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A Research Paper on Electric Vehicle BMS (Battery Management System) Charge Monitoring and Fire Protection

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ABSTRACT – Globally in vehicle segment Electric Vehicle are drastically upgrading and people migrating from diesel/petrol vehicles to electric vehicles. When electric vehicle comes in the discussion then important parameter is Battery pack of EV. A proposed Battery Management System (BMS) tailored for electric vehicles is introduced. This system oversees the operation of a rechargeable battery, whether it be a single cell or a battery pack. Its functions include safeguarding the battery against operating beyond its safe operational parameters and monitoring its condition. These tasks are executed through the electronic PIC microcontroller. The PIC microcontroller serves as the central control unit for the entire system. Connected to this controller are several modules, including a temperature sensor, battery pack with relays, charger, and LCD module. When the battery pack is discharges, it initiates recharging via the relays. Specifically, two relays are employed to facilitate both fast and slow charging modes. The system utilizes a DC motor for vehicle propulsion. During vehicle operation, the microcontroller continuously displays voltage and current values on the LCD module, along with ongoing temperature monitoring. Should the temperature surpass a predetermined threshold, the PIC microcontroller triggers a buzzer for alerts. Charging of the battery is regulated by the microcontroller based on its voltage, with options for both fast and slow charging modes.

1. INTRODUCTION

The ratio of conventional vehicles to electric vehicles are increasing day by day. In this transition energy and Battery pack plays vital role of this system. Governments worldwide are incentivizing the adoption of electric vehicles (EVs), while many automakers have already introduced a range of EV models. Within the Battery Management System (BMS), software algorithms may be employed to predict the battery's remaining capacity and estimate its remaining lifespan. A critical role of the BMS is to safeguard the battery from overcharging or over-discharging, both of which can lead to permanent damage and reduce its lifespan. This is achieved by the BMS controlling the charging and discharging processes and taking action to shut down the battery in case of any irregularities detected. Additionally, the BMS monitors and maintains the battery's temperature within a safe range. In instances of overheating, the BMS may adjust the charging rate or deactivate the battery to prevent harm. Conversely, if the battery becomes too cold, the BMS may increase the charging rate to aid in warming it up. Overall, the BMS plays a crucial role in ensuring the safe and efficient operation of rechargeable battery systems, thereby prolonging their lifespan.

2. PROBLEM STATEMENT

Battery storage is a fundamental component of electric vehicles (EVs), as it stores the energy required for their operation. To maximize the output of a battery and ensure its safe operation, it is crucial to have an efficient battery management system (BMS) in place. The BMS monitors various parameters, determines the state of charge (SOC), and offers essential services to guarantee the safe operation of the battery. A Battery Management System (BMS) plays a pivotal role in electric vehicles (EVs) and other battery-powered systems. It ensures and regulates the operation of the battery pack, ensuring its peak performance, safety, and longevity. As EV implementing many issues come forward in this development stage which are Battery pack caught fire, overcharging of battery, overheating of battery and inefficient working of battery

3. OBJECTIVE

Fire and temperature safety are two vital aspects of an EV BMS that are designed to mitigate ability dangers related to battery malfunctions. Fire safety is of maximum significance as lithium-ion batteries, generally utilized in EVs, can undergo thermal runaway, leading to fires and explosions.

4. SCOPE

1) Enhanced fire detection systems for rapid identification of battery overheating or fire hazards.
2) Enhanced thermal management strategies to effectively dissipate heat and maintain optimal battery temperatures.
3) Implementation of regulatory standards and certifications to enhance fire and temperature safety.
4) The future development of Electric Vehicle Battery Management Systems (EV BMS) includes integrating more advanced fire detection systems.

5. COMPONENTS OF MODEL

(Complete Setup of model)

1) Transformer –

Transformers are devices that convert alternating current (AC) electricity from one voltage level to another with minimal power loss. The potential transformer (PT) functions by employing a step-down transformer to decrease high voltage to a safer lower voltage level.

