

Battery Management System in Electric Vehicle

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ABSTRACT

The Battery Management System (BMS) is an essential subsystem in electric vehicles for monitoring and controlling the charging and discharging of rechargeable batteries. The proposed system is designed to improve battery safety, reliability, and operational life by continuously monitoring important battery parameters such as voltage, current, and temperature. A PIC microcontroller serves as the main controller and processes the information obtained from the sensing units. The system provides fast and slow charging modes according to the measured battery voltage and uses relays to control the charging connection. Battery operating parameters are continuously displayed through an LCD, while abnormal temperature conditions activate a buzzer and protection mechanism. The developed system therefore provides an economical and effective approach for EV battery monitoring, charging control, and protection.

Keywords— Battery Management System (BMS), Electric Vehicle (EV), PIC Microcontroller, Lithium-Ion Battery, Battery Protection, Voltage Monitoring, Temperature Monitoring, Charging Control.

INTRODUCTION

Electric vehicles (EVs) have emerged as an important alternative to conventional fuel-based transportation because of their efficient utilization of electrical energy and reduced dependence on fossil fuels. The increasing cost and limited availability of conventional fuels, along with environmental concerns associated with their use, have encouraged the development of electrically powered transportation systems. An EV uses one or more electric motors for propulsion and obtains its electrical energy primarily from rechargeable battery packs. The performance and reliability of an EV therefore depend considerably on the condition and operation of its battery system.

Rechargeable batteries used in electric vehicles must provide sufficient energy as well as high power during different operating conditions. Lithium-ion batteries are widely used because of their favorable performance characteristics. However, improper charging, excessive discharging, high current, and abnormal temperature can adversely affect battery performance and lifetime. Consequently, continuous monitoring and protection are required to maintain the battery within its safe operating limits.

A Battery Management System performs these monitoring and control operations. The proposed BMS uses a PIC microcontroller to monitor battery voltage, current, and temperature. Sensor information is processed by the controller and the corresponding operating parameters are displayed on an LCD. Charging is controlled through relays, allowing fast and slow charging depending on the battery voltage. The system also provides an alert and protection mechanism when abnormal battery temperature is detected.

LITERATURE SURVEY

D. Bell [1] presented a Battery Management System incorporating an improved battery model that considered self-discharge, temperature effects, and capacity fading. The proposed hardware improved the conventional BMS by incorporating a user interface, thermal management, and current-monitoring functions. K. W. E. Cheng [2] reviewed developments in electric vehicles and discussed important EV subsystems, including battery technology, charger design, electric motors, steering, and braking systems. These studies emphasize the importance of reliable battery monitoring and effective coordination between the battery and other EV subsystems.

Muhammad Nizam *et al.* [3] presented a Battery Management System for lithium-ion batteries focusing on battery-cell monitoring, balancing, and protection. The work highlighted the importance of protecting battery cells against overcharging, excessive discharge, and short-circuit conditions. More recent studies have also investigated energy-storage technologies, battery thermal behavior, core-temperature estimation, and state-of-health estimation [4]–[8]. Collectively, these studies demonstrate that accurate monitoring of electrical and thermal parameters is necessary for improving the safety, reliability, and operating life of EV batteries.

PROBLEM STATEMENT

The battery is one of the most critical components of an electric vehicle and is vulnerable to overcharging, excessive discharge, high current, and abnormal temperature conditions. Such operating conditions may damage the battery, reduce its useful life, increase temperature, and create safety risks. Therefore, an effective BMS is required to continuously monitor battery parameters, protect the battery from unsafe operating conditions, optimize battery performance, and efficiently utilize the available stored energy to improve vehicle operation.

OBJECTIVES

The major objectives of the proposed system are:

1. To continuously monitor important EV battery parameters such as voltage, current, and temperature using sensors and a PIC microcontroller.
2. To provide safe battery charging and protection against overcharging, excessive discharge, and abnormal temperature conditions through automatic charging control, relay operation, and warning mechanisms.

PROPOSED SYSTEM

The proposed Battery Management System is designed around a PIC16F72 microcontroller that acts as the central processing and control unit. The battery pack is interfaced with voltage, current, and temperature sensing circuits. These sensors continuously measure the operating condition of the battery, and the measured values are supplied to the microcontroller for processing. An LCD is used to display battery voltage, current, and temperature, enabling continuous observation of the battery condition.

The charging subsystem incorporates relays that operate as electronic switching elements between the charging circuit and battery pack. Two relay-controlled charging modes are employed to provide fast and slow charging according to battery voltage. The LM35 temperature sensor monitors the thermal condition of the battery. When an abnormal temperature condition is detected, the controller activates the buzzer and performs the required protection operation. The system therefore combines battery monitoring, charging control, user indication, and protection within a single embedded platform.

BLOCK DIAGRAM

Fig. 1 shows the block diagram of the proposed Battery Management System for an electric vehicle, in which the PIC microcontroller acts as the main control unit. The voltage, current, and LM35 temperature sensors continuously monitor the battery parameters, while the controller operates the relays, LCD display, buzzer, LED indicator, and DC motor to ensure safe charging and battery protection.

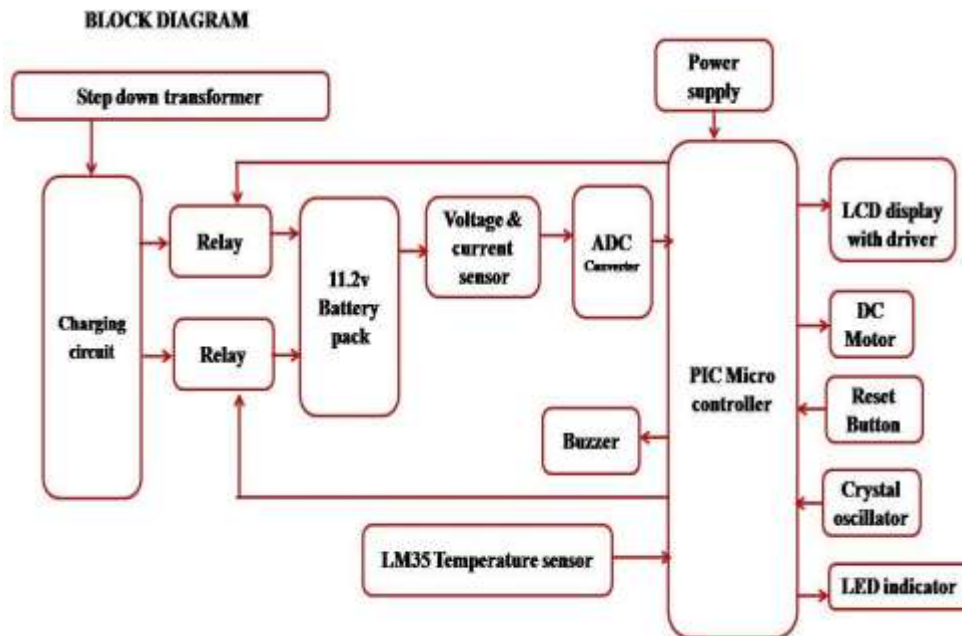


Fig 1:Block diagram of Battery Management System in Ev.

METHODOLOGY

The methodology begins with continuous acquisition of battery parameters. The voltage sensor measures battery voltage, the current sensor determines the current supplied to or drawn from the battery, and the LM35 temperature sensor measures battery temperature. These sensor signals are supplied to the PIC microcontroller through the appropriate interface and analog-to-digital conversion circuitry. The controller processes the sensor readings and continuously displays voltage, current, and temperature information on the LCD.

During charging, the controller evaluates battery voltage and controls the charging circuit through relays. Fast or slow charging is selected according to the battery condition. When the battery reaches its fully charged condition, the charging supply is disconnected to prevent overcharging. During battery operation, current and temperature are continuously monitored. If the temperature exceeds the predetermined safe condition, the system activates a buzzer and disconnects the required input/output connection. The embedded control program is implemented in Embedded C to coordinate sensing, display, charging, and protection functions.

RESULTS AND DISCUSSION

The developed EV BMS with Charger Monitoring and Protection successfully integrates the PIC microcontroller with the temperature sensor, battery pack, charger, relays, voltage and current sensors, buzzer, LCD, and DC motor. During operation, the system continuously displays battery voltage, current, and temperature on the LCD. The two relays

provide fast and slow charging control according to the measured battery voltage. The DC motor is employed as the representative vehicle load during system operation.

The system also demonstrates protective operation under abnormal battery conditions. Temperature is continuously monitored, and when it crosses the predefined limit, the PIC microcontroller activates the buzzer and performs the required switching operation. The embedded program additionally monitors low battery voltage and controls the charging relays. Thus, the prototype demonstrates the fundamental BMS functions of battery monitoring, controlled charging, thermal supervision, user indication, and battery protection.

CONCLUSION

A PIC-microcontroller-based Battery Management System for electric vehicle applications has been developed to provide battery monitoring, charging control, and protection. The proposed system integrates voltage, current, and temperature sensing with relay-based charging control, LCD indication, and buzzer warning. The controller continuously evaluates battery operating conditions and provides fast or slow charging depending on battery voltage while monitoring thermal conditions to improve safety.

The integration of the hardware components and embedded control program demonstrates the successful implementation of the proposed BMS prototype. The developed system provides an economical approach for maintaining battery operation within appropriate limits and improving the safety and reliability of EV battery systems. According to the project report, the complete system was successfully designed, implemented, and tested.

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