A Rectenna for Smart Manufacturing IoT RF Energy Harvesting Applications

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Abstract

Recently, due to the development of wireless sensing systems for use in Smart Manufacturing, there has been an increase in the demand for low cost, small form factor, highly efficient autonomous sensor nodes with built in energy harvesting, management and storage technologies. In this poster, a compact rectenna with lowpass (LPF) structure for Internet of Things (IoT) RF energy harvesting applications is presented. For passing DC frequency and suppression of unwanted harmonics, an integrated LPF structure is designed at 1.96 GHz cut-off frequency using a radial resonator. A zero bias Schottky diode SMS7630-079LF is utilized as a rectifier part. A circular patch antenna is designed and optimized to resonate at 2.4 GHz IoT/ Wi-Fi band. A microstrip matching network is designed between the proposed antenna and rectifier to achieve maximum power transmission and optimised response. The presented topology is designed on high frequency FR4 substrate with thickness 62mil (1.6 mm), dielectric constant 4.4 and loss tangent 0.019. According to the results, by using the proposed LPF structure, second to fifth harmonics have been suppressed with high rejection level. The proposed rectenna depicts a very efficient behaviour as the power received by the patch antenna.

I. Introduction

Todays, RF energy harvesting systems and wireless power transmission circuits have a vital role in next generation wireless and IoT communication systems. Lowpass Filters (LPFs) with small size, high selectivity, sharp response, wide stopband and low insertion loss (IL) are used next generation communication systems for suppression of unwanted signals and harmonics on rectifying diode circuits [1]. A low cost topology for an energy harvesting 2.4 GHz rectenna is presented in [2]. A comprehensive review on the design, methodology and applications of energy harvesting is proposed in [3]. In such IOT oriented RF energy harvesting systems, the antenna has the dual role of data transfer as well as power generation. As such, the design and fabrication of antennas with high gain, high efficiency, low cost and enough bandwidth is critical [4].

II. Proposed Rectenna

- Microstrip Antenna
- Pi Type, Matching Network
- Schottky Diode, SMS7630-079LF
- Harmonic Suppression Structure, LPF

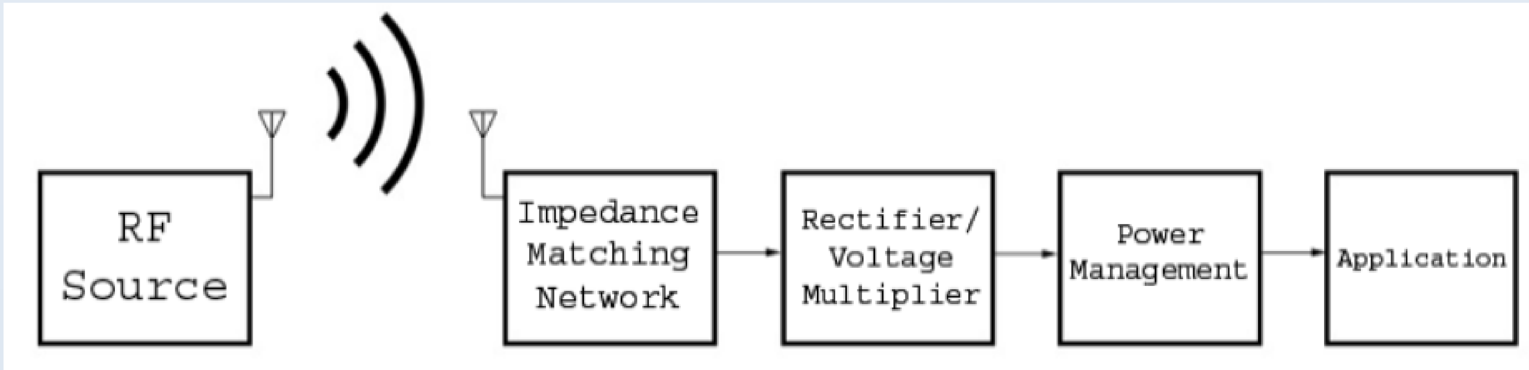


FIGURE 1. RF Energy Harvesting Block Diagram.

