



# **FES BATTERY PACK GEN1 manual**

## **With external BMS (Battery Management System)**

Version 1.13

Type: **FES-BP-14S GEN1**



LZ design d.o.o., • Brod 3D, 1370 Logatec, Slovenia • tel +386 59 948 898  
[info@lzdesign.si](mailto:info@lzdesign.si) • [www.front-electric-sustainer.com](http://www.front-electric-sustainer.com)

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## 1. Important notices

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

Information in this document is subject to change without notice. LZ design reserves the right to change or improve their products and to make changes in the content of this material without obligation to notify any person or organization of such changes or improvements.



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 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 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 unauthorized 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](#).

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



*Never ever shortcut terminals with a metal conductor! This is very dangerous!*

*Handle with care!*

*Do not try to open Battery pack*



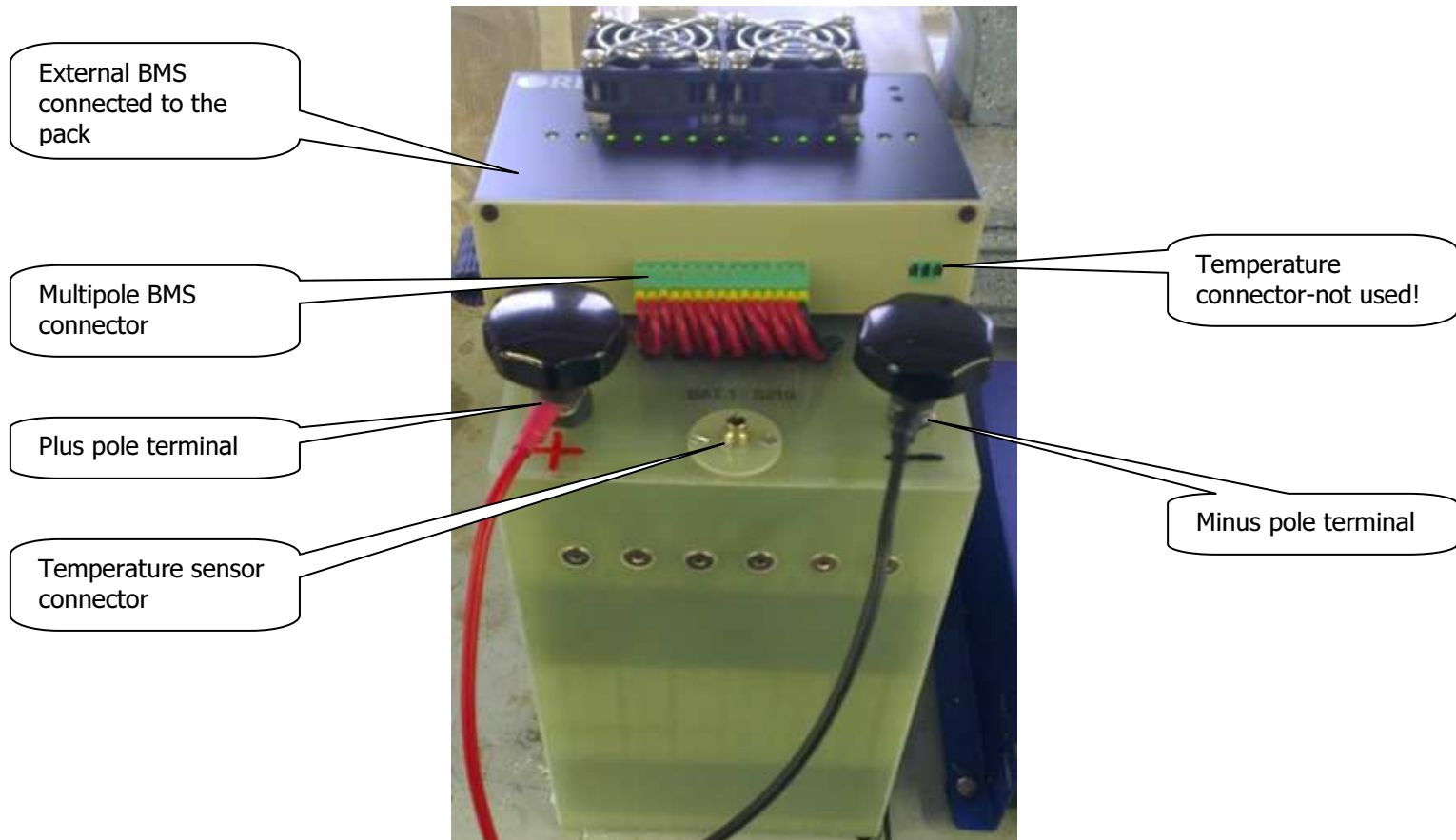
*Do not touch terminals with both hands!*

*Keep battery packs away from children!*

### 2.1 Technical data:

Battery pack type	FES-BP-14S GEN1
Weight of single battery pack	15,5 kg
Box dimensions (WxLxH), without terminals and connector for BMS	154x220x240 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
Approved external BMS type	FES-BMS-7R
Standard charger	KOP1001 BMS
Optional charger	KOP602 BMS

## 2.2 General layout of the Battery pack with connected BMS



## 2.3 External FES-BMS-7R

With Battery packs is delivered usually one or optionally two external BMS (Battery Management System - type FES-BMS-7R) which needs to be inserted into multipole green connector above the cells during charging process. BMS is equipped with 14+2 LEDs to monitor its operation.

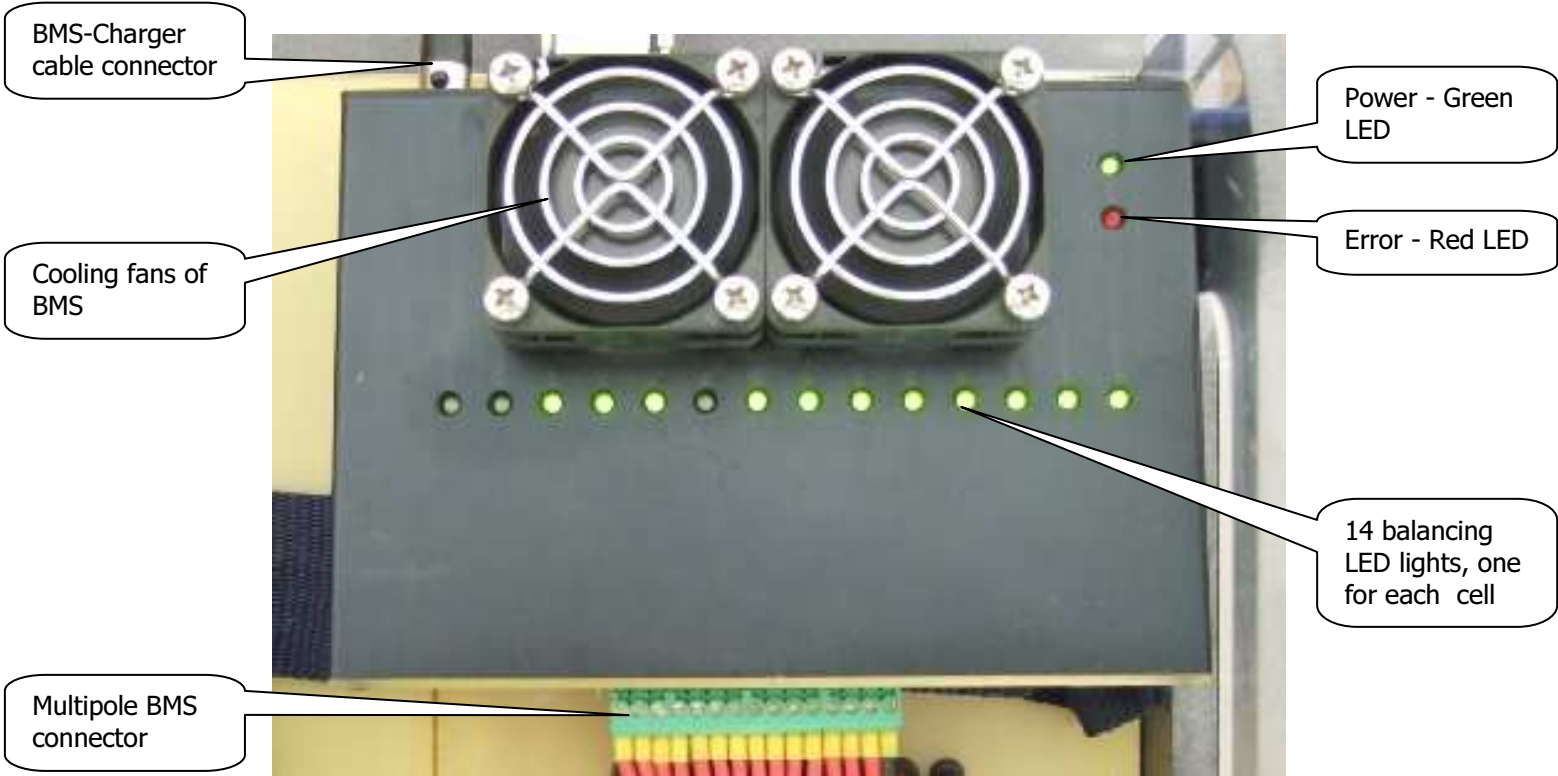
Why BMS is required and how it works?

