

ABSTRACT

The main theme of this paper is to transfer power wirelessly using the concept of highly resonant coupling. Witricity can make an amazing change by removing the use of conventional copper cables and current carrying wires in the field of the electrical & electronics engineering. By using this concept, we can transfer the power to minimum range. This technique can be used for charging batteries those are actually not possible to connect electrically like pace makers which is fixed in the body that runs on a battery. And also this technique can be used in numeral applications, for charging consumer electronics devices such as cell phone, iPod, laptop battery, propeller clock, printer, and scanner wirelessly. This is a promising Technology in which in future the distance between two devices can be improved as the study is going on entire the world.

KEYWORDS: Witricity, high frequency transformer, voltage regulator, transistor, coil.

Introduction

Witricity means wireless electricity. It is based on transmission of energy from one place to another without using wires or any other physical material. The best example for witricity is Lightning. Nikola Tesla at the start of the 20th century discovered a system for transferring large amounts of power across continental distances.

Tesla’s aim was to pass the electrical-wire grid. The paper was never completed due to a number of technical and financial difficulties. Earlier, there has been tremendous increment in the field of consumer electronic such as laptops, mobile phones, PDA’s, robots which is almost run on batteries. As these devices need to perform properly, they store lot of energy making their non rechargeable batteries heavy and large. Also rechargeable batteries need to be constantly recharged for their continuous use. The charging devices that are in use, such as the cord for a cell phone works on the principle of electromagnetic induction. A few other examples of devices that work on electromagnetic induction are rechargeable electric toothbrushes and inductive charging pads. The WiTricity devices work on the similar phenomenon, however magnetic fields are generated “through a process called resonant magnetic coupling” and this “allows power to be transmitted several meters in distance”. Witricity technology includes basic terms like electricity, magnetism, electromagnetism, magnetic induction, energy/power coupling and most important factor is resonance magnetic coupling. First time the idea of wireless power transfer was discovered by Nicola Tesla by using earth’s ionosphere and transfer power.

Functional Block Diagram

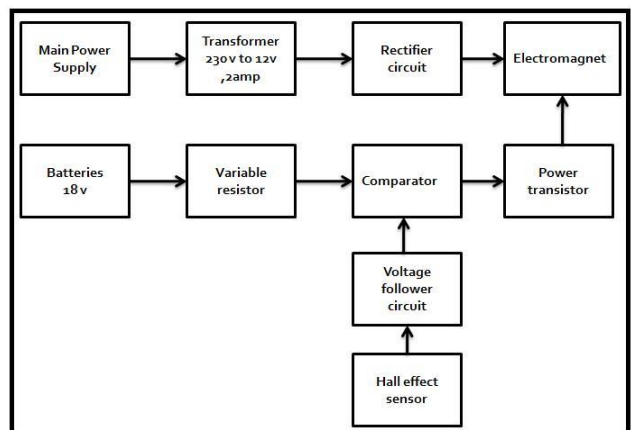


Fig.1 (a) Functional Block Diagram of Witricity

Working principle

1 High Frequency Resonance Transformer

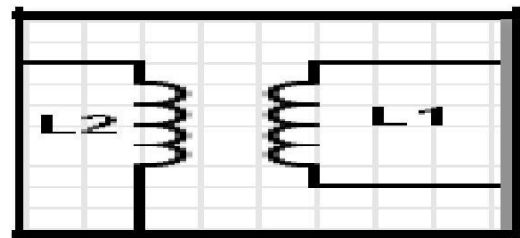


Fig.2 (b) High Frequency Resonant Transformer

The two coils of a transformer resonate at same frequency by the electro dynamic induction or magnetic coupling of electrical energy by the equipment called a resonance transformer. While many transformers consist of two coils existing in single equipment or can comprise of two different equipments employ resonance, this type has a high quality factor Q by avoiding 'iron' losses.

Theory

Witricity works on the basic principle of Electromagnetism which transfers power between two devices having magnetic resonance coupling and dissipate little energy to the environment.

1 Resonance

The behavior of system which oscillates at high amplitude at specific range with respect to other called as resonance. Under resonance condition, the inductor and capacitor have minimum series impedance and maximum parallel impedance whereas the inductive and capacitive reactances are equal in amount.

$$WI = 1/Wc$$

$$W = 1/\sqrt{WI}$$

Where, w is the resonant frequency.

2 Resonant Energy Transfer

Short range wireless energy transmission technologies such as WiTricity, which use magnetic fields for the transmission, function on the principle of resonant energy transfer. A magnetic field is less hazardous to human beings as compared to electric fields. Wireless energy transmission techniques use magnetic field which is having two coils with same resonant frequency. For the better efficiency and less losses, the coils should have high quality factor Q and is used to avoid iron losses and called as a resonant transformer.