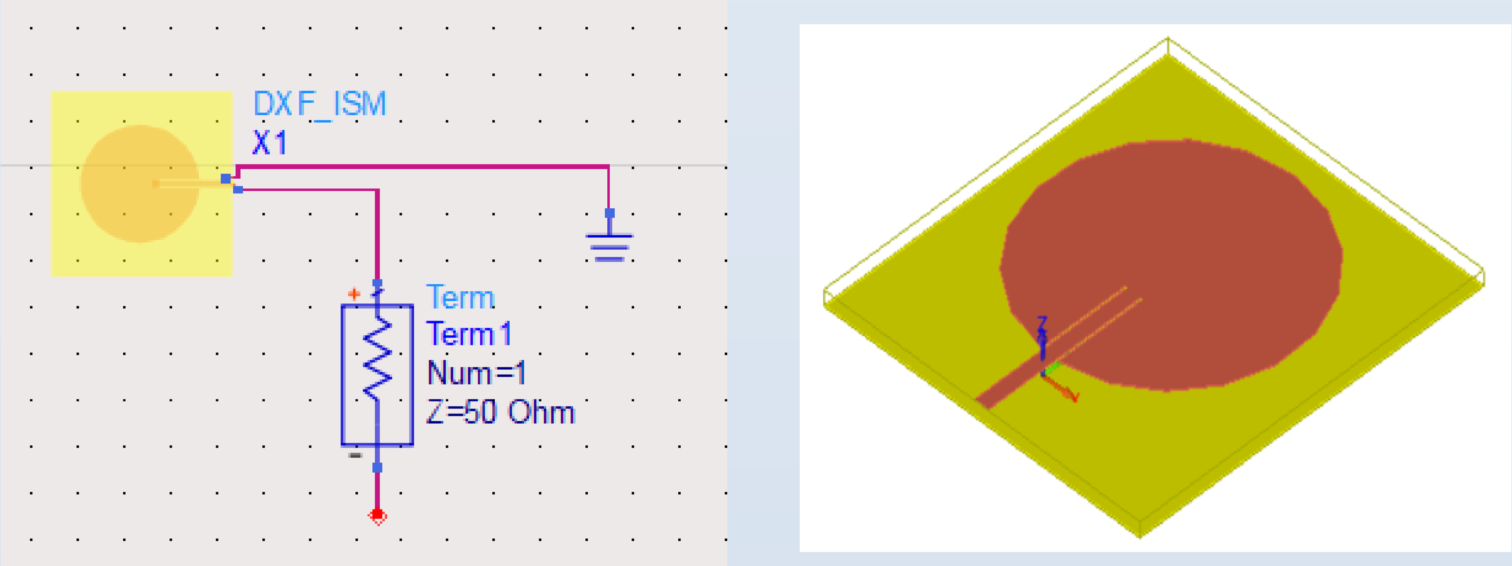


FIGURE 2. Proposed Microstrip Antenna.