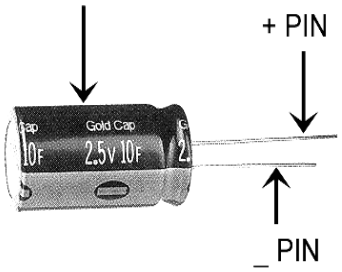
In this project, a transformer is utilized to step down the supply voltage from 230VAC to 12VAC.

2) RECTIFIER –

A rectifier is an electrical device that transforms alternating current (AC), which reverses direction periodically, into direct current (DC), which flows in a single direction only. This process is known as rectification, and it converts AC into pulsating DC. In this case, a bridge rectifier is preferred due to its advantages such as good stability and the ability to provide full-wave rectification. In a bridge rectifier, during the positive half cycle, only two diodes (forming a set of parallel diodes) conduct, while during the negative half cycle, the remaining two diodes conduct. These diodes conduct only in the forward bias direction.

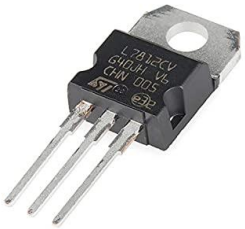
3) FILTER–

In this project, a capacitive filter is employed. It serves to eliminate ripples from the output of the rectifier, resulting in a smoothed DC output. The output obtained from this filter remains constant as long as both the mains voltage and load are kept constant. The simple capacitor filter represents the most fundamental type of power supply filter.



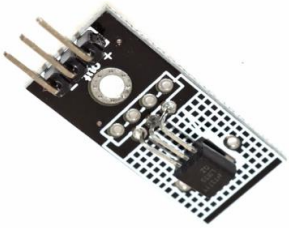
4) VOLTAGE REGULATOR –

The LM7805 series consists of three-terminal positive regulators, which come in the TO-220/D-PAK package. They offer various fixed output voltages, making them versatile and applicable across a broad spectrum of uses.



5) TEMPRATURE SENSOR –

The LM35 series comprises precision integrated-circuit temperature sensors. These sensors produce an output voltage that is directly proportional to the Celsius (Centigrade) temperature. Unlike linear temperature sensors calibrated in ° Kelvin, the LM35 sensor offers an advantage in that users do not need to subtract a large constant voltage from its output to achieve convenient Centigrade scaling.



6) RECHARGABLE BATTERY –

This is an original 1200mAh 18650 battery. 18650 battery is a Li-ion rechargeable battery with a 1200mAh Battery Capacity. This is not a standard AA or AAA battery but is very useful for applications that require continuous high current or high current in short bursts like in cameras, DVD players, iPod, etc.

7) LED -

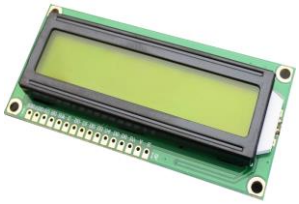
A light-emitting diode (LED) is a semiconductor-based light source. LEDs serve as indicator lamps in numerous devices and are becoming more prevalent in lighting applications. Initially introduced as a practical electronic component in 1962, early LEDs emitted low-intensity red light.
It used for indicating the charging mode of EV BMS.

8) BUZZER -

Essentially, the sound source of a piezoelectric sound component is a piezoelectric diaphragm. This diaphragm comprises a piezoelectric ceramic plate with electrodes on both sides and a metal plate (typically brass or stainless steel). The piezoelectric ceramic plate is affixed to the metal plate using adhesives. When a DC voltage is applied between the electrodes of a piezoelectric diaphragm, mechanical distortion occurs as a result of the piezoelectric effect.

9) LCD DISPLAY -

This LCD (16x2) display is used for the to shown the parameters details of Voltage ,Current, Temperature and charging state.



