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Effect of Slots on Operating Frequency Band of Octagon Microstrip Antenna

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Abstract—*In this paper design and compare slotted and Unslotted hexagonal patch microstrip antenna by using microstrip feed line which is easy impedance matching to 50 ohm and simulated with the help of HFSS 11 software. The proposed antenna have compact in size the total size of antenna 30 × 31 mm^2 and teflone used as substrate material have dielectric constant 2.2.Due to lower dielectric constant provide higher operating bandwidth . This antenna can designed for C-band and X-band applications whose range is from 4-8 GHz and 8-12 GHz. The antenna design with slot on patch has 4.2db gain , return loss-11.96 dB and 290 MHz bandwidth when it operate on 4.35 GHz and at the 7.55 GHz it has 3.2dB gain , return loss -13.53dB and 330 MHz bandwidth and at 10.3 GHz it has 7db gain , return loss -26.72dB and 1100MHz bandwidth .When antenna design without slot it has return loss -12.72 db , 40 MHz bandwidth and -8db gain at 3.35 GHz , return loss -14.76 db,130 MHz bandwidth and gain 1.8dB at 6.10 GHz, return loss -13.26 dB,130 MHz bandwidth and 2.6db gain at 6.60 GHz , return loss -12.77db,160 MHz bandwidth and -3.4 db gain at 10.55 GHz. The simulation model of the proposed slotted antenna designed using software Ansoft HFSS.*

Key words*: Slotted and unslotted microstrip antenna , Teflon.*

1. INTRODUCTION

The field of antenna design has become one of the most attractive fields in the communication. Antenna is the one of most important elements of the wireless communications systems. The antenna designed to transmit and receive electromagnetic wave. The microstrip patch antenna is one of the recently developed types of antenna. Communication has an important role to play in the worldwide society. Now days as the communication systems are rapidly changing over from "wired to wireless". Wireless technology provides low charge alternatives and a flexible way use for communication [1].The microstrip antenna mostly useful for such as aircraft, spacecraft, satellite, and missile applications, where size ,weight, cost, performance, ease of installation, and aerodynamic profile are constraints .Where low profile antenna may be need. Now a days there are many other government and commercial applications, such as mobile radio and wireless communications that's have similar specifications. To fulfill these requirement the microstrip antenna may be used .The other advantage of micro strip antenna is simple in structure and easy to manufacture facility and it's also mechanical rebuts [2]. This antennas are suitable for planer and non planer surface. They are light in weight, low volume ,low cost, low profile ,smaller in dimension and ease of fabrication and conformity. However a microstrip patch antennas naturally have narrow bandwidth and enhancement is usually a demand for practical applications .So for extending the bandwidth countless approaches have been utilized for multi frequency applications.

2. ANTENNA CONFIGURATION

The antenna dimensions calculate by following : -

$$a = F\left\{1+\frac{2h}{\pi F\varepsilon_r}\left[\ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\right\}^{\frac{-1}{2}} \quad (1)$$

Where F can be calculated by using

$$F = \frac{8.791\times10^9}{f_r\sqrt{\varepsilon_r}} \quad \text{.....................} \quad (2)$$

F=resonant frequency of patch

$$a_e = a\left[1+\frac{2h}{\pi a\varepsilon_r}\left(\ln\frac{\pi a}{2h}+1.7726\right)\right]^{\frac{1}{2}}. \quad \text{....... ...}(3)$$

a=Actual radius of patch, h=height of substrate, Ɛr=dielectric constant of substrate.

$$\text{Angle of Inerier}=\frac{2\,n-4}{n} * 90 \quad (4)$$

n=number of segment.

The effective radius of the antenna is obtained with equation given by Where fr is the operating frequency of antenna and εr is the dielectric constant of material and h is the thickness of the circular patch.

