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Design of BMS for Lithium-Ion Battery Used for P.V Solar System

Prof. Devendra Holey[1], Kunal Dhomne[2], Krunal Amnerkar[3], Mayuri Rajurkar[4], Vishal Kumbhare[5]
Department of Electrical Engineering, K.D.K. College of Engineering, Nagpur, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Abstract: ***The evolving global landscape for electrical distribution and use created a need area for energy storage systems, making them among the fastest growing electrical power system products. A key element in any energy storage system is the capability to monitor, control, and optimize performance of an individual or multiple battery modules in an energy storage system and the ability to control the disconnection of the module(s) from the system in the event of abnormal conditions. This management scheme is known as "battery management system (BMS)", which is one of the essential units in electrical equipment. The battery management system (BMS) plays an important role in ensuring the safe and efficient operation of lithium-ion batteries used in photovoltaic (PV) panels. This paper provides a comprehensive review of the literature related to the development of BMS for lithium-ion batteries used in PV panels. The paper discusses the challenges associated with the use of lithium-ion batteries in PV systems and highlights the importance of BMS in mitigating these challenges. Additionally, the paper presents a research methodology used to evaluate the performance of BMS, presents the results of a study, and discusses the managerial implications, limitations, and future scope of the study. The battery management system board is used to protect the battery from overcharge, overvoltage, under – voltage, temperature variation, and unbalanced conditions, and also monitor the state of charge of battery, state of health etc.***

Keywords: BMS, Lithium-ion battery, SOC, Charging-discharging, Cell balancing, Battery Monitoring, MATLAB, Simulink

I. INTRODUCTION

A lithium-ion or Li-ion battery is a type of rechargeable battery which uses the reversible reduction of lithium ions to store energy. It also sees significant use for grid-scale energy storage and military and aerospace applications. Compared to other rechargeable battery technologies, Li-ion batteries have high energy densities, low self-discharge. Life of a lithium-ion battery is typically defined as the number of full charge-discharge cycles to reach a failure threshold in terms of capacity loss or impedance rise. Manufactures' datasheet typically uses the world "cycle life" to specify lifespan in terms of the number of cycles to reach the rated battery capacity. The battery Management System (BMS) is a critical part of any lithium system. The BMS monitors and controls the state of charge, voltage, current, and temperature of the cells in the battery pack. The BMS is typically implemented as a separated circuit board that is connected to to the battery cells. It contains a microcontroller, sensors, and MOSFETs (Metal Oxide Field Effect Transistors) or other solid-state switches. The battery is an electrical energy storage system that can store a considerable amount of energy for a long duration. A battery management system (BMS) is a system control unit that is modeled to confirm the operation safety of the system battery pack. The primary operation of a BMS is to safeguard the battery. Due to safety reasons, cell balancing, and aging issues, supervision of each cell is indispensable. Moreover, BMS ensures the present corrective measures against any abnormal condition at the system infrastructure. Besides, since the system temperature affects the power consumption profile, BMS also confirms the proper procedure to control the system temperature.

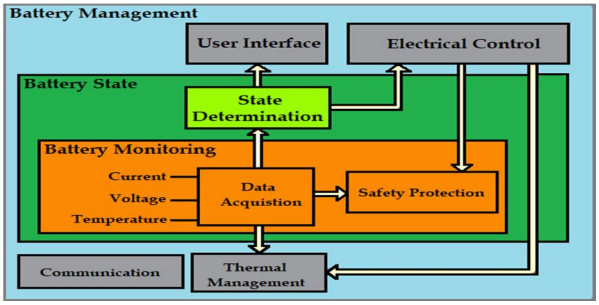

Fig 1. General Block Diagram

1) *Discharging Control:* The function of a BMS is to monitor and maintain the lithium cells before the safe operating condition. For example, of a typical Lithium-ion cell have an under-voltage rating of around 3.7V. It is made sure that not one of the cells in the pack get discharged below 3.7V.
2) *Charging Control:* The charging and discharging process will be monitored by the BMS. Most of batteries tends to reduce in lifespan or damaged when charging not properly. The BMS should make sure both the current and voltage during charging does notrise above their limits so as to not over charge or fast charge the batteries.
3) *State of Charge (SOC):* SOC is the charging indicate of the battery. It shows the battery charging inpercentage. The voltage, charge and discharge current of the pack should always be monitored to predict the capacity of the battery.
4) *State of Health (SOH):* The SOH measures the age and life cycle of the battery based on its usage history. This way knows how muchprovide after full charge. of the battery, as the battery ages and also, know when the battery pack should be replaced.
5) *Cell Balancing:* The function of cell balancing is to maintain balancing of cells. For example, In the battery pack 4 cells are connected in series and the voltage of cell are equal. If one of cell high voltage than the other. This effect will be on entire pack, if one cell is at 3.6V while the other three cells are 4V. During charging these three cells will attain 4V, while other onecell is 3.7V. That time stop charging cell these are charge 4V and discharge up to the remaining cell to 3.7V.
6) *Thermal Control:* The life and efficiency of battery pack mostly depends on the operating temperature. The BMS are measuring the temperature of individual cell and control the thermal system to maintain the normal temperature of the battery pack.

II. SIMULATION WORK

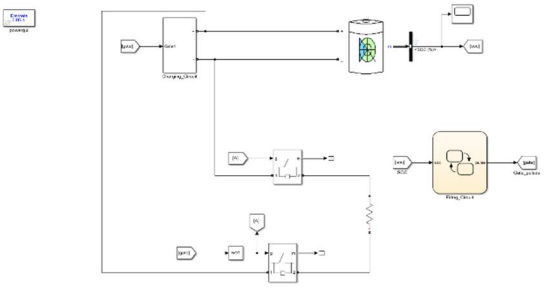

Fig 2. state of charge module

A State of Charge (SOC) circuit is used to measure and display the amount of charge left in a battery or a power source. The circuit typically uses a microcontroller, voltage divider circuit, and display to provide an accurate reading of the battery's current charge level. The SOC display can be a series of LEDs, an LCD, or any other type of visual indicator that shows the battery's charge level. The SOC circuit is commonly used in applications such as electric vehicles, mobile devices, and renewable energy systems where it's important to know the battery's charge level to optimize performance and prevent damage to the battery.

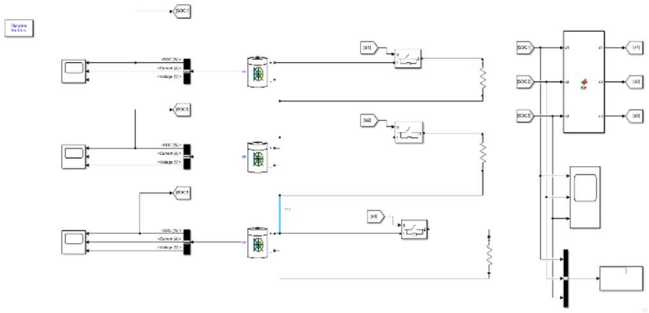

Fig.3 Cell Balancing

One way that the BMS balances the cells is by equalizing the charge between them. When one cell has a higher charge than the others, the BMS can direct a small amount of current to the lower-charged cells to bring them up to the same level. This process is called cell balancing. Another method that the BMS uses to balance the cells is by discharging the higher-charged cells slightly while leaving the lower-charged cells alone. This can help to even out the charge across all the cells.

