ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol4, Issue 5, May 2017

Design and Development of RF energy sensing Circuit Using ADS software

[1] V. Sai Kiran [2] P. Vinay Kumar [3]Yogesh Kumar Choukiker
[1][2][3]Vellore Institute Of Technology, Vellore.

Abstract: **-- This article mainly focuses on study of RF energy Sensor circuit. We are surrounded with enormous Radio frequency signals, mostly varying in the range of 1 GHz to 3.5 GHz. An RF energy sensing Circuit has been designed, In Advanced Digital Simulation software, to detect the level of signal at a particular frequency and converting RF energy into voltage levels. In order to restrict our circuit to a particular frequency, we have designed a Helical Antenna as a receiver which can send RF power to designed circuit. This antenna is designed with particular dimensions such that it has minimum reflection coefficient at desired frequency, allowing only a particular frequency to reach RF sensing circuit.**

I. INTRODUCTION

Use of mobile phones has increased rapidly in recent years, which lead to increase in consumption of battery. Users have to constantly recharge their mobiles himself .Research's are made to minimize the utilization of battery, yet they lack at some point. Also places like wireless sensor nodes located in different places are difficult to access.

Utilization of RF energy sensor allows us to overcome these problems. Rectification of microwave signals to DC power has been proposed for various fields like Helicopter Powering [1],Solar power satellite [2], SHARP systems [3] and also RFID systems. This systemcan be well explained with figure 1.

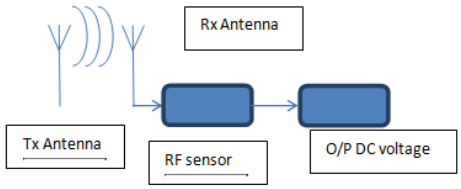

Figure 1: Block diagram of RF sensor working

In this paper we focus on receiving signal from Antenna which works on 3.5 GHz. Helical Antenna is designed in HFSS environment for both transmission and reception. The DC power received at RF sensing circuit depends on power received at Receiver antenna.

II. DESIGN OF RF ENERGY SENSING CIRCUIT

In order to design RF Energy sensor, we have chosen Villard Voltage Multiplier [4]. It is basically a circuit which clamps the input voltage level and uses an envelope detector to convert AC voltage into near DC voltage. A sample circuit of Voltage multiplier is shown in

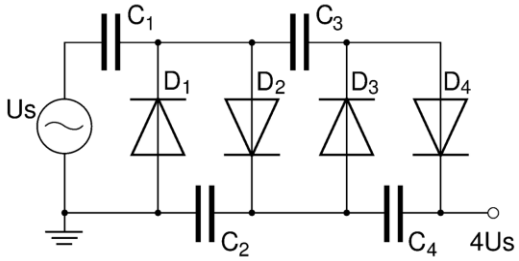

Figure 2.1. Voltage Multiplier

Figure .2.1 . This circuit is a combination of Diode and Capacitors. Diodes are used to allow one half of AC cycle while capacitors are used to store charges and generate voltage

Voltage Multiplier Diode used in Voltage multiplier plays a vital role. It has various specifications to which it allows different types of signals. For our specification which requires a Diode which can cooperate with signal at 3.5 GHz, we choose SchottkyBarrier Diode.

HSMS – 282X Schottky barrier Diode[5] has a characteristic to support signals which work at frequency greater than 2 GHz , Where 'X' is replaced with an integer which defines the type of connection used for Diodes.

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol4, Issue 5, May 2017

Different types of connections are given below as per the value of 'X' are given in table 2.1. Specifications of HSMS - 2822 Schottky Barrier diode is mentioned in table 2.2.

HSMS	Code	Lead Code	Configuration
2820	C0	0	Single
2822	C2	2	Series
2823	C3	3	Common anode
2824	C4	4	Common cathode

Table 2.1: Different configurations with varying codes

Bv	*Cj0*	*Eg*	*Ibv*	*Is*
15 V	*0.7 pF*	*0.69 eV*	*1E-4 A*	*2.2E-8 A*

Table 2.2: a) Specification for HSMS 2822 Diode

N	Rs	Pb	Pt	M
1.08	6 ohms	0.65 V	2	0.5

Table 2.2: b) Specification for HSMS 2822 Diode

III. VILLARD VOLTAGE MULTIPLIER

Villard Voltage Multiplier(VVM) circuit is an approach to convert RF received energy to DC voltage. Figure 3.1shows the block diagram of Villard Voltage Multiplier.