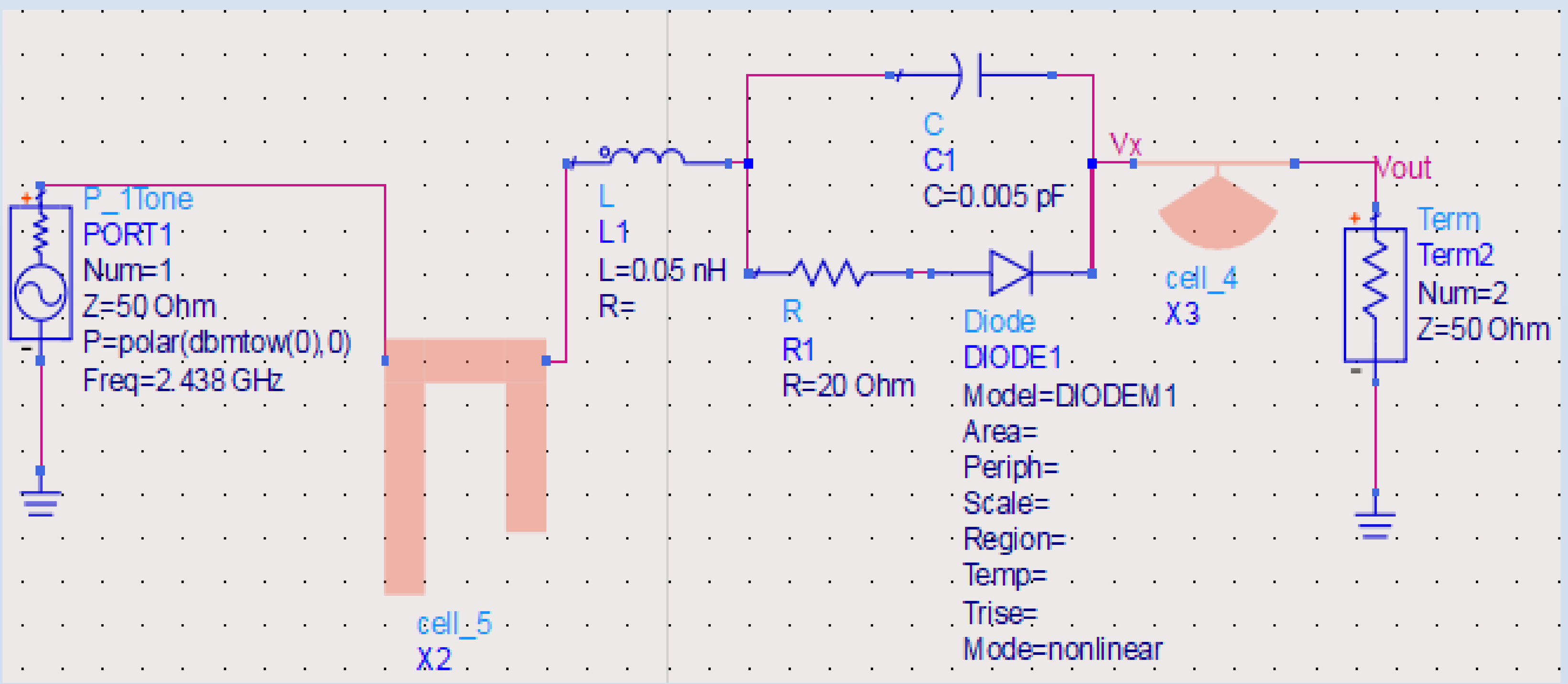
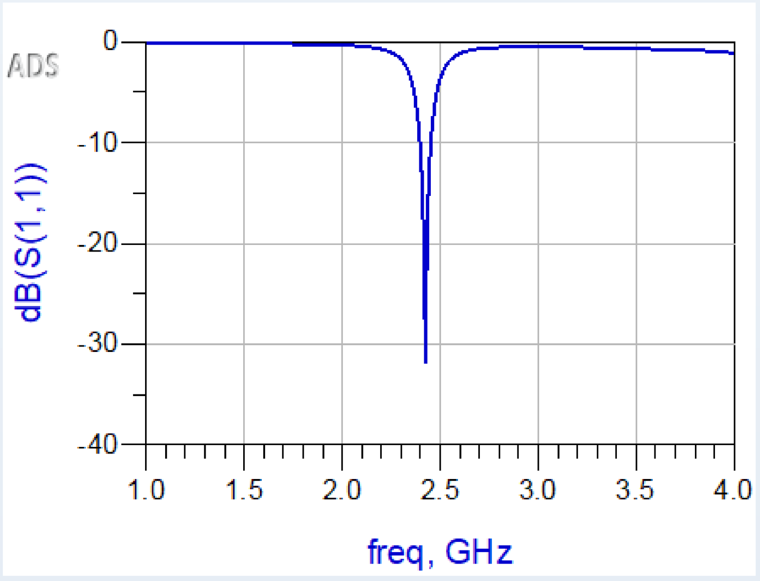


