Bestgo Battery pack parallel configuration guideline

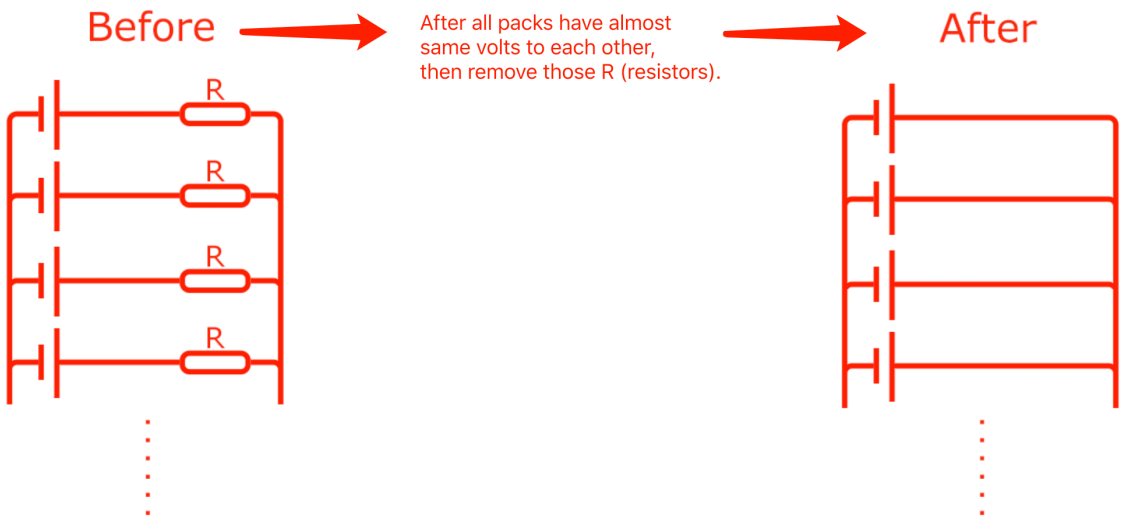
The battery packs must match each of the requirements below:

- The supplier confirms that the model of battery packs can be parallel configured.
- Battery packs should have exactly same model type, version type and production batch type.
- Battery packs have same chemistry and parameters.
- Battery packs all should be brand new, the old or weak pack in configuration can easily damage new packs.
- Please check with the supplier to see how many packs can be paralleled for your specific application.
- After the battery packs have been successfully paralleled, those packs should be treated as one whole pack. Charge and discharge them as the same, never disconnect them for independent use.

Steps to put the packs in a parallel configuration:

- Make sure battery packs have volt difference of no more than 0.3V, then go to next step. If not, please contact us for how to increase the value of "suitable resistance" accordingly, to suit the bigger voltage difference.
- Then, connect the negative poles of battery packs together.
- Then, each pack should have a "suitable resistance" fixed to positive pole, after that, use power cables to connect those "suitable resistances" for parallel config of those battery packs.
  (Explanation: Since packs have different voltages, it will cause the current rush from higher volt packs to lower volt packs, so "suitable resistance" on each pack can control this electricity current rush within an acceptable volume.)
- For example, if one pack has voltage of 51.5V, and the second pack has voltage of 51.2V, there is a 0.3V difference, if we want to limit balancing current among packs to be no more than 60A, the "suitable resistance" should be "0.3V/60A=0.005ohm", or say "suitable resistance" should be no less than 5 milliohm, that 5 milliohm resistance is enough for all of preferred battery pack if volt difference is no more than 0.3V.
  For 0.6V difference, please use resistor of bigger than 10 milliohm.
  For 0.9V difference, please use resistor of bigger than 15 milliohm.

- After that config, current will pass among packs to equalize the voltage, with the lower one raising and the higher one lowering. Eventually, all packs will have the exact same voltage. Once this is achieved, please remove those “suitable resistance”, and use a standard large cable to connect the positive poles together (please review the pictures in next page for the reference).
  A power cable with a "suitable resistance" act in circuit diagram as in below picture.



- After all packs are connected in parallel config, check the voltage on indicators of battery packs, all packs should have one same voltage. Then, pressing the button of "A/Ah/SET" on indicator, to set all packs to show the charging and discharging current value. Please discharge and charge the entire system, closely watch the current value of every battery pack, **to verify and make sure all packs have approximately same current to each other.** If any packs have apparently smaller current, it means here are some poor connections regarding that pack which caused higher resistance. In this situation, please check connections, tightly fix power cables again or use some electric joint glue to remove the poor contacts, let that battery pack work rightly.

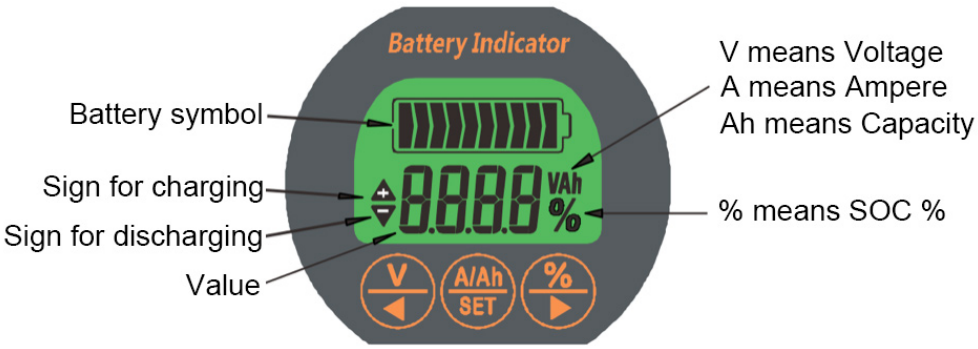
Some notes:

