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Novel & Optimization Technique for Wireless Power Transmission using multi Stage Voltage Doublers 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. 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. Many researchers are performing several analyses about the energy harvesting circuit of wireless power system. In this paper, such approach was also performed, with radio frequencies used as input power of energy harvesting circuit low power devices. 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. In this work, we present a new approach for generation of wireless energy using of 433MHz RF band with multiple stage of voltage multiplier. Advanced design system (ADS) simulator was used to design a multiple -stage voltage multiplier RF energy harvesting circuit Here our target distance is between 3-5m between transmitter and receiver antenna. We can also control the output voltage using of voltage regulator, according to connecting system we can set the certain range of voltage. In this work we are using Agilent HSMS-2860 Rf diode. The proposed system can be used to power low power devices like mobile, mp3 player, digital camera, laptop etc.

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

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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

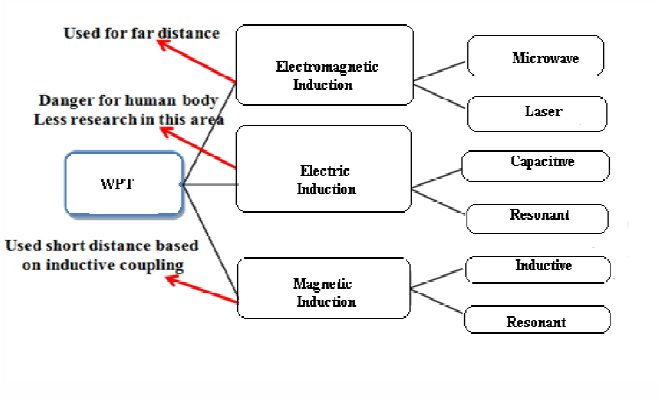

Fig. 1.1.

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.

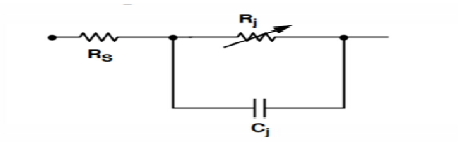

Fig.2.1 Linear equivalent circuit model diode chip

Whereby Cj is the junction capacitance, Rj the junction resistance and Rs the series resistance. Expression for Rj is:

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

Where:
Ib = externally applied bias current in amps
Is = 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 de- sign 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 paper Fig. 3.1 I design which is based on 433MHz ISM Band. According to my design, 433 MHz RF Transmitter which is generate RF signal with some amount of power. Using transmission antenna that signal is transfer to receiver section. At receiver section receiver antenna is receive transmitted RF signal with some amount of power. Now that signal is passing through the impedance matching network.
This network will match the input and output voltage means input voltage on RF-DC is equal to receive voltage at antenna. Now in next step receive voltage is pass from multi stage of RF-DC which will generate sufficient amount of voltage at filter. Filter is combination of RC network. Generated voltage is very heavy so we have to use voltage regulator which will set output voltage at particular level. Finally regulated voltage is passing through voltage regulator & at last final generated output voltage is pass on Low power devices. In this work we are use HSMS 2860 Agilent RF Diode which is working for high frequency range.

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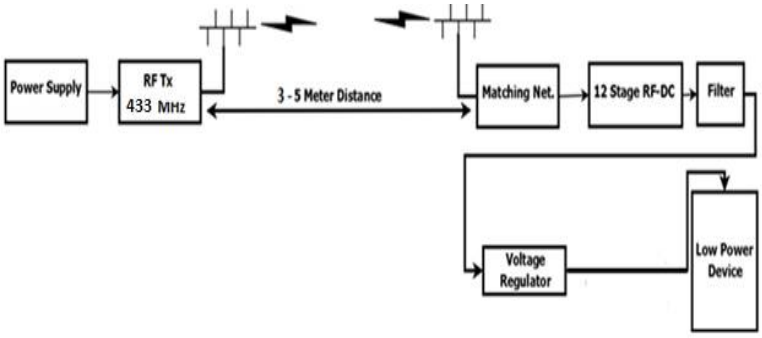

