IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 8, Issue 4, April 2020

On Road Automatic E-Vehicle Wireless Charging System Using Solar Energy

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Abstract: Inductive based wireless charging is the effective wireless charging technique in which current is transferred using electromagnetic induction principle. The wireless charging for E-vehicles in the dynamic state using induction coils, overcomes the problems with the quotidian conventional technologies. In the wireless power transfer method, the solar power from the Photo -Voltaic (PV) cell is transferred to the battery used in the electric vehicle. The solar PV panels generate electric energy by using the light emitted by the sun. The energy obtained is fed to a battery, via a solar charge controller which maximizes the power output from the PV cell. The transmitter circuit converts the DC supply obtained from the source side into a high-frequency AC output by the use of the inverter circuit, which is then transmitted with the help of transmitting coil, to the receiver coil in the load side in the form of electromagnetic (EM) waves. Then receiving coil in the receiver circuit placed inside the electric vehicle and bridge rectifier converts the received AC to DC supply output for charging the electric vehicle. Wireless Power Transfer used in E-vehicles can reduce charging time, range and cost during wireless charging of E-vehicles.

Keywords: Electromagnetic Waves, Solar panel, Wireless charging, E-Vehicle.

I. INTRODUCTION

Charging methods are of two types. They are, wired charging method and wireless charging method. In wired charging, there are several problems related to power loss during transmission. Hence, a dynamic mode wireless charging of electric vehicles is used in this project. The solar panels are used to get the power source for charging of E-Vehicles. Polycrystalline solar panels are used because it is cost-effective and the silicon waste is less when compared with mono crystalline solar panels. Solar panel plays an important role in offering a wider range of eco-solutions. This innovative concept is also an effective and creative method that will provide sustainable, safe, non-polluting and low cost. Since India is in the tropical region, this idea could be used to supply electric power across the country easily.
The power generated using the solar panel is transmitted through wireless power transfer coils (induction coils) to the electric vehicle in a dynamic state. Induction coils are embedded inside the road. By using this type of charging, time can be saved when compared with wired charging. Charging of E-vehicles through induction coil results in higher reliability, higher efficiency, and complete automation technique. Since the charging field is less, it allows only the E-vehicles to get charged and avoids charging of any other gadgets inside the E-vehicle. The supply is transferred through an air gap from one magnetic coil placed inside the road to another magnetic coil fixed at bottom of the car.

II.PROPOSED SYSTEM

Solar panels are used to generate electricity. 5 to 7 solar panel modules are used and each panel generates 6V 300mA. The power obtained from polycrystalline solar panels is stored in the battery. When the battery is fully charged, the auto cut-off will automatically stop the power supply given to the battery and then it is given to the astable multivibrator circuit which generates the square pulse according to the obtained voltage. The output of the astable multivibrator is given to the Darlington pair transistor. It is used because of its high efficiency, high current gain and also high input impedance when compared to a single transistor where automatic switching takes place in which square pulse is converted into AC waveform using TIP127G PNP transistor and TIP122G NPN transistor because induction coil works only in AC supply.

Wireless induction coil charging works on the principle of electromagnetic induction to achieve high efficient dynamic wireless charging. The power generated through the solar panels is stored and it is given to the transmitting part of the induction coil which uses electromagnetic induction principle magnetizes the receiving coil and it is given to the alternative current in receiving part flows through it to achieve high efficient wireless charging. The transmitting coil is mounted in the road surface and the receiving coil is placed in the E-vehicle's bottom. When compared to the resonant coil, the induction coil has higher efficiency and sustainable for dynamic wireless charging. Hardware of proposed system is shown in figure 1.

The proposed system consists of 2 lanes i.e., Solar lane and charging lane. When the E-vehicles need to get the charge, it travels through the separate lane allocated for charging. Due to the formation of the magnetic field between transmitting and receiving coils, the wireless charging takes place and power is transferred to the E-vehicle. The Transmitting coils are mounted at the distance of 12cm between each other to attain continuous effective charging dynamically through electromagnetic induction.

III.BLOCK DIAGRAM

The block diagram of solar-powered roads with wireless charging of E-vehicles is shown in figure 1. The block diagram consists of PV panels, battery charging circuit, inverter circuit, induction coil, bridge rectifier and E-vehicle.

