

Active Balancing

Active cell balancing is a more complex balancing technique that redistributes charge between battery cells during the charge and discharge cycles, thereby increasing system run time by increasing the total useable charge in the battery stack, decreasing charge time compared with passive balancing, and decreasing heat generated while balancing.

Active Cell Balancing During Discharge

The diagram below represents a typical battery stack with all cells starting at full capacity. In this example, full capacity is shown as 90% of charge because keeping a battery at or near its 100% capacity point for long periods of time degrades lifetime faster. 30% represents fully discharged to prevent deep discharge of the cells.

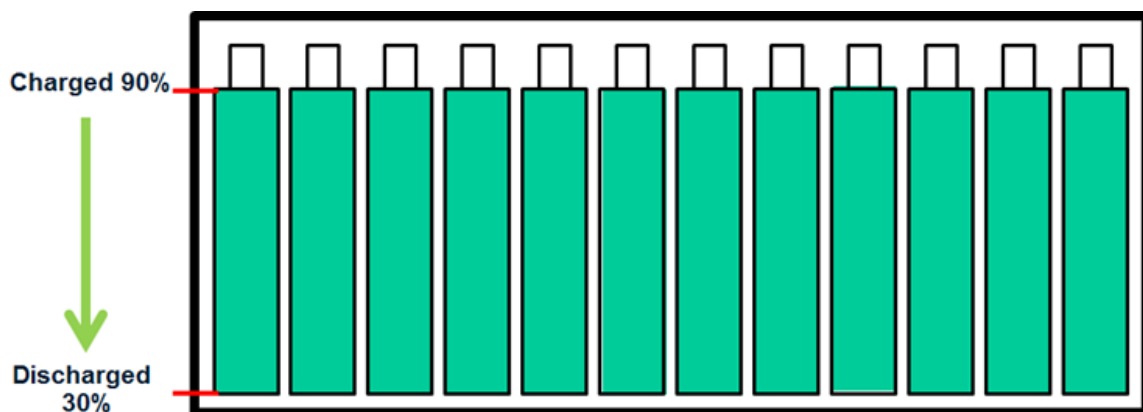


Figure 1. Full capacity.

Over time, some cells will become weaker than others, resulting in a discharge profile represented by the figure below.

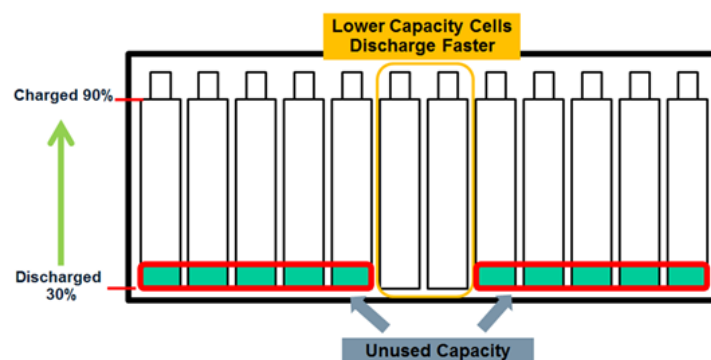


Figure 2. Mismatched discharge.

It can be seen that even though there may be quite a bit of capacity left in several batteries, the weak batteries limit the runtime of the system. A battery mismatch of 5% results in 5% of the capacity unused. With large batteries, this can be an excessive amount of energy left unused. This becomes critical in remote systems and systems that are difficult to access since it results in an increase in the number of battery charge and discharge cycles, which reduces the lifetime of the battery, leading to higher costs associated with more frequent battery replacement.

With active balancing, charge is redistributed from the stronger cells to the weaker cells, resulting in a fully depleted battery stack profile.

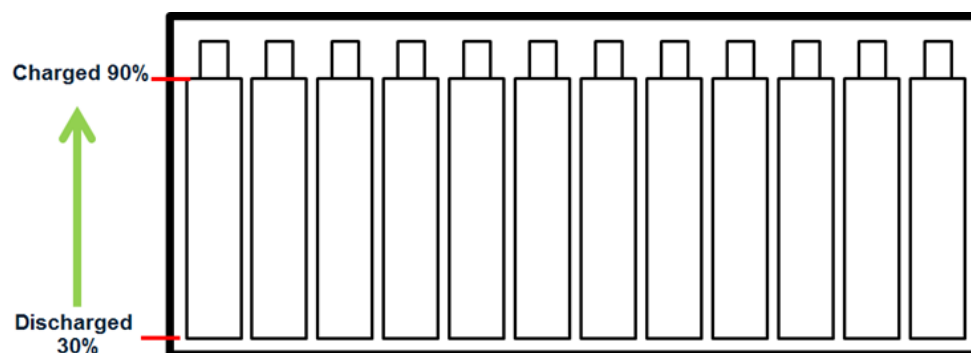


Figure 3. Full depletion with active balancing.

Active Cell Balancing While Charging

When charging the battery stack without balancing, the weak cells reach full capacity prior to the stronger batteries. Again, it is the weak cells that are the limiting factor; in this case they limit how much total charge our system can hold. The diagram below illustrates charging with this limitation.

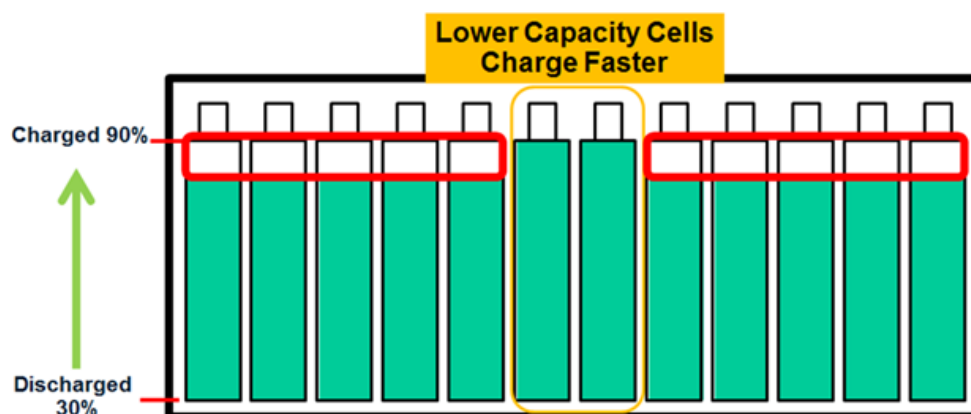


Figure 4. Charging without balancing.

With active balancing charge redistribution during the charging cycle, the stack can reach its full capacity. Note that factors such as the percentage of time allotted for balancing, and the effect of the selected balancing current on the balancing time are not discussed here, but are important considerations.

Active Battery Cell Balancing

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