Ahsanullah University of Science and Technology

Department of EEE

Project Report

Battery Management System (Multi-cell)

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Introduction:

A Battery Management System (BMS) is a crucial component in electric vehicles (EVs) that oversees and controls the battery pack, ensuring its safe and efficient operation.

Objective:

Our main objective is to charge three 3.7V batteries simultaneously to its full capacity and once they are charged the power is diverted from them showing us an indication that it is full charged via the LED turning ON. And to understand its full implication in a smaller scale so that we can potentially use it for bigger projects.

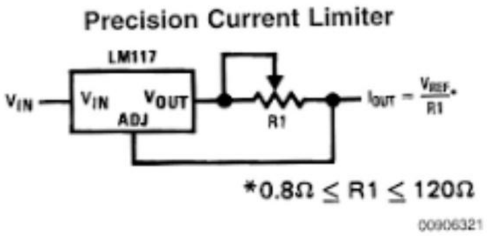
Equipment:

- BD140 Transistor – 3pcs
- TL431 Zener Reference Diode – 3pcs
- Diode 1N4007 – 12pcs
- LM317 – 2pcs
- Wires
- 3.7 Li-ion Battery - 3 pcs
- 100uF Capacitors – 2 pcs
- 20k potentiometer – 3pcs
- Resistors – 20k, 1k, 330, 517, 4.7k Ohms (as per required)
- Red LED – 3pcs

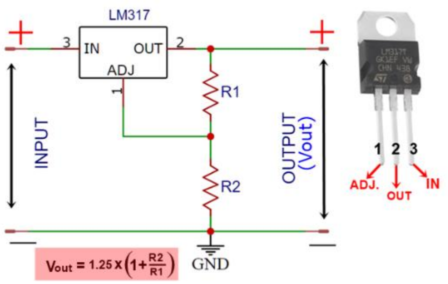
Working Principle:

1. Before Charging: When 12-volt DC supplied to the main circuit all of the batteries get direct connection from it. We adjust the output at the battery end by adjusting the 20k pot at the reference end of TL431 to 4.2V via multimeter for the 3 cells.
2. TL431 inactive: Then we insert the batteries. The current doesn't flow through the TL431 as its threshold voltage is set to 4.2V and the battery is at uncharged. The TL431 remains open and the BD140 transistor stays OFF.
3. After Charged: When the batteries reach their maximum capacity 4.2V, TL431 gets activated and closes letting current flow through BD140 turning it ON.

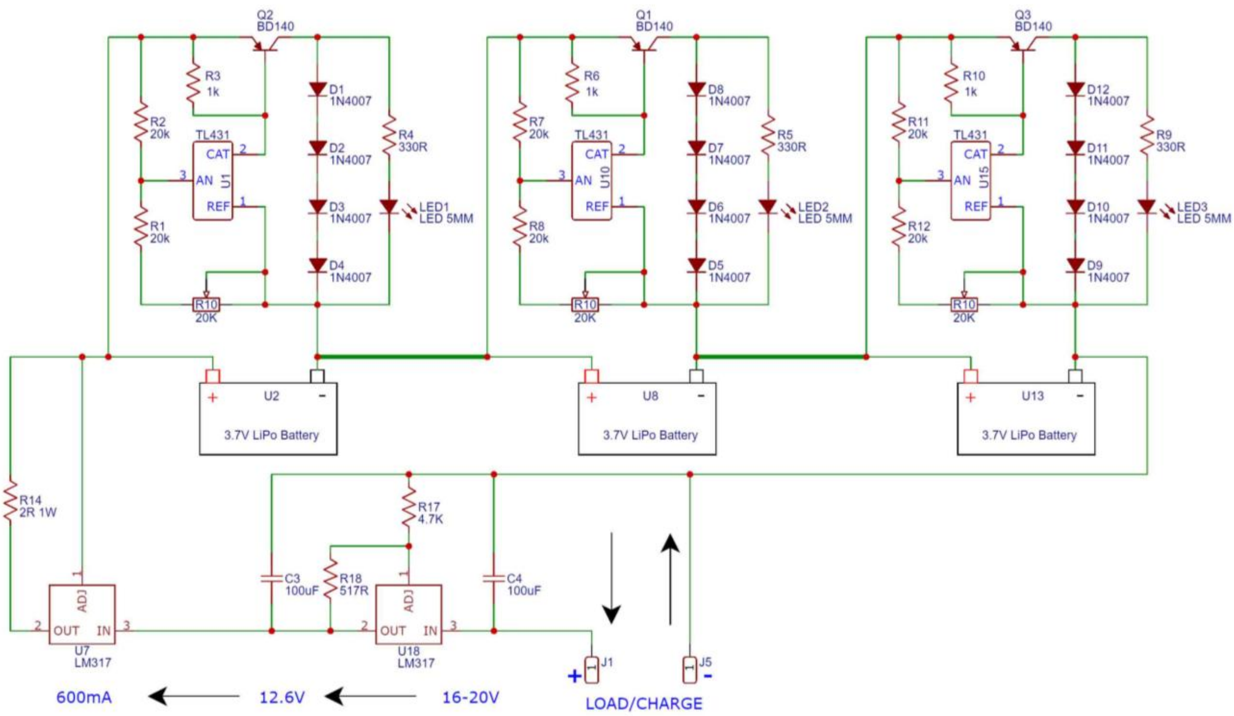
4. Full Charge Indication: Then the current passes through the diodes and turning the LED ON indicating it is fully charged. The current then doesn't flow into the battery anymore and is diverted to the negative end of the power supply. In this way overcharge and undercharge are regulated.
5. LM317 as Current Limiter: Now to limit the current level in this circuit as it is also an important part, we use (U7) LM317 as we can limit current value by adjusting the resistance value in its ADJ pin. Setting the resistance value will use LM317 as current limiter.



