iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 8 **Issue:** V **Month of publication:** May 2020

**DOI:** http://doi.org/10.22214/ijraset.2020.5053

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

# Energy Harvesting using 2.45GHz Rectenna for Powering Sensors in IoT Devices

M. Raghavandaar[1], M. Prathiksh[2], S. Revathy[3], H. Umma Habiba[4]
[1, 2, 3]*B.E. Student, Ph.D. Scholar,* [4]*Professor Department of Electronics and Communication, Sri Venkateswara College Of Engineering, Chennai, India*

***Abstract: Radio frequency energy transfer and harvesting techniques have recently become alternative methods to power the next generation wireless networks. The global move towards wireless access point (AP) densification has alluded towards the possibility of harvesting the unused ambient RF energy, especially in the industrial, scientific and medical band (ISM), in order to power useful electronic devices which collectively make up the so called low energy internet of things (LEIoT). Radio frequency process heating, microwave oven, medical diathermy machines, cordless phones, Bluetooth devices, near field communication devices, garage door openers, baby monitors and wireless computer devices uses the ISM frequencies. These untapped sources of energy grow more and more as a result of the rapid growth in the wireless communication business hence, there is a need to find a new method and means of collecting the ambient RF energy present in the environment and transforming that energy into electrical power. So backing this need a 2.45GHz rectenna based RF energy harvester for powering sensors in IoT devices is designed. Here a 2.45GHz antenna is integrated with rectifier to form the rectenna. The antenna consists of a rectangular patch embedded with feed line designed using the inset feeding technique using the EM simulation tool. By proper port matching good return loss is achieved with reasonable gain and diversity (of the antenna), DC voltage and power (of the rectenna) are analyzed from the simulated results.***
***Index Terms: AP; ISM; IoT; rectenna; energy harvester.***

## I. INTRODUCTION

The Internet of Things will radically alter our world through "smart" connectivity, save time and resources, and provide opportunities for innovation and economic growth. Basis for this is a wealth of information, which enables new forms of automation. Wireless sensors play a key role on the way to the Internet of Things. They are the tools needed to capture and transmit the first data bit in an IoT system. A key requirement for IoT is the ability to place wireless sensor terminals in all kinds of locations to collect data. But there is one big issue: the installation of power-distribution wires, or, in the case of battery use, the battery life or the time period for battery replacement. Nobody would find this a problem with 10 or 20 batteries, but when there are 10,000 or a million or a hundred million, there are concerns not only for battery costs but also the enormous scale of maintenance expenses. This is one reason the dissemination of wireless sensor terminal has become a concern.

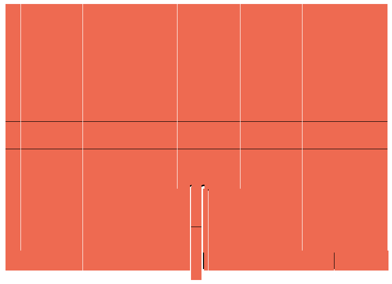
Energy harvesting may provide a solution. Energy harvesting technologies use power generating elements such as solar cells, piezoelectric elements, and thermoelectric elements to convert light, vibration, heat energy and radio frequency into electricity, then use that electricity efficiently [1-3]. When using energy harvesting, there is a point to be considered striking a balance between power generation and power consumption [4-5]. This is because the device will not work if the power generation is smaller than the power to be consumed by the device. Although the generating characteristics of power generating elements are improving year by year, it is difficult to continuously deliver sufficient power to a device on an ongoing basis. A way to solve this is to collect the generated power from the rectenna in a capacitor and execute sensor operation at intervals, resulting in a method that balances the power generation with the power consumption. This paper presents energy harvester for IOT application using the 2.45GHz rectenna operating in the ISM band.

## II. DESIGN OF 2.45GHz RECTENNA

The evolution of the 2.45GHz rectenna is initialized by designing the antenna first then followed by the rectifier and then combining them to form the rectenna. The antenna consists of the rectangular patch designed using the inset feeding technique which forms the top conductor as shown in Fig.1. Then the antenna is made to operate at the desired ISM band frequency (2.45GHz) using proper optimization techniques as given in Fig.2. Then the designed rectifier is attached to the port of the antenna to make it work as rectenna as in Fig.3.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429*
*Volume 8 Issue V May 2020- Available at www.ijraset.com*

The rectifier circuit is a vital part of the rectenna since it decides the RF to DC conversion efficiency. The rectifier circuit consists of a matching circuit, voltage multiplier circuit (converts RF to DC) connected to a storage capacitor and a resistive load. The antenna total dimension is 36.5mm x 29.5mm x 0.8mm with the rectangular patch dimension of 36.5mm x 28.5mm x 0.8mm. The configuration of Schottky diode used is HSMS2862. A value of 1.2Pf, 7Pf, 7Pf, 7Pf, 7Pf, 100pF and 1.2pF are adopted for C1, C2, C3, C4, C5, C6 and L1 after tuning the rectifier circuit. Finally, the circuit is terminated with a resistive load of 1 simulated S11 result obtained is 24dB.



