IMPLEMENTATION OF ROYER OSCILLATOR IN WI-TRICITY FOR LOW POWER TRANSFER

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Abstract- Wi-Tricity is a well known standard which concerns with the process of electro-magnetic induction under resonance. This process has so many advantages and applications. We can transmit and receive power wirelessly by this process. The MIT team transfers power (30W) over a distance of 2m with an efficiency of 40%. They also notice that the evanescent waves are not decaying their energy to the environment (because of resonance). With even closer distance, they obtained an efficiency of about 90%. They found that the resonant power transfer is a million times more efficient than the non-resonant one.

Key Words- Wi-Tricity, Royer Oscillator, Low power, Resonance, Wireless Power.

I. INTRODUCTION

In the early 20th century, Nikola Tesla (father of electronics) wanted to transmit the power wirelessly world-wide by using renewable energy (geothermal energy). Thus he was starting to build a tower namely ‘Tesla Tower’. But it’s not completed due to some lack of technical and financial difficulties. In the past decade, the usage of electronic devices had been increased tremendously especially for communication and medical applications. But charging of these devices is always a problem. To overcome this drawback, in the 21st century MIT scientists came up with an idea called ‘Wi-Tricity’.

They transferred the power efficiently by this invention. We know that each power cord of the electronic appliances, for example mobile phone charger contains transformer. The transformer contains two coils, a primary and a secondary coil. They are made up of conductors (copper). When the primary coil is energized, it converts the current flow into the magnetic field. The secondary coil which is connected to an AC power source, it produces oscillating magnetic field in its vicinity. If another coil is brought nearer to it, it will take the oscillating field and produces current.

Resonance:

It is a property exists in many physical systems. It may be defined as the frequency at which the system can oscillate efficiently. For example, consider a swing. If the child over the swing properly coordinates his leg and arm action, the swing will go higher. Thus energy is transferred efficiently to the system by a simple movement.

Consider a circuit with an inductor and a capacitor. When the magnetic field of the inductor collapses, electric current is induced in the winding and the capacitor gets charged. Now if the capacitor discharges, the resulting current produces magnetic field in inductor. This process repeats continuously. Now resonance occurs only if the inductive and capacitive reactances are equal in magnitude. Thus,

$$\omega L = \frac{1}{\omega C}$$  \hspace{1cm} 1

$$\omega = \frac{1}{\sqrt{LC}}$$  \hspace{1cm} 2

This is the resonant frequency of the given oscillator circuit.

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Q-Factor:
It is a measure of how well a resonant circuit stores the energy. Based on the radiative and resistive losses of the coil, the Q-factor may vary. By reducing the losses, this value can be increased. (i.e) to increase the distance between the coils the Q-factor should be high.

\[
Q = \frac{1}{R} \times \sqrt{\frac{V}{I}} = \frac{a}{b} \tag{3}
\]

This is the Q-factor of the coil. Also, it is noted that inorder to get high Q value, resistance should be reduced.

Royer Oscillator:
It is a type of resonant transformer invented by Royer in 1954. It consists of a center-tapped primary winding, a secondary winding and a feedback winding. The center tapped primary winding(each half) is connected to transistors. The feedback provided here is positive and it couples some flux to the base of the transistor and generate oscillation. The oscillating frequency is determined by the inductance of the winding and the flux density.

III. SYSTEM DESCRIPTION

Block diagram of the Wi-Tricity:

![Fig.1: Basic block diagram of Wi-Tricity](image1)

[2]Starting from the source electronics, AC main is just a power supply given by an AC source which can be converted into DC by a rectifier; else the input may be given directly by a DC battery. The weak signal may be amplified by means of the amplifier. The Impedance matching networks can efficiently transfer the amplifier’s output to the resonator. IMN should be matched in transmitter and also in receiver. Source resonator changes the current into the oscillating magnetic field. The device resonator which is placed in the vicinity of the source resonator caught the magnetic field and converts back into current. The device IMN is used to efficiently couple the resonator’s AC output to the rectifier. Now the rectifier may be used to convert the AC back into DC for a DC load; else it may be given directly to the load in case of AC load. The IMN block was accomplished by inductive coupling by MIT scientists. By adjusting the coupling properly, the efficiency may be increased.

Royer Oscillator:
The basic Royer oscillator is given as follows:

![Fig.2: A typical Royer Oscillator](image2)

When the Vin is applied, as the characteristics of the Q1 and Q2 are not alike and also the drive windings are out-of-phase, one of them will turn ON more and drive it into saturation state and other transistor will be in cut-off state. Now the half of the primary will energize and the magnetic flux increases linearly; and at some point it will saturate and become zero; and now the polarity reverses and the other transistor will turn ON. This cycle repeats and the oscillating magnetic field will produce continuously.

We are taking this royer oscillator as the source resonator and tune the secondary to draw the magnetic field emitted by the primary efficiently. A capacitor(0.47uF) is added parallel to the primary to get the resonance. In the feedback path of oscillator, an inductance of 1mH is provided. The secondary and the primary windings should be chosen at optimum values to get optimum resonant frequency. We are choosing 63.1 KHz as the resonant frequency.

The primary winding we are choosing contains 18turns which is center-tapped. Input voltage given is 18V. The voltage regulator(LM7812) is used in the input circuitry to produce a 12V regulated output. Now the 12V is given to the royer oscillator and now the circuit resonates and the oscillating magnetic field gets emitted from the primary by the application of the tank circuit. The secondary also contains 18turns but not center-tapped. A capacitor(0.47uF) is connected parallel to the secondary to tune the secondary to efficiently draw the oscillating magnetic field emitted from the primary and convert it back to AC and energizes a load(12V bulb).

IV. BENEFITS AND APPLICATIONS:

Advantages:
- It makes the electronic devices more convenient without any cords and battery replacement.
• Reduce the cost which is wasted in wires.
• Since there are no wires in this technology, the hazards like shocks and short circuits could be eliminated, which makes this technology a safer one.
• The devices will become more reliable by eliminating the cords and connectors.
• It is non-hazardous.
• The Off-resonant objects have less interference over the oscillating magnetic field and thus make this technology an efficient one.

Applications:
1. Consumer Electronics:
   It includes all the house-hold electronics items. Laptops, TV, radio, mobile phone etc; can be powered up wirelessly by this technology under a distance of 20-40cm. Analysts expects that this technology will cover above 80% of the consumer electronics by 2020.

2. Medical Devices:
   This technology may be used in implanted devices like pacemakers, heart assisted pumps etc.

3. Defense Systems:
   This technology may be used in defense systems like land rover, defense robots etc[3]. Helmet mounted electronics like night vision and radio devices(packet radio, cordless phone) may be charged wirelessly and thereby reducing the usage of disposable batteries and power cords.

4. Electric Vehicles:
   We highly rely on petrol and diesel for transport. But after some years, petrol and diesel may vanish as they are non-renewable resources. So, we’ve to shift to electric vehicles; but charging it by cords for every 100km is not possible. Thus Wi-Tricity can be implemented here.

CONCLUSION:

Thus we had efficiently transferred the power wirelessly using royer oscillator by Wi-Tricity. With a wide application area, this technology will be prevalent in many areas in the upcoming years. Electronics companies have also started to equip their goods with this technology. Thus this technology has a very bright future. It is also an efficient technology which reduces the plastics and copper wires. The efficiency can be further improved by using superconductors instead of copper wires as they are also diamagnetic. Also the superconductors have low loss and high conductivity than copper, it may replace the copper to increase the efficiency. Thus, we are looking forward for a wireless world with maximum efficiency.

REFERENCES: