FES BATTERY PACK GEN2 manual
With integrated BMS (Battery Management System)
Version 1.19
Type: FES GEN2 14S

LZ design d.o.o., • Brod 3D, 1370 Logatec, Slovenia • tel +386 59 948 898
info@lzdesign.si • www.front-electric-sustainer.com

UAB "SPORTINE AVIACIJA ir KO" Chief designer
_____________________________________________ /K. Juočas/
2017-10-18

UAB Sportinė Aviacija ir Ko, Debesu str.16, Pociunai LT-59327, Prienai, Lithuania
tel.: +370 319 60567, mob.: +370-685- 82668. Web: www.lak.lt E-mail: info@lak.lt
# Table of content

1. Important notices ........................................................................................................................................ 3  
   1.1 Limited Warranty .................................................................................................................................. 3
2. General info .................................................................................................................................................. 4  
   2.1 Technical data ....................................................................................................................................... 4
   2.2 Drawing .................................................................................................................................................. 5
   2.3 General layout of the pack .................................................................................................................... 6
   2.4 Internal BMS ......................................................................................................................................... 7
3. Battery pack Chargers ................................................................................................................................. 8
   3.1 Available chargers ............................................................................................................................... 8
   3.2 Charger to Battery pack connection and charging ............................................................................. 10
   3.3 BMS Control software ....................................................................................................................... 13
4. Before flight ............................................................................................................................................... 14
   4.1 Installing the batteries ........................................................................................................................ 15
   4.2 Preflight test run .................................................................................................................................. 16
5. After landing ............................................................................................................................................... 18
   5.1 Removing the batteries ....................................................................................................................... 18
6. Maintenance ............................................................................................................................................... 19
   6.1 BMS firmware upgrade ...................................................................................................................... 20
7. Transport .................................................................................................................................................... 21
   7.1 Car transport ....................................................................................................................................... 21
   7.2 In glider trailer ...................................................................................................................................... 23
   7.3 Ship/train transport ............................................................................................................................. 23
8. Storage ....................................................................................................................................................... 24
9. Used packs ................................................................................................................................................... 26
10. Revision history ........................................................................................................................................... 26
1. Important notices

It is important to read this 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 LZ design.

"WARNING" means that the non-observation of the corresponding procedure leads to an immediate or important degradation of the flight safety.

"CAUTION" means that the non-observation of the corresponding procedures leads to a minor or to a more or less long term degradation of the flight safety.

"NOTE" draws the attention on any special item not directly related to safety, but which is important or unusual.

1.1 Limited Warranty

This 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.

THE WARRANTIES AND REMEDIES CONTAINED HEREIN ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED OR STATUTORY, INCLUDING ANY LIABILITY ARISING UNDER ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, STATUTORY OR OTHERWISE.

IN NO EVENT SHALL LZ DESIGN BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, WHETHER RESULTING FROM THE USE, MISUSE, OR INABILITY TO USE THIS PRODUCT OR FROM DEFECTS IN THE PRODUCT.

LZ design retains the exclusive right to repair or replace the unit or software, or to offer a full refund of the purchase price, at its sole discretion. 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 (14S). For standard FES application, always a pair of such battery packs is required. One pack is marked as A and second pack as B!

We are using high power SLPB (Superior Lithium Polymer Battery) type of cells, produced by global leader of Lithium polymer battery industry - Kokam Co.

Each Battery pack is equipped with internal BMS (Battery Management System) circuit board 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 10,3mm contact for + pole.

