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Solar Wireless Electric Vehicle Charging System

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Abstract: *The growing demand for sustainable transportation and renewable energy has led to the development of innovative charging solutions for electric vehicles (EVs). This project presents a Solar Wireless Electric Vehicle Charging System that combines solar energy generation with inductive wireless power transfer (WPT) technology. The system harnesses solar energy through photovoltaic (PV) panels, which convert sunlight into electrical energy. This energy is then conditioned and transmitted wirelessly from a transmitter coil embedded in the ground to a receiver coil installed beneath the vehicle.*
The proposed system eliminates the need for physical charging cables, enhancing convenience, safety, and efficiency while promoting clean and renewable energy usage. The design integrates power electronics circuits, such as DC–DC converters and resonant inverters, to maintain stable power transfer and improve charging efficiency. The project aims to demonstrate the feasibility of integrating solar power and wireless charging for electric vehicles, offering a sustainable and user-friendly alternative to conventional plug-in charging systems.

Keywords: *electric vehicles*

I. INTRODUCTION

With the increasing concerns over environmental pollution and the depletion of fossil fuels, the demand for clean and sustainable energy sources has grown rapidly. Electric vehicles (EVs) have emerged as a promising solution to reduce greenhouse gas emissions and dependence on non-renewable energy. However, conventional plug-in charging methods are often inconvenient, time-consuming, and limited by the availability of charging infrastructure.

To address these challenges, this project proposes a Solar Wireless Electric Vehicle Charging System that combines renewable solar energy with wireless power transfer (WPT) technology. Solar panels are used to harness sunlight and convert it into electrical energy, which is then transmitted wirelessly to the vehicle's battery through an inductive coupling mechanism. This eliminates the need for physical connectors, reduces maintenance, and enhances user convenience.

The system's main components include solar photovoltaic panels, power conditioning circuits, transmitter and receiver coils, and a battery management system. By integrating solar power generation with wireless charging, the project promotes green energy utilization and supports the development of a smart and sustainable transportation ecosystem. This technology can be implemented in public parking lots, highways, and residential areas, contributing to the future of intelligent and eco-friendly mobility.

Solar panels

A solar panel, also known as a photovoltaic (PV) panel, is a device that converts sunlight directly into electrical energy using the photovoltaic effect. It is composed of several solar cells made of semiconductor materials such as silicon. When sunlight strikes the surface of the solar cells, it excites the electrons, creating an electric current.

In the proposed system, the solar panel acts as the primary power source. It captures solar energy and generates DC (Direct Current) electricity, which is then regulated using a charge controller or DC–DC converter. This stable DC output is used to power the wireless charging transmitter circuit, enabling the contactless charging of electric vehicles.

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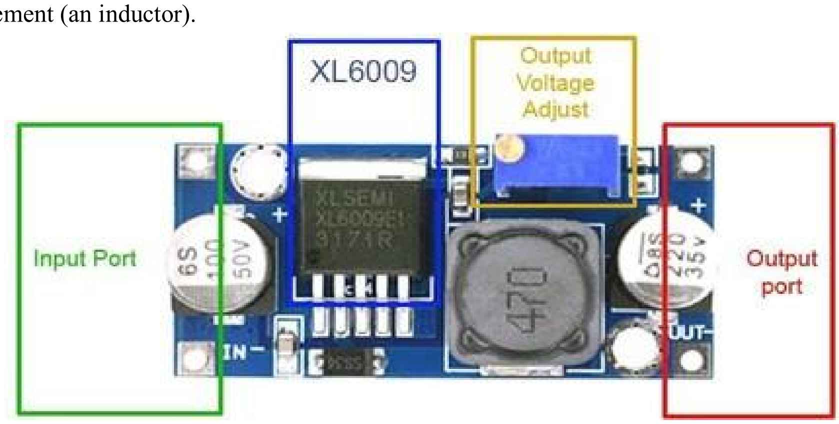
The efficiency of the solar panel depends on several factors, such as sunlight intensity, panel orientation, temperature, and quality of the PV material. Using solar energy reduces dependency on the grid, lowers charging costs, and promotes an environmentally friendly way to power electric vehicles.

