OPTIMIZATION OF BATTERY PARAMETERS FOR AUTOMOTIVE APPLICATIONS

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***Abstract*——— In this paper we are dealing with the Battery Management System which are used in many industrial and automotive applications to make the battery operations more efficient. It has analyzed and monitor the performance of battery and battery fault in the automotive applications. In this paper we can monitor the batteries parameters like voltage, current and temperature and measure it on the DMM Lithium-ion batteries are connected in series. Parameter are monitored through IC BQ76925 which is monitoring IC through arduino . Arduino is used as a gateway. This paper proposes cloud based battery condition monitoring platform for lithium ion battery. The IOT component including data acquisition and wireless communication. In this project we are using Thinger.io cloud where data is stored. The function of Thinger.io is to get data from NODE-MCU. In NODE-MCU there is inbuilt wi-fi facility. Thinger.io supports multiple networkinterfaces and boards.**

***Keywords* —Lithium ion battery, Battery Monitoring IC,Controller, NODE-MCU, IOT.**

INTRODUCTION

Battery Management System is an electronic or electrical system which monitor, control and maintain battery conditions such as voltage, current and temperature. There are various batteries available in market. A battery plays various role in the field of military, transportation, communication especially in portable devices like mobile phones, electric vehicles and appliances. With the improvement in technologies batteries are coming in the form of packs along with a battery management system as smart battery packs. Battery Management System(BMS)is can be implemented in different topologies like centralized, distributed and modular methods. Nowadays there are different types of batteries are available in the market. Because of the improvement in electric vehicles and auto-motive application, Battery Management System (BMS) has become one of the chief components. It is an electronic device or system that monitors and controls a rechargeable battery. Parameters measured may include cell temperature, voltage, and current. Over last two decades there has been an ever-growing trend toward finding a reliable alternative and less polluting source of power for automotive engines. Among all the proposed and practiced technologies, batteries, and more particularly ,Li-ion batteries, have gained the most attraction in auto, space and marines industries thanks to their unique characteristics. High energy density, no memory effect, and low self-discharge rate have made Li-ion batteries a promising source of energy storage. Battery management is an electronic system which is used for rechargeable battery. This is used for protecting the battery from safe operating areas, monitoring its state. There is battery pack in our project which is used for monitor the conditions of battery pack. Nowadays in electric vehicles there is necessity of battery management system because it recuperates energy. It also controls there charging of the battery by recovered energy which is back into the battery pack which consist of few batteries which is connected in series.

II.SOC ESTIMATION METHODOLOGIES

Several battery frame works can be monitored to monitor the health of a battery in an electric vehicle, while the vigorous parameters considered are the state of charge and the state of health. Soc is described as the ratio of the stored charge available relative to that available after a full charge of the battery [17].

$$SOC = Q(t)/Q(full) \quad \text{(1)}$$

where Q(t) is the accessible stored charge and Q(full) is the available full charge of the battery. While State of health is an indicator of state of battery, it has not yet been illustrated, Rahimi-E says [6] The reason for State of health worsening is the ageing of battery which leads to increased internal resistance .

III.BATTERY MANAGEMENT SYSTEM

It is an electronic and electrical device. Battery Management System is basically defined as which manages, control, and monitor the conditions of battery. There are various functions of battery where battery can perform are as follows:

- Voltage Measurement
- Current Measurement
- Temperature Measurement
- Cell Balancing

Voltage Measurement:

Basically it includes voltage parameter of battery pack or individual battery which can measure total voltage of battery, individual voltage of battery. It also measure minimum or maximum voltage of battery.

Current Measurement:

It is current parameter of battery. which can measure total current of battery pack, individual current of battery. It also measure In or Out current of battery.

Temperature Measurement:

It is another parameter of battery which is known as temperature. Which can measure average temperature of battery pack or individual battery. It also measure temperature of individual battery.

Cell Balancing:

most focus on balancing of battery pack its various parameters like voltage, current, temperature .So there are different cell balancing techniques available in market out of them are as follows: It balances the battery parameter using different techniques:

- Passive Balancing
- Active Balancing

Passive Balancing

Primary cells are non-rechargeable batteries which can be used once and after that they are thrown away which is why they are no longer used now. Secondary cells are rechargeable batteries which can be used several times by charging and dis-charging. Several types of rechargeable batteries are available like Lead acid, Ni-Cd, Ni-MH, Li-ion etc used in different applications. Amongst them Li-ion batteries are widely used in commercial applications due to their good performance. In passive cell balancing, a threshold value is selected and if difference between any two cells exceeds that threshold then excess energy is wasted through bypass resistors using bypass resistors. Generally passive balancing is implemented while c harging only [1].

