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RF Harvesting Patch Antenna at 1.8 GHz

Zankhana Pandya[1*], Chalcy Nadar[2], and Abhimanyu Chaurasiya[3]

Department of Electronics and Telecommunication, Atharva College of Engineering
Mumbai-400095, India. Email: zankhanapandya97@gmail.com
Department of Electronics and Telecommunication, Atharva College of Engineering
Mumbai-400095, India. Email: chalcynadar456@gmail.com
Department of Electronics and Telecommunication, Atharva College of Engineering
Mumbai-400095, India. Email: Abhimanyuchaurasiya98@gmail.com

ABSTRACT

In this paper, a 1.8GHz conformal microstrip antenna with the main radiator as a rectangular patch made of copper is designed for Radio Frequency (RF) applications. The parameters examined to measure the performance of antenna are VSWR, Radiation pattern, far-field patterns, Directivity and Gain using HFSS software. Simulation of the proposed patch antenna and relevant adjustments of parameters gave values for the antenna to work efficiently at low cost. FR-4 epoxy material is used as the substrate. The proposed conformal antenna achieved to operate at 1.8 GHz with a directivity value of 5.4299 dB, a gain value of 2.4425 dB and an efficiency value of 44.98%.

KEYWORDS:RF Harvester, 1.8 GHz, Microstrip patch antenna, Voltage Doubler.

***Corresponding author**

ZankhanaPandya

Department of Electronics and Telecommunication,

Atharva College of Engineering

Mumbai-400095, India.

Email: zankhanapandya97@gmail.com

1 INTRODUCTION

Jagadish Chandra Bose pioneered wireless communication in India in the 1800s[1]. He invented a radio wave receiver which led to the development of radio communication. Since then, wireless communication has been one of the promising areas in the domain of communication. Cellular mobile, Bluetooth and Wi-Fi system are examples of a wireless communication system. Wireless communication using radios, telephones, mobiles has been increasing at an exponential rate. This increased use of wireless devices and EM wave broadcasting in space has led to the development of systems that can harvest this ambient energy to power small electronic devices. The antenna is a vital part of any wireless communication system. It is used for coupling the guided medium and free-space. Microstrip antennas are useful because they are lightweight, inexpensive and conformable. They are typically used at frequencies between 1GHz to 100 GHz. The harvested RF signals are passed to a rectifier which converts AC power to DC power.

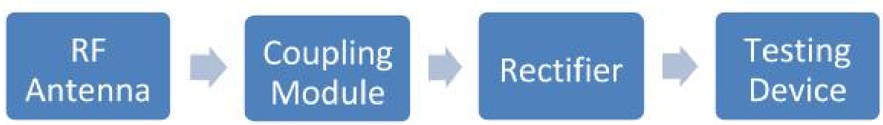

Figure 1: Block Diagram

The RF harvester comprises of a microstrip patch antenna tuned at 1.8GHz, an SMA connector which provides the 50-ohm impedance match between the patch antenna and rectifier. The rectifier takes an AC voltage as input and a DC voltage is obtained as output. A multimeter measures the collected DC power.

2DESIGN AND FABRICATION OF ANTENNA

The microstrip patch antenna is a key building block in wireless communication and global positioning system. Patch antennas are low profile and hence are easy to mount on a flat surface. Basically, a microstrip antenna is formed of a printed antenna patch on one side and a metallic ground on the other side. Patch antennas can be easily fabricated and customized. Rectangular patch antennas are extensively preferred among all patch antennas. A rectangular metallic patch is placed on the substrate, which affects its radiation pattern as well as impedance.

In this paper, a 1.8 GHz frequency band is selected as the operating band. Operators such as Telenor and Reliance Communications have proven that 1800 MHz can deliver high-speed broadband services. Department of Telecom undertook a harmonization exercise that makes 1800MHz more efficient.

