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Simulation of Battery Monitoring System for the Estimation of Battery Health and Average Soc of Battery Pack

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Abstract: - Everyone need to utilize now a day the free energy which is available and hence the electric vehicles are rapidly in use. The radiance energy can be stored in a main part of Electric vehicle that is "battery pack". This paper, focuses on approximation of battery parameters by selecting a lithium-ion battery array having capacity of 48V,40Ah is designed, which is having a BMS (battery management System). Nowadays battery industrial applications in electric vehicles. Active battery uses in this simulation. While designing a battery pack module to run the electric vehicle, multiple cells need to be connected in series as well as in parallel to get sufficient amount of energy. In this simulation, there is approximation of 'State of Charge', 'State of Health', and the cell 'voltage balancing' is monitored with the temperature variations.

Keywords: OCV(open Circuit voltage), EV(Electric Vehicle), 'BMS(Battery management system'), 'State of Charge (SOC)','State of Health (SOH)','Lithium-Ion' (Li-ion).

Introduction

Low Wen Yao, Abd Aziz, Kong, and Nik Idris (2013) earlier designed a Lithium-ion batteries utilizing the MATLAB/Simulink platform, in their work they have represented the equivalent-circuit for its transient and steady-state response. There was further advancement has been done by integrating the intelligent controlling algorithm for battery management system for accurate approximation of the battery parameters in MATLAB/Simulink (Kumar et al. , 2015). In 2016, the researchers were sophisticated a 'Hardware-in-the-Loop' secondary storage framework for energy storage management system and testing was eventually done and verified experimentally to illustrate that MATLAB-based modelling can help to improve efficiency as well as safety too (Barreras et. Al. ,2016). Anusree, Sreelekshmi, and Nair (2018) underlined the importance for combined thermal management in the BMS simulations and pointed out the important role of monitoring and controlling battery pack temperature fluctuations in electric car batteries. For automobile charging, the authors has proposed a wireless thermal tracking system that can be added to MATLAB/Simulink-powered BMS designs to boost performance (Wang et al.,2019). As there was enhancement in each field so, some of the researchers has focused towards algorithm development too. The extended Kalman filters were developed and showed that how the MATLAB can help to enhance the estimation techniques for the parameters of battery packs (Ramachandran et. Al., 2019). Similarly, the battery was also affected due to improper balancing which was addressed by Dalvi & Thale (2020) for automobile power source control by implementing a DSP-triggered inactive cell balancing network which can be developed to optimize cell balancing techniques and provide protection to battery pack. The author has also contributed to closely approximate the 'SOC' and 'state of health' by using 'OCV' parameter of the battery array framework by utilizing again MATLAB/Simulink platform (Lazreg et. Al, 2020). Li-Qing, Jie, Chen-Hao, and He-Shuai (2020) has suggested a significant-correctness in voltage inspection technology for

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battery source management systems, utilizing MATLAB simulations with multiple cell arrangements. The researchers has done advancement for the approximation of 'state of charge' of a battery cell array by using deep learning & algorithms of machine learning. Parallelly, the authors has done simulation by selecting a 'lithium-ion' battery cell array(4S3P) on the platform of MATLAB version R2023b to analysed the battery pack factors in a operational metrics in which the elements are temperature of battery pack, 'SoC(State of charge)','SoH(State of Health) Tapaskar et al. This paper on the basis of the simulation which represents the parameter of battery in MATLAB with balancing of a cell and thermal Management if temperature parameter is in unsafe region i.e., voltage, current, SOH and Average Soc then will come into picture In this paper dust (stare of health) is monitored and accordingly SOH the balancing and thermal management will work Sometime the battery will ages are unbalanced. that will be balanced by with the help of methods.

Table(1): Summary of Component Specification:

Component	Specification
Battery	Lithium-ion battery
Current	40(Ah)
Temperature	40 c
Voltage	48 volts
Load	Dc Motor

Working:

Battery Pack In the existing battery pack the genetic lithium-ion batteries are connected in parallel having nominal voltage 48V, 40Ah. As soon as the charge and discharge the battery its internal Resistance increase and due to that the temperature is also increasing in the Practically this is represented in for existing model with the help of timer function used in MATLAB. The timer functions. In MATLAB generates a signal at a certain time specified in the function