Specifications

Open Circuit Voltage: 11.25V
Short Circuit Current: 0.41 A
Peak Current: 0.34 A
Peak Voltage: 9V
Maximum System Voltage: 1000VDCWin

Boost converter

A Boost Converter is a type of DC–DC converter that steps up (increases) the input voltage to a higher output voltage while reducing the current. It plays a crucial role in the Solar Wireless Electric Vehicle Charging System, where the voltage produced by the solar panel may not be sufficient to drive the wireless power transmission circuit effectively. The boost converter operates using two main components: a switching device (such as a MOSFET or transistor) and an energy storage element (an inductor).



Boost converter

When the switch is turned ON, current flows through the inductor, storing energy in the form of a magnetic field. When the switch is turned OFF, the inductor releases its stored energy, adding to the input voltage and thus producing a higher output voltage.

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XL6009 Technical Specifications

Total voltage given as input	3V to 32V
Total Voltage received at output end	5V to 35V
Output Current	4A
Efficiency	<94%
Load Regulation	0.5%
Voltage Regulation	0.5%
Dimensions	45*20*14 mm (L*W*H)

Overview of XL6009

The XL6009 is a high-efficiency DC–DC boost converter module used to step up a lower DC voltage to a higher level. It is based on the XL6009 integrated circuit (IC), which features a built-in MOSFET switch and operates at a high switching frequency of around 400 kHz. This high frequency allows for smaller inductor sizes and faster transient response, making the circuit compact and efficient.

In the Solar Wireless Electric Vehicle Charging System, the output voltage from the solar panel often varies depending on sunlight intensity. The XL6009 module boosts this variable solar voltage to a stable and higher DC voltage suitable for powering the wireless transmitter circuit.

By using the XL6009 boost converter, the system ensures a consistent power supply to the wireless charging circuit, even under fluctuating solar conditions. This improves the efficiency, stability, and performance of the overall charging system.

The XL6009 is a high-performance DC–DC step-up (boost) converter integrated circuit designed to efficiently convert a lower DC voltage to a higher DC voltage. It is widely used in renewable energy projects, LED drivers, battery-powered devices, and wireless power transmission systems. In this project, it is used to boost the variable DC voltage obtained from the solar panel to a stable and higher level required for the wireless charging transmitter.

Key Features of XL6009:

1) Input Voltage Range: 3 V to 32 V DC
2) Output Voltage Range: Up to 35 V DC
3) Maximum Output Current: 2–3 A (depends on heat dissipation)
4) Switching Frequency: 400 kHz
5) High Efficiency: Up to 94%
6) Built-in thermal shutdown and current limit protection

The XL6009 module has an easy-to-use interface. By connecting the load directly to the OUT+ and OUT- pins and the regulated or unregulated input to the IN+ and IN- pins, you may adjust the output voltage using the potentiometer.

18650 Cell Features and Technical Specifications
Nominal Voltage: 3.6V
Nominal Capacity: 2,850mAh
Minimum Discharge Voltage: 3V Maximum
Discharge Current: 1C
Charging Voltage: 4.2V
Charging Current:0.5C
Charging Time: 3hours(approx.)
Charging Method: CC and CV Cell Weight: 48g(approx.)
Cell Dimensions: 18.4mm(diameter) and 65mm (height)

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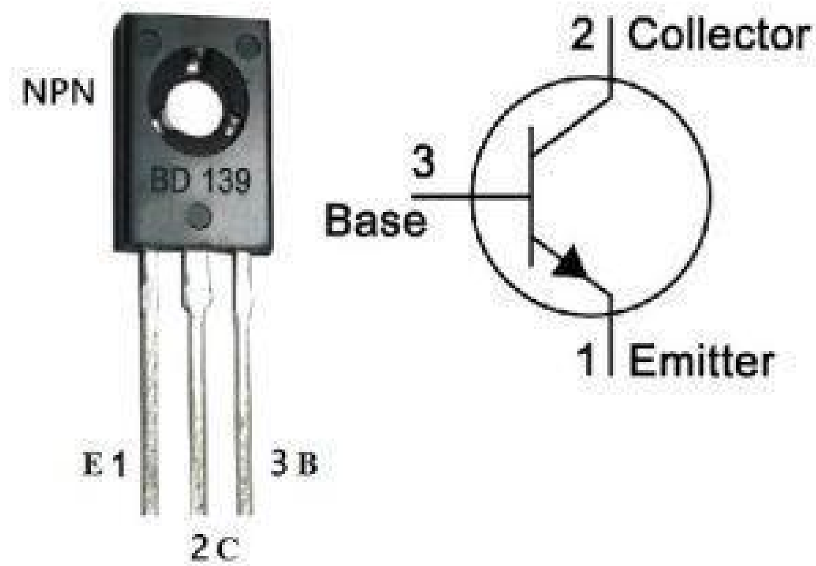
Transistor

