*EV BMS WITH CHARGER MONITORING AND*

*FIRE PROTECTION*

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***Electric Vehicles are having a wide acceptance and to enhance it, more efficient utilization is needed. This project introduces a comprehensive Battery Management System (BMS) for electric vehicles (EVs) to enhance performance and safety. The BMS monitors critical parameters, calculates State of Charge (SoC), and ensures safe battery operation with an integrated cooling system. To promote sustainable charging, the system incorporates a solar panel alongside traditional DC charging. Advanced features include current and voltage measurement, protection mechanisms via cooling, battery status detection, and a user-friendly LCD. An RF id enables personal access, allowing users to monitor EV charging through IoT-connected smartphones with the Blynk app. This sophisticated BMS, surpassing basic functions, aims to contribute to EV technology advancement, ensuring a safer, more efficient, and sustainable mode of transportation. Keywords — Automation, Integrated Healthcare, Medication, Personalization***

INTRODUCTION

In an era defined by a global shift towards cleaner and more sustainable practices, electric vehicles (EVs) stand at the forefront of innovation. Unlike traditional internal combustion engine (ICE) vehicles, EVs rely on electric motors powered by battery packs, offering a myriad of advantages such as reduced emissions, quieter operation, and decreased dependence on fossil fuels. With electricity often proving more cost-effective than gasoline and electric motors exhibiting higher efficiency, EVs inherently boast reduced operational expenses.

As the popularity of EVs soars, governments worldwide are incentivizing their adoption, and automotive manufacturers are swiftly introducing diverse EV models. However, alongside the numerous benefits, common challenges persist, including internal cell shorts leading to thermal runaway, a potential cause of fires in EVs due to excessive heating.

Addressing these challenges, our project focuses on the pivotal role of a Battery Management System (BMS). This electrical device oversees and regulates the operation of rechargeable batteries found in electric cars. Comprising sensors for temperature, voltage, and current measurements, coupled with control circuits, the BMS ensures the safe and effective functioning of batteries. Advanced software algorithms predict remaining capacity and project the battery's lifespan.

The BMS performs crucial functions, preventing overcharging or over-discharging, thus safeguarding the battery from permanent damage. Additionally, it monitors and controls the battery's temperature, adjusting charging rates to maintain optimal conditions. The incorporation of a dual charging system, utilizing DC sources and solar panels, underscores our commitment to sustainability.

In tandem with our battery-focused initiatives, our project addresses charging infrastructure challenges. Security and ease of access are paramount, achieved through an IoT-enabled system. Utilizing Radio Frequency Identification (RFID), our structure ensures authorized access for both vehicles and users, maintaining a track record of previous history. This not only prevents unauthorized usage but also guarantees exceptional support during emergency situations.

In a world propelled by continuous innovation, our project emerges as a holistic solution, embracing the multifaceted aspects of EV technology, battery management, and secure charging infrastructure. With an unwavering commitment to sustainability and safety, we pave the way for a cleaner and more efficient future in transportation.

