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WIRELESS CHARGING OF BATTERY

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***Abstract*— In reaction to the depletion of natural resources, electric vehicles offer a viable alternative. Practical and dependable methods to charge EV batteries are crucial in order to boost the usage of EVs in daily life, and wireless power transfer (WPT) is being investigated as a solution to charge batteries. In this project, a wireless charger prototype system is built and implemented. The necessity for a cable and plug charger, galvanic separation of the onboard electronics, weight, and cost of this charger, and massive energy storage system (ESS) packs are all present in today's electric vehicles.**

This paper has designed and developed an antenna system suitable for vehicles using resonant magnetic coupled wireless power transfer technology to an electric vehicle charging system. The use of WPT in EVs provides a clean, convenient and safe operation. At the core of the WPT systems are two coils namely primary and secondary. For the safe and efficient transfer of energy the rated power, both sides have to be tuned by resonant capacitors. The selection of operating frequency is a key criterion for all applications as it affects the size and dimensions of the coils and the selection of the components for the power electronic circuit. Resonant wireless transmission systems for vehicle charging technology are being developed.

Keywords*— *Wireless power transmission(WPT)

1. INTRODUCTION

Recently, wireless power supply devices which supply electric power wirelessly (conducting medium is air) to different appliances without the use of wires (power cables) or the like have come to be in practical use.

Wireless power transfer (WPT) could be a breakthrough technology that gives energy to communication devices without the facility units. With the remarkable progress being made recently, this technology has been attracting plenty of attention from scientists and R&D firms around the world. Recently, the usage of mobile appliances like cell phones, PDAs, laptops, tablets, and other handheld gadgets, equipped with rechargeable batteries has been widely spreading. it's known that electromagnetic energy is related to the propagation of electromagnetic waves. Theoretically, we are able to use all electromagnetic waves for wireless power transmission (WPT).

Increased concern about the environmental impact of petroleum-based transportation infrastructure, along with the threat of peak oil, has sparked fresh interest in electric transportation infrastructure over the previous few decades. Electric vehicles (EVs) powered by batteries appear to be an excellent answer to the energy crisis and global warming because they consume no oil and emit no pollution. Furthermore, the era of cheap oil is swiftly coming to an end. As a result, the demand for alternatives is expanding, and price competition between alternatives and oil is becoming more realistic.

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Fig1: Wireless Charging of EV(s)

2. LITERATURE REVIEW

In 1864, James C. Maxwell predicted the existence of radio waves by means of a mathematical model. In 1884, John H. Poynting realized that the Poynting vector plays an important role in quantifying electromagnetic energy. In 1888, with the help of Maxwell`s theory, Heinrich Hertz showed experimental evidence of radio waves by his spark-gap radio transmitter. Radio prediction and detection at the end of the 19th century marked the beginning of wireless energy transmission.

During this period Marchese G. Marconi and Reginald Fessenden (pioneers of communication via radio waves), Nicola Tesla suggested an inspiration of wireless power transmission and dispensed the primary WPT experiment in the year 1899. He said “This energy is collected everywhere the world preferably in small amounts, starting from a fraction of 1 to some horse-powers. one amongst its chief uses is going to be the illumination of isolated homes”. He actually built a huge coil that was connected to a high mast of 200-ft with a 3 ft.-diameter ball at its top. He supplied 300 Kw power to the Tesla coil resonated at 150 kHz.

In the USA, there were many MPT research and development projects after **W. C. Brown**: few of them are, retro directive microwave transmitters, rectenna, new devices, and microwave circuit technologies. In Japan also, there were numerous field MPT experiments such as fuel-free airplane flight experiment with MPT phased array with 2.411 GHz in 1992, ground-to-ground MPT experiment with Power Company and universities in 1994-95

Semiconductor Amplifier: After the 1980s, semiconductor devices surpassed microwave tubes as the dominating technology in the microwave world. Advances in mobile phone networks were the driving force behind this. Because of its manageability and mass production, the semiconductor device is projected to enhance microwave applications such as phased array and active integrated antenna (AIA). Some MPT studies with phased arrays of semiconductor amplifiers were carried out in Japan after the 1990s.