KΩ. The

Fig.1. Layout of 2.45GHz antenna

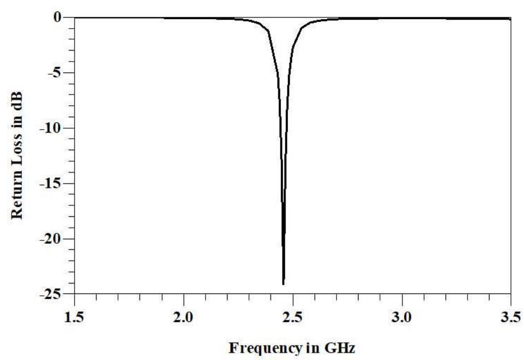



Fig.2. Simulated S11 result of 2.45GHz antenna

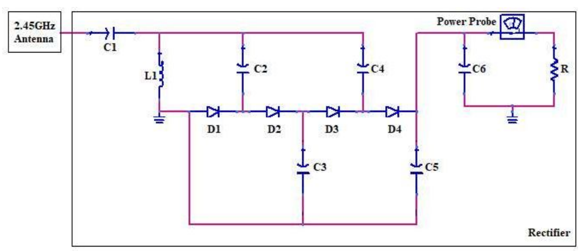



Fig.3. Layout of rectenna for 2.45GHz operation.

## III. RESULTS AND DISCUSSION

Fig.5 and Fig.6 shows the 3D radiation pattern, gain and directivity of 2.45GHz antenna. The radiation pattern is directional. The directional antenna radiates in a particular directions in the azimuth plane. The pattern in any orthogonal plane is directional in nature and so this antenna meets the definition. The Fig.7 shows the current distribution at the center frequency for various phase angles. The converted DC voltage and power is 7.9V and 0.06W respectively is shown in Fig.8.

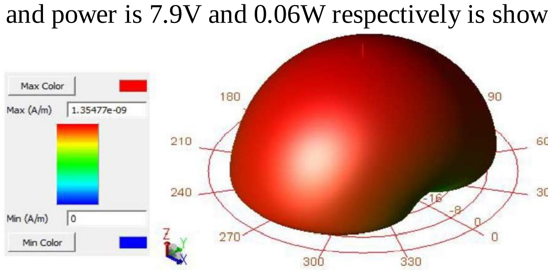



Fig.5. 3D Radiation pattern of 2.45GHz antenna

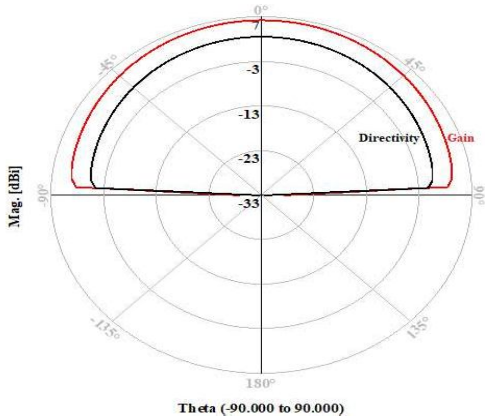
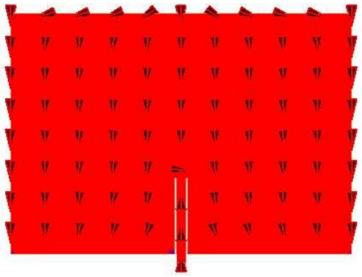
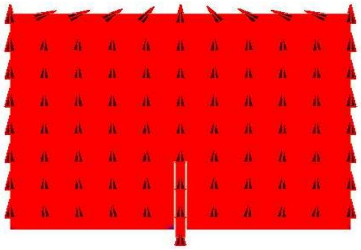


