Solar based wireless Electric Vehicle charging

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Abstract- **Solar wireless Electric (EV) Vehicle charging system is a system that utilizes solar energy to power EVs wirelessly. The components of this system are a wireless charging station, an inverter, a battery storage system, and solar panels. Energy from the Sun is converted by the solar panels into electricity, which is then stored in the battery. The wireless charging pad is powered by the AC energy that the inverter transforms from the DC energy that was previously saved. Without requiring a physical connection between the two, the wireless charging pad transfers energy from the pad to the EV using magnetic induction technology. Due to the lack of connections and cables, charging is now much easier and more practical for the user. An important benefit of this technology is the utilization of solar energy as a source of power for electric vehicles. It lessens reliance on fossil fuels and contributes to a reduction in greenhouse gas emissions. A lot of people can use this system because it can be deployed in many different places, including homes, companies, and public areas. The solar wireless EV charging system is an important step towards a sustainable future, to sum up. It provides an easy and effective approach to power EVs while also lessening its negative environmental effects. This method is an important advancement in the field of sustainable transportation since it has the power to completely change the way we charge our cars.**

Index Terms- **Electric Vehicle, Magnetic induction, Solar Energy, Wireless charging, Wireless power transfer**

I. INTRODUCTION

Solar energy is created by harnessing the heat and light of the sun. It is a plentiful, clean, renewable energy source that has the capacity to supply a sizable amount of the world's energy requirements. Solar panels can be used to capture some of the tremendous amount of energy that the sun radiates in the form of light and heat. Photovoltaic cells, the building blocks of solar panels, transform solar energy into electrical energy. Homes, companies, and other structures, as well as automobiles and other gadgets, may all be powered by this electrical energy. In a technique known as concentrated solar power, solar energy may also be utilized to heat water, create steam, and then use that steam to make electricity. The fact that solar energy is clean and renewable is one of its key benefits. Solar energy creates no emissions and has no adverse effects on the environment, in contrast to fossil fuels, which release greenhouse gases and causes climate change. An important source of energy for both established and developing nations, solar energy is also widely accessible and may be used in many different regions of the world. The usage of solar energy is projected to increase in the years to come given the growing need for sustainable energy sources and the quick advancement in this area.

A power source can transmit electrical energy to a device without the use of physical connections or wires thanks to a technique known as Wireless Power Transfer (WPT). This technique enables energy to be transmitted through the air using magnetic fields and is based on the theories of electromagnetic induction and resonant coupling. WPT has several uses, including as powering wearable technologies, electric car charging, and mobile device charging (EVs). WPT can be done using different methods like magnetic resonance, magnetic induction, and Radio Frequency (RF). Depending on the particular needs of the application, each kind of WPT system offers unique benefits and drawbacks. Convenience is one of the main advantages of WPT. Devices must be physically linked to a power source through a cable or wire in order to charge using conventional techniques. Devices may be charged using WPT without the use of wires or cords by just positioning them close to the power source. This can be particularly helpful in settings where it is challenging to connect devices to a power source, such as in rural areas or congested areas. The elimination of electrical risks associated with conventional charging techniques is another benefit of WPT. The risk of electrical shock and other dangers is decreased with WPT since there is no direct physical contact between the device and the power source. wireless power transmission is a promising technology that has a number of advantages, such as comfort, adaptability, and security. It is anticipated that WPT will take on a greater significance in the future of energy and power management as the need for wireless charging solutions increases.

In a WPT related to an EV system, a charging pad is placed on the ground, and the electric vehicle is fitted with a receiver that can transform the energy transferred into useable electrical power. When the user parks the car over the charging pad, electricity is wirelessly sent to the battery of the car. Convenience is one of the key advantages of charging EVs using WPT. Using cables to physically connect EVs to a charging station is required for traditional charging, which can be time-consuming and cumbersome. With WPT, charging a car is significantly easier because it only requires parking it over the charging pad. A solar wireless electric vehicle (EV) charging system uses wireless power transfer (WPT) and solar energy to charge EVs. The sun's heat and light are harnessed by this system's solar panels to create power, which is then wirelessly sent to the electric vehicle's battery via magnetic fields. An EV is fitted with a receiver that transform the transmitted energy into usable electrical power for the car, where the solar panels are situated at a charging station or other site. The energy is wirelessly delivered from the solar panels to the vehicle's battery when the owner parks the car close to the charging station. A solar wireless EV charging system employs pure, renewable energy from the sun, decreasing the carbon impact of the charging process. This is in contrast to conventional charging systems, which depend on the electrical grid and frequently on fossil fuels. This technique also has the benefit of making charging easier and more flexible by doing away with the requirement for cords and wires. With a solar wireless EV charging system, there is no need for cords or wires because the car may be charged just by parking close to the charging station. A solar wireless EV charging system, in conclusion, is a technology that has a number of advantages, such as practicality, adaptability, and sustainability. Solar wireless EV charging systems are projected to become more significant in the future of electric car charging as the need for clean and renewable energy sources rises.

II. SOLAR WIRELESS EV CHARGING SYSTEM

The Solar Wireless EV Charging System can be classified into mainly into 3 sections: A) PV system and storage, B) Converters, C) Transmitter and Receiver

A. PV system and storage

One of the most important parts of a solar EV charging system is the solar panel portion. The primary function of solar panels is to transform solar energy into electrical energy, which may subsequently be utilized to recharge an EV's battery. A solar EV charging system's solar panels are typically comprised of photovoltaic (PV) cells, which are the fundamental components of solar panels. These solar-powered cells utilize the photovoltaic effect to convert solar energy into electrical energy and are constructed of semiconductor materials like silicon. The size and quantity of solar panels in a solar EV charging system will vary depending on the system's individual needs. The quantity of sunshine that is available at the installation site, the size of the EV battery that needs to be charged, and the preferred charging speed are all variables that might impact the size of the solar panel section. A solar EV charging system's solar panel portion could also comprise more parts in addition to the solar panels, such inverters, charge controllers, and power optimizers. These parts are used to regulate the energy flow from the solar panels to the batteries and to guarantee that the energy is utilized effectively. The input to a solar panel is the irradiance falling on it and an optimum operating temperature and the output to the Solar Panel Section is DC Voltage.

1) Maximum Power Point Tracking (MPPT): MPPT is a technique used to optimize the power output of PV panels by tracking the point at which the PV panel produces the maximum power. This technique can also be applied in solar wireless EV charging systems to maximize the efficiency and charging rate. The MPPT algorithm works by monitoring the output of the solar panels and adjusting the voltage and current to ensure that the maximum power is being delivered to the battery. In addition to MPPT, other techniques can also be used to improve the efficiency of wireless EV charging systems. For example, using high-efficiency power electronics, such as GaN (Gallium Nitride) transistors, can reduce power loss and improve the overall efficiency of the charging system.

2) Perturbation and Observe (P&O) Algorithm: The P&O algorithm is one of the most commonly used MPPT algorithms in solar power systems. It is a simple algorithm that works by perturbing the operating point of the PV panel and observing the change in power output, and then adjusting the operating point in the direction of the power increase until the maximum power point (MPP) is reached.

The algorithm starts by setting the initial operating point of the PV panel to a value close to the open-circuit voltage (Voc) of the panel. The algorithm then measures the power output of the panel at this operating point. The operating point is perturbed by a small amount in one direction, either by increasing or decreasing the voltage, and the power output is measured again. If the power output increases, the algorithm continues to perturb the operating point in the same direction until the power output starts to decrease. At this point, the algorithm changes direction and perturbs the operating point in the opposite direction. The algorithm continues to perturb the operating point back and forth until it reaches the MPP, where the power output is maximized. Once the MPP is reached, the algorithm operates the PV panel at the optimal voltage and current to extract the maximum power.

B. Converters

A converter is a device for converting electrical energy. Converter can convert AC into DC and vice versa; change the voltage or frequency of the current or combination of these. Here we mainly use three types of converters.

1) Boost Converter: A boost converter is an electronic circuit that is used to increase the voltage of an AC or DC input. The boost converter works by converting a low voltage input into a higher voltage output, and it is commonly used in a variety of applications, including power supplies, battery chargers, and voltage regulators. The boost converter operates by storing energy in an inductor during the charging cycle and then releasing the stored energy in the output stage. The output voltage is controlled by adjusting the duty cycle of the switch, which determines the amount of energy stored in the inductor during each charging cycle. The boost converter is a type of switched mode power supply (SMPS) that is commonly used in applications that require high voltage and/or high current. It is particularly useful in applications where the input voltage is low, and the output voltage must be high, such as in battery powered devices or renewable energy systems.

2) DC-AC Converter: A DC-AC inverter is an electronic device that converts DC electricity into AC electricity. Direct current is the type of electricity that is produced by batteries and solar panels, while alternating current is the type of electricity that is used in most homes and buildings for powering electrical devices. The DC-AC inverter works by taking the direct current input and converting it into a square wave or a modified sine wave form, which is then transformed into a sinusoidal waveform. This process is known as inversion, and it allows the direct current to be used to power AC devices, such as lights, appliances, and motors. DCAC inverters are commonly used in a variety of applications, including renewable energy systems, backup power systems, and portable power supplies. They are also used in vehicles, such as boats, RVs, and electric vehicles, to provide AC power from a DC source, such as a battery

3) Full Bridge Rectifier: A full-bridge rectifier is a type of rectifier circuit that is commonly used in the receiver section of a wireless EV charging system. The rectifier is responsible for converting the AC signal induced in the receiver coil into a DC signal that can be used to recharge the EV's battery. A full-bridge rectifier is made up of four diodes connected in a bridge configuration. The diodes are used to rectify the AC signal into a DC signal by only allowing current to flow in one direction. The full-bridge configuration provides full wave rectification, meaning that the rectifier can convert both positive and negative portions of the AC waveform into DC, resulting in a smoother DC output compared to a half-wave rectifier. One of the advantages of using a full-bridge rectifier in the receiver section of a wireless EV charging system is its ability to handle large amounts of current. This is important because the receiver coil must receive a large amount of energy in a short period of time to recharge the EV's battery efficiently. Another advantage of the full-bridge rectifier is its ability to produce a DC signal with a low output ripple voltage. This helps to improve the efficiency of the WPT system and reduce interference with other electronic devices.

C. Transmitter and Receiver

DC Voltage obtained from the solar panel section is now sent to the transmitter side for transmission. A solar wireless EV charging system's transmitter component is in charge of transferring the electrical energy produced by the solar panels to the EV's battery. In this part of the system, magnetic fields are used to transmit energy across the air utilizing WPT technology. A transmitter coil and a power amplifier are the two primary elements of the transmitter portion of a solar wireless EV charging system. The power amplifier boosts the power of the transmitted energy to make sure that enough energy is received by the EV's battery. The transmitter coil creates the magnetic field that conveys the energy. The transmitter portion of the system must be built to cooperate with the reception portion of the EV in order to transmit energy wirelessly. To guarantee that the energy is received by the EV battery with the highest level of efficiency, this calls for careful control of the magnetic field and the frequency of the energy transmission. A solar wireless EV charging system's transmitter part must be built to function reliably and safely even under adverse climatic circumstances including extreme heat, humidity, and exposure to the elements. This DC Output Voltage is of low amplitude and it is amplified using a Boost Converter (DC-DC Power Converter). This amplified

DC Voltage is then made into AC Voltage by using inverters.

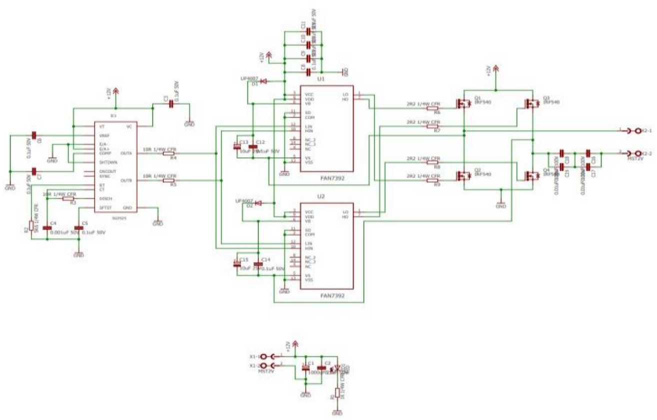
The AC Voltage Received at the Transmitter Coil is transmitted to the Receiver Coil. The receiver section of a solar wireless EV charging system is responsible for receiving the energy transmitted wirelessly by the transmitter section and converting it into electrical energy to recharge the EV's battery. The receiver section consists of several key components, including the receiver coil, rectifier, filter, and voltage regulator. The receiver coil is a critical component in the receiver section, and it is responsible for receiving the magnetic energy transmitted by the transmitter coil. The magnetic energy induces a current in the receiver coil, which is then rectified and filtered to produce a DC signal that can be used to recharge the EV's battery. The rectifier is responsible for converting the AC signal induced in the receiver coil into a DC signal. This is an important step in the charging process because the EV's battery can only be recharged using a direct current signal. The filter is responsible for smoothing out the DC signal and reducing the amount of electrical noise and harmonics. This helps to improve the efficiency of the WPT system and reduce interference with other electronic devices. The voltage regulator is responsible for regulating the voltage of the DC signal to ensure that it is within the proper range for recharging the EV's battery. The voltage regulator helps to protect the EV's battery from overcharging or undercharging, and it also helps to ensure a stable and consistent charging process.

III. DESIGN

IC FAN7392 is used to drive the MOSFET. IC SG3525 is a pulse width modulator control controlling all types of switching power supplies. It is used as a DC to DC (buck- boost) converter. IRF 540 N-channel enhancement mode field-effect power transistor is used in the DC to AC converter section. Fig. 1 and 2 shows the circuit diagram of the Transmitter and the Receiver made using the Easy EDA software.

Inductance of a copper wire: d (coil diameter in inches) =0.040 inches, l (coil length in inches) =200 cm = 79.11 inches, n (number of turns) =8.

Fig. 1. Circuit diagram of Transmitter



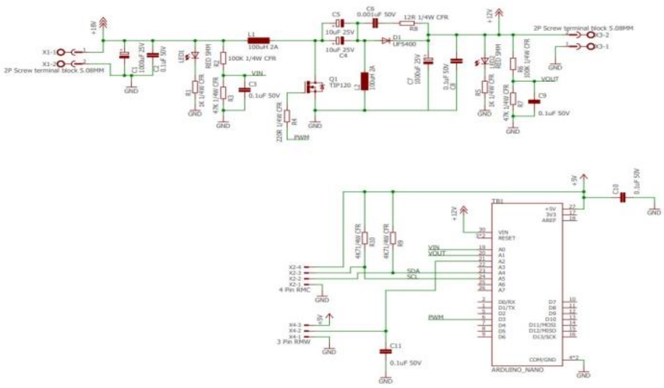


Fig. 2. Circuit diagram of Receiver.

$$Inductance, L = \frac{d^2 * n^2}{18d + 40l} = \frac{1.040^2 * 8^2}{18 * 0.040 + 40 * 79.11}$$
$$= 3.23526 * 10^{-5} H$$

Fig. 3. MATLAB/SIMULINK model of Solar wireless EV Charging system

IV. SIMULATION AND RESULTS

All the Simulations are done using MATLAB/SIMULINK software. Fig. 3. shows the MATLAB/SIMULINK model of Solar wireless EV Charging system.

The outputs obtained from various MATLAB/SIMULINK models discussed above are also depicted here. Fig. 4. shows the PV output to chopper. Fig. 5. shows the output from transmitter and the voltage input at the Receiver. Fig. 6. shows the Transmitter and Receiver side Battery Characteristics.

V. CONCLUSION

The system can autonomously determine the position of the receiver, which allows the charging pad to utilize only the coil with the highest transfer efficiency for charging the EV. Charging is more reliable since the car position is detected instantly and re calibration of the charger is not required if the car slips out of position. In the future, WPT can be used in dynamic EV charging system. The design of the solar wireless

EV charging system was complete. Conversion of solar energy into electricity is done using solar panel. This electricity is of the nature of DC. This DC voltage is converted into AC of required frequency by using an inverter. This AC voltage is then sent to the transmitter coil. By the principle of inductive coupling, this AC voltage from the transmitter Coil is sent to the receiver side. From the receiver side, this AC voltage is converted into DC by using a rectifier circuit. This DC voltage is stepped down to required amplitude by using a stepdown chopper circuit. This stepped down DC voltage is then sent to the battery of the EV for charging it. In the first phase of the project, all the design and simulation was completed for the above mentioned objectives.

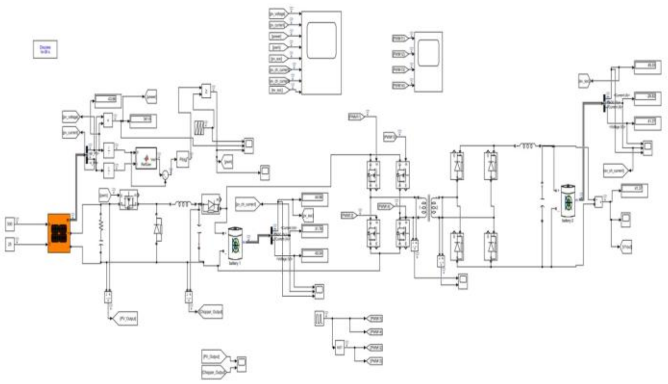


Fig. 3. MATLAB/SIMULINK model of Solar wireless EV Charging system

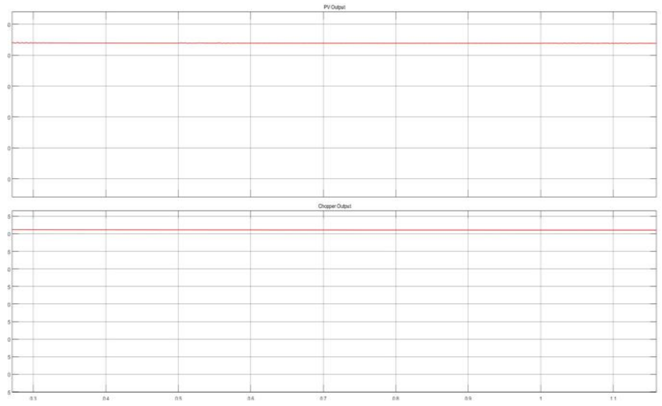


Fig. 4. PV output to chopper.

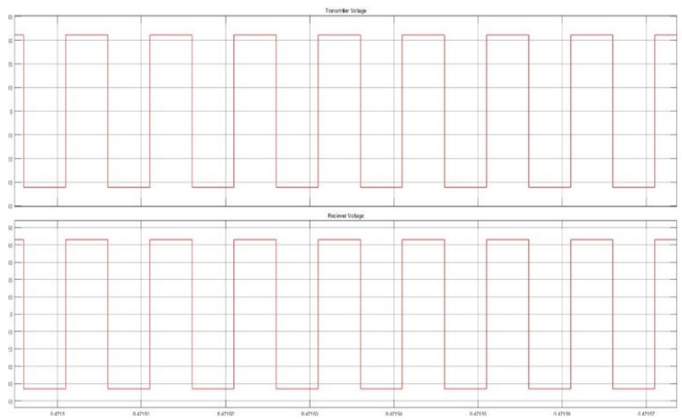


Fig. 5. Output from Transmitter and input at Receiver

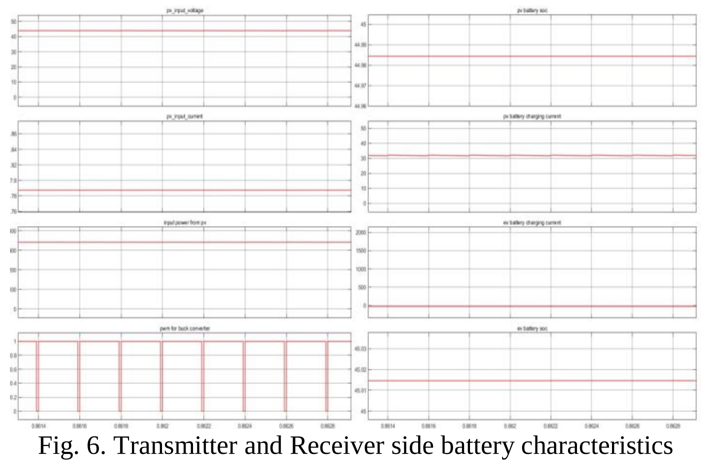


Fig. 6. Transmitter and Receiver side battery characteristics

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