To find the physical parameters of the antenna, we use the following formulas:Calculation of the width

$$W = \frac{c}{2 f_0 \sqrt{\frac{\varepsilon_r + 1}{2}}} \quad \text{(i)}$$

Calculation of the effective dielectric constant

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + \frac{12 h}{W}\right]^{-1/2} \quad \text{(ii)}$$

Calculation of the effective length

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{eff}}} \quad \text{(iii}$$

Calculation of the length extension

$$\Delta L = 0.412\, h \frac{\left(\varepsilon_{eff} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{eff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)} \quad \text{(iv)}$$

Calculation of the actual length of the patch

$$L = L_{eff} - 2 \Delta L \quad \text{(v)}$$

Length of ground plane

$$L_g = L + 6 h \quad \text{(vi)}$$

$$W_g = W + 6 h \quad \text{(vii)}$$

$$L_f = \lambda_g / 4 \quad \text{(viii)}$$

Width of ground plane

$$W_g = W + 6 h \quad \text{(ix)}$$

Length of feed line

$$L_f = {}^{\lambda_g}/_4 \quad \text{(x)}$$

Where,

$$\lambda_g = \frac{\lambda}{(\varepsilon_{eff})^{0.5}} \quad \text{(xi)}$$

$$W_f = \frac{7.48\,h}{e^{\left(\frac{Z_0(\varepsilon_r + 4.14)^{0.5}}{87}\right)}} \quad \text{(xii)}$$

Where f_0 is the resonant frequency, h is the thickness, ε_r is the relative permittivity of the dielectric substrate, c is the speed of light.

After little iteration, the optimized values of the parameters are denoted in the Table.

Table No.1: "Parameter values"

S.No.	Parameter	Value (mm)
1	GND (Length x Breadth)	79.8 x 69.3
2	Patch (Length x Breadth)	71 x 38
3	Feedline (Length x Breadth)	21 x 2.99

Using the above-listed formulas the theoretical values have been calculated. The practical values are obtained after optimizing the calculated values using HFSS. HFSS is a highly efficient full-wave electromagnetic field simulator. We can obtain radiation patterns; return loss, inputimpedance, E-field, H-field and current distributions as well as the gain and directivity information using the software.

For our proposed prototype antenna we have FR- 4 as a substrate with 4.4 dielectric constant and 1.6mm thickness. The geometry of the given antenna is illustrated in Fig. 3.

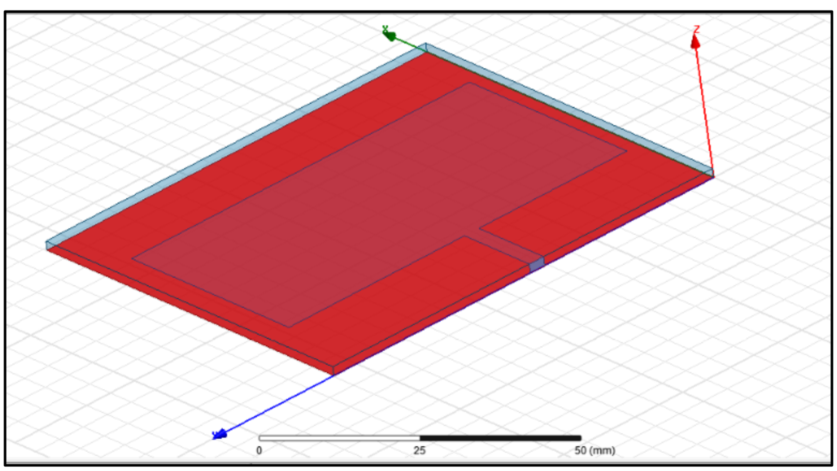

Figure 2: The rectangular microstrip patch antenna

3 RESULTS

3.1 Return loss

Return loss is the loss of power in the signal reflected or returned by the discontinuity of the transmission line. The higher the negative value of the S-parameter, the greater is the accuracy. It is measured in dB.