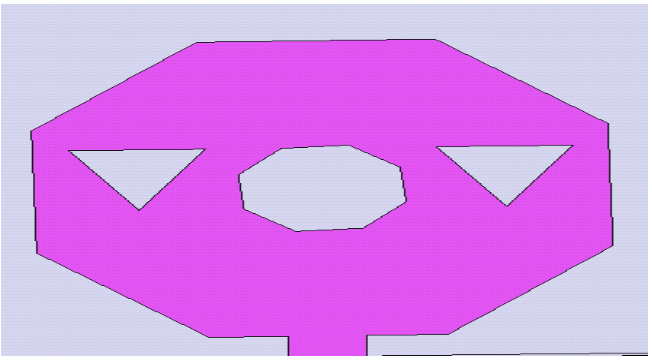

Fig. 1: Slotted patch hexagonal microstrip antenna

Table 1: Same Dimension for both slotted and unslotted antenna

Dimension of substrate	$30 \times 30\ mm^2$
Height of substrate	1.8 mm
Dielectric constant Ɛr	2.1
Radius of patch	13
Dimension of feed line	$3 \times 3mm^2$
Number of segment	8

3. RESULT

Result for slotted patch octagon microstrip antenna

Table 2: Dimension of slot in octagon patch

Size a arms of left triangle slot	5 × 5 × 5mm
Size a arms of right triangle slot	5 × 5 × 5mm
Radius of octagon slot	3 mm
Interial angle of octagon slot	135˚
Length of each segments of octagon slot	2 mm
Number of segments of octagon slot	8

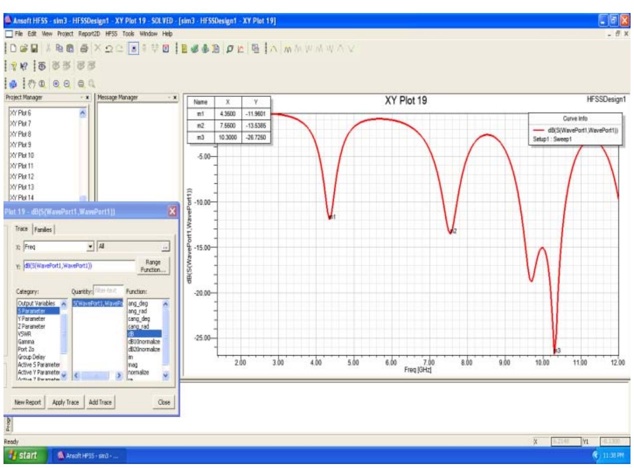

Fig. 2: Return loss of slotted octagon patch antenna

The parameter VSWR is a measure that numerically describes how well the impedance of antenna has matched to the radio or transmission line to which it is connected. VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna. The VSWR 1.67 at frequency band 4.35 GHz, a VSWR 1.53 at frequency 7.55 GHz and VSWR 1.09 at frequency band 10.3 GHz.

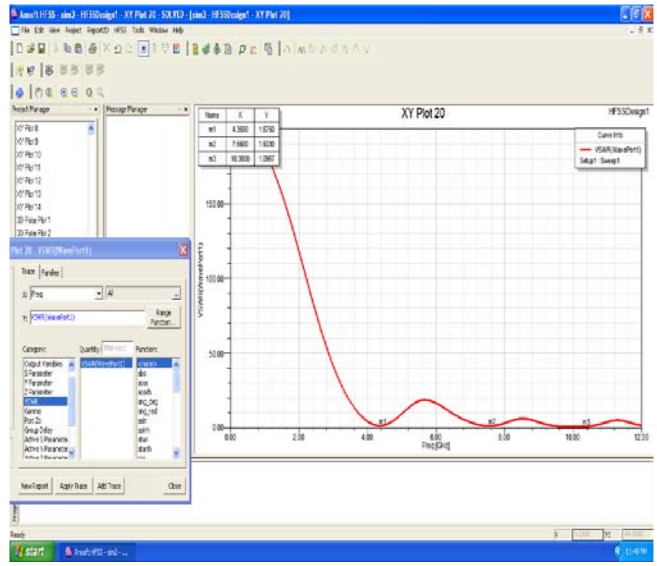

Fig. 3: VSWR of slotted octagon patch antenna

Total Gain of antenna

Its another useful parameter to describe a performance of antenna. The gain is closely related to antenna directivity. The directivity describe a directional properties of antenna. Antenna give a different gain at different frequency. Gain 3dB at frequency 4.35GHz , 3dB at frequency 7.55 GHz and 7dB at frequency 10.3 GHz.