2.1 Technical data:

<table>
<thead>
<tr>
<th>Battery pack type</th>
<th>FES GEN2 14S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of single battery pack</td>
<td>15,7 kg</td>
</tr>
<tr>
<td>Box dimensions (WxLxH), without terminals and ventilators</td>
<td>154 x 220 x 257mm</td>
</tr>
<tr>
<td>Cells producer</td>
<td>Kokam, South Korea</td>
</tr>
<tr>
<td>Electrochemical system</td>
<td>NMC (LiMnNiCoO2)</td>
</tr>
<tr>
<td>Cells type</td>
<td>SLPB100216216H</td>
</tr>
<tr>
<td>Average capacity of each cell</td>
<td>41 Ah</td>
</tr>
<tr>
<td>Number of cells</td>
<td>14</td>
</tr>
<tr>
<td>Energy storage capacity</td>
<td>2,1 kWh</td>
</tr>
<tr>
<td>Maximum total voltage</td>
<td>58,3 V</td>
</tr>
<tr>
<td>Minimum total voltage</td>
<td>42 V</td>
</tr>
<tr>
<td>Maximum current</td>
<td>250A</td>
</tr>
<tr>
<td>Max balancing current per cell</td>
<td>1A</td>
</tr>
<tr>
<td>Internal BMS type</td>
<td>FES-BMS-9R</td>
</tr>
<tr>
<td>Standard 600W small charger</td>
<td>KOP602 BMS</td>
</tr>
<tr>
<td>Optional 1200W bigger charger</td>
<td>KOP1001 BMS</td>
</tr>
<tr>
<td>Optional 2000W fast charger</td>
<td>Robust R2300 BMS</td>
</tr>
</tbody>
</table>
2.2 Drawing
2.3 General layout of the pack:

Top view of FES GEN 2 battery pack
2.4 Internal BMS

FES GEN2 battery pack is equipped with BMS (Battery Management System) electronic circuit.

How BMS works?

BMS electronic measure and control voltage level of each cell in the battery pack. During charging and discharging, battery cells differ in voltage levels, due to slightly different capacity of the cells. Cells with lower capacity become fully charged faster than cells with higher capacity. Those cells which reach maximum preset voltage earlier than the others, are discharged through resistors inside of BMS – the energy dissipates through heating of the upper cover plate, which is milled from Aluminum, and black anodized. To improve dissipation of the heat there are two small ventilators on top of the upper plate which starts running when upper plate reach preset temperature (50°C)
Balancing of each cell is indicated by green light emitting diode (LED).

Note: BMS starts balancing cells only during charging, and above pre-set balancing start voltage (4.10V)

**BMS DATA AND INITIAL SETTINGS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum charging current**</td>
<td>9,18 or 35</td>
<td>A</td>
</tr>
<tr>
<td>Maximum balancing current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>Single cell end of charge voltage*</td>
<td>4.16</td>
<td>V</td>
</tr>
<tr>
<td>Single cell balance voltage start*</td>
<td>4.10</td>
<td>V</td>
</tr>
<tr>
<td>Single cell balance voltage end*</td>
<td>4.16</td>
<td>V</td>
</tr>
<tr>
<td>Single cell under-voltage protection*</td>
<td>3.1</td>
<td>V</td>
</tr>
<tr>
<td>Single cell over-voltage protection*</td>
<td>4.18</td>
<td>V</td>
</tr>
<tr>
<td>Cooling fans start temperature*</td>
<td>50</td>
<td>°C</td>
</tr>
<tr>
<td>Max BMS temperature*</td>
<td>55</td>
<td>°C</td>
</tr>
</tbody>
</table>

*Initial settings may be changed with BMS Control software.
**Max charging current depends on type of charger.
3. **Battery pack chargers**

For charging FES battery pack, we provide special chargers as part of complete FES system.

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

### 3.1 Available chargers

Three types of chargers are available for charging FES GEN2 battery packs:

1. **KOP602 BMS version** (600 W, 2.2kg), maximum charging current 9A. This is standard small FES charger. We provide two such chargers so that both FES GEN2 battery packs can be charged at the same time.

![KOP 602 BMS Charger](image)

2. **KOP1001 BMS version** (1200 W, 3.9kg), with maximum charging current 18A. This is optional FES charger.

![KOP1001 BMS Charger](image)
3. Robust R2300 BMS version (2000W, 6.1kg), with maximum charging current 35A. This is optional FES charger.

