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Wireless EV Charging System Using Inductive Power Transfer and Voltage Regulator

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Abstract:
Inductive power transfer (IPT) is a new technology that allows wireless electric vehicle (EV) charging. It lets energy flow between a charging pad and the vehicle without touching it. This project is all about designing and building a wireless charging system that works well with a voltage regulator to make sure the output stays stable no matter what the load is. The system has a primary coil that is connected to a high-frequency AC power source and a secondary coil that is mounted on the EV. Power is transferred between the two coils through electromagnetic induction. The receiver side has a rectifier and a voltage regulator that change the voltage and keep it at a steady level so that it can charge batteries. The suggested model makes things safer by getting rid of exposed conductive parts, lowering wear and tear, and making things easier for users. Performance analysis includes measuring efficiency, checking voltage stability, and looking at the effects of alignment. This shows that IPT-based wireless EV charging systems are possible for modern transportation.

Keywords: Wireless Charging, Electric Vehicle (EV), Inductive Power Transfer (IPT), Voltage Regulator, Electromagnetic Induction, Power Efficiency, Contactless Charging, Rectifier.

INTRODUCTION

Wireless Electric Vehicle Charging Systems (EVWCS) represent an advanced and emerging technology that enables contactless charging of electric vehicles (EVs) using Wireless Power Transfer (WPT). Instead of traditional plug-in charging, power is transferred through electromagnetic fields between a transmitter (installed on the ground or road) and a receiver (mounted on the vehicle) The rapid growth of EV adoption, driven by concerns like fossil fuel depletion, air pollution, and sustainable transportation, has created a strong demand for efficient, user-friendly, and intelligent charging solutions. Wireless charging addresses many limitations of conventional systems, such as cable wear, safety risks, and user inconvenience. In addition, the integration of the Internet of Things (IoT) enhances EV charging by enabling real-time monitoring, smart energy management, remote control, and communication with the power grid. This combination of WPT and IoT leads to the development of smart, automated, and scalable EV charging infrastructureWireless charging can be classified into static charging (when the vehicle is parked) and dynamic charging (while the vehicle is in motion). This technology improves user convenience, eliminates cable handling, and enhances safety, especially in harsh environmental conditions. With the integration of the Internet of Things (IoT), EVWCS becomes more intelligent by enabling real-time data monitoring, automatic billing, energy optimization, and communication with smart grids.Despite its advantages, the system faces challenges such as power transfer efficiency, alignment between coils, infrastructure cost, and standardization issues. However, ongoing research and development are continuously improving its performance and feasibility. A Photovoltaic (PV) Integrated Wireless Electric Vehicle Charging System combines solar energy generation with wireless charging technology to create a clean, efficient, and sustainable charging solution for electric vehicles. In this system, solar panels convert sunlight into electrical energy based on the principle of Photovoltaic Effect, which is then used to charge EVs through Wireless Power Transfer.The integration of PV systems reduces dependence on conventional grid power and promotes the use of renewable energy, making EV charging more environmentally friendly. The generated solar energy can either be directly used, stored in batteries, or supplied to the grid, ensuring continuous and reliable charging even during low sunlight conditions.Additionally, incorporating the Internet of Things (IoT) enables smart control, real-time monitoring, energy optimization, and efficient power distribution. This makes the system more intelligent and adaptable to varying energy demandsThe rapid growth of electric vehicles (EVs) and the increasing demand for sustainable energy solutions have led to the development of advanced charging technologies such as Photovoltaic (PV) integrated Wireless Electric Vehicle Charging Systems. These systems combine renewable energy generation with contactless charging to create an efficient and eco-friendly solution for modern transportation. The use of solar energy, based on the Photovoltaic Effect, reduces reliance on fossil fuels and supports global efforts toward clean energy adoption.Wireless charging in EVs is achieved through Wireless Power Transfer, which eliminates the need for physical connectors and enhances user convenience, safety, and system reliability. When integrated with PV systems, the generated solar power can be utilized directly, stored in batteries, or fed into the grid, ensuring flexibility and continuous operation.A comprehensive analysis of such systems involves examining multiple aspects, including system design, power electronics interfaces, energy management strategies, efficiency optimization, and control techniques. The inclusion of the Internet of Things (IoT) further enhances system performance by enabling real-time monitoring, smart scheduling, fault detection, and adaptive energy distribution