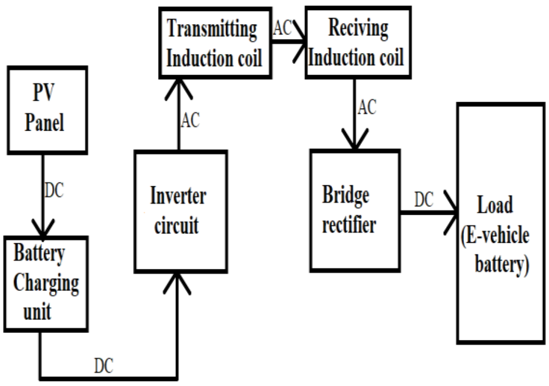

Fig.1 Block diagram of proposed system

A. WIRELESS POWER TRANSFER SYSTEM

The electrical energy is almost transferred through wires. It is better than conventional wired system. This technique involves low cost maintenance, zero recharging time, pollution free and unlimited range power can be consumed until the battery is full in E-vehicle. Induction coil is used for wireless charging of E-vehicles. The distance of charging varies according to the number of turns in the coil. It consists of flat coils with several windings. The difference between transmitting and receiving coil exists in the number of turns. As the transmitting coil have more number of windings than the receiving coil through which higher efficiency is obtained using induction coil wireless transfer in the dynamic state.

Coils are placed at transmitting and receiving end. The transmitting coil is placed in the road and the receiving coil is placed in the bottom of the E-vehicle. While the transmitting and receiving coils are brought into contact electromagnetic induction takes place and the power is transferred to the battery of E-vehicle. Induction coils work in AC and the E-vehicles battery works in DC. So, bridge rectifier is placed in the E-vehicle to convert Alternating Current into Direct Current. Electrically safe and secure charging is convenient in E-vehicles. The block diagram of wireless power transfer system is shown in figure 2.

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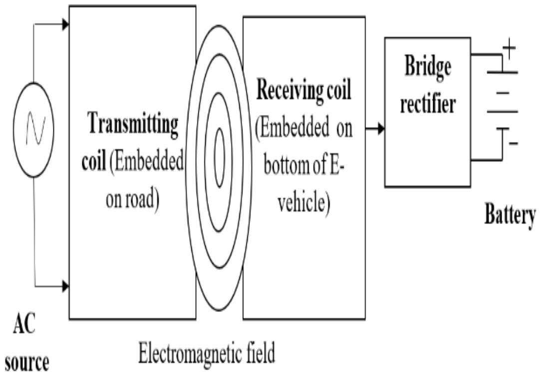

Fig.2 Block diagram of wireless power transfer system

B. SOLAR PV PANEL

Solar energy is the renewable source through which electricity is employed for providing power to the E-vehicles. Solar panel consists of 60 cells in it, each cell generates 0.46V of electricity totally it generates 12.3Volt. In a cell, 5 solar panel modules are used and each panel generates 6Volt 300milliAmpere. The size of solar panel used is 8*5cm. The power obtained from polycrystalline solar panels is stored in the battery. The process used to make polycrystalline silicon panel is simple and cost effective. Solar panel produces power continuously which is employed for charging E-vehicles throughout the day when sun rays fall into the PV panel. Module of PV panel is shown in figure 3.

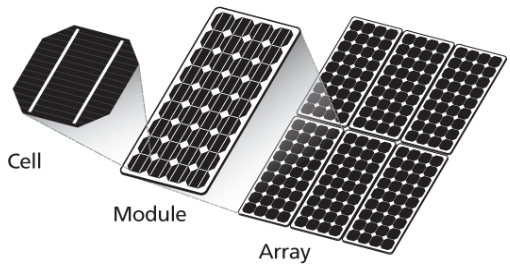

Fig.3 PV panel module (8*5cm) 12.3V

C. STORAGE UNIT

In transmitting side, 12V lead-acid battery of 4.5Ah capacity is used for storing generated power supply from the solar panel. Li-ion battery of 12V and 1.5Ah capacity is used in E-vehicle. When battery is fully charged, auto cut off will automatically cut the supply from the solar panel and when battery is getting discharged, auto cut off will turn off and battery gets charged automatically. Thus, it involves for charging and discharging of E-vehicles. Auto cut off is achieved with the TIP127 PNP Darlington pair transistor. When the base is forward biased, the current keeps on flowing to the battery but when the battery is full, the base of TIP127 PNP transistor gets reverse biased. So, auto cut off takes place to avoid over loading of battery and damages occurs in battery.

In the sides of the road Lead acid battery is used because it has more stability to withstand the heat, more resistant to corrosion, reliable, delivers high current, low input impedance and tolerance to overcharging. The lithium ion battery is used in the E-vehicle because it has low maintenance and it is light in weight which reduces the weight of the E-vehicle. So, the motor size also can be reduced with increase in speed. Hence, the overall cost for manufacturing the E-vehicle is reduced.

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D. INVERTER CIRCUIT

The power generated from the solar panel is in the DC supply. But the inductive wireless charging works in the AC supply only. Therefore, Inverter circuit is used to transform the DC supply in the battery charging unit into AC supply in the induction coils. Inverter circuit consists of three elements namely Darlington pair transistors TIP127G PNP and TIP 122G NPN, DC power source from solar panel, Square pulse waveform from Astable multivibrator. When the DC power source is given to the Darlington pair transistors TIP127G and TIP122G, the square pulse waveform produce triggering pulse and the transistors switch between ON and OFF continuously. Thus, the DC waveform changes into AC waveform required for wireless power transfer.

E. BRIDGE RECTIFIER

Bridge rectifier is placed in E-vehicle and it is used to convert AC supply into DC supply, which flows in one direction. Bridge rectifier is used because it gives twice the output compared to other rectifiers. It can also produce DC with less ripples comparatively. This rectified DC voltage is stored in the Li-ion battery placed in E-vehicles.

F.DC GEARED MOTOR

D.C. motors are used to operate in the steady state in a speed range close to their no-load speed. This type of speed is generally too high for most of the applications. In order to reduce this speed, complete range of geared motors are used, each with a series of gear ratios. Together they can be used to implement a wide variety of functions. Its principal characteristic defines its ability to withstand a maximum torque in the steady state.

IV. FLOW CHART

The flow chart of the wireless charging of E-vehicles using solar energy is shown in figure 4.

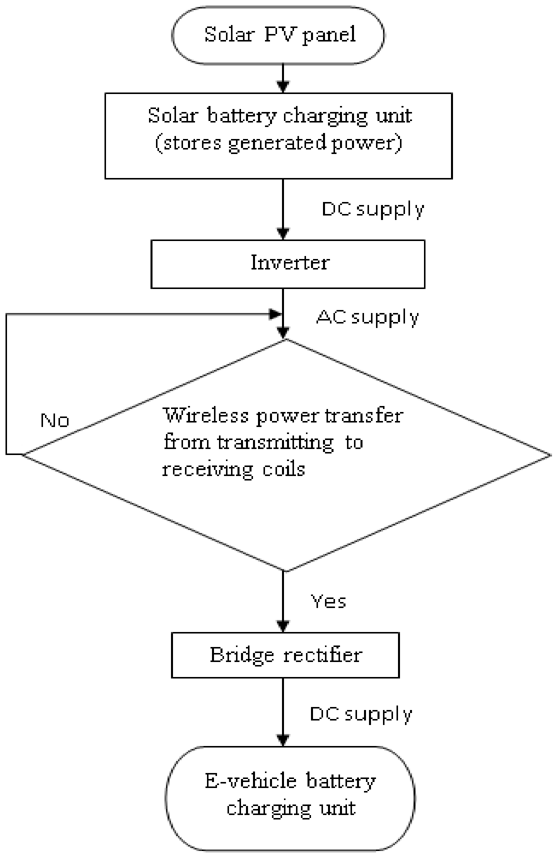

Fig.4 Flowchart

 DOI 10.17148/IJIREEICE.2020.8413

IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 8, Issue 4, April 2020

V. HARDWARE

The DC power supply generated from the solar panel is given to the lead-acid battery through auto cut-off which helps in protecting the battery from overloading. Since the induction coil works only in AC supply, the DC supply from battery is inverted into AC using astable multivibrator and Darlington pair transistors (PNP & NPN). The AC supply from the inverter circuit is given to the transmitting coil.Hardware module of wireless charging of e-vehicles using solar energy is shown in figure 5.

