IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁑ Impact Factor 8.102 ⁑ Peer-reviewed / Refereed journal ⁑ Vol. 12, Issue 6, June 2023

DOI: 10.17148/IJARCCE.2023.126116

CHARGING AND DISCHARGING STATUS OF BATTERY IN EV APPLICATION

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Abstract: In this review study, the examination of battery charging and discharging focuses on methods to improve battery performance. Overcharging, undercharging, temperature regulation, and safety concerns are only a few of the challenges associated with battery charging that are discussed. The advantages, disadvantages, and applicability of various charging techniques for various battery chemistries are assessed. The effectiveness of the battery and the system as a whole is assessed in respect to various discharge techniques, and discharge-related difficulties are noted. Improvements in the charging and discharging processes are investigated, as well as battery integration with grid interactions and renewable energy sources. Overall, this assessment provides insightful data on the charging and discharging state of batteries and makes recommendations for enhancing battery performance across a range of applications.

Keywords*:* Battery charging, Battery discharging, state of charge (SoC), state of health (SoH), battery status parameter, charging techniques, discharging strategies, battery monitoring, energy management, renewable energy integration, battery performance optimization.

I. INTRODUCTION

The problems caused by conventional fossil fuel-powered vehicles, such as environmental pollution and dependence on finite energy resources, have been addressed, and electric vehicles (EVs) have emerged as a possible answer. Every electric vehicle (EV) has a battery at its core. This vital part stores and transmits electrical energy to power the propulsion system of the vehicle. The total functioning and market viability of EVs are significantly influenced by the performance, efficiency, and lifespan of their batteries.

Fundamental elements that directly affect an electric car battery's operational properties and user experience are the charging and discharging procedures. Effective charging methods guarantee optimal energy replenishment, reduce charging time, and offer EV users a hassle-free experience. Effective discharging techniques, on the other hand, guarantee steady power delivery, maximize the driving range, and improve the efficiency of EVs as a whole.

Due to intensive research and development efforts, the field of battery charging and discharging for electric vehicles has made great strides recently. Due to this, new charging technologies, including traditional and quick charging methods as well as creative discharge techniques targeted at enhancing battery performance and extending battery life, have emerged.

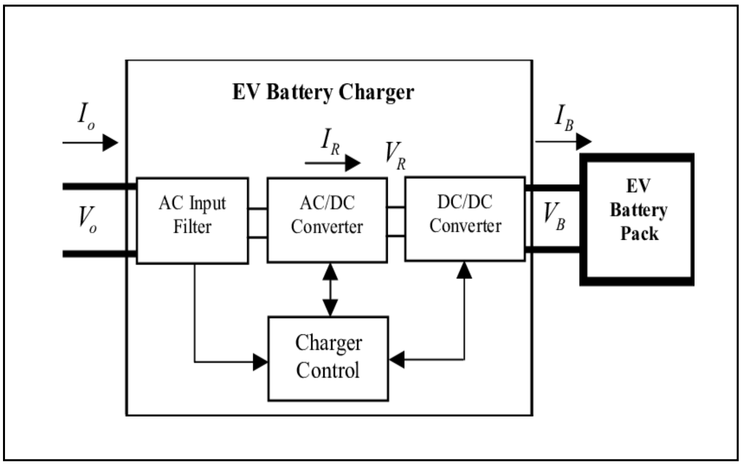

Fig 1.1 Block Diagram

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In-depth examination and synthesis of the most recent cutting-edge charging and discharging techniques for electric car batteries are the goals of this thorough review work. It will examine the main issues, developments, and potential outcomes in this dynamic area. This review intends to shed light on the key elements that affect battery charging and discharging efficiency, safety, and longevity by reviewing the available literature, experimental research, and technical advancements.

Various charging and discharging methods, including as wireless charging, fast DC charging, traditional AC charging, vehicle-to-grid (V2G) systems, and regenerative braking, will be discussed and evaluated throughout this analysis. We will examine the underlying concepts, benefits, drawbacks, and prospective applications of each technique while also taking into account how well they work with various battery chemistries that are frequently utilized in EVs.

The effect of charging and discharging techniques on battery health, degradation mechanisms, and cycle life will also be covered in this review. We will go through the value of modern battery management systems (BMS) in monitoring and enhancing charging and discharging procedures to ensure safe and dependable operation as well as techniques for battery thermal management to lower the risk of overheating during charging.

This review paper's ultimate goal is to offer a thorough understanding of the charging and discharging condition of EV batteries, providing useful information for researchers, engineers, decision-makers, and EV aficionados alike. This review aims to contribute to the growth of sustainable transportation and the broad adoption of electric vehicles as a clean and effective method of transportation by assessing the current status of the field and outlining future research priorities.

II. METHODOLOGY

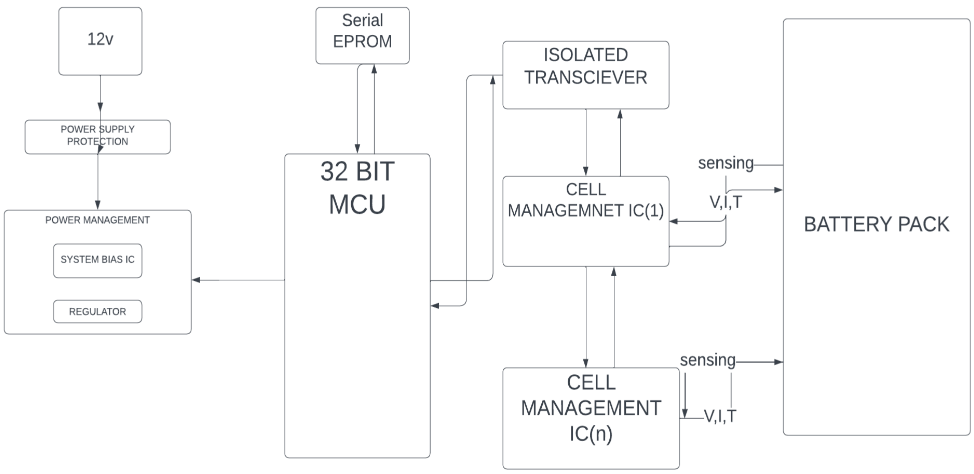

Fig 2.1 Charging and Discharge status of Battery

STMicroelectronics provides high accuracy readings in 48V and high-voltage battery packs as part of its extensive line of EV battery monitoring solutions. The block diagram for a typical BMS architecture can be shown in Figure 1, where a number of cell management ICs are employed to monitor the voltage, current, and temperature of each battery pack cell. The L9963, a Li-ion battery monitoring and protection chip for high-reliability automotive applications and energy storage systems, is an example of an AEC-Q100 approved IC ideal for EV battery management. To suit the needs of 48 V and higher voltage systems, up to 14 stacked battery cells can be monitored. SPI communication or an isolated interface can be used to send the data. The transformer isolated interfaces allow several L9963 devices to be daisy-chained together and communicate with a single host CPU while offering high-speed, low EMI, long-distance, and dependable data transmission.

With the ability to accommodate almost all EV battery system topologies, Analogue components offers a wide range of battery management system components. With a total measurement error of less than 1.8mV, the LTC6810 (Figure 2), for example, measures up to 6 series-connected battery cells. The LTC6810 is compatible with the majority of battery topologies thanks to its cell measurement range of 0V to 5V. Long, high-voltage battery strings can have multiple devices connected in series for simultaneous cell monitoring. For high-speed, RF-immune, long-distance communications, each LTC6810 includes an iso SPI interface.

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For a variety of automotive applications, NXP offers BMS ICs that are reliable, secure, and scalable. A Li-Ion battery cell controller IC built for automotive applications such HEV, EV, E-bike, and E-scooter is the MC33771. The instrument includes coulomb counting, temperature monitoring, and ADC conversions on the differential cell voltages and currents. Additionally, it offers transformer isolated daisy chain and standard SPI connectivity to an MCU for processing and control.

III. RELATED PAPERS

1] This study reviews the objectives of EV management in power systems, the control structures of EVs at charging stations, and optimisation techniques for charge and discharge management in energy systems. It divides the objectives that can be achieved by effective charge and discharge management into three groups: network activity, economic, and environmental objectives. The objectives of network activity include reducing peak load problems, improving load balancing, and increasing grid stability. Economic objectives include maximising charging and discharging techniques to reduce expenses, increase revenues, and improve the EV integration's economic feasibility. Environmental objectives include reduced greenhouse gas emissions, increased use of renewable energy, and assistance with the transition to sustainable energy.

Challenges such as battery deterioration, difficult communication and control systems, and market and regulatory restrictions are reviewed. This research highlights the importance of efficient EV charge and discharge management in tackling the operational and technical issues related to their integration into the power grid.

This study explores the integration of EVs into power systems and focuses on effective control structures, management objectives, and optimization techniques for EV charging and discharging in energy systems.

2] This research fills a gap in the literature by offering a thorough and organized taxonomy of charging/discharging procedures for Plug-in Electric Vehicles (EVs). The authors start by defining each charging/discharging approach in detail and compare them in detail, classifying their differences according to factors such as complexity, economics, power losses on the grid, capacity to provide ancillary services, operational factors, and negative effects on EVs, the power grid, or the environment. The authors then offer suggestions on the most effective tactics.

This research provides a comprehensive overview of different charging and discharging strategies for plug-in EVs. It compares these strategies based on factors such as complexity, economics, power losses, grid stability, and environmental impact.

3] This study examines the need for battery management, in particular state-of-charge estimation. It analyses patents and papers pertaining to state-of-charge estimate techniques for batteries used in electric vehicles. The methods under consideration are divided into three groups depending on their theoretical and experimental characteristics: conventional methods based on battery experiments, contemporary methods based on control theory, and novel approaches with an emphasis on control theory-based algorithms. The review's conclusions suggest that research in this area mostly concentrates on control theory-based algorithms, especially intelligent algorithms, because they exhibit potential.
This review paper discusses various methods for estimating the state of charge (SOC) of electric vehicle batteries. It categorizes these methods into conventional, contemporary, and novel approaches, with a focus on control theory-based algorithms.

4] SOC, SOH algorithms, and a specialized drive technique are all included in a comprehensive solution for online inspection and defect identification of EV batteries throughout their life cycle. EV and battery ageing models are used in a potential future life prediction approach for battery detection during EV charging in EV charging stations with PV systems. However, the current EV battery testing techniques lack accurate measurements and predictions despite being simple to use and inexpensive. Future research should focus on merging cutting-edge technology with current applications and more deeply researching the technical aspects of battery identification during EV charging to overcome these restrictions. To pinpoint their drawbacks and spur advancements in EV battery testing, it is also vital to compare existing technologies in a variety of dimensions.

This study presents a comprehensive solution for online inspection and defect identification of EV batteries in charging stations with photovoltaic (PV) systems. It highlights the limitations of current battery testing techniques and the need for further research and development.

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5] This essay discusses the pressing problems of environmental degradation and the energy crisis caused by an increase in the usage of fossil fuels in transportation. It focuses on the importance of lithium-ion batteries in developing technology, notably in electric vehicles (EVs). To improve SOC estimate by tackling cumulative errors and initial value variations, the research introduces the extended Kalman filter (EKF) approach. It includes a model analysis, an explanation of the EKF mechanism, an algorithm for estimating SOC, and a comparison of its effectiveness to the ampere-hour integration method (Ah). The study compares the EKF approach with the ampere-hour integration method (Ah) with the goal of estimating the state of charge (SOC) in battery management systems, but does not specifically identify the drawbacks of the EKF technique.

This essay discusses the importance of battery management and accurate state of charge (SOC) estimation, particularly in Li-ion batteries used in EVs. It introduces the extended Kalman filter (EKF) approach as a means to improve SOC estimation accuracy.

6] This study highlights the importance of battery management in electric vehicles, particularly in the case of state-of-charge (SoC) estimates. It provides a thorough analysis of illustrative patents and papers that focus on approaches for determining the state of charge of electric vehicle batteries. The report underlines that estimating approaches based on control theory, in particular intelligent algorithms, have been the main focus of research in this area. Further research should focus on building a comprehensive database to increase accuracy, developing cutting-edge battery models to capture the complex dynamics, and utilizing the strengths of each algorithm to achieve the best performance. The difficulty of precisely measuring the state of charge in electric car batteries is highlighted throughout the study, which also offers a thorough summary of the numerous estimation techniques used in research. It highlights the increased interest in algorithms based on control theory, particularly intelligent ones, and identifies significant areas for future research to improve battery management in electric vehicles.

This review paper discusses the challenges of electric vehicle battery charging and highlights the importance of battery performance parameters such as state of health (SoH) and state of charge (SoC) estimation. It emphasizes the need for accurate parameter calculation to improve battery management systems and overall EV performance.

