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WIRELESS POWER TRANSFER SYSTEM FOR MOVING ELECTRIC VEHICLES USING MAGNETIC RESONANCE.

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Abstract: Electric vehicles are seen as an alternative option in response to the depletion of resources. In order to increase the use of EVs in daily life, practical and reliable methods to charge batteries of EVs are quite important, accordingly wireless power transfer (WPT) is considered as a solution to charge batteries. In this project, a prototype system of wireless charger which has 60 kHz operation frequency is circuit. A Resonant wireless transfer system for vehicle charging technology is designed and implemented. Plug-in Electric Vehicles (PEV) are burdened by the need for cable and plug charger, galvanic isolation of the on-board electronics, bulk and cost of this charger and the large energy storage system (ESS) packs needed.Wireless Charging system‘s Wireless charging opportunity. It Provides convenience to the customer, inherent electrical isolation, regulation done on grid side and reduce on-board ESS size using dynamic on-road charging. The main objective of our project is to design and develop antenna system suitable for vehicle using resonant magnetic coupled wireless power transfer technology to electric vehicle charging system. Application of WPT in EVs provides a clean, convenient and safe operation. At the core of the WPT systems are primary and secondary coils.

I. INTRODUCTION

Recently, wireless power supply devices which supply electric power wirelessly (in the medium of air) to apparatuses without power cables or the like have come to be in practical use. The principles upon which wireless electric power transmission is realized are generally categorized into three types. Electromagnetic induction non-contact power transmission employs the phenomenon in which application of an electric current to one of adjacent coils induces an electromotive force in the other coil with magnetic flux as the medium. Wireless power transfer (WPT) is a breakthrough technology that provides energy to communication devices without the power units. With the remarkable progress being made recently, this technology has been attracting a lot of attention of scientists and R&D firms around the world. Recently, the usage of mobile appliances such as cell phones, PDAs, laptops, tablets, and other handheld gadgets, equipped with rechargeable batteries has been widely spreading. It is known that electromagnetic energy is associated with the propagation of electromagnetic waves. Theoretically, we can use all electromagnetic waves for a wireless power transmission (WPT).

The difference between the WPT and communication systems is only efficiency. Maxwell's Equations indicate that the electromagnetic field and its power diffuse to all directions. Though we transmit energy in a communication system, the transmitted energy is diffused to all directions. Though the received power is enough for a transmission of information, the efficiency from the transmitter to receiver is quiet low. Therefore, we do not call it the WPT system. During the last few decades, increased concern over the environmental impact of the petroleum-based transportation infrastructure, along with the specter of peak oil, has led to renewed interest in an electric transportation infrastructure. Battery-powered electric vehicles (EVs) seem like an ideal solution to deal with the energy crisis and global warming since they have zero oil consumption and zero emission. Moreover, we are quite rapidly reaching the end of the cheap oil era. Therefore, the need for alternative growing and the price competition of alternatives against oil is becoming more and more realistic.

II. LITERATURE SERVEY

In 1864, **James C. Maxwell** predicted the existence of radio waves by means of mathematical model. In 1884, John H. Poynting realized that the Poynting vector would play an important role in quantifying the electromagnetic energy. In 1888, bolstered by Maxwell's theory, Heinrich Hertz succeeded in showing experimental evidence of radio waves by his

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spark-gap radio transmitter. The prediction and evidence of the radio wave in the end of 19th century was start of the wireless power transmission.

During the same period of **Marchese G. Marconi and Reginald Fessenden** who are pioneers of communication via radio waves, Nicola Tesla suggested an idea of the wireless power transmission and carried out the first WPT experiment in 1899. He said "This energy will be collected all over the globe preferably in small amounts, ranging from a fraction of one to a few horse-powers. One of its chief uses will be the illumination of isolated homes". He actually built a gigantic coil which was connected to a high mast of 200-ft with a 3 ftdiameter ball at its top. He fed 300 Kw power to the Tesla coil resonated at 150 kHz. The RF potential at the top sphere reached 100 MV.

Unfortunately, he failed because the transmitted power was diffused to all directions with 150 kHz radio waves whose wave length was 21 km. To concentrate the transmitted power and to increase transmission efficiency, we have to use higher frequency than that used by Tesla. In 1930s, much progress in generating high-power microwaves, namely 1-10 GHz radio waves, was achieved by invention of the magnetron and the klystron. After World War II, high power and high efficiency microwave tubes were advanced by development of radar technology. We can concentrate a power to receiver with microwaves. We call the wireless power transmission with microwaves as microwave power transmission (MPT). Based on the development of the microwave tubes during the World War II, W. C. Brown started the First MPT research and development in 1960.

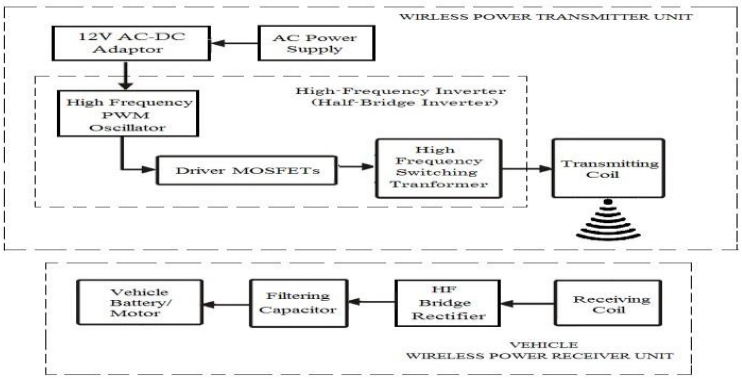
First of all, he developed a retina, rectifying antenna which he named, for receiving and rectifying microwaves. The efficiency of the first rectenna developed in 1963 was 50 % at output 4WDC and 40% at output 7WDC, respectively.

With the rectenna, he succeeded in MPT experiments to wired helicopter in 1964 and to freeflied helicopter in1968. In 1970s; he tried to increase DC-RF-transmission-RF-DC total efficiency with 2.45 GHz microwave. In 1970, overall DC-DC total efficiency was only 26.5 % at 39WDC in Marshall Space Flight Center.

However, we have to use a phased array antenna for the MPT from/to moving transmitter/receiver which include the SPS because we have to control a microwave beam direction accurately and speedily. The phased array is a directive antenna which generates a beam form whose shape and direction by the relative phases and amplitudes of the waves at the individual antenna elements

III. METHODOLOGY

Block Diagram:



AC Power Supply

The supply for the wireless power transmitter is taken from AC220v source.

AC-DC Adapter (SMPS)

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

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High Frequency PWM Oscillator

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

Driver MOSFETs

Here two driver MOSFETs are used to switch the high frequency transformer. The two ends of the transformer primary is 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 a AC square wave in the primary of the transformer.

High Frequency Transformer

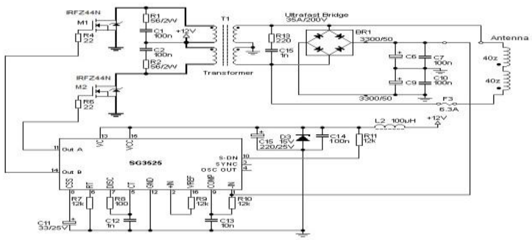
Here the DC-AC conversion takes place in the high-frequency switching transformer. Unlike normal transformer, the core of the HF transformer is made of ferrite which makes it capable of operating at higher frequencies. Due to high frequency switching the losses in conversion is very lower than normal transformer. Here the HF transformer converts DC current into a high-frequency AC current. The primary of transformer has three tappings, one is centre tap for DC current input and other two tapings for 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

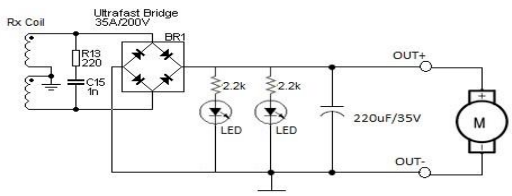
Half bridge inverter circuit driver consists of a high-frequency switching transformer and two MOSFETs. The switching transformer primary is connected to two MOSFETs and secondary is connected to transmitting coil. The half bridge inverter converts input DC voltage into a high frequency AC voltage.

CIRCUIT DIAGRAM:

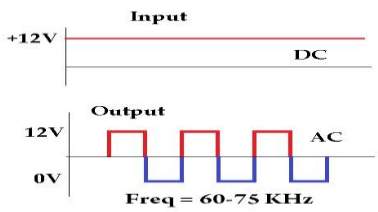
Transmitter Circuit Diagram



Vehicle Receiver Circuit Diagram



Input and Output of High Frequency Inverter:



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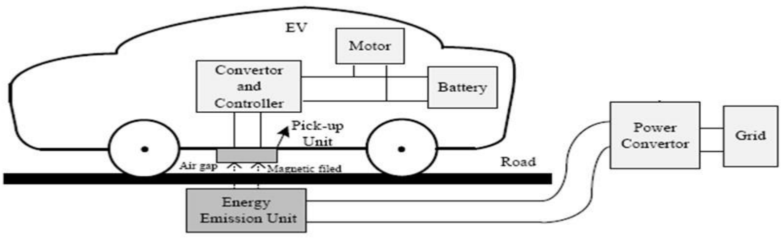
PRACTICAL APPLICATION:



The electrical power flows from the power transmitter coil inside the platform to the receiving coil inside the bottom of the electric vehicle. Electrical charging is done once the resonant frequency of both the coils matches and the vehicle charged automatically. When the vehicle is moved the charger goes to the power saving mode and cut off the charger coil.

System Operation:

The wireless power transfer system consists of a power transmitter part and a power receiver part. The power transmitter part is composed of an inverter and power lines. The inverter provides power, and the power lines carry current and generate magnetic flux. The power receiver part is composed of pickup modules, rectifiers, and regulators. The pickup modules generate power from induced voltage and current, the rectifiers convert ac power to dc, and the regulators control the output voltage, which is input to batteries and motors.

The inverter receives power from an electric power company and converts 60-Hz operating frequency into 20-kHz resonance frequency. Although the inverter can be controlled to provide constant voltage, constant current control is more advantageous in dealing with changes in the load resistance or multi-pickup charging. Therefore, in the OLEV system, the inverter converts 60-Hz power to 260-A constant current at 20-kHz resonance frequency. The power line modules are installed underneath the road and along the road.
Some of the transferred power is used to drive the motors, and the remainder is used to charge the batteries. When the vehicle stops, all of the power is used to charge the batteries.

WIRELESS POWER TRANSMISSION:

Wireless power transmission is not a new idea. Nikola Tesla demonstrated transmission of electrical energy without wires in early 19th century. Tesla used electromagnetic induction systems. William C Brown demonstrated a micro wave powered model helicopter in 1964. This receives all the power needed for flight from a micro wave beam. In 1975 Bill Brown transmitted 30kW power over a distance of 1 mile at 84% efficiency without using cables.
Researchers developed several technique for moving electricity over long distance without wires. Some exist only as theories or prototypes, but others are already in use.
Consider an example, in this electric devices recharging without any plug-in. The device which can be recharged is placed on a charger. Supply is given to the charger and there is no electrical contact between charger and device.
Previous schemes for wireless power transmission included attempts by the late scientist Nikola Tesla and the Microwave power transmission. Both Tesla's design and the later microwave power were forms of radiative power transfer. Radiative transfer, used in wireless communication, is not particularly suitable for power transmission due to its low efficiency and radiative loss due to its Omni directional nature.

METHODS OF WIRELESS POWER TRANSMISSION:

- Inductive coupling
- Transformer coupling
- Resonant Inductive Coupling
- Radio and Microwave Energy Transfer