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 the BMS aluminum housing box. To improve dissipation of the heat there are two small ventilators on top of the BMS which starts when temperature of the box reach preset temperature.

Balancing of each cell is indicated by 14 green light emitting diode (LED).



*External BMS can balance cells also without presence of a CHARGER if voltage of cells is above pre-set balancing voltage (only at GEN1 packs)*



Different LEDs are blinking during balancing process

**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 External BMS firmware update**

Update of external BMS firmware, is possible only by manufacturer!

### 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, then 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 provided with GEN1 packs.



KOP1001 BMS Charger

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



Smaller KOP 602 BMS Charger

Battery chargers KOP1001 and KOP602 are modern programable fully automatic devices. They are programmed so, that they works only in combination with provided BMS. BMS needs to be connected to battery pack multipole connector, and with a signal cable to the charger.

**Charger is programmed with suitable settings for FES BP 14S GEN1. Do not extent or shorten + and - charging cables as this would effect on charging, due to voltage drop on cables!**

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, then 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 in this case, you should check that you have a suitable fuse (16 A) on the grid.



BMS-Charger signal cable plugged into the Charger, yellow LED light is ON-Charger is working





BMS-Charger signal cable with round connectors on each side



ON-OFF  
switch (on  
back side  
on BMS)

BMS-charger  
cable  
connector

BMS-PC cable  
connector (on  
back side)

Back side of BMS with ON-OFF switch, BMS-PC cable with DB9 connector, BMS-Charger signal cable with round connector connected

### 3.2 Charger to Battery pack connection and charging



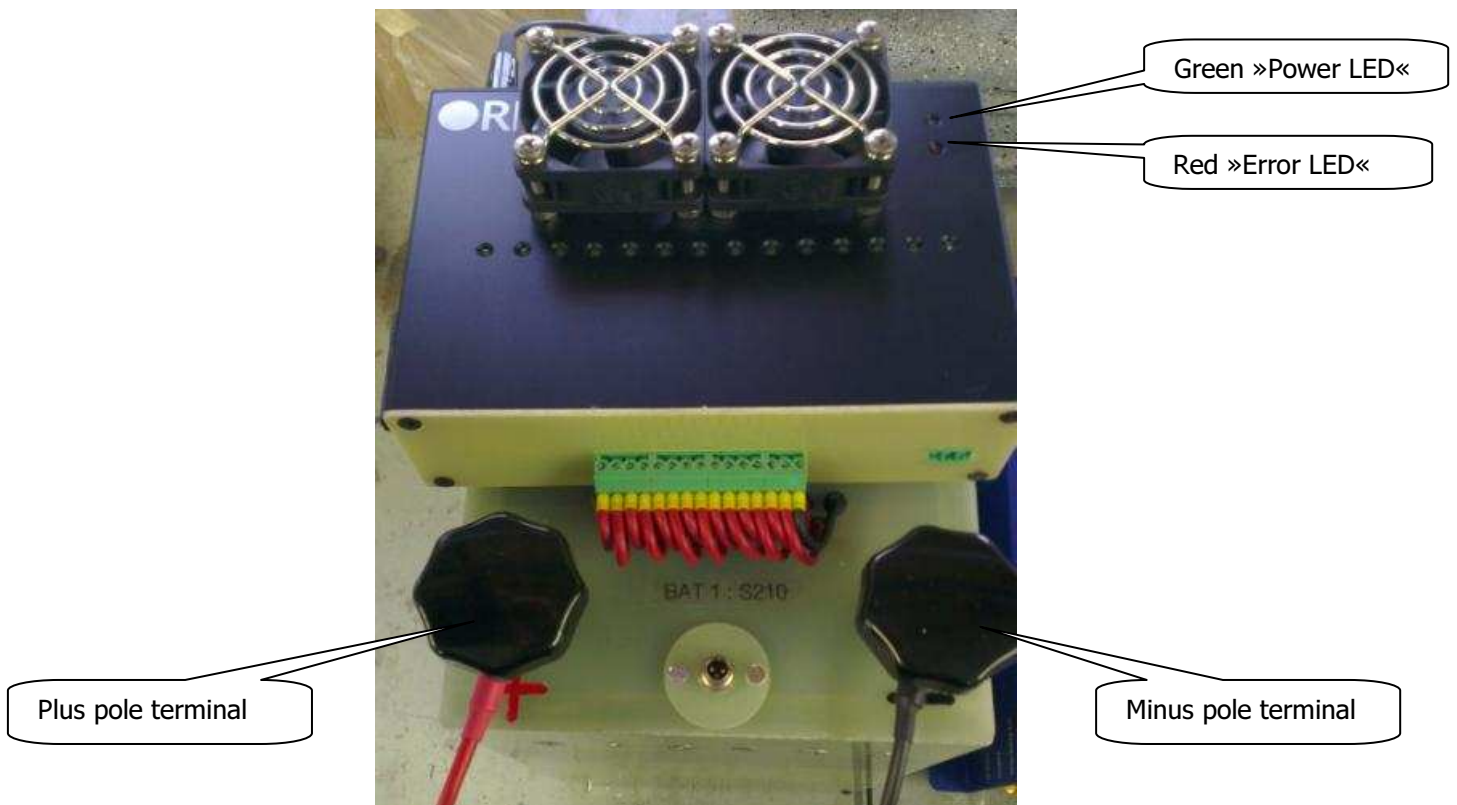
*Place Charger on a safe, secure position. Keep away from dust, direct sunlight, fire, smoke, children and any unattended person!*



*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 BMS to first battery pack
2. Connect RED + and BLACK - cables from charger to first battery pack
3. Connect charger and battery pack with Charger-BMS signal cable
4. Plug in Charger to 220V 50hz outlet
5. Turn ON switch on back side of BMS

Immediately after BMS switching ON, the BMS starts test procedure. Red »Error LED« turns ON to signal the system's test procedure.



6. If the test procedure is OK, then »Error LED« turns OFF and BMS starts working in normal mode. BMS sends signal to the CHARGER to start charging and »Orange LED« on CHARGER indicates the start of charging. It is also possible to hear the contactor "click" inside of the CHARGER.

Charging current rises slowly to the final value of 18 A, and cooling fans in CHARGER starts working.

7. In normal mode green »Power LED« of BMS is 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 are ON, it means that those cells have slightly higher voltage compared to the lowest one.

If there is more than 30mV (preset value) difference between highest and lowest cell, then balancing start even before one cells reach 4,1V.

**Possible scenarios:**



1. If one or more cells have higher voltage levels that the others, it will discharge them, the temperature rise of BMS 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.**

8. Red »Error LED« is ON only during the initial test procedure. After the test is completed, 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 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).
5	BMS temperature is too high (50°C)*.
6	Number of cells is not set properly.
9	Wrong chemistry settings in BMS

\*Initial settings may be changed with BMS Control Software.

9. When first cell reaches 4.160V, charging current is reduced. If there is a big difference between cells (more than 50mV) then it can take quite long time until they all reach 4,16V, as charging current is only 1A.

10. When finally all cells reach 4.160V (+/- 2mV) than **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!**



When green Power LED is continuously ON, this clear sign that charging process is properly completed!

- 11.** Switch OFF BMS and disconnect it from Battery pack. Unplug charger from outlet. Remove charging cables and signal cable from Battery pack.
- 12.** Charge second Battery pack!