New Rectenna Technology: The word "rectenna" consists of a "rectifier circuit" and an "antenna". Rectenna can receive microwave power and convert it to direct current. A rectenna is a passive device with a rectifying diode that operates without a power supply. Circuits, especially diodes, primarily determine RFDC conversion efficiency. Silicon Schottky diodes were commonly used in early rectenna. New components such as SiC and GaN should increase efficiency. Recently, rectenna with FETs or HEMTs have appeared. A single shunt full-wave rectifier is always used for the rectenna. It consists of diodes connected in parallel to the circuit, λ / 4 distributed lines, and capacitors connected in parallel. Ideally, 100% of the received microwave power should be converted to DC power.

Recent Technologies of Rectenna Array: The rectenna is going to be used as an array for prime power MPT because one rectenna element rectifies some W only. For the usually phased array antenna, mutual coupling and phase distribution are problems to resolve. For the rectenna array, the problem is different from that of the array antenna because the rectenna array is connected not in the microwave phase but in the DC phase

1. METHODOLOGY

The concept of roadway-powered electric vehicles has been offered as a solution to battery concerns. The electric car is charged on the road via wireless power charging, allowing the battery to be reduced and eliminating the requirement for charging time. Our project's main goal is to design and construct an antenna and wireless power transfer system for electric vehicles in motion (EVs). The wireless power transfer technique for electric vehicles is built using the resonant magnetic coupling theory. The electrical power will flow from the transmitter coil inside the platform to the receiving coil inside the bottom when the frequency of the vehicle's power receiver is tuned exactly to the resonance frequency of the transmitter unit below the road.

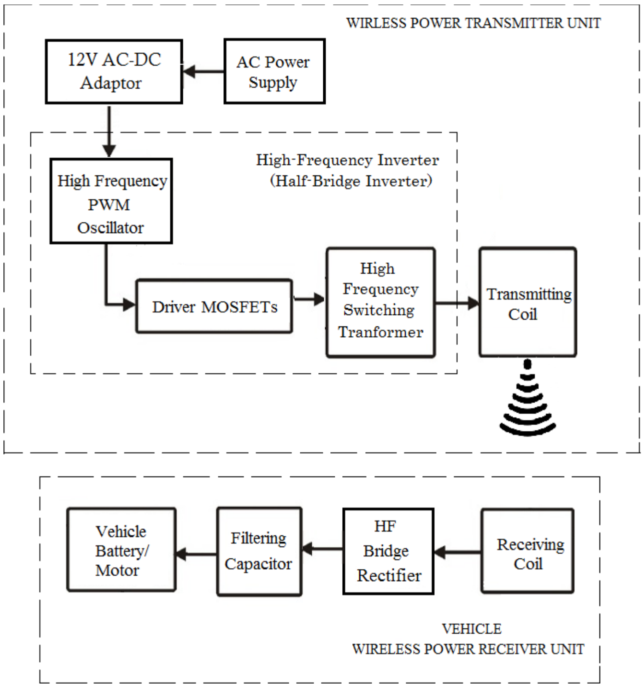

Fig.2: Block Diagram of the system

AC Power Supply

The supply for the wireless power transmitter is taken from an AC 220v source.

AC-DC Adapter (SMPS)

A Switching Mode power supply is used here to convert AC to DC. Here the input of the SMPS is 220v AC and the output will be 12v DC.

High-Frequency PWM Oscillator

The oscillator is designed using KA3525 IC. KA3525 IC circuit generates PWM switching pulses for the MOSFETs to drive. The oscillator produces a PWM frequency in 65 kHz range. Here two separate PWM pulses PWM1 and PWM2 are produced which are supplied to the two MOSFET gates. Each PWM pulses are 90 degrees out of phase, which results in alternative switching of each MOSFET.