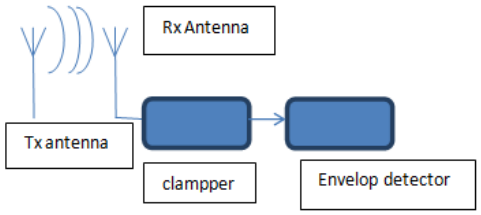

Figure 3.1: Block diagram of VVM

Advanced Digital simulation software is used to design Villard voltage multiplier circuit.Figure 3.2.shows single staged Villard voltage multiplier , with power source at left side, clamper in middle and envelop detector at rightend.

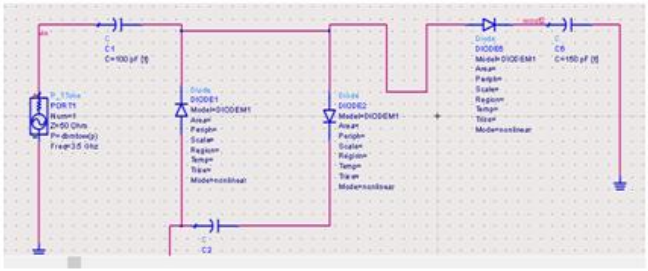

Figure 3.2 : Single staged Villard Voltage Multiplier

Clamper circuit can be cascaded to increase the storage level, with increase in number of stages,output DC voltage increases. 3 Staged Villard voltage multiplier is shown in figure 3.3.

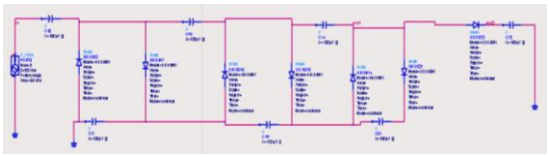

Figure 3.3.3 Staged Villard voltage multiplier

Since the power source attracts RF signals in environment, we need to select power from aparticular frequency. To do this, we have designed a Helical Antenna which acts a receiver and sends received power level to RF circuit

IV. DESIGN OF HELICAL ANTENNA FOR TX AND RX.

Helical antenna is designed to work at 3.5 GHz in HFSS software. Pitch and Radius are chosen accordingly so that it produces minimum reflection coefficient at 3.5 GHz.Values chosen for design are shown in table-4.1 and Helical antenna[6] is shown in figure 4.1.

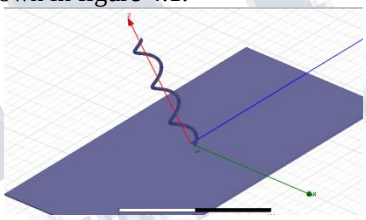

Figure 4.1: Helical Antenna Design in HFSS

Radius	Pitch	Turns	Frequency	Gain
6.175mm	30mm	3	3.5 GHz	10.161dB

Table 4.1 : Helical Antenna specifications.

Helical antenna designed in HFSS Helical antenna with above mentioned specifications is designed , Radiation patter is shown in Figure 4.2 and Reflection coefficient shown in Figure 4.3.

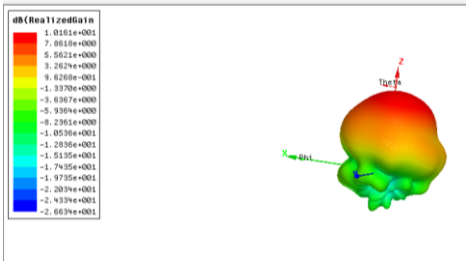

Figure 4.2: Radiation patter of Helical antenna

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol4, Issue 5, May 2017

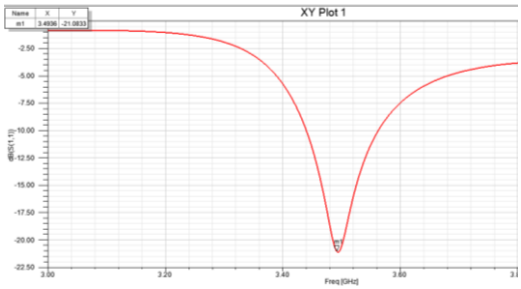

Figure 4.3: Reflection coefficent of Helical antenna

witha gain of 10.161 dB, Antenna behaves as a decent receiver. From this designed antenna, it sends power only from RF signals which resonates at 3.5 GHz.