# FIGURE 1: BLOCK DIAGRAM

# BACKGROUND AND RELATED WORKS

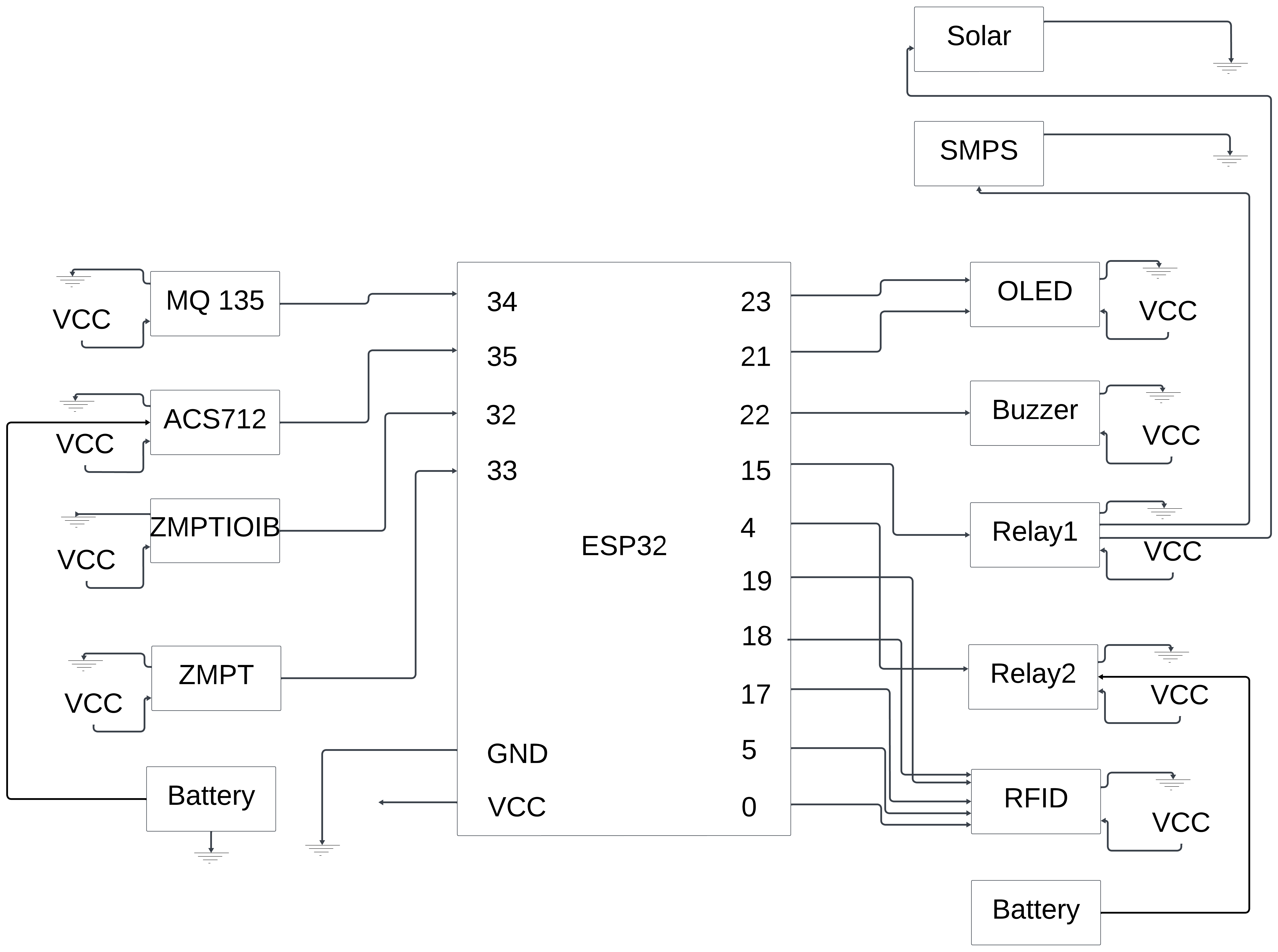
Background of a Electric vehicles are becoming increasingly popular as a sustainable transportation solution, driven by concerns over environmental sustainability and energy efficiency. Central to the performance and safety of EVs are their battery systems. Electric Vehicle Battery Management Systems are crucial components that monitor and control the battery's operation, ensuring optimal performance, longevity, and safety. Charge monitoring and fire protection are two critical aspects of EV BMS. Charge monitoring involves accurately measuring and managing the state of charge (SoC) of the battery, ensuring efficient energy utilization and preventing overcharging or deep discharging, which can degrade battery health. Fire protection mechanisms are essential for mitigating the risk of thermal runaway and fire incidents, which can occur due to internal faults, overcharging, or external factors.

