

# EV Power BCU-EVPPAK-4C Battery Control Unit Instructions. 4 Cell 12V



---

## **BCU-EVPPAK Features**

- Simple to install and use, microprocessor control.
- Low power requirement, just 15mA when switched on with relay active.
- Prevents overcharge and over-discharge of LFP batteries.
- 12V (4 cell) operation.
- 240A (or 3 x 80A) capacity with normal relay, 500A capacity with optional high power relay.
- Capable of controlling multiple batteries in parallel.
- Plug and play with EV Power Pak 12V batteries.
- Works with any charger that is suitable for LFP batteries.

---

## **BCU-EVPPAK Specifications**

- Supply Voltage - 8 - 30VDC
- Power Consumption - <5mA (off), 15mA (on) @ 13VDC
- Switching current - 240A (80A per pole)
- Dimensions - 65 x 110 x 35mm : control enclosure, 52 x 76 x35 :120A relay
- Weight - 360g, control enclosure and 240A relay
- Environmental - -20 to +60 Celsius

---

## **Objective of this manual**

This manual will help with installation and operation of the BCU-PPAK-4C battery control unit in conjunction with EV Power Power Paks.

An understanding of electrical principles and competence with electrical tools is required. Ability to use the volts, amps and Ohms setting of a multimeter is a prerequisite.

---

## Disclaimer

**This is a guide only. Potentially lethal voltages and currents are involved when working with batteries. It is the responsibility of the installer to have the appropriate qualifications and skills for working with high voltages. No liability whatsoever will be assumed by EV Power for injury, accidents or damage resulting from the use of these instructions.**

Read these instructions several times before commencing installation.

**WARNING: Do not try to charge or discharge Lithium (LFP) batteries without the BCU installed. One over-charge or over-discharge WILL cause permanent damage.**

Every effort has been made to make this apparatus as reliable and robust as possible. However electronics can fail. The BCU-PPAK is designed to be the last line of battery protection and should not be relied upon to disconnect the battery under normal operating conditions. Connected loads and chargers should have inbuilt low/high voltage cutoff mechanisms. EV Power assumes no responsibility for battery damage resulting from failure of the BCU other than statutory warranty requirements.

---

## Introduction

The EV Power Battery Control Unit is designed for Lithium Iron Phosphate (LiFePO<sub>4</sub>, LFP) batteries of capacity 40-400Ah and nominal voltage of 12.8V. These batteries are generally used in applications where light weight, high power and long life are required.

The BCU-PPAK-4C is designed to control 4 cell (12V) battery packs. It monitors overall battery voltage and also the condition of each cell via the patented one wire link to BMS cell modules.

It is designed to be the simplest possible method of providing complete LFP battery protection.

This overall system consists of a single Battery Control Unit (BCU) and multiple cell modules that bolt directly on top of each cell. The cell modules perform the cell balancing function during charging and connect together via a one wire interface. The BCU controls a relay that interrupts power to/from the load/charger in the event of a battery problem.

No battery fuel gauge functions are incorporated in the system and there are no digital outputs available to interface with external devices. No temperature monitoring is done.

In combination with an approved switch mode charger the BCU-PPAK-4C will provide automated charging of EV Power Paks or LFP cells with EV Power BMS modules attached.

---

## How it works - Usage

The BCU performs a number of functions:

- 1) It monitors the battery voltage, if the voltage falls below 12V or rises above 15.5V (flashing red LED) for more than 30 seconds the relay will open. Then will be a solid red LED.
- 2) It monitors the BMS cell module loop. If any cell goes below 2.5V or above 4.0V (flashing red LED) for more than 10 seconds the relay will open. Solid red LED.
- 3) If the battery voltage is below 11.9V or above 15.9V and the BMS cell loop signals an error on one cell the relay will immediately open, no delay. Solid red LED.

The BCU is operated by pressing the red button.

- One press to switch on
- One press to switch off
- Press and hold to override and engage relay after a dropput. Use this only if necessary.

The BCU has a green LED to indicate that the relay is switched ON.

The BCU also has a red LED to indicate battery error conditions.

- Two red flashes, one or more cell modules is registering a cell fault. ( $< 2.5V$  or  $> 4.0V$ )
- Four red flashes, low battery voltage,  $< 12V$
- Five red flashes, high battery voltage,  $> 15.5V$
- no leds, BCU has dropped the contactor and switched itself OFF.

