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Microstrip Patch Antenna with U-slot for WLAN Application

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ABSTRACT: *In this paper, Microstrip patch antenna fed through a probe feed is designed , fabricated and experimentally verified for WLAN application by cutting u-slots in the patch, When a single u-slot is introduced in the patch, it resonates at 2.6Ghz and 3.6Ghz with a return loss of -31dB and -13dB. If another u-slot is introduced in the patch, it resonates at 2.09 GHz, 3.2Ghz and 4.96 GHz with a return loss of -18.2dB, -16.2dB and -27.9dB respectively. The maximum gain and peak directivity achieved at 4.96 GHz is 6.5dBi and 8.17dBi respectively. The VSWR parameter was found to be less than 2 within the operating frequency range. It can be used for WLAN application.*

Keywords: *Microsrip patch antenna , probe feed, u-slots, HFSS, return loss(s11), gain , directivity ,*

I. INTRODUCTION

In this paper, Microstrip patch antenna fed through a co-axial probe feed[1] is designed, fabricated and experimentally verified for WLAN applications by cutting u-slots in the patch. When a single u-slot is introduced in the patch, it resonates at 2.6GHz and 3.6GHz with a return loss of -31dB and -13dB.if another u-slot is introduced in the patch, it resonates at 2.09GHz, 3.2GHz, 4.96GHz with a return loss of -18.2dB, -16.2dB, -27.9dB respectively. The maximum gain and peak directivity achieved at 4.96GHz is 6.5dBi and 8.17dBi respectively. The VSWR parameter was found to be less than 2 within the operating frequency range. It can be used for WLAN applications.

Initially microstrip patch antenna with U-slot was mainly used for enhancement of bandwidth. However, researches revealed that wideband characteristic can be modified to multiband characteristic by intelligent placement of U-slots, by disturbing the surface current flow in the patch [2], [3], and [4].

Experimentally, it has been shown that variations in parameters such as the width and length of the U-slot size of the patch, probe size and location as well as substrate permittivity can dramatically change the antenna's behavior[5]. To date, no analytical methods have been developed that accurately relate the complex relationships between the antenna dimensions and characteristics .Consequently, no analytical procedures can be offered to determine the dimensions. Hence the simulation results obtained after optimizing all these parameters are shown in the following section.

II. ANTENNA CONFIGURATION

The basic rectangular microstrip patch antenna is shown in Fig.1 .The patch is fed through a probe feed .the dielectric used in the design is FR-4 due to its availability whose di-electric constant is 4.4. The overall size of the antenna is L×W×H is 61×72×1.6 mm. The patch antenna intended to operate at multiband frequency having length (Lp) and width (Wp) is formed on the dielectric substrate above the ground plane.

1. Design of single U-slot Microstrip Antenna

The basic geometry of U-slot antenna was introduced by Huynh and Lee in 1995[6]. A single u-slot is introduced in the patch to resonate at 2.6GHz and 3.6GHz with a return loss of -31dB and -13dB as shown in the fig1. The dimensions of the slots are varied accordingly for desired performance. The proposed antenna dimension are tabulated in table1.