Active Balancing

Active cell balancing is a charge re distribution method in which excess energy is distributed from highly charged cell to low charge cell using inductors or capacitors until both are equalized. Over charging generates heat causing oxidative chemical reactions leading to thermal run away and also it leads to internal short circuit of battery [2]. But in this design primary focus on cell balancing and displaying on cloud iot so there is in built balancing function is present in IC. There are various batteries present in market but all is not feasible so we decided to use lithium-ion battery because its speed is fast and is low rechargeable [13].

IV.PROBLEM STATEMENT

A. Problem Statement

Overcharging of a battery pack can happen due to negligence of the user and can lead to the overheating of the battery pack. Also, it can result in the leakage of the battery chemical components which can damage the other crucial parts of the Electric Vehicles. Thus, it is not favorable to operate the battery in overcharged conditions. A proper set of battery

management system is required to keep a check on the overcharging of the battery and also to stop the charging once the process is completed.

B. Objective

- To connect the batteries in series and test the volt-age, current and temperature of battery pack.
- To design , simulate and implemention of battery monitoring IC(BQ76925) circuit.
- To develop a program for displaying the parameters of battery.
- The data send to cloud can be access through different systems like computer, mobile, laptop, tablets.

V. SYSTEM ARCHITECTURE

The proposed BMS as shown in figure1. Is implemented using battery pack, battery monitoring ICBQ76925, controller, NODE-MCU and cloud IOT.

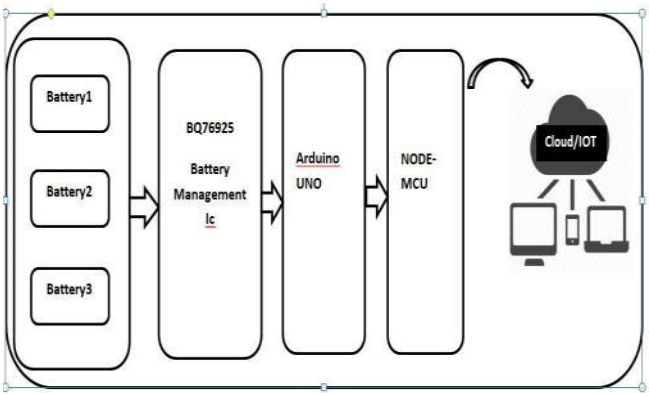

Fig.1.Block Diagram of BMS

- *Battery Pack*

In our paper main focus on monitoring of various parameters of batteries so we have to choose proper battery pack. In market there are various types of batteries are available like Lead acid, Lithium ion battery but we are using Lithium ion battery because of its advantages. Lithium-ion (Li-ion) batteries are one of the most popular batteries in the world today due to the world wide use of mobile phones and laptop computers. as long as conventional batteries such as lead acid batteries which have been manufactured for one and a half centuries. There are two reasons why Li-ion batteries have become the major type in such a short period: their excellent performance and timely advent to meet the growing market of consumer electronic products such as camcorders, mobile phones, and laptop computers. Automotive Li-ion batteries are different from automotive lead acid batteries that function for starting ,lighting, and ignition. They are used as traction power sources in hybrid electric vehicles(HEVs), plug-in hybrid electric vehicles (PHEVs), and electric vehicles (EVs) [4]. Now a days there are different types of batteries are available in market but all is not feasible so we decided to use lithium ion battery pack because of its speed, efficiency, rechargeable. Lithium-ion batteries are used as energy storages in many electric devices, ranging from small battery packs used in cell phone or cameras to large battery system for EV s or temporary energy storages for photo voltaic systems. Advantages of li-on batteries include high energy and power densities, long life and lack of memory effect [5].

The proposed work of this battery is to connect battery pack in series and measure different parameters of battery like voltage, current , temperature and balance it.

- *Battery Monitoring IC*

The bq76925 host-controlled analog front end is part of a complete pack monitoring, balancing, and protection system for 3-, 4-, 5-, or 6-series cell Li-Ion and Li-Polymer batteries. The bq76925 device allows a Host controller to monitor individual cell voltages, pack current and temperature easily. The Host may use this information to determine unsafe or faulty operating conditions such as over voltage, under voltage ,over temperature, over current, cell imbalance, state of

charge, and state of health conditions. Cell input voltages are level-shifted, multiplexed ,scaled, and output for measurement by a Host ADC. A dedicated pin provides a low-drift calibrated reference voltage to enable accurate measurements [3].

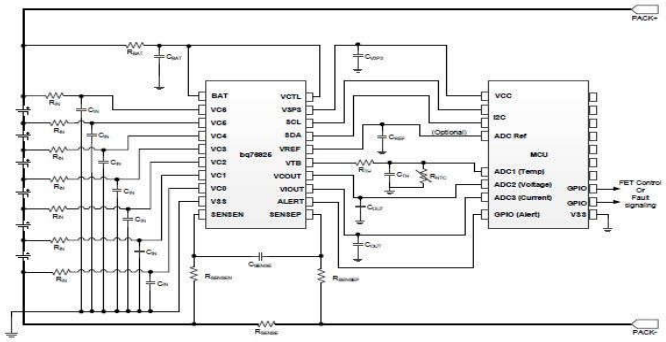

Fig.2.Circuit diagram

Features:

1) Analog Interface for Host Cell Measurement.
2) Analog Interface for Host Current Measurement
3) Switchable Thermistor Bias Output for Host Tempera-ture Measurements.
4) I2C Interface for Host Communications.
5) Over current comparator with dynamically adjustable threshold.
6) Supply voltage range from 4.2 to26.4V.

The voltage across an external sense resistor is amplified and output to a Host ADC for both charge and discharge current measurements. Two gain settings enable operation with a variety of sense resistor values over a wide range of pack currents. To enable temperature measurements by the Host, the AFE provides a separate output pin for biasing an external thermistor network. This output can be switched on and off under Host control to minimize power consumption. [14] The bq76925 device integrates cell balancing FETs that are fully ESP8266 with Arduino IDE. It support direct connection of USB port. It is the combination of features of Wi-Fi station and microcontroller. It can be used for connect to internet tofetch or upload data. It is self-contained Wi-Fi networking solution. This module comes with a built-in USB connector and a rich assortment of pin-outs. With a micro USB cable, we can connect Node MCU to laptop. The proposed of this micro controller is to transfer a data on cloud. Which is digital form for accessingThinger.io we have to set Wi-Fi ID and passwords to we get data on cloud i.e current ,voltage and temperature.

VI .SYSTEM SOFTWARE AND HARDWARE

In this paper we uses two software like Dip trace for PCB layout and for programming we uses arduino software. The figure .3.shows system hardware implementation. Where three batteries connected in series and we have to measure current, voltage and temperature and display it on cloud. This paper is based on IOT platform where Thinger.io platform is used controlled by the Host. The balancing current is set by external resistor up to a maximum value of 50mA. These FETs may be utilized in conjunction with cell voltage measurements to detect an open wire on a cell sense-line. The bq76925 device integrates cell balancing FETs that are controlled individually by the host. The device does not automatically duty cycle the balancing FETs such that cell voltage measurement for protection detection is taken when balancing is off. The host MCU is responsible for such management. Otherwise, the MCU is free to turn on the voltage measurement during cell balancing, which enables the open-cell detection method described in this document. However, the bq76925 device does prevent two adjacent balancing FETs from being turned on simultaneously. If such a condition occurs, both adjacent transistors will remain off [[8,9].

- *voltage monitoring:*

The cell-voltage monitoring circuits include an input level-shifter, multiplexer(MUX),and scaling amplifier.

- *current monitoring*

Current is measured by converting current to voltage througha sense resistor connected between SENSEN and SENSEP.

- *temperature monitoring:*

To enable temperature measurements by the Host, the bq76925 device provides the LDO regulator voltage on a separate output pin (VTB)for biasing an external thermistor network. The bq76925 device provides voltage, current, and temperature outputs in analog form. controller (MCU)with an analog- to-digital converter(ADC)is required to complete the measurement system. A minimum of three input ADC channels of the MCU are required to measure cell voltages, current, and temperature output. Thebq76925 device an supply an external reference for the MCU ADC reference, Compare the internal reference voltage specification of the MCU to determine if using the AFE reference would improve the measurement accuracy[7].

