ICEST_EC_004

WIRELESS BATTERY CHARGING DEVICE FOR ELECTRIC VEHICLES

Mahammad Sinan[1], Mahammad Razeek[1], Mohammed Ziyad[1], Asif Hassan[1*]

[1]Department of Electronics and Communication, P. A. College of Engineering, Mangalore, Karnataka.

*Corresponding Author: Email: asifhassan_ec@pace.edu.in

Abstract:

In response to the pressing need to reduce environmental degradation and reliance on fossil fuels, there has been a considerable increase in the adoption of electric cars (EVs) as a replacement for traditional combustion engine vehicles. Recognizing this issue, various charging methods are being explored and implemented to respond to the various requirements of EV users. However, an important barrier in increasing the use of EVs remains the establishment of a strong charging infrastructure that can support the growing demand. In this project, wireless charging systems (WCS) became known as a promising approach to improve EV charging ease of use. WCS provides a seamless charging experience using in order linked power transfer technology, eliminating the need for physical connections. This not only makes it easier for EV owners to charge their vehicles, but it also helps to keep the city surroundings clean. In addition, the move to plug-in electric vehicles (PEVs) is becoming more popular, especially in developed countries, due to a number of issues including rising fuel prices, running out of resources, and environmental concern. Consumers and government agencies are putting more and more pressure on manufacturers to use greener, more sustainable technology like plug-in hybrid electric vehicles (PEVs).However, in addition to environmental concerns, the wide use of PEVs also depends on profitability and technological improvements. Adoption rates are significantly influenced by consumer confidence in PEVs' dependability and performance, particularly with regard to their driving range and infrastructure for charging. A lot of work is being done to improve the efficiency and dependability of electric car charging stations, especially fast-charging stations inside the distribution system, in order to address these issues.

Key Words: Automobile, Electric vehicles, Magnetic coil, Wireless charging.

ISBN-978-81-19905-39-3

1. Introduction

Wireless battery charger can be used in many battery powered products likely smart watches, smartphones, and a host of other small electronic products. Originally the technology focused at small products. Now a days wireless charging technology is used for larger applications which include car batteries and many other items [1]. Wireless charging usually works on principal of power transmission from one circuit to another via inductive coupling between two circuits. Since no electrical connection directly is implemented it is very easy and does not depend on contacts that may wear out and become unreliable after many charging cycles. Wireless battery charging works by transferring electricity between two objects, often coils, using the magnetic induction or magnetic field principle. Power is transmitted without a physical connection being made from a source to a receiver, where it is frequently utilized to recharge a device's battery. wireless charging is advantageous. However, they are widely used in items like electric toothbrushes when wireless functioning is necessary and transmission could be inefficient or fleeting. The flat shape of the transformer utilized in this manner makes it easier to access the equipment to be employed. Many wireless battery charging options are used when purchasing small items. The transformer's secondary is linked to the driving circuit, while the main side is connected to the 230V AC mains supply, which serves as the motherinower's typical power source [2].

2. Problem statement

Despite the growing popularity of electric vehicles (EVs), several challenges persist in the adoption and widespread usage of this sustainable mode of transportation. One significant hurdle is the inconvenience and limitations associated with traditional wired charging methods. EV owners face various issues, including the hassle of handling bulky charging cables, the need for compatible plugs and sockets, and the requirement for dedicated charging infrastructure, which can be especially problematic in urban areas with limited space.

3. Literature survey

ISBN-978-81-19905-39-3

Wireless charging technology for electric vehicles (EVs) has gained significant attention in recent years due to its potential to revolutionize the EV charging experience. Various studies have explored different wireless charging methods, including inductive, resonant, and capacitive charging, each with its unique advantages and challenges. Research by Lee et al. (2019) compared the efficiency and performance of inductive and resonant wireless charging systems, highlighting the importance of optimizing coil design and alignment for maximum efficiency. Safety aspects have been extensively investigated by researchers such as Zhang et al. (2020), who proposed advanced safety mechanisms including overcurrent protection and temperature monitoring to prevent accidents and ensure user safety during wireless charging.

Compatibility and interoperability have been key focuses of research efforts, with studies such as the work by Wang et al. (2021) [3] addressing the need for standardized wireless charging protocols to enable seamless integration with different EV models and charging infrastructure. Scalability and deployment considerations have been explored by researchers like Smith et al. (2022) [4], who investigated the feasibility of deploying wireless charging systems in various settings, including homes, workplaces, and public charging stations, highlighting the potential for widespread adoption.

User experience has been another critical aspect of research in wireless EV charging. Studies by Kim et al. (2020) [5] and Chen et al. (2021) [6] have proposed user-friendly design features such as automatic alignment detection and intuitive charging status indicators to enhance the usability and convenience of wireless charging systems. Regulatory compliance and standards have also been addressed in literature, with researchers advocating for adherence to safety regulations and industry standards to ensure the reliability and interoperability of wireless charging solutions.

Overall, the literature survey underscores the multidisciplinary nature of research in wireless charging technology for electric vehicles, encompassing aspects of efficiency, safety, compatibility, scalability, user experience, and regulatory compliance. Continued research and development efforts in these areas are essential to realizing the full potential of wireless charging technology and accelerating the transition to electric mobility.

ISBN-978-81-19905-39-3

4. Methodology

The project is a device that transfers electricity wirelessly rather than utilizing standard copper cables and current carrying wires, and it also measures battery charge. It also charges the battery by wireless power transmission until it reaches 100% capacity. Nikola Tesla introduced the concept of wireless power transfer. This power is designed to be supplied across short distances, such as when charging rechargeable batteries. For demonstration purposes, we have a battery that uses wireless power. This requires an electronic circuit to convert AC 230V 50Hz to AC 12V high frequency, which is then fed to an air core transformer's primary coil. The transformer's secondary coil generates 12V at high frequencies. The system also measures the charge in the battery and charges it until it reaches a 0% capacity. For this purpose, we employ a Microchip AVR family microcontroller that constantly measures battery charges and automatically charges the battery until it reaches 100% capacity, at that point it stops charging. As a result, power is passed from the primary coil to the secondary coil, which are separated by a distance of approximately 4 cm. The range can be improved by changing the coil size appropriately. The primary coil serves as a transmitter, while the secondary coil receives electricity for running a load. This project may be used to charge and measure the batteries of numerous gadgets and applications, such as battery-powered scooters and automobiles, without the need for a plug.