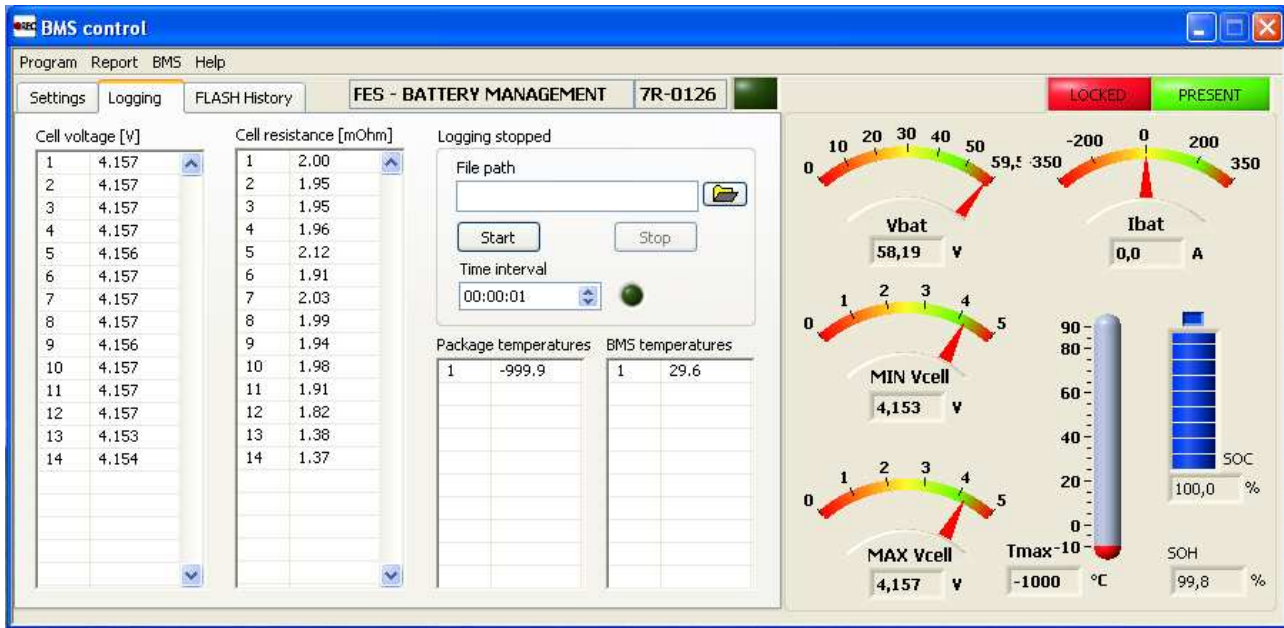


Both battery packs **must have** approximately the same cell voltage levels (close to 4.16 V per cell), before usage. Using two packs with too much difference in voltage levels is not allowed!

Maximum 0,4V difference between total voltages of both packs is acceptable. If there is bigger voltage difference it is **not acceptable!**

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



Fully charged cells

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 are 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. Installation 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 different 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. Put one battery packs into the fuselage so that terminals are facing forward
5. Slide it back to rear position
6. Put another pack into the fuselage so that terminals are facing rearward
7. Place fixation plates
8. Tighten fixation knobs on fixation plates
9. Insert and secure both temperature sensor connectors, to each battery pack
10. Connect + red power cable to M10 threaded + terminal of front battery pack and tighten it well with a knob
11. Connect - black power cable to M8 threaded - terminal of rear battery pack, and tighten it well with a knob
12. Close cover of battery compartment

#### 4.1 Ground test before each flight



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

1. Remove a tail dolly in order to achieve safer propeller clearance
2. Open cover of battery compartment
3. Check that "Power switch" is OFF
4. Insert "Power fuse" between free + and – terminals of the packs, and tighten both knobs
5. Close cover of battery compartment
6. Seat into the cockpit of the glider, and close canopy
7. Check that nobody is in line of propeller disk or in front of the sailplane
8. Switch ON FCU
9. Switch ON "Power switch"
10. Wait about 8 second, and battery capacity bottles should get back to 100% value (this will happened only if total voltage is above 114V)
11. Start motor but use only small RPM to check proper operation. In case that you would like to test system at max power, somebody needs to hold a fuselage tube down, and hold a glider
12. Check if propeller braking and automatic positioning is working fine

#### 5. Taking Battery packs out of sailplane

1. Check that Power switch (Key) is OFF
2. Check that FCU instrument and all other instruments (Flight computer, Flarm, Radio, Transponder, PDA...) are switched OFF
3. Open cover of battery compartment
4. Untighten knobs above Power fuse and remove Power fuse away
5. Untighten knobs above power cables and disconnect them from terminals. Fix power cables to the side of battery compartment box
6. Remove temperature sensor connector, from each battery pack
7. Fix temperature sensor cable to the side of battery compartment box
8. Untighten fixation knobs on top of upper fixation plate
9. Take the fixation plates out
10. Firmly grip the front battery by a carrier strap
11. Lift it out of the fuselage and put it on safe place
12. Firmly grip the rear battery by a carrier strap and slide it forward along the bottom of the battery compartment
13. Lift the battery pack out of the fuselage and put it on safe place
14. Close cover of battery compartment

## 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 (for instance in the basement where is usually colder), at normal humidity conditions.



