Design Study of Microstrip Antenna with Various Feeding Techniques: A Review

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Abstract— This paper presents a review of the design of microstrip patch antenna for 5.2GHz resonant frequency with four different feeding techniques. Investigations show that all the designs are working in C-band with satisfactory bandwidth and radiation characteristics.

Keywords —Microstrip Antenna, Feeding techniques, Bandwidth and C- band.

1. INTRODUCTION

In present developments of the microstrip antenna technology patch gained a significant progress due to its compact size and light weight moreover ease of fabrication and design flexibility. The microstrip patch antennas can provide dual and circular polarizations, dual-frequency operation, broad bandwidth and feed line flexibility [1][2].

Increasing gain and impedance bandwidth and decreasing dimensions of microstrip antennas are primary goals of researchers. Many methods such as using parasitic patches, multilayer structures, materials with low dielectric constants and air gap between layers have been reported for increasing impedance bandwidth and gain bandwidth [3].

2. ELECTROMAGNETIC COUPLING TO MICROSTRIP ANTENNA

A feed line is used to excite to radiator by direct or indirect contact. Feeding techniques for Microstrip patch antennas can be classified into two main categories i.e. Contacting and Non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element while in the non-contacting scheme electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch[4]. There are many different techniques of feeding and four most popular techniques are coaxial probe feed, microstrip line, aperture coupling and proximity coupling. A comparative study of various feeding techniques is given in the table 1 below [1].

Table 1: Comparison of various feeding techniques for MSA.

S. N	Characte -ristics	Line feed	Co-axial feed	Aperture coupled	Proximi-ty feed
1	Spurious radiation	More	More	Less	Minimu m
2	Reliabilit y	Bette r	Poor	Good	good
3	Fabricati on	Easy	Solderi ng required	Alignme nt required	Alignme nt required
4	Bandwid -th	2-5 %	2-5 %	12-15%	8-10%

3. ANTENNA DESIGN AND CONFIGURATION

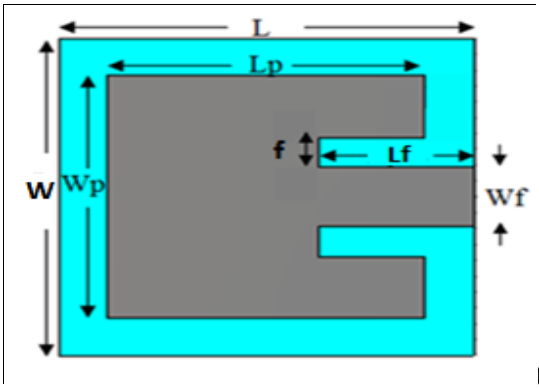
The design approach and antenna configurations are describe in this section. The simple transmission line model was used for the antenna size calculation for which the formulas are given below.

$$W = c/2f\,[(\varepsilon_r + 1)/2]^{-1/2} \quad \text{----------(1)}$$

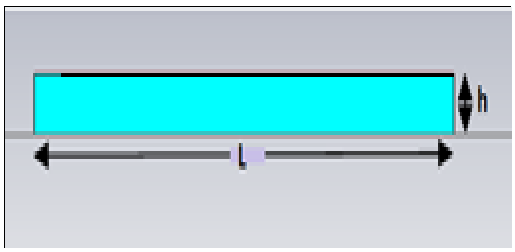
$$L = c / 2f\sqrt{\varepsilon_{re}} - 2\Delta L \quad \text{----------(2)}$$

Where ε_{re} and ΔL can be calculated from [2]

The microstrip patch antenna with edge feeding is designed and simulated using the CST Microwave studio [5] for the resonant frequency 5.2 GHz at first. The microstrip edge feed is a conducting strip which is usually smaller than the patch. This feeding technique is simple to design, easy to fabricate, simple to model and easy to match by controlling the inset position. The top and side view is shown in figure 1(a-b).