The relay is a special type called a magnetic latching relay. It consumes no power when switched on. The downside of this is that it can remain on if power to the BCU is removed or if the BCU fails for any reason. Check that the relay is operating correctly occasionally by switching off and on the BCU.



**SOME LOADS AND CHARGERS HAVE INTERNAL CAPACITORS WHICH DRAW LARGE INRUSH CURRENTS WHEN CONNECTED. THIS MAY CAUSE THE RELAY CONTACTS TO FUSE CLOSED. SUITABLE PRE-CHARGE CIRCUITS SHOULD BE INCORPORATED IN THIS CASE.**



**DO NOT DISCONNECT POWER TO THE BCU WHILE THE RELAY IS IN THE ON STATE or battery protection will be removed.**

If the BCU cuts off the battery during discharge the battery is most likely nearly empty. **DO NOT RESET AND CONTINUE DISCHARGE!** Reset and charge the battery immediately.

Note that the 12V cutoff threshold equates to approximately 10% remaining battery capacity, more or less. The battery should be considered to be flat at this level to allow for a safety buffer.

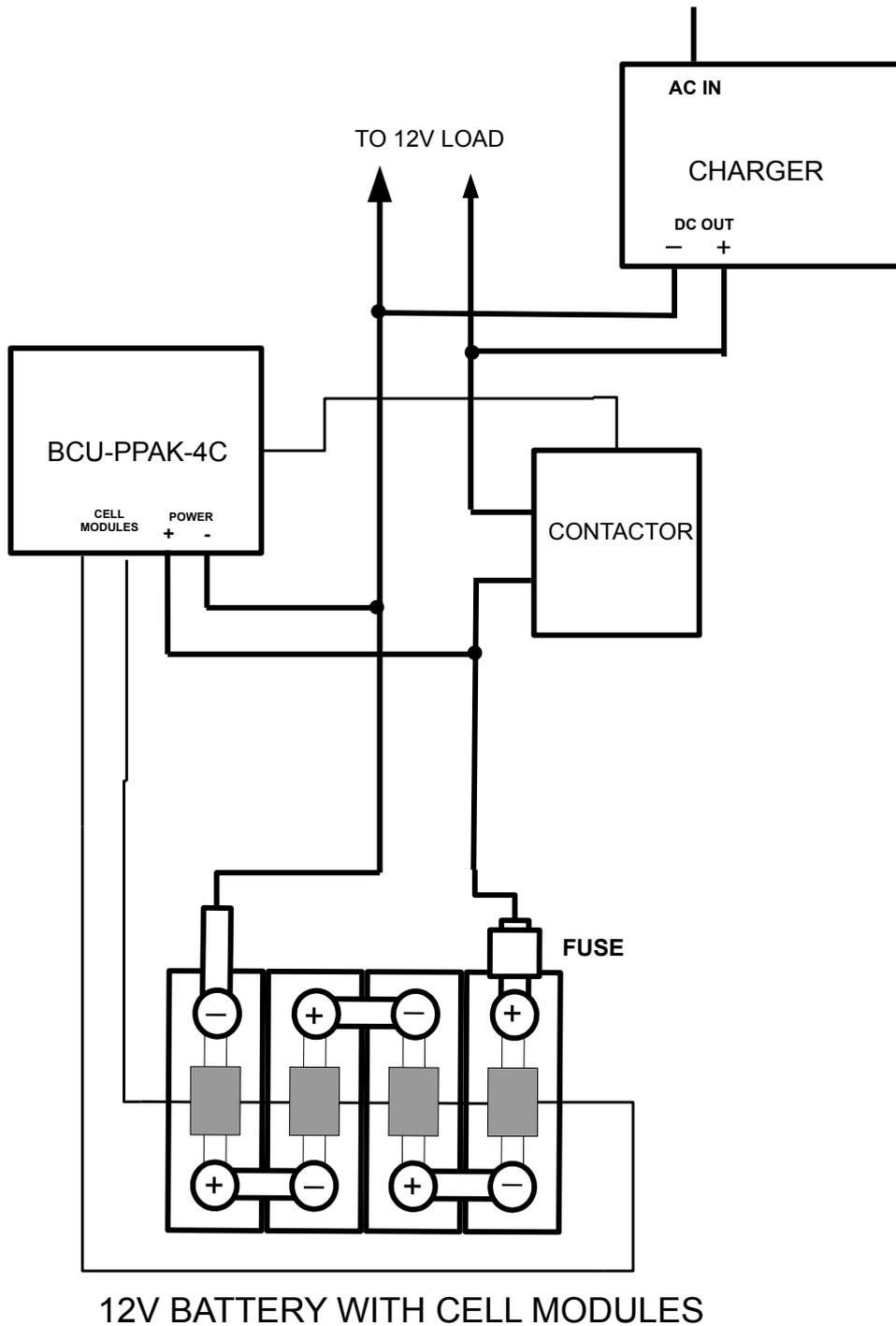
Note that even when switched off the BCU consumes a small parasitic current. It will take some months to drain a full battery at this rate but it is best to either leave the battery on continuous float charge 13.6-13.8V or to disconnect the BCU if the battery is to be stored for long periods.