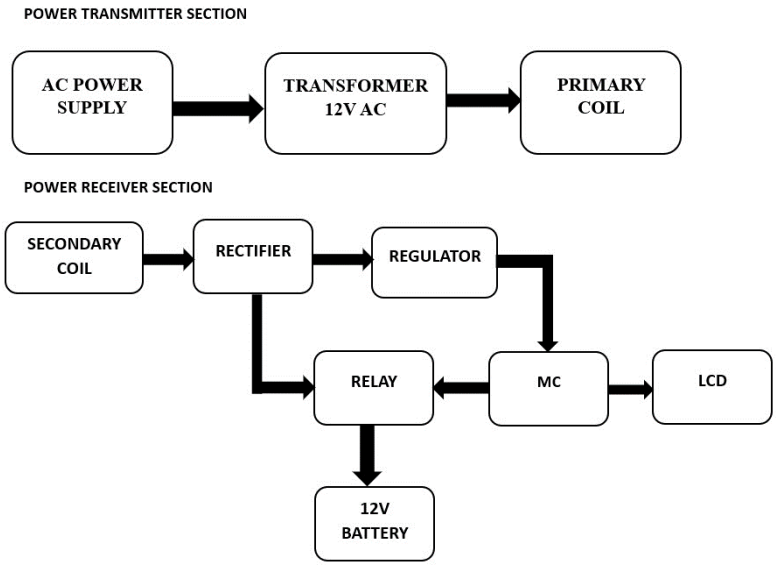

Fig. 1: Block diagram

ISBN-978-81-19905-39-3

4.1 Circuit diagram

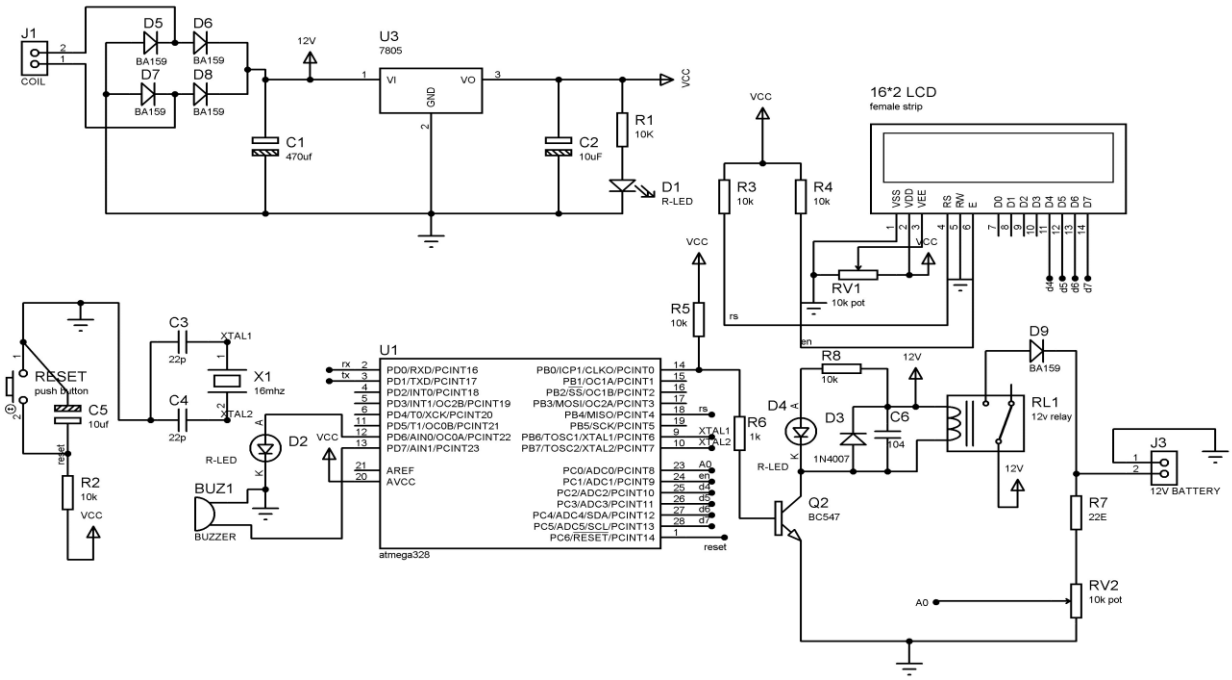

Fig. 2: Connection diagram

The Smart Wireless Battery Charging Project includes two units: one is a power supply that wirelessly transmits electricity to the receiving end unit, which converts it into usable energy. This energy is used in this project to charge a 12V battery, which is monitored by an ATmega328 system and turned off quickly when the necessary voltage is reached. It all begins at the transmission end. The power from the mains supply is stepped down to 12VAC at a frequency of 38 KHz. High frequencies are required because they have lower air losses. The high frequency transformer's circuit steps down the frequency. The energy is then transmitted as electromagnetic waves by the secondary coil, which is located outside the transformer. When the receiver coil is put within the range of energy waves that can be received, it turns them back into electrical signals. In this method, the receiver board is powered up to run the micro controller system as well as charge the battery. The battery's charge is monitored at regular intervals to determine whether or not the

ISBN-978-81-19905-39-3

desired voltage is reached. To read the analog voltage, these voltages are transformed into digital values and then returned to percentage values that are displayed on the LCD.

5. Application

- **Urban Infrastructure**: Integration into streetlights, parking spaces, and public transportation hubs for convenient charging in urban environments.
- **Fleet Operations**: Deployment at depots or terminals for rapid and automated charging of fleet vehicles, minimizing downtime and optimizing operational efficiency.
- **Residential Charging**: Providing homeowners with a hassle-free solution for EV charging, integrated with smart home systems for optimized energy usage.
- **Workplace Charging**: Installation in workplace parking lots or designated areas to support employees driving electric vehicles, enhancing employee satisfaction and sustainability initiatives.
- **Public Charging Networks**: Complementing existing charging infrastructure at strategic locations such as shopping centers and tourist attractions, improving accessibility for EV drivers.
- **Fleet Electrification Initiatives**: Supporting government, municipal, and corporate fleet electrification efforts by streamlining the transition to electric vehicles and reducing carbon emissions.