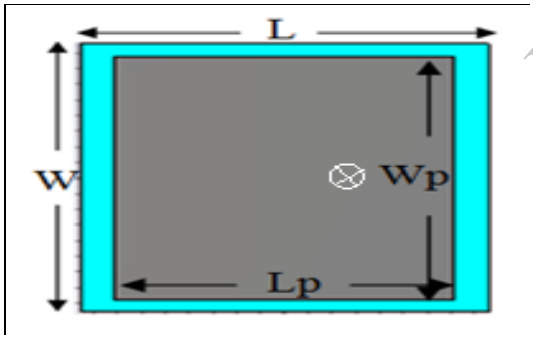
(a)



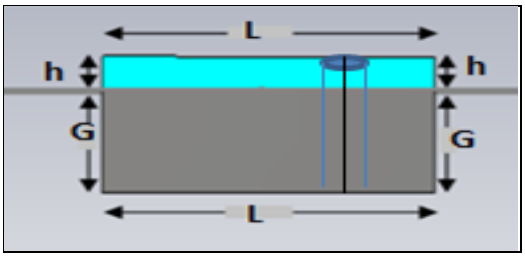
(b)

Figure 1. Edge Fed (a) top view (b) side view

Simillarly coaxial fed MSA is designed and simulated for resonant frequency 5.2 GHz. Coaxial probe feeding is feeding method in which that the inner conductor of the coaxial is attached to the radiation patch of the antenna while the outer conductor is connected to the ground plane. Figure 2(a-b) shows the coaxial fed MSA.



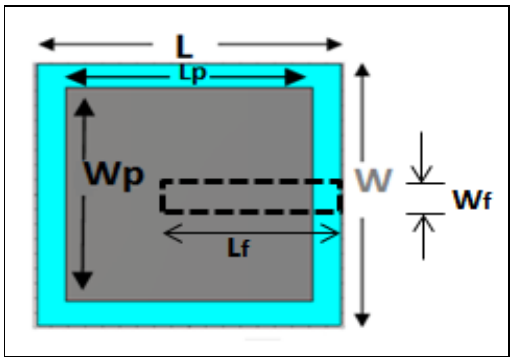
(a)



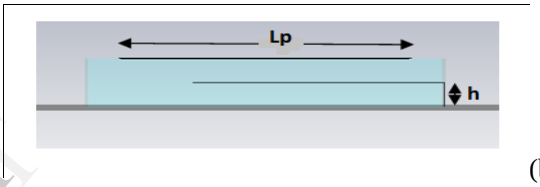
(b)

Fig. 2. Coaxial Fed (a) top view (b) side view

Then proximity fed MSA is designed in the simmilar way. In this feeding technique the substrate is separated by feed line which is microstrip fed and at the bottom there is ground plane. The patch is attached at the surface of the upper substrate. The radiation is achieved by the patch though the microstrip feed. The design is shown in figure 3(a-b).



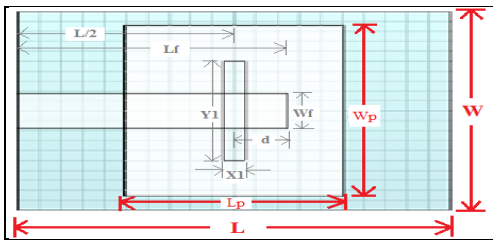
(a)



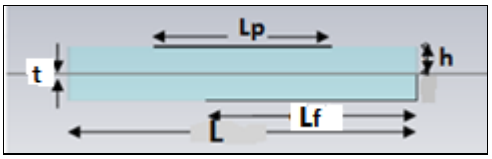
(b)

Fig. 3. Proximity fed (a) top view (b) side view

In the last aperture coupled MSA is designed and simulated and shown in figure 4(a-b). An aperture coupled feed consist of two different substrate separated by a ground plane. On the bottom side of lower substrate there is a microstrip feed line whose energy is coupled to the patch through a slot on the ground plane separating two substrates.



(a)



(b)

Fig. 4. Aperture coupled (a) Top view (b) Side view

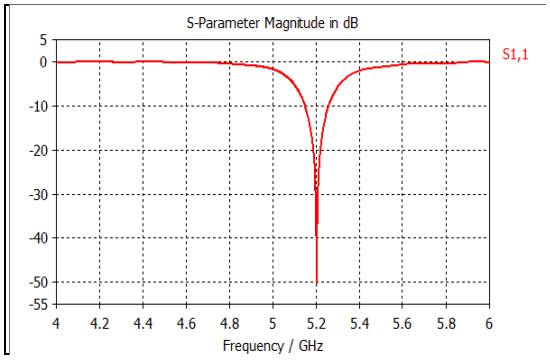
A compiled tabe for the optimised values of all the necessary parameters are given in table 2.

Table 2 : Optimised design parameters of proposed MSAs.(All in millimetre)

Parameters	Edge fed	Coaxial fed	Proximity fed	Aperture coupled
L, W, h	20, 20,1.524	17, 17, 1.524	17, 17, 1.524	20, 20, 1.524
L_p, W_p,t	15, 15, 0.002	14, 15, 0.002	14, 14, 0.002	10, 10, 0.002
L_f, W_f	7.5, 3.733	-	12.4, 3.5	12, 3.6
X_1, Y_1	-	-	-	1, 10
f	2	-	-	-
G	-	6	-	-

4. RESULTS AND DISCUSSIONS

$|S_{11}|$ in db parameter and radiation patterns for the proposed microstrip antennas are proposed in this section. $|S_{11}|$ in db the parameters of all the four designs, namely edge fed, coaxial fed, proximity fed and aperture coupled, are given in figure 5 (a-d) . It can be seen in the figure 5 (a) that edge fed MSA has $|S_{11}|$ equal to -50 db. Similarly from figure 5 (b) coaxial fed MSA has $|S_{11}|$ equal to -45 db. Also for the proximity fed MSA $|S_{11}|$ equal to -35 db as shown in figure 5 (c). And in the last the $|S_{11}|$ equal to -30 db for the aperture coupled MSA and shown in figure 5 (d).



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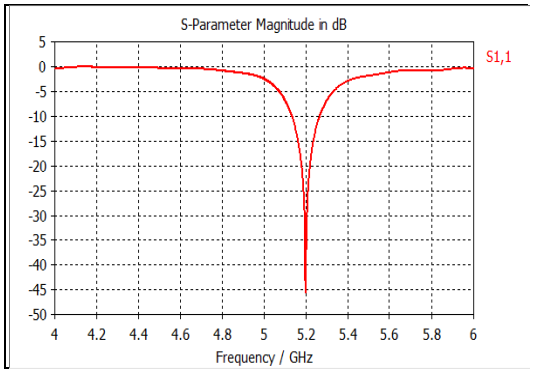

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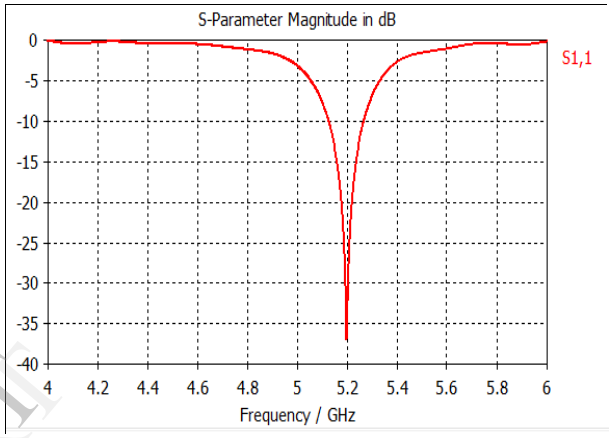