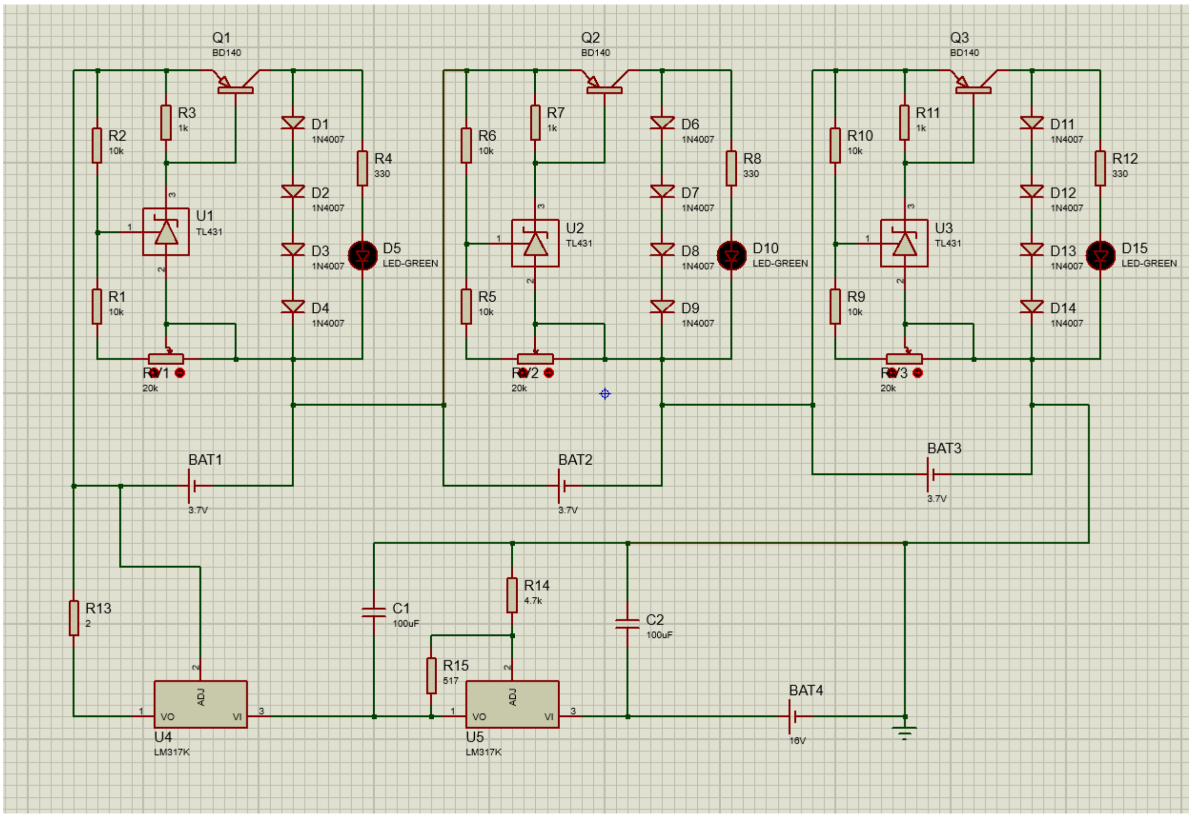
6. LM317 as Voltage Controller: Now to limit the voltage input in the circuit, we use the U18 LM317 as voltage control mode in order to make the output 4.2V even if the input power supply is greater than 5V.

