7.4 KVA Electric Vehicle charger using RFID Security

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Abstract

The need for safe and effective charging infrastructure has increased as a result of the growing popularity of electric cars (EVs). In this study, an microcontroller-controlled 7.4 kVA electric vehicle charger with RFID-based authentication and overcurrent protection is designed and implemented. By confirming RFID credentials prior to turning on power delivery, the recommended approach makes sure that only authorized users can enter the charging station.

The system includes a sensor for real-time current monitoring for increased safety. To avoid electrical risks, the microcontroller immediately disconnects the power relay if the charging current over 35A. Live feedback on current usage and charging status is provided by a display module.

The firmware, which was created with IDE, effectively handles user identification, relay control, and safety features. High authentication accuracy, steady power control, and dependable overcurrent protection at 35A are demonstrated by experimental validation conducted under a variety of operational situations. The solution is appropriate for both home and commercial EV charging applications since RFID incorporation improves security.

To increase overall functionality and user experience, future improvements might include cloud-based monitoring, mobile app integration, and smart grid compatibility.

Key Words: EVSE, RFID, Smart Charging, Power Electronics, Secure Authentication, Overcurrent Protection.

1. INTRODUCTION

Electric vehicles (EVs), a greener alternative to traditional fuel-powered mobility, are becoming more and more popular as a result of the global shift toward sustainable energy alternatives. However, the absence of safe, effective, and intelligent charging infrastructure is a significant obstacle to the broad adoption of EVs. Conventional EV charging stations frequently lack adequate authentication procedures, which makes them vulnerable to theft, illegal entry, and wasteful power use. To increase security, optimize energy utilization, and enhance user experience, EV charging systems must have controlled access and real-time monitoring.

This study has useds an microcontroller to build and implement a 7.4 kVA Electric Vehicle Supply Equipment (EVSE) with RFID-based authentication and overcurrent safety. Because of its great efficiency, low power consumption, and support for numerous communication interfaces, the microcontroller is chosen as the core processing unit and is hence a good fit for embedded control applications. Current sensors for real-time monitoring, safety circuits for protection, contactors and relays for power regulation, and an RFID module for secure user authentication are all included in the system. Real-time feedback on charging status, power consumption, and safety alarms is provided via an intuitive Display.

Only registered users can start charging thanks to the RFID-based access control, which does away with the need for human authentication. In order to avoid electrical risks, a transformer also continuously measures the charging current. If the current surpasses 35A, the controller automatically disconnects the power relay. Under various load scenarios, this overcurrent prevention device guarantees safe operation and improves system reliability.

The suggested EVSE system is appropriate for public EV charging hubs, businesses, and home charging stations because it is made for both residential and commercial use. The practicality and efficacy of the developed charging system are illustrated in this study through the system design process, hardware and software implementation, system validation, and experimental findings.

2.1 System Design & Architecture

Through the integration of RFID-based authentication, real-time current monitoring, and overcurrent prevention via an microcontroller, the 7.4 kVA EVSE system is intended to offer a safe and effective charging solution. The system is made up of a number of hardware and software elements that cooperate to provide user authentication, controlled power distribution, and safety features.

As the central processing unit, the microcontroller manages power regulation, safety enforcement, and authentication. Because the RFID module (MFRC522) authenticates users, only those with permission can start charging. After authentication, the contactor and relay turn on, giving the EV power. The charging current is continuously monitored by a transformer , which makes sure it stays below 35A. To avoid overheating or electrical problems, the controller instantly cuts off the relay if an overcurrent condition arises. Display improves user involvement and monitoring by giving real-time input on charging status, current consumption, and safety alarms. Through a relay-based switching mechanism that activates or deactivates power delivery in response to safety circumstances and authentication, the power supply unit makes sure that all components receive the operating voltages they require.

The software architecture, which was created with IDE, employs a modular design to effectively manage protection, monitoring, and authentication features. When the device first boots up in standby mode, a message asking the user to touch their RFID card is displayed. After authentication is successful, charging starts, and the sensor keeps an eye on the current flow all the while. The system immediately turns off the relay and shows a warning if an overcurrent condition is found. By tapping their RFID card once more, the user can manually end the charging session, deactivating the relay and resetting the device.

The EVSE system is equipped with a number of safety measures, such as an emergency shutdown mechanism, short-circuit prevention, and overcurrent protection. It is appropriate for EV charging stations in homes, offices, and businesses, guaranteeing a safe, dependable, and easy charging experience.

2.1.1 Block Diagram

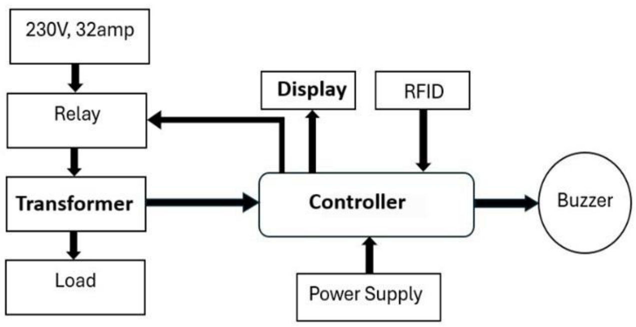

Fig.1 Block Diagram

2.1.2 Working Principle

A systematic and secure charging procedure is ensured by the 7.4 kVA EVSE system's automated safety features, real-time current monitoring, and RFID-based authentication. The microcontroller is essential for controlling power, authentication, and system security.

The RFID module, relay, transformer, display, and other parts of the system are initialized when it is turned on. It then goes into standby mode and asks the user to tap their RFID card. The controller compares the credentials to stored data after the RFID card has been scanned. The relay and contactor turn on, enabling power to reach the EV and displaying a confirmation message if the card is legitimate. An error notice is displayed on the screen and access is refused if the card is not permitted.

The charging current is continuously measured by the sensor while charging, and the Display shows the current readings in real time. The controller displays an overcurrent warning and instantly cuts power to the relay to avoid overheating or electrical risks if the charging current over 35A. By tapping their RFID card once more, the user can also manually halt charging, deactivating the relay and putting the device back in standby mode.

The EVSE system has an emergency shutdown mechanism, short-circuit prevention, and overcurrent protection to guarantee safety. The system automatically disables the relay, stopping additional power flow and showing a warning message, if any abnormal condition is detected. The charging procedure is automated, dependable, and efficient thanks to its well-organized operation, which guarantees strong safety features, intelligent power management, and secure authentication.

2.3 Results & Testing

The 7.4 kVA EVSE system has undergone extensive testing. extensive testing for safety features, power efficiency, and authenticity verification. The testing will mainly encompass validating RFID identity, current monitoring in real-time, and overload protection, all intended to warrant safe and effective charging.

Old and new types of RFID cards from both allowed and unallowed users would be utilized to test how accurate the RFID authentication module is at giving access only to users who are registered. Real-time current monitoring will be verified by measuring the charging current with respect to load conditions while confirming its shows on an Display. The current protection should be tested by increasing the current long enough and above the 35A value and checking if the system is cutting it when the overcurrent condition is observed.

Subsequent testing will also analyze energy efficiency by recording power consumption and maximizing losses. The next analysis will be of the system's response time relative to emergencies like a forced shutdowns or short circuits. The expected results should include successful registered user authentication, instantaneous relay cutoff at the instance of an overcurrent, and stable operation under a variety of load conditions.

Practical testing has followed full deployment to prove its system durability and operation within actual home and business charging settings. Future developments may integrate cloud data tracking and mobile app capability for improved monitoring and control.

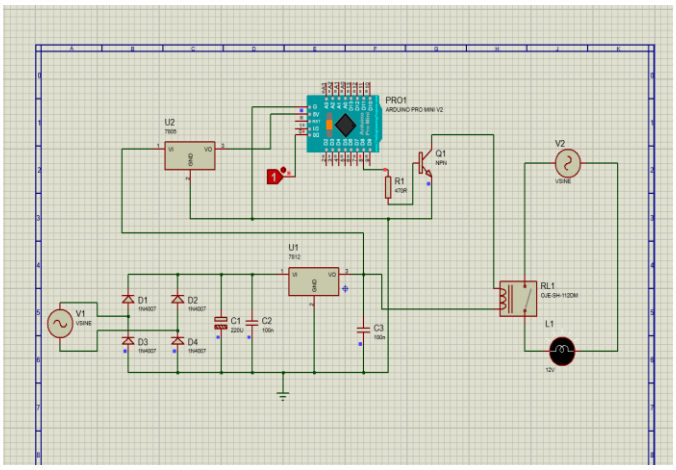

Fig.2 Simulation

3. CONCLUSIONS

Equipped with RFID-based authentication, real-time current monitoring, and automatic safety measures, the 7.4 kVA Electric Vehicle Supply Equipment (EVSE) will ensure reliability, efficiency, and security for the charging solution. Through controlled power delivery and other related protection against current overload, managed by the microcontroller that boosts the overall safety of this system, only authorized persons will gain access to the EV charging station. The system has been successfully implemented and demonstrates high authentication accuracy, power efficiency, and advanced safety features. Automatic relay cutoff once overcurrent sets in would boost the protection and reliability, while real-time monitoring would also enhance cost-effective energy consumption.

This methodology would work well after several tests, enabling the EV charging stations to channel themselves at home, work, or commercial buildings. Future refinement would encompass cloud-based monitoring, connectivity with a smart grid, and a mobile application to have a full system of better performance and user convenience. The successful completion of this system marks a significant advancement in safe and sophisticated EV charging infrastructure, and with that, confidently enlarge electric vehicle usage.

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