Whitepaper

ATESS next-generation BMS with active balancing technology

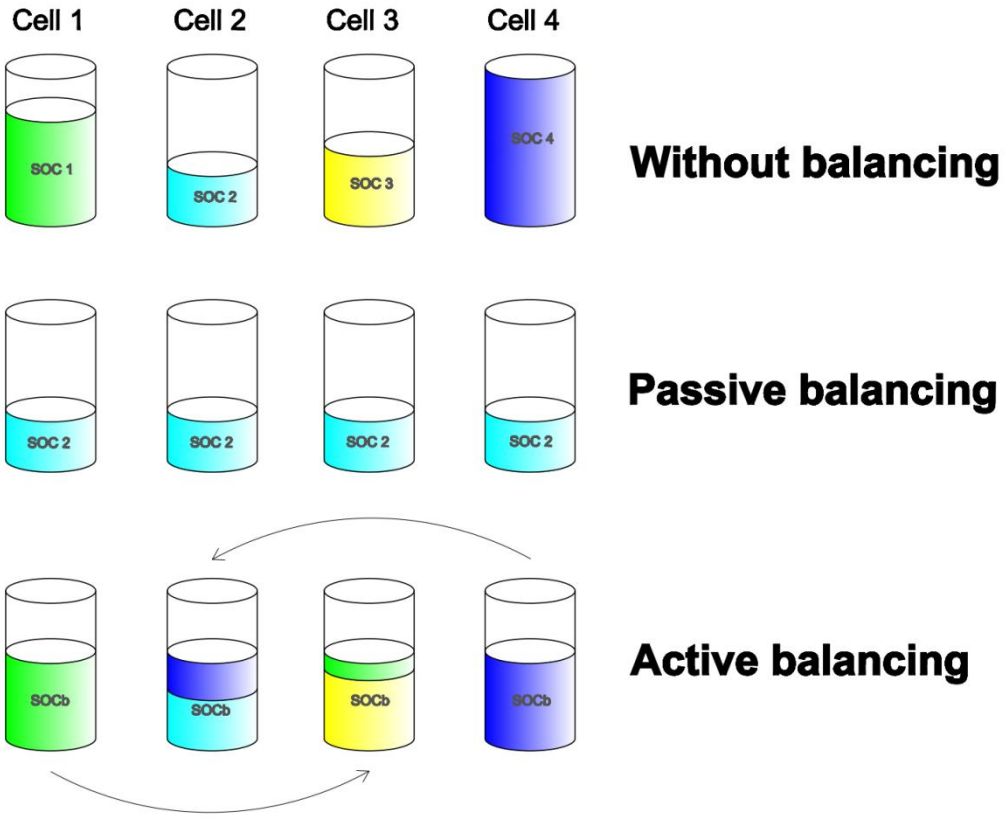
With the penetration of energy storage systems, today the service life and operating environment of lithium batteries are drawing more attention. In the past years, ATESS has been committed to the research and development of lithium battery BMS. By the end of 2021, we have finally delivered a satisfactory result: The ATESS next-generation battery system integrated intelligent active balancing technology is officially launched. The application of active balancing will ensure that the battery system always is in the best performance condition, hence improving the service life of the battery, also it can make the battery system adapt to diverse load conditions, meanwhile greatly reducing the cost of maintenance, increasing system reliability, stability and load adaptability.

Background

Lithium battery in the running process will be affected by a variety of features, such as overvoltage, undervoltage, overcharge, discharge, thermal runaway and voltage imbalance between batteries, among these, the most important factor is voltage imbalance, it will change over time of each of the batteries in the battery pack voltage, thus reduce the capacity of the battery pack in the battery. On the other hand, the weakest cell will also determine the performance of the overall battery pack. Therefore, in order to ensure the overall performance of the battery pack, we should balance each cell in the battery pack to lower the voltage difference between the cells is as much as possible. At present, based on cell voltage and battery SOC, active balancing and passive balancing have been proposed in the industry.

