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TASK1.3- Box of Shame:

Requirement

If you have a simple circuit that drives high power 12V LED with current limiting resistor 3.3ohm and need to drive them with 80C LiPo (lithium Polymer) batteries that have 5200mAh charge, assume that girls stay inside the box of shame for about 5 hours. How many batteries are connected in parallel to light up the LED for more than 5 hours.

1. Assume all batteries have equal voltage.
2. Assume the LED is ideal (deal with it as a short circuit in forward bias)
3. The current limiting resistor is a high-power resistor.

ANSWER:

We need more than 5 batteries in parallel to increase the usage time and voltage remains the same.

The battery life required is more than 5 hours so we will consider the minimum is 5.

Using battery life equation:

B.F = capacity of battery / circuit current

5 = ??/ (12/3.3)

Capacity = 18.1818Ah = 18181.8mAh

There is something called:

THE 80% LIPO BATTERY RULE TO THE RESCUE

This simply means that you should never discharge a Li-Po pack down **past 80% of its CAPACITY** to be safe (80% discharged in other words).

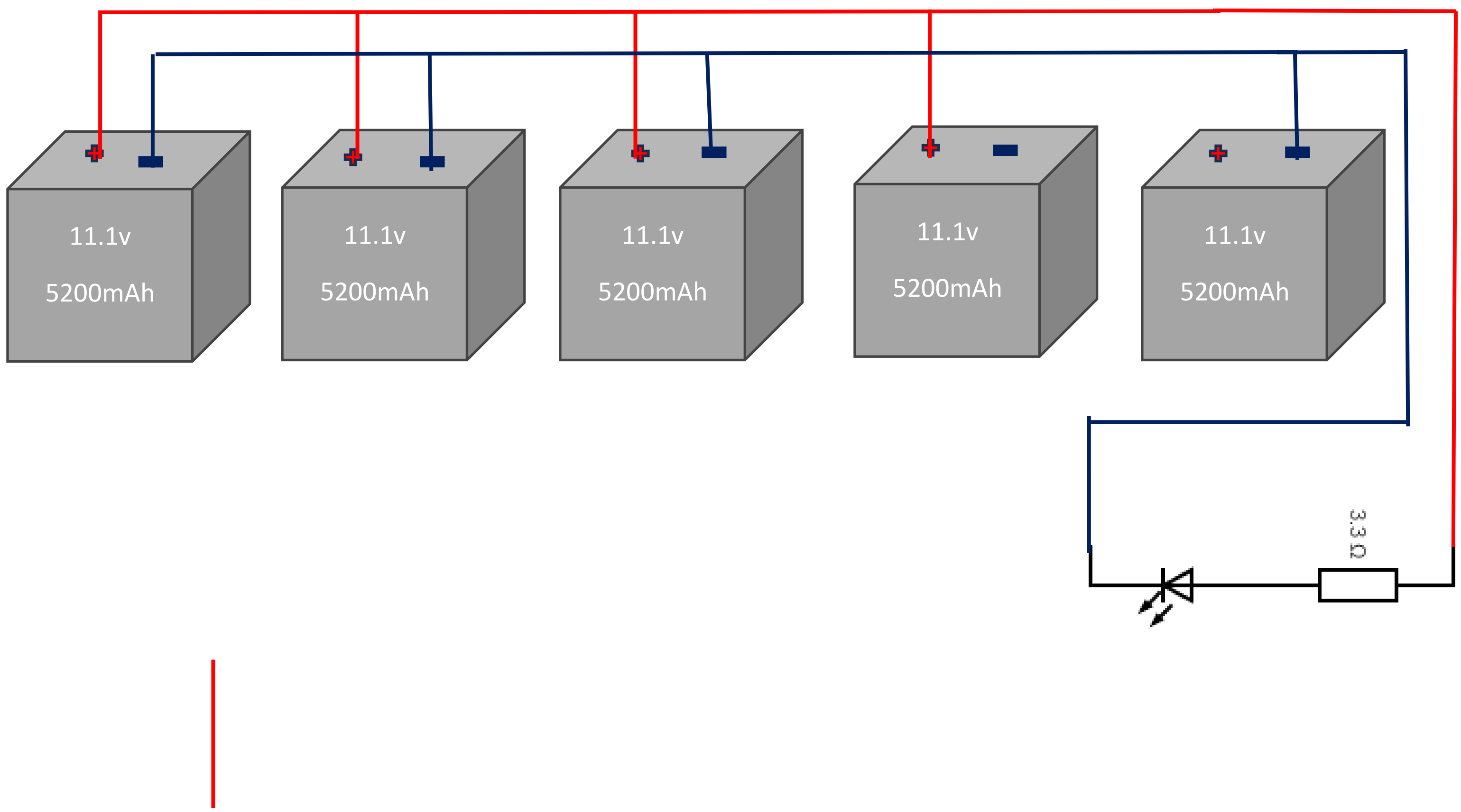
As one battery has 5200mAh so we should never draw more than 4160 mAh out of the pack **and we are connecting the batteries in parallel.**

