

DESIGN OF A 5.2GHz MICROSTRIP PATCH ANTENNA FOR WLAN APPLICATIONS

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ABSTRACT

Recent development in communication systems requires low profile, low cost, and lighter weight antenna that gives good and/or high performance over a given band of frequency. This technological trend has focused much effort on the design of a Microstrip patch antenna. However, as the number of operating frequency bands increases, so also difficulty in antenna design increases. In addition, for the miniaturization of a wireless communication system, the antenna must also be small enough to be placed inside the system to transmit and receive more information. Also, a large bandwidth is required, and its enhancement is currently a popular research area. In this paper, a design of a 5.2 GHz microstrip patch antenna for WLAN applications is discussed and presented. The proposed antenna structure and radiation behavior and/or characteristics are studied and analyzed using CST Studio. The operating frequency is resonating at 5.2 GHz with maximum achievable bandwidth of 240 MHz (from 5.07-5.31 GHz) at a -10 dB impedance bandwidth which is in line with the 5.2 GHz band and the gain is 5.63 dB with a reflection coefficient of -29.29 dB at 5.19 GHz. The proposed antenna is designed on an FR4 substrate with a thickness of 1.6 mm and a dielectric constant of $\epsilon_r = 4.4$. It is recommended that the proposed antenna can be a good candidate for WLAN band applications.

Keywords: Wireless Local Area Network, Computer Simulation Technology.

1 INTRODUCTION

There is an increased demand for wireless communications such as WLAN to boom the growth of the wireless system. With technological advancement, it is so challenging to design an efficient small antenna for wireless applications. One of the most popular techniques in designing antenna is microstrip technology, which has different shapes that include rectangular, triangular, and square shapes. Microstrip patch antenna has highly practical application in wireless communication and offers ease, cheap cost of fabrication, and integration with feeding system. In microstrip configuration, the patch is connected and attached on the upper or lower side of the dielectric substrate with the ground plane on the other side [1]. Corporate or series feeding settings can be used to feed the microstrip patch antenna. There is a rapid change in the telecommunication industry because of the increased demand and the need to improve or create more communication networks and a contest in satisfying the requirements of emerging technologies [2]. Nuraddeen, Yakubu discussed a paper titled 'Design and Analysis of Rectangular Microstrip Antenna Resonating

at 5.2 GHz for WLAN Applications.’ The design provides a simple rectangular microstrip antenna with a return loss of -3.5 dB, a VSWR ratio is 1:4.8965, and a gain of 7.951 dB. It is observed that the reflection coefficient is less than -10 dB. So, the return loss should be improved to reach at least a standard below -10 dB by employing parameter sweeping [3]. Jaswinder and Rajesh proposed a ‘Coaxial Fed Rectangular Microstrip Patch Antenna for 5.2 GHz WLAN Application.’ The results show that antenna parameters were obtained to be 219.2 MHz for antenna bandwidth, -23.09 dB, and an achievable gain of 5.208 dB. The antenna used a co-axial feeding technique to feed the microstrip patch [4]. Swagata proposed ‘Design and Analysis of 5.2 GHz Rectangular Microstrip Patch Array Antenna using Split Ring Resonator.’ This author focuses on the effect of split ring resonators on the antenna. It can be observed that the gain before the introduction of the split ring resonator is less compared to after the introduction of the split ring resonator [5]. However, this proposed antenna would provide an improved version of the reviewed antennas or previous literature above in terms of good impedance matching, reflection coefficient, bandwidth, and gain. The reflection coefficient $|S_{11}|$ is -29.29 dB, achievable bandwidth of 240 MHz (from 5.07-5.31 GHz), and a gain of 5.63 dB respectively.

2 DESIGN SPECIFICATION

Operating frequency, dielectric constant, loss tangent, and the height of the substrate are the key parameters that need to be obtained first before starting any microstrip patch antenna design. However, the antenna parameter such as achievable bandwidth, gain, and/or radiation coefficient can only be obtained by computing the width (W) as well as the Length (L) of the patch, as shown in Figure 1.

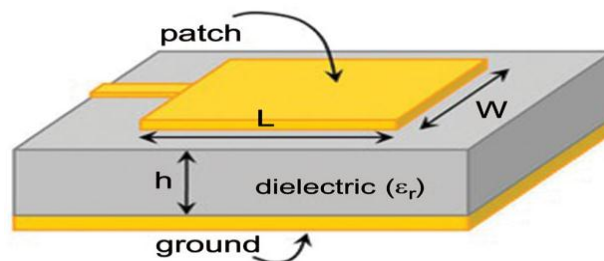


Figure 1. Microstrip Patch Antenna

The proposed antenna has an operating frequency of 5.2 GHz, the height or thickness of the substrate is 1.6mm, and the dielectric constant of $\epsilon_r = 4.4$. the dimensions of the antenna viz the length and width can be obtained using the microstrip patch antenna formulas in [1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14]. However, the length and width of the antenna patch obtained are 13.45mm and 17.55mm for an optimized value respectively. The bandwidth, reflection coefficient, gain, directivity, and other parameters were monitored and observed. Figure 2 shows the proposed 5.2 GHz microstrip patch antenna for WLAN applications.

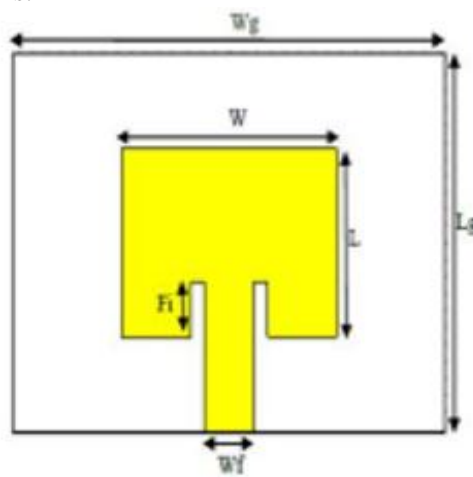


Figure 2. Proposed WLAN Antenna

The complete dimension of the proposed microstrip patch antenna operating at 5.2 GHz for WLAN applications is tabulated in Table 1 below.

Table 1. Design Specifications and Parameters of a Proposed Antenna

Description	Parameter	Value (mm)
Width of Patch	Wp	17.55
Length of Patch	Lp	13.45
Width of Substrate	Ws	22.5
Length of Substrate	Ls	20.5
Length of Feed	Lf	9.21
Width of Feed	Wf	2.93
Inset Length	Li	4.0
Inset Width	Wi	5.0

3 SIMULATED RESULTS

The simulation results of the proposed microstrip patch antenna operating at 5.2 GHz for WLAN applications in terms of antenna performances are explained, discussed, and presented.

3.1 Reflection Coefficient or Return Loss

Figure 3 shows a reflection coefficient output and/or return loss for the simulated result of the microstrip patch antenna operating at 5.2 GHz frequency. It is noticed that the antenna resonates at exactly 5.19 GHz with $|S_{11}|$ below -29.29 dB. From the result obtained in this proposed antenna, it is observed that there is a massive improvement in terms of reflection coefficient when compared with the cited literature. Most of the work reviewed above shows that the reflection coefficient is less than -29.29 dB as in the proposed antenna. This shows that the proposed antenna has a better reflection coefficient.

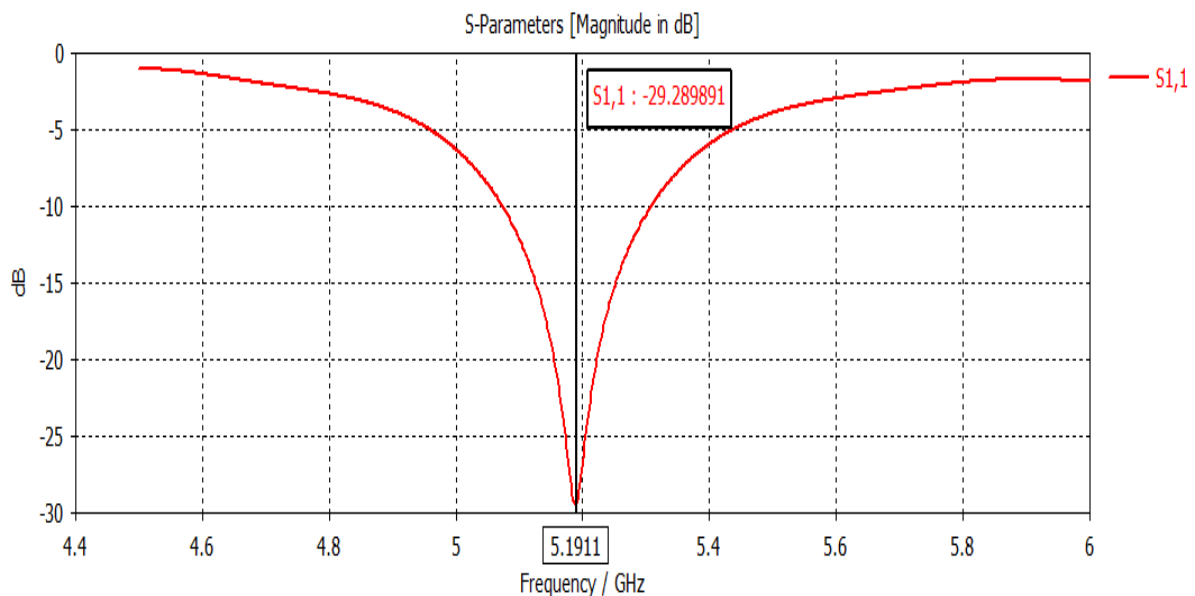


Figure 3. Reflection Coefficient Results for Microstrip Patch WLAN Antenna

3.2 Antenna Achievable Bandwidth

Figure 4 below shows the antenna bandwidth at a standard of -10 dB impedance bandwidth, the simulation result for the proposed microstrip patch antenna operating at 5.2 GHz shows an antenna bandwidth of 240 MHz (from 5.07-5.31 GHz) at the resonance frequency of 5.19 GHz. The

240 MHz bandwidth achieved in this proposed antenna shows that the bandwidth is a little bit improved compared with 219.2 MHz or less in the cited works above. Even though, the bandwidth can be improved by employing different available techniques for bandwidth enhancements.

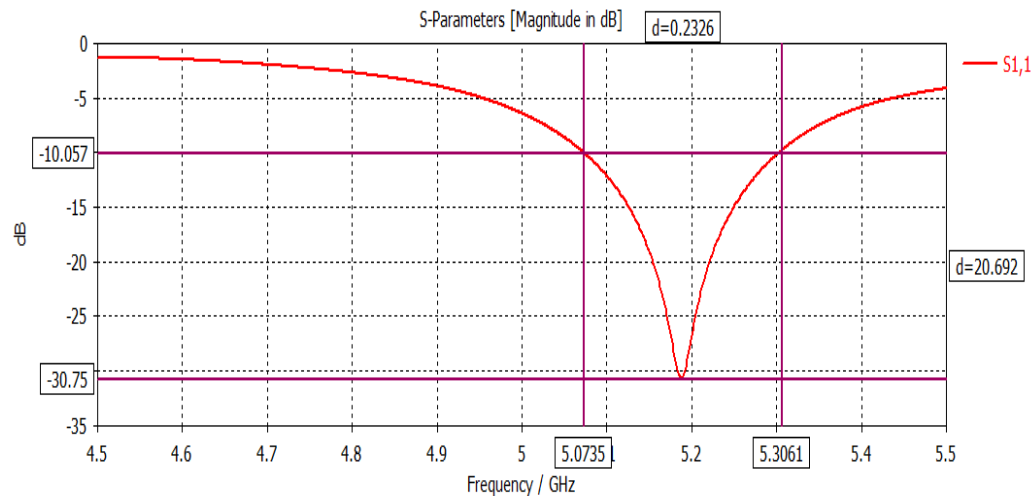


Figure 4. Bandwidth Result of Microstrip Patch WLAN Antenna

3.3 Directivity and Radiation Pattern

The directivity and radiation pattern of the proposed microstrip patch antenna are discussed and presented. It is observed from the diagram that the radiation pattern is more directional with a directivity of 5.62 dBi. Figures 5a and 5b show the radiation pattern in 3D and polar representations. It can be observed that this proposed WLAN antenna has a very good gain or directivity which is similar and/or greater than the cited works, even though the gain could be increased or improved using an array or MIMO techniques.

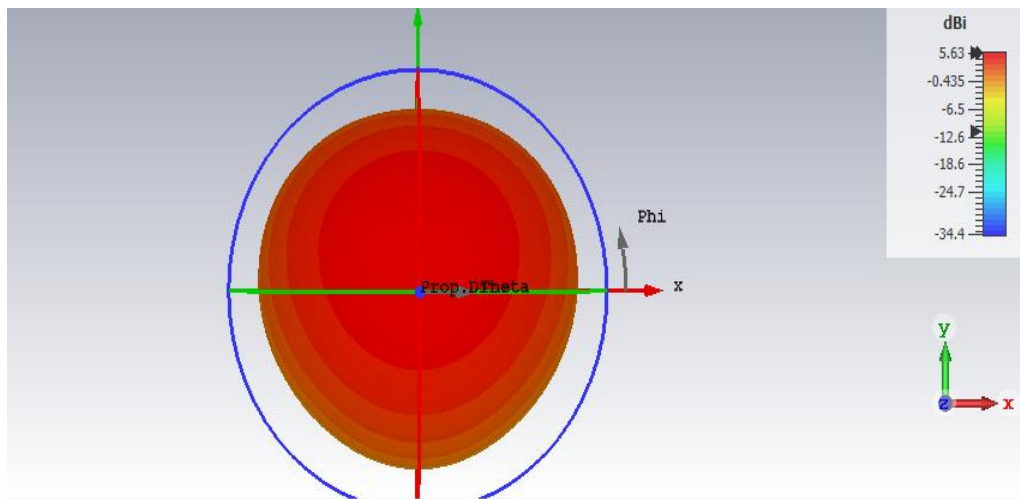


Figure 4a. Simulated 3D Plot of Microstrip Patch WLAN Antenna

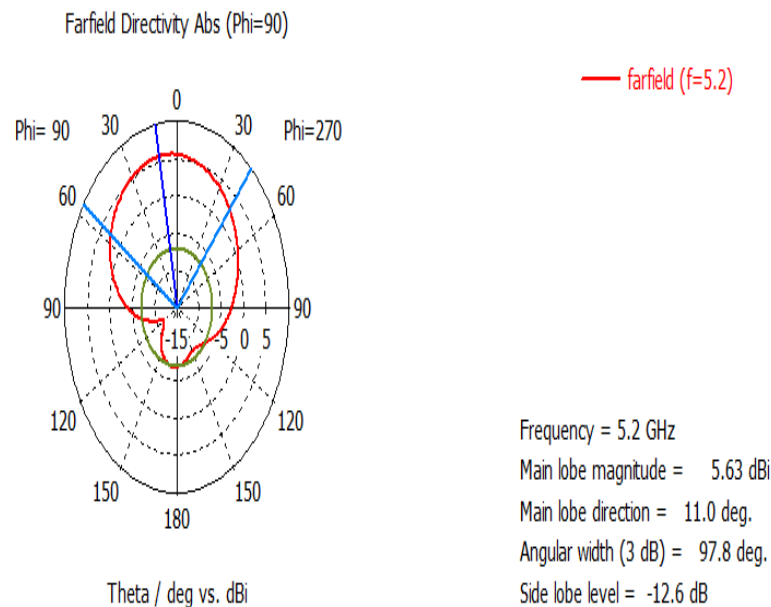


Figure 4b. Simulated Polar Plot of Microstrip Patch WLAN Antenna

4 CONCLUSIONS

A design of a 5.2 GHz microstrip patch antenna for WLAN applications is discussed, presented, and implemented using CST Studio. The antenna was designed using FR4 (lossy) substrate with a dielectric constant of $E_r = 4.4$ and thickness of substrate 1.6mm. The -10 dB impedance bandwidth has been achieved and it has been observed that it recorded 240 MHz (from 5.07-5.31 GHz) bandwidth, the return loss and/or reflection coefficient of -29.29 dB as well as the Directivity of 5.63 dBi. Hence, the antenna can be a good candidate for WLAN applications. However, in future work, the antenna can be improved in terms of gain, bandwidth, and other antenna parameters by employing array, MIMO, intruding slot to make it a dual-band, or any available techniques.

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