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

## 7. Transport

### 7.1 Car transport

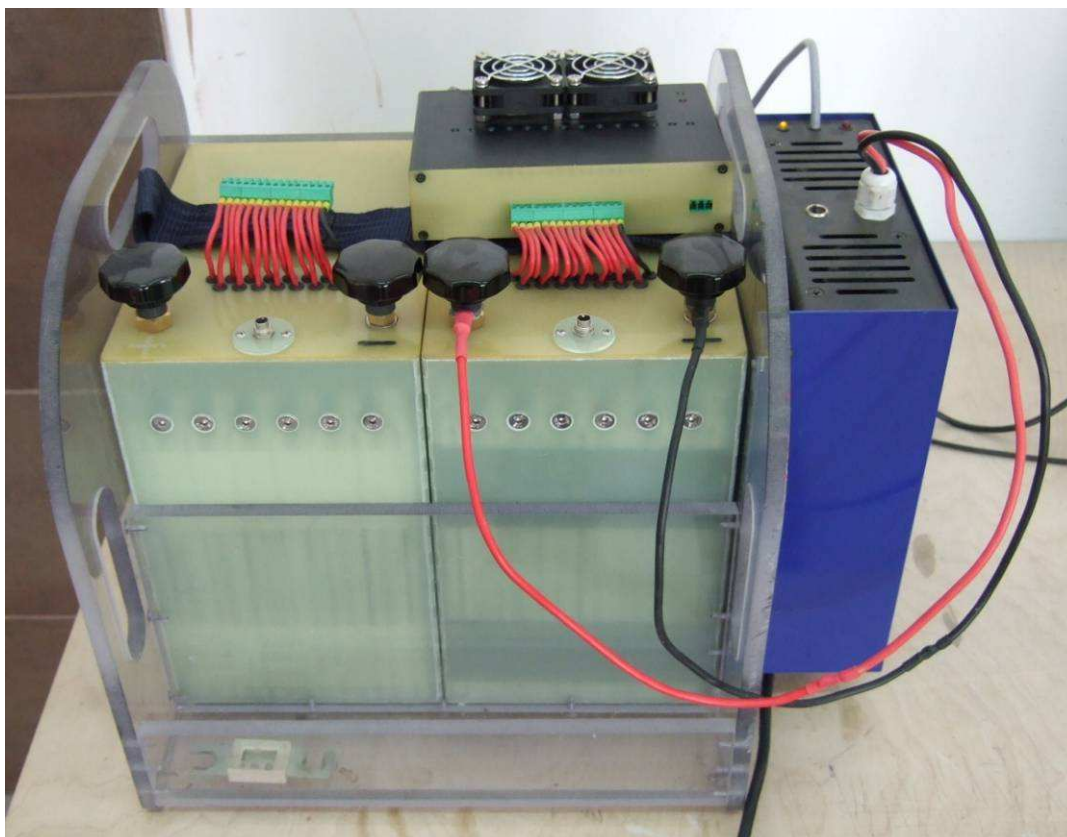
When transporting your packs with your car, make sure that packs can not move during car acceleration and braking. If surface in your car is very slidy, then we advise you to use special transport box, which you can order as part of optional equipment. Its construction effectively prevent sliding and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

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



*During transportation always use terminal protection covers (or knobs on some types)!*

Optionally is available special box for transportation of battery packs in a car. It is designed so that it preventing sliding of battery packs in luggage compartment, in turns. Charger can also be fixed on this box if requested. Front part of the transportation box has a suitable space for storage of BMS and cables when not used.



**8. Used packs**

Check document "Handling instruction for used battery"

**9. Revision history**

February 2013	Initial release of manual, Version 1.0
April 2013	Minor updates, Version 1.1
June 2013	Minor updates, Version 1.11
February 2014	Minor update, Version 1.12
August 2014	Some info about good practice added, Version 1.13