If the relay opens during charging it means either the charge voltage has gone too high or the cells are unbalanced. Try resetting and charging a few times. If one red LED on the BMS cell modules on the battery comes on long before the others then that cell is running too high. Contact EV Power for advice in this instance.



The BCU is the last line of defence for the battery pack. It should not be relied upon to disconnect the battery every time it is used. It is there as a backup. No battery warranty can be assumed if the load has no inherent low voltage cutoff.

## BATTERY CONTROL UNIT CONNECTIONS SIMPLE 12V BATTERY

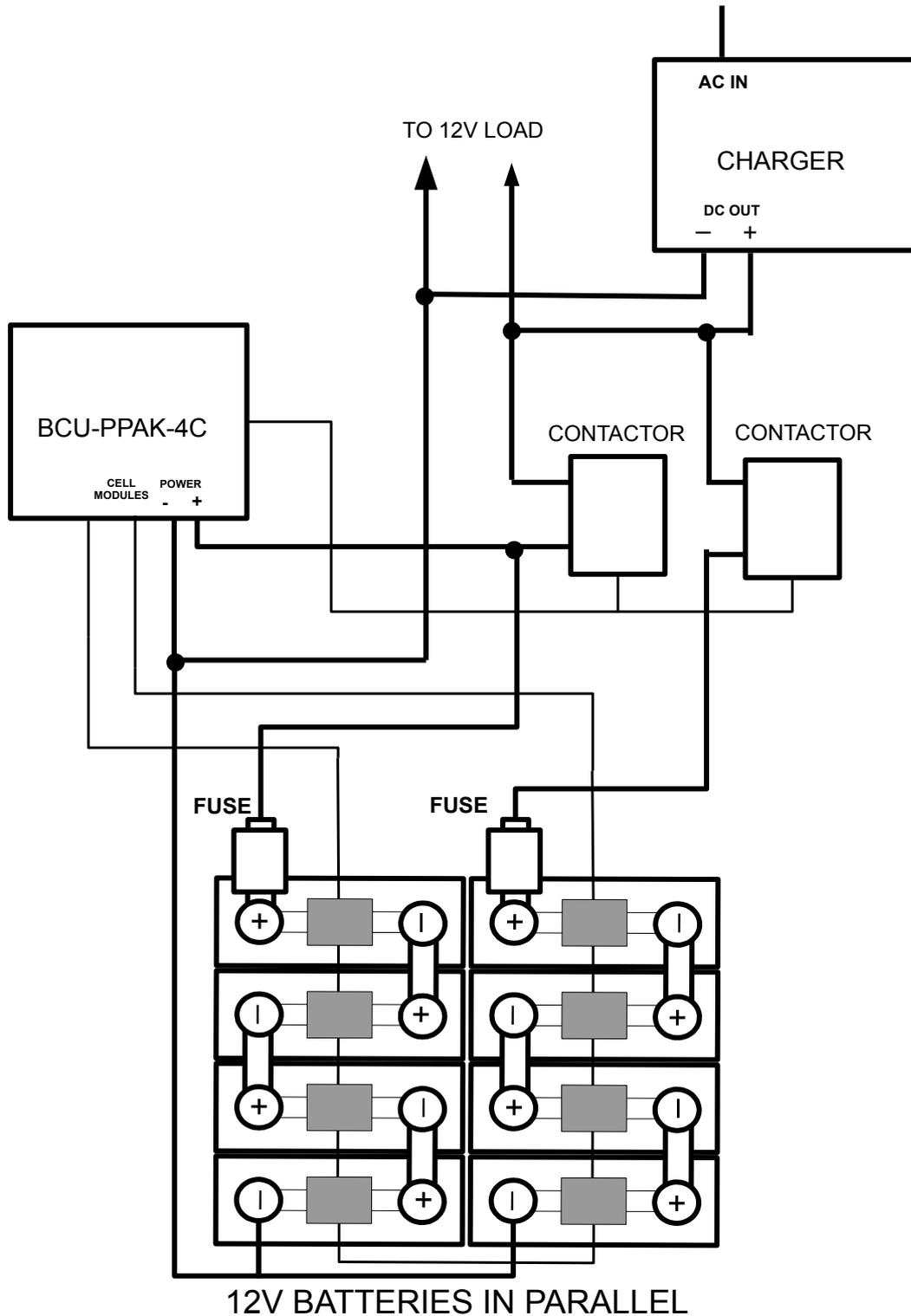


Note- the contactor is the latching relay attached to the BCU.

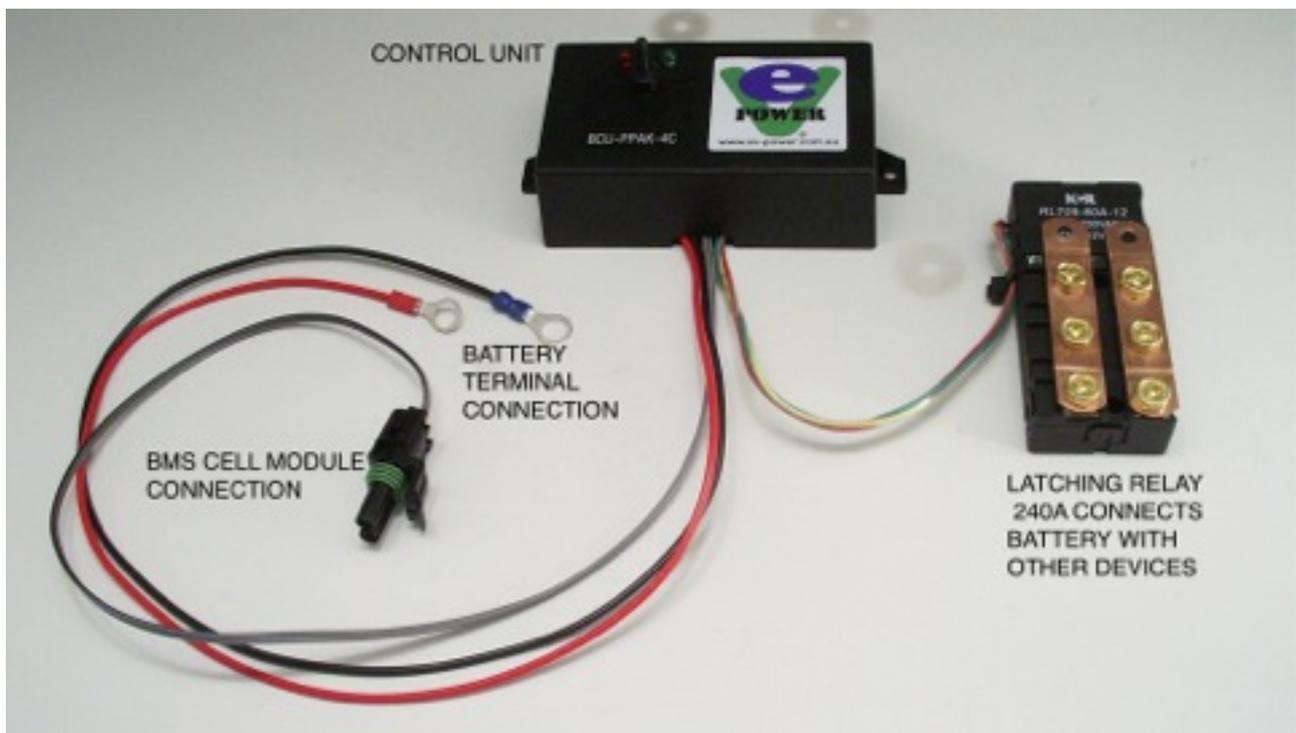
- For a fuse use Jaycar P/N SF1980 or similar.