KOP602, KOP1001 and R2300 are modern programmable fully automatic battery chargers, which works only in combination with BMS which is inside of the battery pack.

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

Those chargers 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.

**Note:** 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.

**Warning:** If you have another pair of Battery packs, make sure that you do not mix packs between the two sets. The same two packs of one set (first marked as A, second marked as B) must be always used in pair!
3.2 Charger to Battery pack connection and charging

**Caution:** Place charger on a safe, secure position. Keep away from dust, direct sunlight, fire, smoke, childrens and any unattended person!

**Warning:** Before charging, physical condition inspection of the battery packs should be done. Any sign of mechanical damage, such a puncture, dents, scratches, must be evaluated and reported to manufacturer 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.

3. Plug in charger to (220V AC, 50-60hz only) outlet
4. Turn on BMS switch on top of the 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 to start charging. Orange LED on front panel of the charger starts burning, which indicates charging. It is also possible to hear contactor "click" inside of the charger. Charging current rises slowly to the final value of 9 A (or 18A at 1200W, 35A at 2000W 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 has slightly higher voltage compared to the lowest one.

1. If one or just a few cells have higher voltage levels that the others, BMS will discharge them, the BMS temperature rise will be minimal.

2. In case that one cell has lower voltage level than the others, all higher cells will need to be discharged so that at the end all of them will be balanced. This leads to higher BMS temperature rise, even if voltage difference is only 0.010 V (10mV).

If upper BMS cooling plate of battery pack reach 50 °C, then cooling ventilators starts working.

Caution: Sometimes in hot conditions, temperature of BMS cooling plate could still rising despite of working ventilators. In such case when temperature of cooling plate would reach 55 °C, charger would be switched off automatically. When temperature drops down to 45 °C, charger would start charging again.

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:

8. 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 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.

At this point Green “Power LED” stops flashing and become continously Green.

This is clear sign that charging cycle is properly completed!

10. Switch OFF BMS on top of Battery pack. Unplug charger from outlet. Unplug charging cables and signal cable from Battery pack.

11. Charge second FES GEN2 battery pack!

Warning: 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 1V difference between total voltages of both packs is acceptable. If is more 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!

**Caution:** When thunderstorm is approaching, stop charging immediately and disconnect the charger from the wall.

List of red error codes:

<table>
<thead>
<tr>
<th>Number of red blinks</th>
<th>Error description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single or multiple cell voltage is too high (4.2 V) *</td>
</tr>
<tr>
<td>2</td>
<td>Single or multiple cell voltage is too low (3.24 V) *</td>
</tr>
<tr>
<td>3</td>
<td>Cell voltages differ more than preset value (0.5 V) *</td>
</tr>
<tr>
<td>4</td>
<td>Cells temperature is too high (&gt;55 C) *</td>
</tr>
<tr>
<td>5</td>
<td>BMS temperature is too high (&gt;50°C) *</td>
</tr>
<tr>
<td>6</td>
<td>Number of cells is not set properly</td>
</tr>
<tr>
<td>7</td>
<td>Too low temperature for charging &lt; -1°C</td>
</tr>
<tr>
<td>8</td>
<td>BMS do not recognize temperature sensor</td>
</tr>
<tr>
<td>9</td>
<td>Communication error</td>
</tr>
<tr>
<td>10</td>
<td>Measurement of cell below 0,1V or above 4,8V</td>
</tr>
<tr>
<td>13</td>
<td>Wrong chemistry set by BMS control software</td>
</tr>
</tbody>
</table>

*Initial settings may be changed with BMS Control Software.*
3.3 FES BMS Control software

If you want to monitor and log how voltage levels of each cell in the battery pack are rising during charging, you can use dedicated FES BMS Control software on PC (or via optional FES LCD display).

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, which can be obtained from FES dedicated website, in download section.

Cells voltage levels, and calculated internal resistance values on fully charged battery pack
4. Before flight

Valid for FES Self-launchers:

For self-launching FES battery packs must be always recharged, so that maximum power for good climb rate is available. This is especially important for:
- cold batteries, when voltage drop under high power load is bigger
- short runways
- high altitude runways
- hot summer conditions

Valid for FES Self-sustainers:

Before each flying day, battery packs should be recharged, especially if motor was significantly used during previous flights, and long cross-country flight is planned; so that maximum energy will be available when needed.

Note: It is recommended to recharge Battery packs just a day or two before flight is planned. However, plan charging so that there will be enough time for properly completed charging process!
4.1 Installing the batteries

**Warning:** Make sure that both battery packs are fully charged before installation into sailplane. Both battery packs must have approximately the same voltage level of each cell (close to 4.16 V per cell). There should be less than 1V difference, between total voltage levels of each battery pack!

1. Check batteries for any visual damage

**Warning:** Even small visually detectable damages imply that the affected battery is not airworthy.

2. Open battery compartment cover
3. Check: "Power switch" OFF
4. Check: Sailplane main switch (fuse) OFF
5. Insert first pack (terminals facing forward) and slide it back to rear position
6. Insert second pack (terminals are facing rearward)
7. Place pair of fixation plates in the middle of rear pack, above carrying strap and tighten fixation knob
8. Secure forward battery in the same way
9. Lift power cables from side support
10. Plug in shorter cable, with 8mm pin in BLUE (or BLACK) housing, to minus marked 8mm socket of front battery pack
11. Plug in longer cable with 10mm pin in RED housing, to plus marked 10mm socket of rear battery pack
12. Insert DATA cable connectors, to each battery pack DATA connector

**Caution:** Prior to insert DATA cable connector make sure that the orientation is correct. Connector should be plugged in straight direction, otherwise pins could be damaged.

13. Close battery compartment cover

**Warning:** In flight the battery compartment cover must be sealed with tape. If water could possibly enter in the battery compartment on the ground (e.g. rain shower or when cleaning), then also on the ground the battery compartment cover must be sealed. Entering water, even in small quantities, could damage the batteries.
4.2 Preflight test run

After battery packs were recharged, it is always required to perform short motor run, so that FCU instrument can recognize recharge and new charge level is stored to the FCU memory.

Short motor run is also recommended before first flight in flying day.

1. Remove propeller covers and tail dolly
2. Open battery compartment cover
3. Check: Power switch OFF
4. Switch ON, BMS on each battery pack, and wait until initial check is completed
5. Insert connecting cable between the front pack + terminal, and rear pack – terminal
6. Close battery compartment cover, and seal it with tape
7. Seat into the cockpit of the glider, and close canopy
8. Check that nobody is in line of propeller disk or in front of sailplane
9. Switch ON, FCU and wait a few seconds until appearance of normal screen
10. Switch ON, Power switch

11. Wait about 5 second, so that charge level (indicated as bottles) reach 100% value (this will happen only if total voltage is above 114V)
12. Gently rotate throttle knob clockwise to start motor. Use only small RPM, just to check if system works normally

Caution: New battery charge level will be stored to the FCU memory, only if motor is started, for short time.

13. Check if automatic positioning is working properly
14. Switch OFF, Power switch

Standard type of “Connecting cable”, as used on most FES systems
Right angle type of “Connecting cable”, as used on LAK gliders
5. After landing

**Warning:** After last landing in flying day (or if you decided not to fly) it is mandatory to unplug “Connecting cable”, from the battery packs! At the same time, also both BMS switch on top of the battery packs, must be switched OFF.

**Caution:** Make sure that “Power switch” is OFF before removing connecting cable;

**Note:** Only when connecting cable is unplugged, FES system is completely shut down. Otherwise there is still some current consumption, which could result in discharge of battery packs, below critical level of 90V, if connecting cable is left connected for a week or two. After such scenario, a new battery packs would be required.

5.1 Removing the batteries

When battery packs total voltage drops below 110V, it is suitable to take them out of the glider, and recharge them shortly before next flight is planned.

