Battery Management System

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Abstract — *As humanity is evolving the consumption of energy is increased. Continue power supply is not possible everywhere. So that we require energy storage devices. The stored energy is used in the places where the supply of energy is not available. The stored energy need to be a monitor protected and easy to use. Battery management system is providing the function of monitoring the storage energy protection from overload and overheating and easy to use for charging and discharging purpose. The stored energy can be transferred from one place to another place easily in the form of battery, cells or any store energy storage device.*

Keywords*:* Battery management system monitoring, protection, energy balancing energy management.

1. INTRODUCTION

As we are living in a modern lifestyle of 21st century the consumption of energy has increased in our daily life. Today every person has a personal electronic device such as phone laptop tablets smart watch. This all devices required secondary power supply called a battery. The power of a battery should be managed properly and safely. As the demand of the energy consumption is increase the battery power is also increase there is a necessity for a battery power management or called as a management system. Battery management system can be defined as it is an electronic device to control monitor protection of a battery from overloading overheating overcharging.

BMS need to performed very accurately for safe operation of electrical energy storage system and energy storage devices. BMS are controlling may system in real time operations. BMS monitoring system includes over voltage, over current, over temperature, over heat, optimizing battery performance, maintenance of schedule, prediction of failure and prevention form failure of system. Battery management system is also collecting the data of system and perform the calculation and analysis for improving BMS efficiency.

2. NEED OF BMS

The 90% of the batteries is used in daily life is lithium ion batteries. The lithium ion battery can explode due to overheat over current for any fault occurs in a battery. This should be harmful for human kind. We are required to take a protection against this accident so that we required a BMS for the protection and monitoring to increases the lifespan of a cell or battery and the current conditions such as charging, discharging overcharging etc

In a battery bank there are server cells of a battery is connected in parallel or series but every cell has their own characteristics for charging and discharging there may be a chance for a seam cells are connected in series but the characteristics of a charging is different [2]. To manage the overall power or voltage of a battery is required to manage each and every cell.

All lithium-ion (Li-ion) batteries require a BMS. This is due to the fact that all Li-ion batteries will fail if overcharged, completely discharged or operated outside their safe temperature window. Each Li-ion cell type has its own safe operating area, which makes it necessary to program the BMS accordingly shows the safe operating area typical for a C/lithium iron phosphate cell. Li-ion batteries must have a battery safety and longevity. State-of-function in the form of state of charge (SOC), state of discharge and state of health (capacity) Prompt caution and servicefor the battery management system. This could be cell imbalance or calibration or high temperature. When the capacity falls below the user-set target threshold, it indicates end of life.

3. BMS TOPOLOGIES

There are mainly three type battery management topologies is available as shown in below

3.1 Centralized

One single unit of controller circuit require to controller hole BMS. This is most commonly used method to build the battery management system. Economically the centralized type of BMS is most suitable. The cost is reduced due to a smaller number of controlling units is used. It also makes circuit less complex.[3]

3.2 Distributed:

In distributed type of BMS, each cell required their own control unit. There is single communication unit between the battery and controller circuit. Distributed BMS are Most expansive type of BMS. Because of the greatest number of controlling units is used. It also makes most complex circuit of BMS.

3.3 Modular:

Modular type of BMS, required certain number of controlling units. Each controller unit is connected to certain number of cells for controlling the circuits. module BMS is have being advantage and disadvantage between centralized and distributed BMS. This type of BMS is mostly used in industry battery management system.

As w working on Centralized control type of BMS. In this central control BMS control unit is placed in the centre of the BM Sand control all the cells at the sometimes [4]. It reduces circuit size but the accuracy of the system is good. The connection of the circuit may be a little complex to configure.

4. BLOCK DIAGRAM:

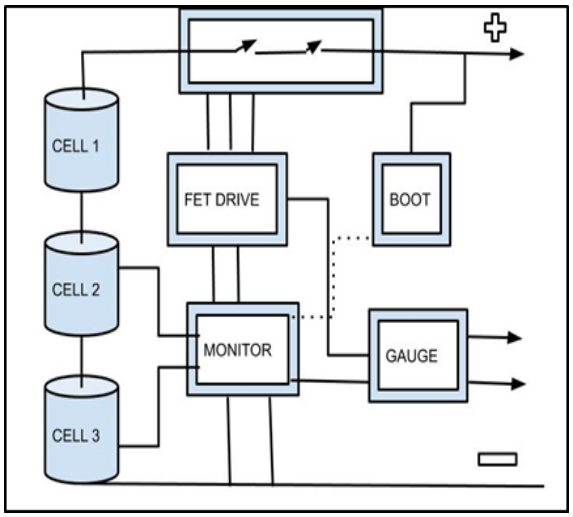

fig -1: design block diagram

5. WORKING PRINCIPAL

Battery management system is an electronic device which management rechargeable battery pack and protects the battery from operating against safe area, by state monitoring, reporting its data, calculation of secondary data, controlling its temperature, charging and discharge of battery to balance the battery pack. BMS is external circuit the 5V TO 12V input voltage required. Due the operation of main device BMS is observes, analyse and measure the cell value and provide as constant output current and voltage as requirement.[8]

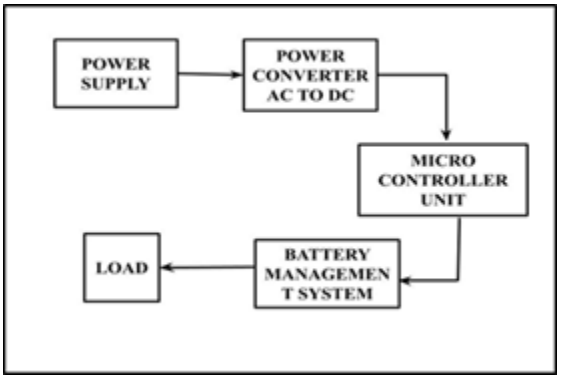

Fig -2: work flow diagram

6. COMPONENTS REQUIRED

6.1 Integrated circuit (IC's)

The DW01A battery protection IC is to protect lithium-ion battery from degrading the lifetime or damage which is caused due to overcharge, over discharge, or over current for one-cell lithium-ion battery powered systems. HY22131 IC and BB3A IC [5]. It is used for balance charging IC activate Transistor, deactivate through resistor if goes above rated voltage.

Table -1: list of same components and its rated value

No.	Items		Unit	Value
1	Rated Capacity		Ah	40.0
2	Nominal Voltage		V	3.15
3	Charging		/	CC/CV
4	Charge Upper Limit Voltage		V	3.65
5	Discharge Cut-off Voltage		V	23
6	Charging Current		A	13.2
7	Discharging Current		A	40
8	Max Discharge Current		A	120
9	Weight		Kg	1.34=0.1
10	Resistance		mΩ	<5
11	Dimension (H x W x L)		mm	56*110*160
12	Working Temperature	Charge	℃	0 – 45
		Discharge	℃	-20 – 60
13	Storage Temperature	1 month	℃	-20 – 60
		3 months	℃	-20 – 45
		6 month	℃	-20 – 25

	s		
	Atmospheric pressure		86 – 106
	Relative Humidity		25% - 85%

6.2 Power MOSFET:

The controlling the current and voltage is the primary function of power MOSFT. The current and voltage is supply to source, drain and gate terminals respectively. MOSFET is also used as switching operation in BMS.[7] the free moving electrons in channels are controlled by the gate voltage applied to gate terminal. The current in MOSFET is flow in directions of source to drains.

6.3 Temperature Sensor:

This is electronic component that can read or sense the temperature of the particular source of input. That are mostly Resistance temperature detector (RTD) or thermocouple or thermistor to collected the thermal data convert it in digital form of data for observer. The temperature of system is need to be maintained for efficient operations.

7. MODE OF WORKING

The battery management system is operating in different mode of operations. The different mode of operation is given below

7.1 Charging

To maintain operational voltage of battery cell, BMS is used to charge minimum voltage value of cell [11].

7.2 Discharging

BMS prefers discharging of maximum voltage cell instead partially charged or impart cells [11].

7.3 Cell Balancing

BMS is designed to maintain optimal voltage of battery or a battery pack to achieve this condition BMS perform charging or discharging [11].

7.4 Protection Circuit Against Over Temperature

Automatically change the switch when the temperature of cell BMS is all operate as a protection device. it achieves the critical value for the safety of the system [13].

7.5 CAN BUS Interface

Interface can bus interface is provide digital information of battery or cell. it communicated with digital device and BMS system [10].

8. DESIGN ALGORITHM

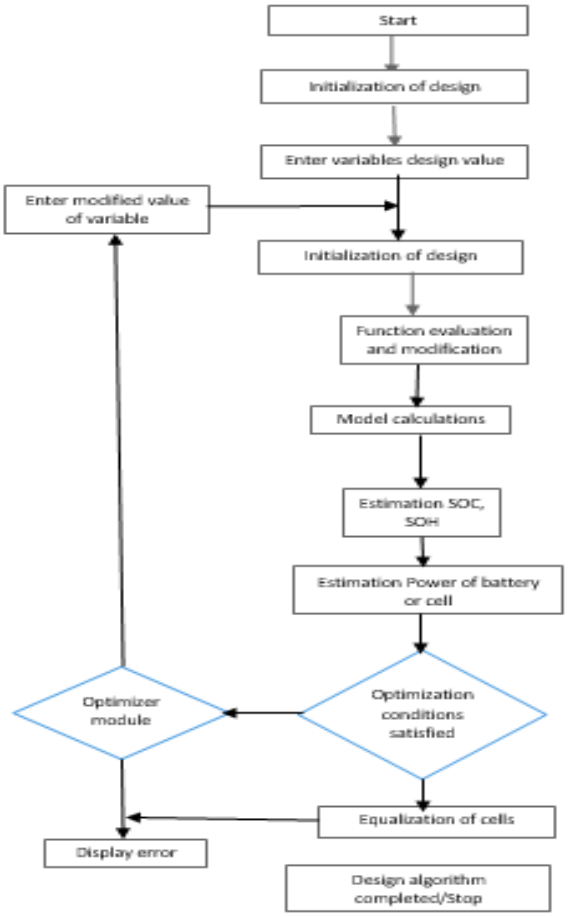

Fig -3: design algorithm of BMS

9. FEATURES OF BMS

There is same important feature of BMS IS GIVEN BELOW

9.1 Monitoring

BMS monitoring system is program to monitor many functions of device and electronic component. It shows all the value of output in digital form of data such as

- Output current.
- Output voltage.
- Circuit temperature.
- Charging status.
- Battery status.
- Notifications (frailer, connected to supply, warning etc).

9.2 Temperature Sensing

It shows the thermal effect on the performance and functioning of BMS. It also senses the temperature of internal circuit. To measure and maintain the average temperature of system, input and output coolant, temperature of each cell and the temperature of surrounding. Because the li-ion are very sensitive to heat. It easy get exploded by overheating.[13]

9.3 State of charge (SOC)

The time required to charge one cube unit of area of battery or call. The SOC is keep as low as possible for quick charging.[12]

$$SOC_{(new)} = SOC_{(old)} - \Delta SOC$$

$$SOC_{(new1)} = SOC_{(old)} - \frac{i\,new\,\Delta t}{Qr}$$

9.4 State of health (SOH)

the capacity of the cell is different form each other for the same rated value and manufacture of cell. The cell capacity is also reduced with time in different rates. The measurement or current capacity of cell is show health of cell.

$$SOH = \frac{\text{nominal capacity} - \text{loss of capacity}}{\text{nominal capacity}.}$$

9.5 State of power (SOP)

Due to the internal resistance is different in each cell and this internal resistance can change with usage of cell, temperature, chemical properties and other surrounding condition as well. The power value of cell is changing and different. The real time status of power of cell and the power available in cell or battery.

9.6 State of Safety (SOS)

The operation of BMS is safe for the operator. Due to that safety status has to be higher. The safety is required for the continuous change value of current flow, change in temperature, over voltage and current, over hearting and any component failure is accurse in system. The BMS is operation in safe range of changing value.

9.7 Current:

Current input and output of the battery need to be controlled and monitored for safety of the device. Current control is also increasing the efficiency of the system.

9.8 Computation

Computation of BMS need to be very efficient and accurate. system has to perform many operations such as data collection, data processing, data analysis and communication other part of system. Computation in BMS is also important because of it has to perform many calculations such as charging current, charging limit, charging current limit, discharging and discharging current limit, state of charging, state of discharging, state of power, state of health, input and output current and voltage, temperature, energy stored and efficiency etc. time required in calculation such functions is should be low.

9.9 Communication

The BMS has bi – direction type of communications in two different mode of communication such as Internal communications and external communications. Both modes are operating simultaneously in real time of operations.

The internal communication used central control unit to connect with internal hardware and its components at a level of cell. This communication can be done by using

- Switching components
- Relay
- Solid state components
- sensor

External communications is done between BMS and other high level hardware such as computers or HMI. This communication can be done by wirelessly or wired connected devices. Its simple and easy to use for command and control. External communication can be achieved by various methods such as

- Serial communications.
- CAN bus communications.
- DC bus serial communications.
- Various wireless communications.

These communications methods are used for different operations in system.

9.10 Protection

A battery management system is act as protections device as well. It protected the its internal component include its battery cell and main device. As the LI-ion battery can be explode its dangers for operators. BMS is providing protection against

- Over and under current
- Over and under voltage
- Over heat
- Over pressure
- Leakage current and voltage
- Short circuit
- Over charging and discharging
- Fault in connected device
- Ground fault

- System or command failures.

The protection circuit is not same in all BMS. It can various by BMS type, BMS size, battery or cell used, connected device, purpose of used etc. the protection circuit of BMS can stop or reduce the operation of the device connected. [9]

10. APPLICATIONS

Battery management system has various application in different fields of operations. It has single cell BMS for study and research to multiple cell BMS for industrial used. The technology of BMS is under the research and development stage of evolution. Application of this technology is increases as new development Same of the BMS applications are given below

- Mobile phone
- Invertor UPS
- Laptop
- Chargeable Electronic gadget
- Testing of electrical battery
- Manage the continuous or alternate power supply
- Transportation vehicles (EV, HEV)
- Space technology
- Energy storage device or system
- Solar power plant

11. LIMITATION OF BMS

- Circuit diagram is complex.
- Costly due to increasing the component.
- Cell balancing is difficult.
- System is bulky.
- Power consumption is increases.
- Pressure management is difficult.

12. CONCLUSION

Demonstrates a complete battery management system which monitors the critical parameters and perform an active cell balancing of a battery pack whenever required. Theis BMS system is integrated with microcontroller (MSP430) for monitoring and controllingunit.

As we find the BMS is an electronic device that can we used in daily life. This can improve the efficiency, power quality, power factor of the system. BMS can also be used as monitoring and protection purpose as it increases the output voltage of the battery bank of the system.

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