



FES BATTERY PACK GEN2 manual

With integrated BMS (Battery Management System)

Version 1.13

Type: **FES-BP-14S-GEN2**



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Table of content

1. Important notices	3
1.1 Limited Warranty	3
2. General info	4
2.1 Technical data	4
2.2 General layout of the pack.....	5
2.3 Internal BMS	5
2.4 BMS firmware upgrade.....	6
3. Battery pack Charger	7
3.1 Charger general info	7
3.2 Charger to Battery pack connection and charging	9
3.3 BMS Control software.....	12
4. Instalation packs to sailplane	13
4.1 Ground test before each flight	13
5. Taking Battery packs out of sailplane.....	14
6. Storage.....	15
7. Transport.....	15
7.1 Car transport.....	15
8. Used packs	15
9. Revision history.....	15

1. Important notices

It is important to read these manual carefully before using the FES battery pack! It contains important information about your FES system, having a vital importance to the flight safety. If you need more information please contact the FES manufacturer.

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A Yellow triangle is shown for parts of the manual which should be read carefully and are important



Notes with a red triangle describe procedures that are critical and may result in reduced flight safety or may lead to critical situation



A bulb icon is shown when a useful hint is provided to the reader

1.1 Limited Warranty

This LZ design FCU product is warranted to be free from defects in materials or workmanship for one year from the date of purchase. Within this period, LZ design will, at its sole option, repair or replace any components that fail in normal use. Such repairs or replacement will be made at no charge to the customer for parts and labour, the customer shall be responsible for any transportation cost. This warranty does not cover failures due to abuse, misuse, accident, or unauthorised alterations or repairs.

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To obtain warranty service, contact your local LZ design dealer or contact LZ design directly.

2. General info

This is standard FES battery pack which is built from 14 cells which are all wired in serial. For FES application you need two of them. One is marked as A and second as B!

We are using one of the best high power Lithium Polymer cells (LiPo) available on the market produced by renowned manufacturer Kokam. You can find detailed technical data about these cells in [Technical Specifications](#).

Each Battery pack is equipped with internal BMS (Battery Management System) which is fixed above the cells, and is equipped with 16 LEDs to monitor its operation.

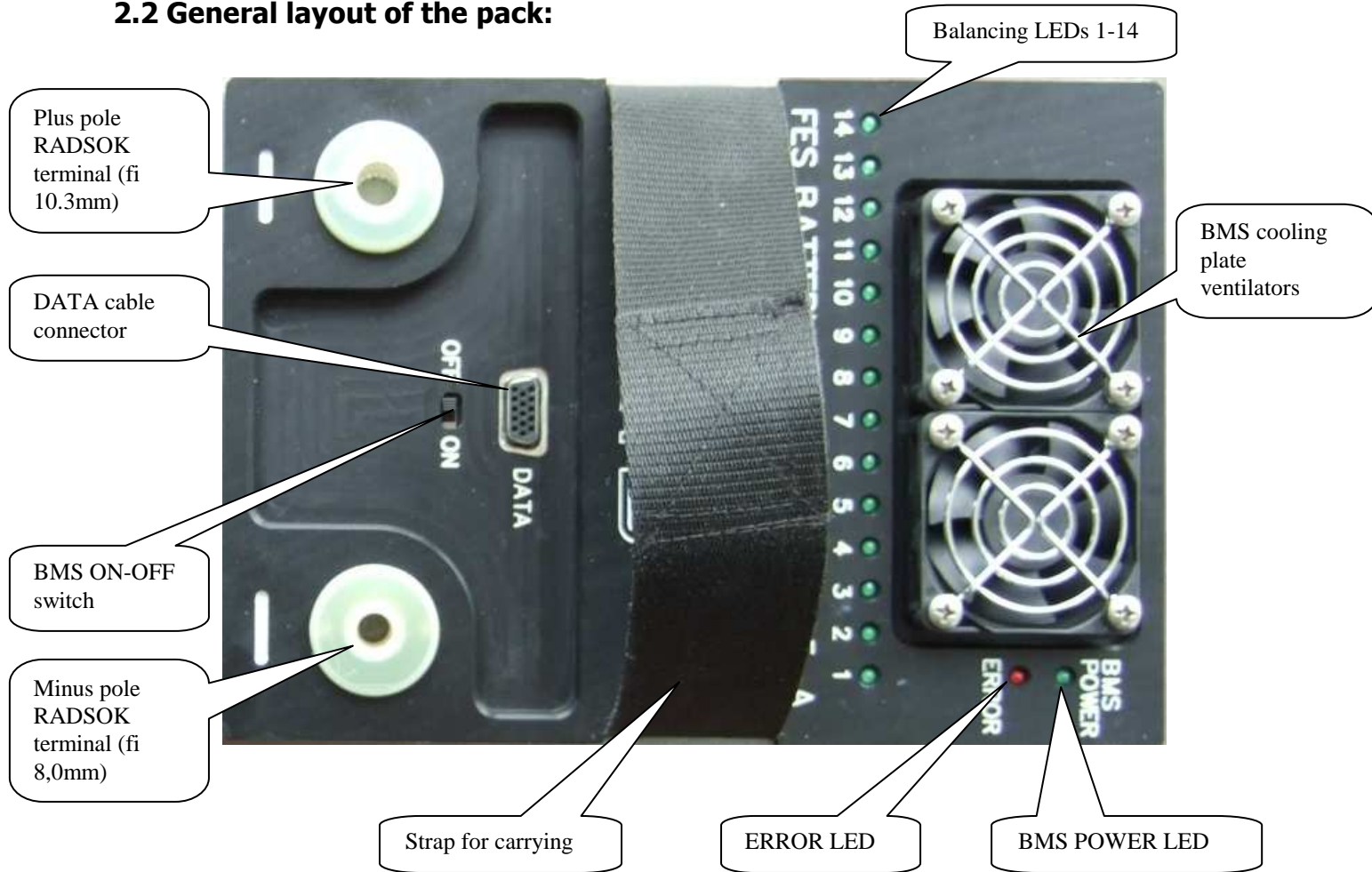
For + and - terminals we chose to use Amphenol Radsok hyperbolic high power contact technology. High current female contacts are hidden inside of the pack.

To avoid possible wrong connections there is 8mm contact for – pole and 10mm contact for +pole.

2.1 Technical data:

Battery pack type	FES-BP-14S GEN2
Weight of single battery packs	16 kg
Box dimensions (WxLxH), without terminals and ventilators	154x220x257 mm
Cells producer	Kokam, South Korea
Cells type	SLPB100216216H
Average capacity of each cell	43 Ah
Number of cells	14
Energy storage capacity	2,1 kWh
Maximum total voltage	58,3 V
Minimum total voltage	42 V
Maximum current	250A
Max balancing current per cell	1A
Internal BMS type	FES-BMS-9R
Standard charger	KOP602 BMS
Optional charger	KOP1001 BMS

2.2 General layout of the pack:



Top view of FES GEN 2 battery pack

2.3 Internal BMS

Your battery packs are equipped with internal BMS (battery management system) electronic circuit. What is a BMS?

During charging and discharging LiPo battery cells differ in voltage levels, due to slightly different capacity of cells. Cells with lower capacity charge and discharge faster than cells with higher capacity. LiPo cells have nearly linear voltage to capacity dependence. BMS controls the voltage of each cell in the battery pack. Cells which have higher voltage than others are discharged through resistor inside of BMS – the energy dissipates through heating of upper plate of pack which is milled from Aluminum. To improve dissipation of the heat there are two small ventilators on top of the upper plate which starts when upper plate reach preset temperature.

Balancing of each cell is indicated by green light emitting diode (LED).



Internal BMS in battery pack balance cells only in the presence of a CHARGER and above pre-set balancing voltage.

