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# Optimized design of 2.4 GHz Microstrip Antenna for Wireless Local Area Network applications

SANAULLAH RIND
MUHAMMAD SOHAIL
MUZAMIL BOKHARI
*Department of Physics, University of Balochistan, Quetta, Pakistan*

**Abstract**

*This "study describes the development of a rectangular microstrip antenna (RMPA).The development is on defected ground structure. We use high frequency structure simulator software for the proposed design and results. Microstrip antenna operates on the resonating frequency of 2.4GHz. The 2.4 GHz resonating frequency of the suggested antenna works makes it suitable for WLAN applications. This paper includes the simulated outcomes and design factors for the suggested antenna. Although microstrip antennas come in a variety of forms, our focus is on rectangular-shaped antenna designs that can support the resonant frequency mentioned above. The selection of this resonant frequency is made in order to make the antenna the ideal option for use in a WLAN. The dielectric material FR-4 Epoxy is used in the proposed design. The suggested construction uses epoxy, the 1.5mm thick dielectric substance with a 4.4 dielectric constant. This antenna having a microstrip feedline of 50 ohms input impedance. The proposed antenna having a low profile attributes which is desirable for WLAN applications."*

**Keywords**: Microstrip patch antenna (MPA), high frequency structure simulator, WLAN, return loss, Gain, VSWR, bandwidth

## 1. INTRODUCTION

Microstrip antennas were first interject in the 1950s. PCB technology was interpose in the 1970. At that time, MSA was widely used as a versatile antenna due to its advantages. The Rectangular MPA is designed in HFSS software. We focus on a rectangular MPA consisting of rectangular patches with length of patch (L) and length of width (W). The proposed antenna operates on the WLAN of 2.4GHz frequency. This designed MSA is optimized to cover WLAN[1].Due to speedy miniaturization of personal communicating devices, there is a demand for smaller antennas. Precisely to increased electronics integration, the dispatch technique become smaller. Antennas account for a significant portion of the total package volume. The rectangular MPA is the most popular of all types of microstrip antennas available. The making of MPA is very easy, applying conventional microstrip manufacturing techniques[2]. WLAN with resonant frequency of 2.4 GHz applicable to, is necessary for WLAN applications. Antennas come in a variety of shapes, but here we focus on rectangular antenna designs, which are above the resonant frequency. Optimize our antenna design using the optometric high-frequency structure simulator HFSS. To take over wireless local area networks, the propose antenna is optimized. The propose antenna is simple, easy to manufacture, and fascinating for his present and future Wireless applications[3].Recently, the need for miniature antennas for wireless communications has raised the grip of microwave and wireless engineers in researching the design of miniature microstrip antennas. Small and lightweight antennas may be preferred to support the high mobility needs of wireless telecommunications devices. Compact microstrip antennas are one of the best applications for this purpose [4] Microstrip antennas are acceptable for microwave and millimeter waves usage. They use printed circuit board technology. This technology develops quickly with the development of antennas with patches of conductive material etched. Such antennas are usually called Microstrip patch antennas. Patches can be of any shape[5].Due to speedy product of wireless communication , the need for microstrip patch antennas uprise.MPA consists of a strip of metal called a radiating element into a nonconductor substance. The second side of the dielectric board is covered with a base level . Emitting spots can be quadrate, rectangular, slim strips, roundabout , oval, or other configurations. With the increasing of wireless communications, the usage for MPA is increased [6]. Advantages of micro strip antennas include their planar infrastructure , ease of fabrication, compactness, and conformability to mounting structures. They are also mechanically robust, simple to make using current printed-circuit technology, and easy to integrate with feed networks. Mobile radio and wireless communications, as well as high performance aero plane, spaceship, satellite, and missile applications, all employ it. Is utilised in a variety of applications, including communication systems, satellites, and biological ones.RFID, broadcasting , cellphone, GPS, MIMO, surveillance network, radar systems, remote and missile guidance, and others MSAs are frequently used in such applications. The numerous distinct and appealing characteristics of the micro strip patch antenna [1][6]. Microstrip patch antennas are fairly easy to make using common microstrip fabrication methods.

In the present work we used the simulation software HFSS and analytical modeling. This research is conducted by these methodological approaches. By using microstrip circuit design the data collection methods are described. By rectangular patch design equations and analytical methods, the optimized wireless local area network microstrip antenna is conducted. The research was rigorously conducted and can be replicated by simulation and analytical modeling. In this, it is a standard methodology in our research area.The configuration for miniaturization of antenna design is represent in the second part. Simulated results are demonstrated in next section, finally, conclusion is present in the last section.

## II ANTENNA DESIGN PROCEDURE

The experimental setup of this study consists of a PV system which is silicon based. The system is combined with concentrator and cooling system. This system is comprised of the following design:

### A) Antenna Specification.

Present RMPA antenna is specified for use in 2.4GHz UHF-band applications for wireless local area networks. A metallic ground surface can move the reverberation recurrence, so an ideal complex form match is expected to guarantee that a receiving wire is mounted on a metallic surface that doesn't debase the radio wire's presentation by mirroring the per user signal.

A RMPA need to be in continuous orientation but gain refers to the electromagnetic energy propagating in a particular direction and therefore the directional antennas are entirely infeasible in MPA system. In the above stated concern the limiting factor of range due to gain, the present work is provided around the enhancement of power transmission coefficient, gain and impedance bandwidth of microstrip patch antenna. so that condition of maximum power transfer theorem could fulfil and the gain and impedance bandwidth could be enhanced.

### B) Proposed Antenna Geometry:

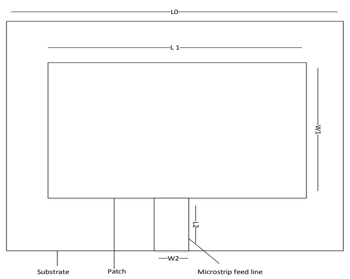


**Figure 1 Geometry of antenna**

The shape of proposed microstrip patch antenna is portrayed in Figure 1. Dimensions of antenna is given in table 1.We simulate the proposed design on the HFSS programming and obtained the recreated results.

**Table 1 Microstrip antenna parameters**

| **Parameters** | **Symbol** | **Values (in mm)** |
|---|---|---|
| Height | H | 1.6 |
| Lenght of substrate | $L_0$ | 60 |
| Width of substrate | $W_0$ | 60 |
| Lenght of patch | $L_1$ | 38 |
| Width of patch | $W_1$ | 29.4 |
| Lenght of feed | $L_2$ | 24.8 |
| Width of feed | $W_2$ | 3 |

## III. SIMULATION RESULTS

Simulation of microstrip patch antenna design is completed in a high-frequency electromagnetic. simulation software named ANSYS HFSS . As we finished the plan part of antenna, then we got the simulated results of proposed microstrip patch antenna in terms of return loss ,VSWR, radiation pattern, 3D polar plot and Gain.

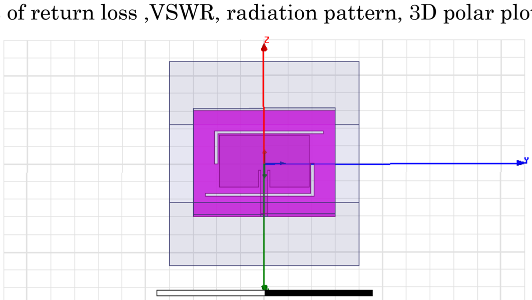


**Figure 2 Microstrip antenna using HFSS Software**

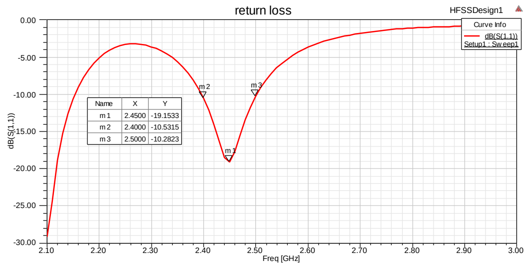


**Figure 3 Proposed rectangular microstrip patch antenna SII Parameter**

In figure 3 we could mention that the designed MPA providing us -19.1533 dB return loss at the resonant frequency of 2.4GHz. We could also observed the bandwidth of designed antenna from figure 3. For calculation of bandwidth of MPA ;

$$\text{Bandwidth} = f_{high} - f_{low} = \qquad (3.1)$$

Substituting the values of high frequency and low frequency in equation 3.1.

Bandwidth = (2.5000 – 2.4000 ) GHz

Bandwidth = 0.1GHz / 100MHz

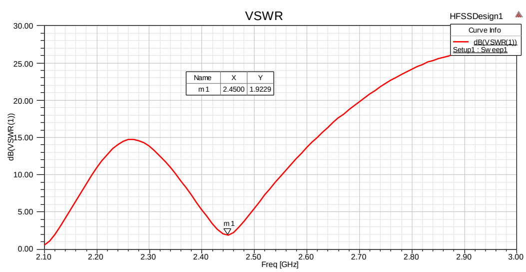


**Figure 4 VSWR**

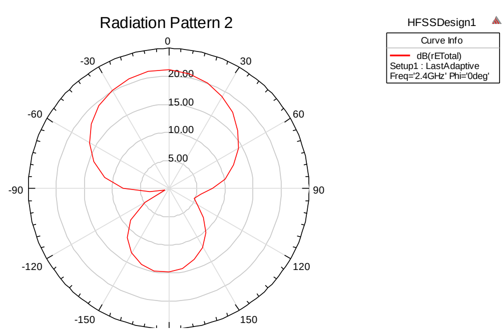


**Figure 5 2D Radiation Pattern**

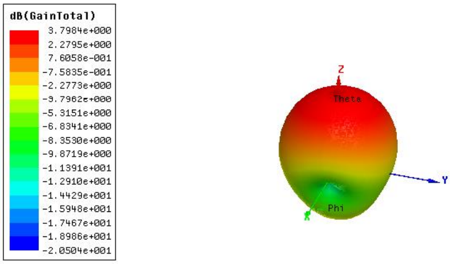


**Figure 6 3D Polar Plot**

In "Figure 4 we obtained the VSWR with least value of 1.9 at 2.4500GHz. 2D radiation model and 3D-polar plot are shown in figure 5 and in figure 6 . Radiation configuration insinuates the heading of the electromagnetic waves communicates away from antenna. We set the solution frequency of 2.4GHz with generally outrageous number of passes 20 with most noteworthy delta S of 0.02. Table 2 point out the performance comparison of the proposed antenna."

**Table 2 Performance comparison for the state of microstrip patch antenna at 2.4 GHz.**

| Reference | Year | Antenna Shape | Antenna Size(mm) | Bandwidth(MHz)/ Fractional B.W | Gain (dB) | Return Loss | Remarks (Compared with Proposed Antenna) |
|---|---|---|---|---|---|---|---|
| [11] | 2014 | Meander line monopole | 32×1.6×0.8 | 7.6% | 0.5 | -13.5 | Lower gain |
| [12] | 2003 | Double T-monopole | 70×50×1.6 | 3.43% | 1.3 | -14 | Enhanced size and lower gain and bandwidth |
| [13] | 2019 | Meander line microstrip path | 40×10×1.6 | 146<br>12.5% | 1.347 | -19.11 | Lower gain |
| [9] | 2017 | RMPA | 39.5×31×1.5 | 85.1 MHz | 3.667 | -8.6045 | Low return loss and bandwidth |
| [14] | 2018 | MIMO | 120×65×1.6 | 54.9% | 2.85 | -18 | Enhanced size and lower gain |
| Proposed Antenna | 2023 | RPMA defected ground | 38×29.4×1.6 | 100MHz<br>4.08% | 3.755 | -19.15 | Small size with High gain |

## V. CONCLUSION

The proposed microstrip antenna is such a type of designed then it has a 2.4GHz return loss of -20.7976 dB. The VSWR of the proposed antenna is 1.9 at the frequency of 2.4500 GHz which is manageable. The HFSS simulation software has been used to replicate the designed of MPA. For this antenna, the microstrip feed line is used to create a bandwidth of 100 MHz at the desired resonant frequency of 2.4GHz. The designed MSA is optimized so that it includes WLAN, as previously mentioned. The suggested microstrip antenna has a low profile, making it very small, simple to make, and fed by a 50 microstrip feed line, making it a desirable structure for both present and future WLAN uses."

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