7] Battery-powered electric vehicles (EVs) are becoming increasingly popular due to a growing focus on lowering air and noise pollution and dependence on fossil fuels. However, the limited range and extended charge times for the electric batteries in modern EVs are two major drawbacks. Pulse charging techniques have recently been achieved in shortening the time it takes to charge a battery. The evaluation of the battery's electrical characteristics is a critical area to pay attention to because it has a significant impact on the driving range of an electric car. It is crucial to be knowledgeable about numerous battery performance factors in order to comprehend battery behavior under varied circumstances.

Research and development efforts are concentrated on increasing the accuracy and reliability of calculating these parameters. This will enable improved battery management systems and improved overall performance of EVs.

8] This research examines the impact of various control techniques on battery life in renewable energy systems. CCCV is the most widely utilized technique, while Fuzzy logic control and model predictive control have recently been proved to be able to shorten charging times while still protecting batteries. Temperature regulation is also a vital component of battery management. To determine which control method is best for use with real-world systems, the study evaluates a variety of traditional and contemporary control techniques. It draws attention to the importance of battery life cycles and the necessity for efficient control systems to improve battery performance, slow down ageing, and lengthen their useful lives.

9] This research study evaluates a variety of traditional and contemporary control techniques for controlling battery charging and discharging operations in renewable energy systems. It draws attention to the importance of battery life cycles and the necessity for efficient control systems to improve battery performance, slow down ageing, and lengthen their useful lives. The study suggests a field-programmable gate array (FPGA)-based Advanced BMS design that is executed utilizing a MATLAB-to-FPGA design pipeline. The FPGA-based method has benefits such as reduced Non-recurring Engineering (NRE) costs, low power requirements, rapid operation speeds, and significant programmable logic and data storage capacity. A presentation of experimental findings is made, followed by simulation-validation and synthesis-verification of the register transfer level (RTL) design. Overall, with advantages in terms of cost, power consumption, speed, and data storage capacity, the FPGA-based Advanced BMS represents a promising semiconductor solution for a generalized BMS.

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10] Electric vehicles (EVs) have gained popularity due to their performance and efficiency, making them promising solutions for global environmental challenges and CO2 emissions. Li-ion batteries are commonly used in EVs due to their various benefits. A Battery Management System (BMS) is essential for improving battery performance, including control of charging and discharging, precise monitoring, heat management, safety, protection, and accurate estimation of the State of Charge (SOC). Existing estimation algorithms face challenges such as performance degradation, complex electrochemical reactions, and inaccuracy. This research introduces advanced SOC estimation techniques like LSTM, GRU, and CNN-LSTM, as well as hybrid techniques to estimate SOC average error, and provides a detailed comparison of these techniques, highlighting their merits and demerits for researchers implementing EV applications. The research also identifies factors, challenges, and potential recommendations.

ACKNOWLEDGMENTS

To everyone who helped with the completion of this review paper on the charging and discharging status of electric car batteries, we would like to offer our profound gratitude and appreciation.

First and foremost, we would like to express our gratitude to the scientists and researchers who have devoted their time and energy to carrying out in-depth research on battery, charging, and battery management systems for electric vehicles. Their invaluable efforts have made a big difference in the development of environmentally friendly transportation and the widespread use of electric vehicles.

We sincerely thank the writers of the books and academic articles that served as the basis for our review. We now have a thorough understanding of the essential factors that influence the effectiveness, security, and longevity of battery charging and discharging thanks to their analytical work.

Additionally, we would like to show our gratitude to the engineers and technical specialists who created and enhanced numerous methods for charging and discharging the batteries of electric vehicles. Their creativity and knowledge opened the path for new technologies that offer better user experiences and performance, such as wireless charging, fast DC charging, regenerative braking, and vehicle-to-grid systems.

Additionally, we would like to recognize the role played by the politicians and decision-makers who have helped foster an atmosphere that is conducive to the study and advancement of electric vehicle technology. These individuals have recognized the value of sustainable transportation. Their initiatives to promote safe and efficient mobility options are essential for attaining a greener future.

Last but not least, we would like to thank our friends, family, and coworkers for their unwavering support and encouragement as we completed this review paper. Their steadfast backing has served both inspiration and encouragement. We gratefully thank the contributions made to this review paper by all the people and organizations named above, as well as any that may have been unintentionally left out. They all contributed, and without them, this task would not have been possible

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