ECU.**