LITERATURE REVIEW

[1] : Z. Zhou et al. (2022) proposed a bi-level framework for microgrid capacity planning integrated with dynamic wireless charging, improving energy management and system efficiency . [2]T. Theodoropoulos et al. (2022) developed scalable EV charging strategies under voltage constraints, enhancing grid stability.[3] Panchal et al. (2018) presented a comprehensive review of wireless charging technologies, highlighting inductive and resonant coupling as the most practical methods for EV applications[4]TA and Marshiana (2025) introduced an adaptive coil and compensation integration technique, achieving high efficiency in wireless power transfer systems:5](Shahid Karim et al., 2026) presented a comprehensive review on wireless power transfer (WPT) and IoT-based EV charging systems. The authors analyzed inductive, resonant, and capacitive power transfer methods and highlighted the importance of real-time monitoring, cybersecurity, and smart grid integration. They also identified key research gaps such as lack of system integration and real-world validation. [6](V. Ramakrishnan et al., 2024) focused on improving the efficiency of wireless charging systems for EVs. Their study analyzed coil configurations, compensation techniques, and converter topologies, concluding that power transfer efficiency depends heavily on impedance matching and coil alignment.:[7] Rahulkumar J. et al. (2023) studied inductive power transfer pad design for EVs. The authors highlighted that magnetic coupling and pad structure significantly influence power transfer efficiency and vehicle performance. [8]Patil et al. (2020) reviewed wireless charging systems and identified challenges such as high installation cost and electromagnetic interference in dynamic charging system[9]Ahmad et al. (2021) analyzed different wireless charging methods and pointed out research gaps such as misalignment problems, electromagnetic interference, and optimization of coil design.[10]Mahesh et al. (2021) compared various inductive charging systems and emphasized improvements in safety, fast charging, and interoperability.

EXISTING SYSTEM

Wireless electric vehicle charging primary relies on inductive power transfer which just operate as same as like that transformer but in the air gap between the primary and a secondary coil. It has 2 terminals grid side also called as transmitter witch has ac to dc converter which helps utility ac power were rectified into dc and its high power frequency inverter helps to achieve efficient power transfer cross an air gap the dc were converted into a high frequency ac which tropically between 20khz and 85khzand we also use the transmitter coil this coil usually buried in the ground or a charging pad its create a fluctuating magnetic field. And a compensation network capacitors re added to create a resonant circuit maximizing power transfer and minimizing the reactive power losses and the second part is the vehicles side receiver it has receiver coil mutated on the undercarriage of the ev this makes the magnetic flux and a inducing and ac voltage and a rectifier produces induced ac is converted back into dc and a voltage regulator dc-dc converter this is a critical component that stabilize the voltage to a specific level which was required to a battery management system in it and safely despised variations in the air gap in it.

DISADVANTAGES

- Efficiency losses
- Alignment sensitivity
- High infrastructure cost
- Weight and space
- Foreign object detection
- Heat dissipation

PROPOSED SYSTEM

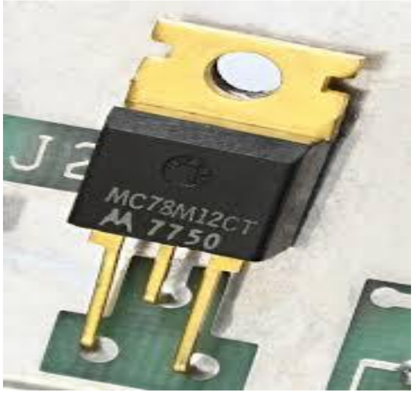
This system moves beyond basic circuit to replace lcc compensation topology on both the transmitter and receiver sides this lcc resonant network uses an additional inductor and two capacitor per side of it.this makes a resonant frequency independent of coupling coefficient to a load and also providing high stable power transfer even the car parking was not perfect and it has the active synchronous rectifier which replaces standard diodes on the vehicles side of it with mosfets this will reduces the forward voltage drop and also for bidirectional power flow in tithe integrated shielding a multi-layer plate design that guide the magnetic flux density in air gap and a real time alignment assist is a low power rf both feedback loop between car and pad to guide the driver for maximum efficiency.

