

Wireless Power Transmission using RF-DC Energy Harvesting

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Abstract—As we know in present era every person needs wireless system, but still power transmission for low power device we are using wired device. As we know for every low power device continuous power supply is very important issue so there is need of wireless power transmission system. Through this system we can charge our battery by wireless power. Wireless power transmission is based on strong coupling between electromagnetic resonant objects to transfer energy wirelessly between them. This differs from other method like simple induction, microwaves or air ionization. This system consists of transmitter and receiver that contain magnetic loop antennas critically tuned to the same frequency. Basically three types of wireless power transmission which are electromagnetic induction, magnetic induction, and electric induction. In this work we will design a system which is based on electromagnetic induction and RF energy harvesting. Electromagnetic induction is used for far distance and RF energy harvesting concept is not new but this system will not able to harvest a minute amount of energy which is not sufficient for low power devices.

Keywords- HSMS-2860, RF energy harvesting, WPT(Wireless Power Transmission)

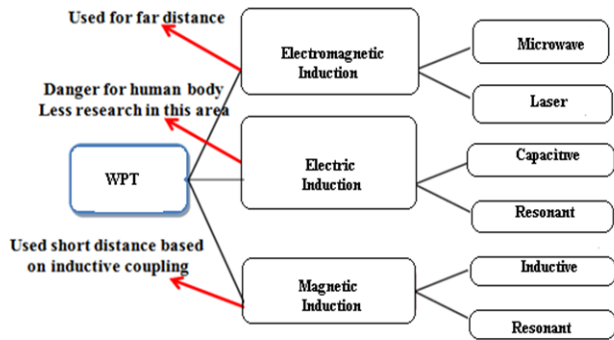
I. INTRODUCTION

Over 100 years ago, the concept of wireless power transmission began with the patented ideas and demonstrations by Tesla, he describes a method for utilizing acts transmitted through natural media". In this patent, Tesla describes several ways of transmitting electrical disturbances through the natural media: One of these ways consists of producing by a suitable apparatus rays or radiations that is disturbances which are propagated in straight lines through space, directing them upon a receiving or recording apparatus at a distance, and thereby bringing the latter into action. This method has been brought particularly into prominence in recent years through investigations by Heinrich Hertz." Though described in somewhat confusing legal language, it is obvious that the disturbances in Tesla's patent are electromagnetic waves. Claim 11 of this patent species that the patented method of utilizing or disturbances transmitted through the natural media

from a distant source, which consists in storing in a condenser electrical energy derived from an independent source, and using, for periods of time predetermined as to succession and duration, the accumulated energy so obtained to operate a receiving device. What is described above is wireless transmission of energy, storage of the energy in a capacitor and energy management over time.

Currently world is change into wireless technology every human need wireless devices. Wireless power transmission is a big issue for low power devices. As we know low power devices are like smart phone, Mp3 player, Digital camera, Laptop etc. These low power devices are used in our daily life, due to continues use we have to charge rapidly our device, for charging we are using some conducting charger which we mount on wall and connect with our device. When every system is wireless so there is need of wireless power transmission for low power device which will reduce this problem. We can transfer the power by two approach, first one is wire and second is wireless. There are two types of devices low and high power. We can transfer the power via wireless but those systems are having some issues. Basically there are three approaches for wireless power transmission it is depend upon distance that which approach we are using. For example if we want to transfer power in short distance so we can use induction based approach.

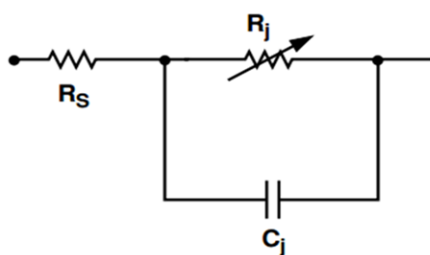
At present commercially there is wireless battery charger is available which is based on induction approach those system are known as PAD charger. There is some other approach for wireless power transmission and that approach is electric induction based. This approach is not good for human and environment so practical implementation of this approach is useless. Now finally there is one more approach which we can use for power transmission and that approach is electromagnetic induction which is done by microwave or RF signal. This approach we can use for far distance. But still this approach is having some challenges and in this work we will solve those challenges. Consequently, it is very difficult to estimate the amount of RF power that can be harvested at any location ahead of time. Fig. 1.1 shows the classification of wireless power transmission.



II. LITERATURE REVIEW

There have been many works done on RF energy harvesting. Most works are related to antenna design, antenna return loss and optimization of voltage doublers stages. Many authors tried to develop the patch antenna and spiral antenna to capture large amount of RF power.

The authors in [10] developed an optimization of the voltage doublers stages in an energy conversion module for Radio Frequency (RF) energy harvesting system at 950 MHz band is presented. Two 10 stage voltage multipliers were designed and the Agilent diode HSMS-2850 and HSMS-2822 were compared, Agilent's HSMS-286x family of DC biased detector diodes have been designed and optimized for use from 915 MHz to 5.8 GHz. They are ideal for RF/ID and RF Tag applications as well as large signal detection, modulation, RF to DC conversion or voltage doubling. The linear equivalent circuit model diode chip is.



Whereby C_j is the junction capacitance, R_j the junction resistance and R_s the series resistance. Expression for R_j is:

$$R_j = \frac{8.33 \times 10^{-5} \text{ nT}}{I_b + I_s}$$

Where:

I_b = externally applied bias current in amps

I_s = saturation current

T = temperature (K)

n = ideality factor

The authors in [5] developed the concept of transmitting power without using wires i.e., transmitting power as

microwaves from one place to another is in order to reduce the cost, transmission and distribution losses. This concept is known as Microwave Power transmission (MPT). They also discussed the technological developments in Wireless Power Transmission (WPT).