In existing simulation of BMS there are following function present

1 Measurement and display Parameters of battery

2. Battery Protection circuit

3 cell balancing

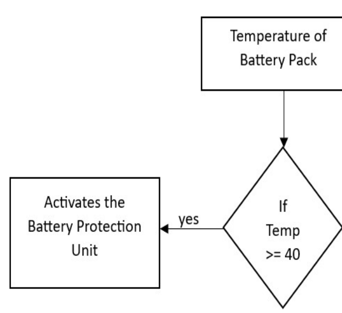
4. Thermal management system

Measuring unit is used here for the Measurement of soc Average Soc, Soh and Temperature of battery pack

$$SOH = \frac{Actual\ current}{Rated\ current}$$

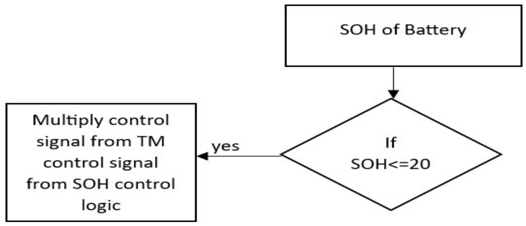
The measuring unit measure the 'state of health' of the battery. ratio of actual energy storage capacity to the Nominal current of a battery Pack.

Thermal Management system control flow is indicated in the figure (1), where the temperature of battery pack is increase that is e >= 40 if yes then activate the Battery protection Circuit Battery Protection unit in the SOH of Battery

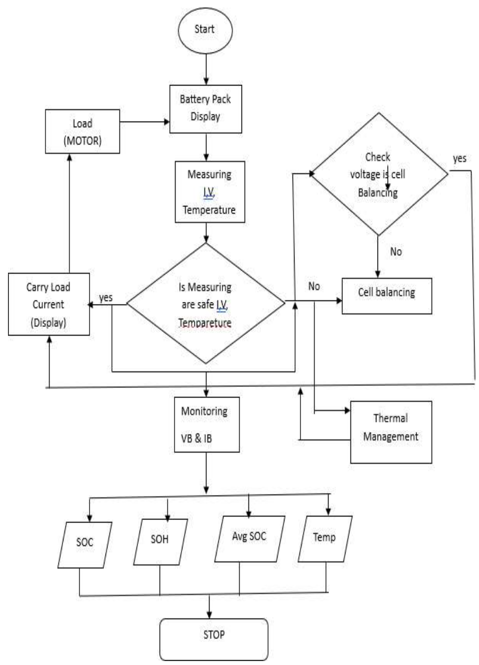


Figure(1): Control Flow for Thermal Management

of supply to the SOH is less than 20 then if yes multiplying by control signal from thermal management control signal from SOH control logic, then circuit breaker it will disconnect the load



Figure(2): SOH Control Cycle



Figure(3): System Algorithm

Algorithm

The algorithm of this system is indicated in figure (3).

Methodology:

The ‘SOC’ approximation for the battery -The ‘SOC’ is indicates the battery accessible capacity out of its rated capacity. It is having representation in percentage from 0 to 100%. Level 0% shows completely dead and Level 100% shows a fully charged. This is helpful to show approximation of ‘SOC'. The Current, the cells terminal voltage measurement and thermal level of cell array is also necessary while monitoring energy storage devices. In this paper the maximum level for soc is 80% and depth of discharge is 20%. The soc is calculated by following equation

$$SOC = \frac{SOC\ Initial - Qn}{Qmax} * 100$$

where,

Qn=Nominal charge Q max=Maximum charge
SOC initial = given by measurement

$$SOH = \frac{Actual\ current}{Rated\ current} * 100$$

Variations of Temperature

Table(2): Output Parameters (Soc, SoH)

Sr.no	Time in sec	Temperature	SOC	SOH	Average .SoC
1	1	27	80	3.248*10^-05	80
2	2	30	80	3.248*10^-05	80
3	3	34	80	3.248*10^-05	80
4	4	40	80	41.15	80
5	5	50	80	41.15	80

Simulation Model

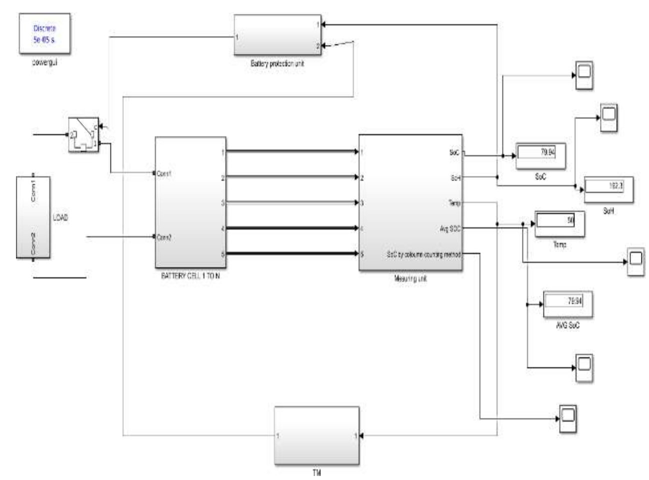
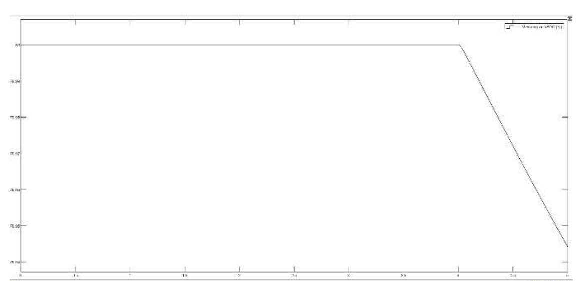