The SOT-32 plastic box contains a bipolar NPN transistor, similar to the BD139. Because of its low cost and high collect or current, this type of transistoris utilised in many different electrical circuits. This transistor can drive loads such as motors, high- power LED relays, etc. upto1.5A. It may easily be used in an electrical circuit due to the exceptionally high VCE (collector- emitter) and VCB (collector-base) voltages. The 12.5 W dissipation current of the collector terminal makes it ideal for usage in audio amplifier circuits. Just 0.5V is the transistor's saturation voltage.



BD139 transistor

Currently, lithium-ion technology is the most commonly employed type of rechargeable battery. It is responsible for energizing our everyday devices such as electric vehicles and cell phones.

BD139 Transistor Pin Configuration

Pin Number	Pin Name	Description
1	Emitter	Emitter, which is often connected to ground, allows current to drain out.
2	Base	Controls the transistor biasing, which is used to switch the transistor to ON state as well as OFF state.
3	Collector	Through a collector that is typically attached to a load, current enters.

Features

- It is mounted in a plastic case and comes in the To-225 box.
- This transistor's collector current (IC) is 1.5 A.
- This transistor has an 80 V collector–base voltage and a 5 V breakdown voltage from the emitter to the base.
- This transistor's DC gain (hfe) ranges from 40 to 160, and its breakdown voltage from emitter to base (VBE) is 5 volts.
- Collector has a dissipation factor of 12.5 W.
- The junction's operating and storage temperature spans the range of –55 to +150.
- This transistor can be found in PB-Free packages as well.

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Coils

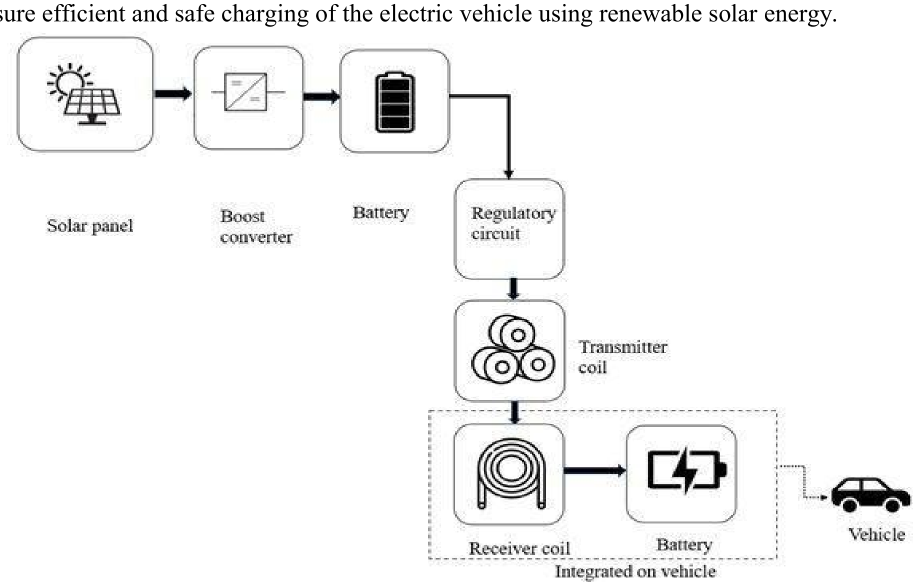
The coils are the most important components of the wireless power transfer (WPT) system. They are responsible for transmitting and receiving electrical energy through electromagnetic induction — without any physical connection. The system uses two main coils: a transmitter coil and receiver coil.

