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An Aperture Coupled Microstrip Patch Antenna for Application at 7.5GHz

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***Abstract*—This paper presents design and simulation of work on microstrip patch antenna with aperture coupling for applications at 7.5GHz of C band. This design of antenna consists of two substrates of FR4 (Flame Retardant 4) material with dielectric constant ($\mathcal{E}_r$)=4.4 and thickness (h)=1.6mm, and there is a rectangular slot at ground plane which is sandwiched between two substrates and unique flower type design on rectangular patch. Ansoft HFSS simulation software is used for designing and simulation of the antenna based on given operating frequency. From the simulation results, the impedance bandwidth of an antenna is obtained form 7.35 GHz to 7.64 GHz (i.e. 290 MHz) at resonant frequency of 7.52 GHz.**

***Keywords*— Aperture Coupling, Microstrio Patch Antenna, FR4, HFSS.**

I. INTRODUCTION

In recent few years, the development in wireless communication systems have caused microstrip patch antenna very popular due to their attractive features like light weight, planar profile, ease of analysis and fabrication using modern printed circuit technology [1]. The aperture coupled feeding technique was first introduced by D. M. Pozar and has been used for feeding microstrip antennas widely since it provides advantage of isolating spurious feed radiation by using common ground plane.[2] Generally, Microstrip antennas are fed by using various feeding techniques like microstrip line feed (Inset feeding), coaxial (Probe) feed, proximity coupled feed and aperture coupled feed [3].

II. FEEDING TECHNIQUES

There are various ways to feed the microstrip antenna, some popular of them are described here.

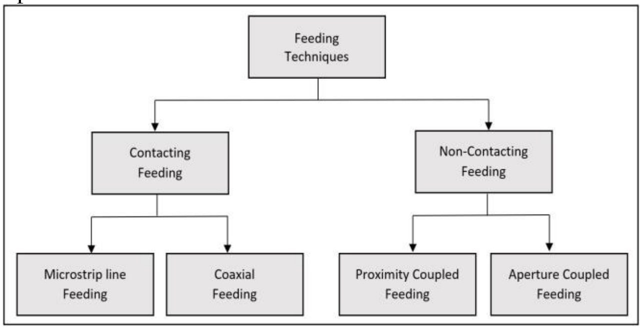


Fig. 1: Different types of Feeding Techniques

TABLE I. COMPARISON BETWEEN DIFFERENT FEEDING TECHNIQUES[6]

Characteristics	Microstrip Line feed	Coaxial Feed	Proximity Coupled Feed	Aperture Coupled Feed
Spurious Feed Radiation	More	More	Minimum	Less
Reliability	Better	Poor due to Soldering	Good	Good
Ease of Fabrication	Easy	Soldering & Drilling Needed	Alignment Required	Alignment Required
Impedance Matching	Easy	Easy	Easy	Easy
Bandwidth	2-5%	2-5%	13%	21%

From table I shown above, we can say that Aperture coupled method is better than other feeding methods. Results of Aperture coupled feeding and Proximity coupled feeding (i.e. Non-contacting techniques) are better than that of Microstrip line feeding and Coaxial feeding (i.e. Contacting techniques) in terms of Return loss (S_{11}), VSWR and Gain [5]. The basic disadvantage of using microstrip line feeding technique is spurious feed radiation and Coaxial Feeding is difficult to model and it gives narrow bandwidth. Proximity coupled feeding is better only if gain is primary issue to design an antenna but aperture coupled feeding is more efficient to improve performance of an antenna without reflection in the system [6].

III. APERTURE COUPLED MICROSTRIP PATCH ANTENNA

Figure 2 shows the structure of microstrip patch antenna with aperture coupled feeding technique.

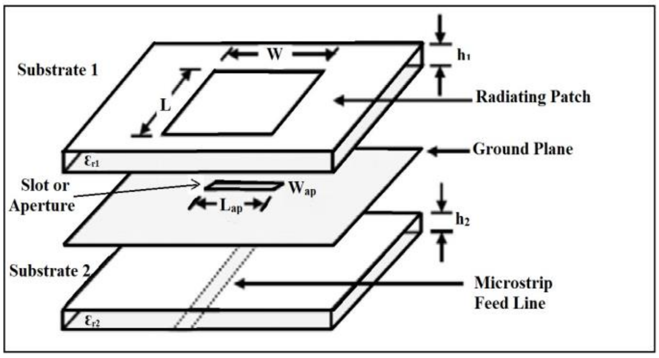
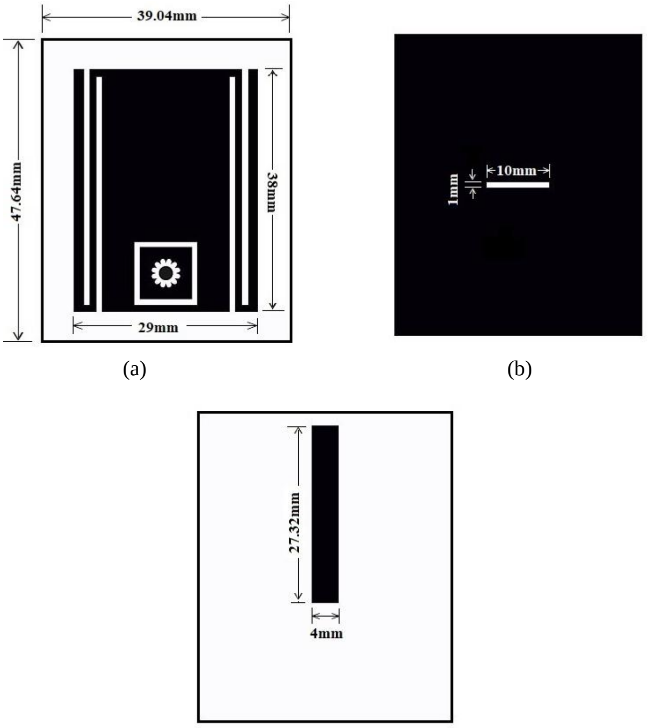