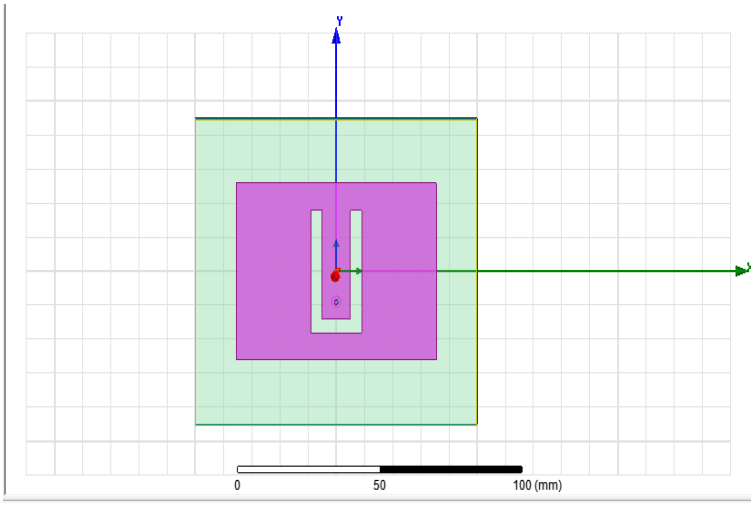


Fig. 1 Geometry of single U-slot antenna

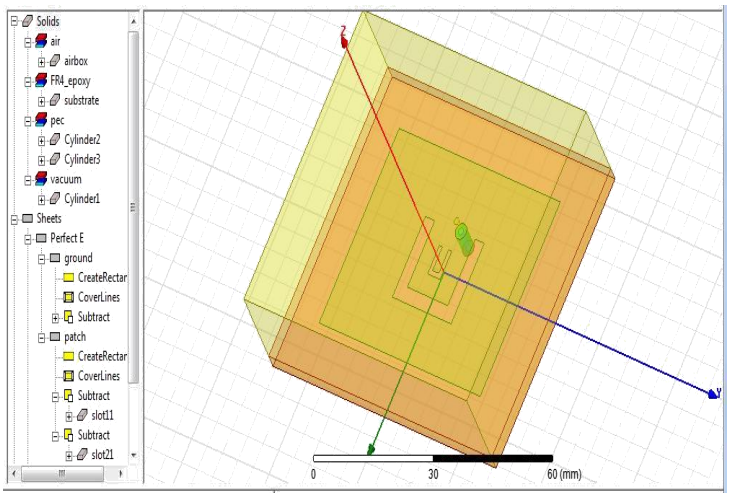


Fig. 2 Geometry of of Two U-slot antenna

Table 1 Proposed parameters of single U-slot antenna

Parameters	Unit(mm)
Patch Length (L)	61
Patch Width (W)	72
Thickness of the substrate (h)	3
Dielectric constant of the substrate	4.4
Length of vertical first U-slot	20
Length of horizontal first U-slot	3
Width of first U-slot	3

2.Design of double U-slot Microstrip Antenna

Another u-slot is introduced in the patch of the antenna to resonate at 2.09GHz, 3.2GHz, 4.96GHz with a return loss of -18.2dB, -16.2dB, -27.9dB respectively as shown in the fig2. The dimensions of the slots are varied accordingly for desired performance as shown in the table. The feed location is also changed accordingly for low spurious radiations. The dimensions of the co-axial feed are given in the table2.

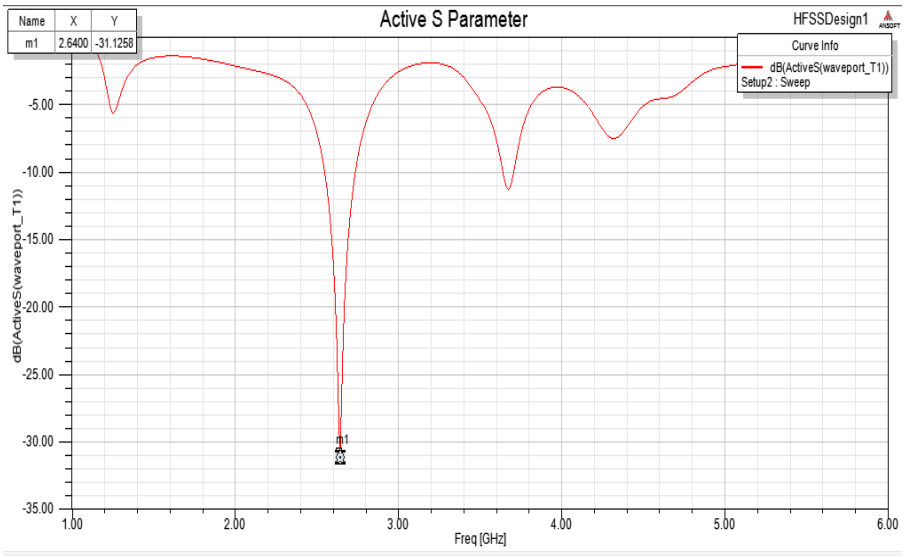
Table 2 Proposed parameters of Two U-slot antenna

