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Design and Analysis of I & J Cut Microstrip Antenna

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ABSTRACT: Basically an antenna converts radio waves to electrical signal and vice versa. The following are its types: Wire Antennas, Reflector Antennas, and Micro strip antennas. Among all the above, micro strip antenna is less expensive. In this paper, its implementation and its application are discussed. The two categories are rectangular antenna and triangular antenna. The design & optimization of rectangular patch antenna have been investigated with vital parameters such as return loss, VSWR, and gain for mobile communication application. For antennas with fractal shapes, they will radiate, and often have multiband properties and hence it is being in usage. I and J cut patterns are studied, simulated using HFSS 13 software and compared and concluded.

KEYWORDS: Return loss, VSHR, Gain, I & J pattern, Parameters calculation.

I. INTRODUCTION

In its most fundamental form, a Micro strip Patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. It consists of a patch of metallization on a substrate. They are low profile, light weight antenna. Hence can be used for low power handling capability. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. Micro strip patch antenna radiate primarily because of the fringing fields between the patch edge and the ground plane. The dielectric material used must have high dielectric constant as it reduces antenna size. Its low dissipation factor increases critical electrical properties. The rectangular antennas used so far are only single-frequency application. But for multimode-frequency, the antennae designed must be compact with less radiation loss.

In this paper, it proposes I and J type antenna which can handle multi-frequency with its I cut and J cut patterns. I-cut has four radiating surfaces among which two on either sides radiating in opposite direction. Hence they cancel out each other. Therefore its radiation range is equivalent to that of plane rectangular antenna. When a high frequency application antenna to be implemented for low frequency I-cut and J-cut patterns can be used efficiently.

II. FRACTAL GEOMETRY

It is a mathematical set that exhibits a repeating pattern that displays at every scale. The replication is exactly the same at every scale. It uses iteration. It mainly details irregular set. A fractal is a never-ending pattern. Fractals are infinitely complex patterns that are self-similar across different scales. They are created by repeating a simple process over and over in an ongoing feedback loop. Fractal geometry in designing micro strip antenna can reduce its size even when the frequency application increases with good efficiency.

III. DESIGN OF THE ANTENNA ELEMENT

DESIGN SPECIFICATIONS:

The three essential parameters for the design of a rectangular Micro strip Patch Antenna. For communication applications the prescribed frequency is around 3GHz to 5.2GHz. The dielectric material used must have high dielectric constant as it reduces antenna size. For be used in cellular phones, it is essential that the antenna is not bulky. The specifications are as follows:

Frequency of operation (f_o):- 5.2 GHz

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Dielectric constant of the substrate (ε_r):-
Material selected for our design is RT Duroid which has a dielectric constant of 2.45.
Height of dielectric substrate (h):- We consider the value to be 1.58mm
The parameters considered are as follows:
f = 5.2 GHz
${}^{\varepsilon}r = 2.45$
h = 1.58mm
c = 3*10^8 m/s

1.) CALCULATION OF WIDTH (w) :

$W = c / (2\ f_r \sqrt{({}^{\varepsilon}r+1)/2})$
W = 21.96mm

2.) CALCULATION OF EFFECTIVE DIELECTRICCONSTANT (${}^{\varepsilon}eff$):

${}^{\varepsilon}{}_{eff} = ({}^{\varepsilon}r+1)/2+ ({}^{\varepsilon}r-1)/2*[1+12*h/w] \wedge (-0.5)$
${}^{\varepsilon}{}_{eff}$ = 2.256mm

3.) CALCULATION OF EFFECTIVE LENGTH (Leff):

$L_{eff\ =}\ c/ (2*f_r*\sqrt{{}^{\varepsilon}{}_{eff}})$
L_{eff} = 19.205mm

4.) CALCULATION OF LENGTH EXTENSION (ΔL):

$\Delta L = 0.412*h*(({}^{\varepsilon}eff+0.3)/ ({}^{\varepsilon}eff0.258))*((w/h+0.264)/ (w/h+0.8))$
ΔL = 0.8023mm

5.) CALCULATION OF ACTUAL LENGTH OF PATCH(L):

$L = L_{eff} -2*\Delta L$
L = 17.6004mm

6.) CALCULATION OF GROUND PLANE DIMENSION:

$L_g = 6*h + L$
L_g =27.0804mm
$W_g = 6*h + W$
W_g = 31.44mm

IV. TABULATION OF BASIC SPECIFICATIONS:

NAME OF PARAMETERS	FORMULA	VALUE
WIDTH	$W= c\ / (2\ f_r \sqrt{({}^{\varepsilon}r+1)/2})$	21.96mm
EFFECTIVE DIELECTRIC CONSTANT	${}^{\varepsilon}{}_{eff} = ({}^{\varepsilon}r+1)/2+({}^{\varepsilon}r-1) / 2*[1+12*h/w]\wedge(-0.5)$	2.256mm
EFFECTIVE LENGTH	$L_{eff} = c/(2*f_r*\sqrt{{}^{\varepsilon}eff})$	19.205mm
LENGTH EXTENSION	$0.412*h*(({}^{\varepsilon}eff+0.3)/({}^{\varepsilon}eff0.258))*((w/h+0.264)/(w/h+0.8)$	0.8023mm
ACTUAL LENGTH	$L= L_{eff} -2*\Delta L$	17.6004mm
GROUND PLANE	$L_{g=}\ 6*h + L$ $W_g = 6*h + W$	27.0804mm 31.44mm

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V. IMPORTANT PARAMETERS CONSIDERED

Return loss:
The return loss of an antenna signifies how well the antenna is matched to the 50 transmission line (TL).Return loss indicates how much of the incident power is reflected by the antenna due to mismatch. It is the loss of power in the signal returned/reflected.

When the graph is examined, lower peaks are sighted. Normally a good antenna must have a return loss less than -10dB. The return loss of rectangular antenna and that of ‘I’ cut antenna are the same. In ‘I’ cut antenna center frequency is lower than the considered parameter. Thus according to the application we can reduce center frequency by using ‘I’ cut pattern. The reduction in antenna is due to the cancellation of the opposite reacting radiation on two sides of ‘I’ cut. But in ‘J’ cut pattern three sides radiate in three different center frequencies.

VSWR:
It stands for Voltage Standing Wave Ratio, and is also referred to as Standing Wave Ratio (SWR). VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna. It is determined from the voltage measured along a transmission line leading to an antenna. VSWR is the ratio of the peak amplitude of a standing wave to the minimum amplitude of a standing wave.

Antenna Gain:
It is how much power is transmitted in the direction of peak radiation to that of an isotropic source.

VI.TABULATION OF PARAMETERS

SHAPE OF THE ANTENNA	FREQUENCY (GHz)	RETURN LOSS (dB)	VSWR (dB)	GAIN (dB)	THETA (DEGREE)
RECTANGULAR PLANE	5.2400	-38.6521	2.5	0	-50
‘I’ PATTERN	3.5440	-9.7952		-2.2318	0
‘J’ PATTERN	3.75	-12.40	27.220	-2.3830	0
	4.30	-4.00	22.50	-6.4	-50
	6.31	-15.20	8.00	-4.8	50
	5.25			-2.3830	0

VII. SIMULATIONAND DISCUSSION

We have used HFSS 13 software to simulate.

1. Following are for rectangular patch initial plane antenna.

Return loss:

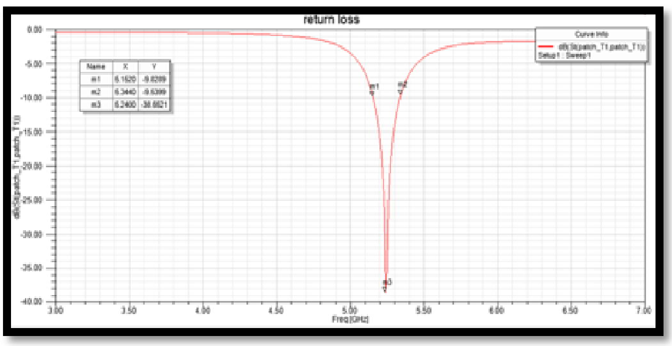

Fig.1 Return loss vs. Frequency

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VSWR:

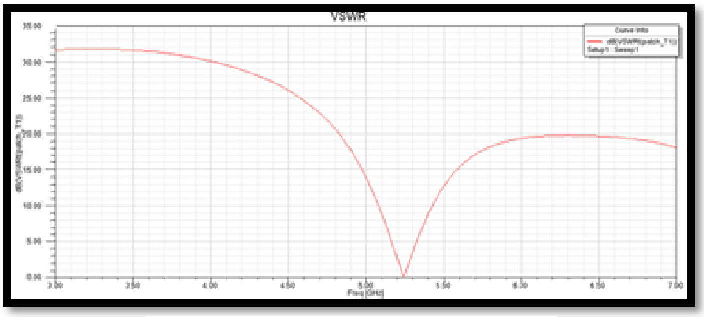

Fig.2 VSWR vs. Frequency

GAIN:

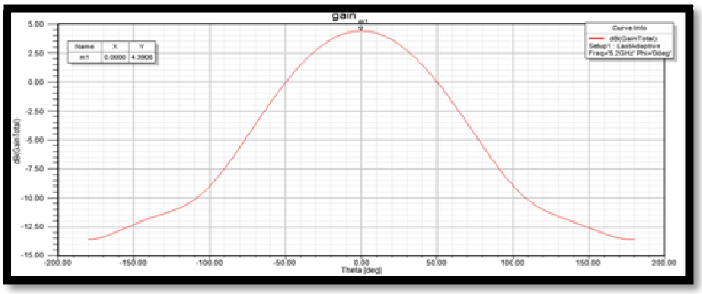

Fig.3 Gain vs. Theta

2. Following are for ‘I’ pattern:

Return loss:

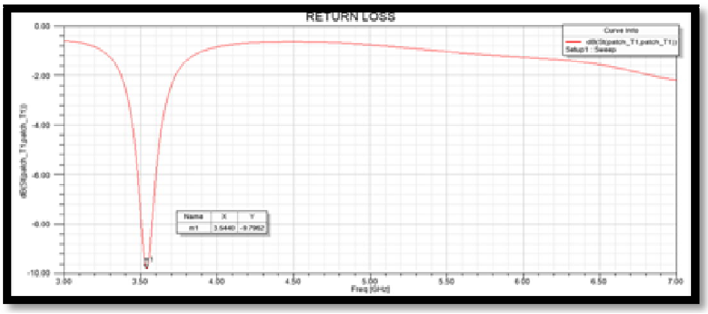

Fig.4 Return loss vs. Frequency

Gain:

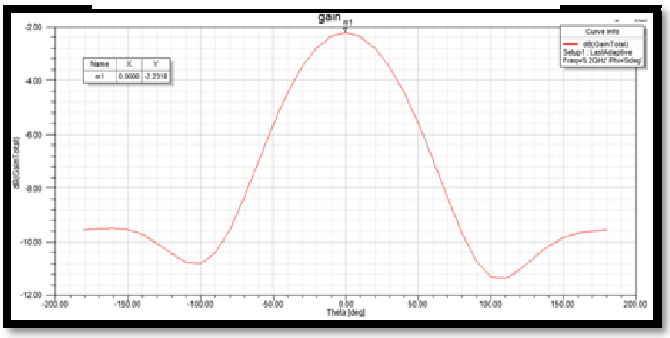

Fig.5 Gain vs. Theta

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3. Following are for 'J' pattern:

Return Loss:

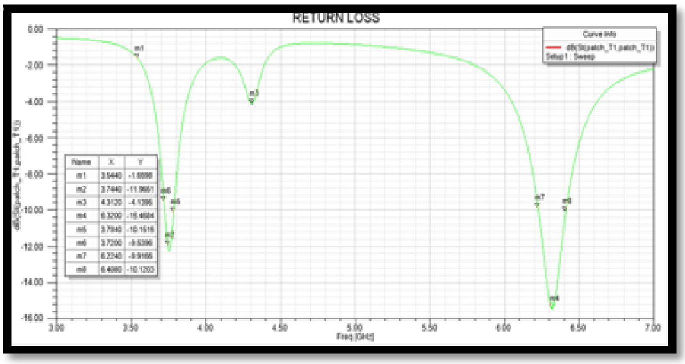

Fig.6 Return loss vs. Frequency

VSWR:

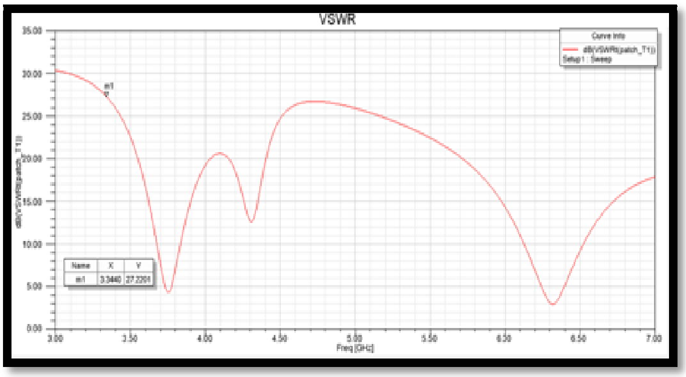

Fig.7 VSWR vs. Frequency

Gain:

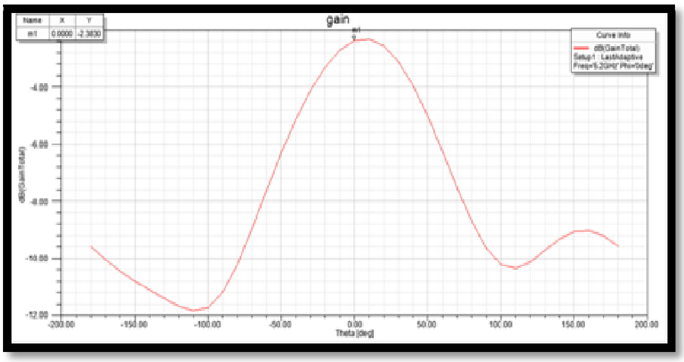

Fig.8 Gain vs. Theta

VIII. CONCLUSION

On the basis of the simulated results it is observed that the 'I' and 'J' cut antennas can be used for real time applications because of its good response. As analyzed during simulation 'I' cut antenna is advanced in its features. The micro strip antenna along with the fractal design is compatible and economical.

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