So:

N(number of batteries) = total cap / one cap

N = 18181.8 / 4160 = 4.3 ≈ 5

N ≥ 5


11.1v
5200mAh
11.1v
5200mAh
11.1v
5200mAh
11.1v
5200mAh
11.1v
5200mAh
3.3 Ω

BMS

Definition

Battery management system (BMS) is technology dedicated to the oversight of a battery pack, which is an assembly of battery cells, electrically organized in a row x column matrix configuration to enable delivery of targeted range of voltage and current for a duration of time against expected load scenarios.

How do battery management systems work?

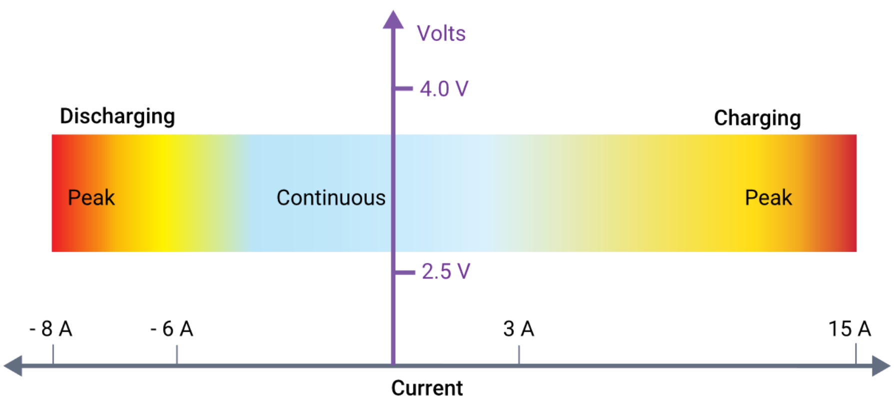
Battery management systems do not have a fixed or unique set of criteria that must be adopted. The technology design scope and implemented features generally correlate with:

- The costs, complexity, and size of the battery pack
- Application of the battery and any safety, lifespan, and warranty concerns
- Certification requirements from various government regulations where costs and penalties are paramount if inadequate functional safety measures are in place

There are many BMS design features, with battery pack protection management and capacity management being two essential features. We'll discuss how these two features work here. Battery pack protection management has two key arenas: electrical protection, which implies not allowing the battery to be damaged via usage outside its SOA, and thermal protection, which involves passive and/or active temperature control to maintain or bring the pack into its SOA.

Electrical Management Protection: Current

Monitoring battery pack current and cell or module voltages is the road to electrical protection. The electrical SOA of any battery cell is bound by current and voltage. Figure 1 illustrates a typical lithium-ion cell SOA, and a well-designed BMS will protect the pack by preventing operation outside the manufacturer's cell ratings. In many cases, further derating may be applied to reside within the SOA safe zone in the interest of promoting further battery lifespan.



Battery cell manufacturers usually specify maximum continuous charging and discharging current limits, along with peak charging and discharging current limits. A BMS providing current protection will certainly apply a maximum continuous current. However, this may be preceded to account for a sudden change of load conditions. BMS may incorporate peak current monitoring by integrating the current and after delta time, deciding to either reduce the available current or to interrupt the pack current altogether. This allows the BMS to possess nearly instantaneous sensitivity to extreme current peaks, such as a short-circuit condition that has not caught the attention of any resident fuses, but also be forgiving to high peak demands, as long as they are not excessive for too long.

Electrical Management Protection: Voltage

a lithium-ion cell must operate within a certain voltage range. These SOA boundaries will ultimately be determined by the intrinsic chemistry of the selected lithium-ion cell and the temperature of the cells at any given time.

Moreover, since any battery pack experiences a significant amount of current cycling, discharging due to load demands and charging from a variety of energy sources, these SOA voltage limits are usually further constrained to optimize battery lifespan.