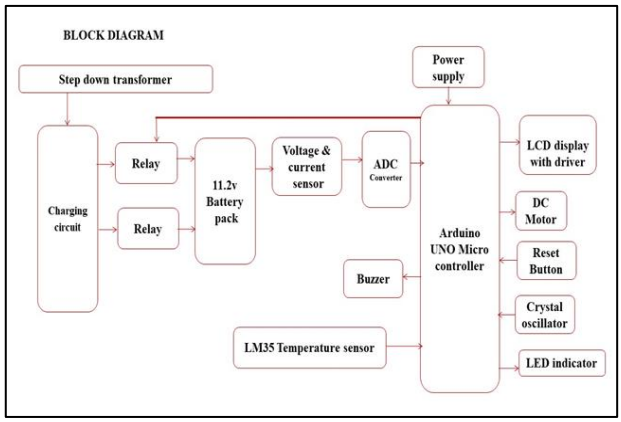
10) RELAY

A relay functions as an electrically operated on/off switch. While many relays utilize an electromagnet to activate a switched mechanism, various other operating principles are also employed. Relays are employed in applications where it is necessary to control a circuit using low-power signals, or where a single signal can control multiple circuits. The earliest relays were employed in far-distance telegraph circuits, where they received a signal from one circuit and re-transmitted it to another circuit.

11) ARDUINO UNO MICROCONTROLLER

The Arduino Uno is a microcontroller board built around the ATmega328P (datasheet). It features 14 digital input/output pins, with 6 capable of PWM output. Additionally, it includes 6 analog inputs, a 16 MHz ceramic resonator , a USB connection, a power jack, an ICSP header, and a reset button. The board is fully equipped to support the microcontroller; simply connect it to a computer via a USB cable or power it using an AC-to-DC adapter or battery to begin. The Arduino Uno encourages experimentation, as mistakes can be rectified easily by replacing the chip for a small cost, allowing for a fresh start if needed.

6. WORKING PRINCIPLE



Battery management systems (BMS) do not adhere to a fixed or standardized set of criteria. Instead, the design scope and features implemented typically align with:

a) The overall costs, complexity structure, and size of the battery pack

b) The specific application of the battery, taking into consideration safety, lifespan, and warranty concerns.

c) Certification requirements dictated by government regulations, where adherence to functional safety measures is crucial to avoid significant costs and penalties for non-compliance.

Usually in the working of this model :

Battery charge monitoring: While charging the battery and in the dynamic condition of the electric vehicle how much battery Percentage(SOC) have left it indicates on the LCD display so that customer to take action accordingly.

Battery fire protection: Normally EV battery temperature while charging is the 15℃ to 30 ℃. In this circuit if battery temperature goes beyond 43℃ while charging then supply gets cutoff through relay and starts the fan for cooling purpose of battery.

7. MERITS

1) Less Maintenance required for this system
2) Reliability high due to Arduino UNO is used.
3) Applicable for e-bike as well as EV car.
4) Automatic operation hence no manual intervention.
5) Usage of this enhance the safety and efficiency of the battery

8. LITERATURE REVIEW

1) EV (BMS) CHARGE MONITORING & BATTERY MANAGEMENT SYSTEM
Swarda Ashok Wanare, Samiksha Bajirao Gade, Drushti Nitin Kokane,Chetan Rajendra Jadhav, Prof. Beldar Geeta Nandu

This author in the present paper, gives a brief description of the Battery management system and how charge is monitoring the battery pack.

2) Battery Management System in Electric Vehicles

PriyankaR. SandeepV. RaviO. Shekar

In this paper we get detailed and specific information of battery management system which helps us to focused on which parameters which directly / indirectly contributed to EV battery life as well as battery safety.

9. CONCLUSION

The system is designed to continuously monitor battery voltage, current, and temperature. If any irregular behavior is detected, such as abnormalities or anomalies, the system is programmed to promptly cease input or output from the battery to ensure safety and prevent potential damage.

10. REFERENCE

1) EV (BMS) CHARGE MONITORING & BATTERY MANAGEMENT SYSTEM
Swarda Ashok Wanare, Samiksha Bajirao Gade, Drushti Nitin Kokane,Chetan Rajendra Jadhav, Prof. Beldar Geeta Nandu
2) www.google.com
3) www.wikipedia.com