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Design of Notch Loaded and Coupled Ring Shaped Antenna for Wireless Communication System

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ABSTRACT: This paper presents an optimization of Bandwidth and directivity of Microstrip patch antenna using coupling and notching which has been designed for wireless applications.By varying the parameters of notching the bandwidth is enhanced. For Simulation, software IE3D simulation tool is used.The results yield that obtained antenna has resonance at 2.539GHz and it also shows improvement over fractional bandwidth.The substrate is of thickness 1.6mm,dielectric constant of 4.4 and loss tangent of 0.0013.The obtained bandwidth is 33.8%(1.92GHz-2.71GHz) with a return loss of -25.95dB,gain of 3.85dBi,directivity of 4.15dBi,antenna efficiency of 93.33% and radiation efficiency of 93.57% at a resonant frequency of 2.539GHz.The antenna is fed by50ΩMicrostrip line feed.

KEYWORDS: Microstrippatch antenna, coupling, Notching,Circular ring,IE3D Simulation Tool.

I. INTRODUCTION

Antennas are transducers to transmit or receive electromagnetic waves. It is a transition between free space wave and guided wave and vice versa. During last 50 years, Microstrip antenna is used in field of wireless communication system [1-3].The reason behind this success is its advantages such as low manufacturing cost, light weight, low profile and ease in fabrication. The use of Microstrip antenna has been enhanced by the wireless revolution in the transfer of information.For designing of microstrip antenna we have to determine resonant frequency accurately because Microstrip antenna has narrow bandwidth and it can operate near resonant frequency.

In this paper the proposed antenna is designed using circular ring [5-7] and to enhance the bandwidth notching [8] is loaded and to match the operating frequency with resonant frequency we have done coupling [9-10] and applied microstrip line feed [11-12]. This antenna is used for resonance at 2.539GHz.The material which is used in design is Glass epoxy of dielectric constant 4.4 and loss tangent of 0.0013.Simulation results such as radiation pattern, gain, directivity and efficiency are presented.

II. MATHEMATICAL FORMULAS TO CALCULATE THE DESIGN DIMENSIONS OF MICROSTRIP PATCH ANTENNA

The mathematical formula[4] is used to calculate the dimensions of ground plane and microstrip patch in the form of length and width.

The formula of calculating the width of Patch antenna is given as:

$$W = \left(\frac{c}{2 f_r}\right)\left(\frac{\varepsilon_r + 1}{2}\right)^{-1/2}$$

Where: $c = 3\times10^8\ ms^{-1}$, ε_r=4.4, f_r =2.45 GHz

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Formula of effective dielectric constant is given as:-

$$\varepsilon_{eff} = \left(\frac{\varepsilon_r + 1}{2}\right) + \left(\frac{\varepsilon_r - 1}{2}\right)\left(1 + \frac{12h}{W}\right)^{-1/2}$$

Where: h=1.6 mm

Formula of extension in length is given as:

$$\Delta L = 0.412h\left(\frac{\varepsilon_{eff} + 0.3}{\varepsilon_{eff} - 0.258}\right)\left(\frac{\left(\frac{W}{h}\right) + 0.264}{\left(\frac{W}{h}\right) + 0.8}\right)$$

Dimensional calculation of parameters such as resonant frequency (f_r), dielectric constant (ε_r), substrate thickness (h) and loss tangent (tan δ) and 50Ω Microstrip linefeed is used. The parameters of antenna are given in table1.

Table 1: Antenna Design Specification

S. NO	Antenna Parameter	Data
1.	Resonant frequency (f_r)	2.45 GHz
2.	Substrate thickness (h)	1.6 mm
3.	Dielectric constant (ε_r)	4.4
4.	Loss Tangent (tan δ)	.0013

III. ANTENNA DESIGN PROCEDURE

The parameters of ground plane are Wg=38mm and Lg=47mm.The parameters of patch are Lp=28mm and Wp=37mm. In this proposed design make a rectangular patch of W1 and Lp .Secondly make a semi circular sector of radius R and then merge with the patch. Then a circular ring of inner radius=9 mm and outer radius=11mm is

inserted in the patch with same centre. Then after loaded a notch and coupling to enhance the bandwidth and resonant peak.A 50Ω microstrip line feed is used at mid of length of the patch antenna. The position of feed is (Lg/2) on the positive X axis from the origin as shown in table 2.

The design of calculated notch loaded coupled ring shaped microstrip patch antenna is shown in Fig.1.

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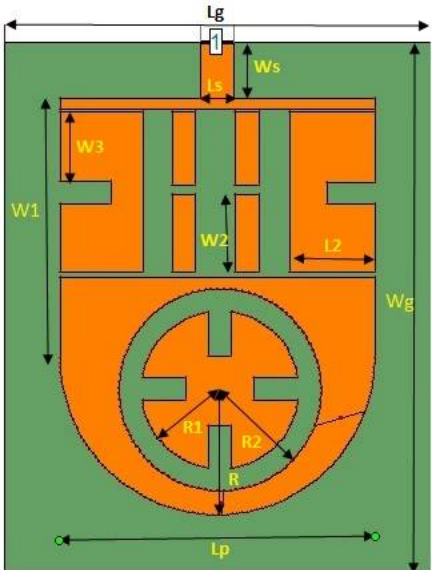

Fig.1 Geometry of proposed antenna and all dimensions in mm

Table 2: Calculated Antenna Dimensions

S No.	Antenna Dimension	Data (mm)
1.	Ground Length (L_g)	38
2.	Ground Width (W_g)	47
3.	Patch Length (L_P)	28
4.	L2	7.5
5.	R1	9
6.	R2	11
7.	R	14
8.	Ls	3
9.	Ws	5
10.	W3	6.2
11.	W2	6.9

IV. SIMULATION RESULT AND DISSCUSSION

The result of proposed microstrip patch antenna is analyzed by using IE3D antenna designing software at select resonant frequency of 2.45 GHz. The graph of return loss Vs frequency is plotted for the range of frequency 1GHz to 3GHz, because within this range the curve crosses the -10dB which is shown in Fig.2.

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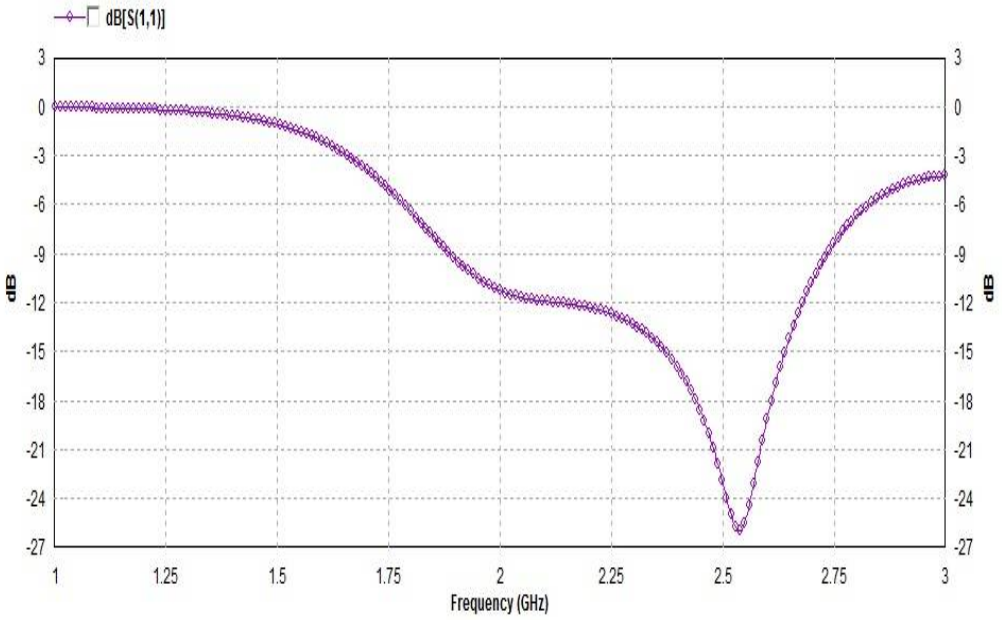

Fig.2 Return loss vs. frequency graph of proposed antenna

From Fig.2, it is observed that the bandwidth of proposed antenna 784 MHz (33.8 % fractional bandwidth) between 1.92 GHz to 2.71 GHz band and Return loss of -25.95 dB at resonance frequency 2.539GHz has been obtained. It is also observed that operating resonance frequency 2.539 GHz shows close value with designed resonance frequency 2.45GHz.

The graph of Gain Vs Frequency of proposed antenna is shown in Fig.3.

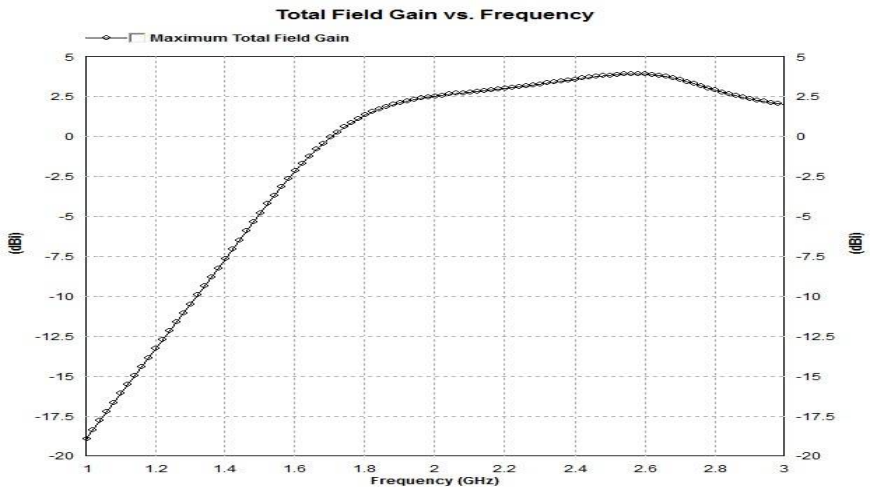

Fig.3 Gain vs. Frequency graph

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The maximum gain of proposed antenna is 3.87 dBi. It is also observed that the gain of proposed antenna at resonant frequency 2.539 GHz is 3.8563 dBi.