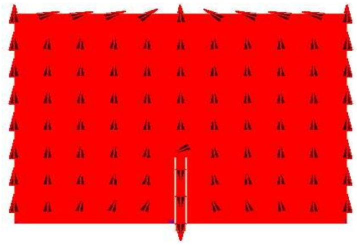

Fig.6. Gain and directivity of 2.45GHz antenna



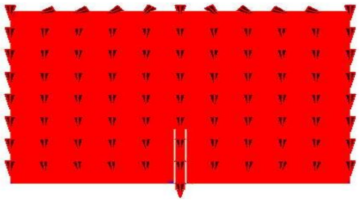
(a)



(b)



(c)



(d)

Fig.7. Current distribution of 2.45GHz antenna at (a) 0/360, (b) 90, (c) 180 and (d) 270 degree phase

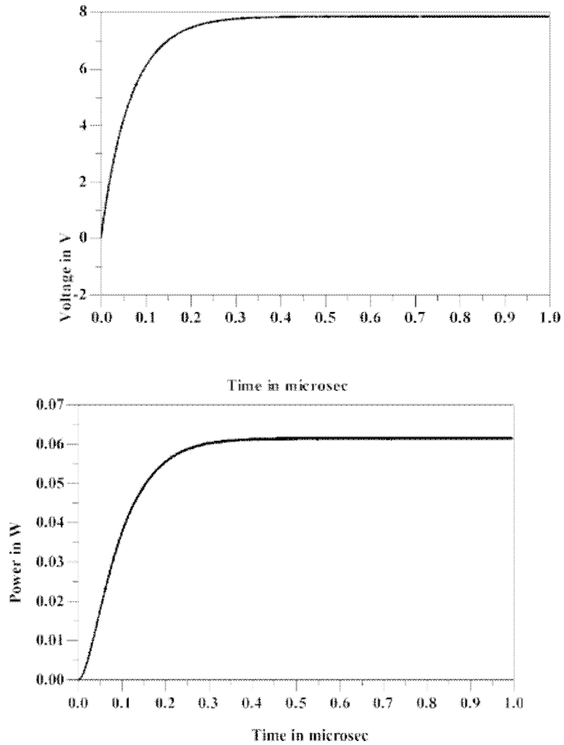


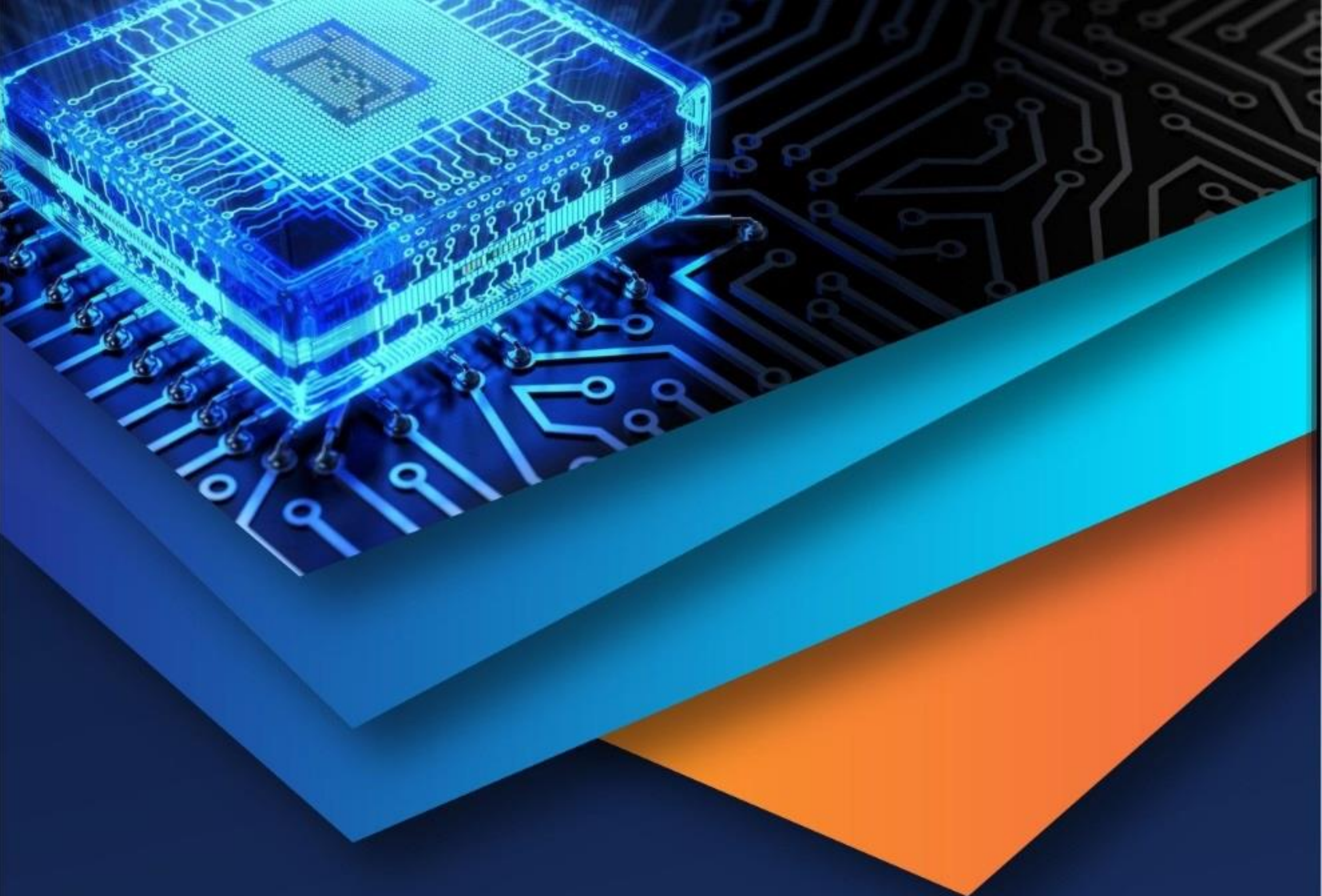

Fig.8. Output DC voltage and power of the 2.45GHz rectenna

## IV. CONCLUSION

In this paper, the performance of a 2.45GHz antenna and rectenna has been verified with the good return loss and the proper matching respectively. The antenna operates well at return loss of 24dB at the 2.45GHz and the size is 36.5mm x 29.5mm x 0.8mm which is enough to harvest required amount of energy to power sensors. The 2.45GHz frequency and good return loss of the antenna is achieved by proper matching which is a good candidate in energy harvesting for IoT application. In future the efficiency of the rectenna can be calculated by varying the load resistance value by calculating the respective voltage and current. The converted DC voltage and power is 7.9V and 0.06W respectively.

## REFERENCES

[1] P. E. Glaser, "Method and apparatus for converting solar radiation to electric power," US Patent, no. 3781647, Dec. 1973.
[2] Thorat Ashwini Anil, Prof. Katariya S. S., " Solar Power Satellite", IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) ISSN: 2278-2834, ISBN: 2278-8735, PP: 59-64.
[3] J. O. Mespadden and J. O. Mankins, : "Space Solar power programs and microwave wireless power transmission technology," IEEE Microwave Mag., pp. 4657, Dec, 2002.