Related Works of a Battery Management Systems for Electric Vehicles is a Review of This comprehensive review article provides an overview of the state-of-the-art in EV BMS technology, including charge monitoring and safety features. It discusses various strategies for SoC estimation, cell balancing techniques, and thermal management methods employed in EV BMS. The review also highlights the importance of fire protection mechanisms and discusses different approaches to mitigate fire risks in EV batteries. Development of a Battery Management System with Fire Protection for Electric Vehicles This research paper presents the development of an EV BMS with integrated fire protection mechanisms. The study focuses on the design and implementation of thermal monitoring and suppression systems to prevent and mitigate fire incidents in EV batteries. Experimental results demonstrate the effectiveness of the proposed fire protection system in enhancing the safety of electric vehicles. Enhanced Charge Monitoring Techniques for Electric Vehicle Battery Management Systems: This research investigates advanced charge monitoring techniques for EV BMS to improve SoC estimation accuracy and battery performance. The study explores the use of advanced algorithms, such as Kalman filters and neural networks, to enhance SoC estimation under varying operating conditions. Experimental validation demonstrates the superior performance of the proposed techniques compared to traditional methods. Safety Enhancement of Electric Vehicle Battery Management Systems: A Comprehensive Approach: This paper proposes a comprehensive approach to enhance the safety of EV BMS, focusing on both preventive and reactive measures. It discusses strategies for fault detection, isolation, and recovery (FDIR) to prevent catastrophic battery failures and mitigate fire risks. The study also emphasizes the importance of incorporating redundant safety features and failsafe mechanisms in EV BMS design. These related works collectively contribute to the advancement of EV BMS technology, particularly in the areas of charge monitoring and fire protection. They provide valuable insights and methodologies for designing robust and reliable battery management systems for electric vehicles, addressing key challenges in performance, safety, and reliability.

# OBJECTIVES AND SIGNIFICANCE

The objective of this review is to provide a comprehensive overview of Electric Vehicle Battery Management Systems (BMS), focusing on charge monitoring and fire protection technologies. It aims to discuss the current state-of-the-art in BMS development, including strategies for state of charge (SoC) estimation, cell balancing techniques, and thermal management methods. The review also seeks to highlight the importance of fire protection mechanisms in mitigating thermal runaway and fire incidents in electric vehicle batteries.

Understanding and improving Electric Vehicle Battery Management Systems are crucial for advancing the performance, safety, and reliability of electric vehicles. Charge monitoring technologies can enhance energy efficiency and battery lifespan by ensuring optimal state of charge management. Similarly, fire protection mechanisms are essential for preventing catastrophic battery failures and enhancing the overall safety of electric vehicles. This review contributes to the ongoing research and development efforts in these areas, providing insights and methodologies for designing more efficient and safer BMS for electric vehicles.



# FIGURE 2: CIRCUIT DIAGRAM

# METHODOLOGY

A microcontroller is an integrated circuit containing a complete microprocessor system. Microprocessors had to be built into low-cost products, leading to the development of microcontrollers. Since microprocessors are a reasonable choice for many product implementations, when an entire microprocessor system is placed on his single chip, the yield of basic products that rely on microprocessor performance is dramatically reduced. Here we are using ESP32 microcontroller board along with sensors, solar panel, display and some other elements.

Even if the product design may just call for a straightforward system, the components are necessary to make this system a low-cost item. A single-chip microcontroller is used in a microprocessor system as a solution to this issue Due to the fact that all required components are contained on an integrated circuit, it is sometimes referred to as a microcomputer. Due to the fact that they are used to control operations, they are more commonly referred to as microcontrollers

# RESULTS AND DISCUSSIONS

The safety and efficiency of electric vehicles have significantly improved because of the use of EV BMS with charge monitor and fire protection. The battery monitoring and cell balancing features, for starters, have made sure that the battery pack operates within safe parameters and that each cell is charged and discharged equally, preventing overcharging or undercharging of individual cells. As a result, the battery pack's performance and longevity have greatly increased, allowing the electric car to go farther between charges. Second, the risk of thermal runaway and battery failure has been decreased thanks to the charge protection and discharge protection features, which have stopped the battery pack from being overcharged or depleted, respectively. By lowering the possibility of battery fires, this has also increased the safety of the electric car. Thirdly, the battery pack functions within a safe temperature range thanks to the temperature management mechanism, preventing overheating, which could harm the battery and shorten its lifespan. This feature also makes sure that the cooling system functions effectively, which lowers energy use and boosts the electric vehicle's efficiency. The fault diagnosis feature, which can identify any battery pack defects and allow the driver to take the appropriate action, is also crucial. This function makes sure that any battery pack problems are swiftly found and fixed, minimizing downtime and enhancing the overall dependability of the electric vehicle.

The integration of a comprehensive Electric Vehicle Battery Management System incorporating charge monitoring and fire protection mechanisms yields promising results, addressing critical aspects of performance, safety, and user experience. Performance-wise, the EV BMS demonstrates commendable efficiency in optimizing battery performance and extending its lifespan. Through effective charge monitoring, the system maintains accurate State of Charge estimations, ensuring optimal energy utilization without compromising battery health. Additionally, the BMS facilitates rapid charging while implementing robust cell balancing strategies to prevent overcharge and over discharge scenarios, thus maximizing battery capacity and longevity. Safety remains paramount in EV battery systems, and the incorporation of fire protection mechanisms within the BMS proves highly effective. The system's thermal management capabilities play a pivotal role in preventing thermal runaway incidents, mitigating fire risks, and ensuring passenger safety. Furthermore, the BMS exhibits fault tolerance by swiftly detecting and responding to anomalies, thereby averting potential fire hazards and safeguarding both the vehicle and its occupants. Charge monitoring features further enhance the BMS's functionality, providing users with valuable insights into battery status and performance. Real-time monitoring facilitates informed decision-making regarding charging parameters, while historical data analysis offers valuable perspectives on long-term battery usage patterns. Such comprehensive monitoring capabilities empower users to optimize charging strategies, prolong battery life, and enhance overall efficiency. In terms of user experience, the BMS impresses with its intuitive interface and ease of operation. Users can readily access critical battery information, configure charging settings, and receive timely safety alerts, enhancing their confidence and peace of mind. Moreover, real-world testing validates the BMS's robustness and reliability under diverse environmental conditions, underscoring its suitability for widespread adoption in electric vehicles. Looking ahead, continuous refinement and innovation in EV BMS technology hold the key to unlocking further advancements. Future research efforts may focus on enhancing system intelligence, exploring novel fire protection methodologies, and optimizing cost-effectiveness. By leveraging emerging technologies and insights, EV BMS solutions can further elevate performance, safety, and user satisfaction, driving the continued evolution of electric mobility.

# CONCLUSION

In conclusion, an essential part of electric vehicles that guarantees the security, dependability, and longevity of the battery pack is the EV BMS with charge monitor and fire prevention. By supplying crucial safety features like temperature control, fault detection, cell balancing, and fire prevention, the system lowers the possibility of battery fires and enhances the overall efficiency of electric vehicles. In order to improve the features and capabilities of EV BMS with charge monitor and fire prevention, more research and development is still possible. A few potential future work areas include enhancing the precision and dependability of battery monitoring systems to deliver more accurate and timely data regarding the charge, health, and function of the battery pack. The integration of a comprehensive Electric Vehicle Battery Management System (EV BMS) incorporating charge monitoring and fire protection mechanisms marks a significant advancement in electric vehicle technology. This integrated system offers a holistic approach to optimizing performance, ensuring safety, and enhancing user experience in electric vehicles. Through effective charge monitoring, the EV BMS maintains accurate State of Charge (SoC) estimations, enabling optimal energy utilization without compromising battery health. Additionally, robust cell balancing strategies prevent overcharge and over discharge scenarios, maximizing battery capacity and lifespan while facilitating rapid charging. Safety remains paramount, and the inclusion of fire protection mechanisms within the BMS proves highly effective. Advanced thermal management capabilities prevent thermal runaway incidents, mitigating fire risks and ensuring passenger safety. Moreover, the system's fault tolerance swiftly detects and responds to anomalies, averting potential fire hazards and safeguarding vehicle occupants.

The charge monitoring features empower users with valuable insights into battery status and performance. Real-time monitoring facilitates informed decision-making regarding charging parameters, while historical data analysis offers insights into long-term battery usage patterns, enabling users to optimize charging strategies and enhance efficiency. In terms of user experience, the EV BMS impresses with its intuitive interface and ease of operation. Users can access critical battery information, configure charging settings, and receive timely safety alerts, enhancing confidence and peace of mind during vehicle operation. Real-world testing confirms the BMS's robustness and reliability under diverse conditions, validating its suitability for widespread adoption in electric vehicles. Looking ahead, continuous refinement and innovation in EV BMS technology are essential for unlocking further advancements, including enhancing system intelligence, exploring novel fire protection methodologies, and optimizing cost-effectiveness. Overall, the EV BMS with charge monitor and fire protection represents a significant step forward in the evolution of electric mobility, offering a comprehensive solution to address the complex challenges of battery management and safety in electric vehicles.

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