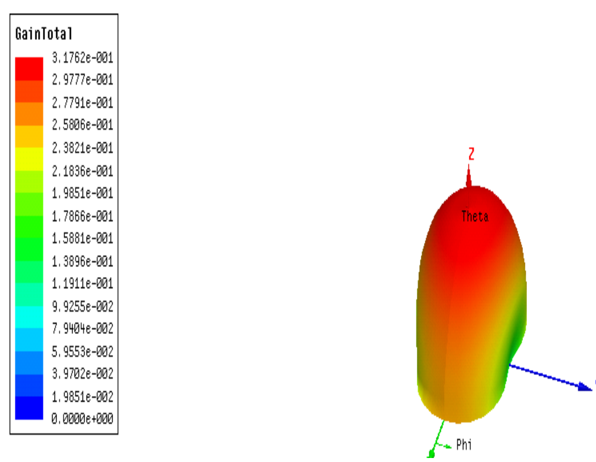

Fig. 4: Gain at frequency 4.35 GHz

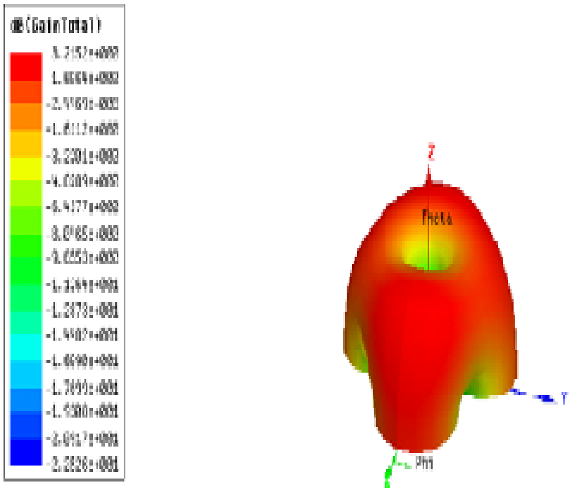

Fig. 5: Gain at frequency 7.55 GHz

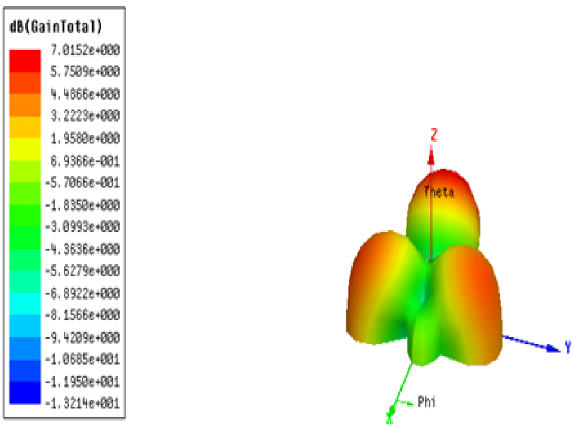

Fig. 6: Gain at frequency 10.34 Ghz

Result of unsllotted patch microstrip antenna

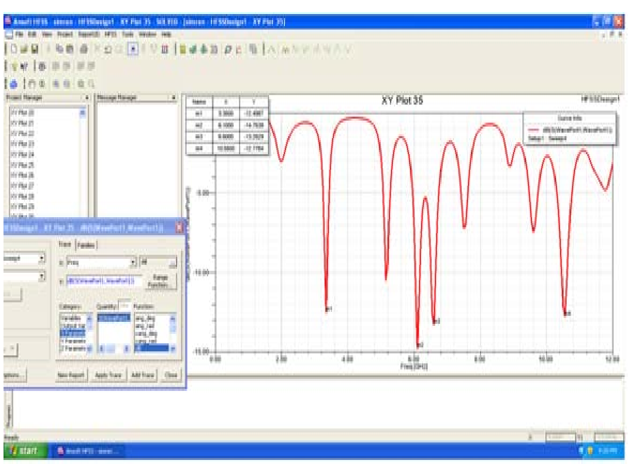

Fig. 7: Return loss of unslotted octagon patch microstrip antenna

The return loss (S) -12.49dB at frequency 3.35 GHz,-14.76 dB at frequency 6.10GHz,-13.26dB at frequency 6.60 GHz and -12.77dB at frequency 10.55GHz.

VSWR 1.16 at frequency 3.35GHz , 1.44 at frequency 6.10GHz,1.55 at frequency 6.10GHz and 1.59 at frequency 10.55 GHz.