<http://search.jaycar.com.au/search?w=sf1982&view=list>

## BATTERY CONTROL UNIT CONNECTIONS PARALLEL CONNECTED BATTERIES



Note: the two contactors shown can be two poles of the three pole 80A latching relay provided.



Use a wrench as a brace when tightening the relay terminals to prevent damage.

---

## High Power Applications

For batteries in parallel one pole of the relay is required per battery to prevent high current damage if one cell fails in one pack. The standard relay has three poles which may be used to control up to three battery packs in parallel. Just remove the copper bus bar from the battery side of the relay.

Current drain may be 80A per parallel pack. So two batteries in parallel = 160A capability.



For applications which require more than 80A continuous per battery a high power contactor option is available. It can supply up to 500A . Please advise when purchasing.

---

## General Battery Guidelines

LFP cells should be housed in a metal battery box away from dust, excessive heat and moisture. Appropriate restraints should be used that are capable supporting at least 5 times the battery weight in the event of a vehicle rollover. All restraints should be well insulated so as not to short out battery terminals.



Ensure that a dry powder type fire extinguisher is accessible somewhere close by. Lithium Iron Phosphate batteries do not generally catch fire even under extreme abuse. However they will burn if heat is applied from another source such as a short circuit. They contain organic solvent electrolyte which is flammable when released.



Be careful when working on batteries with metal tools, short circuits can occur very easily with catastrophic consequences. The handles of metal tools should be insulated with heat shrink or plastic duct tape.



**DO NOT ALLOW YOUR BATTERY TO RUN FLAT. IT WILL BE PERMANENTLY DAMAGED AND EV-POWER CAN TAKE NO RESPONSIBILITY FOR THIS. THE BATTERY SHOULD BE CHARGED AT LEAST ONCE A**

## MONTH IF BEING STORED.

---

### Cell Module Installation

This is covered in another manual. Install the cell modules first. It is not required for the prefabricated EV Power Pak batteries.

---

### Charger Control

Any charger used should charge to  $3.65V \times$  the number of cells in the battery. This peak voltage applies to ALL LiFePO<sub>4</sub>/LFP battery brands.

**Note: 3.60-3.65V is the standard peak charge voltage for LiFePO<sub>4</sub> (LFP) chemistry.**

It is important that once the peak voltage is reached the charger should begin to taper the charge current and switch off or fall to a lower voltage when the current falls to 1% of the Ah capacity.

Most modern chargers have a “Gel” or “AGM” charge program which is almost ideal for LFP batteries. Charge to 14.6-14.8V then float indefinitely at 13.6-13.7V. The charger may be left on when the battery is not in use if it has this characteristic.

Do not use chargers which have an “equalization” phase (unless it can be disabled). This will try to charge the battery too high and damage it.

---

### Commissioning the system

First double check all the connections.

Switch on the BCU.

After double checking all high voltage connections connect the AC power to the charger input. The charger should commence charging. If not then check that all the green cell module LEDs are illuminated and all the cell module and signal wires are correctly connected.

Do this for a few seconds and switch off the charger at the wall.

Disconnect one of the signal wires between the cell modules. The red LED on the BCU will flash. After a delay of about 10 seconds the relay will switch off. Switching on the charger at this time should have no effect, that is, it will not switch on. Switch the charger off at the wall and reconnect the signal wire.

Reset the BCU by switching OFF/ON again.

Switch on the charger, it should now work. Charge until the battery is full and the charger switches off. If the BCU switches off then an overcharge has been attempted. Reset and recharge while watching the battery closely.

The battery should now be ready for use.

---

## General Charging Tips

Once the battery pack is balanced it can be used and charged as required. Occasional partial recharges are acceptable but should not be commonplace or the balance of the battery may be affected.

If there is a battery error the BMS will terminate charging. This may not be serious if the battery is slightly out of balance after a few partial charges or deep discharges. However if it persists it may be necessary to check the battery.

If the battery has been discharged to a point where one or more of the cells is below 2.5V the BCU will disconnect the battery. In this case reset the BCU by switching OFF/ON and recharge immediately.

If the BCU keeps terminating charging do not persist or worse battery damage may result. Check the battery and charge individual cells if required using a small current (1A max).



