BATTERY-MANAGEMENT SYSTEM (BMS) FOR ELECTRIC VEHICLE

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Abstract- in any application of battery we are using battery pack. This battery pack is basically a combination of battery cells connected in series. Due to charging & discharging there is possibility of overcharge or undercharge of the battery cells. Because of this there is chance of permanent damage of the battery cells connected in series. But due to series connection of battery cells no any use of battery pack for the specific application. To avoid these possibilities battery management is vital for most applications where batteries are a power source such as electric vehicles, hybrid vehicles etc. In vehicle applications the safety, operation, and even the life of the passengers depends on the battery system. This attribute is exactly the major function of the battery-management system (BMS)—to check and control the status of battery within their specified safe operating conditions. In this paper, a typical BMS block diagram has been proposed using various functional blocks. Battery management system (BMS) is essential for enhancing the battery's life cycle and safety. As a result, a BMS is required to realize both the effective cell monitoring and balancing. Moreover, individual cell balancing and monitoring circuit with a smaller size are required in a large number of battery cells. To meet these requirements, a modularized charge equalizer using the monitoring integrated circuit (IC) is proposed for EV battery strings. The proposed scheme exhibits efficient charge equalization with simple control of the monitoring IC. In the proposed equalizer, the battery string is modularized into a master module and multiple slave modules.

I. INTRODUCTION

Now a day's batteries are useful in lots of applications such as electric vehicles, hybrid vehicles, battery backup applications, power tools etc. The paper contains all the functions required for general-purpose monitoring of series connected lithium ion batteries as used in electric vehicles, battery backup applications, and power tools. The part has multiplexed cell voltage and auxiliary ADC measurement channels for up to six cells of battery management. The BMS not only controls the operational conditions of the battery to prolong its life and guarantee its safety but also provides accurate estimation of the SOC and SOH for the energy management modules in the applications. The specific characteristics and needs of the battery powered applications, such as deep charge/discharge protection and accurate state-of-charge (SOC) and state-of-health (SOH) estimation, intensify the need for a more efficient BMS. The BMS should contain accurate algorithms to measure and estimate the functional status of the battery and, at the same time, be equipped with state-of-the-art mechanisms to protect the battery from hazardous and inefficient operating conditions. One of the important parameters that are required to ensure safe charging and discharging is SOC. SOC is defined as the present capacity of the battery expressed in terms of its rated capacity. SOC provides the current state of the battery and enables batteries to safely be charged and discharged at a level suitable for battery life enhancement. Thus, SOC helps in the management of batteries. As the view of safety section, temperature is an important factor in the operation of a battery. In addition to the safety issue that is defined by the temperature range, the efficiency of the battery is also affected by the ambient temperature because of degradation of its capacity and an increase in internal resistance. Therefore, the BMS needs to have the ability to control the temperature of the battery and keep it at the optimal point under different operating conditions. The need to dissipate the heat produced by the battery cells due to electrochemical reactions will be more serious when several cells are compacted in a battery pack. Thermal management uses heat-transfer analysis to determine the distribution of heat inside the atterypack and embed channels to remove the heat using air or a liquid, if necessary.

II. THE PROPOSED BATTERY MANAGEMENT SYSTEM

The monitoring IC can be used to monitor four, five, or six battery cells connected in series. Atypical configuration for a six-cell battery monitoring application is shown in Figure 1. However, lithium ion battery applications require a significant number of individual cells to provide the required output voltage. For more than six cells daisy-chain interface of monitoring IC allows through serial protocol. The daisy-chain interface allows the monitoring ICs to be electrically connected to the battery management chip without the need for individual isolation devices between each monitoring IC.