3 Resonant Coupling

The job of primary coil is to produce a magnetic field and that of secondary coil to capture that field as much as possible. For this process, the coil must have magnetic core in between the two coils. If the distance between two coils is large then the power cannot be transfer efficiently and can cause resistive losses in the primary coil. By using resonance coupling the efficiency can be enhanced considerably.

Circuit Diagram of Witricity

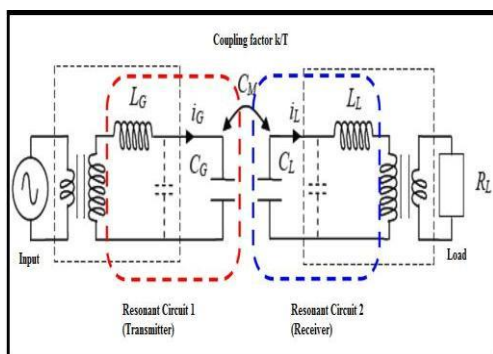


Fig.3 (c) Circuit Diagram of Witricity

Types of coupling

1 Strong coupling: Energy Transfer With k/T >>1

A k/\sqrt{LGS} FD is known as the relative coupling parameter. It represents the ratio of “how fast energy is transmitted between transmitter and receiver and how fast it is lost due to intrinsic losses in these resonators”. $k/T \gg 1$ the energy transferred to the destination should be much more than that lost during the transmission process. When this inequality satisfied, the coupling rate is much higher than the loss rate. Hence strong coupling takes place.

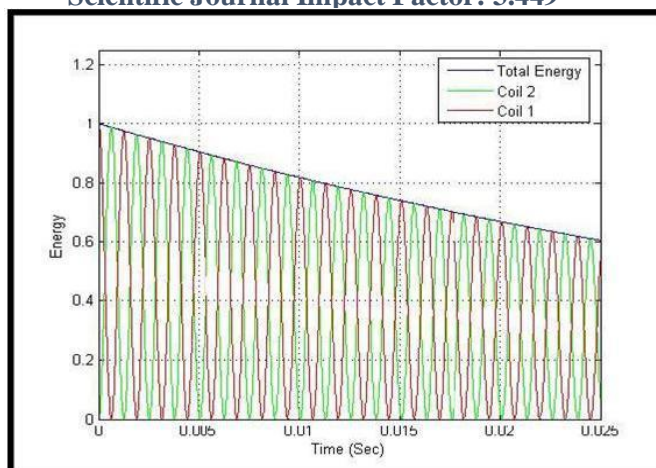


Fig.4 (d) Energy variation in each resonant coil and total energy

2 Weak coupling: Energy Transfer With k/T <<1

If $k/T \gg 1$ is not satisfied the energy transferred to the destination is less than that lost during the transmission process. When this inequality is satisfied, the coupling rate is less than the loss rate. Hence weak coupling takes place. As can be seen in Fig.4 and Fig.5, the energy in the system decrease s rapidly when $k/T=0.5$ and $k/T=1$. Though the transmission improves as k/T increases, if $k/\sqrt{LGS} = 1$ is not satisfied, the system will not resonate since system energy will be lost.

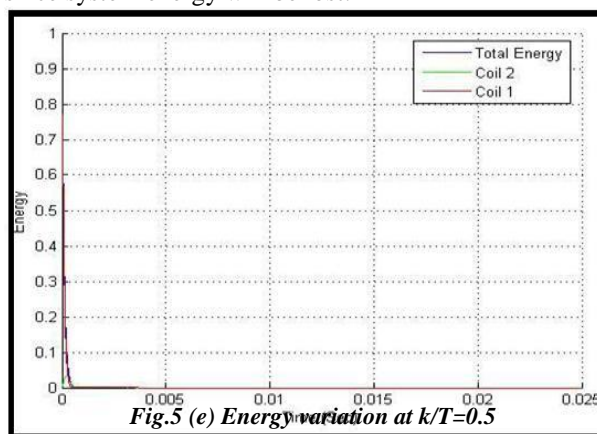


Fig.5 (e) Energy variation at k/T=0.5

3 Non-resonant case

The two non-resonant objects i.e., if there resonant frequency not same, interact weakly and exchange energy ineffectively. It can be observed that the energy absorbed by the device is always very small and the total system energy is also decaying in this case.