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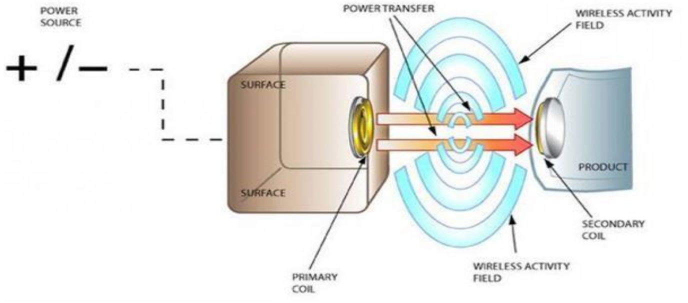
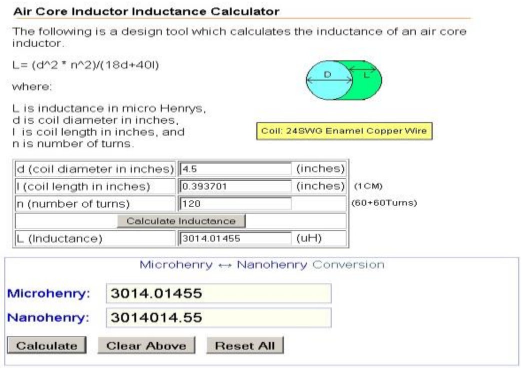
Resonant Inductive Coupling:



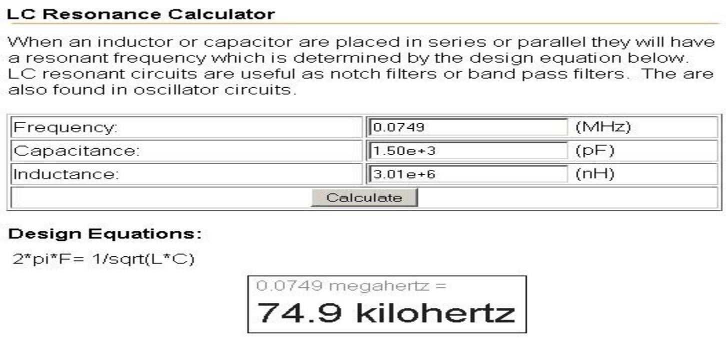
With inductive resonance, electromagnetic energy is only transferred to recipient devices that share the identical resonant frequencies as the energy source, so energy transfer efficiency is maintained, even when misalignment occurs.

IV. CALCULATIONS:

AIR CORE COIL INDUCTANCE CALCULATION



LC RESONANCE FREQUENCY CALCULATION:



APPLICATIONS:

- Wireless power has a bright future in providing wireless electricity. There are no limitations in power applications. Some of the potential applications are powering of cell phones, laptops and other devices that normally run with the help of batteries or plugging in wires.

- Wireless power applications are expected to work on the gadgets that are in close proximity to a source of wireless 'power, where in the gadgets charges automatically without necessarily, having to get plugged in.

- By the use of Wireless power there is no need of batteries or remembering to recharge batteries periodically. If a source is placed in each room to provide power supply to the whole house

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- Wireless power has many medical applications. It is used for providing electric power in many commercially available medical implantable devices.

- Another application of this technology includes transmission of information. It would not interfere with radio waves and it is cheap and efficient.

ADVANTAGES:

- No need of line of sight - In Wireless power transmission there is any need of line of sight between transmitter and receiver. That is power transmission can be possible if there is any obstructions like wood, metal, or other devices were placed in between the transmitter and receiver.

- No need of power cables and batteries - Wireless power replaces the use of power cables and batteries.

- Does not interfere with radio waves

LIMITATIONS:

- Wireless power transmission can be possible only in few meters.

- Efficiency is only about 40% for long distances and near 85% for short distances.

- As Wireless power is in development stage, lot of work is done for improving the efficiency and distance between transmitter and receiver.

V. CONCLUSION

In this project we have introduced a controller that can be used in Wireless EV charging systems to charge electric vehicles without wires. The proposed controller is capable of self-tuning the switching operations of the converter to the resonance frequency of the WPT system, and therefore eliminates the need for switching frequency tuning. Also, it enables soft-switching operations in the converter, which will result in a significant increase in the efficiency of the power electronic converter. Contactless electric vehicle (EV) charging based on inductive power transfer (IPT) systems is a new technology that brings more convenience and safety to the use of EVs. Since it eliminates the electrical contacts, it would not get affected by rain, snow, dust and dirt, it is a safe, reliable, robust and clean way of charging electric vehicles, reduces the risk of electric shock.

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