The graph of Directivity Vs Frequency of proposed antenna is shown in Fig. 4.

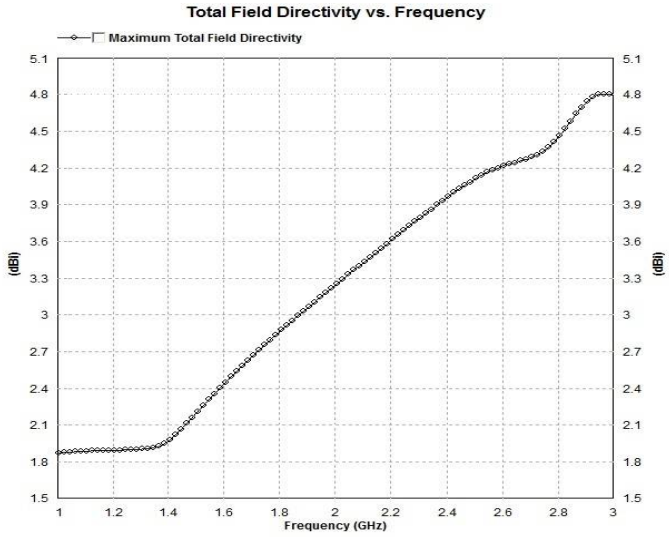

Fig.4 Directivity Vs. Frequency graph

The maximum directivity of proposed antenna is 4.8039dBi. It is also observed that the directivity of proposed antenna at resonant frequency 2.53 GHz is 4.155 dBi.

The graph of Efficiency of design antenna is shown in Fig.5.

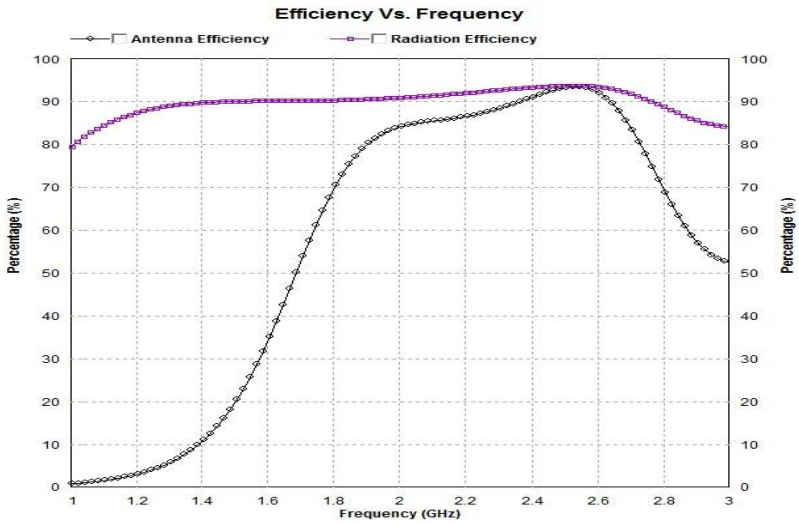

Fig.5 Efficiency vs. Frequency graph

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From Fig.5 it is observed that the maximum antenna efficiency and radiation efficiency of proposed antenna is 93.34% and 93.585 % respectively. It is also observed that the antenna efficiency and radiation efficiency of proposed antenna at resonant frequency 2.539 GHz is 93.3364 % and 93.5725 % respectively.

The graph of radiation pattern of optimised antenna is shown in Fig.6.

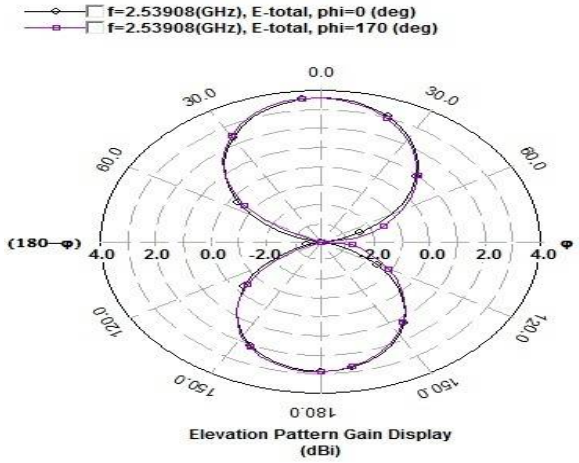

Fig.6 Radiation pattern

The radiation pattern of the proposed antenna has bidirectional radiation pattern as shown above.

V. CONCLUSION

From the analysis of proposed antenna it is observed that the bandwidth, resonant frequency and return loss depends on dimensions of the etching of the patch antenna. Bandwidth is improved up to 33.8 %.The designed antenna can be applicable in wireless communication system.

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