



e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

Volume 10, Issue 3, March 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.122

9940 572 462

6381 907 438

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Design of Dynamic Current Mode Multi-Cell Charger by Cell State Synchronization

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ABSTRACT: Nowadays, lithium-ion (Li-ion/Polymer) batteries are playing a substantial role in energy storage solutions for modern-day consumer products such as mobile phones, laptop computers, EVs and portable devices. In This Scenario Overcharging and over-discharging cells can lead to damage, resulting in battery fires, capacity reduction or reduced lifetime. Conventional BMS devices addresses safety and reliability concerns by providing measurements that ensure each cell is functioning within a constrained operating range. But it is not giving clear communication to the Battery Charger about the regulated charge control to the battery Stack. So, in this system proposes the Internal Cell State Based Dynamic Current Mode Multi-Cell Charge by Cell State Synchronized PWM Control.

KEYWORDS: Li-ion, battery charger, BMS, multi-cell, PWM.

I. INTRODUCTION

The challenges in battery monitoring charging and arise due to the fact that the chemical process involved in generating the electrical energy cannot easily be expressed in terms of parameters of a model and the model itself, will be different for different conditions of the battery and for different external triggers like current, voltage and load. Batteries are used either as a primary or as a secondary storage of energy for Processing Industries, EVs, Auto Industries and Portable Devices. The secondary storage batteries are subjected to charging and discharging cyclically. The charging/discharging cycles degrade the performance of the battery, thus reducing its efficiency in terms of capacity to hold charge. Since batteries operate by converting the chemical energy in the electrolyte into electrical energy, the degradation affects the chemical reactions as well as the interaction between electrode plates and the electrolyte. The latter is also due to deposition on the electrodes. The battery performance is also affected due to aging.

The performance degradation of a battery needs to be monitored so that once the performance in terms of storage capacity and energy delivery falls below a threshold, the battery can be replaced. The performance degradation of a battery is measured in terms of state-of-charge (SOC), Voltage and Current. The SOC is the total amount of charge left in the battery, and is expressed in terms of percentage of the total charge that the battery in its present condition can hold. The SOH is the percentage of the total charge of a fully charged new battery that a fully charged battery in the current condition can hold. Battery Management systems (BMS) are developed to monitor the battery condition to improve the battery charging operation. And it leads to extend the life of Cell. The BMS is also used to keep track of charging/discharging of the batteries as well as management of sources of energy and loads.

In this paper, addresses some issues in BMS, mainly on Charge control, Cell Voltage monitoring, Temperature monitoring, continuous load monitoring. Rapid advancements in Li-ion/Li Polymer battery technology have resulted in high specific power/energy, high terminal voltage, higher efficiency and long cycle life. Therefore, Li-ion/Li Polymer batteries have become standard in electric vehicles, Automotive/Processing industries, Renewable energy and other Portable applications. Most of the battery powered applications comes with a battery management system (BMS) which determines the battery states such as state of charge (SOC) and state of health (SOH) and controls the charge/discharge rates to enhance the life of the battery But in this project taken care about all the parameters of the cells like Cell Voltage, Cell temperature, Internal Impedance of the Cell, SOC and SOH with load and without load conditions. Based On these Conditions the design of dynamic current mode multi-cell charger by cell state synchronization through the Fuzzy logic algorithm.



II. SMART BATTERY MANAGEMENT SYSTEMS

The task of battery management systems is to make sure the optimal use of the residual energy present during a battery. So as to avoid loading the batteries, BMS systems protect the batteries from deep discharge, from over voltage, which are results of utmost fast charge and extreme high discharge current. Within the case of multi-cell batteries, the battery management system also provides for cell balancing function, to manage that different battery cells have same charging and discharging requirements.

The multi-channel battery monitoring and balancing system is meant for Li-Ion battery packs utilized in automotive, industrial and consumer applications. It fulfils four main functions: cell voltage measurement, temperature measurement, cell balancing, isolated communication to main battery charging controller. Additionally, it provides the required diagnosis tools to make sure proper function of the controlled battery, because the Active thermal control may be a key element within modern Li-Ion battery packs as cell temperature for charging has got to be kept between 0 to 45°C and for discharging between -20 to 60°C; operation outside these ranges leads to accelerated aging, reduced capacity or maybe full damage of the battery.

III. SYSTEM THEORY

Rapid advancements in Li-ion/Li Polymer battery technology have resulted in high specific power/energy, high terminal voltage, higher efficiency and long cycle life. Therefore, Li-ion/Li Polymer batteries have become standard in electric vehicles, Automotive/Processing industries, Renewable energy and other Portable applications. Most of the battery powered applications comes with a battery management system (BMS) which determines the battery states such as state of charge (SOC) and state of health (SOH) and controls the charge/discharge rates to enhance the life of the battery. In this paper taken care about all the parameters of the cells like Cell Voltage, Cell temperature, Internal Impedance of the Cell, SOC and SOH with load and without load conditions. Based On these Conditions the design of dynamic current mode multi-cell charger by cell state synchronization through the Fuzzy logic algorithm.

The design of dynamic current mode multi-cell charger by cell state synchronization is a Multi cell battery charger CC/CV Power Supply unit consists of BMS cum battery charger. Based on The BMS feedback output Signal to the battery Charger output current is controlled. The block diagram is shown in Fig.1.

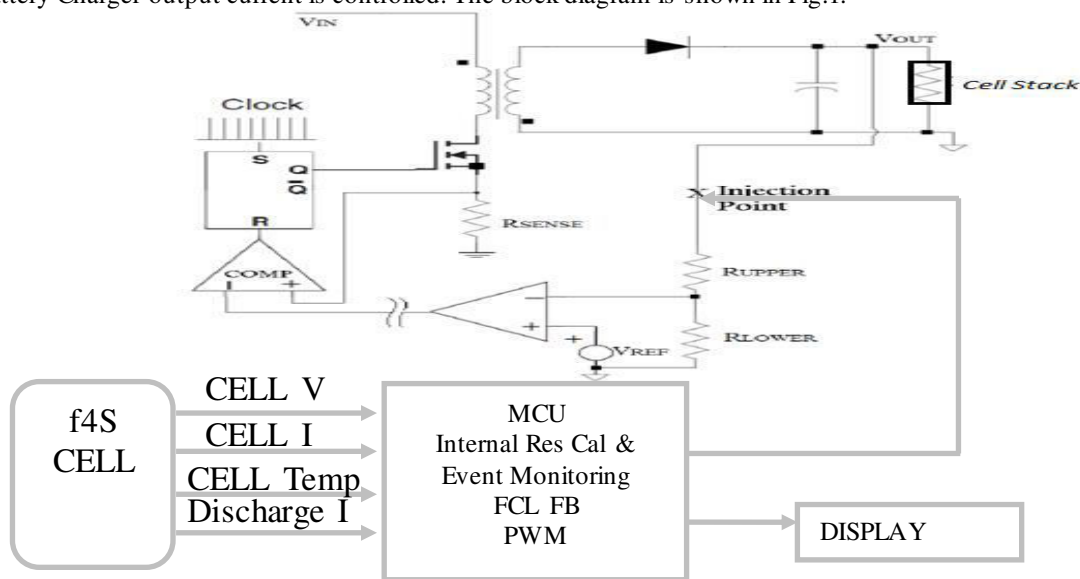


Fig.1. Block Diagram

This paper designed based on the flyback topology. Due to Multi cell stack charging with linear charging describes the steps taken to design, build and test a 20W Flyback Switched Mode Power Supply (SMPS) that uses the CC to control the circuit. The reason for changing the dedicated feedback controller to an MCU with CIPs is to gain control, monitoring, communications and automated features, which are some of the demands in a new SMPS. Designers who



have used only Application Specific Integrated Circuits (ASICs) may think of them as analogue devices, such as op amps and comparators that are integrated in a Single IC that does not need code supervision to work normally, but can be interconnected and configured in a sandbox-type environment.

At the start of a cycle, the IC oscillator sets the SR latch and turns on the external power MOSFET. If the load current increases, the output voltage decreases slightly, causing the FB pin voltage to fall below the 800mV reference. Conversely, if the load current decreases, the FB voltage rises above the mV reference and the error amplifier sinks current away from the ITH pin causing its voltage to fall. If the current comparator does not trip, This IC automatically limits the duty cycle to 80%, resets the SR latch, and turns off the external MOSFET. For example, if the load current increases, the output voltage decreases slightly, and sensing this, the error amplifier sources current from the ITH pin, raising the current comparator threshold.

IV. RESULT AND DISCUSSION

The Conceptual Blocks created based technical function of AC to DC battery charger and BMS. The simulation block is shown in Fig.2.

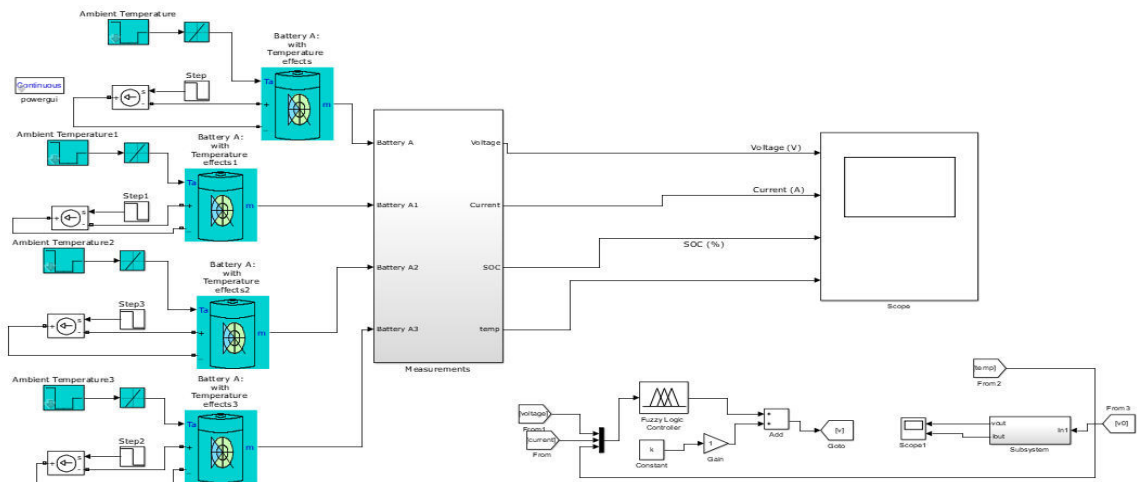


Fig.2. Simulation BMS model

The BMS control PWM signal from the MCU is comprised of Cell’s SOC, SOH Cell Voltage, Discharging Current, Temperature and internal resistance. Based on This Error Signal Simulated output shown in Fig.3 and without Error BMS output signal Generated output is shown in Fig.4.

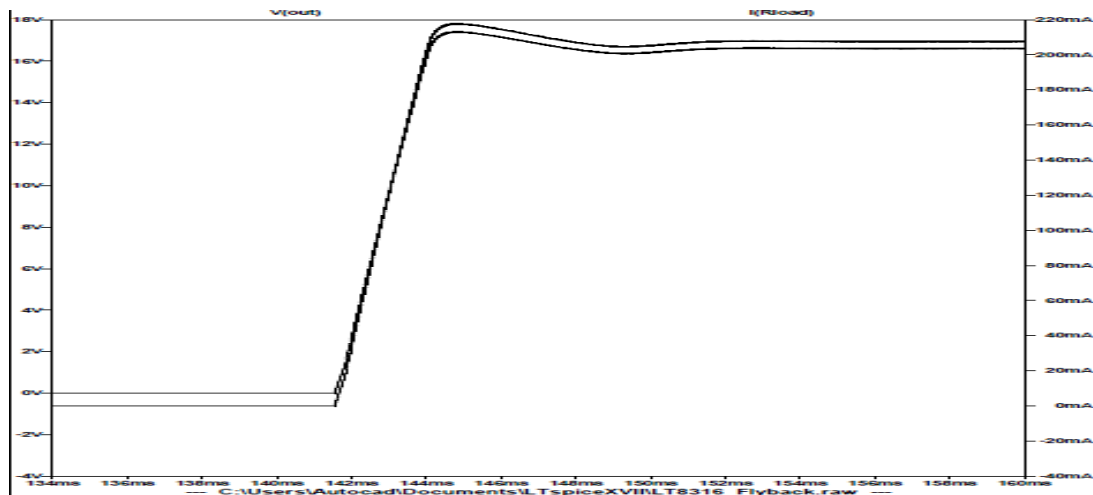


Fig.3. Current and Voltage wave form is output of the battery charging unit Injected by the PWM input derived from the Error Signals of the BMS



Fig.4. Current and Voltage wave form is output of the battery charging unit Injected by the PWM input derived from the Error Free Signals of the BMS

The battery charger designed simulation blocks is shown on Fig.5.

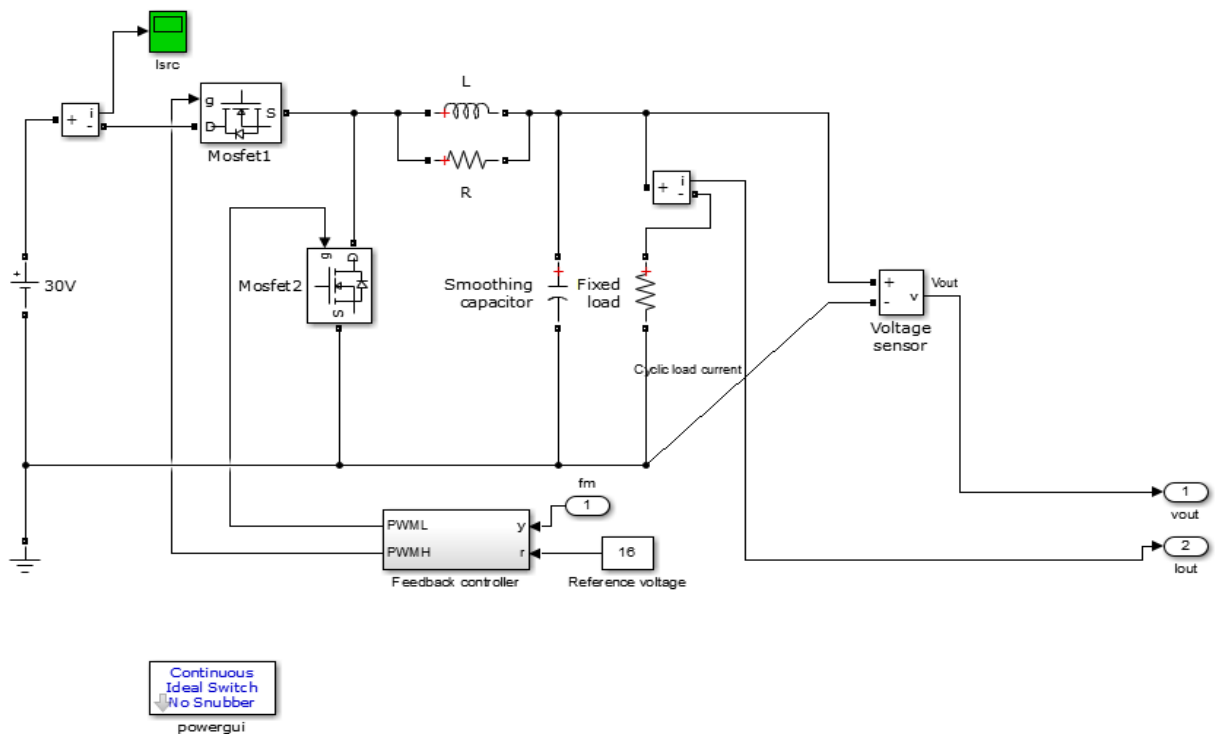


Fig.5. Battery Charger Simulation Blocks



The Battery Cell Charging Profile Period is shown on the Fig.6.