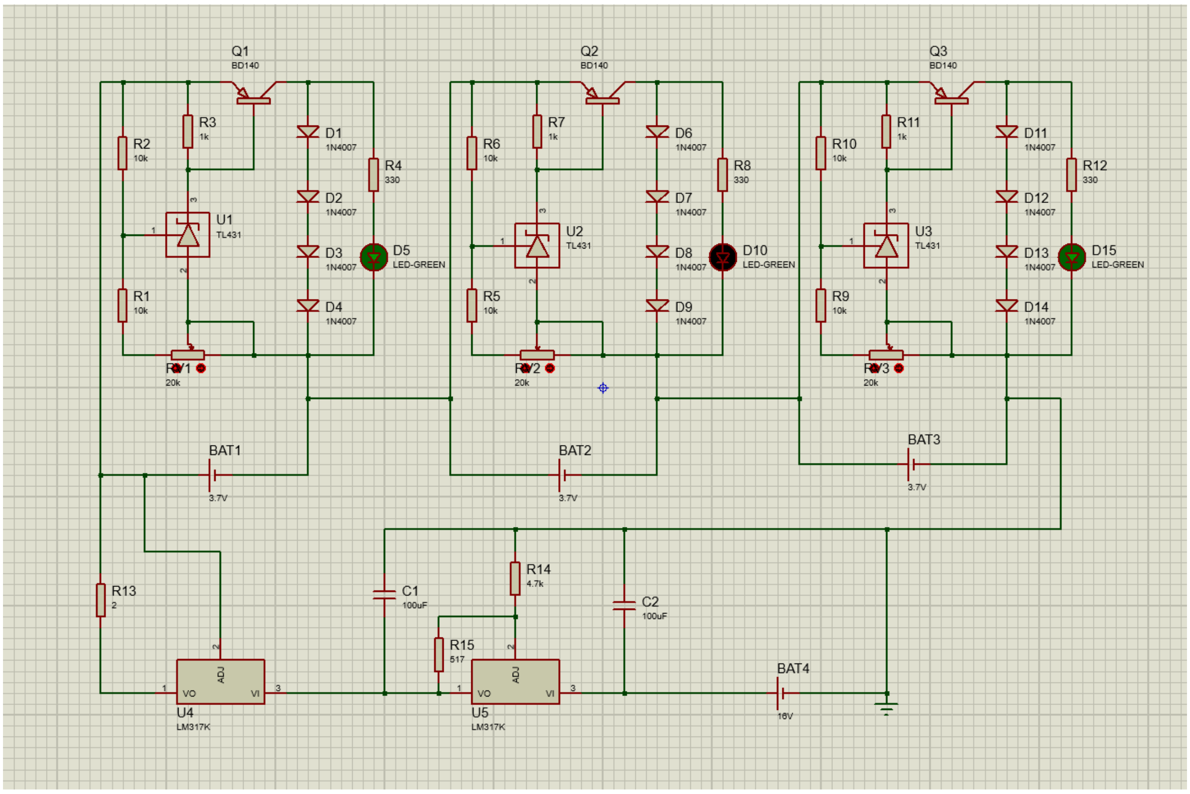


Circuit Diagram:



As we cannot simulate batteries getting charged in Proteus, we varied the 20k potentiometer in order to increase/decrease the reference voltage to imitate battery being charged, and found out the LED turns ON in the first and third cell as they are set as CHARGED. And the second cell's LED is OFF as its imitation is not CHARGED.





Significance:

The BMS acts as the "brain" of the battery pack, continuously monitoring various parameters and making real-time adjustments to optimize performance and safety. Here's how it works:

1. Monitoring: The BMS constantly monitors individual cell voltages, temperature, current flow, and other critical parameters.
2. Protection: It implements safety measures to prevent overcharging, over-discharging, excessive temperatures, and short circuits, which can lead to battery damage or even thermal runaway (fire). Battery can enlarge in size.
3. Control: The BMS controls the charging and discharging processes, ensuring that the battery operates within safe limits and optimizes energy usage.
4. Balancing: It balances the charge levels across individual cells, preventing some cells from becoming overcharged or undercharged, which can reduce battery life and capacity.

Why is a BMS needed?

- Safety: Lithium-ion batteries used in EVs are sensitive to overcharging, over-discharging, and high temperatures. The BMS prevents these conditions, ensuring the safety of the vehicle and its occupants.
- Performance: The BMS optimizes battery performance by ensuring that each cell is used efficiently and that the battery operates within its ideal range.
- Longevity: By preventing damage and balancing cell charge, the BMS helps prolong the lifespan of the battery pack, reducing the need for costly replacements.
- Reliability: The BMS ensures consistent and reliable battery operation, preventing unexpected breakdowns or performance issues.

How does it help in EVs?

- Extended Range: By optimizing battery performance and preventing energy waste, the BMS helps maximize the driving range of the EV.
- Faster Charging: The BMS controls the charging process, allowing for faster and more efficient charging without damaging the battery.

- Improved Performance: The BMS ensures that the battery delivers consistent power to the electric motor, providing optimal acceleration and performance.
- Increased Lifespan: By preventing damage and balancing cell charge, the BMS helps extend the overall lifespan of the EV's battery pack.

In conclusion, the Battery Management System is a critical component in electric vehicles, ensuring the safety, performance, longevity, and reliability of the battery pack. It acts as the "brain" of the battery, continuously monitoring, protecting, and controlling its operation to maximize its potential and ensure a smooth and efficient driving experience.

Discussion:

As per simulation and practical resting, the LED turned ON when the battery reached around 3.8V and was dimly lit prior reaching that point. All three cells showed indication of charged, uncharged and in between charged. The proper output shows out project was a success. With multimeter used testing the voltage was controlled, current was limited.