ADVANTAGES

- Load independence
- Higher efficiency at distance
- Reduced components stress
- Safety and user advantages on lod\fod
- Autonomous compatibility
- Space optimization

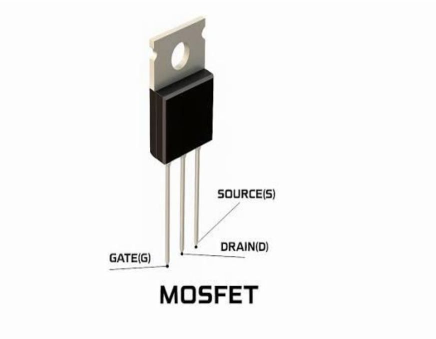
HARDWARE REQUREMENTS

VOLTAGE REGULATOR



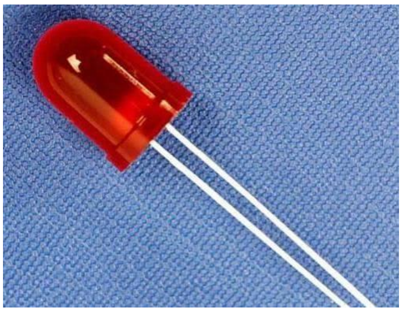
Voltage Regulator (Small 3-pin chip with metal tab): This takes the battery's 12V and drops it down to a steady 5V to power the microcontroller without burning it out.

MOSFET



MOSFETs (4 Black components with silver heatsinks): These are high-speed electronic switches. They take the weak signal from the microcontroller and use it to switch the heavy battery current into the coil.

Indicator LED (RED

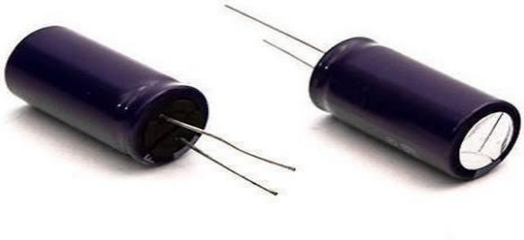


Indicator LED (RED): A simple light to show that the transmitter board is receiving power and is active.

LED INDICATOR

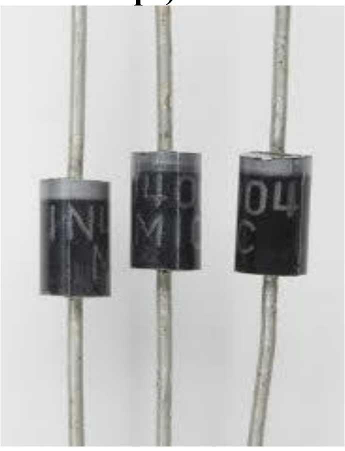
COB LED (The bright purple/white square): This is a "Chip on Board" LED. It is a high-intensity light source that demonstrates the system is working.

Electrolytic Capacitors



Electrolytic Capacitors (Small cylinders): These act like tiny temporary batteries to "smooth out" the power so the switching doesn't cause voltage drops.

Diodes (Small black cylinders with a silver stripe)



Diodes (Small black cylinders with a silver stripe): These form a Bridge Rectifier. The power coming from the coil is AC (swapping directions), but the LED needs DC (one direction). These diodes act as one-way valves.

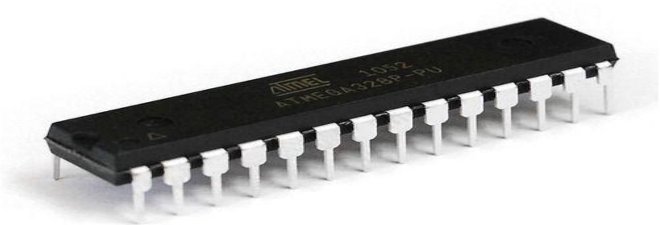
Electrolytic Capacitors

Electrolytic Capacitors (Small cylinders): These act like tiny temporary batteries to "smooth out" the power so the switching doesn't cause voltage drops