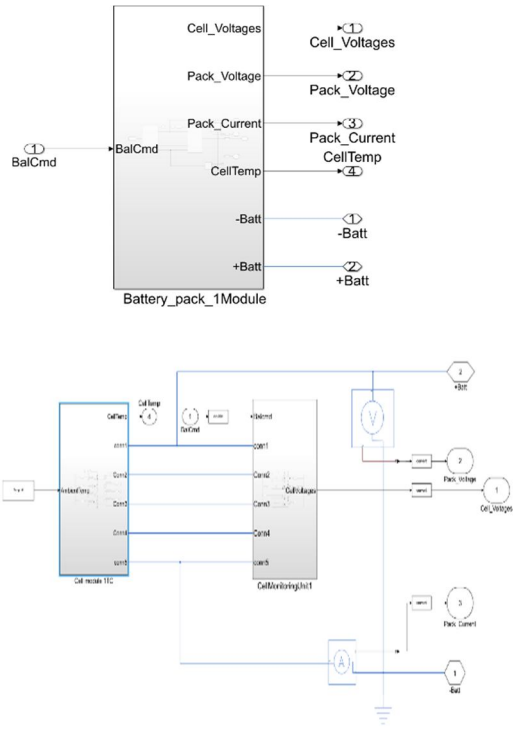

Fig.4 Battery module for 1 cell

III. SIMULATION RESULT

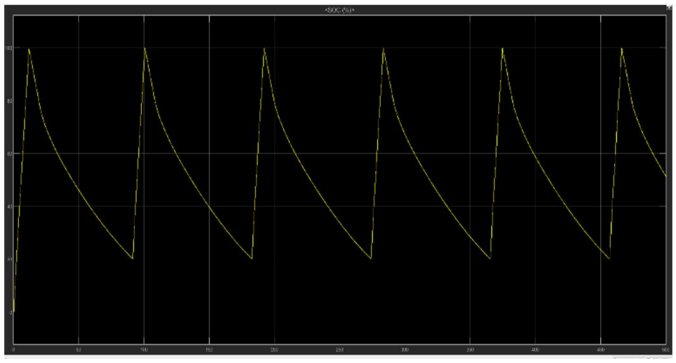

Fig.2 Output of state of charge module

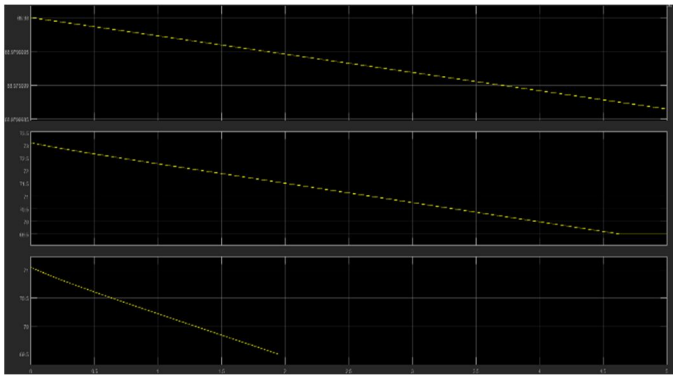

Fig.2 Output of cell balancing

IV. FUTURE SCOPE

Future potential exists for lithium-ion battery utilization in PV panel systems with a battery management system (BMS). A BMS can increase battery life, increase battery safety, and optimize battery performance, among other advantages. Due to their high energy density and extended cycle life, lithium-ion batteries are more popular as an energy storage solution with the rise in demand for renewable energy sources, particularly solar panels. Lithium-ion batteries do, however, require careful management to prevent overcharging, overheating, or over-discharging, which can shorten the battery's lifespan and cause damage. In order to prevent overcharging and overheating and to make sure that the battery is discharged within safe limits, a BMS can monitor the battery's state of charge, temperature, and voltage levels. The BMS can also maximize the battery's performance and energy efficiency during charging and discharging.

V. CONCLUSIONS

A lithium-ion battery's charging and discharging processes are managed and observed by an electronic device known as a battery management system (BMS). A BMS is necessary to ensure the lithium-ion battery used in a PV panel system performs safely and effectively. The BMS assists in preventing the battery from being overcharged or over-discharged, which can result in safety risks and shorter battery life. Additionally, it balances the battery pack's various cell voltages, which is essential for maintaining peak performance and capacity. A BMS is an essential part of a lithium-ion battery for a PV panel system, to sum up. It helps to maximize the battery's performance and lifespan by ensuring safe and effective battery operation.