To remove batteries next procedure should be followed:

1. Check: Power switch OFF
2. Check: Sailplane main switch (fuse) OFF
3. Open battery compartment cover
4. Remove Connecting cable from terminals of battery packs
5. Remove red and black power plugs from battery packs
6. Fix both power cables on right side of battery compartment wall
7. Remove DATA connectors from each battery packs
8. Fix DATA cable to side of battery compartment
9. Unscrew both battery pack fixation knobs
10. Take all fixation plates out
11. Firmly grip the front battery by a carrier strap
12. Lift the battery pack out of the fuselage and put it on a safe place
13. Firmly grip the rear battery pack by the carrier strap und slide it forward along the bottom of the compartment
14. Lift the battery pack out of the fuselage and put it on a safe place
15. Close battery compartment cover

**Caution:** For transport and storage of the batteries always a transport box or something similar must be used which protects the batteries from mechanical damage. Make sure you put battery packs on a dry and safe place. Read FES Battery pack manual section 7 and 8 for further instructions.
6. Maintenance

With proper and careful use of FES battery packs, there is practically no maintenance required. FES battery packs are built from the most suitable cells available, so that they can provide high power and good endurance and will serve you for many years and charging cycles.

Unfortunately, some capacity deterioration will occur due to aging of the cells whether the battery packs are in use or not. The useful life of a lithium cells is based on several factors which can prevent the battery from providing sufficient current draw due to increased internal resistance.

Suitable uses and treatment that will reduce this deterioration include:

1. During powered flight, use low power settings as much as possible and practical.
2. Do not discharge cells below 3,4V (total voltage at 95V), if is not really necessary.
3. Store battery packs at suitable temperatures when they are not in use (review next chapter 7. Storage)
4. Store battery packs at suitable charge levels (around 50% SOC, see next chapter 7. Storage)

Good indication of the battery packs condition is SOH - State of Health % parameter, which can be read in lower right corner of BMS control software. It is calculated from average internal resistance of the cells, measured during charging, and number of charging cycles.

With poor treatment of the battery packs, their cells internal resistance will be rising faster, and so calculated SOH % level will become lower. When it will be as low as 50%, it would be time to think about replacement of the battery packs (at least the cells, BMS electronic could be reused).

Poor condition of the cells can be recognizable also during powered flight:

- much deeper voltage drops at max power settings
- much reduced maximum achievable power (with fully charged packs)
- much reduced usable capacity – altitude gain and range of level flight
- temperature rise gradient of the battery pack will become much faster

We suggest replacing FES battery packs, when maximum available range of level flight (to reach 90V or 55°C, whatever first), is reduced to one third of the range experienced when they were new. Probably there would be not much sense to utilize them further on in such conditions.

Please handle FES battery packs very carefully, to avoid mechanical damage of housing. Only if battery packs are free of any damages it is allowed to charge them and then install them into the glider. They must be always visually inspected before each charging and before installation to the glider. This is even more important when glider is used by a syndicate of pilots or in aeroclubs. If the housing is found to be damaged, sometimes also cells inside might be damaged, which could be dangerous. In such case please contact manufacturer, for evaluation of damage and further steps.
6.1 BMS firmware upgrade

From time to time there might be available new improved version of BMS firmware. It is easy to perform upgrade, by using provided BMS-Charger-PC cable, and BMS Control software which is available to download from FES dedicated website. If there is any strange behaviour of BMS, upgrade usually resolve the problem.

To perform upgrade is it required suitable .bin file, which we can send it to customer by email. Please save it to chosen location on PC disk drive.

Connect BMS-Charger-PC cable to BMS and to USB port of PC. Run BMS Control Software, cancel any initial error messages which might appear (note that for firmware upgrade green PRESENT indication is not required). From upper menu choose BMS, then Firmware upgrade and browse for .bin file where you save it on PC (named like: BMS_9R-2.22.bin). Switch ON, the BMS switch on top of the battery pack. Wait until programming will reach 100% in progress window. BMS will restart itself and start working normally!
7. Transport

7.1 Car transport

During transportation in the car, FES battery packs must be protected against mechanical damage and moisture. We strongly recommend using:

- FES Plastic box (for basic protection)
- pair of FES Stainless steel boxes (for advanced protection)

For safety reasons, transport box should be placed into the luggage compartment, if possible pushed forward up to the front wall. Transportation box should be additionally secured, so that it can not move backward during acceleration, or forward at braking.

