EV BMS With Charge Monitor and Fire Detection

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Abstract. Electric vehicles (EVs) are undoubtedly the way of the future. However, as of 2023, EV technology has not reached its full potential in terms of efficiency and safety. The cause of majority of the electric vehicle fire events is a battery explosion or fire. This paper presents an integrated approach to manage EV battery systems, which combines a Battery Management System (BMS) with charge monitoring and fire detection. The system is built to continuously monitor the battery's voltage, current, and temperature and to immediately turn off the battery's input or output if any unexpected behaviour is noticed.

Keywords: *EVs, BMS, Temperature Sensor*

1 Introduction

The adoption of electric vehicles (EVs) has been steadily increasing in recent past, driven by a combination of factors viz. environmental concerns, fuel efficiency, and government incentives. However, managing the battery systems that power EVs is a serious challenge that must be addressed to ensure the safety and efficiency of these vehicles. The battery system in an EV consists of several battery cells, which need to be monitored and regulated to prevent overcharging or discharging, which can lead to reduced battery The BMS consists of battery cells, a battery life, reduced performance, and even safety hazards such as fires.

Battery Management Unit (BMU), and sensors, which work together to monitor and regulate theVoltage sensors are used to monitor voltage and control the amount of current that can go to the battery while it is charging. Charging circuitry is utilised to do this. Battery voltage is displayed on the LCD. The current sensor monitors current drawn from the battery when it is connected to a load and shows the parameter on LCD. The temperature sensor is used to keep track of the battery's temperature both while charging and discharging. The system automatically sounds a buzzer alarm and displays a message on the LCD if the battery temperature is seen to differ from the expected values. As a result, the technology enables an intelligent and effective battery charging and detecting system.

Battery's state of health, state of charge, and temperature. The charge monitoring system provides real-time feedback on the charging process, including the amount of power being

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delivered, the battery's charge level, and the charging speed. Additionally, the fire protection system uses a combination of thermal management and fire suppression techniques to detect and prevent potential fires from occurring.

2 Block diagram of BMS

All of the active functions for a step down (buck) switching regulator are provided by the voltage regulator LM2576 family of monolithic integrated circuits. Fixed versions with 3.3V, 5V, or 12V fixed outputs are available. The output voltage range for adjustable versions is 1.23 to 37 volts. Both variants have excellent line and load regulation and can drive a 3A load.

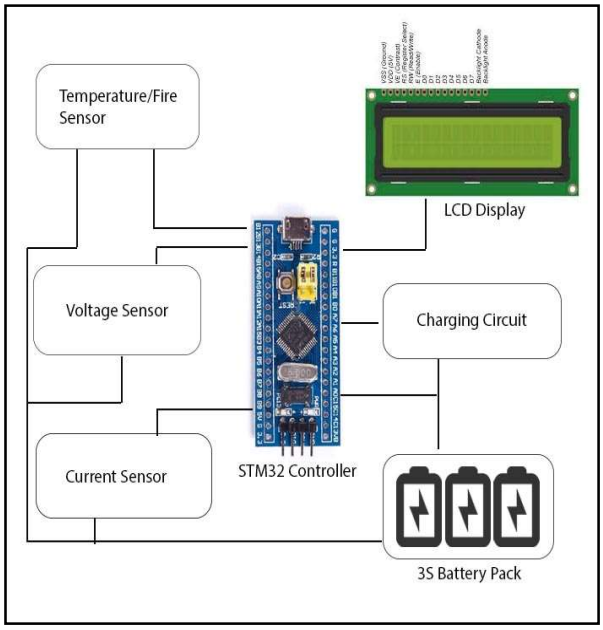

Fig.1 Battery Management System

The STM32 is a popular type of microcontroller that used in many different kinds of gadgets. Additionally, it has the ability to connect to various other kinds of microcontrollers. STMicroelectronics developed the STM32 line of microcontroller units (MCUS), which is based on a 32-bit ARM Cortex-M processing core. Using a series and parallel communication method, a variety of external devices, including as sensors,cameras, motors, and other devices, can be connected to this microcontroller.

The DHT11 is a common temperature sensor. Fig. 1 displays the circuit diagram. The sensor has an 8-bit microprocessor for serial data output of temperature and humidity information in addition to a dedicated NTC for measuring temperature. Furthermore, the sensor is factory-calibrated, which simplifies integration with other microcontrollers.

The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of 1°C and 1%.

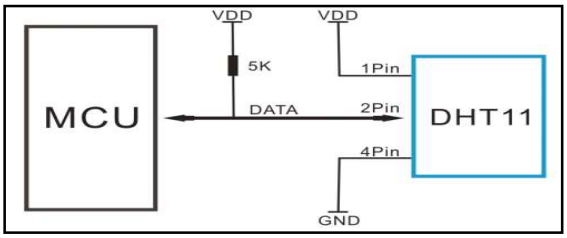

Fig 2. TEMPERATURE SENSOR

3 CIRCUIT DIAGRAM OF BMS

A Battery Management System (BMS) with a charge monitor typically works by monitoring the charge level of the battery pack and controlling the charging process to ensure the battery is charged safely and efficiently.

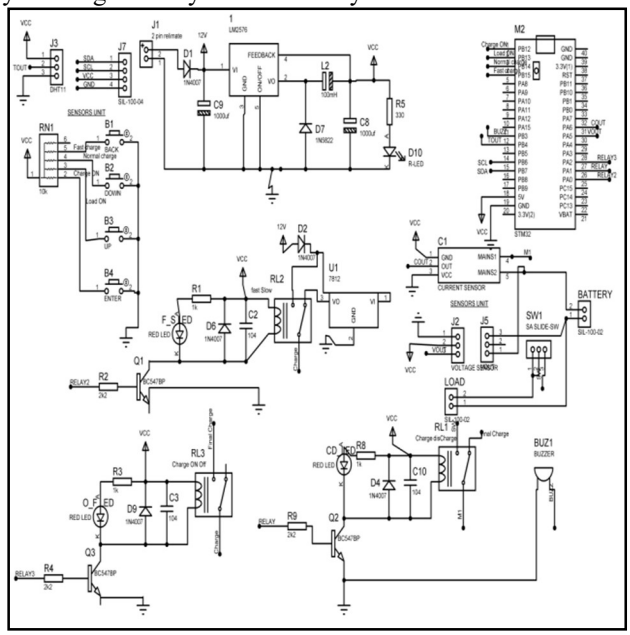

Fig.3. Circuit Diagram of BattryMangement System

Here are the basic steps involved:

i. **Charge monitoring**: The BMS monitors the charging current and voltage of the battery pack to determine its state of charge (SOC).

ii. **Charge control**: Based on the SOC information, the BMS controls the charging process by adjusting the charging current and voltage to prevent overcharging and overheating.

iii. **Charge balancing**: The BMS also ensures that the individual cells in the battery pack are balanced, meaning they are charged to the same voltage level, to prevent overcharging of any cell.

iv. **Data collection**: The BMS collects and stores data about the battery's performance and health, such as its charge level, charging and discharging history, temperature, and any abnormalities detected during operation.

v. **Communication**: The BMS communicates with the user or the system in which the battery is installed, providing real-time data about the battery's performance and health.

Overall, the BMS with charge monitoring provides a complete solution for managing the charging process of a battery pack, ensuring its safe and efficient operation, and extending its life.

4 FIRE PROTECTION IN BMS

Fire protection is a critical aspect of Battery Management System (BMS) design, especially for large battery packs used in electric vehicles, renewable energy systems, and other applications. Here are some ways that BMS can provide fire protection:

i. **Temperature monitoring:** The BMS monitors the temperature of the battery pack and individual cells and takes corrective actions if the temperature exceeds the safe limit. If the temperature reaches a critical level, the BMS can trigger alarms, disconnect the battery pack from the load, or initiate other protective measures to prevent a fire.

ii. **Overcharge and over-discharge protection:** The BMS prevents overcharging and over-discharging of the battery pack, which can cause overheating and lead to a fire.

iii. **Short circuit protection:** The BMS detects and protects against short circuits, which can cause high current flows and lead to a fire.

iv. **Isolation:** The BMS can isolate a faulty cell or module from the rest of the battery pack to prevent thermal runaway and the spread of fire.

v. **Ventilation:** The BMS can provide a ventilation system to remove heat from the battery pack and reduce the risk of fire.

vi. **Fire suppression:** The BMS can include a fire suppression system, such as a fire extinguisher or fire-retardant material, to extinguish or contain a fire in case of an emergency.

Overall, fire protection is an important consideration in BMS design, and a well-designed BMS can help prevent fires and ensure the safe operation of battery packs.

5 Results

Fig.4 Control Circuit Connections

As shown in Fig.4, when the supply is given, the charging process takes place by choosing the charge option using the push buttons connected to B12, B13, B14, B15 pins of STM32 Micro-Controller.

i. During the charging process, the voltage increases gradually which is represented on LCD display and led glows.

ii. When the battery is fully charged, the voltage cutoff as the voltage exceeds beyond 12v is detected by voltage sensor and led goes off. All the variations of parameters like current, voltage and temperature and soc are monitored and controlled by sensors which are shown in Fig.5. on 16*4 LCD display.

iii. The cutoff current, which is roughly 5 amperes, is significantly more than the required current for secure charging.

iv. Similarly, during the discharging process shown in Fig. 6, the voltage is going to decrease. Here the load with 12v voltage capacity is used for power consumption. And also the temperature gradually increases when the energy is consumed so called discharging.

v. Figure 5.8.7 & 5.8.8 shows the temperature rise due to fire risks or short circuit Conditions. If the temperature increases beyond the limited value i.e., 500C, the buzzer sounds which is used for fire or heat indication. Here the DHT11 module is used to sense the temperature.

It might be advisable to install an additional CC or CV regulator to limit the amount of current during charge since it is generally advised to charge lower than half the capacity, or 0.5c, for safe charging.

Fig.5 DISPLAY OF BATTERY WHILE SLOW CHARGING

Fig. 6 DISPLAY OF BATTERY WHILE FAST CHARGING

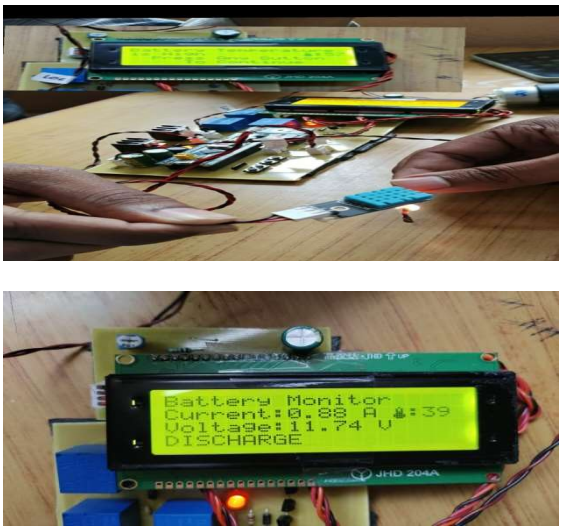

Fig. 7 DISCHRGE OF BATTERY ON THE LCD DISPLAY WITH VOLTAGE READING AND TEMPERATURE DISPLAY

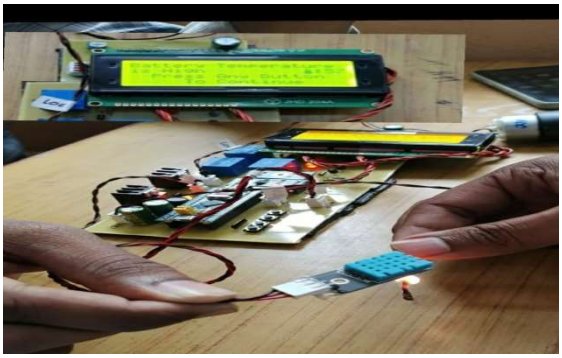

Fig. 8 Detection of High Temperature of Battery On the LCD

6 Conclusions

The system is intended to monitor battery voltage, current, and temperature continuously and to immediately stop taking input or output from the battery when any odd behaviour is noticed.

The advantages that this system offers are as follows:

i. Battery Status Display and Monitoring
ii. Battery charging according to the necessary input parameters
iii. Temperature monitoring with an automatic cutoff

The technology we created will not only keep an eye on the battery and charge it securely, but it will also guard against accidents. The system's charging and monitoring circuitry is activated when it is turned on, enabling the user to safely charge the 3S battery. The current sensor monitors battery current when it is connected to a load and displays the parameter on the LCD Display.

The creation of these hardware modules was done with the intention of offering a basic defence. We tried to design these hardware modules to satisfy almost all of the needs unique to the platform, such as: 1) Adaptable 2) Easy to use 3) Engage in dialogue with

users 4) The most recent technological innovations Work will continue on this platform since, despite all of these capabilities, there is still much room for improvement.

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