The transmitter coil is placed on the charging station or embedded in the ground. It is connected to the power transmitter circuit, which supplies a high-frequency alternating current (AC).

When AC flows through the coil, it produces an alternating magnetic field around it. This magnetic field acts as a medium for wireless energy transfer.When the primarycoilisenergized,it createsarapidlychangingmagneticfieldaround the coils. This changing magnetic field induces a high amounts of the voltage in the secondary side of the coil through electromagnetic induction. The primary and secondary coils are designed to have a resonant frequency, which allows for efficient energy transfer between them. This resonance is achieved by using capacitors and inductors in the circuit, which store and release energy in a cyclical manner.

Block diagram

The block diagram of the Solar Wireless Electric Vehicle Charging System represents the overall flow of energy — from solar energy generation to wireless power transfer and finally to battery charging. Each block performs a specific function to ensure efficient and safe charging of the electric vehicle using renewable solar energy.



Block diagram

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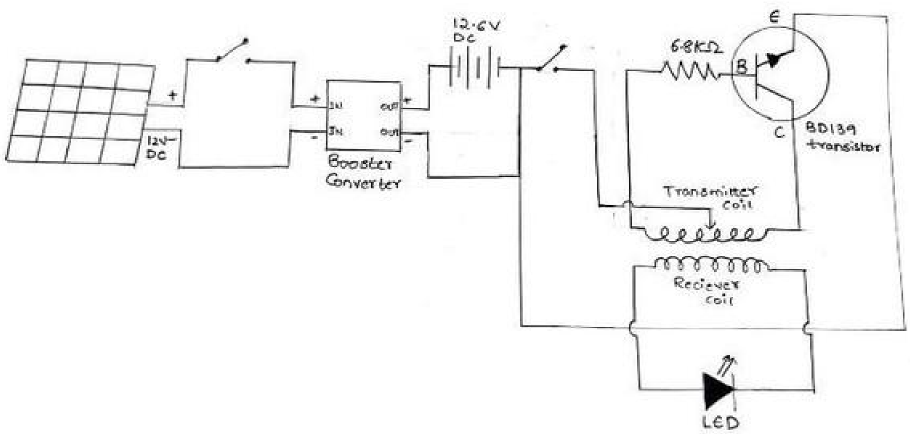
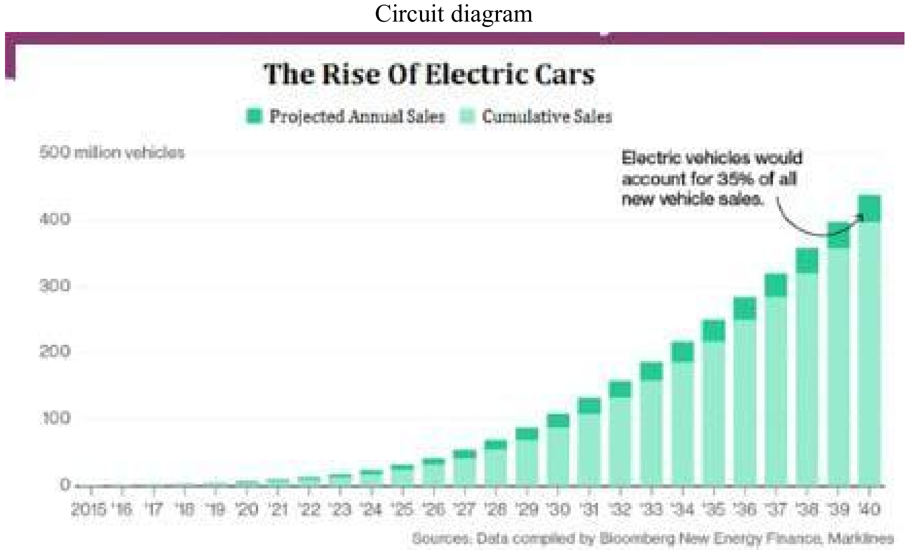


Circuit diagram



II. WORKING

The Solar Wireless Electric Vehicle Charging System works by converting solar energy into electrical energy and then transmitting this energy wirelessly to charge an electric vehicle's battery. The system integrates solar power generation, DC–DC voltage boosting, and wireless power transfer technologies to provide a clean, safe, and contactless charging method.The system allows an electric vehicle to be charged wirelessly using renewable solar energy, eliminating the need for physical connectors. It ensures clean energy usage, user convenience, and electrical safety, making it a sustainable and futuristic solution for EV charging.