BMS INITIAL SETTINGS

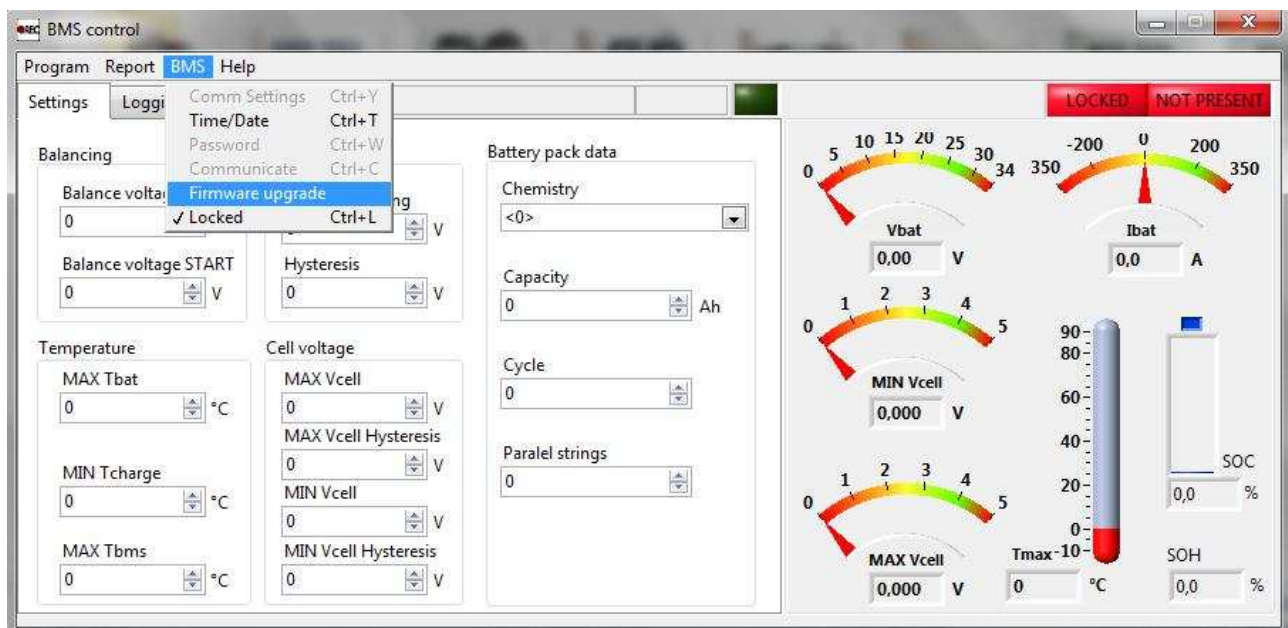
Parameter	Value	Unit
Single cell end of charge voltage*	4.16	V
Single cell charging hysteresis*	0.1	V
Single cell balance start voltage*	4.1	V
Maximum charging current	18	A
Single cell balance 100 %*	4.16	V
Balance resistor	3.9	Ω
Single cell under-voltage protection*	3.24	V
Single cell over-voltage protection*	4.20	V
Single cell over and under-voltage protection hysteresis	0.01	V
BMS over-temperature protection*	45	°C
BMS over-temperature hysteresis	10	°C

***Initial settings may be changed with BMS Control software.**

2.4 BMS firmware upgrade

If it would be necessary, then it is easy to perform upgrade of BMS firmware using provided BMS-Charger-PC cable, and BMS Control software.

Upgrade file is specific for each BMS as its included also serial number of BMS. We can send you suitable upgrade files by email.



3. Battery pack Charger

For charging FES battery pack we provide a special CHARGER as part of complete FES system.



If you are ordering only Battery packs, than you need to specify if you want to order also charger and which type!

3.1 Charger general info

Two types of chargers are suitable for charging FES battery packs.