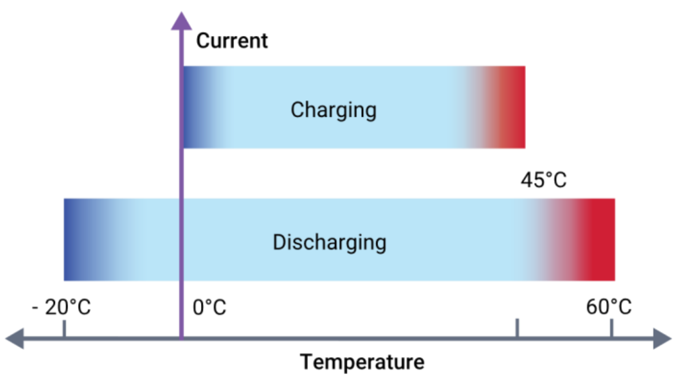
The BMS must know what these limits are and will command decisions based upon the proximity to these thresholds. For example, when approaching the high voltage limit, a BMS may request a gradual reduction of charging current, or may request the charging current be terminated altogether if the limit is reached. However, this limit is usually accompanied by additional intrinsic voltage hysteresis considerations to prevent control chatter about the shutdown threshold.

On the other hand, when approaching the low voltage limit, a BMS will request that key active offending loads reduce their current demands. In the case of an electric vehicle, this may be carried out by reducing the allowed torque available to the traction motor.

the BMS must make safety considerations for the driver the highest priority while protecting the battery pack to prevent permanent damage.

Thermal Management Protection: Temperature

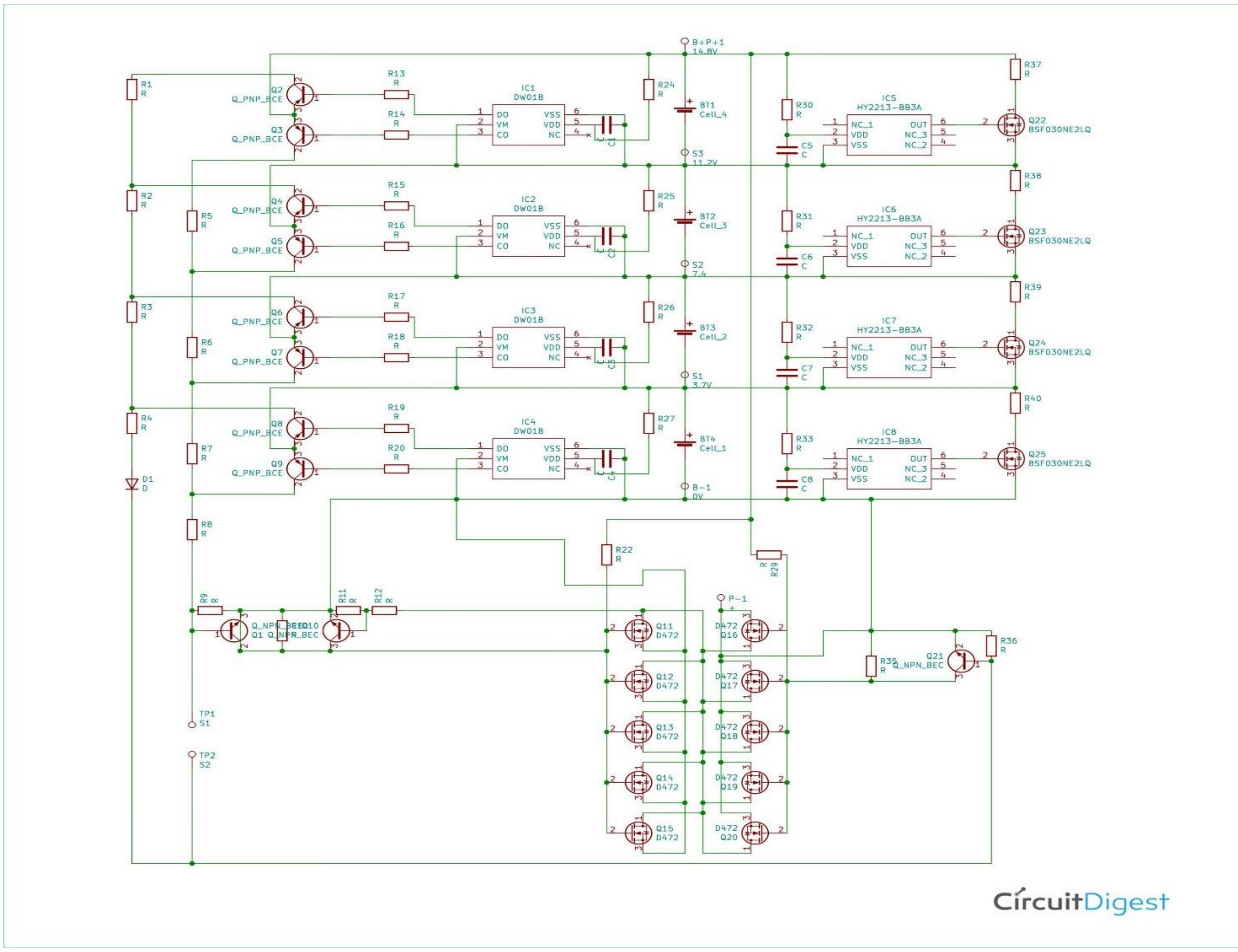
At face value, it may appear that lithium-ion cells have a wide temperature operating range, but overall battery capacity diminishes at low temperatures because chemical reaction rates slow down remarkably. With respect to capability at low temperatures, they do perform much better than lead-acid or NiMh batteries; however, temperature management is prudently essential since charging below 0 °C (32 °F) is physically problematic. The phenomenon of plating of metallic lithium can occur on the anode during sub-freezing charging. This is permanent damage and not only results in reduced capacity, but cells are more vulnerable to failure if subjected to vibration or other stressful conditions. A BMS can control the temperature of the battery pack through heating and cooling.