When E-vehicle enters into the charging lane, the AC supply from the transmitting coil which is mounted on the lane is transferred to the receiver coil placed at the bottom of the E-vehicle by electromagnetic induction principle. The battery in the E-vehicle works in DC supply so, the transmitted AC supply is rectified using a bridge rectifier. The rectified DC supply is given to the E-vehicle's battery which is made up of Li-ion and the E-vehicle starts charging dynamically.

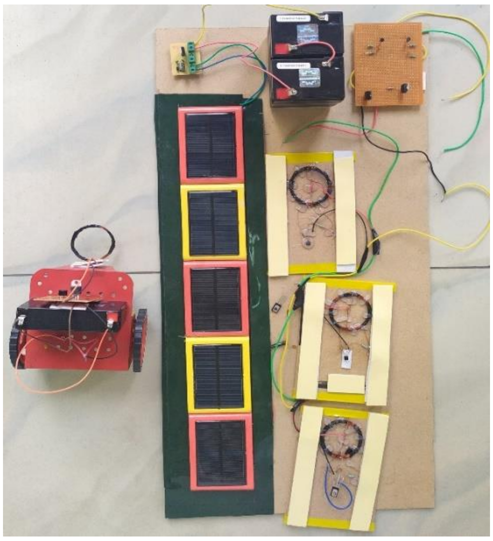

Fig.5 Hardware module of wireless charging of E-vehicles using solar energy

VI. SOFTWARE

The NI MULTISIM software is used which consists of integrated import and export features. Wide range of components available. It is a real world troubleshooting software. Software consists of solar panel circuit, battery charging circuit, astable multivibrator circuit, wireless power transfer through induction coil. The solar PV panel ranges from 0 to 12 V.In the solar panel circuit the PV value is adjusted to control the current.An 8 ohm resistor is placed in parallel inorder to control the voltage to our specified values. The diode IN4007 is connected in series with PV cell to stop reverse voltages.Solar panel circuit is shown in figure 6.

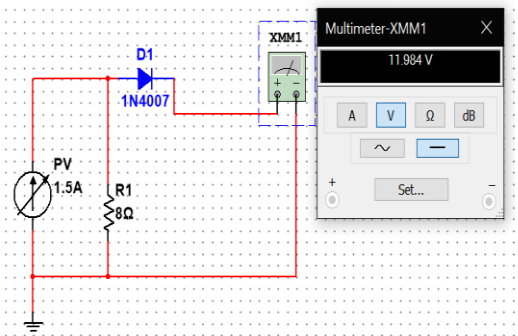

Fig.6 Solar panel circuit

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The battery charging circuit is used to store energy into lead-acid battery of capacity 12V and 4.5Ah.It consists of PNP transistor where the base of the transistor is connected to battery. The PNP transistor is in reverse biased state which allows the battery to charge. If the battery gets fully charged, the transistor gets forward biased and the circuit gets cut-off automatically.Battery charging circuit is shown in figure 7.

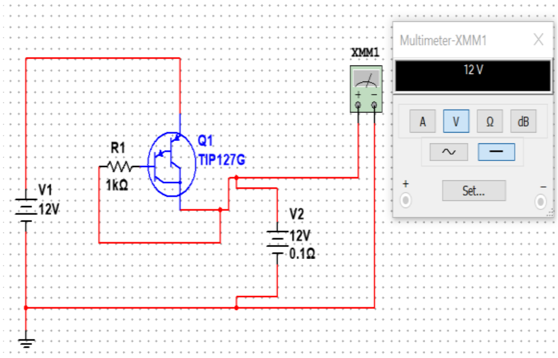

Fig.7 Battery charging circuit

Astable multivibrator is used to generate square wave pulses.In Astable multivibrator the circuit is not stable in both the state. So, it continuously switches from one state to other state. But in monostable multivibrator one of the states is stable, but the other state is unstable. So, Astable multivibrator is used. The Astable multivibrator circuit oscillates between a “HIGH” state and a “LOW” state producing a continuous output.Astable multivibrator circuit is shown in figure 8 and astable multivibrator output is shown in figure 9.