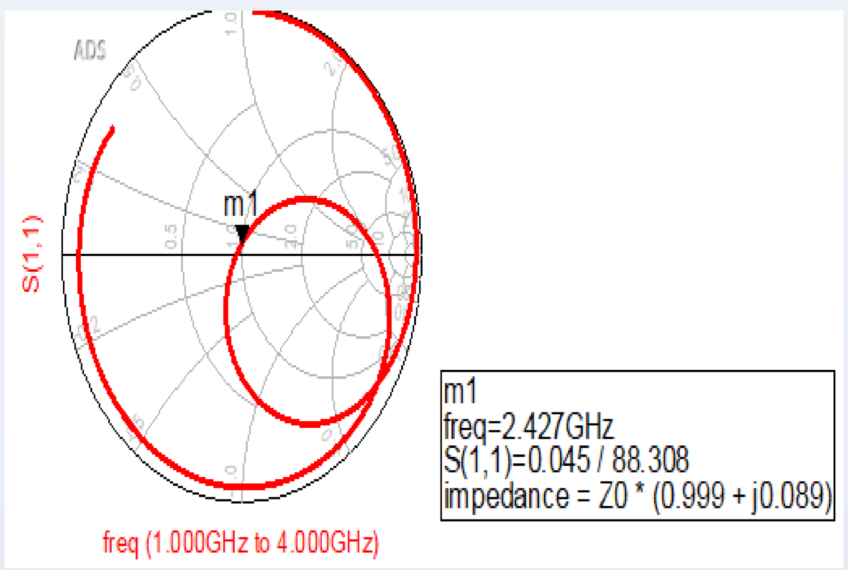
FIGURE 3. Proposed Rectifying Circuit.

III. Results and Discussion

Microstrip Antenna:

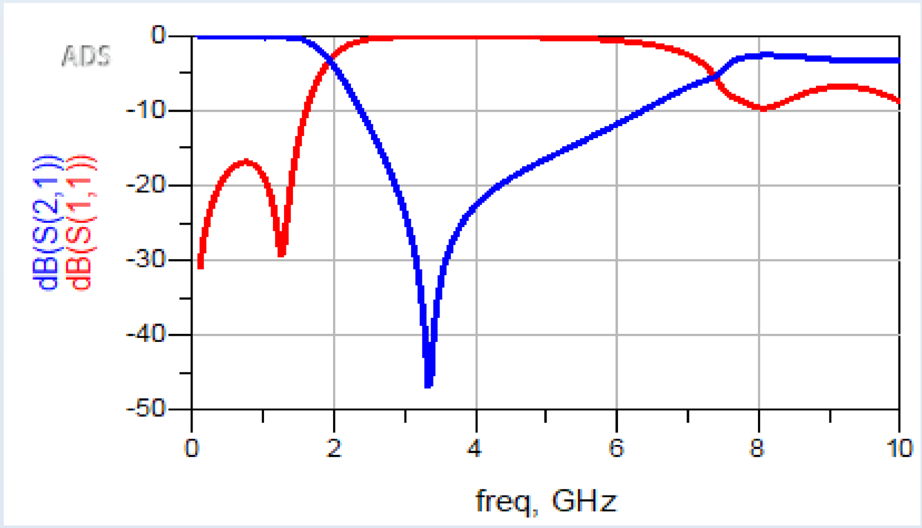
dB(S(1,1)= -32, Input Impedance= very close to 50 Ohm,





Microstrip LPF:

