International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2585
Volume 4, Issue 4, April-2018

Design and Fabrication of Microstrip Patch Antenna at 2.4 GHz for WLAN applications

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Abstract*: In this paper, a rectangular microstrip patch antenna is designed using HFSS software. The designed antenna has a resonating frequency of 2.4 GHz which is applicable to Wireless Local Area Network (WLAN). This paper shows the design considerations of the proposed antenna as well as the simulated and measured results of the same. The design is made on FR-4 Epoxy material used as a dielectric material with its dielectric constant = 4.4 and thickness of 1.6mm. The simple structured configuration and low profile of the proposed antenna makes the fabrication process easy and also suitable for the application in the WLAN. Gain and Return loss are measured at this frequency.

***Keywords*: Microstrip patch, WLAN, HFSS**

I.INTRODUCTION

Wireless communication system requires low profile, light weight, high gain, and simple structure antennas to assure reliability, mobility, and high efficiency characteristics And the main advantage of these antennas is that they can be produced in mass with very nominal cost. One of the main disadvantage of these antennas is having narrow bandwidth and large size. Many advances in electronic field such as smart phones, smart watch and wearable gadgets have increased the demand for the small conformal antennas. MSAs are widely used in Radio-Frequency Identification (RFID), Broadcast radio, mobile systems, Global Positioning System (GPS), satellite communication, television systems, multiple-input multiple output (MIMO) systems, vehicle collision avoidance system, surveillance system, direction founding, radar systems, remote sensing, missile guidance, and so on [1]-[2].Various configurations can be used to design microstrip antenna for WLAN applications. In [3] U shaped microstrip patch is designed at 2.4 GHz. In [4] patch antenna is designed having thickness of 1.5mm at 2.4 GHz.

I. DESIGN EQUATION AND PROPOSED ANTENNA

This section introduces the design of the proposed antenna. First the rectangular patch antenna is designed based on the design equation. The antenna is fed with inset feed transmission line. Material used for proposed antenna is FR4 having thickness 1.6 mm and dielectric constant of 4.4 [5]-[6].

Following design equation are used to design the proposed antenna. [6]

$$w = \frac{c}{2f_o\sqrt{\frac{\epsilon_r+1}{2}}} \quad (1)$$

$$L_{eff} = \frac{}{2f_o\sqrt{\epsilon_{eff}}} \quad (2)$$

$$\epsilon_{eff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r+1}{2}\left(\frac{1}{\sqrt{1+\frac{12t}{w}}}\right) \quad (3)$$

$$L = L_{eff} - 2\Delta L \quad (4)$$

$$\Delta L = 0.412 * t * \frac{(\epsilon_{eff}+0.3)\left(\frac{w}{t}+0.264\right)}{(\epsilon_{eff}-0.258)\left(\frac{w}{t}+0.8\right)} \quad (5)$$

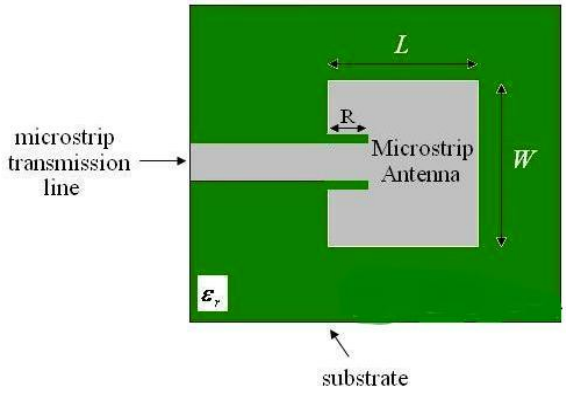

Fig.1 Inset Feed Microstrip Patch Antenna

In the above equation, Zin(0) is the input impedance if the patch was fed at the end. Hence, by feeding the patch antenna as shown, the input impedance can be decreased. This method can be used to tune the input impedance to the desired value.

$$Z_{in}(R) = \cos^2\left(\frac{\pi R}{L}\right) Z_{in}(0) \quad (6)$$

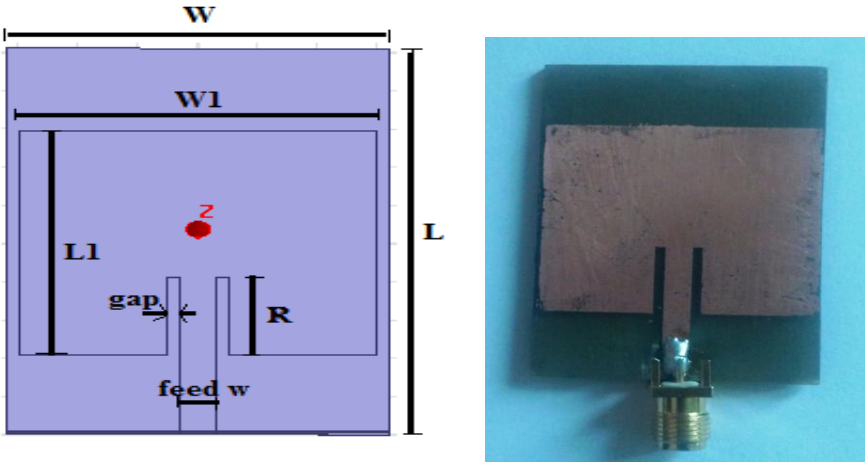

Fig. 2 Simulated and Fabricated Antenna.

The rectangular patch is designed using equations 2 to 5. While the feed line dimensions are determined using equation 6. After successful simulation in HFSS, the antenna is fabricated as shown in Figure 2. This antenna can be used for Wireless local area network application. Dimensions of projected antenna are given in Table 1.

TABLE I
Dimensions of Projected Antenna

Substrate length(L)	50mm
Substrate width(W)	32mm
Thickness(h)	1.6mm
Patch length(L1)	29.44mm
Patch Width(W2)	30mm
Inset length(R)	10.308mm
Feed line width(Feed_w)	3.05mm
Gap	1mm

II. RESULTS AND DISCUSSION

The projected antenna is simulated using High Frequency Structure Simulator (HFSS).The simulated and measured reflection coefficient is shown in Fig 3.It can be seen that simulated S_{11} at 2.4 GHz is -13.43 dB and measured S_{11} at the 2.43 GHz is -12.26 dB. The simulated and measured results are having good matching with each other. The simulated radiation pattern is shown in Fig 4.The Gain of proposed antenna is 3.498dB which is a good value of gain for microstrip patch antenna.

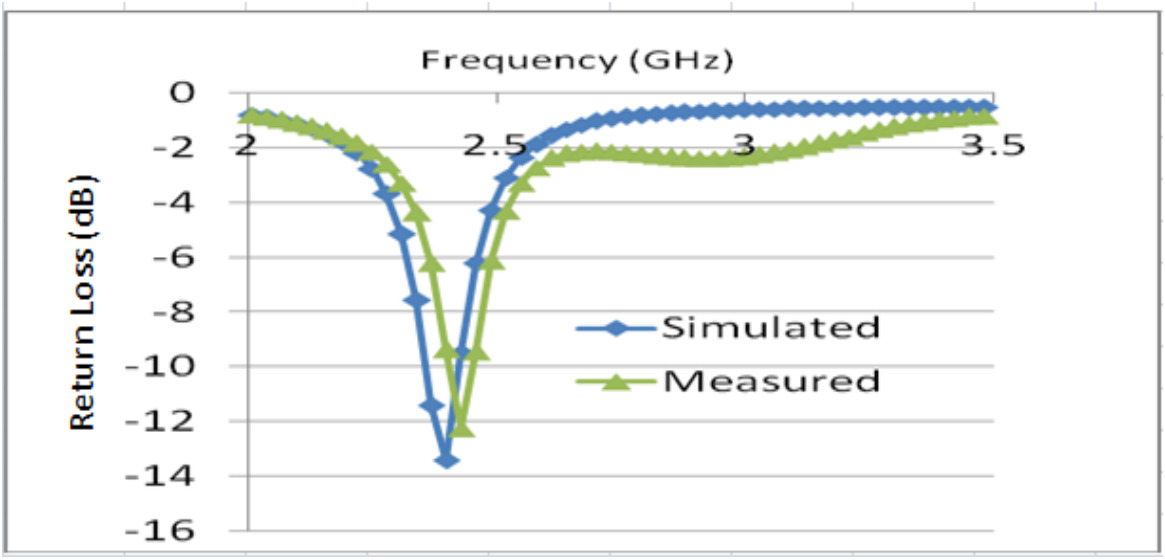

Fig. 3 Simulated and Measured S_{11}.

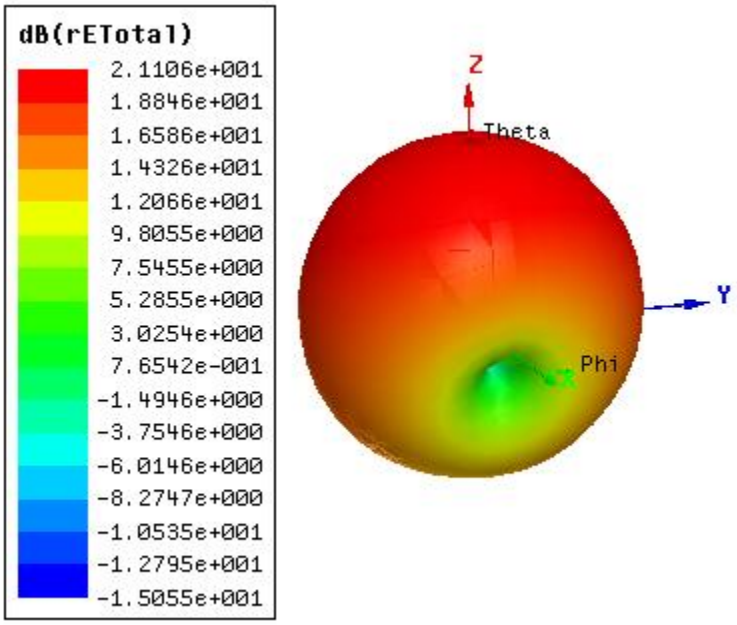

Fig. 4 Radiation Pattern of projected antenna in HFSS.

IV. CONCLUSIONS

Microstrip antenna is very popular now a day due to its advantages and it is a developing area of research. Their applications are boundless, in view of their less weight, small size, and simplicity of assembling. In this paper microstrip patch antenna is designed and fabricated at 2.4 GHz for WLAN applications. The simulated result and measured result show good matching to each other. The gain value is 3.498 dB which is good for wireless applications.

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