A Dual Band MPA For WLAN Applications

Shweta Vincent, Pooja Balachandran, Anwesha Paul, Om Prakash Kumar, Tanweer Ali

Abstract: Microstrip patch antenna (MPA) has a numerous benefits such as light weight, easy accessibility, provides dual polarization simultaneously, mechanical stiffness etc. Hence finds widespread use in wireless communication. Designing such antenna could however pose a greater challenge. This paper describes the design and simulation of dual band antenna operating at 2.4 (lower WLAN) and 5.2 (upper WLAN) GHz. The antenna comprises of a rectangular patch with two rectangular slots at the side and one circular slot at the center of the radiating part. The length of the slot can be viewed as inductance and capacitance can be viewed as distance between the slots. These intervenes the current flow on the surface antenna thus helping the designed antenna to operate at dual band. The designed antenna has the advantage of compact size, simple configuration, less mutual coupling between the slots, good impedance matching and uniform omnidirectional pattern.

Index Terms: microstrip patch antenna, wireless communication, radiation pattern.

1 INTRODUCTION

DUE to the rapid decline in the size of personal communication devices, there is a need for more light-weight antennas in recent years [1-3]. As communication devices gets decreased in size due to greater electronics integration, the antenna becomes an importantly larger component of the kit's total volume. This results in a demand for large antenna size reductions. Microstrip antenna can be used in wide varieties of wireless applications such as communication systems, satellite communication and even for biomedical applications [4-8]. Microstrip patch antennas offer benefits and versatility than the conventional antennas, such as low cost and volume, light weight, low profile, compact size and ease of manufacture and conformity [9]. Additionally, the microstrip patch antennas can provide omnidirectional pattern with frequency agility, broad bandwidth, versatility of feed line, and beam scanning. A microstrip patch antenna in its basic form consists of a radiating part on one side of a dielectric substrate and a ground plane on the back plane as illustrated in Fig. 1. The radiating part is mainly made up of copper materials which are conducting and may take any desired shape. The radiating patches along with feed lines are photo etched on the substrate. In this paper a compact patch antenna is proposed for WLAN applications. The configuration shows dual band operation at 2.4 GHz (lower WLAN) and 5.2 GHz (upper WLAN). Slots are introduced in the radiating part to achieve dual band operation. Microstrip feeding is used to achieve impedance matching of 50 ohms. Parametric studies are computed to validate the optimized dimensions. The antenna has simple configuration and exhibits omnidirectional pattern at both the frequency of operation.

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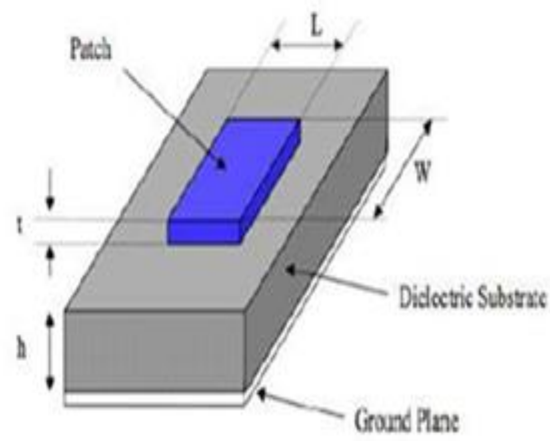


Fig 1: *Illustration of a basic Microstrip patch antenna [9]*

2 DESIGN APPROACH OF THE ANTENNA

The antenna proposed is designed using HFSS av.14.0 software. The substrate material for the proposed design isaFR4 with dielectric constant of a4.4, h=1.6mm and loss tangent of δ=0.01, respectively. The method approach used to design the proposed antenna in the HFSS software is finite element. The Fig. 2 and Table 1 illustrate the overall design and optimized dimensions of the proposed antenna. It can be visually perceived that the final antenna configuration consists of a rectangular patch with two rectangular and one circular slot etched out with uniform ground plane pattern. Multiband resonances are responsible for the slots within the radiating patch. The current distribution of the radiating surface is affected by the rectangular slots, thus increasing the total current range, resulting in multiband resonance in antenna. A rectangular strip line at the bottom is the feed line that is designed using lumped port excitation. Feed line width (t1) plays a crucial role in achieving good matching impedance

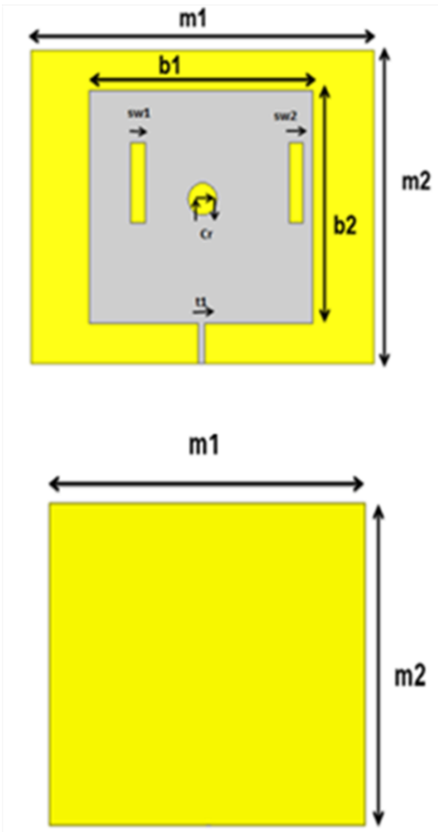


Fig. 2. *Front and aback patch of the proposed antenna.*

TABLE 1

DIMENSIONS (MM) OF THE DESIGNED ANTENNA

m1=80	b1=65	sw1=2	Cr=2.5
m2=80	b2=80	sw2=2	t1=5

3 ANTENNA DESIGN CONSIDERATION

The antenna is designed at 2.4 GHz frequency sweeping between 1 – 6 GHz using FR4 substrate. The three parameters important to microstrip patch antenna design are:

1. Operating frequency (f0): The antenna resonant frequency must be correctly chosen,
2. Substrate dielectric constant (εr).
3. Dielectric substrate height (h): The dielectric substrate height is an important part for the calculation of antenna design, after all antenna should not be bulky.

The various antenna design equations are given below [9].

3.1 Fringe Factor

3.2 Length of the patch

$$L = L_{eff} - 2\Delta L$$

$$\text{Where } L_{eff} = \frac{C}{2Lf_0\sqrt{\epsilon_{reff}}}$$

3.3 Length of the patch

For any patch antenna frequency is given for TM10 mode as Where, n and m are modes, respectively, along W and L

$$f_0 = \frac{c}{2\sqrt{\epsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right]^{1/2}$$

3.3 Length of the patch

For efficient radiation, the width W is given as

The model for the transmission line applies only to infinite ground planes. Nevertheless having a finite ground plane is

$$\Delta L = 0.412h\frac{(\epsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\epsilon_{reff} - 0.258)(\frac{W}{h} + 0.8)}$$

essential to practical considerations. It can been seen that similar results can be acquired for both finite and infinite aground planes, if the aground plane happens to be about 6 times the thickness of the substrate all around the periphery which could be greater than the patch dimensions.

Therefore, rectangular microstrip patch antenna is modelled

$$W = \frac{C}{2f_0\sqrt{\frac{\epsilon_r+1}{2}}}$$

after calculating all the parameters using the above formulae.

4 PARAMETRIC STUDY

The parametric studies are carried out to observe the effect of slots on antenna performance. The analysis is carried out on sw1 and sw2 since these slots have a drastic effect on the

$$L(g) = 6h + L$$

$$W(g) = 6h + W$$

impedance matching of the designed antenna. The length of the slot can be viewed as inductance and capacitance distance can be viewed between the slots.

4.1 Effect of left slot sw1

Slot sw1 impact is observed by changing sw1 while the other slot remains constant. The study shows a change in both S11 and other bands is prevalent at 2.4 and 5.2 GHz. Optimal results are found for sw1=2 mm, as shown in Fig. 3(a).

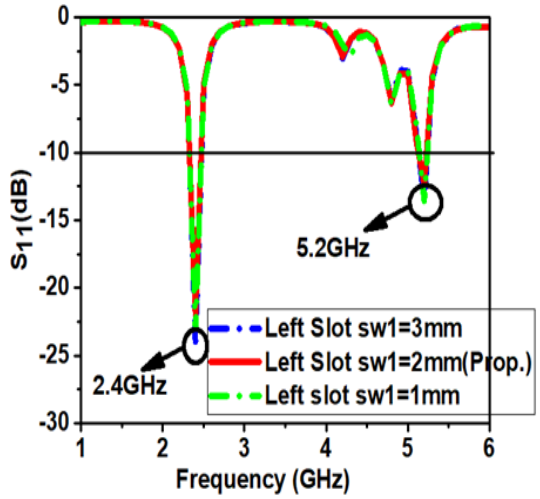


Fig. 3 *(a). Effect of Slot sw1 on impedance matching of the antenna*

4.1 Effect of right slot sw2

Slot sw2 is also investigated and shown in Fig. 3 (b) which is similar to slot sw1. A small dimensional variation significantly changes the aS11 of the antenna that is proposed. The optimal result is found for sw2=2 mm.

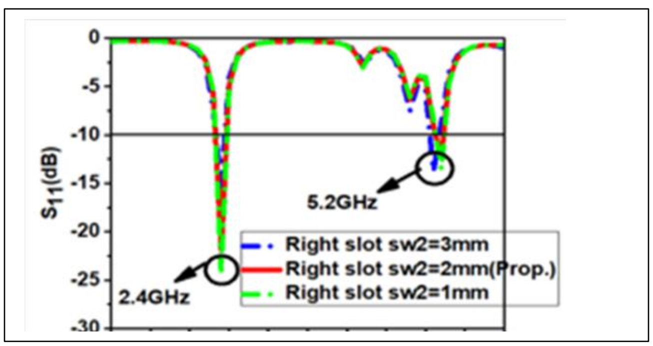


Fig. 3 *(b). Effect of Slot sw1 on impedance matching of the antenna*

5 ANTENNA CHARACTERIZATION RESULTS

The simulation S11 results of the antenna that is proposed has been illustrated in Fig. 4.alt can be seen that the antenna works at 2.4 GHz (WLAN) and 5.2 GHz (higher WLAN) frequencies, respectively. The fractional bandwidth at 2.4 GHz is 16.6 % and at 5.2 GHz is 7.69 %, respectively. The bandwidth obtained and the proposed design's compact size makes it ideal for WLAN applications. The radiation properties of the proposed design are shown in Fig. 5. The proposed design can be observed to have unidirectional pattern of radiation in both plane E and plane H. The unidirectional nature of the radiation pattern enables point-to-point contact to be made using the antenna. Low across-polarization values are observed for both plane E and H plane.

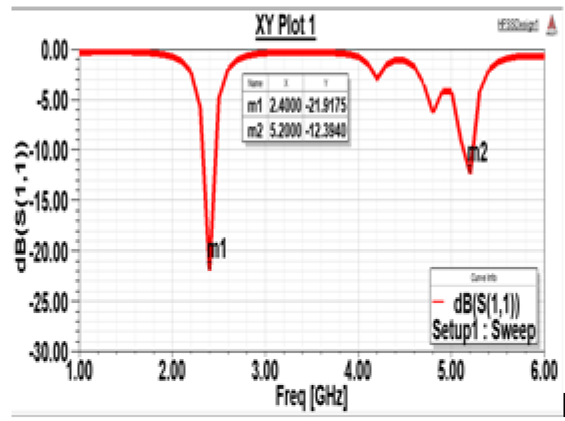
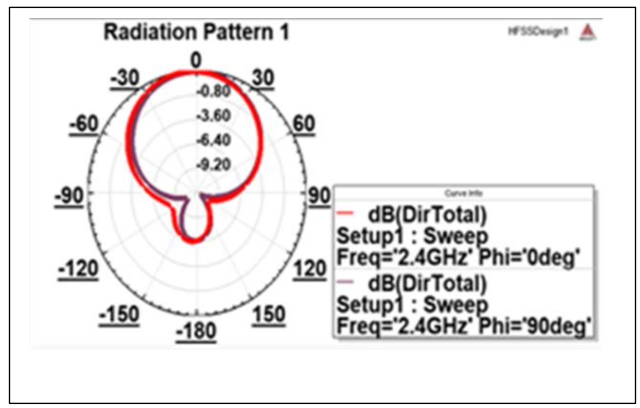
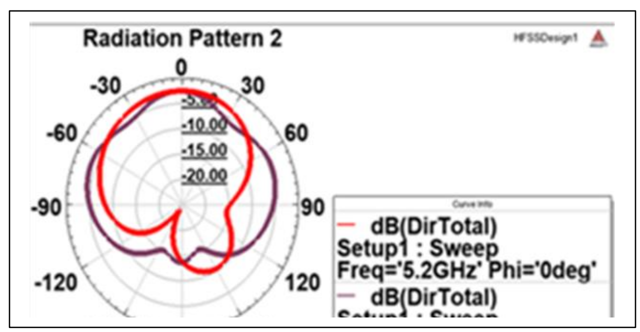


Fig. 4. *Simulation result of the antenna*



(a)



(b)

Fig. 5*. The pattern of radiation at (a) 2.4 GHz (b) 5.2 GHz*

6 CONCLUSION

This paper presents a microstrip patch antenna design for 2.4 GHz and 5.2 GHz. The multiband resonance is obtained and the design slots influence the distribution of surface current. Parametric studies shows that a small modification in the slot has a drastic effect on the proposed system function. The design and simulation of the microstrip patch antenna has been developed successfully and is examined using Ansys HFSS. The proposed design has compact area, simple design and good impedance matching which makes it versatile for WLAN applications.

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