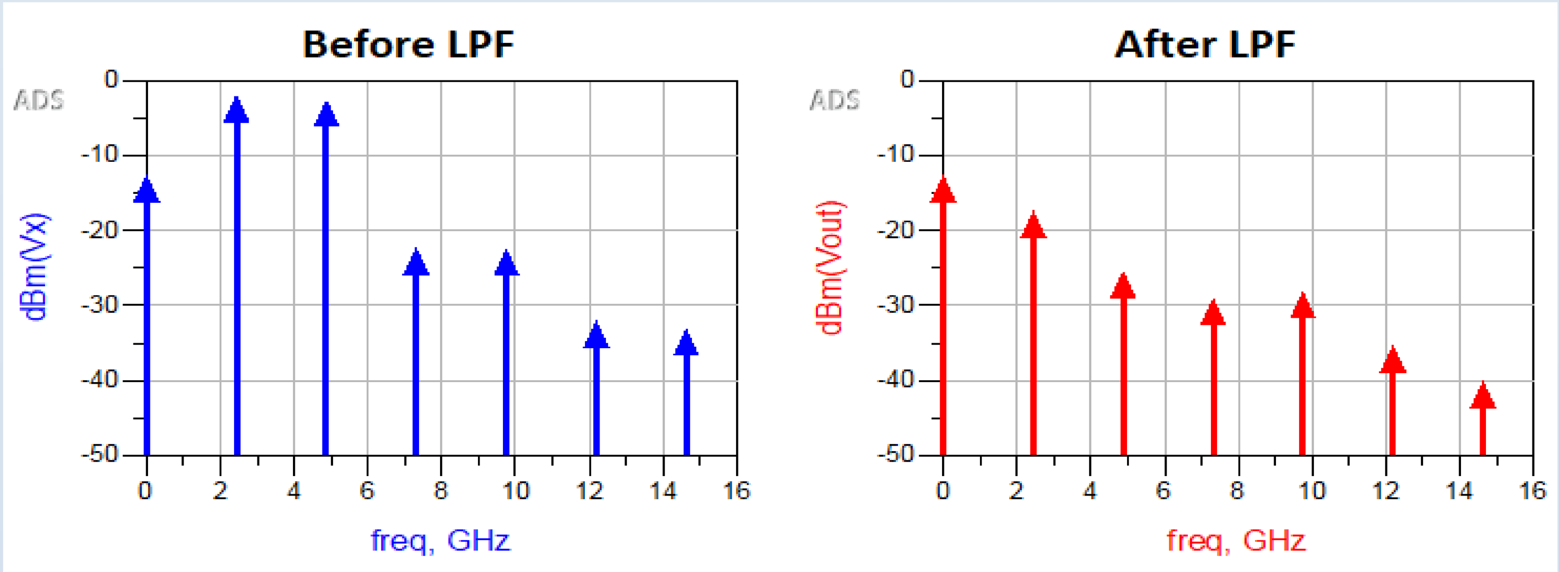
Cut-off Frequency= 1.98 GHz, Stop band Bandwidth=2.38-6.4 GHz

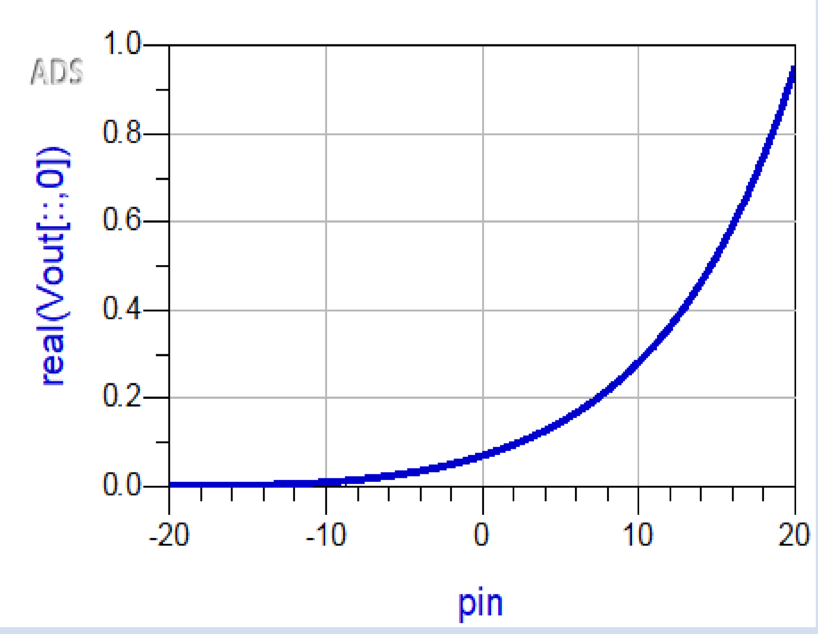


Rectenna:

Harmonic Suppression: 2nd to 7th, with high attenuation level

Vout: 0.01to 0.9 Volt, Pin:-20 to 20 dBm





Advantages:

- A simple and comprehensive topology
- Using in Wireless applications
- Harmonics suppression
- Well matching network between all of parts
- Affordable using low-cost substrate and technologies
- Good simulation results

Conclusion and Future Work

- This work presents the design of a rectenna with harmonic suppression structure for IoT smart manufacturing RF energy harvesting systems.
- According to obtained results, the proposed topology has a good results at 2.4 GHz, high level attenuation level of harmonic suppression and suitable DC output voltage.

** Future work will focus on design, simulation, fabrication and measurement a comprehensive rectenna for RF energy harvesting applications.*

References

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