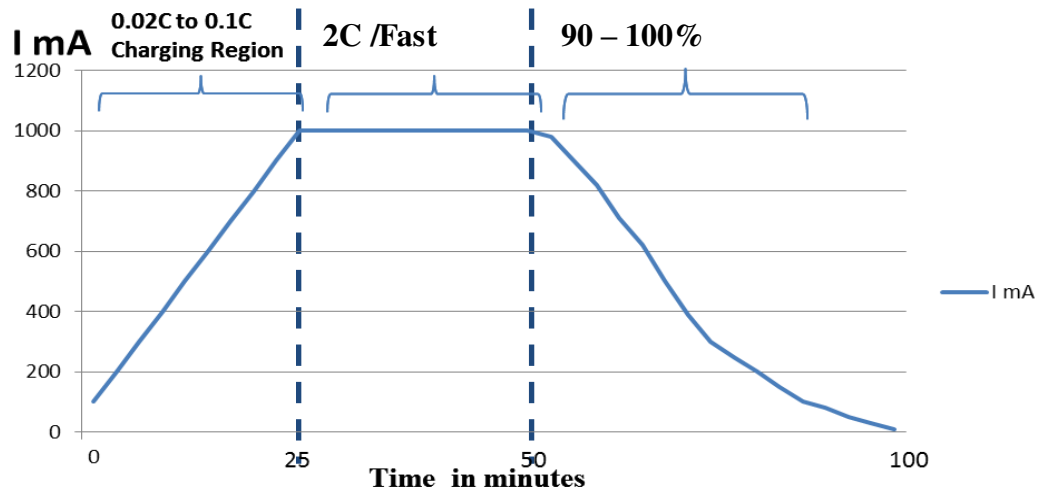


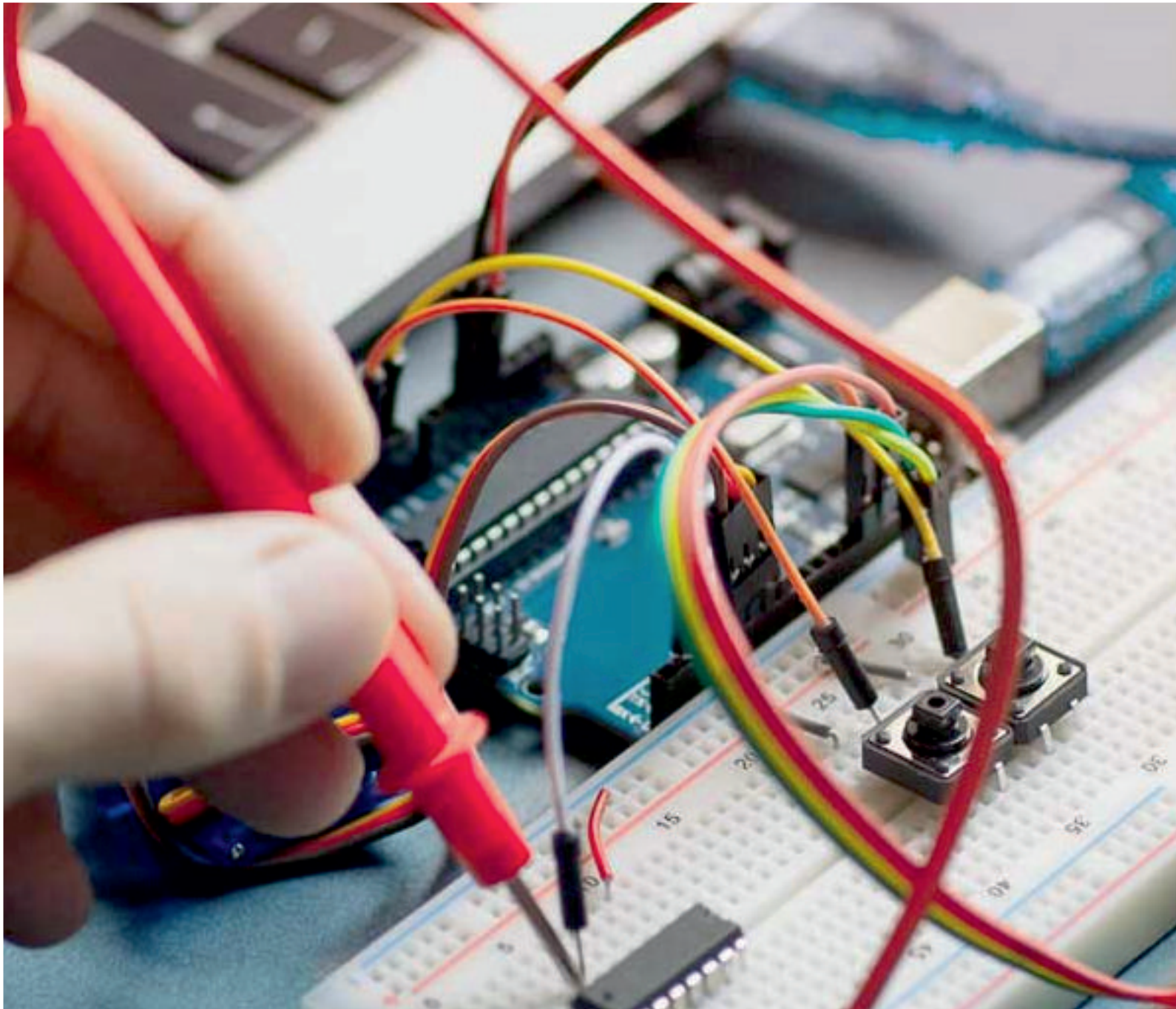
Fig.6. Conceptual Charging Profile Period

V. CONCLUSION

The Battery Charger cum Smart Battery Management systems concepts and Hardware Blocks are created Based on the BMS'S Measurement Signals of Cell Voltage, Cell Current, Temperature and State of Charge. These are member functions of the Fuzzy logic system. The Fuzzy derived output control signal is converted into Switching PWM. This PWM signal is High frequency; the signal-controlled results are validated on the simulation of the power supply section and BMS. This Type of charging Profile will reduce the temperature rises in the charging and Discharging of Battery stacks easily identifies the less Voltage cells and State of the Charge. This will improve the life cycle efficiency the Multi cells also Reduces the Burst happenings of the cells during charging or discharging period.

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