WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

EV Battery Charging Protection and Monitoring

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ABSTRACT

Now a day's world is shifting towards electrified mobility to reduce the pollutant emissions caused by nonrenewable fossil fueled vehicles and to provide the alternative to pricey fuel for transportation. Since EV batteries are most high-cost component, charging EVs safely is the most important. To protect battery from any fluctuation in supply or high temperature, proposed system is designed. This system will also provide IOT connectivity and control of EV batteries. This system will help to improve the life of batteries by protecting it from any fluctuation and temperature rise. Similarly, it will provide better performance monitoring and control over internet application. In this system, current sensor and voltage sensor are used to measure the power delivered to battery. Also an temperature sensor is used to measure the battery temperature. All 3 sensors will send signal to microcontroller which will convert the signal into corresponding value and compare it with set cutoff value and display it. With the keypad and display user can set charging time. In case of any fluctuation in input supply, or when the set charging time completes, microcontroller will switch off the input supply using cut off device to protect the battery from any fault or from overcharging. Microcontroller will also send values and alert to the webpage or android application through wifi module. User can turn on or off the charging through it. Buzer is used to provide audio signal. Power supply will provide the required power to every circuit element. With the feature of adjustable cutoff values proposed system will be compatible with any vehicle's battery.

Key word: Protection of EV battery, Monitoring Different parameters of EV charging, Visualize charging status

Introduction

The protection and monitoring of electric vehicle (EV) chargers are critical components in ensuring the reliability, safety, and efficiency of the growing EV infrastructure. Protection of EV chargers begin with physical security measures. Charging stations, often located in public places, must be safeguarded against vandalism and theft. This involves the installation of surveillance cameras, adequate lighting, and physical barriers to discourage unauthorized access.

First and foremost, physical security plays a vital role in safeguarding EV charging stations. These stations are often distributed across urban and suburban landscapes, making them susceptible to vandalism, theft, and damage. Ensuring the physical protection of charging equipment is not only about preserving assets but also maintaining the reliability and availability of charging services. Measures such as surveillance cameras, adequate lighting, and physical barriers can deter unauthorized access and enhance the overall security of charging stations.

In an increasingly connected world, cybersecurity emerges as a paramount concern in the protection of EV charging. Charging stations are typically part of larger networks, enabling remote monitoring, payment processing, and data collection. While this connectivity enhances convenience and accessibility for users, it also exposes the system to cyber threats. Malicious actors could potentially gain unauthorized access, disrupt charging services, compromise user data, or even cause physical damage to charging equipment. Implementing robust cybersecurity measures, including firewalls, encryption, intrusion detection systems, and regular security audits, is essential to fortify the resilience of the EV charging infrastructure against digital threats Safety is another fundamental dimension of EV charging protection. Charging stations handle high-voltage electricity, and safety hazards can arise if not appropriately managed. To mitigate these risks, EV charging stations are equipped with a range of safety features.

Electric vehicle (EV) batteries are at the heart of the growing shift towards cleaner and more sustainable transportation. These batteries play a pivotal role in powering electric cars, providing the energy needed for propulsion.

EV battery protection encompasses a range of technologies and strategies designed to safeguard the battery pack from various potential risks and to optimize its performance. These protective measures are essential to extend the lifespan of the battery, maintain its capacity over time, and minimize the risk of thermal runaway or other safety issues.

Charging protection is another vital aspect of EV battery management. Proper charging is necessary to prevent overcharging, undercharging, or excessive temperature rise, which can all negatively impact the battery's health and safety. To this end, charging protection systems are integrated into EVs and charging infrastructure to ensure safe, efficient, and controlled energy transfer from the power source to the battery pack

Electric vehicle (EV) charging protection involves a set of integrated measures to ensure the safety and health of the EV battery during the charging process. It includes safeguards against overcharging, overheating, and fast charging stresses. These systems use advanced Battery Management Systems (BMS) to optimize charging and prevent hazards, promoting the longevity and reliability of EV batteries.

