Solar Based Wireless Electric Vehicle Charging System

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Abstract: **With the increasing adoption of Electric Vehicles (EVs), there is a growing demand for sustainable, efficient, and contactless charging systems. This project presents a solar-based wireless EV charging system that leverages resonant inductive coupling to transmit energy without the need for physical connectors. The system harnesses solar power as its primary energy source, which is stored in a rechargeable battery and converted into high frequency alternating current using a MOSFETbased inverter.**

A PIC microcontroller is used to generate Pulse Width Modulated (PWM) signals that operate the inverter at a frequency of approximately 150kHz. The resulting magnetic field is transmitted through a transmitting copper coil and received by a receiver coil embedded in the electric vehicle. This energy is then rectified and regulated to safely charge the EV's onboard battery system. This innovative solution addresses the limitations of conventional wired chargers, offering a contactless, eco-friendly, and intelligent alternative. The system is ideal for deployment in smart parking lots, commercial buildings, and urban mobility hubs, aligning with the global push for green transportation infrastructure.

Keywords: **Wireless Power Transfer, Solar Energy, Electric Vehicle Charging, PIC Microcontroller, Inductive Coupling, Resonant Frequency.**

I. INTRODUCTION

The growing global shift towards sustainable and smart transportation solutions has significantly increased the demand for reliable, efficient, and environmentally friendly electric vehicle (EV) charging systems. Traditional plug-in charging stations, while effective, often require human interaction, involve extensive cabling infrastructure, and rely heavily on grid electricity, which may not always align with the green goals of electric mobility.

To address these limitations, this project proposes a solar-based wireless electric vehicle charging system that integrates the principles of resonant inductive coupling with the capabilities of renewable solar energy. The system aims to enable safe, contactless, and fully automated power transfer to EVs without the need for physical connectors, thereby enhancing both operational convenience and system sustainability.

At the heart of the system lies a pair of self-resonating copper coils, tuned to approximately 150kHz, which facilitate energy transfer through the phenomenon of coupled resonance — a principle pioneered by Nikola Tesla. Solar energy harvested by the photovoltaic panel is stored in a rechargeable battery and then converted into high-frequency alternating current (AC) using a MOSFET-based inverter. This inverter is controlled by a PIC microcontroller, which generates Pulse Width Modulated (PWM) signals to regulate the switching frequency.

The transmitting coil generates an oscillating magnetic field that wirelessly transfers energy to the receiver coil installed within the electric vehicle. The received AC energy is then rectified and regulated before being used to safely charge the onboard EV battery. This fully automated charging process is not only efficient but also eliminates the safety risks and mechanical wear associated with conventional plugin systems.

This project highlights the convergence of power electronics, wireless communication, and renewable energy, offering a forward-looking solution ideal for implementation in smart parking systems, automated charging stations, and modern urban mobility infrastructure. By leveraging the advantages of automation and solar power, this system presents a compelling alternative to traditional EV charging setups, reflecting a meaningful step toward the next generation of intelligent and eco-friendly transportation networks.

II. SYSTEM MODEL

The block diagram represents a solar-based wireless EV charging system built using a stepdown transformer, MOSFET drivers, copper coils, a PIC microcontroller, and supporting circuitry. Solar energy is collected using a solar panel and stored in a rechargeable battery through a charging circuit. The system includes a MOSFET driver (IRFZ44), controlled by the PIC microcontroller, which uses PWM signals to generate a high-frequency output (around 150kHz) for wireless power transmission via copper coils. The energy is transferred wirelessly from a transmitting coil to a receiving coil, where it is rectified and regulated using a 7805 voltage regulator. Components like an LED indicator and reset button provide basic system feedback and control.

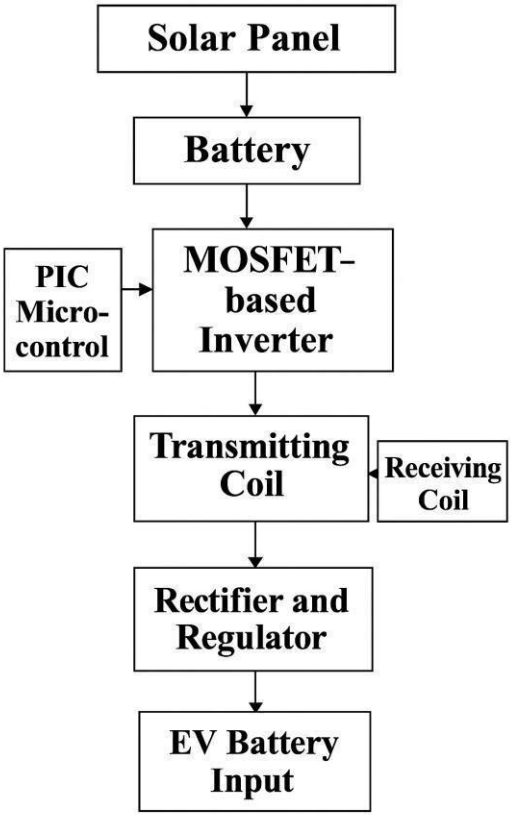

Fig.1: Block Diagram

a) Step-Down Transformer (230V to 12V, 3A):