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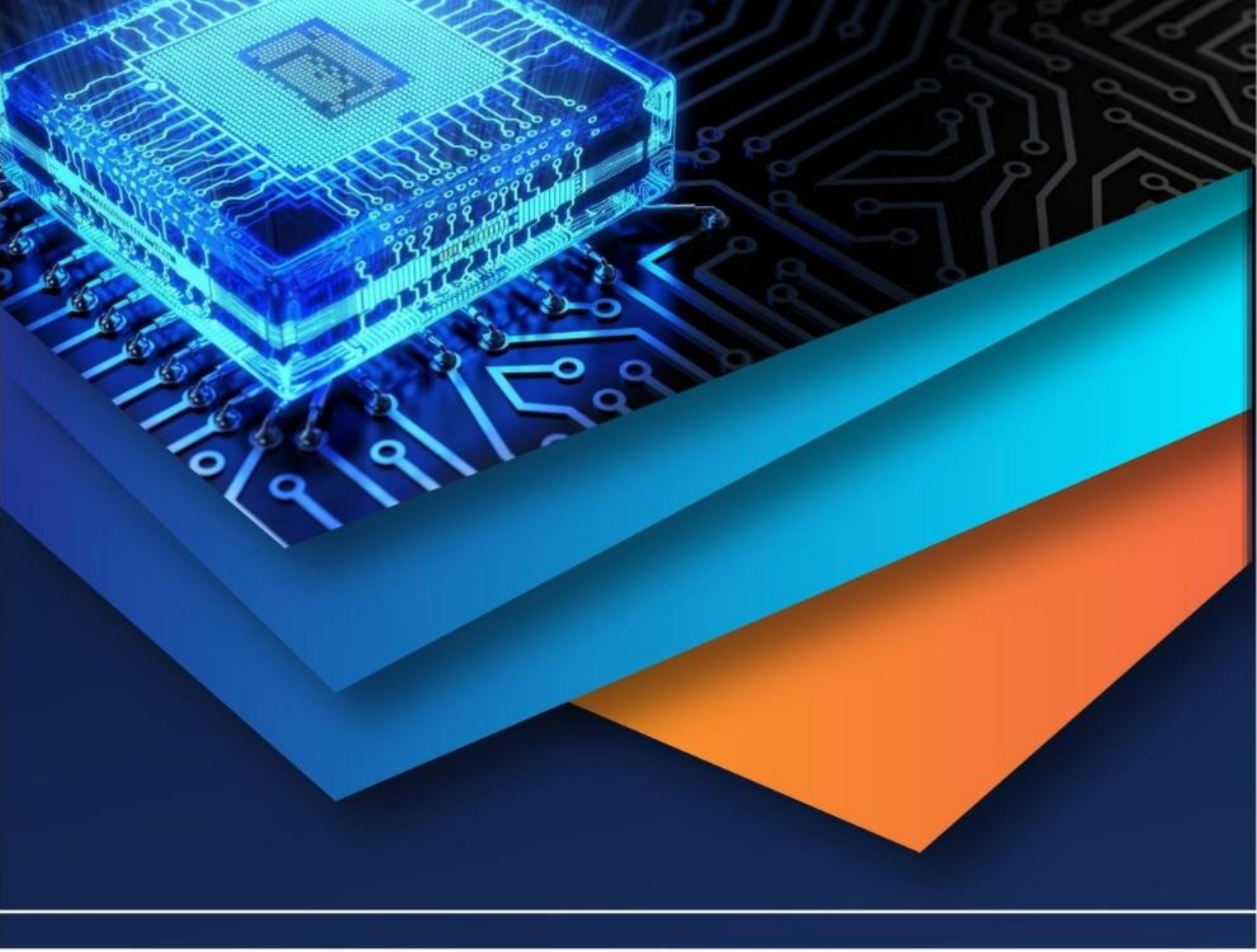

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