V. OUTPUT POWER ANALYSIS

Once the power is received at RF energy sensing circuit, it undergoes clamping at initial stage. Clamped signal .Once the signal reaches Envelop detector, it is converted to DC signal. DC signal is shown in Figure 5.1.

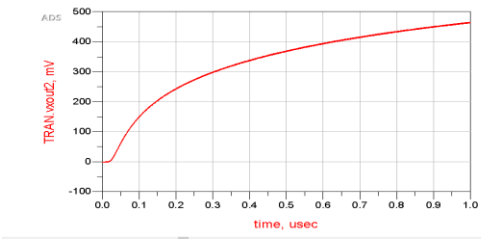

Figure 5.1: DC voltage Vs. Time output.

Similarly, Voltage level VS input power analysis is done in ADS environment, Figure 5.2 shows, output voltage level vs. input power for 1,2,3,4 – staged Villard Voltage Multiplier Circuits.

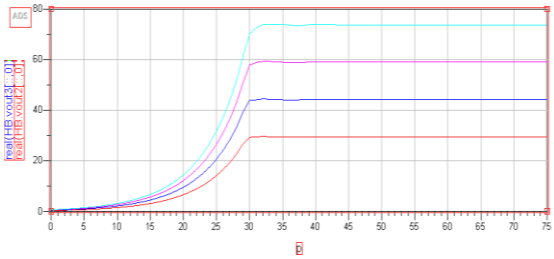

Figure 5.2: Output voltage Vs input Power

On observing output constant output voltage level at minimum input power, we can conclude that RF power received at Helical antenna can be converted to Detectable Voltage level using Villard Voltage Multiplier.

VI. FUTURE WORK

Since we have designed a circuit to convert RF signal sent at a particular frequency into DC voltage levels, we can provide a solution for an existing problem in society. Above circuit can be used to provide an alternative to clear traffic for Ambulance like vehicles, which are stuck in traffic.

Communication between Ambulance and Traffic pole is taken over with Helical antenna , which we designed earlier. Process of communication happens at 3.5 GHz. If an ambulance is detected near a traffic signal,receiver ,which constantly receives power from signals transmitting at 3.5 GHz, send power to RF energy sensing Circuit. Whena threshold levelof power is received, it gives a constant output DC voltage. This voltage can be sent to Micro-controller which controls all the traffic signals as an indication to clear traffic.

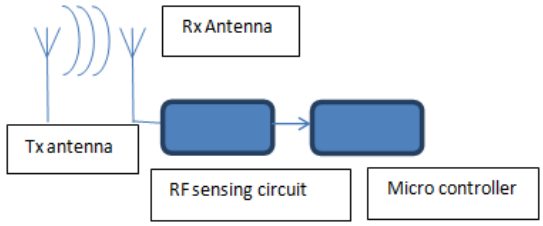

Figure 6.1.Shows Block diagram of entire system.

As per future works, We can improve the security, so that not everyone using 3.5 GHz are given access to control traffic signals. Advanced micro-controllers can be used to increase efficiency

REFERENCES

[1]. Brown, W. Mims, J. Heenan, N. "An experimental microwave powered helicopter"Raytheon Company, Burlington, MA, USA; 1965 IEEE International Record, vol. 13, part 5, pp. 225-235.

[2]. Hitoshi Hayami, Masao Nakamura, and Kanji Yoshioka "The Life Cycle CO2 Emission Performance of the DOE/NASA Solar Power Satellite System: A Comparison of Alternative Power Generation Systems in Japan" IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS PART C: APPLICATIONS AND REVIEWS, VOL. 35, NO. 3, AUGUST 2005.

[3]. East, T.W.R.; "Self-steering. self-focussing phased array for SHARP" Antennas and Propagation Society International Symposium, 1991. AP-S. Digest 24-28 June 1991 Page(s):1732 - 1735 vol.3

[4]. Investigation of RF Signal Energy Harvesting

[5]. HSMS-282x Surface Mount RF Schottky Barrier Diodes

[6]. John D. Kraus, "The Helical Antenna", Proceedings of the IRE, Volume 37, Issue 3, March 1949 Page(s):263 - 272W.

[7]. Constantine A. Balanis, "Antenna Theory: Analysis and Design", Second Edition, Page(s): 505-512.