Parameters	Unit(mm)
Patch Length (L)	61
Patch Width (W)	72
Thickness of the substrate (h)	3
Dielectric constant of the substrate	4.4
Length of vertical Second U-slot	8
Length of horizontal Second U-slot	1
Width of Second U-slot	1
Feed Offset	-8.66 in y

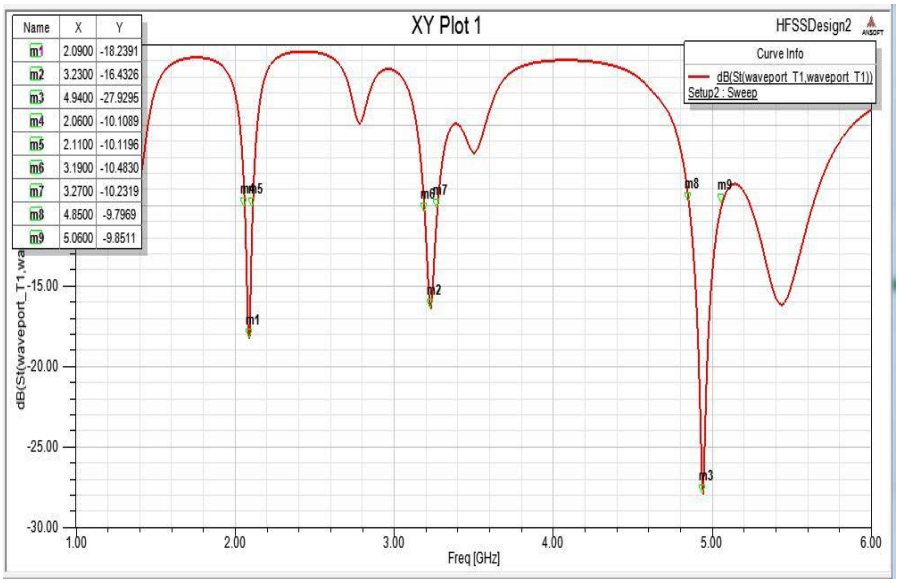
III. SIMULATION RESULTS

Simulation of proposed antenna fed via a co-axial probe has been performed in HFSS. Antenna with single U-slot resonate at two frequencies i.e. 2.64GHz and 3.6GHz and Antenna with dual U-slot resonate at three frequencies i.e. 2.09GHz, 3.26GHz and 4.96GHz. The return loss of proposed single U- slot antenna is shown in Fig. 5(a). The lower band resonance is at 2.6GHz with return loss of -31.12 dB and upper band resonance occurs at 3.6GHz with return loss of -13.30 dB. Two U-slot antenna resonates at 2.09GHz, 3.26GHz and 4.96GHz with return loss of -18.2 dB, -16.4 dB and -27.9dB respectively as shown in Fig.5(b).

The proposed single and two U-slot microstrip patch antenna shows considerably good gain, directivity and VSWR values. Measured Return loss , gain, directivity and VSWR at different resonant frequencies for single and two U slot antenna are tabulated in Table 3.The polar plots for single U-slot antenna and two U-slot antenna at resonant frequency 2.64 GHz and 4.96GHz respectively are shown in Fig.6.