Crystal Oscillator

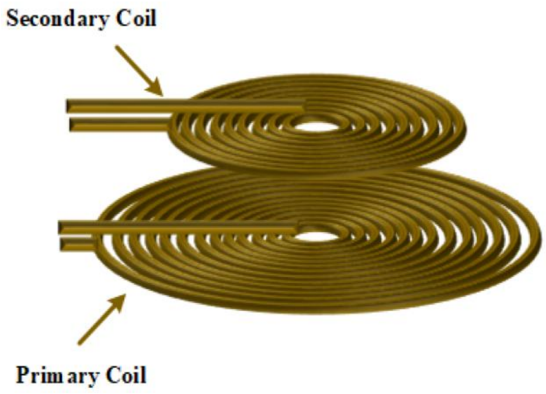
Crystal oscillator is an electronic circuit that uses the mechanical resonance of a vibrating piezoelectric crystal (typically quartz) to create an electrical signal with a precise frequency. This signal is most commonly used to provide a stable clock signal for microprocessors and to stabilize frequencies for radio transmitters and receivers.This provides a precise "heartbeat" for the microcontroller so it switches at exactly the right frequency

Microcontroller



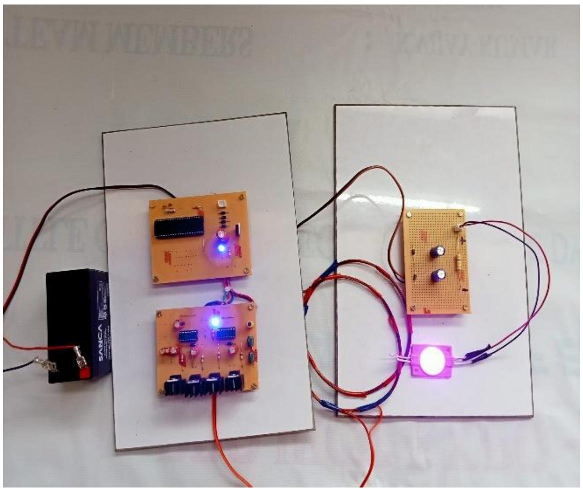
Microcontroller (Large Black Chip): This is likely an ATmega or PIC chip. It acts as the "brain," sending out high-frequency ON/OFF signals.

Primary coil (transmitter) and Secondary coil (receiver)



wireless charging, the primary coil (transmitter) and secondary coil (receiver) function together like an air-core transformer to transfer energy through a magnetic field.

Result



It was possible to design and test a wireless EV charging system that used Inductive Power Transfer (IPT) and a voltage regulator. The system showed that it could send power between the primary and secondary coils over a short air gap without needing to touch. The voltage regulator made sure that the output voltage on the receiver side stayed stable, even when the load changed. When the coils were properly aligned, the experimental results showed that the system worked well and didn't lose much power. It was found that misalignment and greater distance between coils made power transfer less efficient, which is a major problem with IPT systems. But the rectifier and regulator made sure that the DC output was always the same, which was good for charging batteries. The system was safe, dependable, and easy to use, which meant that physical connectors were no longer needed. These results show that wireless EV charging is a useful and promising option for future electric mobility uses.

CONCLUSION

The Wireless EV Charging System utilizing Inductive Power Transfer (IPT) and a voltage regulator represents a significant advancement in EV charging technology. This system allows for efficient energy transfer between a ground-based transmitter coil and a receiver coil embedded in the vehicle, eliminating the need for cables and plugs. IPT technology enhances safety by reducing electrical shock risks and offers convenience, especially in public charging stations. The voltage regulator ensures a stable output, optimizing charging efficiency and battery lifespan. With proper alignment and design, IPT systems can achieve high efficiency, making them suitable for widespread adoption.n India, wireless EV charging can boost EV adoption by simplifying charging infrastructure. It can be particularly useful for public transport, taxis, or private vehicles, reducing downtime and enhancing user experience. Future developments could focus on improving coil design, increasing power transfer efficiency, and reducing costs.The integration of IPT with smart grids and IoT could further enhance functionality, enabling features like automated charging and billing. As EV adoption grows in India, wireless charging can play a key role in making electric mobility more convenient and appealing.

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