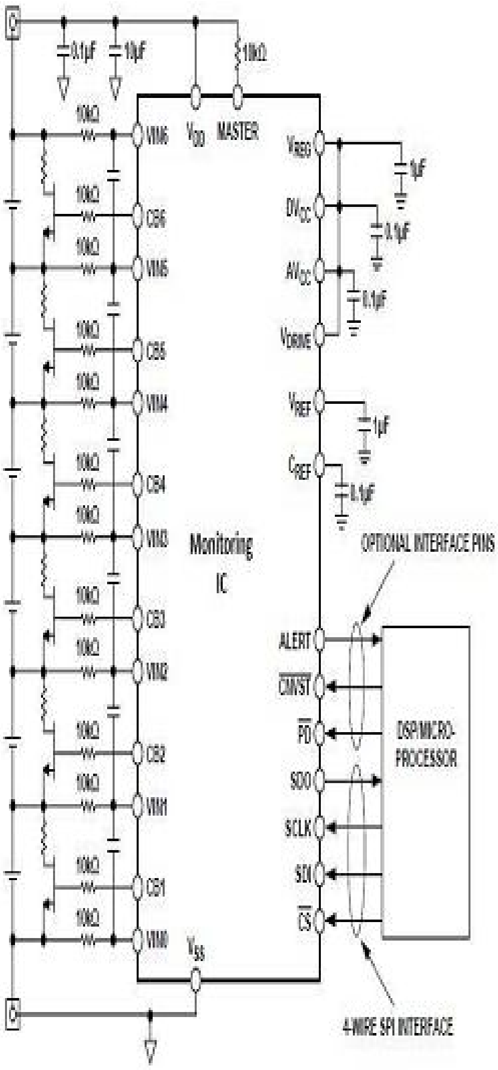

Fig.1 Configuration diagram for six battery cells

Battery Pack is a number of Battery cells connected in series for the monitoring & balancing purpose. For the electric vehicle generally 3V to 4.2V range voltage cells are used. According to different vehicle module probably 48V or 72V battery pack is used in electric vehicle. The monitoring IC contains all the functions required for general purpose monitoring of stacked lithium ion batteries as used in electric vehicles, battery backup applications, and power tools. The part has multiplexed cell voltage and auxiliary ADC measurement channels for up to six or twelve cells of battery management. An internal ± ppm/°C reference is provided that allows a cell voltage accuracy of ± mV. A good resolution ADC is available and allows conversion of stacked cells within some µs. The AD7280A also includes a dynamic alert function that can detect whether the cell voltages or auxiliary ADC inputs exceed an upper or lower limit defined by the user. The AD7280A has cell balancing interface outputs designed to control external FET transistors to allow discharging of individual cells. VIN Inputs: Analog Inputs VIN are available for getting input voltages of the battery cells. CB Outputs: Cell Balance output for balancing of cells purpose. These pins provide a voltage output that can be used to supply the gate drive of an external cell balancing transistor. AUX Inputs: Auxiliary, Single-Ended ADC Inputs. By using these signals we are detecting the temperature of all the cells which are monitored by monitoring IC. In this system main intension is to estimate SOC and SOH using the captured battery variables such as battery voltage, current, and temperature. SOC is defined as the capacity of a battery, expressed as a percentage of its rated capacity. Mainly it indicates the energy left in the battery. SOC is useful to understand the status of travelling distance of an battery operated vehicle from the available capacity of the battery. SOC is influenced by the temperature, operating cycles, and discharge rate; therefore, BMS should incorporate a model of the battery that takes into account the effects of these factors to deduce SOC. Typical inputs to the model include the voltage, current, and temperature, and they are obtained by the respective sensors from the battery pack. The sensors provide the analog inputs, which are digitized using A–D converters. The inputs are constantly monitored at regular intervals by the microprocessor. The SOC indication is useful not only to estimate the running distance but, in addition, to keep the batteries at a specified SOC to deliver and accept charging without the risk of over discharge or overcharge of the cells.

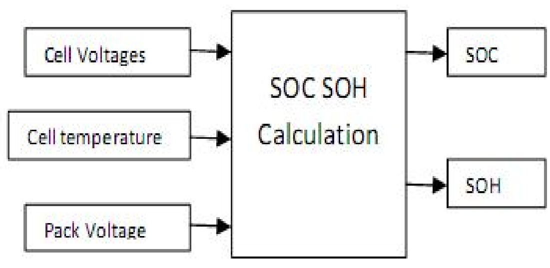

Fig.2 Estimation of SOC & SOH

The state of health (SOH) of a battery is a subjective term and mainly depends on the application. The SOH indicates the state of the battery between the beginning of life (BOL) and end of life (EOL) in percentages. The EOL of a battery is reached when the battery cannot perform according to the minimum requirements. For EV applications this is defined by the battery manufacturers when one of the following conditions has been fulfilled: - The capacity of a battery under reference conditions has dropped to 80% compared to the rated capacity under reference conditions. This is known as capacity fading. - The maximum power delivered by the battery under reference conditions has dropped to 80% compared to the rated power under reference conditions. This is known as power fading.