(a)



(b)

Fig. 5 Return loss (a) single U-slot antenna (b)Two U-slot antenna

Table 3 Various antenna parameter (a) single U-slot antenna (b)Two U-slot antenna

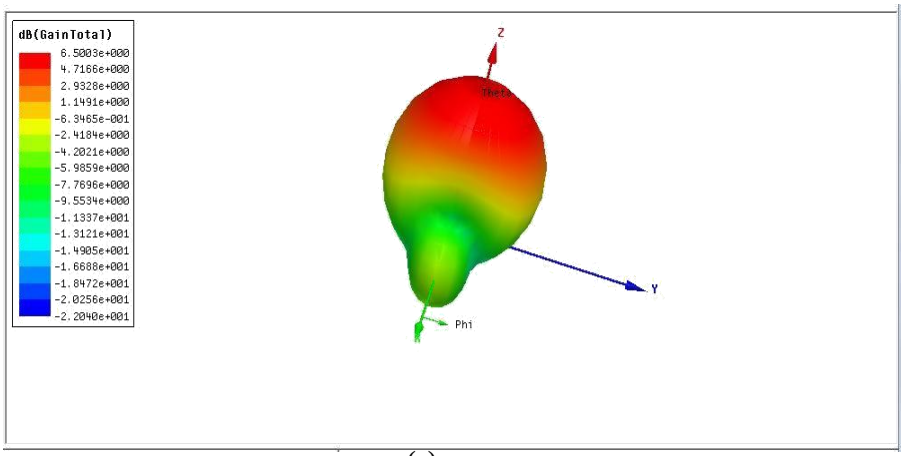
Frequency (GHz)	Gain (dB)	Directivity (dBi)	VSWR
2.64	5.62	6.58	1.24
3.6	5.42	7.12	1.36

(a)

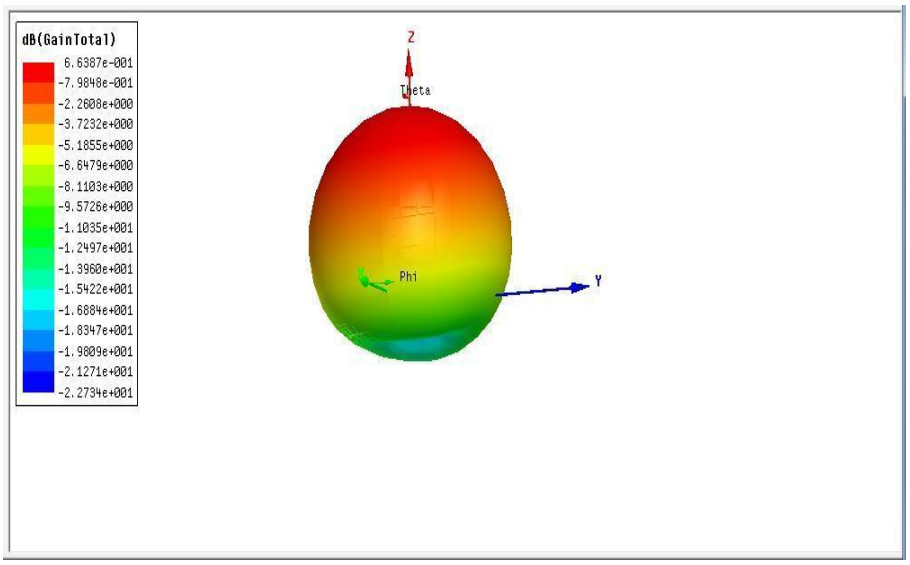
Frequency (GHz)	Gain (dB)	Directivity (dBi)	VSWR
2.09	5.65	2.16	1.27
3.26	4.25	6.52	1.64
4.96	6.5	8.17	1.19

(b)

For Two U slot antenna fed via co-axial probe, the maximum Directivity achieved at 4.96 GHz is 8.17dBi and The VSWR parameter was found to be less than 2 within the operating frequency range[7].