[4] Young-Ho Suh, Student Member, and Kai Chang., " A High-Efficiency Dual-Frequency Rectenna For 2.45- And 5.8-Ghz Wireless power Transmission", IEEE Transactions on Microwave Theory and Techniques, Vol.50, No.7, July 2002.
[5] Rakesh Kumar Yadav, Sushrut Das and R. L. Yadava, Rectennas design, development and applications", Rakesh Kumar yadav et al. International Journal of Engineering Science and Technology (IJEST), ISSN: 0975-5462, Vol.3, No.10 October 2011.
[6] M. S. Alam, M. T. Islam and N. Misran, " Design Analysis of an Electromagnetic Band Gap Microstip Antenna", American Journal of Applied Sciences 8 (12): 1374-1 377, 2011.
[7] Akhil Nair" Use of Geosynchronous satellites for production and wireless transfer of solar power" Proc. of the second International Conference on Advances in Computing, Control and Communication (CCN), 2012.
[8] Norhanani ZAKARIA, Sharul Kamal Abdul RAHIM, Thean Song OOI, Kim Geok TAN, Ahmed Wasif REZA, MohdSubri Abdul RANI, "Design of stacked Microstrip Dual-band Circular Polarized Antenna", radio engineering, VOL. 21, NO 3, Sep 2012
[9] M. S. A. Rani, S. K. A. Rahim, A. R. Tharek, T. Peter, and S. W. Cheung, " Dual- band Transparent Antenna for ISM Band Applications", PIERSProceedings, Taippei,March25_28,2013.
[10] Sajina Pradhan, Seong-Ro, Lee Sun-Kok Noh and Dong-You Choi, "Comapartive study of Rectenna for Electromagnetic Energy Harvesting", International Journal of Control and Automation Vol.7, No.3, pp.1 01 -1 12,2014.




10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429


# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY