WIRLESS POWER TRANSFER SYSTEM AT VARIOUS DISTANCE LEVELS USINGMAGNETIC RESONANT COUPLING

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Abstract- Wireless power transmission is the transmission of electrical energy without using any conductor or wire. It is useful to transfer electrical energy to those places where it is hard to transmit energy using conventional wires. In this paper we designed and implemented a wireless power transfer system using the basics of magnetic resonant coupling. Numerical data are presented for power transfer efficiency of both receivers. Graphs are given to show the comparison of power and efficiency with distance of both receivers.

Keywords – Keywords: Wireless Power Transfer, Magnetic Resonant Coupling, Quality Factor

I. INTRODUCTION

Wireless power transmission (WPT) is an efficient way for the transmission of electric power from one point to another through vacuum or atmosphere without the use of wire or any substance. By using WPT, power can be transmitted using inductive coupling for short range, resonant induction for mid-range and Electromagnetic wave power transfer. By using this technology, it is possible to supply power to places, which is hard to do using conventional wires[1]. Currently, the use of inductive coupling is in development and research phases. The most common wireless power transfer technologies are the electromagnetic induction and the microwave power transfer. For efficient mid range power transfer, the wireless power transfer system must satisfy three conditions: (a) high efficiency, (b) large air gap, (c) high power. The microwave power transfer has a low efficiency[2]. For near field power transfer this method may be inefficient, since it involves radiation of electromagnetic waves. Wireless power transfer can be done via electric field coupling, but electric field coupling provides an inductively loaded electrical dipole that is an open capacitor or dielectric disk. Extraneous objects may provide a relatively strong influence on electric field coupling[3]. Magnetic field coupling may be preferred, since extraneous objects in a magnetic field have the same magnetic properties as empty space. Electromagnetic induction method has short range. Since magnetic field coupling is a nonradiative power transfer method, it has higher efficiency. However, power transfer range can be increased by applying magnetic coupling with resonance phenomenon applied on Magnetic field is generated when electric charge moves through space or within an electrical conductor. The geometric shapes of the magnetic flux lines produced by moving charge (electric current) are similar to the shapes of the flux lines in an electrostatic field. wireless power transfer (WPT), wireless power transmission, wireless energy transmission (WET),or electromagnetic power transfer is the transmission of electrical energy without wires as a physical link In a wireless power transmission system, a transmitter device ,drive-n by electric power from a power source, generates a time-varying Electromagnetic field, which transmits power across space to a receiver device, which extracts power from the field and supplies it to an electric load.

Wireless power transfer between two coupled to parallel LC tuned circuits, each consisting of a copper conductor loop acting as an inductor and a capacitor. Both LC circuits are tuned to equal individual resonant frequencies[4]. Basically this is a ZVS diver circuit. I used SW3205 MOSFET, but you can use other power MOSFET such as IRF540 or IRFZ44.

II. Proposed Algorithm

2.1 Inductive coupling and Magnetic coupling

Inductive or magnetic coupling works on the principle of electromagnetism. When a wire is proximity to a magnetic field, it induces a magnetic field in that wire. Transferring energy between wires through magnetic fields is inductive coupling[5].

Magnetic resonant coupling uses the same principles as inductive coupling, but it uses resonance to increase the range at which the energy transfer can efficiently take place. Resonance can be two types: (a) series resonance & (b) parallel resonance. In these both types of resonance, the principle of obtaining maximum energy is same but the methods are quite different.

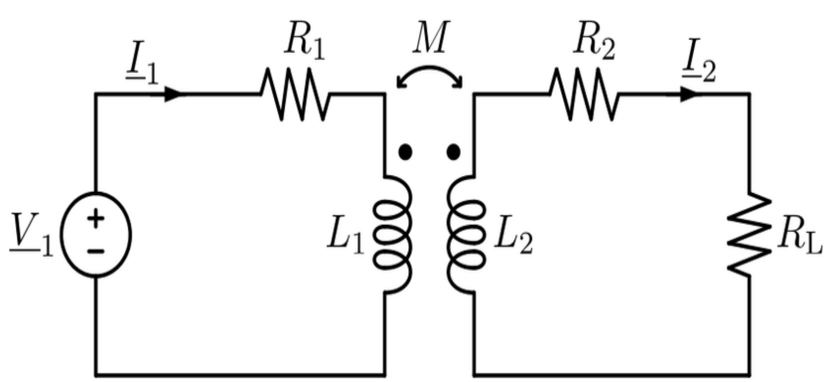

Figure 2.1 Equivalent circuit of Magnetic Resonant Coupling

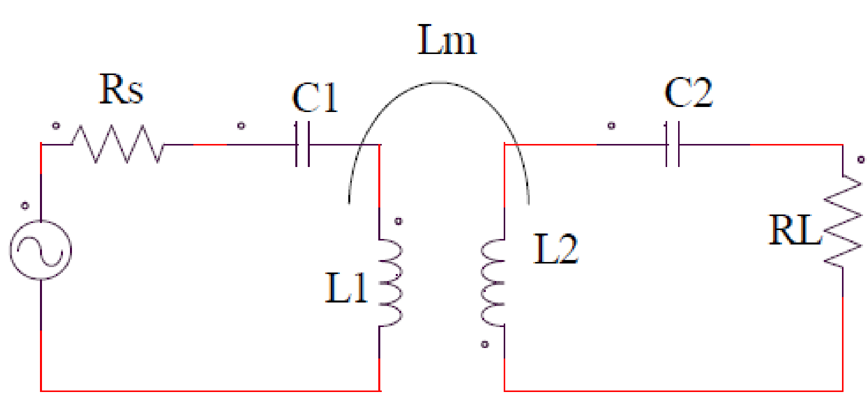

Figure 2.2 Equivalent circuit of Magnetic Resonant Coupling

Quality factor (Q-factor) is a dimensionless parameter to describes the characteristic of an oscillator or resonator, or equivalently the characterizes a resonator's band width relative to it can frequency. Higher Q indicates a lower rate of energy loss relative to the stored energy of the oscillator; the oscillations die out more slowly that to determine the qualitative behavior oscillators. A system with low quality factor to be over damped. Such a system does not oscillate at all, when displaced from its equilibrium steady state output, it returns to it by exponential decay, approaching the steady state the value asymptotically. System with ($Q > ½$) is said to be under damped[6]. Under damped systems combine oscillation at a specific frequency with decay of the amplitude of the signal. A system with an quality factor ($Q = ½$) is said to be critically damped. An over damped system, the output does not oscillate, an does not overshoot its steady-state output (i.e., it approaches a steady-state asymptote).

Like an under damped response, the output of such a system responds quickly to a unit step input. The efficiency of the coupled system depends on how much energy is transferred from the transmitted to the receiver circuit. The maximum energy found on the transmitted is the amount of energy initially put on the inputcapacitor.

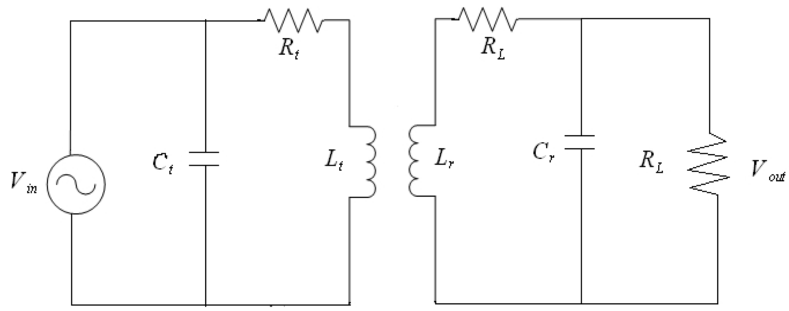

Figure 2.3 Resonant wireless power transmission circuit

III. Experiment and Result

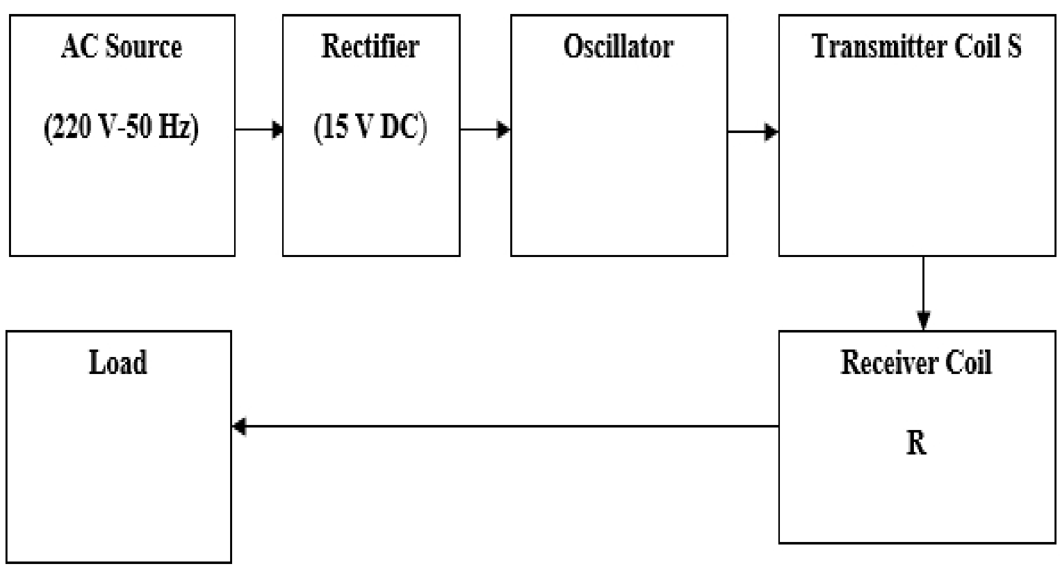

Figure 3.1 Block diagram of wireless power transmission system

1). BLOCKDIAGRAM

AC Source:- An ac source is rated at 220V, 50Hz.the time taken for voltage to change from its peak value to zero.
Rectifier:-A rectifier is a device that converts an oscillating two- directional alternating current (AC) into a single-directional direct current (DC).
Oscillator:-An oscillator is a circuit which produces a continuous, repeated, alternating waveform without any input.
Transmitter Coil:-Current in primary coil (transmitter) generates magnetic field.
Receiver Coil:-Magnetic field induces current in a secondary coil

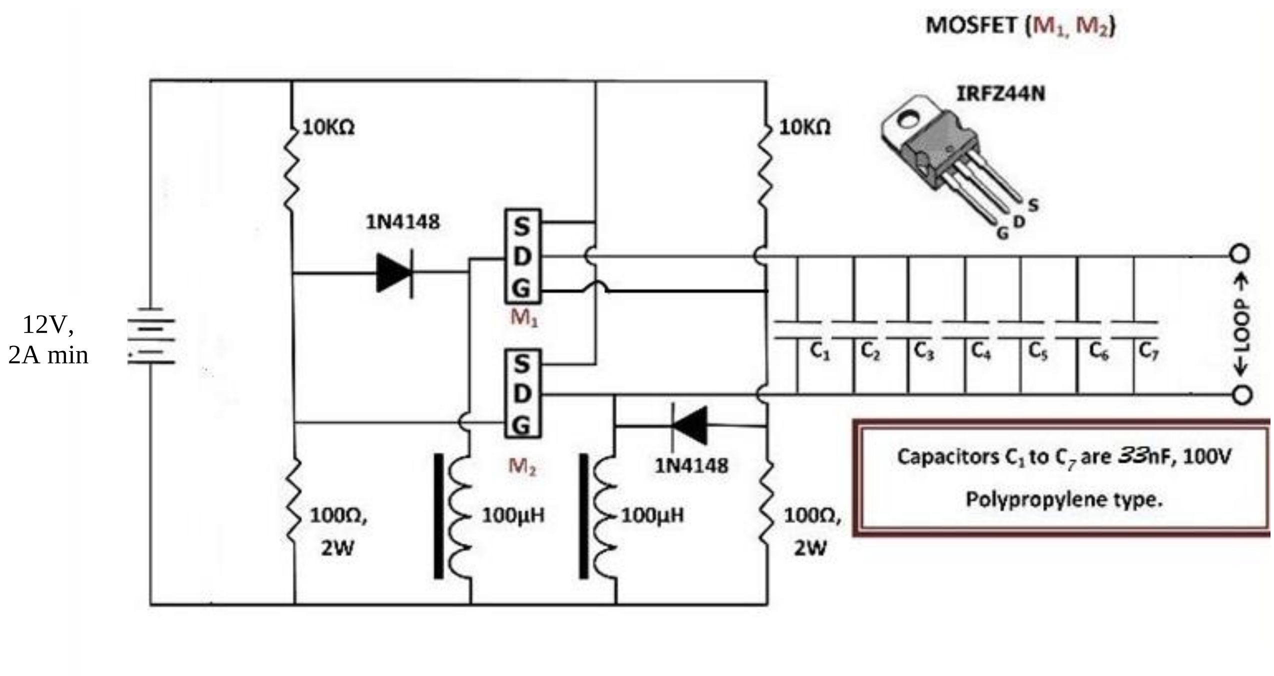

Figure 3.2 transmitter schematic diagram

Transmitters are devices that are used to send out data as radio waves in a specific band of the electromagnetic spectrum in order to fulfill a specific communication need, be it for voice or for general data[7]. In order to do this, a transmitter takes energy from a power source and transforms this into a radio frequency alternating current that changes direction millions to billions of times per second depending on the band that the transmitter needs to send in. When this rapidly changing energy is directed through a conductor, in this case an antenna, electromagnetic or radio waves are radiated outwards to be received by another antenna that is connected to a receiver that reverses the process to come up with the actual message or data[8-10].

A transmitter is composed of "Power supply, Electronicoscillator, Modulator, RF amplifier".

Power supply:-The energy source used to power the device and create energy for broadcasting
Electronicoscillator:-Generates a wave called the carrier wave where data is imposed and carried through the air
Modulator:-The actual data into the carrier wave by varying some aspect of the carrier wave
RF amplifier :-Increases the power of the signal in order to increase the range where the waves canreach.

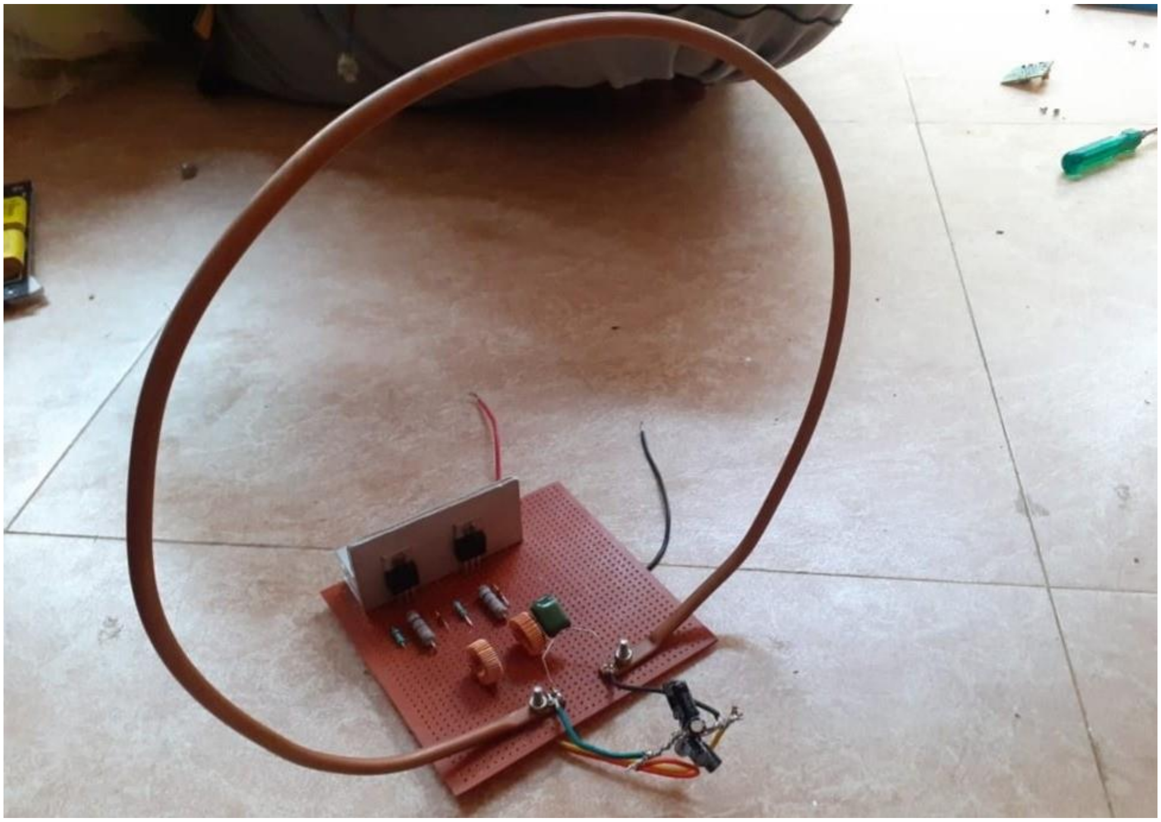

Figure 3.3 Transmitter coil

CALCULATIONS:-

Table -1 Power calculation of Transmitter at Sending End

Distance(cm)	Voltage(v)	Current (A)	Power(μw)
22	0.15	0.0343	514.5
18	0.162	0.0343	555.66
14	0.186	0.0343	637.98
12	0.209	0.0343	716.87
8	0.244	0.0343	836.92
4	0.346	0.0343	1186.78

After completing the basic device we took the measurement of power efficiency of the receiver. For efficiency calculation, we have taken transmitting and receiving end power of the two receivers respectively. The formula for efficiency calculation is,

$\eta = (Pout/Pin) * 100$ (1)

We used the following formula for power calculation,

$P=VI$ (2)

Power calculations for Receiver at Receiving end.

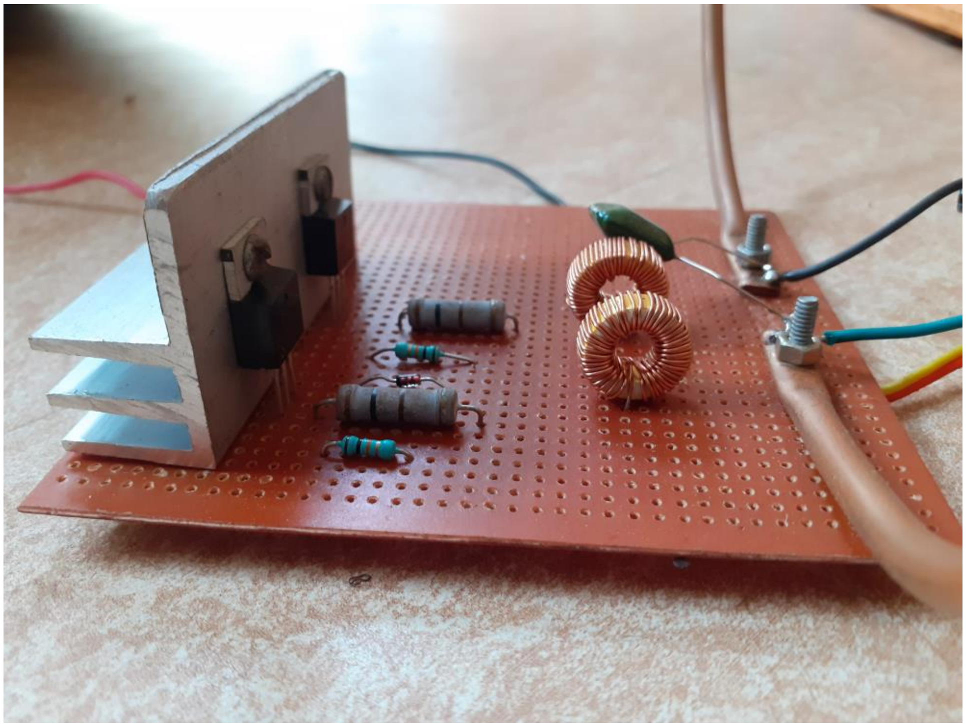

Figure 3.4 Receiver coil

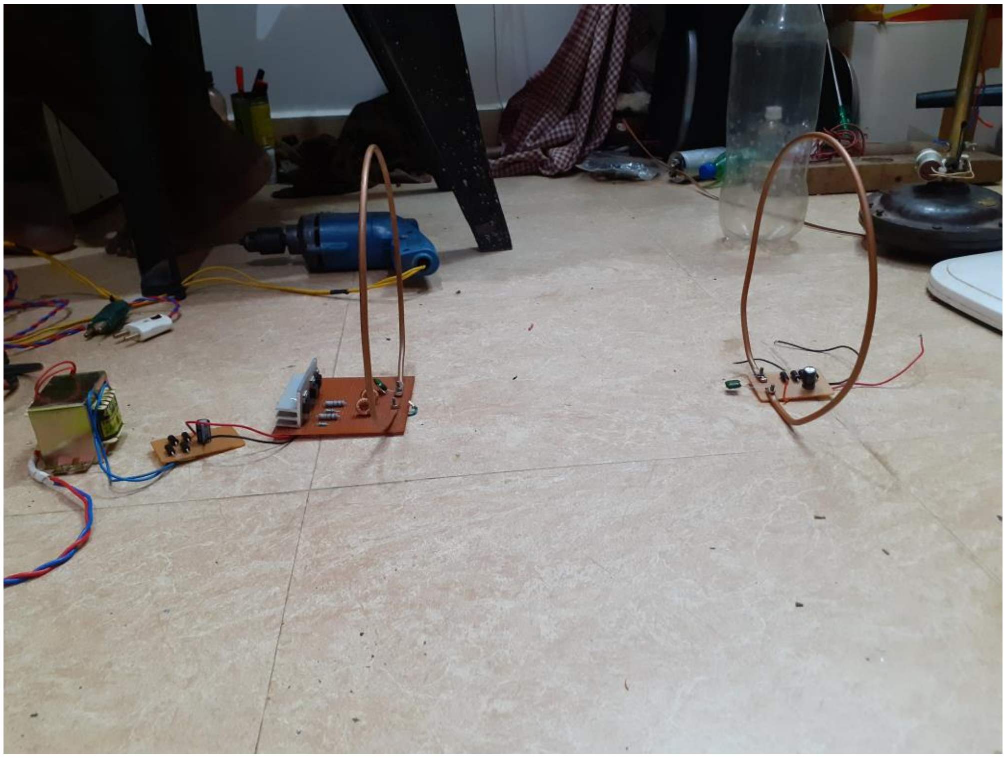

Figure 3.5 Transmitter and Receiver coil

Table-2 Power calculation of receiver at receiving End

Distance(cm)	Voltage(v)	Current (A)	Power(µw)
22	0.10	0.0241	241
18	0.102	0.0245	249.9
14	0.116	0.0253	293.48
12	0.160	0.0264	422.4
8	0.204	0.0269	548.76
4	0.286	0.0276	789.36

IV.CONCLUSION

The goal of this project was to design and implement a wireless power transfer system via magnetic resonant coupling. After analyzing the whole system systematically for optimization, a system was designed and implemented. Experimental results showed that significant improvements in terms of power-transfer efficiency have been achieved. Measured results are in good agreement with the theoretical models. We have described and demonstrated that magnetic resonant coupling can be used to deliver power wirelessly from a source coil to a with a load coil with an intermediate coil placed between the source and load coil and with capacitors at the coil terminals providing a sample means to match resonant frequencies for the coils. This mechanism is a potentially robust means for delivering wireless power to a receiver from a source coil.

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