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Multiband Circular Microstrip Patch Antenna for WLAN Application

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ABSTRACT

A compact single layer Microstrip Patch Antenna (MSA) for 3.6 – 15 GHz WLAN applications is presented in this paper. The implementation of proposed technique is commercially performed using available electromagnetic simulators. These simulators are mainly based on the method of finite difference time domain (FDTD) to achieve the desired specifications. The circular patch antenna with optimal co-axial feed is determined and used for 802.11 WLAN applications. The obtained results show stable radiation characteristics in the desired band. The experimented results for BER and power radiation are also presented.

Keywords *BER ,BW, Co-Axial Feed , CST, Microstrip Patch Antenna (MSA), PEC, WLAN*

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I. INTRODUCTION

Due to increasing growth of wireless systems and demand for a variety of new wireless applications like WLAN, design of broadband and high gain antennas to cover a wide frequency range is highly in demand. The study of above will be beneficial in applications like high performance aircraft, satellite, missile, mobile radio and wireless communications. The design and implementation of the above antennas have several advantages like small size, low-cost fabrication, low profile, conformability, ease of installation and integration with feed networks.

With advancement of technology, the requirement of an antenna to resonate at more than one frequency i.e. multi-banding is also increasing day by day. Microstrip patch antenna is best choice to fulfil the above requirements. Along with that a Microstrip patch antenna offers many advantages like low fabrication cost, supports both linear as well as circular polarization etc. Bandwidth of a Microstrip patch antenna can be improved by various methods like cutting U-slot [1], increasing the substrate height, decreasing of substrate width etc. Antenna array can also be used to improve the bandwidth [2]. In this paper a simple Microstrip patch antenna with coaxial feed is designed [3],[4].

II. ANTENNA DESIGN CALCULATIONS

A) Calculation of width: For efficient radiation, the width w is given as

$$w = \frac{c}{2f_r}\sqrt{\frac{2}{\in_r + 1}} \qquad (1)$$

B) Calculation of Extension length:

$$\Delta L = \frac{0.412h(\in_{ref} + 0.3)\left(\frac{w}{h} + 0.264\right)}{\left(\in_{ref} - 0.258\right)\left(\frac{w}{h} + 0.8\right)} \qquad (2)$$

C) Effective dielectric constant

$$\in_{ref} = \frac{\in_r + 1}{2} + \frac{\in_r - 1}{2}\left[1 + \frac{12h}{w}\right]^{-0.5} \qquad (3)$$

D) Actual Length
$$L = \frac{c}{2 f_r \left(\in_{ref}\right)^{0.5}} - 2\Delta L \quad (4)$$

E) Dimension of circular patch antenna is calculated as:

$$a = \frac{F}{\left\{1 + \frac{2h}{\pi \in_r F}\left[\ln\left(\frac{\pi F}{2h}\right) + 1.7726\right]\right\}^{0.5}}$$
$$F = \frac{8.791\times10^9}{f_{r\partial}\left(\in_r\right)^{0.5}} \quad (5)$$

Where F is fringing effect which makes the patch electrically larger. Now the effective radius of the antenna is

$$a_e = a\left\{1 + \frac{2h}{\pi \in_r a}\left[\ln\left(\frac{\pi a}{2h}\right) + 1.7726\right]\right\}^{1/2} \quad (6)$$

III. ANTENNA DESIGN

Fig.1 shows the co-axial feeding technique. The details of the proposed design performances are discussed below .The geometry of proposed coaxial fed Microstrip patch antenna with single band operation for WLAN application shown in Fig. 2. The excitation of antenna is given through coaxial feed line.

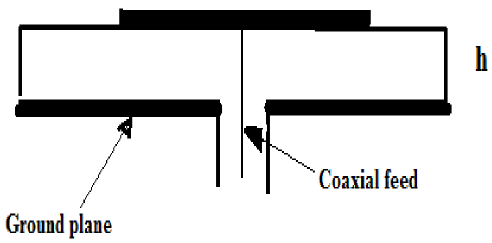

Fig. 1 Co-axial feeding technique

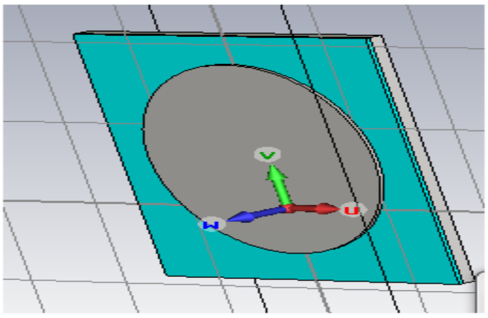

Fig. 2 view of proposed Micro-strip patch antenna

MSA consists of substrate with a thickness of 2.1 mm, dielectric constant of 2.33 and loss tangent of 0.00889. The dimensions of the proposed antenna are: Ground size = 60mm×62mm, Substrate size = 60mm×62mm and Patch size $A = \pi\left(23.2^2\right)mm^2$ with thickness = 0.7mm. The best desired results are obtained by proper impedance matching.

Dimension of antenna:

Ground size =60mm×62mm	Substrate size =60mm×62mm
Patch size $A = \pi\left(23.2^2\right)mm^2$	Patch thickness=0.7mm Substrate/Ground thickness=2.1mm

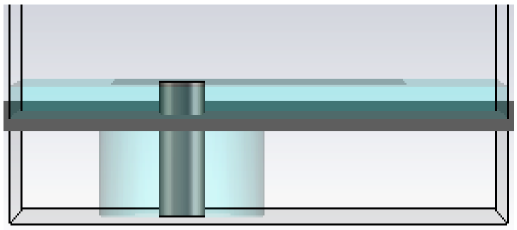

Fig.3 Side view of the proposed Microstrip patch antenna

The side view of the coaxial fed proposed antenna is shown in Fig .3.

IV. SIMULATION RESULTS

Simulation studies of proposed antenna are carried out using CST Microwave Studio .The simulated reflection coefficient $S11$ of the proposed antenna shown in dB. The scattering parameter $S11$ gives the reflection coefficient at port 1 where we apply the input to the Microstrip patch antenna. It should be less than -10 dB for the acceptable operation. It shows that the proposed antenna resonates at frequency equal to 2.344 GHz which gives the wideband characteristic of the patch antenna. The simulator shows the bandwidth of about 140 MHz (2.34-2.48 GHz) which is achieved at -10 dB reflection coefficient (VSWR≤2) [3]. The reflection coefficient value that is achieved at this resonant frequency is equal to -23.901 dB. This reflection coefficient value suggests that there is good matching at the frequency point below the -10 dB region. It covers the frequency band for the WLAN application.

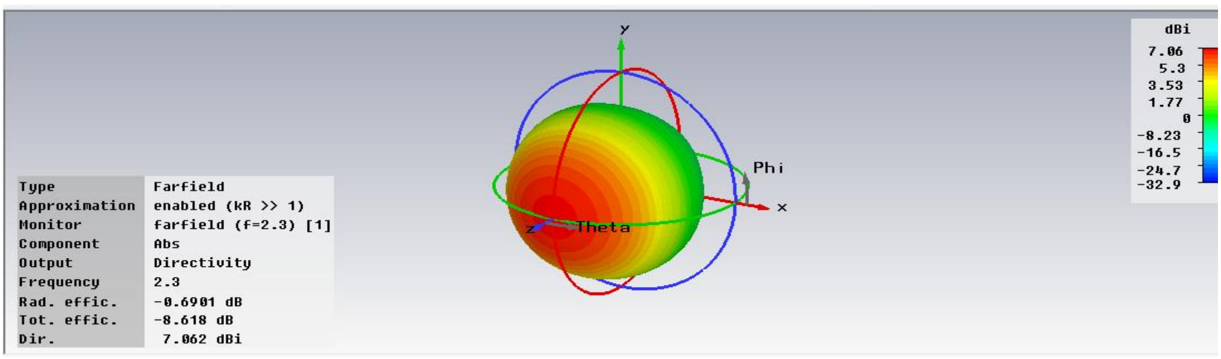

Fig. 6 3D Radiation pattern for fr=2.3 GHz

Radiation pattern is a graphical representation of the relative field strength that can transmit or received by the antenna. The antenna should not have the side lobes and back lobes .Ideally lobe is defined as a roundish and flattish projecting or hanging part of patch surface. We can minimize them but we cannot remove them completely. Figure 6 shows the simulated 3-D radiation pattern with directivity of 7.061 dBi for proposed antenna configuration at the resonating frequency of 2.314 GHz.

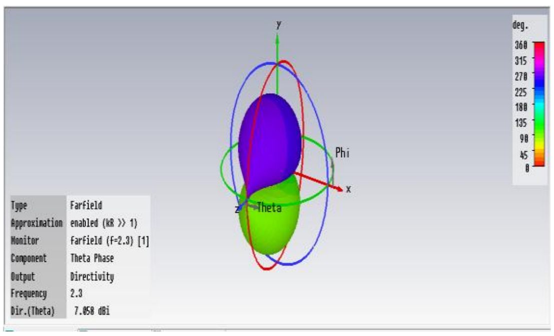

Fig. 7(a) E-plane with theta phase

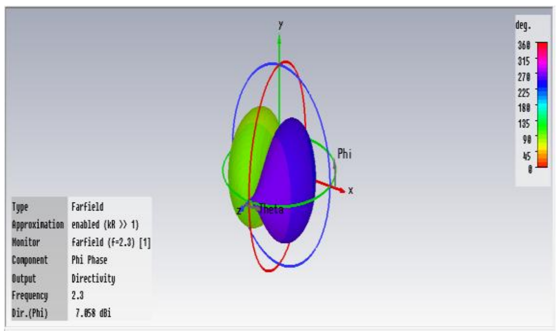

Fig. 7(b) H-plane with phi phase

Figure 7(a) and (b) show the simulated E-plane (phi=90º, theta=varying) and H-plane (theta=90º, phi=varying) radiation patterns for proposed antenna configuration at the resonating frequency of 2.314 GHz.

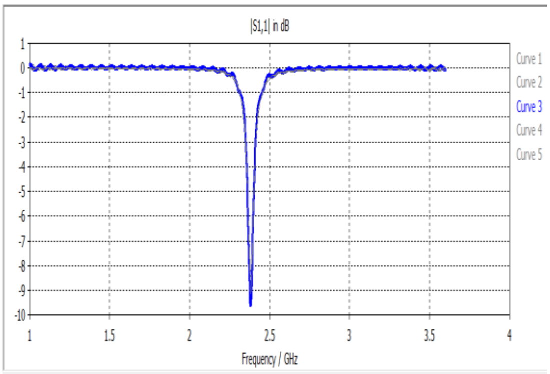

Fig -8 S-11 curve for different values of ‘ *w* ’

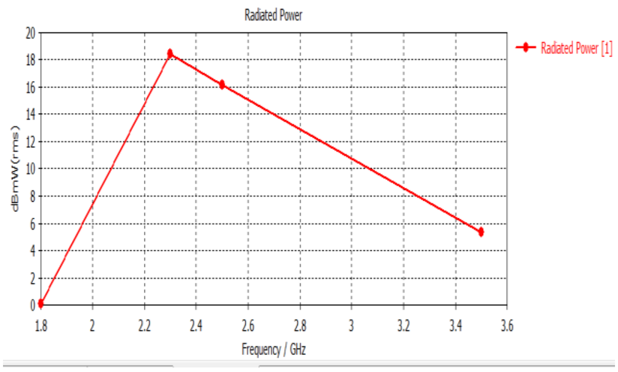

Fig.9 shows radiated power at resonant frequecy

*S*11 gives the reflection coefficient at port 1 where we apply the input to the Microstrip patch antenna. It should be less than -10 dB for the acceptable operation. It shows that the proposed antenna resonates at frequency equal to 2.35 GHz which gives the measure of the wideband characteristic of the patch antenna. The simulated impedance bandwidth of about 140 MHz and reflection coefficient value suggests that there is good matching at the frequency point below the -10 dB region. It covers the frequency band for the WLAN application. The radiation power shows the maximum peak value at resonant frequency.

Table 1.1 shows the radiation power, total efficiency and Return losses (dB) for different frequencies. The given values are shown in table1.1 is obtained by simulation and analyzed using Computer Simulation Technology (CST) Microwave Studio.

Table 1.1 Indicate the different results by CST studio

Frequency (GHz)	**Radiation Power W(rms)**	**Total efficiency(db)**	**Band Width (GHz)**	**Return loss(dB)**
1.80	0.023	-24.00	0.140	-0.0098
2.30	0.07	-9.00	0.140	-0.6777
2.38	0.07	-9.23	0.140	-9.7523
2.50	0.045	-10.38	0.140	-0.3942
3.00	0.025	-16.26	0.140	-0.0293
3.40	0.013	-23.22	0.140	-0.0134

The given circular patch antenna is used for 802.11and 802.16(a) WLAN application. The return loss is used for BPSK over AWGN channel and we obtained the symbol error rate (BER) which is show in fig (10).

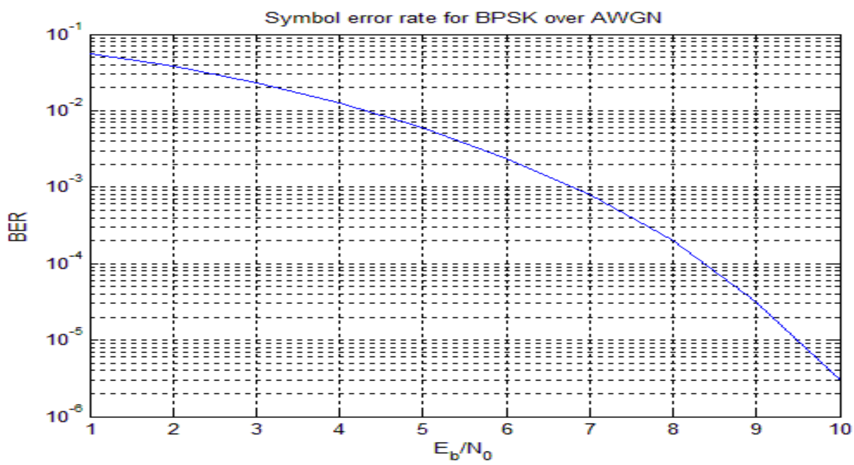

Fig 10 BER plotation of circular patch antenna using AWGN channel

V. CONCLUSION

In this paper, a suspended configuration of circular patch antenna with coaxial feed is introduced to obtain a wideband characteristic. By optimizing the antenna parameters, concludes a wide impedance bandwidth of 2.34-2.48 GHz. The structure of the antenna is simple which helps in 802.11 and 802.16(a) WLAN application. The simulated and measured results show that the bandwidth of the patch antenna is successfully broadened; the proposed antenna shows the better performance in higher data rate for communications requiring circular polarizations. The designed antenna has future growth in OFDM and WLAN systems.

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