Driver MOSFETs

Here two driver MOSFETs are used to switch the high-frequency transformer. The two ends of the transformer primary are connected to the 'Drain' pin of the two MOSFETs. When a MOSFET gets turned ON, then current flows through the primary winding of the transformer. Half of the primary gets turned ON by one MOSFET and another half by another MOSFET. Both MOSFETs switch alternatively producing an AC square wave in the primary of the transformer.

High-Frequency Transformer

Here the DC-AC conversion takes place in the high-frequency switching transformer. Unlike a normal transformer, the core of the HF transformer is made of ferrite which makes it capable of operating at higher frequencies. Due to high frequency switching the losses in conversion is very lower than a normal transformer. Here the HF transformer converts DC current into a high-frequency AC current. The primary transformer has three tappings, one is a center tap for DC current input, and the other two tapings for the return path of the current through MOSFETs during switching. The secondary output will be HF AC current, which is given to the transmitter coil.

Half Bridge Inverter

Half-bridge inverter circuit driver consists of a high-frequency switching transformer and two MOSFETs. The switching transformer primary is connected to two MOSFETs and the secondary is connected to the transmitting coil. The half-bridge inverter converts input DC voltage into a high-frequency AC voltage.

Transmitting Coil

The transmitter coil is designed with windings of copper coils that convert the high frequency oscillating electrical current into electromagnetic waves resonating at a particular frequency.

Receiving Coil

The receiver coil receives electromagnetic waves from the transmitter antenna and converts them back into high-frequency electrical output.

HF Bridge Rectifier

A high frequency (HF) bridge rectifier consists of fast switching rectifier diodes that convert HF AC voltage from the receiving coil into a DC voltage.

Filtering Capacitor

The filtering capacitor filters out the ripple generated at the rectifier and produces a smooth and stable DC voltage output, which can be used to drive the vehicle motor or for battery charging purposes.

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2. EXPERIMENTAL RESULTS

To achieve the desired results various simulation using PSIM software was carried out. The simulation circuit has been shown in fig 3. The results of the simulation have been represented using graphs and shown in fig 4 and fig 5. Note: the simulation is for the experimental purpose only the actual hardware circuit may differ.