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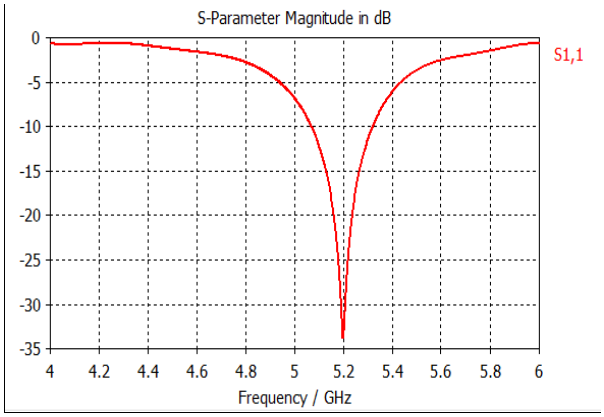
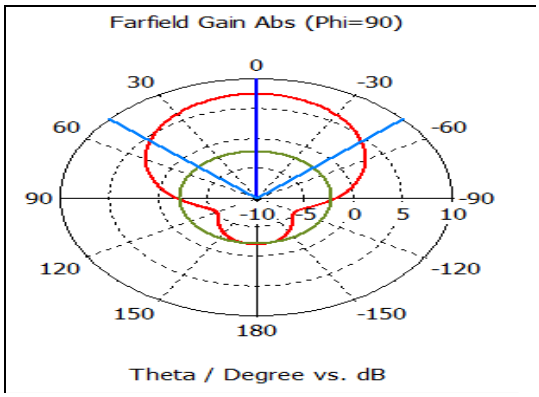


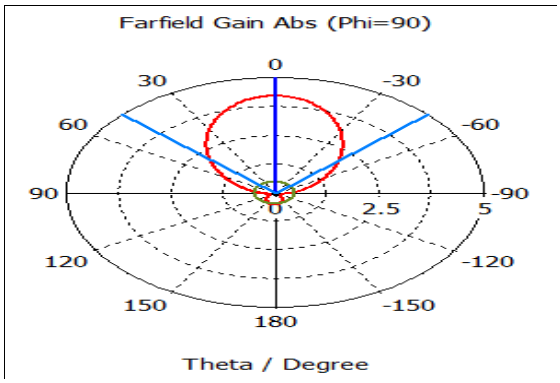
(d)

Fig.5. The S(11) parameters (a) Edgte fed (b) Coaxial fed (c) Proximity fed (d) Aperture coupled

The radiation patterns for all the proposed designs are given in figure 6(a-d). For better understanding of the results the radiation patterns at Ø=90° is also given.



(a)



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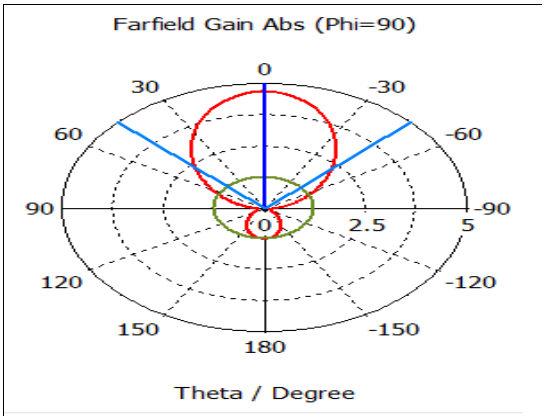
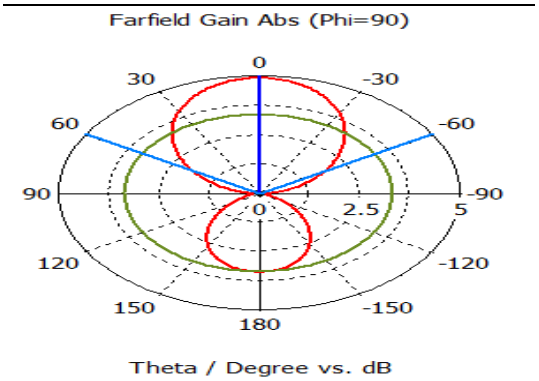


(c)

A comparative review of the results for all the designs is given in table 3 below.

Table 3: A comparative review of the results

SN	Characteristics	Line feed	Co-axial feed	Aperture feed	Proxi-mity feed
1	Operating freqquency (GHz)	5.2	5.2	5.2	5.2
2	Gain (db)	7.35	4.19	5.54	4.48
3	Bandwidth (MHz)	111	133	250	140



(d)

Fig. 5. Radiation pattern for ø=90°. (a) Edgte fed (b) Coaxial fed (c) Proximity fed (d) Aperture coupled.

5. CONCLUSION

A comparative and design study of basic microstrip patch antenna with four different feeding techniques is carried out in this work. It is found that all the designs are working in C-band for operating frequency 5.2 GHz and making the MSAs suitable for W-LAN applications [6].

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