1. KOP1001 BMS version (1200 W, 3,9kg), with maximum charging current 18A.
This is standard FES charger.



KOP1001 BMS Charger

2. KOP602 BMS version (600 W, 2,2kg), maximum charging current 9A.
This is smaller optional FES charger.



KOP 602 BMS Charger

Battery chargers KOP1001 and KOP602 are modern programable fully automatic devices, which works only in combination with BMS which is inside of battery pack.

We program each charger with suitable settings for FES BP 14S GEN2.

The charger stores data about charging times and Ah charged. This data may be accessed for further analysis by manufacturer.

Required input voltage is 230V~ 50/60 Hz. Unfortunately is not available 110V version of charger. If your country is using 110V grid, than you should use suitable voltage step up transformer.



Before using the charger, check that the fuse on the grid is suitable. For 1200W charger it should be minimum 10A fuse. Always try to connect charger directly to inlet, without extension cables and splitters if possible.



Each Battery pack must be charged separately.



If you ordered another pair of Battery packs, make sure that you do not mix boxes between the sets. The same two boxes of one set must be always be used!



Optionally, an additional charger could be ordered, so that you could charge both packs simultaneously. However, you should check that you have a suitable fuses (16 A) on the grid.

3.2 Charger to Battery pack connection and charging

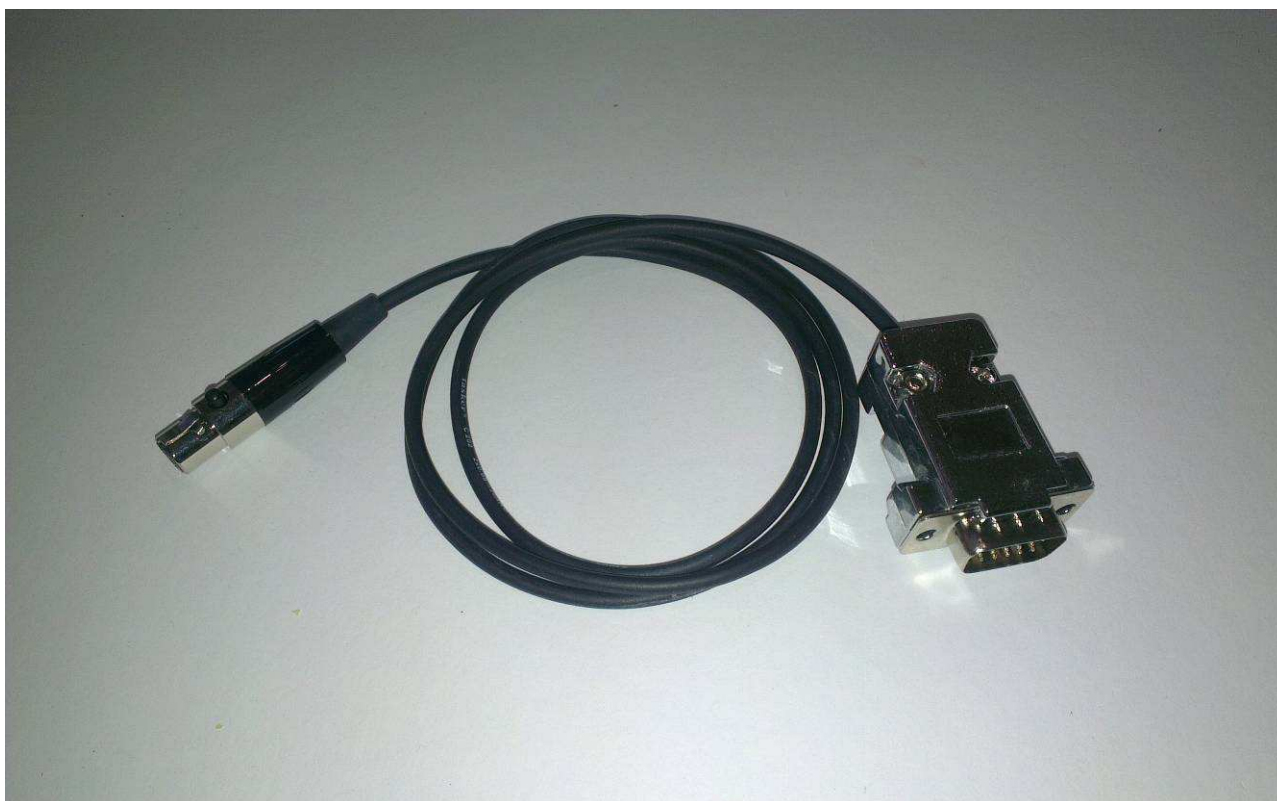


Place Charger on a safe, secure position. Keep away from dust, direct sunlight, fire, smoke, children and any unattended person!



Before charging an inspection for physical condition of battery packs should be done. Any sign of physical damage such a punctures, dents, scratches, must be evaluated before charging.

1. Connect RED + and BLACK - cables from charger to first battery pack.
2. Connect charger and Battery pack with BMS-Charger signal cable.



BMS-Charger signal cable

3. Plug in Charger to (220V AC, 50-60hz only) outlet
4. Turn on BMS switch on top of Battery pack cover

Immediately after BMS is switched ON, the BMS starts test procedure - with check of all 14 cells, one by one. Red »Error LED« turns ON during system's test procedure, and switch OFF again when test is completed without error.

5. When test procedure is completed also a green »Power LED« starts blinking, which is clear sign that BMS starts working in normal mode. At the same time, BMS sends signal to the CHARGER in order to start charging. Orange LED on front panel of the CHARGER starts burning, which indicates charging. It is also possible to hear the sound of contactor "click" inside of the CHARGER. Charging current rises slowly to the final value of 9 A (or 18A at 1200W version), and after some time, cooling fans in CHARGER starts.