- The SOC function of intelligent indicator is designed for individual usage for battery packs. If put in parallel config, SOC function will became inaccurate, please consider to only show value of electric current or voltage in priority on indicators when packs in parallel config. If insist to show the SOC, please reset the SOC calculation of all the intelligent indicators after parallel config is done, it is helpful for the SOC accuracy.
- To reset the SOC calculation: Please charge the parallel configured packs to completely full, then let indicator to show SOC state, after that, press and hold on the "%/>" button for 3 seconds, the indicator will set this status as 100% SOC, then shortly press "A/Ah/Set" button again to save the state and exit, the SOC will be reset and start the calculation and calibration automatically. After discharge to almost empty and charge to almost full for several cycles, SOC will became more accuracy. For more details, please review the operation guid file of the intelligent indicator.

Requirements on battery models in parallel config:

- If total power drawing from load is no more than capability of single pack, can use nominal preferred packs.
- If not, please use the pro-version battery packs and config the wires from multi-pins socket accordingly, for more details, please check on file of "multi-pins socket definition on pro-version battery pack".

The SOC function of intelligent indicator is designed for usage with individual packs, it is NOT utilized for packs placed in parallel configuration. However, the voltage and current information on indicators are still exactly right to reflect each individual battery packs in parallel configuration. Operator can use those indicators to exactly monitor the each current of every individual battery packs.



Above picture is the interface and buttons of intelligent indicator.

Press the "V/<" button, it will show the voltage of battery pack,

Press the "A/Ah/SET" button, it will show the current (ampere) of battery pack, press button again, will switch to show the Capacity (Ah) of battery pack.

Press the "%/>" button, it will show the SOC percentage of battery pack.

In each state, the related sign will been shown, like, "V", "Ah", "%" etc.

Modify the setting of low voltage cut off value of device after parallel config:

After the parallel configuration is completed, we suggest setting the device (such as a controller of motor) to a low voltage protection value that is much higher than the cut-off voltage protection value of the battery pack. This is a preventative measure to prevent triggering the cut off protection feature when drawing current from the battery pack; It is harmful to trigger any BMS protection features for the parallel configured system. In the BMS default setting, when any cell voltage reaches 2.5V, our LiFePO4 battery packs will trigger cut-off protection, while when cell volt is 3.0V, it already in almost empty electricity state. Based on that, we suggest to set the low volt cut off value of the device no less than "3.0V*N" for the parallel configured battery system.

(PS: N is the number of 3.2V parallel units in series config of LiFePO4 battery pack)

The following table shows the voltage when discharged to different SOC states at different current ratios. This test is based on cells cut-off voltage at 2.5V. We can see that even if the cells have only 5%SOC they still have a high volt around 3.024V ~ 3.095V. So, we suggest the device low volt alarm value much higher. We recommend setting alarm value to approximately 15%SOC and the cut off value to approximately 5% SOC.

	20% SOC	15% SOC	10% SOC	5% SOC
C/2 or 0.5C	3.177 volt	3.145 volt	3.117 volt	3.024 volt
C/3 or 0.33C	3.182 volt	3.152 volt	3.127 volt	3.034 volt
C/5 or 0.2C	3.200 volt	3.170 volt	3.153 volt	3.073 volt
C/10 or 0.1C	3.208 volt	3.180 volt	3.166 volt	3.088 volt
C/20 or 0.05C	3.214 volt	3.187 volt	3.175 volt	3.095 volt

C/2, C/3, C/5 means the ratio of current to total capacity. For example, if you use a 200Ah LiFePO4 battery pack to discharge at 100A current, it means 100A/200Ah= C/2 or 0.5C. If you want to set the device low volt alarm to 15%SOC, it should be “3.145V*N series". If this 200Ah pack is 24V LiFePO4, N means 8 series. So, the alarm setting is "3.145V*8= 25.16V". While if we put 5 packs in parallel config, the capacity became 1000Ah, the current ratio became 100A/1000Ah= C/10 or 0.1C, the alarm setting should be modified to "3.180V*8=25.44V".

(This test is based on 23°C /73°F with LiFePO4 chemistry, with lower temperate volts will decrease.)

Please note that paralleling these battery packs can increase the total capacity (total running time). However, we do not suggest to exceed the maximum current value of the any single battery pack. because several packs in parallel may begin to output unbalanced value of current after hundreds of cycles (i.e. some packs output less current, while some battery packs output more current). In another potential situation, if one pack triggers protection and subsequently shuts off, the other packs must share the burden which held by that shut-off pack. This will exacerbate the situation and cause more packs to trigger cut-off protection. Considering this possibility, we require that even just one battery pack will be able to withstand the entire power requirement of the entire system, this is the most reliable way in a parallel configuration. In some emergency usage conditions, you can increase the power consumption of the battery packs configured in parallel, but should make sure all the time all battery packs are in the very good condition, it means each pack has good healthy (low inner resistance and close inner resistance value to each other), and they are all working in good SOC range (100%~20% range for discharge state, 20%~70% range for charge state), and the temperature is within a reasonable range. If you do have special requirement of increase current in parallel config, please contact us for the consult.

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