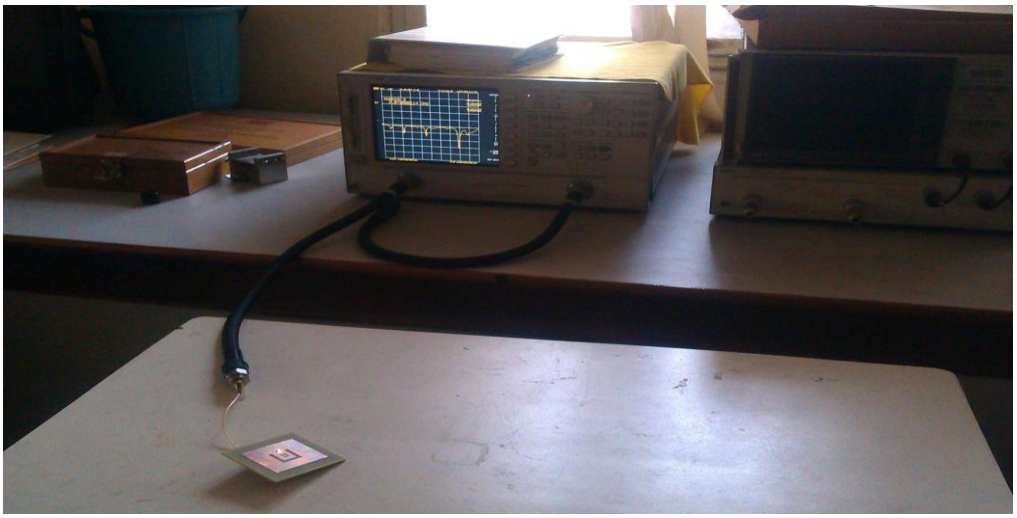
(a)



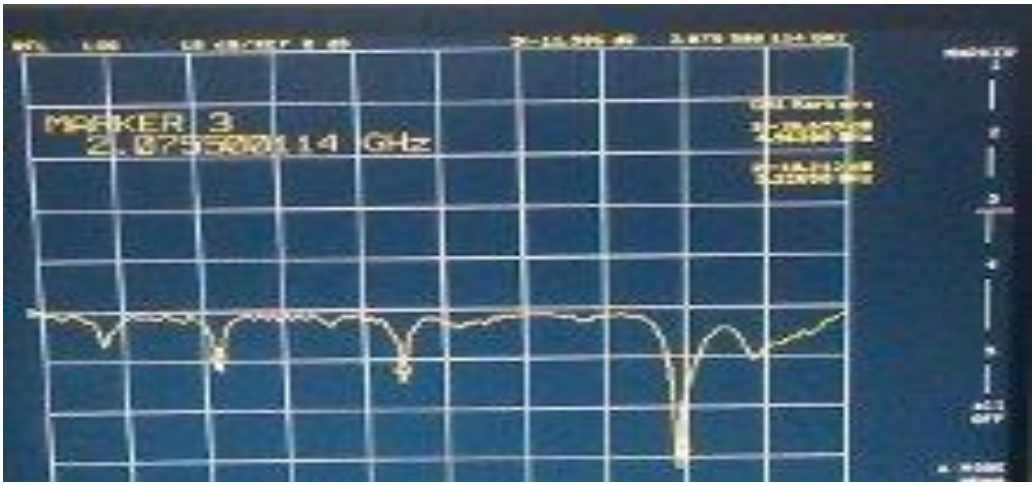
(b)

Fig. 6 polar plot (a) single U-slot antenna (b)Two U-slot antenna

IV. FABRICATION RESULTS



(a)



(b)

Fig. 7 (a) fabricated antenna connected to network analyzer
(b) Frequency versus return loss graph

V. CONCLUSION

A Microstrip patch antenna using single U-slot and Two U-slot is designed, fabricated and experimentally verified for WLAN applications We have shown single U-slot resonating at 2.6GHz and 3.6 GHz with return loss of -31dB and -13dB, and with double U-slot at 2.09GHz, 3.2GHz, 4.9GHz with Return loss of -18.2dB ,-16.2dB, -27.9dB. Finally the max gain and peak directivity achieved at 4.9 GHz is 6.5 dBi and 8.17 dBi respectively.

This paper represents simulation based results using HFSS and compared it with the fabricated antenna results. By Using simple feeding technique for designing this antenna make this antenna a good choice in many communication systems. This antenna can be further improved by varying the various parameters such as substrate thickness, width, length of the patch and slot in terms of resonant frequencies and bandwidth for WLAN applications.

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