III. OPERATIONAL PRINCIPLES

Voltage, Temp, Current

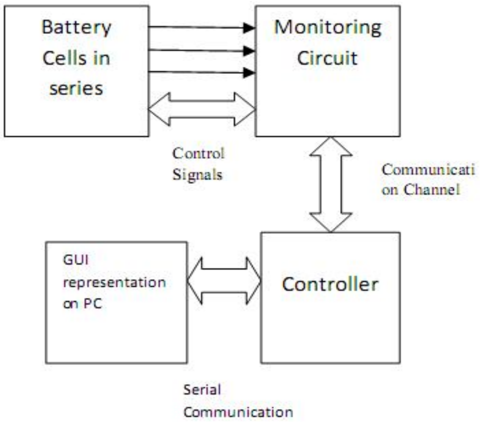

Fig.3 Representation of system

Figure 3 shows the actual representation of the system. AD7280A monitoring IC is used for the data capture from the battery cells. Voltage, temperature, current & battery pack voltage are the parameters gathered from the battery pack. Based on the selected algorithm by using above parameters calculate the SOC, SOH parameters & display on the laptop or PC. According to the threshold values of the cell balancing voltage & temperature controller operates the cell balancing outputs & cooling fan outputs. Li-ion cells are designed to provide a voltage in the range of approximately 2.8 to 4.2 V. It is very important to maintain the voltage of a Li-ion cell between its designs limits at all times, or the cell will be irreparably damaged. If a cell's voltage is allowed to drop below threshold voltage, the cell can go into a state of deep discharge, from which it may take large duration of time may be hours or even days to recover. In fact, deep discharge may cause the cell to short-circuit, an event from which it will not recover. Overcharging to a voltage greater than 4.2 V can be even worse because this can cause the cell to destruct, possibly with severe overheating or other catastrophic results. During the lifecycle of the battery, battery may be charged and discharged for hundreds or even thousands of times. As this occurs, the individual cells may age differently. Some cells may become slightly (or more than slightly) mismatched with respect to the others. If this phenomenon is not corrected, one or more cells may become undercharged or overcharged, either of which can lead to failure of the battery. The methodology for correcting this condition is called balancing. Balancing is the process of forcing all of the cells to have identical voltages. This is accomplished by a balancing circuit.

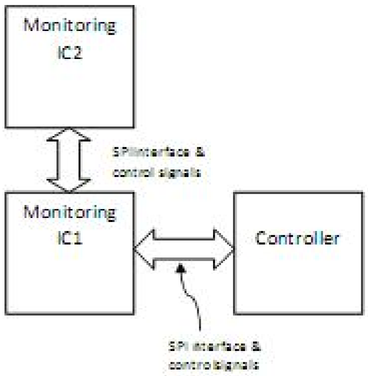

Fig.4 Daisy Chain structure of communication

Figure 4 shows the daisy chaining of cells if want to capture data from more than 6 cells. One monitoring IC is able to capture data of 6 cells of battery pack connected in series. In this case monitoring-2 IC transferred data to controller through monitoring IC-1.

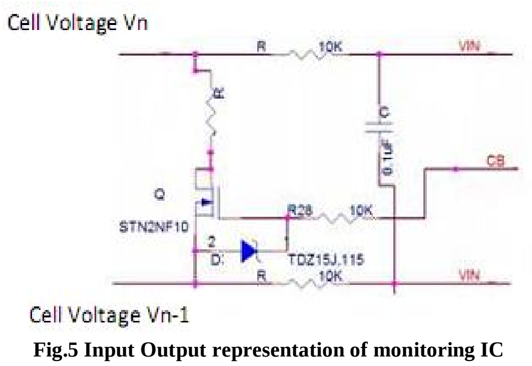

Fig.5 Input Output representation of monitoring IC

In figure 5 VIN is a voltage input to monitoring IC, due to this input understand the voltage status of battery cell & according to if there is any difference between other comparing cells then it turns on the MOSFET as shown in the fig. to manage all the cells at equal level.

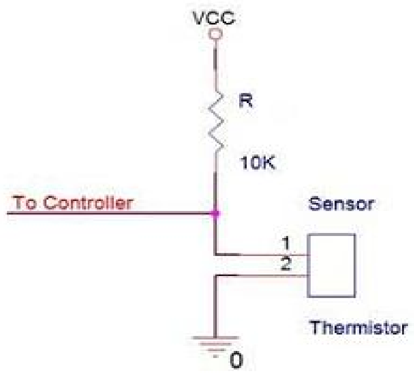

Fig.6 Temperature Signal Processing

Figure 6 shows the processing of signal from temperature sensor. Basically temperature signal is thermistor, due to change in temperature whose resistance changes & by using this property we captured the voltage change respective to resistance change & gives to controller ADC pin for further processing.

CONCLUSION

An individual charge equalizer with a monitoring IC is proposed. The proposed method effectively uses the cell switches and the battery monitoring IC for cell balancing, thermal management, SOC estimation, SOH estimation of lithium-ion battery pack.

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