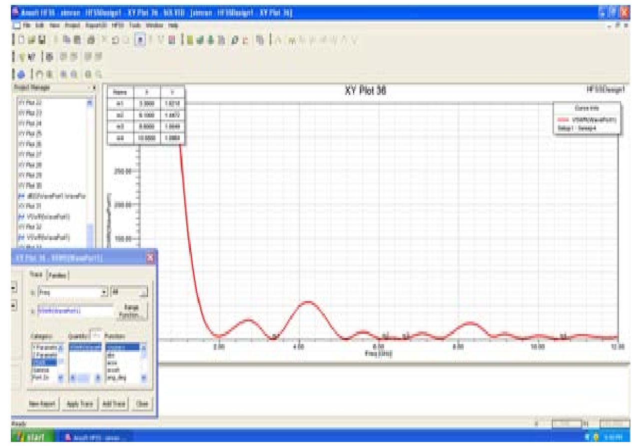

Fig. 8: VSWR of unslotted octagon patch microstrip antenna

Total gain of antenna

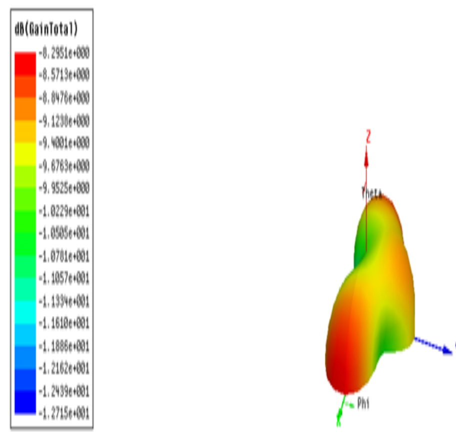

Fig. 9: Gain at frequency 3.35 GHz

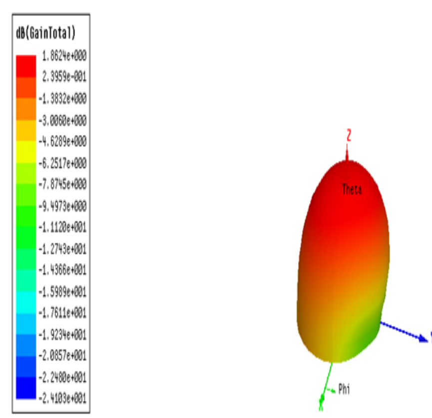

Fig. 10: Gain at frequency 6.10 GHz

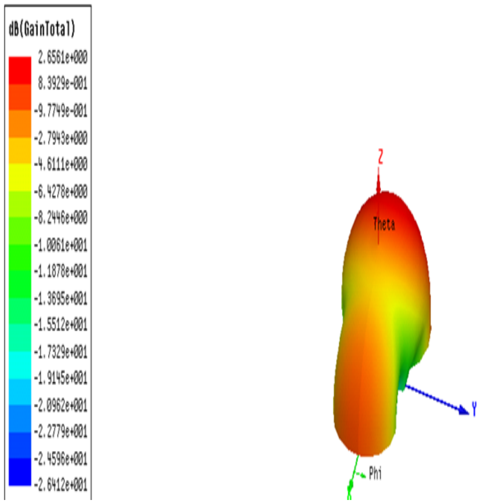

Fig. 11: Gain at frequency 6.60 GHz

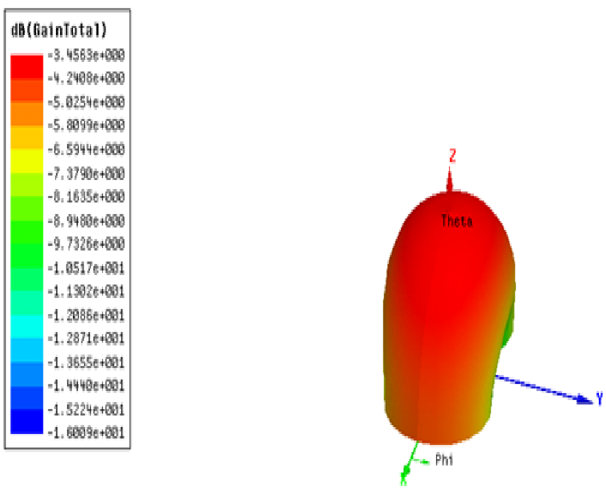

Fig. 12: Gain at frequency 10.55 GHz

Table 3: Comparisons of slotted and unslotted microstrip antenna

Patch	Frequency band	Band width	Return loss	VSWR	Gain	Radition Efficiency
Slotted	4.35 GHz	290 MHz	-11.72 dB	1.67	3 dB	94%
	7.55 GHz	330 MHz	-13.53 dB	1.53	3.2 dB	96%
	10.55 GHz	110 MHz	-26.72 dB	1.09	7 dB	92%
Unslotted	3.35 GHz	40 MHz	-12.49 dB	1.16	-8 dB	44%
	6.10 GHz	130 MHz	-14.76 dB	1.44	1.8 dB	64%
	6.60 GHz	130 MHz	-13.26 dB	1.55	2.6 dB	70%
	10.55 GHz	160 MHz	-12.77 dB	1.59	3.4 dB	60%

4. CONCLUSIONS

Octagon microstrip antenna designed with slot and without slot on compact octagon patch using microstrip line feed for a wide band wireless communications systems is fabricated on TEFLON and designed in HFSS. The result demonstrates that the proposed antenna with triangular and octagon slots and the cuts at special positions can to generate steady radiation patterns and is capable of wrapping the frequencies demanded by UWB Communication system, RFID, GSM, Wi-Fi and Wimax. Good agreement between the simulated and measured results further validates the utility of proposed antenna for given applications. Different design parameters with their effects were a studied. From the measurement results, this when this antenna is designed with slot give a performance at band 4.35 GHz a return loss is -11.96 dB ,bandwidth 290 MHz and gain 4.2 dB, at 7.55 GHz a return loss is -13.53dB , bandwidth 330MHz and gain 3.2 db, at 10.3 GHz a return loss is -26.72dB,bandwidth 1100 MHz and gain 7dB and the unslotted antenna at 3.35 GHz a return loss is -12.49dB,bandwidth 40 MHz and gain -8dB,at 6.10GHz a return loss-14.76 dB ,bandwidth 130 MHz and gain 1.8dB ,at 6.60 GHz a return loss -13.26dB,bandwidth 130MHz and gain 206dB,at 10.55 GHz a return loss -12.77 dB ,bandwidth 160MHz and gain -3.4dB. The slots and cut used here plays an important role in balancing resistive part and reactive part which affects the impedance matching.

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