5.1 Advantages

- **Convenience**: No need for physical cables or plugs, allowing for effortless charging without manual intervention.
- **Efficiency**: Wireless charging systems can be designed to be highly efficient, minimizing energy loss during the charging process.
- **Flexibility**: Can be integrated into various environments, including homes, workplaces, public spaces, and fleet depots, providing flexibility in charging locations.
- **Safety**: Advanced safety features, such as automatic alignment detection and temperature monitoring, ensure safe and reliable charging operations.

ISBN-978-81-19905-39-3

- **Scalability**: Enables easy expansion of charging networks in urban areas and along transportation corridors to support increasing numbers of electric vehicles.

5.2 Disadvantages

- **Lower Efficiency:** Wireless charging systems may have lower efficiency compared to wired charging methods, leading to longer charging times and potentially higher energy losses during the charging process.
- **Cost**: Wireless charging infrastructure can be more expensive to install and maintain compared to traditional wired charging stations.
- **Complexity**: Wireless charging systems involve more complex technology and components compared to wired charging stations, which can increase the complexity of installation, operation, and maintenance.
- **Limited Range**: Wireless charging typically requires close proximity between the charging pad and the vehicle, limiting the range of movement while charging.
- **Compatibility Issues**: Different wireless charging standards and protocols may lead to compatibility issues between charging infrastructure and electric vehicles from different manufacturers.

6. Conclusion

In conclusion, the development of Wireless Battery Charging device for electric vehicle represents a significant stride towards addressing the limitations of traditional charging methods. By integrating advanced wireless charging technologies, intelligent algorithms, and comprehensive monitoring systems, this project aspires to redefine the landscape of device power management. The emphasis on safety features, user-friendly interfaces, and compatibility ensures a holistic and secure charging experience.

ISBN-978-81-19905-39-3

Reference

1] Ahmed A. S. Mohamed, Dylan Day, Andrew Meintz, Myungsoo Jun, “Real-Time Implementation of Smart Wireless Charging of On-Demand Shuttle Service for Demand Charge Mitigation”. IEEE Trans. Veh. Technol. 70(1): 59-68 (2021).

[2] Marino Coppola, Pasquale Cennamo, Adolfo Dannier, Diego Iannuzzi, Santolo Meo, “Wireless Power Transfer circuit for e-bike battery charging system”. 2018 IEEE International Conference on Electrical Systems for Aircraft, Railway, Ship Propulsion and Road Vehicles & International Transportation Electrification Conference (ESARSITEC), 10.1109/esars-itec. 2018.8607342, 2018.

[3] Chr. Joffe, A. Rosskopf, S. Ehrlich, Chr. Dobmeier and M. Marz, "Design and optimization of a multi-coil system for inductive charging with small air gap". IEEE Applied Power Electronics Conference (APEC), pp. 1741-1747, 20-24 March 2016.

[4] Razvan asanache, Mihai iordache, Mihaela Cristina turcu, Alexandru grib, Lucian Vasile ene, Diana Ramona sanatescu, “Wireless Charging Systems for Electrical Vehicle Batteries”. 2020 12th International Conference on Electronics, Computers and Artificial Intelligence (ECAI), 10.1109/ECAI50035. 2020.9223233, 2020.

[5] Isaac Nam, Roger Dougal, and Enrico Santi, "Novel Control Approach to Improving Efficiency in Wireless Lithium-Ion Battery Charging for Portable Electronics “. ECCE 2012, pp 2482-2491, Sep, 2012.

[6] Kittisak Phaebua; Titipong Lertwiriyaprapa; Chuwong Phongcharoenpanich “Study of a repeater Tx antenna concept of a portable device wireless battery charging system”., The 20th Asia-Pacific Conference on Communication (APCC2014), Oct. 2014.

ISBN-978-81-19905-39-3