Electric Vehicle Charging in-Motion using Wireless Power Transfer

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Abstract

In this paper, power transfer system to charge electric vehicles in motion using wireless power transfer is presented. The design consists of a circular receiver coil mounted on a vehicle and a larger circular transmitter coil fixed to the ground. Wireless power transfer is a convenient, safe, and in electric vehicle charging it has seen rapid growth in recent years.

Keywords - *WPT, RIC*

I. INTRODUCTION

WPT technology has numerous inherent advantages over conventional means of power transfer, thus has received much attention in the past decade and has been proposed to apply to a wide range of applications, ranging from low power biomedical implants electrical vehicle charger to railway vehicles with efficiency up to 95% or higher in some prototype systems. Magnetic WPT systems rely on magnetic field coupling to transfer electric power between two or more magnetically coupled coils across relatively large air gap. In this paper, a wireless charging system for lightweight electric vehicle is designed, built and tested.

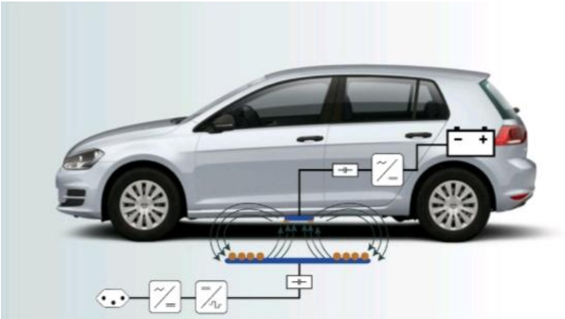

Fig. 1. Energy flow.

A. Wireless power transfer

. Wireless power transfer (WPT), wireless energy transmission, or electromagnetic power transfer is the transmission of electrical energy from a power source to an electrical load, such as an electrical power grid or a consuming device, without the use of discrete human-made conductors. Wireless power is a generic term that refers to a number of different power transmission technologies that use time-varying electric, magnetic, or electromagnetic fields. In wireless power transfer, a wireless transmitter connected to a power source conveys the field energy across an intervening space to one or more receivers, where it is converted back to an electrical current and then used.

Wireless transmission is useful to power electrical devices in cases where interconnecting wires are inconvenient, hazardous, or are not possible. Wireless power techniques mainly fall into two categories, non-radiative and radiative. In near field or non-radiative techniques, power is transferred by magnetic fields using inductive coupling between coils of wire, or by electric fields using capacitive coupling between metal electrodes. Inductive coupling is the most widely used wireless technology; its applications include electric toothbrush chargers, RFID tags, smartcards, and chargers for implantable medical devices like artificial cardiac pacemakers, and inductive powering or charging of electric vehicles like trains or buses. A current focus is to develop wireless systems to charge mobile and handheld computing devices such as cellphones, digital music players and portable computers without being tethered to a wall plug. In far-field or radiative techniques, also called power beaming, power is transferred by beams of electromagnetic radiation, like microwaves or laser beams. These techniques can transport energy longer distances but must be aimed at the receiver.

B. Inductive coupling

In inductive coupling (electromagnetic induction or inductive power transfer, IPT), power is transferred between coils of wire by a magnetic field. The transmitter and receiver coils together form a transformer. An alternating current (AC) through the transmitter coil (L1) creates an oscillating magnetic field (B) by Ampere's law. The magnetic field passes through the receiving coil (L2), where it induces an alternating EMF (voltage) by Faraday's law of induction, which creates an AC current in the receiver. The induced alternating current may either drive the load directly, or be rectified to direct current (DC) by a rectifier in the receiver, which drives the load. A few systems, such as electric toothbrush charging stands, work at 50/60 Hz so AC mains current is applied directly to the transmitter coil, but in most systems an electronic oscillator generates a higher frequency AC current which drives the coil, because transmission efficiency improves with frequency.

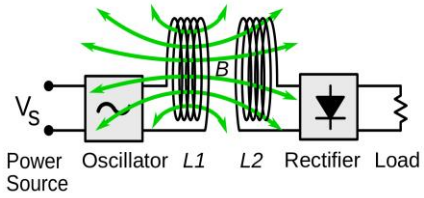

Fig 1.1 Inductive wireless power system

C. Resonant inductive coupling

Resonant inductive coupling (electro dynamic coupling strongly coupled magnetic resonance) is a form of inductive coupling in which power is transferred by magnetic fields (B, green) between two resonant circuits (tuned circuits), one in the transmitter and one in the receiver (see diagram, right). Each resonant circuit consists of a coil of wire connected to a capacitor, or a self-resonant coil or other resonator with internal capacitance. The two are tuned to resonate at the same resonant frequency. The resonance between the coils can greatly increase coupling and power transfer, analogously to the way a vibrating tuning fork can induce sympathetic vibration in a distant fork tuned to the same pitch.

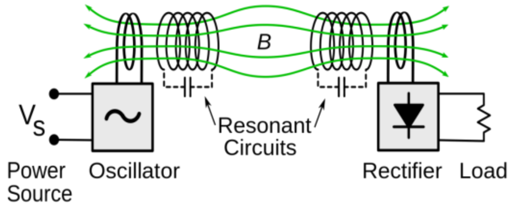

Fig 1.2 Resonant inductive wireless power system

D. Capacitive coupling

In capacitive coupling (electrostatic induction), the conjugate of inductive coupling, energy is transmitted by electric fields between electrodes such as metal plates. The transmitter and receiver electrodes form a capacitor, with the intervening space as the dielectric .An alternating voltage generated by the transmitter is applied to the transmitting plate, and the oscillating electric field induces an alternating potential on the receiver plate by electrostatic induction, which causes an alternating current to flow in the load circuit. The amount of power transferred increases with the frequency the square of the voltage, and the capacitance between the plates, which is proportional to the area of the smaller plate and (for short distances) inversely proportional to the separation.

II. RELATED WORK

Solar based mobile were designed. As advance wireless charger particularly for small load system was implemented recently. Furthermore, a prototype of the whole system, consisting of a commercial panel, the thermal and electrical circuits and an innovative wireless remote data acquisition system has been setup. The latter, based on an open-source electronic platform, has the necessary accuracy, and remote data capture and flexibility features. The model has been carefully calibrated and the simulated results, based on the solar irradiance, the ambient temperature and the wind speed, have been compared with experimental data. The results are analyzed and discussed in the paper. Such a validated model can be used to establish if and when it is more convenient to use a hybrid structure rather than two separate devices

A. Block diagram

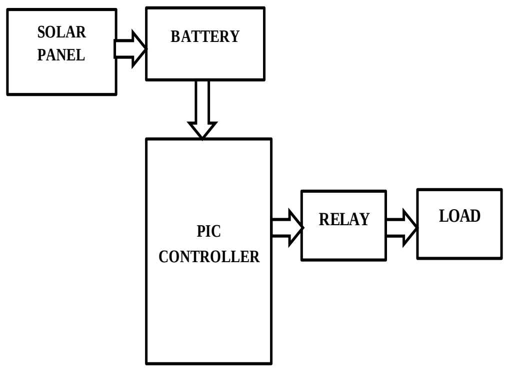

Fig 2.1: existing block diagram

B. Disadvantage

- High complexity switching process.
- High power losses

III. PROPOSED MODEL

In this proposed system, we implement ARDUINO microcontroller based wireless power charging methodology in electric vehicles. This system consists of ARDUINO microcontroller, inductive coils, vehicle prototype module. Solar panel system is implemented to transfer the power to the primary coil. Solar panel is connected to the battery directly. Then it can be driven into the rectifier circuit through an inverter. In inverter circuit is connected by ARDUINO microcontroller to switching the power supply. The switched power is fed into the inverter through driver circuit. The coil has high capacity of inductance which can able to transfer the power with high frequency. It is named as the high frequency coil. Those power input are connected to the high frequency primary coil which is laid under the road segment. The vehicle has receiving coil segment. The receiver section consisting of the receiver coil, rectifier and regulator. When the vehicle move along the primary coil, receiver coil in vehicle receives the power from the primary coil by the electromagnetic induction technique. That received power is driven to the regulator through rectifying circuit. Then the power is stored in the battery. The battery power is given to the controller and the motor driver circuit. Motor driver is used for control the motor of vehicle. The vehicle can charge automatically when it cross over the primary coil connected to the battery. By this, we can able reduce the pollution of air and demand in petroleum products.

A. Transmitter block

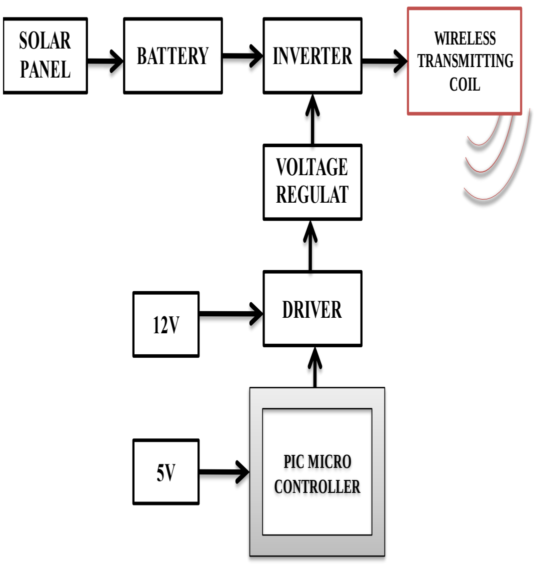

Fig 3.1: transmitter block diagram

B. Receiver block

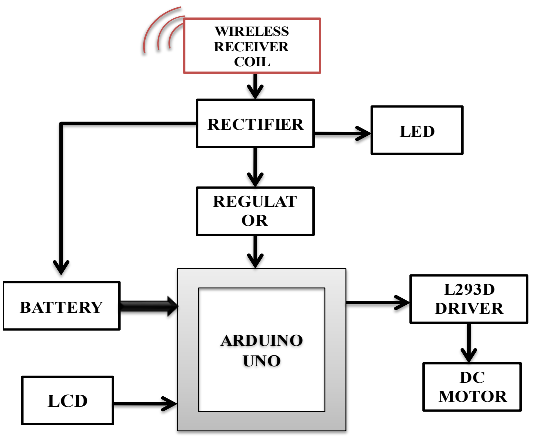

Fig 3.2: receiver block diagram

IV. CONCLUSION

A high efficiency wireless power transfer system for electric vehicle charging application is proposed. system configuration and design considerations were analysed and discussed in details. The popular renewable sources of energy, solar energy source is individually model and then combined together to represent a distributed generation system in the simulink model. A prototype was designed, built and tested with solar panel to verify the circuit performance of the developed WPT charging system.

V. FUTURE WORK

In future we plan to further explore wireless power transfer technology for large load application like electricity supply home and hospital.

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