4 Influence of k/T on the Total Energy in System

Based on the above analysis, we can see that k/T is a significant parameter in the energy transmission system. With the growth of k/T , the proportion of energy lost in system decreases and the total energy decays more slowly. Shown in Fig. 6, the total energy in system is proportional to the time and varying nearly linearly when $k/T > 50$.

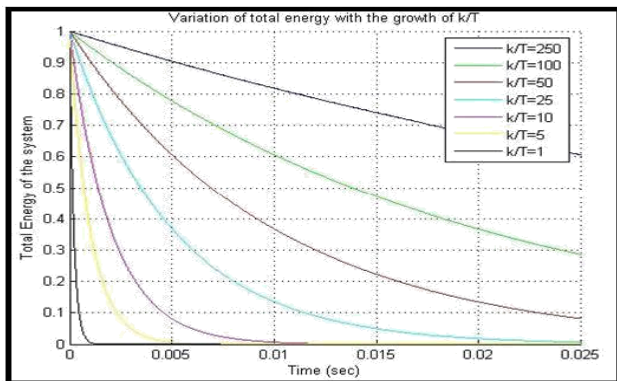


Fig.6 (f) Variation in Total energy of the system with the growth of k/T

5 Energy Transfer and Efficiency

As per the principle, when a primary coil loaded in full capacity is subjected to a significant amount of energy, the coil rings along with the formation of an oscillating magnetic field. There is an energy transfer between the inductor's magnetic field and capacitor's electric field, at resonant frequency. The primary coil forms a series RLC circuit, and the Q factor for such a coil is: $Q=1/R\sqrt{L/C}$.

The Quiescent factor(Q factor) of the two coils plays a very important role in the wireless energy transmission. By maintaining a high Q factor, one can achieve higher efficiency between two coils kept several diameters apart, thus the field generated by the coil weakens as the field move away from the point of origin.

Implementation

The WiTricity circuit is designed in a way that the frequency of the alternating current is increased to the resonant frequency. The travelling current induces magnetic and electric fields in the inductor and capacitor loops respectively which extends up to 5 meters around the device. In the inductor loop of any mobile gadget magnetic field generates an electric current having the receiver coil with the same resonant frequency. Thus both the circuits resonate together and energy transfer is achieved. The above circuit is a good example of the WiTricity system. As can be seen from the diagram, it uses two coils which are tuned at the same resonant frequency. The main supply is given to transformer which induces high frequency AC on the primary coil. When achieved. The above circuit is a good example of the WiTricity system. As can be seen from the diagram, it uses two coils which are tuned at the same resonant

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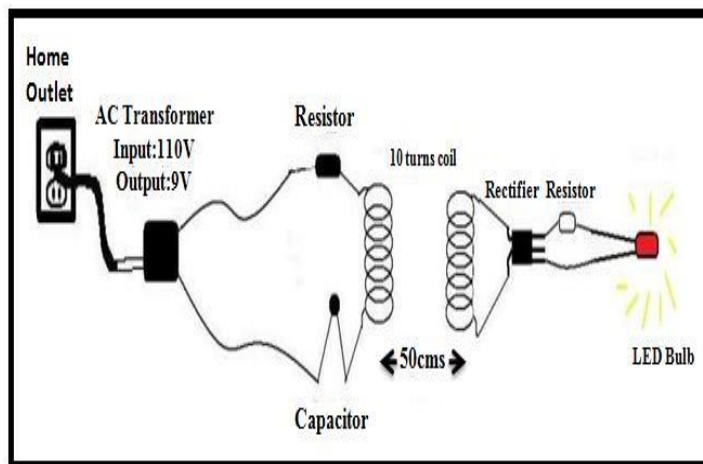


Fig.7 (g) WiTricity circuit used to glow LED Bulb.

Advantages

- 1) It is an ecofriendly system.
- 2) It is unaffected by day night cycle, weather or season.
- 3) Little maintenance.
- 4) Operating expenses are less compared to other devices used for doing same work.
- 5) It causes very less noise pollution compared to other practical devices.
- 6) As there is no friction therefore there is no energy loss except losses due to air friction.
- 7) It is very safe and energy efficient technique.
- 8) It will go to replace the batteries and the connecting cords.

Conclusion

As we have witnessed WiTricity can effectively be used to transfer power wirelessly. WiTricity is a convenient and cost effective technology as it will help minimize the use of plastic and copper used in electric devices. As the resonant frequency gets tighter, the energy transferred to other objects drops away. With improved efficiency and range, this technology will change the way we look at energy transfer.

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Future Scope

- 1) Air base for Jet aircraft and other Airplanes.
- 2) Spinning wheel mechanism for Helicopter.
- 3) Local transport vehicle like buses, bikes etc.

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