III. RESULTS

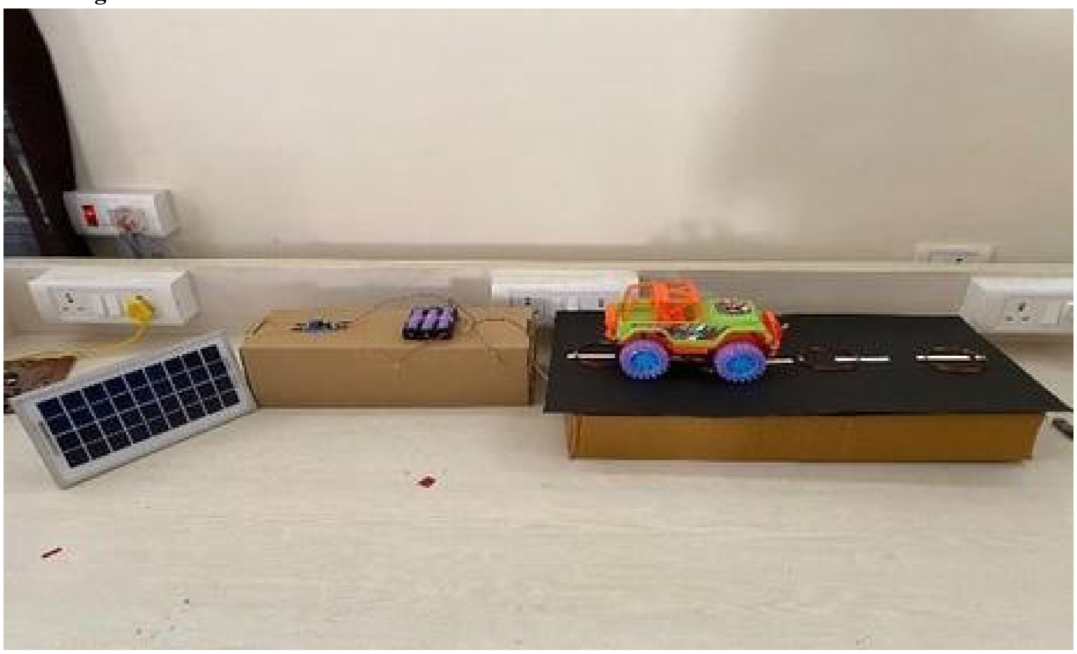
The Solar Wireless Electric Vehicle Charging System was successfully designed and implemented to demonstrate the wireless transfer of power using solar energy as the main source. The system efficiently converted sunlight into electrical energy through the solar panel, boosted the voltage using the XL6009 converter, and transmitted power wirelessly between the transmitter and receiver coils through electromagnetic induction.

The output from the receiver coil was rectified and regulated to provide a stable DC voltage suitable for charging a small battery or load. Experimental testing confirmed that:

The solar panel generated sufficient DC voltage under sunlight.

The boost converter effectively increased the voltage to the required level.
The wireless transmission occurred successfully at short distances (typically a few centimeters). The charging process was contactless, safe, and reliable.

Output working model



IV. CONCLUSION

The Solar Wireless Electric Vehicle Charging System provides an innovative and eco-friendly solution to modern transportation challenges. By integrating solar energy with wireless power transfer (WPT) technology, the system enables contactless charging of electric vehicles using clean and renewable energy. This eliminates the need for physical connectors, reduces human effort, and enhances both safety and convenience.
Through the use of components such as the solar panel, XL6009 boost converter, inverter circuit, and transmitter–receiver coil setup, the system successfully demonstrates the conversion of solar energy into electrical energy and its wireless transmission for battery charging.
This technology not only promotes sustainable energy utilization but also supports the development of smart transportation infrastructure. With further optimization—such as improved coil alignment, higher efficiency circuits, and energy storage integration—this system can be effectively implemented in public charging stations, highways, and residential areas.