The proposed work of this IC is to monitor the battery parameters. It having inbuilt cell balancing technique. This IC monitor current, voltage and temperature of battery pack which connected across IC. [13]

The communication between controller and IC bq76925 is controlled through I2C protocol which is communication protocol. Data is transfer between controller and IC. First analog data is converted into digital form using controller. If cell balancing is not succeeded then data is transfer back to IC through I2C

Node MCU

It is cloud based battery condition monitoring kit. It is open source IoT platform which is used for transfer the data on cloud. First analog data is converted into digital by controller then given to Node-MCU which is iot platform. Which uses Thinger.io platform by using this platform we able to connect arduino board using Wi-Fi, ethernet or other supported board like ESP8266, NodeMCU. In arduino there is inbuilt library version of Thinger.io. This client library allow connecting different IOT devices to the Thinger.io. Here we uses ESP8266 Node MCU which is micro controller designed by Espressif Systems. It allows us to program ESP8266 with Arduino IDE.

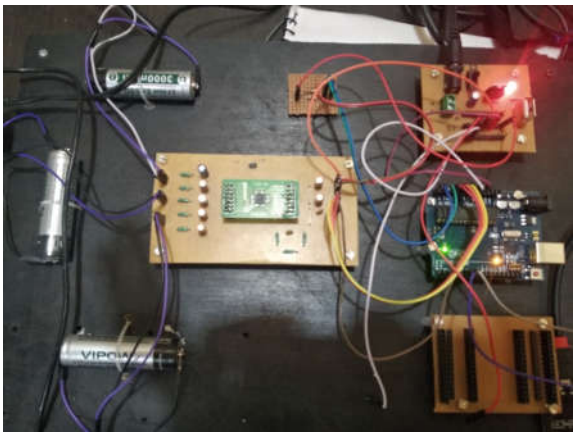

Fig.3.System Hardware

Description of hardware part of system where first there is a battery pack which contain Lithium- ion batteries which is connected in series so we have to measure its parameters. We choose Lithium-ion because of its advantages then its output connected to battery monitoring IC [11]. Where the purpose of battery monitoring IC is to monitor batteries parameters. There is in built cell balancing technique is available it balances the cell and output given to the controller which convert analog data into digital form. Then this data is sent to cloud via micro controller Node MCU where in built Wi-Fi facility is available which is useful for accessing Thinger.io platform for uploading data on cloud. Finally current, voltage and temperature is display on cloud

VII.RESULTS

As expected Battery Management System is able to monitor and control the cell voltage, current and temperature as shown in figure. It is display on cloud where Thinger.io platform for cloud is used. Where Thinger.io is accessed through Wi-Fi it is in built in ESP8266 Node MCU. So we have to access Thinger.io we must have to set Wi-Fi ID and password. So Thinger.io will recognise which device will send the dataESP8266 it is the device.

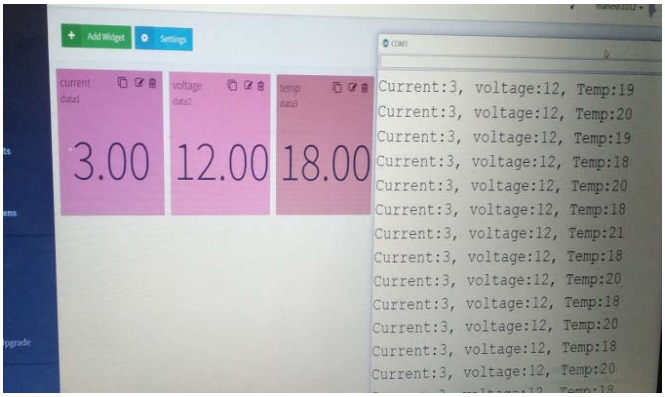

Fig.4.Output

VIII. CONCLUSION

The BMS forms the perilous section of the control unit. Thus, evaluation of SOC, SOH and hence the useful period of a battery ensures the excellent utilization of the battery capacity. A common solution is not needed due to different circumstances in real-world applications. Various measurement methodologies are to be applied based on different conditions to boost and optimize battery performance in Electric vehicles Design and validation of Battery Management system is successfully accomplished. Several task like cell voltage, cell current and cell temperature of battery pack have been supervised and displayed on cloud.

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