Parallel Battery Management System for Electric Vehicles

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***Abstract**: Battery bank comprises of 'N' No. of. Battery pack where the required cells are connected in parallel and each pack will be made to connect both in series and parallel combination to attain a required voltage. Multi Secondary Coaxial Winding Transformer is used to maintain the battery in balanced condition. During charging and discharging of battery, each battery pack is connected to the secondary winding of transformer including Electronic Switches, Temperature Sensor, Voltage & Current Sensor. The voltage, current and temperature sensor is used to measure the parameters of each pack, from which the state of the health, state of the charge and temperature of the battery can be calculated. The voltage induced in the primary side is based on the switching frequency & duty cycle of the MOSFET. To compensate the required voltage needed by the load, a boost converter is connected to the system on the primary side of the system where the transformer will be coupled. The output is connected to the inverter that produces power to drive a BLDC motor.*

Keywords: Lithium Ion Cell, Multi Secondary Coaxial Winding Transformer, BMS, Rintmodel.

I. INTRODUCTION

The world is moving through the pollution free and the contribution of electric vehicles for that will be a important one. In India within 2022 the production of petrol and gasoline engine is stopped. We need to drive a electric vehicle the battery is very important to use the battery effectively and efficiently the Battery Management system is required. The BMS is used to maintain a battery health (SOH), State of charge (SOC), charging and discharging time. In this project discuss about Battery management system and new methodology.

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II. EXISTING SYSTEM

In the existing current Battery Management System, the cells are wired in series to achieve a required voltage to drive a BLDC motor. By using this method suppose if any one cell is faulted the overall system is drop so this system is not efficient and effective. To overcome this we implement the new methodology. The battery will convert a chemical

Energy into electrical energy so it will operate on different state at different atmosphere. The charging and discharging of each cell is not equal. If one cell discharge very quick one cell charge very quick so to maintain these cell balancing is done.

III. PROPOSED SYSTEM

The battery pack used in the electric vehicle for the proposed system has a capacity in the order of hundred volts. It is made up of several hundred of Lithium Ion batteries which are connected in a serial or parallel mode in a group. Due to some of the shortcomings in the manufacturing process, it may lead to variations in capacities, internal resistance and voltage difference between the lithium ion batteries that are connected together. These inconsistencies in the parameters of the battery may lead to reduce life span and poor performance in the longer run. Therefore it is very much necessary to control the charging and discharging cycles of those batteries. It can be achieved by battery balancing methods. The modes of balancing are divided as passive and active balancing [1]. System with passive balancing consumes the energy for working while the active balancing system gives the energy to other batteries and thus save the overall energy consumed [2][3]. In this paper, a novel method is proposed in which the electrical energy to the output is got from the battery pack to the individual batteries from a fly-back transformer by exploring the zero-speed operation characteristics of the PWM CSI-fed IMDs.

This balancing system is achieved by using a transformer which has more secondary with coaxial winding. The battery pack provides the balance energy which is needed in excess to the system. The transformer's primary side is given to the input terminals of the battery system and the transformers' secondary side is attached to the individual battery cell.[9] The corresponding battery which has the lesser voltage will be charged first in this pack. When the battery 1 has low voltage, the switch S0 will be connected to it.

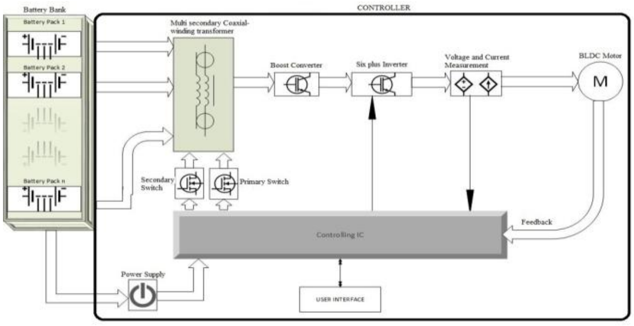

Fig.1: Block diagram of BMS

During this cycle, energy will be stored via the transformer as given in A of Fig.1. After this cycle is over, switch S1 is connected to the battery and S0 is disconnected as shown in B. During this cycle, the output of the transformer gives the equivalent power to charge Battery 1. By this method, the individual battery is charged through the transformer from the battery pack. Buck-Boost converter is used to maintain a constant output voltage[10]. The DC output from the converter can be converted into AC by the inverter. Sinusoidal wave form the inverter can convert a three phase supply to drive a BLDC motor. The PWM signals is fed from the microcontroller to control the on and off of the switch by the switching frequency the output is desired. Motor drives which are fed by current source inverter will have capacitors that are connected at the output. Therefore a fraction of the current from the system will be passed through the capacitors. In this section, the influence of capacitor on the control of the system is investigated[11]..