Fig. 2: Design of an Aperture Coupled Microstrip Patch Antenna

Figure 2 shows the structure of microstrip patch antenna with aperture coupled feeding technique, which consists two dielectric substrates, where ground plane is sandwiched between two substrates. A patch is printed on the dielectric substrate which is above the ground plane and the feed is printed on the dielectric substrate which is below the ground plane. There is slot or aperture is made on the ground plane through which radiating patch and microstrip feed are coupled electromagnetically.

IV. ANTENNA STRUCTURE AND DESIGN

The proposed design of an aperture coupled microstrip patch antenna is as shown in fig. 3.



(a) (b)

(c)

Fig. 3: Proposed design of an aperture coupled microstrip patch antenna; (a) Patch; (b) Ground Plane; (c)Microstrip Feed Line;

(a) (b)

Fig. 4: Antenna after Fabrication; (a)Top view; (b)Bottom view

For designing an aperture coupled microstrip patch antenna for 7.5GHz resonant frequency following parameters were used.

TABLE II. DESIGN PARAMETERS

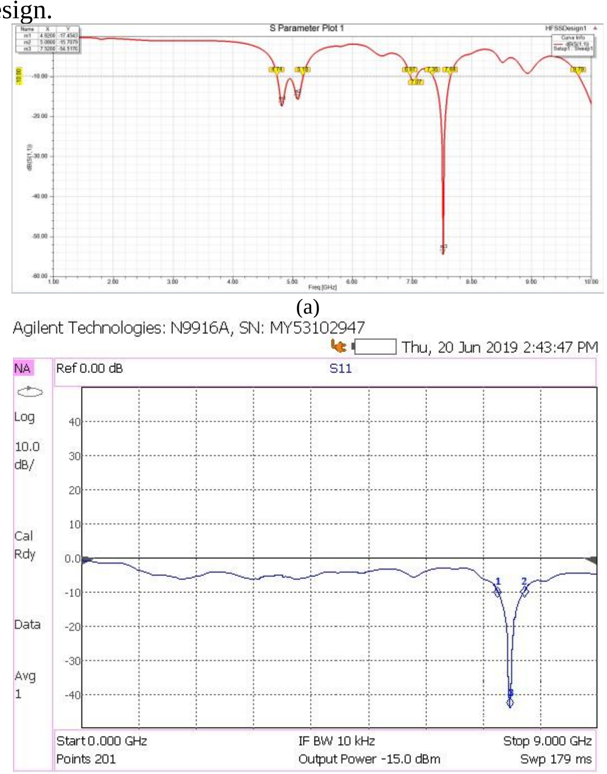
Sr. No.	Parameter	Dimensions
01	Length of patch (L_p)	38mm
02	Width of patch (W_p)	29mm
03	Length of Substrate (L_s)	47.64mm
04	Width of Substrate (W_s)	39.04mm
05	Length of Feed (L_f)	27.32mm
06	Width of Feed (W_f)	4mm
07	Length of Aperture (L_{ap})	1mm
08	Width of Aperture (W_{ap})	10mm
09	Substrate Material	FR4
10	Height of Substrate (H)	1.6mm
11	Dielectric Constant of Substrates ($\mathcal{E}_r$)	4.4
12	Resonant Frequency (F_r)	7.5GHz

V. RESULTS

Ansoft HFSS simulation software is used for designing and simulation of the antenna based on given operating frequency. Fabricated antenna is tested on Vector Network Analyzer (VNA) at Terna College of Engineering, Nerul.

A. Return Loss (S_{11}) Plot:

For better performance the return loss and bandwidth of the antenna should be maximum. Following fig. 4 shows the simulated and fabricated return loss plots of proposed antenna design.



(a)

(b)

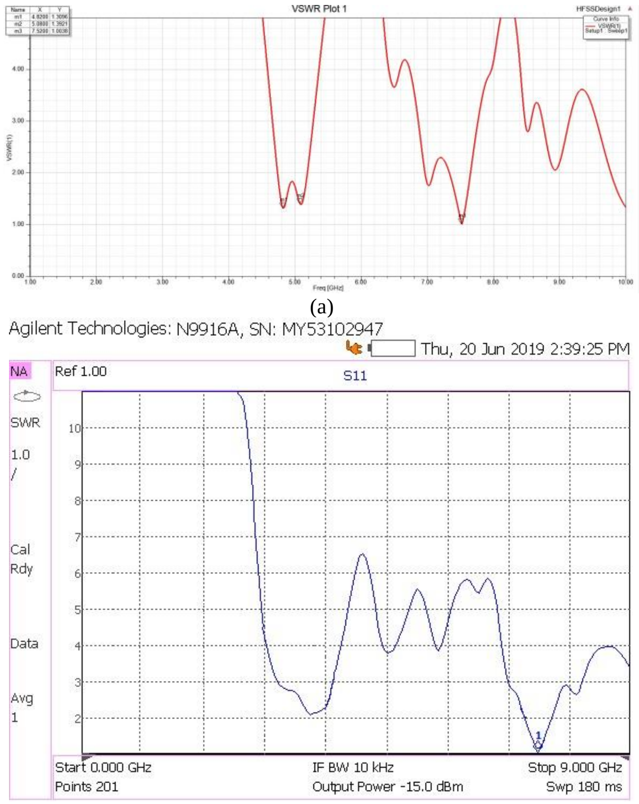
Fig. 5: Return Loss (S_{11}) Plot; (a)Simulated (b)Fabricated

TABLE III. RETURN LOSS (S_{11}): SIMULATED VS FABRICATED

Simulated			Fabricated		
Frequency (GHz)	Return loss (dB)	Bandwidth (MHz)	Frequency (GHz)	Return loss (dB)	Bandwidth (MHz)
4.82	-17.454	200	7.5	-43	300
5.08	-15.707	220			
7.52	-54.517	290			

B. Voltage Standing Wave Ratio (VSWR):

For better performance VSWR should be between 1 and 2 (i.e. 1<VSWR<2). Following fig. 5 shows the simulated and fabricated VSWR plots of proposed antenna design.



(b)

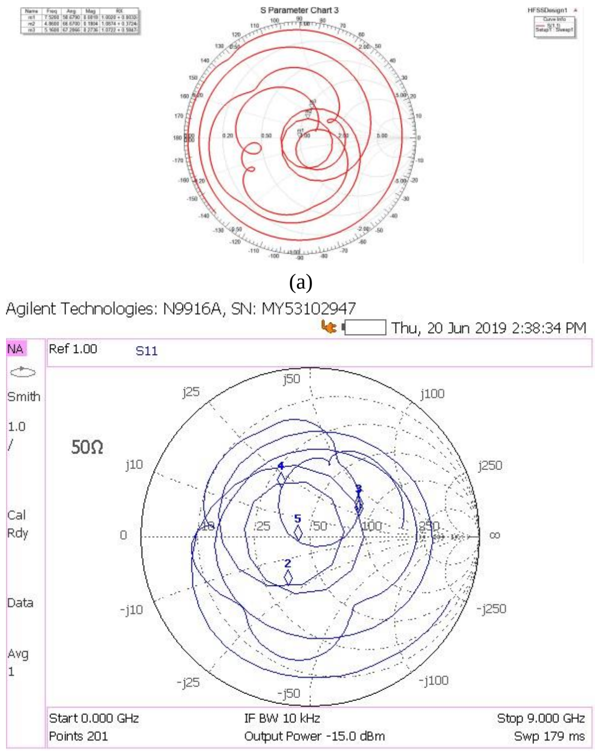
Fig. 6: VSWR Plot; (a)Simulated (b)Fabricated

TABLE IV. VSWR : SIMULATED VS FABRICATED

Sr. No.	Simulated		Fabricated	
	Frequency (GHz)	VSWR	Frequency (GHz)	VSWR
1	4.82	1.3096	7.5	1.004
2	5.08	1.3921		
3	7.52	1.0038		

C. Smith Chart:

Following fig. 6 shows the simulated and fabricated Smith Chart plots of proposed antenna design at 50Ω impedance.



(b)

Fig. 7: Smith Chart; (a)Simulated (b)Fabricated

CONCLUSION

An aperture coupled microstrip patch antenna having resonant frequency of 7.5 GHz, return loss of -43dB and bandwidth of around 300 MHz has been designed according to design specifications using Ansoft HFSS simulation software. The antenna is fabricated using FR4 material having dielectric constant (ε_r) 4.4 and height (h) 1.6mm. The antenna is tested using Vector Network Analyzer (VNA). Further this antenna can be useful for C band applications.

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