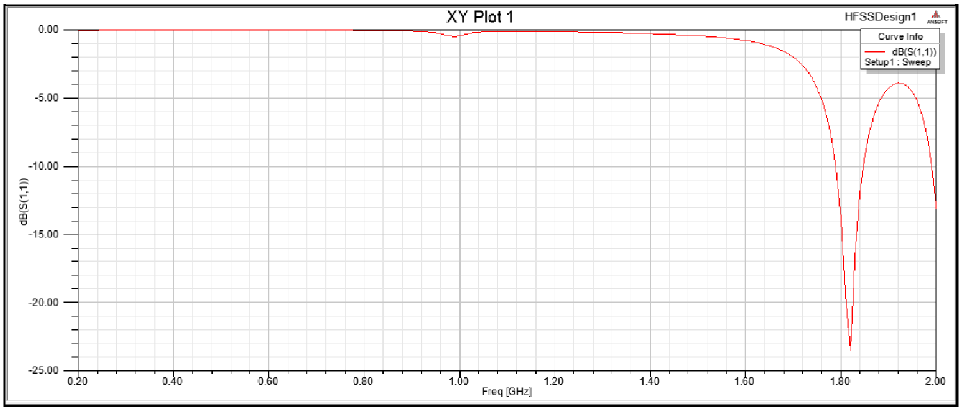

Figure 3: Return loss plot

3.2 Voltage Standing Wave Ratio

It is defined as a measurement of the mismatch between the load and the transmission line.For the ideal case or better matching, the value of VSWR is 1.

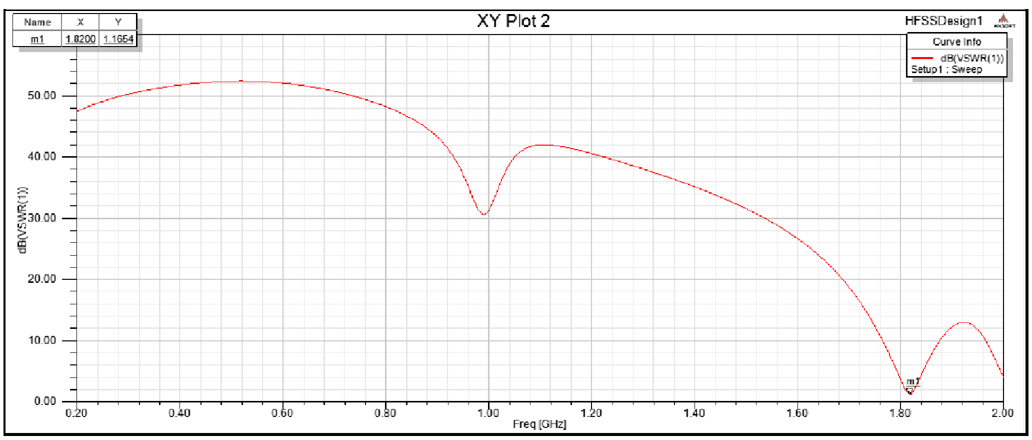

Figure 4: VSWR plot

3.3 Gain

Gain is the ratio of the radiation field intensity of the designed antenna to that of the omnidirectional antenna. It is measured in dB.

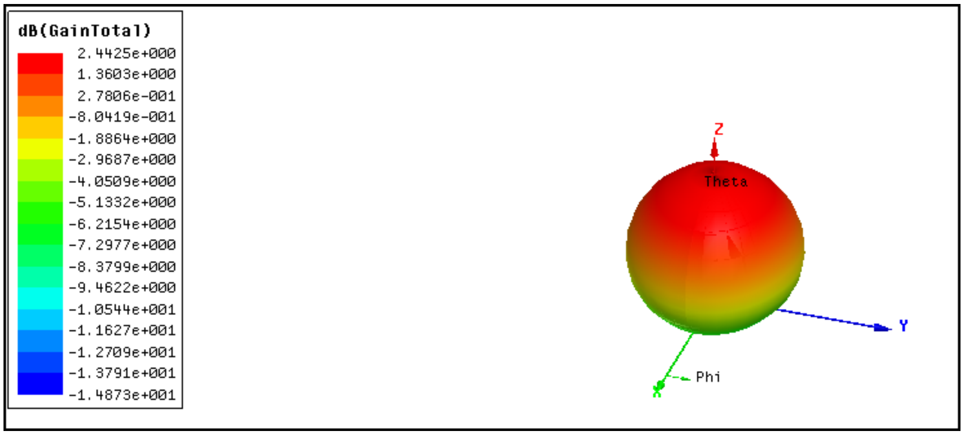

Figure 6: Gain plot

3.4 Directivity

Directivity is the quantitative measure of max gain obtainable in a particular direction. It is measured in dB.