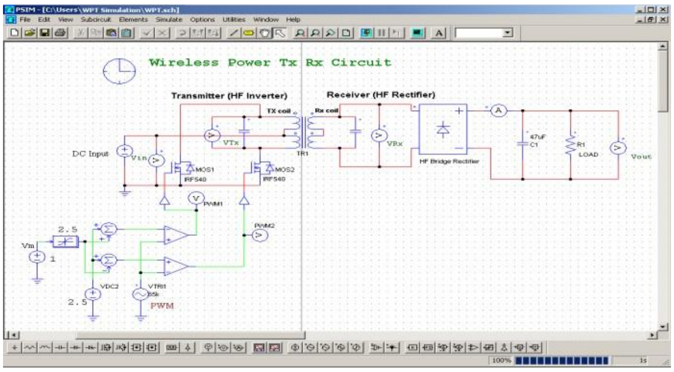

Fig 3: Simulation Circuit

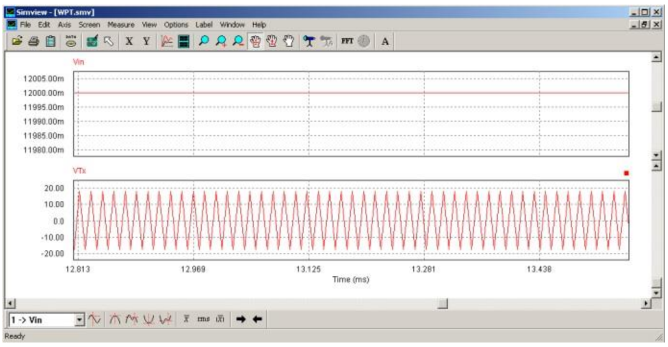

Fig 4: Vin – Input Voltage VTx – Transmitting Voltage

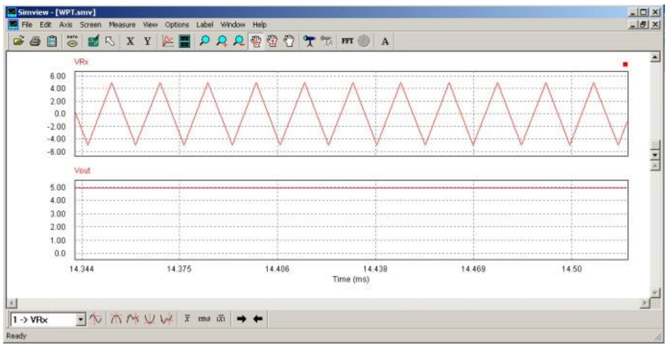

Fig: VRx – Receiving Voltage Vout – output voltage (supplied to the motor)

The actual hardware of the project using the simulation has been depicted in fig 5 and fig 6. Fig 5 shows the transmitter unit and fig 6 shows the receiving unit.

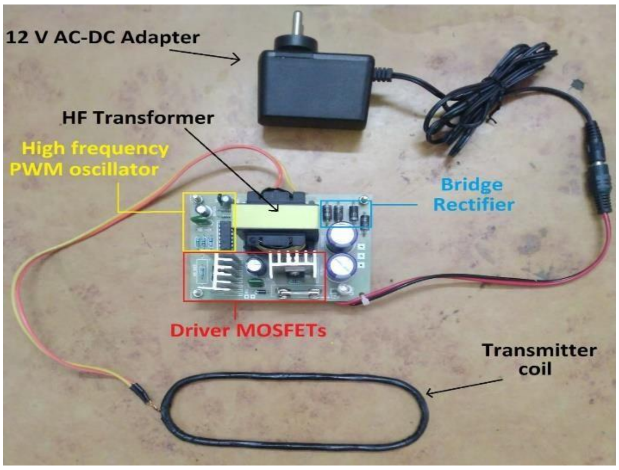

Fig 5: Transmitter Unit

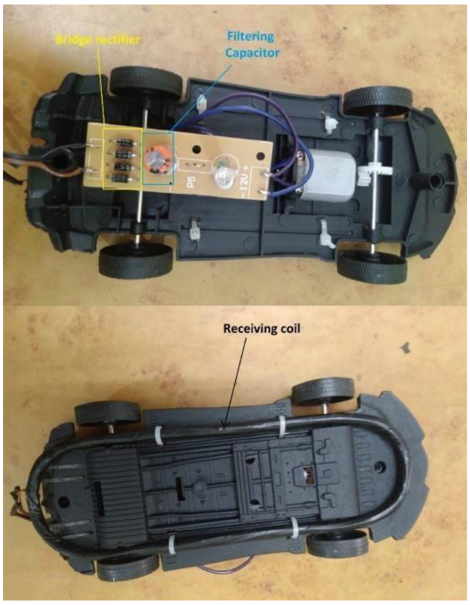

Fig 6: Receiving Unit

3. CONCLUSION

The project introduced a controller that can be used in a wireless EV charging system to charge an electric vehicle without wires. The proposed control can tune the switching behavior of the converter itself to the resonant frequency of the WPT system, eliminating the need to tune the switching frequency. It also enables smooth switching operation of the converter and greatly improves the efficiency of the power electronics converter. Contactless charging of electric vehicles (EVs) based on Inductive Energy Transfer Systems (IPTs) is a new technology that brings more convenience and safety to the use of electric vehicles. With no electrical contacts, it is a safe, reliable, robust, and clean EV charging method that is not affected by rain, snow, dust, and dirt, reducing the risk of electrocution.

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