Figure (4): MATLAB Simulink model of BMS

Results



Figure(5): State of charge

this graph show maximum value of soc is up to 80% and minimum is up to 20% the x-axis represent sample time and y-axis represent the level of soc that is 80 %

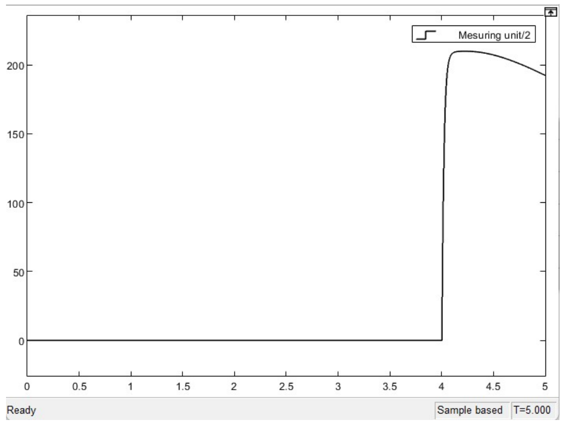


Figure (6): State of Health

Soh represent the health of the battery which is initially good and then it is going to doctoral after the no of charging and discharging cycle of Battery in the graph x-axis is sample time and y-axis is health of the battery

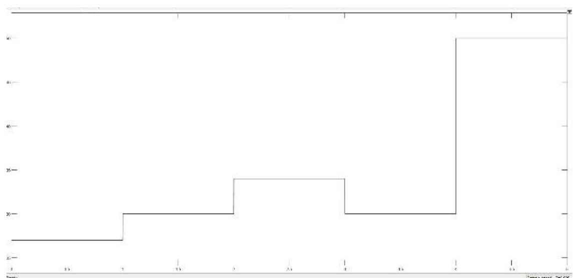


Figure (7): Temperature Variations

As number of time we charging and discharging the health of battery doctoral and due to which their is a ride in temperature in which represents in this graph the safe region of a temperature is up to 40% and after which up the temp rise more than 50% centigrade then it will initiator thermal run away

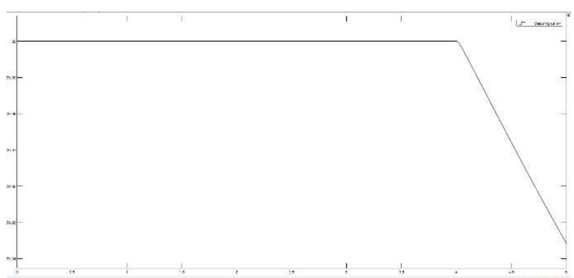


Figure (8): Average State of Charge

The figure (8) indicates average SoC of 4 battery cells.

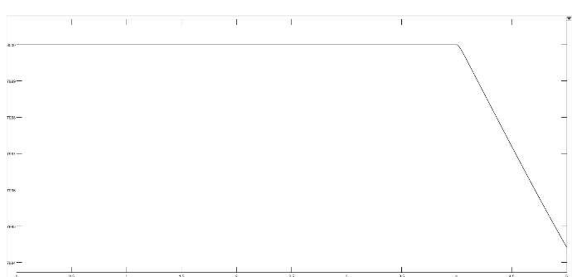


Figure (9): Coulomb Counting Method SOC

The figure(9), represent the SoC which is measured with the help of column counting method considering initial SoC and the current value of the SoC .The graph shows there is a highest accuracy in the measured value of soc and the value of soc given by manufacturing

Conclusion

Electric vehicle's main part is battery pack which provides the essential power flow to the other parts of it. This power flow has to be monitored and as well as the monitoring of storage devices parameters has to be done by its manager that is BMS which protects it. This BMS also enhances the performance of battery and its life. One of the protections to battery balancing technique is the active call battery balancing which one is cost effective and simple solution can be used in an EV cell array. In this paper, circuit of battery balancing integrated along 'coulomb counting' technique for approximation of State of Charge(SOC.), 'SOH', Average 'SOC' and temperature.

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