The authors in [9] presents an overview and the progress achieved in RF energy harvesting, which involves the integration of antenna with rectifying circuit. Different combinations of antenna and rectifier topologies yield diverse results. Therefore, this study is expected to give an indication on the appropriate techniques to develop an efficient RF energy harvesting system.

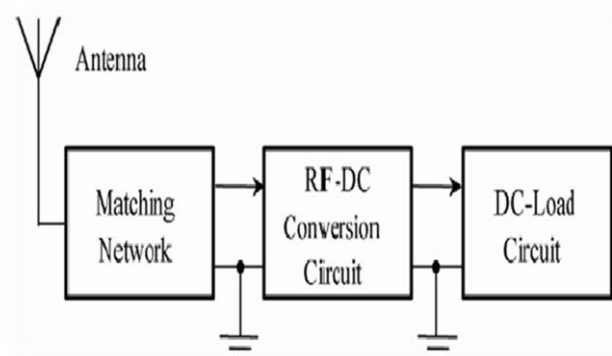
The authors in [13] presents a guideline to design and optimize a RF energy harvester operating in ISM Band at 902 MHz. The circuit is implemented on a standard FR4 board with commercially available off-the-shelf devices. The topology of the impedance transformation block is selected to reduce the losses which improves the overall performances of the system.

The authors in [2] presents an optimization of the voltage doublers stages in an energy conversion module for Radio Frequency (RF) energy harvesting system at 900 MHz band. The function of the energy conversion module is to convert the (RF) signals into (DC) voltage at the given frequency band to power the low power devices/circuits. The design is based on the Villard voltage doublers circuit. A 7 stage schottky diode voltage doublers circuit is designed, modeled, simulated, fabricated and tested in this work.

The authors in [7] simulated and designed 1,7, and 9 stage voltage multipliers which led to the final statement that are: Higher voltage can be achieved by increasing the number circuit stages and Voltage gain decreases with increasing number of stages.

III. METHODOLOGY

In this work we will design wireless power transmission which is based on RF-DC energy harvesting. Here we are using advance design system software. Through this advance design system software we will work on electronic component and radio frequencies. In this approach basically we are focusing on low power device like mobile phones which are used by almost all the peoples now a days. Due to continuous use of low power device we have to charge rapidly our device. Using this wireless power transmission we have to charge our low power device without wired.



Schematic view of a RF energy harvesting system

This is the block diagram of RF energy harvesting system which is divided into three major parts are antennas, matching network, RF-DC conversion circuit, DC-Load circuit. An antenna is a specialized transducer that converts a radio frequency field into alternating current or vice versa. There are two basic types of antenna. The transmitting antenna which is fed with AC from electronic equipment and generates an RF field where as the receiving antenna which intercepts RF energy and delivers AC to electronic equipments. During impedance matching, a specific electronic load is made to match a generator output impedance for maximum power transfer. The need arises in virtually all electronic circuit, especially in RF circuit design. The design of RF-DC conversion circuit used for energy harvesting system from ambient at downlink radio frequency. The function of this circuit is to convert the RF energy signal into DC voltage that can be used to energize the low power electronic device. The DC load circuit is used to store the energy.

IV. APPLICATIONS

As we know present era we are living in the age of wireless system where we will transmit & receive data using the channel of wireless. Similar after few years we will live in the era of Wireless Power Transmission. So there are many application of WPT those are wireless charger for electronic device like mobile phones, laptop, digital camera. Wireless power system for electronics system like electric tooth brush, mixer grinder. Remote area location based MCU power supply and also wireless node sensor power system. Generating power by placing satellites with giant solar arrays in Geosynchronous Earth Orbit and transmitting the power as microwaves to the earth known as Solar Power Satellites (SPS) is the largest application of WPT. Another application of WPT is moving targets such as fuel free airplanes, fuel free electric vehicles, moving robots and fuel free rockets. The other applications of WPT are Ubiquitous Power Source (or) Wireless Power Source, Wireless sensors and RF Power Adaptive Rectifying Circuits. The near field energy transfer are electric and consumer electronics, industrial purpose and for far field energy transfer are solar power satellites, energy to remote areas.

V. FUTURE WORK

In this paper we are using wireless power transmission for far distance. This approach is still having some challenging parameters are voltage, power, number of stages, distance between transmitter and receiver. So we will solve those problems by increase the strength of output DC voltage. So there is no need of conducting charger which we mount on wall and connect with our device. Because through wireless power transmission we can charge our device through wireless charger. The tool which we used for wireless power transmission is Advance Design System.

VI. CONCLUSION

Wireless power transmission is new and progressive area. As we are living in the era of wireless communication. So there is need of wireless power transmission system. But previous existing wireless power transmission is have some limitations

and problem. According to previous coil based magnetic induction is very dangerous for human life. But still with some good efficiency & modification there is some PAD based charger is available which is based on magnetic induction. But those charger have the limitation of distance. Now for complete wireless power transmission is under research area. Some researchers are present there model which is based on WPT (wireless power transmission) but those approach are having the issue with distance, efficient power generation, radiation issue. So in my approach we will try to reduce those previous existing problems.

ACKNOWLEDGMENT

The Authors thanks the Department of ECE at DR. C.V. RAMAN UNIVERSITY for facilitating the development of the project, making available resources for testing the system and also for final deployment.

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