Survey and Specification

1. The survey and specification process involves evaluating various aspects, starting with overvoltage protection. This entails defining the maximum allowable charging voltage and selecting appropriate overvoltage protection components such as Zener diodes or voltage regulators.
2. Moving on to overcurrent protection, it is crucial to assess the maximum charging current, set an overcurrent protection threshold, and employ current sensors along with fuses to safeguard against excessive currents.
3. Short circuit protection necessitates the identification of potential short circuit points, definition of the response time for protection, and the use of fuses, circuit breakers, or electronic protection devices to mitigate risks. Reverse polarity protection involves assessing the risk of reverse polarity during charging and implementing diodes or reverse polarity protection circuits accordingly.

Literature Review

The paper provides an overview of the existing and proposed EV charging technologies in terms of converter topologies, power levels, power flow directions and charging control strategies. The paper also reviews the existing research results on the charging safety of electric vehicles, analyzes the influencing factors of the charging safety of electric vehicles, summarizes the charging safety protection methods, and forecasts the future research direction of charging safety.The authors conclude that the charging safety and charging safety protection methods of electric vehicles have become the research priorities for scholars. The paper has reference value and reference significance for the charging safety research of electric vehicles. DC fast chargers are still in the developing phase and therefore standards and protection requirements are not well established due to specifications in high power, complex grounding topologies, and fault types. The battery management system (BMS) is responsible for the energy management of the battery to ensure reliable, electric networks. Standards and grid codes are designed to ensure reliable and safe EV integration with the power grid and other energy resources.

Discussion and Methodology

Problem Statement

The problem of Electric Vehicle (EV) charger protection and monitoring arises from the increasing adoption of electric vehicles and the need to ensure safe and efficient charging infrastructure. This system aims to safeguard EV charging stations and optimize the performance of Battery.

Solving the identified problem of EV charger

It involves a comprehensive approach that combines hardware and software solutions to ensure the safety security and Monitoring of charging infrastructure.

Risk Assessment:

- Begin with a thorough risk assessment to identify potential threats and vulnerabilities to EV chargers. This includes assessing the physical location, weather conditions, and potential malicious activities.

Hardware Protection:

- Implement Surge Protection Devices (SPDs) to safeguard against power surges and voltage spikes.
- Employ physical security measures such as enclosures, locks, and tamper-proofing to deter unauthorized access.

Remote Monitoring:

- Deploy sensors to collect real-time data on charger status, power consumption, and environmental conditions.
- Utilize secure communication protocols to transmit data to a central monitoring system.
- Implement user authentication and access controls for remote management.

Data Analytics:

- Analyze collected data to identify anomalies or irregularities in charger performance.

- Implement machine learning algorithms for predictive maintenance, predicting potential hardware failures before they occur.
- Use data insights to optimize charger utilization and energy management.

Methodology

The methodology for EV charger protection and monitoring involves a systematic approach to ensuring the safety, security, and efficient operation of electric vehicle charging stations.

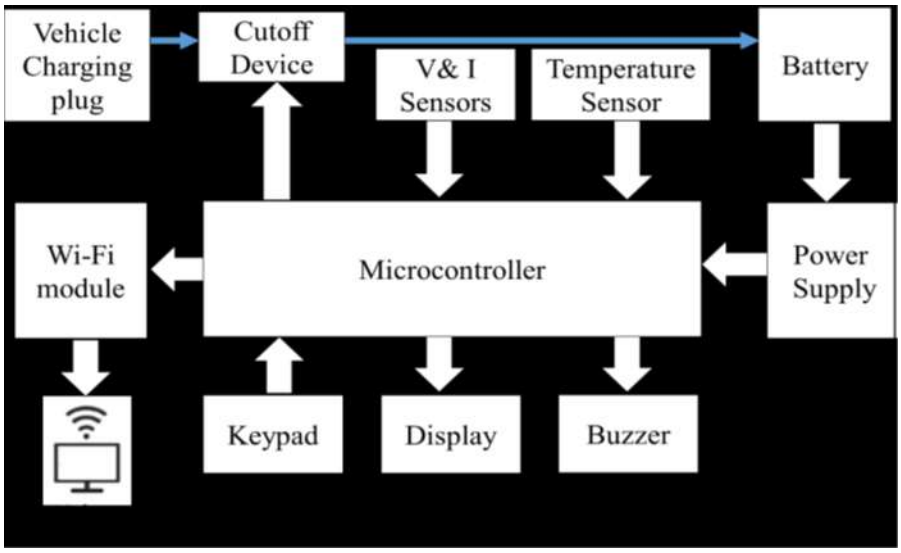

FIG. BLOCK DIAGRAM OF EV BATTERY CHARGING PROTECTION AND MONITORING

- **Microcontroller atmega328 :** ATmega328/328P is an Advanced Virtual RISC (AVR) microcontroller. It supports 8-bit data processing. ATmega-328/328P has 32KB internal flash memory. ATmega328/328P has 1KB Electrically Erasable Programmable Read-Only Memory (EEPROM).
- **Voltage sensor :** A voltage sensor is a device that measures voltage. Voltage sensors can measure the voltage in various ways, from measuring high voltages to detecting low current levels. These devices are essential for many applications, including industrial controls and power systems
- **Current sensor :** A current sensor is a device that detects and converts current to an easily measurable output voltage, which is proportional to the current through the measured path.
- **Temperature Sensor : A temperature sensor is a device that detects and measures hotness and coolness and converts it into an electrical signal.**
- **DC Battery :** A lithium-ion battery is a type of rechargeable battery that is charged and discharged by lithium ions moving between the negative (anode) and positive (cathode) electrodes.
- **WiFi module :** Wifi modules or wifi microcontrollers are used to send and recieve data over Wi-Fi. They can also accept commands over the Wi-Fi. Wi-Fi modules are used for communications bewtween devices. They are most commonly used in the field of Internet of Things.
- **LCD display :** LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrument panels.
- **Cut Off Devices :** A device that terminates the flow or supply of something. An energy cut-off device is a safety device found in a water heater.
- **LEDs :** an electronic device that emits light when a voltage is applied to it.
- **Buzzer :** A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric.

Another ***More components are also used.***

In this paper, an cost effective and compact system will be design which will make the EV charging process safe, convenient and will help to increase the life of EV battery. Major design objectives of paper are as follow:

- Measure and detect the fluctuation in input voltage and current.
- Measure and detect the high temperature.
- Measure and display the battery percentage.
- System must automatically cutoff the charging once battery is full to protect it from overcharging.
- Cut off the supply automatically when any value crosses the set limit.

ADVANTAGES

- System will protect the battery against any fluctuation or fault in supply.
- System will protect battery from overheating in case of long use or damage. Interactive HMI system will provide option to user to adjust the cutoff values
- System will enable users to set the charging time as per flexibility and convenience. System will provide online monitoring and control of charging status and battery percentage.
- IOT based system will automatically save the log of readings for future reference.

Since the system cutoff values are adjustable, it can be compatible with any vehicle's battery.

Conclusion

In conclusion, the literature on Electric Vehicle (EV) battery charging protection reflects a comprehensive and evolving field, driven by the imperative to ensure the safety, efficiency, and reliability of EV charging systems. The diverse research efforts encompass a range of protective measures, addressing challenges such as overvoltage, undervoltage, overcurrent, temperature fluctuations, short circuits, reverse polarity, electromagnetic interference (EMI), and the establishment of proper isolation and grounding.

Acknowledgment

With deep sense of gratitude we would like to thanks all the people who have lit our path with their kind guidance. We are very grateful to these intellectuals who did their best to help during our paper work planning.We express our deep sense of gratitude and sincere regards to our paper guide **Prof. N.B. Ranotkar** for his valuable supervision, co-operation and devotion of time that he has given to our paper. We are also grateful to head of department **Prof.V.S. Patil** for his facilities extended during paper work and for her personal interest and inspiration. We wish to express our profound thanks to **Prof. P.M. Dharmadhikari**, Principal,Sandip Polytechnic, Nasik, for providing necessary facilities to make this paper success.

Finally, we would like to thank all those who directly or indirectly helped us during the work. We also owe our sincere thanks to all faculty members of Electrical Department who have always extended a helping hand.

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