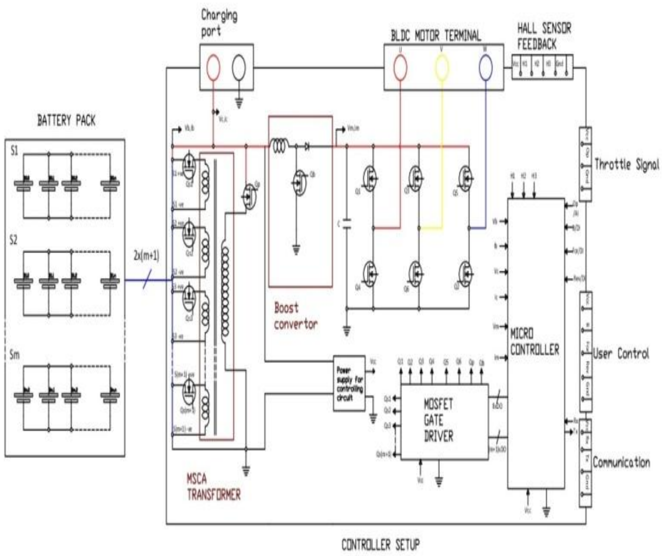

Fig.2: Implementation of BMS

IV. BATTERY BALANCING METHOD

The model proposed in this paper is based on the Rintmodel [4][5]. To estimate the State of Charge, a counting method is used in this system. In the BMS shown in Fig.2, DC power source is used to supply the electric energy and the battery gets charged. The voltage parameter of the battery is supplied by a source that is controlled. The amount of current flowing through the cell is determined and integrated to find the variation in battery's SOC[6]. The model of the function which is shown in Fig.2 is integrated as an entirety. During the balancing process, the input signal given is the beginning state of charge and the current value. The output signal from the system is the battery voltage and current State of Charge of the battery. The State of charge of those 3 batteries in the initial stage are given as 0.25, 0.20, and 0.28.

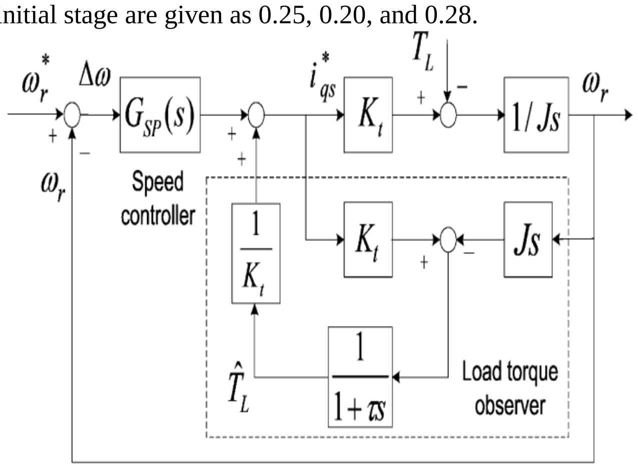

Fig. 3: Balancing method

The conventional method of BMS can work well except in the cases where lower speed and zero stator frequency conditions occur[7]. Since in case of stator frequency nearing zero, the stator quantities will not be affected by the rotor speed and, therefore, the speed cannot be determined from the taken stator voltages and currents. Also the voltage of the stator that is provided by the inverter will be hard to measure and is assumed to be same as the reference voltage taken from the DC link voltage and the switches of the inverter. In case of higher speeds, the errors which may occur due to these assumptions can be neglected. But in case of low speeds, the errors can be high as the voltages are minimized to maintain the reference flux[8]. Therefore the errors that occur due to the voltage drops and the dead times that happen in the switching devices will be more when the voltage range is low. So they need a high computational effort and human intervention in the machine like high frequency signal injection and modifications on the rotor slots. But in case of many attempts to get the flux accurately and estimation of speed for a wider range induction motor drives that have been proposed recently, it seems far that the solutions do not meet.

V. HARDWARE IMPLEMENTATION

The hardware circuit for speed control of Induction Motor is shown in Fig.4. 230V AC supply is given to the Auto transformer and 100 V is given to rectifier which converts it into DC voltage. Dc Voltage from the rectifier is converted into AC by VSI and given to the Induction motor. Speed is measured by a Speed sensor and the output is passed to a dsPIC microcontroller. This will function as a feedback loop that generates the switching pulse for gate pulse depending on the speed. Speed can be controlled by Field oriented Control that is done using coding a program in the microcontroller.

The controller output gives a PWM signal that is fed to inverter switches as gate signal. The modulation and control of the switching frequency is high so that the ripples can be eliminated by the low inductance.