Active balancing VS. passive balancing

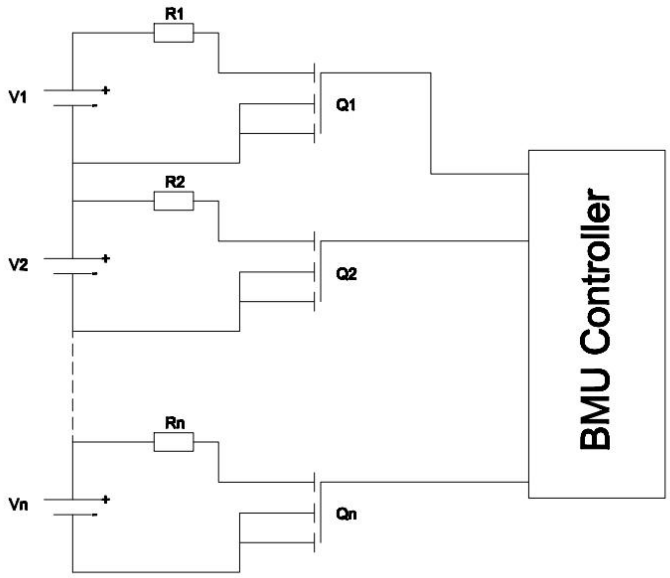
Passive balancing technology equalizes the SOC of each cell by dissipating the energy from the higher SOC cell, and formulates all batteries with similar SOC to the SOC of the lowest level cell, which is also called dissipative balancing technology. Active balancing technology transfers energy from a cell with a higher SOC to a cell with a lower SOC, so that the SOC of each cell is equal. It's called non-dissipative balancing technology. As we can be seen from the figure below, passive balancing will make the SOC of the whole battery pack =SOC 2, and active balancing will make the SOC of the whole battery pack =(SOC 2+SOC 4)/2+(SOC 1+SOC 3)/2)/2.



Passive balancing technology-switch resistance shunting

Passive balancing technology uses resistors in the balancing circuit. The circuit will balance the voltage of each cell by dissipating the energy of the higher cell voltage, and make the entire battery pack reach the battery pack voltage equivalent to the lowest cell voltage. At the same time, we should note that passive balancing technology only works under charging conditions, because passive balancing cannot have reverse switching, and reverse switching will only cause the battery pack to be more unbalanced, which goes against the original intention of the balancing technology.

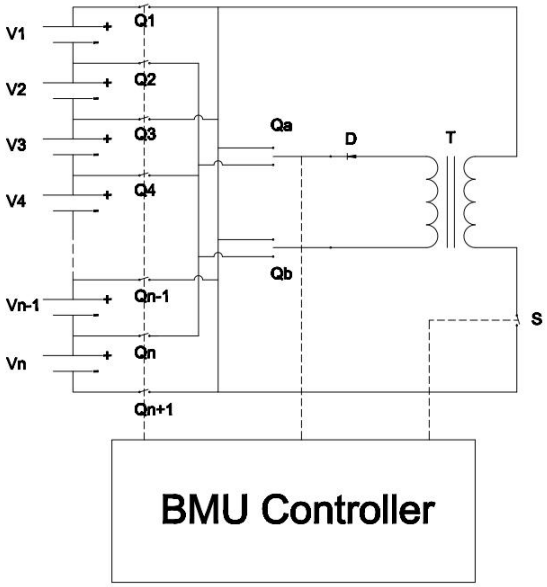
The passive balancing technology adopted by ATESS is shown in the figure below. In the figure, V1 to Vn are the voltages of each battery cell connected in series in the module, Q1 to Qn are the relays corresponding to each battery cell, and R1 to Rn are each battery cell. More corresponding fixed shunt resistors. ATESS' BMS connects a resistor in parallel with each cell connected in series through a controlled relay to balance the voltage of each cell. In this design, when the voltage sensor detects the voltage imbalance, it determines which resistor should be shunted . Among them, the resistance value will be determined according to the required balance current.



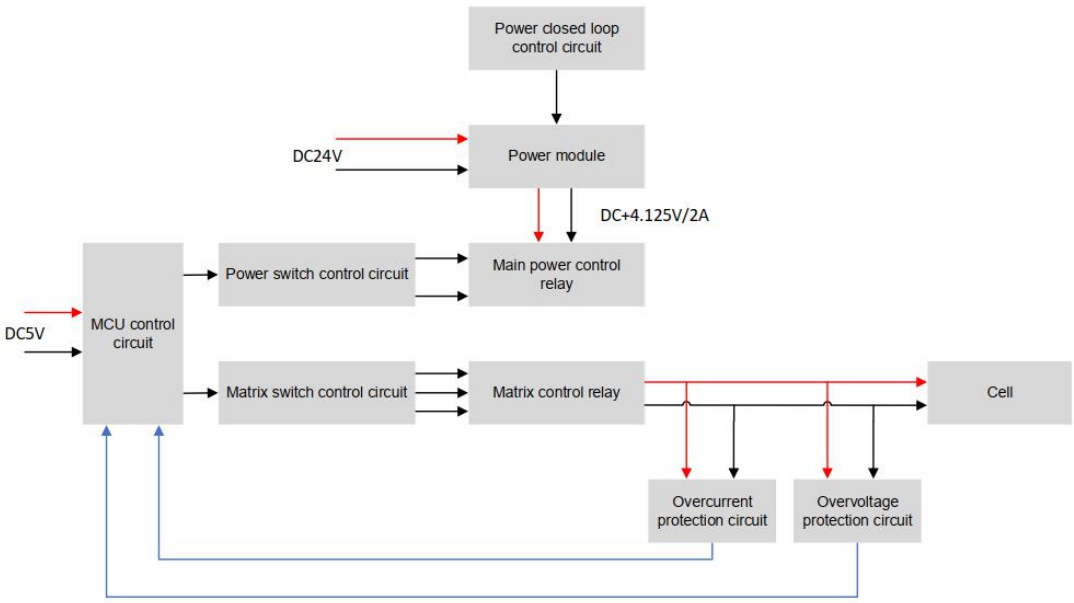
ATESS new active balancing technology—Single transformer active balancing

As mentioned earlier, we can also call active balancing technology as non-dissipative balancing technology, because it transfer energy from higher to lower cell untill all cells are balanced. On the other hand, active balancing can be also used for charging and discharging bi-directional operation, so compared with passive balancing, this balance circuit can effectively balance the battery cells.