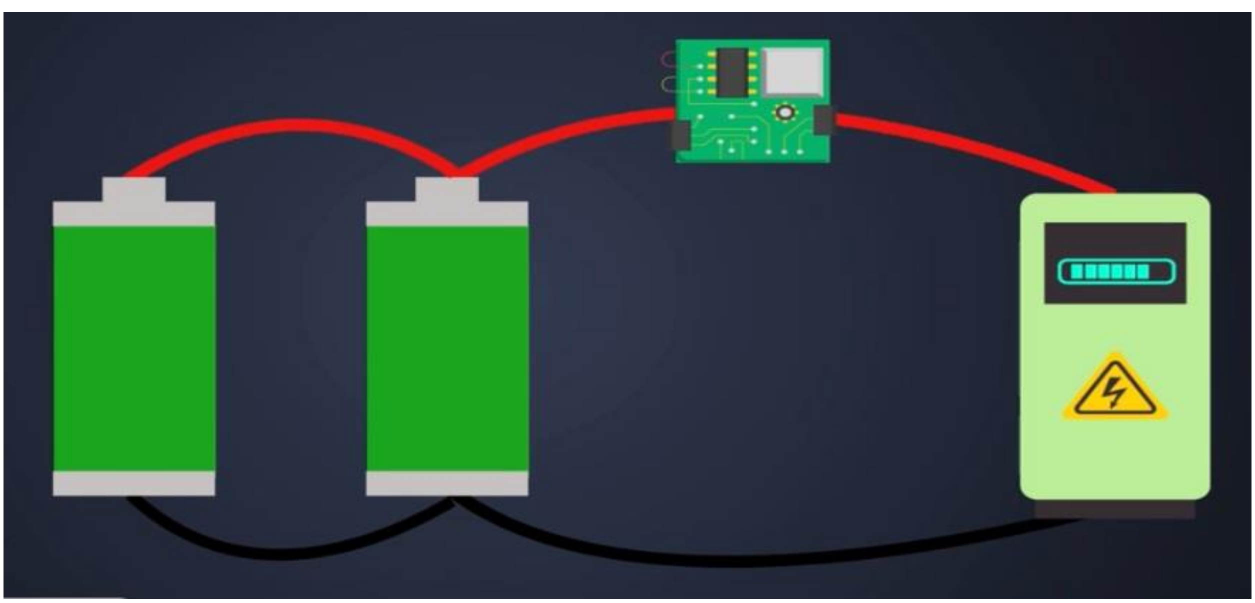


Capacity Management

Maximizing a battery pack capacity is arguably one of the most vital battery performance features that a BMS provides. If this maintenance is not performed, a battery pack may eventually render itself useless.

Circuit Diagram of BMS:





BMS Connection with the Battery Pack