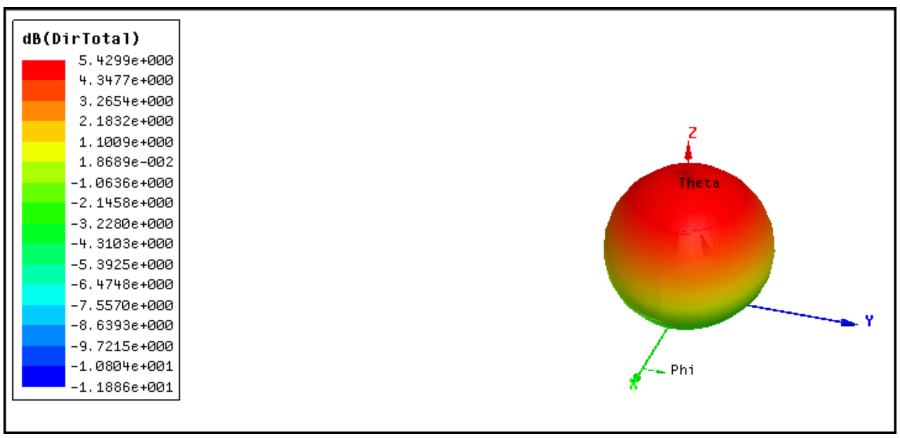

Figure 7: Directivity plot

3.5 Radiation Pattern

Radiation patterns are the graphical representation of the electromagnetic power distributed in free space.

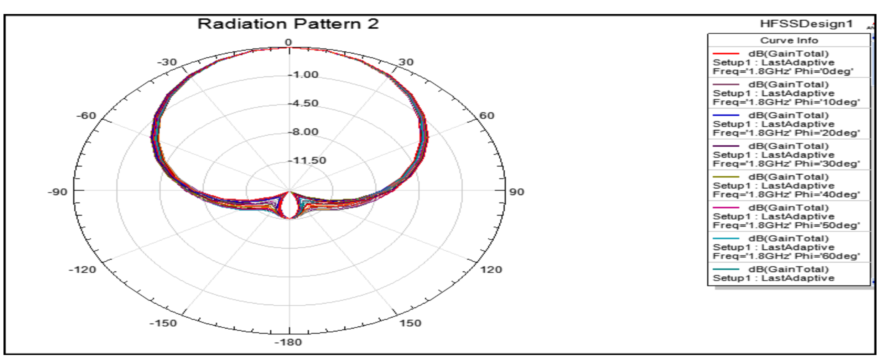

Figure 8: Radiation Pattern

4 TESTING OF ANTENNA

The antenna was tested using a network analyser. The results confirmed that the resonant frequency of the patch antenna is 1.75 GHz quite near to the intended RF frequency. The position of the marker M2 in the figure 9 indicates the operating frequency. The bandwidth of the patch antenna is 24MHz.

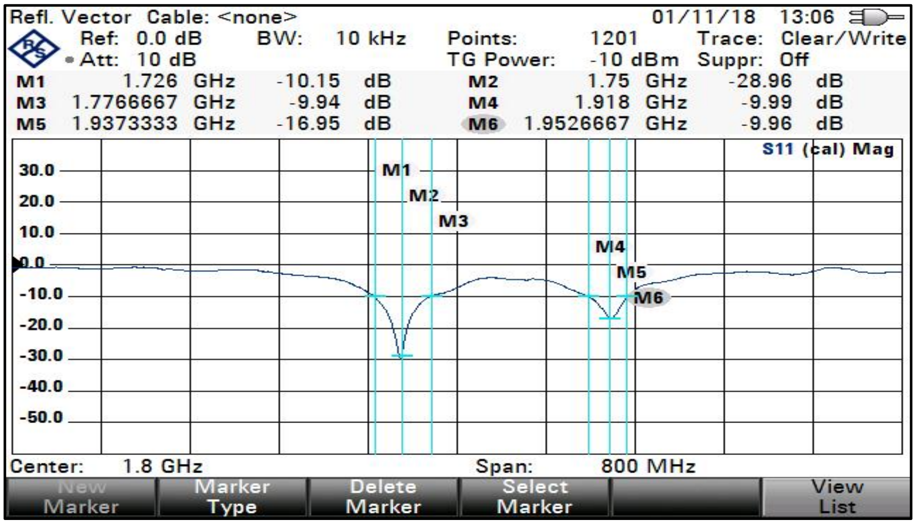

Figure 9: Testing of Antenna on Network Analyser

5RECTIFIER MODULE

Here, Voltage Doubler is used for rectification and to increase the value of the output DC voltage. It is a voltage multiplier circuit which multiplies the voltage by a factor of two. The circuit consists of two diode-capacitor network stages. Schottky diode model - 1N 5711 and 6.9pF capacitors are utilized. The rectifier prototype is a through-hole type.

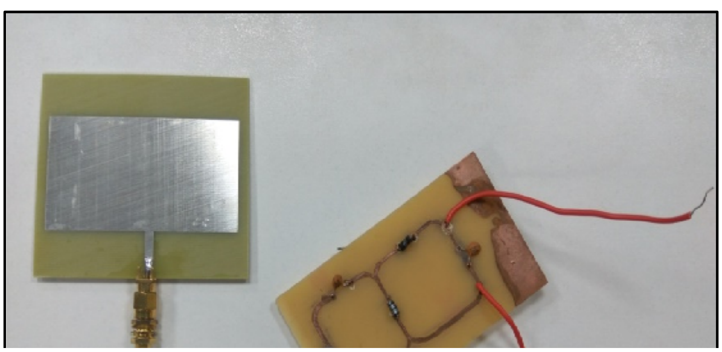

Figure 10: Rectifier Module

The received signals are rectified by the voltage doubler to produce approximately twice the input voltage. Theoretically, the power harvested is 1Watt as seen from the HFSS simulations. The practical results are ranges from 0.1mvolt to 0.6mvolt in the multimeter.

6. CONCLUSION

The conception and simulation of a rectangular patch antenna that operates at 1.8 GHz frequency was successfully designed using HFSS. From the analysis of the return loss and VSWR, it is clear that this antenna works on the designed RF frequency range. The output was measured with a multimeter and as seen in the figure the voltage was obtained between 0.3mV-0.6mV.

Figure 11: Experimental analysis

REFERENCES

1. VarunAggarwal. Jagadish Chandra Bose: The Real Inventor of Marconi's Wireless Receiver, Div. of Electronics and Comm. Engg., NSIT, Delhi, India
2. HashibulAlam.Design Rectangular Microstrip Patch Antenna for IEEE 802.15.3a (WPAN) with MB-OFDM Ultra Wide Band Communication System .International Journal of Scientific and Research Publications,February2014; 4(2):1 ISSN 2250-3153
3. Suresh Gyan, Kratika Jain Sandhya SharmaDual Band Rectangular Microstrip Antenna for Wireless Communication SystemsInternational Journal of Innovations in Engineering and Technology (IJIET).
4. Asokan, Thilagam S, Vinoth Kumar K. Design and Analysis of Microstrip Patch Antenna for 2.4GHz ISM Band and WLAN Application IEEE Sponsored 2nd International Conference On Electronics And Communication System
5. Constantine A. Balanis. Antenna Theory: Analysis and Design. 4th Edition. John Wiley and Sons Ltd: Hoboken, United States; 01 Apr 2016.