Fig.3.1 Wireless Power Transmission System

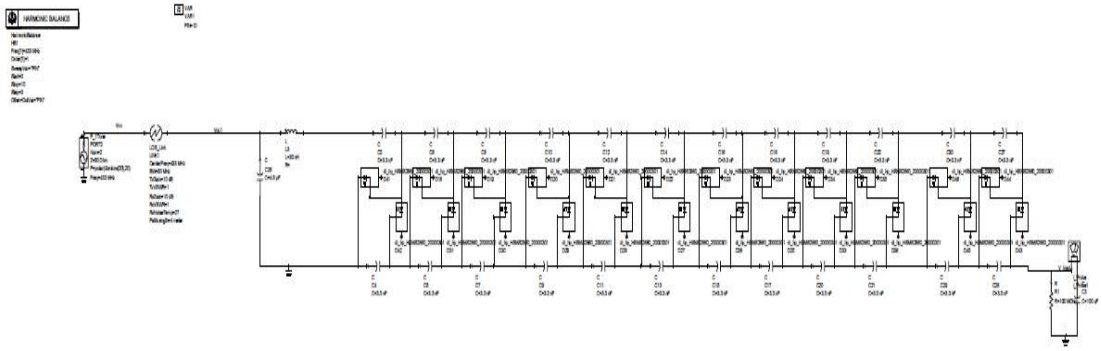

Fig. 3.2 Implementation Design

In Fig. 3.2 we will design our Voltage multiplier circuit by using of capacitor and HSMS2860 diode, where we will use total 12 stages which will increases the output voltage.
As we already know antenna is a biggest pain for this kind of design. So here we will try to use lower dbI antenna which will reduce the radiation issue. In our design we will use 10 dbI antenna for transmitter and receiver side. In this design at initial stage we will do impedance matching process because without that we are not able to transmit generated input power by source. After that we move to the voltage multiplier section.
Here we are targeting some of the very important parameters which will do comparative analysis with previous existing wireless power transmission technique. For comparison we will fix antenna dbI factor with 10 dbI on transmitter and receiver section. So these are the followings parameters for this analysis: **Voltage, Current, Power, Number Of Stages (Voltage Doublers), Distance between Transmitter & Reciever.**

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 ginder. 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.

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V. RESULTS

Here in fig. 5.1 will present all simulation result which is based in **Advance Design System Software.**
According to my design it is combination of 4 Steps:
Transmission Power Section
Transmission & Reception Section
Match Network
Voltage Multiplier
Load Circuit
Here we will show the study in terms of Voltage, Current, Cost.

Distance Between Transmitter and Receiver Antenna is 5 Meter:

Output Graphs:

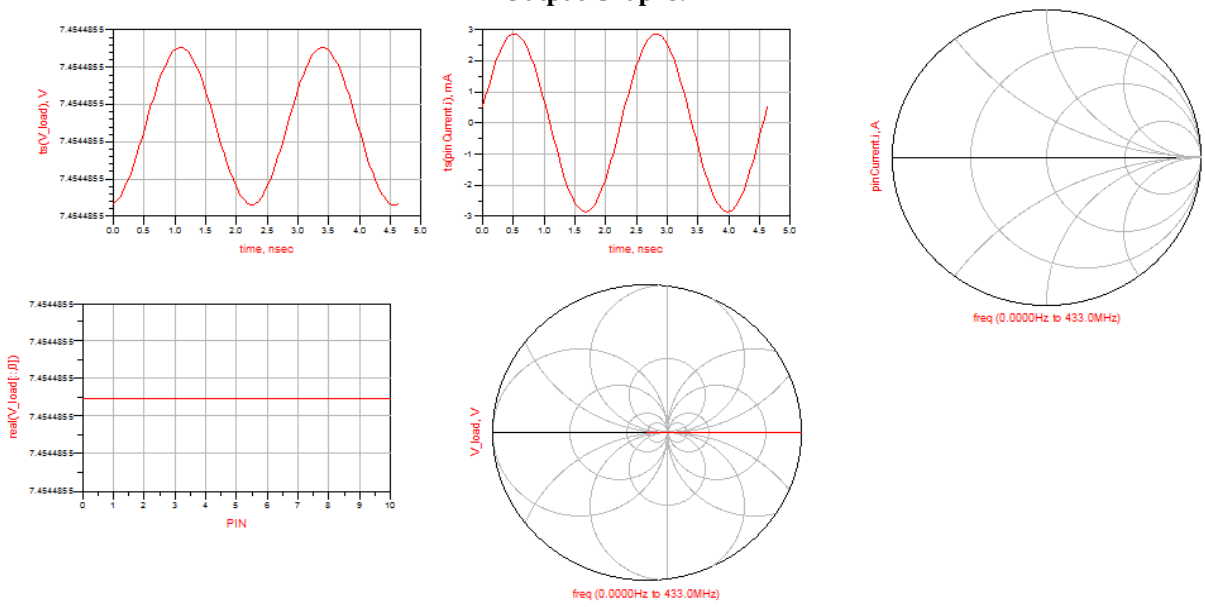

Fig. 5.1

The fig 5.1 is the output result which obtained by running the implementation design of fig. 3.2 .

VI.CONCLUSION

Basically we design a system which is use for wireless power transmission. The designed system is basically based on electromagnetic approach with operating frequency of 433MHz. As we already save previous existing issues of electromagnetic approach, so here we resolve some of those issues like we resolve distance problem here we are easily to make more than 7V for 5 meter distance. Similar in our design cost is very less as compare to previous approach because in our approach we are using total 24 RF diode which lesser than previous existing approach. Here our system is working for 10dbi so its easy to make this type of design because total number of radiation is less because it will generate approach 100mW, which is not dangerous for human life. In this approach our transmitter and receiver antenna is very good for radiation point of view it will generate very few amount of radiation.

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