6. In normal mode green »BMS Power« LED of BMS is starting flashing. This means that the BMS is turned ON, but not necessary balancing. Normally balancing starts when one cell reaches pre-set value, usually 4,1V (could be changed by BMS Control Software). If any of 14 green LED cell balancing indicators is ON, it means that this cell have slightly higher voltage compared to the lowest one.



Possible scenarios:

1. If one or more cells have higher voltage levels than the others, it will discharge them, the BMS temperature rise will be minimal.
2. If only one cell has lower voltage level than all the others, all higher cells need to be balanced. This leads to higher BMS temperature, even if voltage difference is only 0.010 V (10mV).

If BMS gets hot despite of working ventilators (more than 55 °C) during charging, this means that it has a lot of work with balancing (scenario 2). In such case CHARGER will switch off automatically until temperature of BMS will drop for about 10 degrees.

7. Red »Error LED« is ON only during the initial test procedure. After the test is finished it turns OFF. Some system errors are also indicated with red »Error LED« by the number of ON blinks, followed by a longer OFF state. Number of blinks identifies the error:

Number of ON blinks	Error
1	Single or multiple cell voltage is too high (4.2 V)*.
2	Single or multiple cell voltage is too low (3.24 V)*.
3	Cell voltages differs more than 20 mV (0.02 V).
4	Cells temperature is too high (>55 C)*.
5	BMS temperature is too high (>50°C)*.
6	Number of cells is not set properly.
7	Too low temperature for charging < -1 °C.
8	BMS do not recognize temperature sensor.
9	Communication error.
10	Measurement of cell below 0,1V or above 4,8V.
13	Wrong chemistry set by BMS control software.

*Initial settings may be changed with BMS Control Software.

8. When first cell reaches 4.160V, charging current is reduced. If there is a big difference between cells (more than 50mV) than it can take quite long until they all reach 4,16V, as charging current is only 1A.
9. When finally all cells reach 4.160V (+/- 2mV) then **BMS send a signal to CHARGER to stop charging**. Green "Power LED" stop flashing and **is turned ON** When this happened charging and balancing is properly **completed!**
10. Switch OFF BMS on top of Battery pack. Unplug charger from outlet. Remove charging cables and signal cable from Battery pack.
11. Charge second Battery pack!

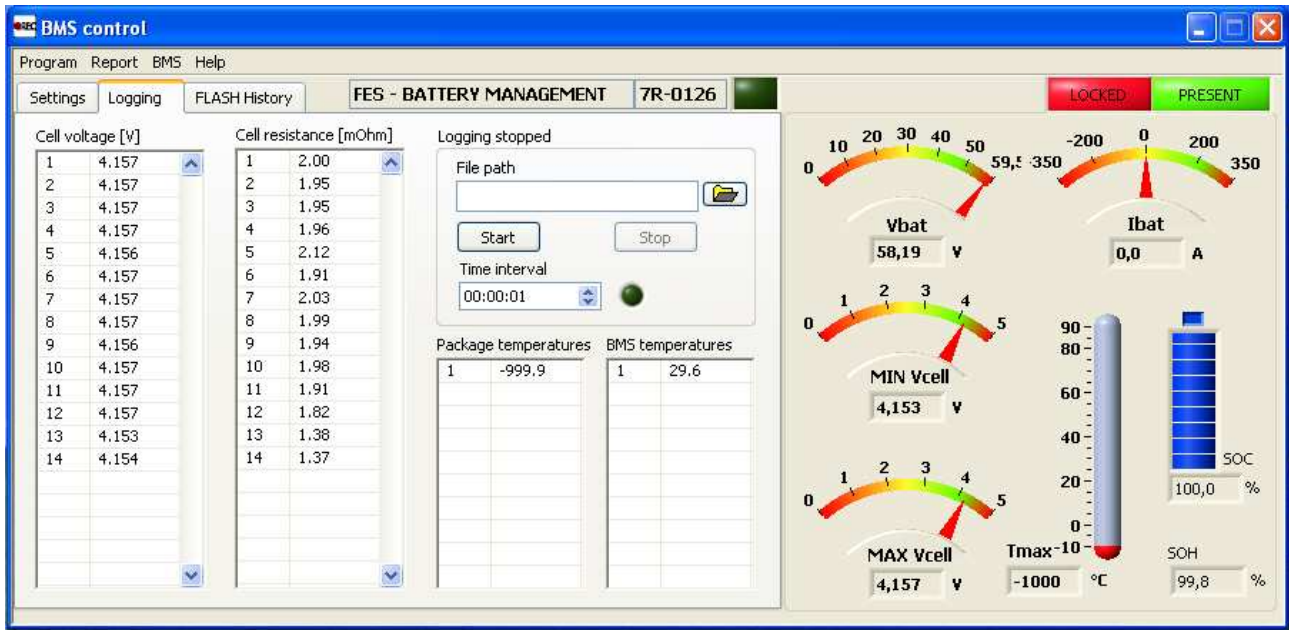


Both battery packs **must have** approximately the same cell voltage levels (close to 4.16 V per cell), before usage. Using two packs with too much difference in voltage levels is not allowed!

Maximum 0,4V difference between total voltages of both packs is acceptable. If is more is not OK!

For instance Pack 1: 58,24V (4.160 per cell), Pack 2: 57,82V (4,130V per cell), this is just acceptable!

3.3 FES BMS Control software



Cells voltage levels on fully charged battery pack

If you want to monitor and log how voltage level of each cell in battery pack is rising during charging, you can use dedicated BMS Control software on PC.

In case that some problems is discovered during charging, log file can be created and later you can send it by email to FES manufacturer. It can help us to discover the problem and find a suitable solution.

How to install and use FES BMS Control software is described step by step in dedicated FES BMS Control manual.