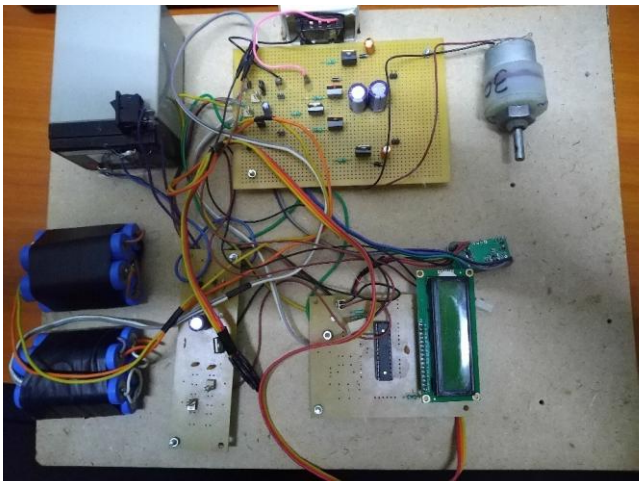

Fig.4 Experimental Setup

The input supply to the main circuit is 230V AC having frequency of 50HZ is shown in Figure.5 which is obtained by using Digital Storage Oscilloscope.

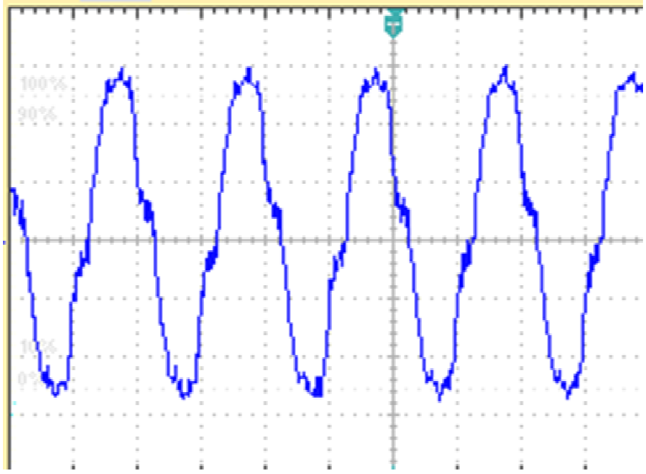

Fig.5 AC Supply

Pulse-width modulation (PWM) is a modulation technique that controls the width of the pulse, basically the duration of pulse, which is based on modulation signal information.

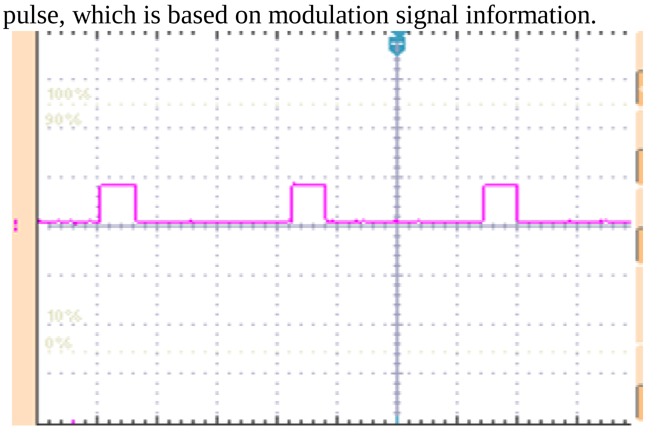

Fig.6 PWM signals

Although this modulation technique can be used to encode information for transmission, its main use is to allow the control of the power supplied to electrical devices, especially to inertial loads such as motors. The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast pace. The longer the switch is on compared to the off periods, the higher the power supplied to the load. The PWM switching frequency has to be much faster than what would affect the load, which is to say the device that uses the power. The output waveform for Voltage and Current is shown in Figure.7.which is obtained by Digital Storage Oscilloscope

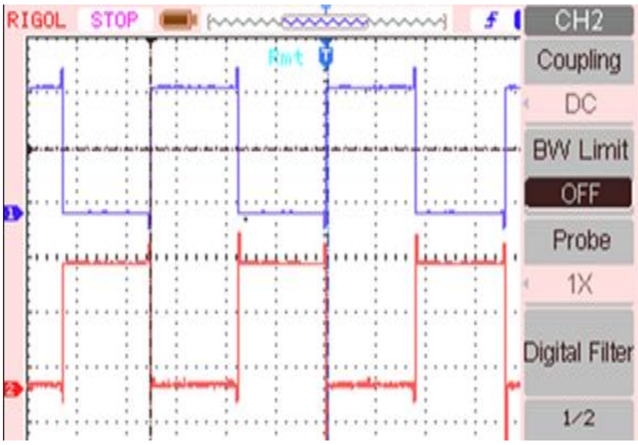

Fig.7 Output waveform of Voltage and Current.

VI. CONCLUSION

Hardware results indicate a decrease in balance time whenever the duty cycle of the switch is more, but the loss increases. But if the frequency of the switching is increased, loss of energy is reduced, also due to small current SMS balance time becomes longer. Therefore, the use of a high-frequency transformer is very much needed in balancing the system. To make the balance current to be high, the inductors are designed in such a way. For the following system to use in a vehicle, the size and volume of the transformer must be designed in an appropriate way. Therefore, transformer working with high frequency must be used in the design to balance the system. The inductors are designed in such a way to make the value of balance currents more.

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