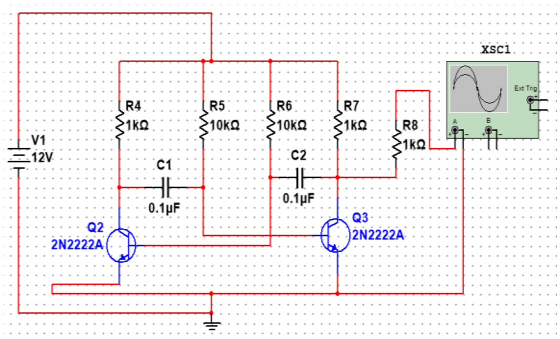

Fig.8 Astable multivibrator circuit

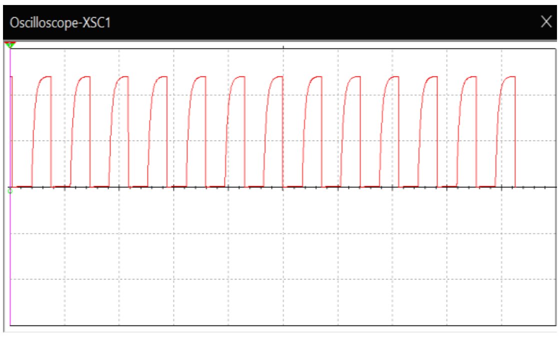

Fig.9 Astable multivibrator output

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The wireless power transfer is done using the induction coils by its transmitting wavelength.It includes a transmitter coil and a receiver coil. The transmitter coil is powered by AC current to create a electromagnetic field, which in turn induces a voltage in the receiver coil. The output of the receiver coil is rectified from AC to DC current using the bridge rectifier.Wireless power transfer through induction coils is shown in figure 10.

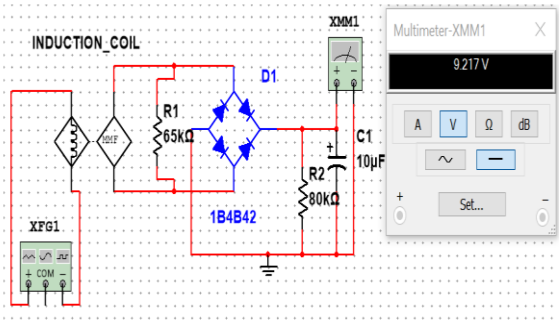

Fig.10 Wireless power transfer through induction coils output

VI. RESULT AND DISCUSSION

Here, the graph is plotted between frequency and voltage of transmitting and receiving coils with the wireless dynamic power transfer of induction coil. Transmitting coil output voltage waveform is shown in figure 11 and the receiving coil output voltage waveform is shown in figure 12.

Battery	Transmitting coil	Receiving coil
12.83V	+12.83V to -12.83V	+10V to -10V
9.83V	+9.83V to -9.83V	+7.6V to -7.6V

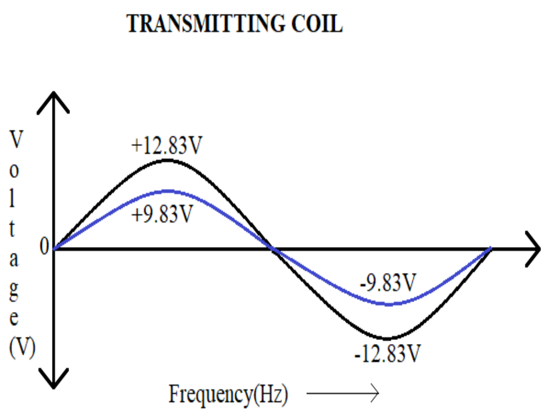

Fig.11 Transmitting coil output voltage waveform

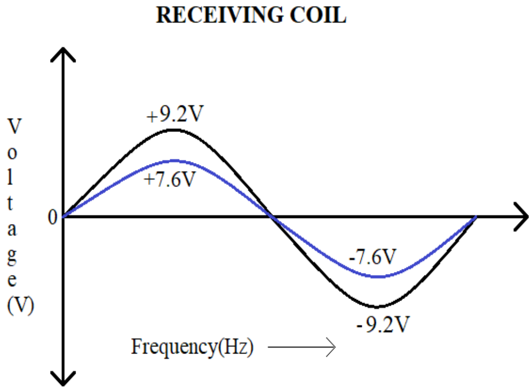

Fig.12 Receiving coil output voltage waveform

VII. CONCLUSION

Solar-powered panels with wireless charging of E-vehicles are integrated with solar panels and induction coils. The system provides monitoring of power generated and user-friendly wireless charging technique. The proposed system provides power supply from conventional sources (solar power) is used for dynamic wireless charging.

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