**Never tap a portion of the battery for powering lower voltage peripheral devices. Use a DC-DC converter.**

---

## About Lithium Iron Phosphate Batteries

A “battery” is made up of “cells”. Each cell is an individual unit that cannot be split into a lower voltage component.

LFP cells have a nominal voltage of 3.2-3.4V. This is the voltage that the cells drop back to when at rest. They will stay around 3.2V until about 90% discharged when the voltage will begin to decrease until fully discharged at 2.5V. It is highly recommended to discharge less than 80% of the cells total Amp Hour capacity. This will help to maximize the cell life.

LFP cells may be connected in “series” (+ to – to + etc) to obtain a higher nominal voltage. This creates a “battery”. They may also be connected in “parallel” (+ to +, - to -) to increase the Ah capacity. Under no circumstances should cells or a battery be short circuited, that is the + connected directly to the – to create a loop. This will damage the cells and most likely the operator also.

Under no circumstances should the cell voltage be allowed to fall below 2.5V for a sustained period. Permanent damage will result. It is possible that this situation may occur if the battery is allowed to stand for a long time (ie. months). In this situation the BMS will not allow recharge because a cell is outside the safe range. To try and rectify the problem a small 4.5V 300mAh DC plug pack type power supply can be applied to individual cells one at a time until the cell voltages rise above 2.5V and the BMS will allow normal charging to commence. Care must be taken with the first few charges as the battery may be severely unbalanced.

A visual check of the battery pack during charging should be made every 3 months. Switch off the BCU and on again to check that the contactor is operating correctly. Check the cells for corrosion or other damage.

---

## Important Notes

- **Take care with the routing of power cables**

Electric motors such as those used in electric winches are electrically “noisy” and can cause large inductive voltage spikes when switched on and off. Inverters can do the same. This may cause the BCU to reset and disconnect the load in some instances. Make sure the BCU and its attached cables are away from any large power cables and motors. If you are having trouble try rerouting cables. Keep the BCU input cables close together. If necessary use ferrite chokes on the BCU power inputs.

- **Recharge fully at regular intervals**

LFP batteries do not have a memory, however continuous partial recharges may cause the battery to become unbalanced and lead to dropouts during charging. During daily usage it is important to occasionally charge the battery pack completely until the charger switches off. Continual partial recharges will prevent the BMS balancing the pack and so may result in premature charger disconnects when the battery is next fully charged.

- **Never tap a portion of the battery for powering lower voltage peripheral devices.**

This will unbalance the battery and result in continual charging errors. Use a suitable DC-DC converter to power low voltage devices.

- **Do not bypass the BMS during charging under any circumstances.**

It is designed to protect your battery but cannot do so if it is disconnected. The charger AC current must be supplied via the BMS. If there is a problem with the BMS do not charge the battery until it is corrected.

- **Do not allow the battery to go flat. If it goes flat this is a very serious situation. The battery should be periodically charged when it is being stored to prevent self discharge. The BMS uses a small amount of power whether the battery is used or not so regular charging is important.**

---

## Glossary

Cell - one individual unit of a battery. Lithium (LFP) cells have a nominal voltage of 3.2-3.3V

Cell Module - a small electronic device that connects between the positive and negative terminal of a lithium cell. It regulates the cell voltage during charging and reports back to the master unit if a cell falls outside its safe operating voltage of 2.5-4.2V.

Battery - a number of cells connected in series and/or parallel.

Relay - a switch controlled by an electrical signal.

Contactor - a big relay.

LiFePO<sub>4</sub> - Lithium Iron Phosphate used in the EV Power battery chemistry. Also known as LFP.

Series connection - electrical connection of cells daisy chained positive to negative to increase the battery voltage. Battery voltage = cell voltage x number of cells in series.

Parallel connection - electrical connection of cells positive to positive, negative to negative. This increases the amp hour capacity but maintains the same cell voltage. Battery capacity = cell capacity x number of cells in parallel.

Amp hours (Ah) - a measure of the capacity of a cell or battery. This is the number of amps x number of hours the cell can supply. For lithium cells the rate is usually calculated over a one hour period.

Nominal Voltage - the resting voltage of a charged cell. For Lithium cells this is normally 3.2-3.3V.

Watts (W) - a measure of electrical Power. Watts = Amps x Volts , ( $P = I \cdot V$ )