Fig.a Step-Down Transformer

The transformer is used to convert high-voltage AC (230V) into a lower voltage level (12V AC), suitable for further rectification and regulation. It acts as the initial power conversion stage, providing a safe and manageable voltage for the circuit's components.

b) 7805 Voltage Regulator:

Fig.b 7805 Voltage Regulator

The 7805 voltage regulator ensures a constant 5V DC output regardless of variations in the input voltage. This regulated output is essential for powering low-voltage devices such as the microcontroller and control logic.

c) PIC Microcontroller (16F72):

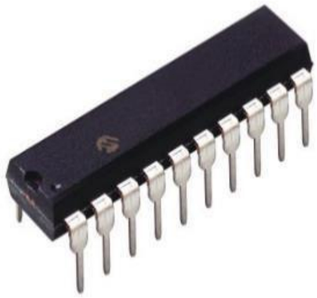

Fig.c PIC Microcontroller (16F72)

The PIC16F72 is an 8-bit microcontroller that controls the system’s timing and logic. It generates Pulse Width Modulation (PWM) signals to drive the MOSFETs, managing the switching frequency needed for efficient power transmission.

d) MOSFET Driver (IRFZ44):

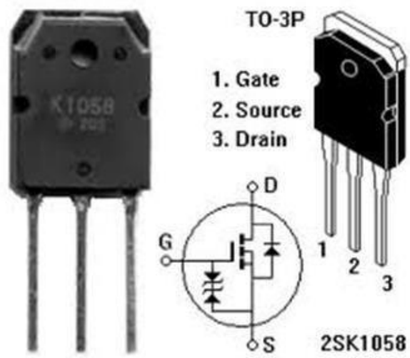

Fig.d MOSFET Driver (IRFZ44)

MOSFETs are used to switch the DC power rapidly into high-frequency AC for transmission. The IRFZ44 is suitable for high-speed switching applications, allowing the system to produce the desired 150kHz output with minimal losses.

e) Transmitting and Receiving Copper Coils:

Fig.e Copper Coils

Copper coils are used in resonant inductive coupling to wirelessly transmit energy. When energized, the transmitting coil generates a magnetic field that induces voltage in the receiving coil, enabling contactless power transfer.

f) Rechargeable Battery (12V)

Fig. f Rechargeable Battery

A 12V lead-acid or lithium battery is used to store solar energy. It provides a steady supply of power for wireless charging even in the absence of sunlight.

g) Solar Panel (12V, 5W)

Fig. g Solar Panel

The solar panel converts sunlight into DC electricity using the photovoltaic effect. It serves as the primary power source, enabling off-grid, eco-friendly operation.

h) Charging Circuit

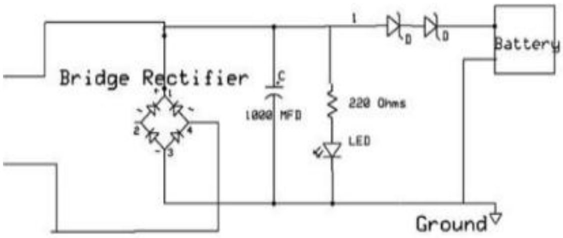

Fig. h Charging Circuit

This section includes the rectifier, capacitor, and protective diodes to manage energy flow from the solar panel to the battery. Diodes are used for reverse current protection, ensuring battery safety.

i) LED

Fig. i LED

LEDs are used as charging status indicators. If the LED glows, it indicates that the circuit is live and the battery is charging.

j) Reset Button:

Fig. j Reset Button

The reset button manually restarts the microcontroller, helping to reinitialize the program during errors or malfunctions. It is a simple but essential feature for troubleshooting and control.

k) Crystal Oscillator

Fig. k Crystal Oscillator

Used to provide a highly stable and accurate clock signal to the microcontroller. This helps maintain consistent PWM signal generation, crucial for stable inverter and coil operation.

III. METHODOLOGY

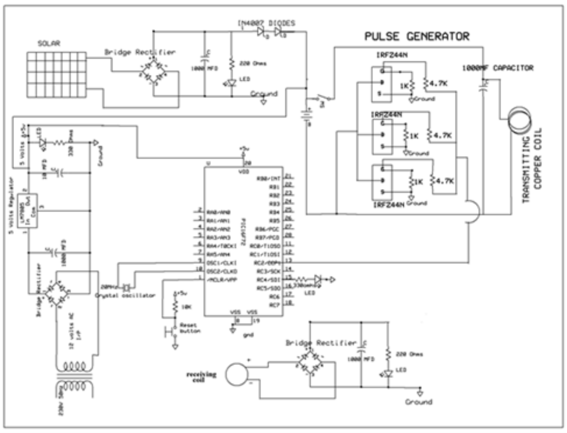

Fig.2: Connection Diagram of the System

This project is designed to transmit electrical power wirelessly using solar energy and inductive coupling. The solar panel converts sunlight into DC power, which is filtered using a bridge rectifier and then regulated to a stable 5V supply. This power is used to run the PIC microcontroller, which manages the overall control of the system. A crystal oscillator connected to the microcontroller ensures accurate timing. The microcontroller operates a pulse generator made with IRFZ44N MOSFETs that creates high-frequency signals to drive the transmitting copper coil. A capacitor is also used to support stable pulse generation.
When the transmitting coil is energized, it produces an alternating magnetic field. A nearby receiving coil captures this energy and converts the received AC signal into DC using a bridge rectifier. This output can be used to power small loads like LEDs. Diodes (IN4007) are used for reverse current protection, and multiple LEDs are placed throughout the circuit to indicate the system status, such as solar power input, voltage regulation, and output reception. The system effectively demonstrates wireless power transfer using clean, renewable solar energy.

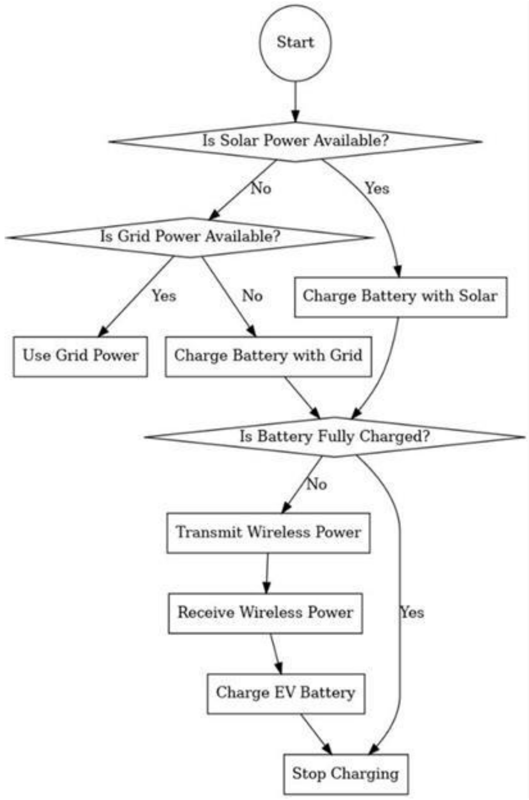

Fig.3: Flow Chart of the System

The proposed solar-based wireless electric vehicle (EV) charging system operates through an intelligent power management flow. The system first checks for the availability of solar energy. If available, solar power is used to charge the system battery. In the absence of solar power, it switches to grid power if available. The battery continues charging from the available source until it reaches full capacity. Once fully charged, the system initiates wireless power transmission to the electric vehicle through a transmitter and receiver coil setup.

The microcontroller plays a crucial role in monitoring power source availability, battery status, and controlling the wireless power transfer process. When the EV battery reaches full charge, the system automatically halts the charging to prevent overcharging and energy loss. This setup ensures efficient, autonomous EV charging with a priority on renewable solar energy, contributing to sustainable and contactless energy solutions.

IV. RESULTS

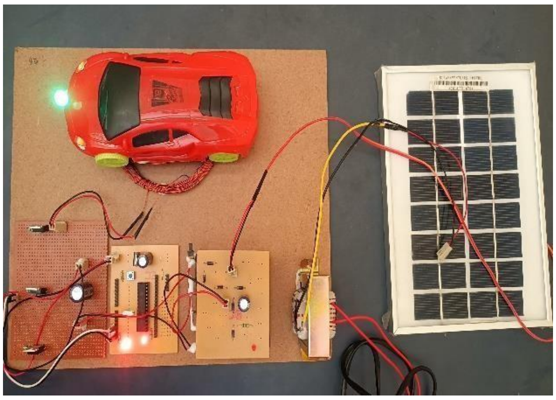

Fig.4: Model

V. CONCLUSION

This project introduces an innovative approach to electric vehicle charging by combining solar power with wireless energy transmission. It provides a clean, sustainable alternative to conventional wired charging systems, helping reduce reliance on nonrenewable energy sources. The use of solar energy ensures continuous power availability during daylight hours, while the wireless transfer mechanism adds convenience by eliminating the need for physical connectors.

The system is designed to be cost-effective, lowmaintenance, and adaptable to different environments, making it suitable for implementation in both urban and rural areas. Its ability to operate independently from the grid makes it especially useful in remote locations. With the increasing shift towards electric mobility, this technology has the potential to contribute significantly to the development of a smart, green, and accessible EV charging infrastructure.

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