The active balancing technology adopted by ATESS is shown in the figure below. In the figure, V1 to Vn are the voltages of the battery cells connected in series in the module, Q1 to Qn+1 are semiconductor switches, D is a diode, and S is a semiconductor controlled by the primary side. T is the transformer for the entire battery pack. The working strategy of this technology is that the entire battery pack current is switched S to the transformer T, and the output of the transformer is rectified and transmitted to the lowest cell through the corresponding semiconductor switch. Therefore, control is required to select the target unit and switch device. In the cell-to-battery technology, the target cell is a higher-energy cell that is moved to the battery pack through a transformer to balance the voltage of the target cell and other cells in the battery pack.



ATESS active balancing technology-working mode and strategy



Functional block diagram of ATESS active balancing

Standby state of active balancing

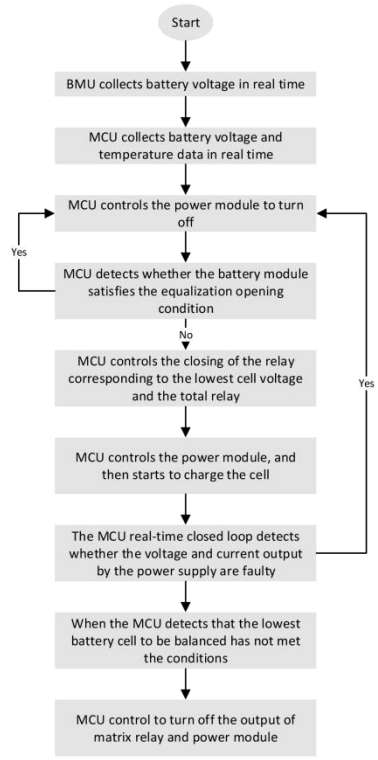
When the battery pack is static, the BMU active balancing module will collect the battery voltage in real time. Meanwhile, the balancing opening condition has been set inside the module. The constant current power module is turned off by outputting a low-level signal, and all relays are turned off.

On state of active balancing

When the MCU detects that the battery pack meets the balancing condition, it identifies the cell with the lowest voltage and controls the corresponding cell relay. According to the balance strategy of controlling odd or even, the three relays are closed at the same time, and the BMU outputs a high level to make it constant. The current power module works to charge the lowest voltage cell with a constant current. It is judged that the round of balancing period is 15S, the opening balancing is 12S, and the closing balancing is 3S. The MCU calculates the average cell voltage and the voltage difference of the lowest battery cell in real-time, and makes a balance judgment with the voltage range. If there are other single cells that meet the opening balance conditions after a cycle, the MCU opens the corresponding relay paths and charges them till balanced.

Off state of active balancing

If it is judged in the next balancing period (15S) that the lowest single cell to be balanced does not meet the balancing conditions, the MCU will also turn off the balancing circuit relay and balancing power module corresponding to the cell in advance, and re-determine whether there is still other single cells that meet the balanced settings. If not, turn off all balancing circuits and balancing power modules, and the entire balancing system will remain in the standby state.



Operation strategy of ATESS active balancing

Advantages

1. **Reduce maintenance costs**: Battery systems with active balancing will greatly lower the maintenance frequency so that reduce the maintenance manpower and expenses.
2. **More stable and reliable:** BMS with active balance can manage each cell in the system more quickly and flexibly, to ensure the voltage consistency of the cell, so that the battery system can achieve the best charge-discharge performance, once the voltage consistency of the cell is guaranteed, the capacity of load running will also have a great improvement.
3. **Stronger load adaptability**: without active balancing, battery cells have relatively poor voltage consistency, that means it won't be able to run the load which it could have because the weaker batteries cannot meet discharge requirement, and leading to battery thermal runaway. Battery with active balancing system can avoid danger like this to a great extent.

Summarize

Obviously, active balancing is more flexible and act faster than passive balancing. Although there will be extra cost, ATESS offers a 10-year warranty (* under specific test conditions) on battery systems with active balancing, and it will also significantly reduces maintenance costs. So overall, this investment is worth it. If you would like to know more potential advantages of this technology, please consult us for further information. If you have a specific project, ATESS is here to provide you the most economical and efficient energy storage solutions.