4. Instalation of Battery packs into sailplane



*Both battery packs **must have** approximately the same cell voltage levels (close to 4.16 V per cell), before usage. Using two packs with more than 0,4V difference in total voltage levels between packs is not allowed!*

1. Open battery compartment cover
2. Check that "Power switch" is OFF
3. Check that FCU instrument and all other instruments (Flight computer, Flarm, Radio, Transponder, PDA...) are switched OFF
4. Insert first pack into the fuselage so that terminals are facing forward and slide it back to rear position.
5. Insert second pack into the fuselage so that terminals are facing rearward.
6. Place pair of fixation plates in the middle of rear pack, above carrying strap and tighten fixation knob.
7. Place pair of fixation plates in the middle of front pack, above carrying strap and tighten fixation knob.
8. Lift power cables from side support.
9. Plug in shorter cable, with 8mm pin in BLACK housing, to minus marked 8mm socket of front battery pack.
10. Plug in longer cable with 10mm pin in RED housing, to plus marked 10mm socket of rear battery pack.
11. Insert DATA cable connectors, to each battery pack DATA connector.
12. Turn ON "BMS switch" on each battery pack, and wait until initial check is completed
13. Close battery compartment cover

4.1 Ground test before each flight



It is strongly recomended to perform short ground test run before a flight, to be sure that everything works fine.

1. Remove a tail dolly in order to achieve safe propeller clearance
2. Open battery compartment cover
3. Check that "Power switch" is OFF
4. Insert "connecting cable" between the front pack + terminal, and rear pack - terminal
5. Seat into the cockpit of the glider, and close canopy
6. Check that nobody is in line of propeller disk or in front of sailplane
7. Switch ON FCU, and wait a few seconds until appearance of normal screen
8. Switch ON "Power switch"
9. Wait about 8 second, and battery capacity bottles should get back to 100% value (this will happened only if total voltage is above 114V)
10. Gently rotate throttlly knob clockwise in order to start motor. Use only small RPM, just to check if system works normally.



New battery capacity will not be stored to the FCU memory, only when motor is started.



In case that you would like to test system at max power, somebody needs to hold a fuselage tube down, and hold a glider.

11. Check if propeller braking and automatic positioning is working fine



"Connecting cable" which is used to connect both Battery packs together in a glider

5. Taking Battery packs out of sailplane

1. Check that "Power switch" is OFF
2. Check that FCU instrument and all other instruments (Flight computer, Flarm, Radio, Transponder, PDA...) are switched OFF
3. Open battery compartment cover
4. Pull out "Connecting cable" from battery packs
5. Pull out both (RED + and BLACK -) power plugs from battery packs
6. Fix both power cables to the right side of battery compartment box
7. Remove DATA connectors, from each battery pack
8. Fix DATA cable to the side of battery compartment box
9. Unplug tighten battery pack fixation knobs
10. Take all fixation plates out
11. Firmly grip the front battery by a carrier strap
12. Lift it out of the fuselage and put it on safe place
13. Firmly grip the rear battery by a carrier strap and slide it forward along the bottom of the battery compartment
14. Lift the battery pack out of the fuselage and put it on safe place
15. Close battery compartment cover

6. Storage

When you will stop flying before the winter (or any other longer period of no flying) it is advisable to discharge Battery packs to middle voltage which is 3,7V per cell. (this is about 52V per pack, or 104V on FCU instrument). Store packs at room temperature of 20 degrees or lower temperature (for instance in the basement where is usually colder), at normal humidity conditions.



Always try to avoid having packs exposed to high temperature, as high temperature is decreasing life of cells significantly.

7. Transport

7.1 Car transport

When transporting your packs with your car, make sure that battery packs can not move during car acceleration and braking. In case when luggage surface in your car is very slidy, we advise you to use special transport box, which you can order as part of optional equipment. Its construction effectively prevent sliding and moving of packs in your car.

Do not leave packs for longer time in hot car under sun.

8. Used packs

Check document "Handling instruction for used battery"

9. Revision history

February 2013	Initial release of manual
March 2013	Minor updates, Version 1.1
June 2013	Updates of error codes Version 1.11
December 2013	New photo of BMS-PC cable Version 1.12
August 2014	Some info about good practice added Version 1.13