For safety reasons (and common sense) it is not allowed to transport battery packs in the car cockpit, for instance behind drivers or co-drivers seat, or infront of the co-driver seat, as in case of accident it could be very dangerous!

Do not leave battery packs in the parked car, under sun in hot summer, as they might be exposed to high temperatures.

For basic protection during transportation, storage or charging we developed FES Plastic box (optionaly available).
For advanced protection during transportation, storage or charging we developed a pair of FES Stainless steel boxes (optionally available).

Pair of FES stainless steel storage boxes

FES GEN2 Battery pack placed into FES Stainless steel box
7.2 In glider trailer

It is not allowed to transport battery packs in the front area of glider trailer.

For transportation in glider trailer, FES battery packs must be placed in the battery compartment of the glider, and they must be properly fixed as during flight.

“Connecting cable” must be always removed when glider is stored in trailer.

7.3 Ship/ train transport

When your glider is transported by RORO ship (or train) in its trailer, in Container, ship with or without its trailer, we suggest placing FES battery packs into battery compartment of the glider, so they are properly fixed as during flight.

Another possibility is to place battery packs into FES Stainless steel boxes, and fix them to the corner of the container.

It is recommended that gliders are packed into bright coloured containers, where internal temperature of the container on hot days at the sea might be lower. Other possibility is to paint at least upper area of container with white paint.
8. Storage

When you stop flying for longer time, for instance during winter time, **it is mandatory** to discharge FES battery packs to 50% of charge. This is to middle voltage, 3.7V per cell (this is about 52V per pack, or 104V indicated on FCU instrument, when motor is stopped).

- you can discharge them during last flight at the end of season, or
- you can use FES discharging assistant device (more info about this optional equipment you can find on our FES website)

![FES discharging assistant](image)

The most important environmental factor for slowing aging is the temperature at which battery packs are stored. Store battery packs between 10°C to 20°C, at normal humidity conditions. Do not store batteries at high temperatures or below freezing temperatures or in very humid environment (like in poor all metal glider trailer).

Always try to avoid having packs exposed to high temperature, as high temperature is decreasing life of cells significantly.
Warning sticker as above, with some basic information regarding storage, is located on rear vertical wall of each FES GEN2 battery pack!
9. Used packs

Check document “Handling instruction for used battery”.

10. Revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Change Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 2013</td>
<td>Initial release of manual, Version 1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>March 2013</td>
<td>Minor updates, Version 1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>June 2013</td>
<td>Updates of error codes, Version 1.11</td>
<td>1.11</td>
</tr>
<tr>
<td>August 2014</td>
<td>Some info about good practice added, Version 1.13</td>
<td>1.13</td>
</tr>
<tr>
<td>March 2015</td>
<td>Update with drawing, transportation box and sticker, Version 1.14</td>
<td>1.14</td>
</tr>
<tr>
<td>July 2015</td>
<td>Minor updates, Version 1.15</td>
<td>1.15</td>
</tr>
<tr>
<td>October 2016</td>
<td>New maintenance section, Version 1.16</td>
<td>1.16</td>
</tr>
<tr>
<td>November 2016</td>
<td>Additional info about DATA connector, Version 1.17</td>
<td>1.17</td>
</tr>
<tr>
<td>September 2017</td>
<td>Minor correction about BMS switching OFF, and new info about powerfull R2300 charger, Version 1.18</td>
<td>1.18</td>
</tr>
<tr>
<td>October 2017</td>
<td>Updated Storage and transport, new assembly drawing</td>
<td>1.19</td>
</tr>
</tbody>
</table>