



Different Coupling of Notch Loaded Rectangular Microstrip Patch Antenna for Wireless Communication System

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Abstract: In this paper comparison of different shapes of coupling of microstrip patch antenna is discussed. The bandwidth of proposed design antenna is 37.43 % (2.705 GHz-1.852GHz). The antenna has been designed for 2.45GHz operating frequency and the result of different coupling is compared by IE3D simulation tool. The return loss is -15.698dB, gain of 3.7447 dBi and Directivity of 6.8002 dBi. The resonant frequency is 2.5470GHz which is near to our operating frequency. The antenna is fed by 50Ω Micro strip line feed.

Keywords: Microstrip patch antenna, coupling, Rectangular patch, IE3D Simulation Tool.

I. INTRODUCTION

Antennas are used to transmit or receive electromagnetic waves. It is used to convert free space wave to guided wave and vice versa. During recent years, Microstrip antenna is useful in wireless communication system [1-3]. The reason for this success is its uses which are its low cost, light weight, low profile and advantage in fabrication. The use of Microstrip antenna has been increased by the wireless revolution in the transfer of information.

To design the 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 rectangular patch [5-7] and to increase the bandwidth the coupling is used and to match the operating frequency with resonant frequency we have done different coupling [9-10] and applied microstrip line feed [11-12]. This antenna is used for resonance at 2.5470GHz. The material used in design is Glass epoxy of dielectric constant 4.4 and loss tangent of 0.0013. Results such as radiation pattern, gain and directivity are presented.

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

The formula [4] which is used to calculate the dimensions of ground plane and microstrip patch in terms of length and width. The formula for calculating the width of Patch antenna is given as:

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

Where: $c = 3 \times 10^8 \text{ ms}^{-1}$, $\epsilon_r = 4.4$, $f_r = 2.45 \text{ GHz}$

Formula for effective dielectric constant is given as:-

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

Where: $h = 1.6 \text{ mm}$

Formula of extension in length is given as:

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

Dimensional calculation of parameters such as resonant frequency (f_r), dielectric constant (ϵ_r), substrate thickness (h) and loss tangent ($\tan \delta$) 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 ($\tan \delta$)	0.0013

III. ANTENNA DESIGN PROCEDURE

The parameters of ground plane are Width is 38mm and Length is 47mm. The parameters of patch are Length is 28mm and Width is 37mm. Different coupling having the same structure and rectangular patch have a ring slot with inner radius R_1 of 9 mm and outer radius R_2 of 11mm. Then notching is done in patch and different couplings are used to enhance bandwidth and to match the resonant peak to that of design frequency. The design of calculated notch loaded coupled rectangular microstrip patch antenna with 50 Ω microstrip line feed inserted at mid of length of the patch antenna is shown in Fig.1.

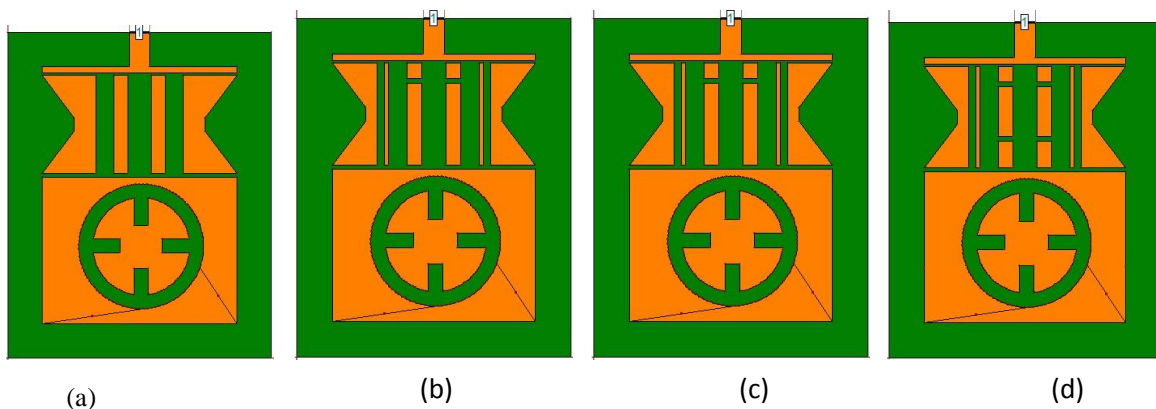


Fig.1 Design of coupling of microstrip patch antenna (a) first coupling, (b) second coupling, (c) third coupling and (d) fourth coupling.

IV. COMPARATIVE ANALYSIS

Dimension of all couplings are different from each other so that analysis of their characteristics are comparable. Results of all the parameters such as Bandwidth, Gain and Directivity are listed in table 2. S11 of the different coupling of the microstrip patch antenna is shown in Fig.2.

From Fig.2, it is observed that the bandwidth of proposed antenna 853.7MHz (37.43 % fractional bandwidth) between 1.8537 GHz to 2.7074 GHz band and Return loss of -15.169 dB at resonance frequency 2.547GHz has been obtained. It is also observed that operating resonance frequency 2.547 GHz shows close value with designed resonance frequency 2.45GHz. The graph of Gain vs. Frequency of proposed antenna is shown in Fig.3.

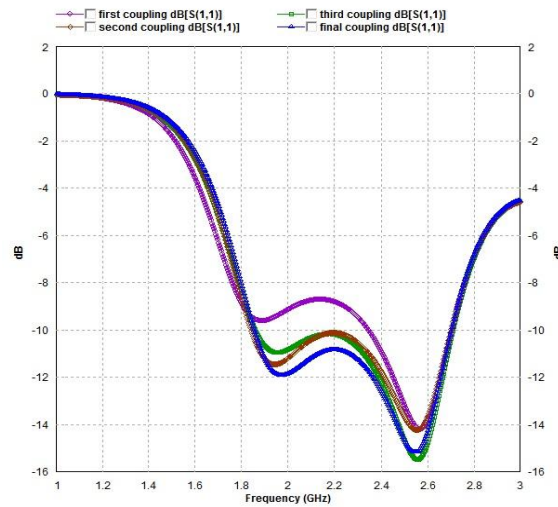


Fig.2 Comparison of S11 of the different couplings of microstrip patch antenna

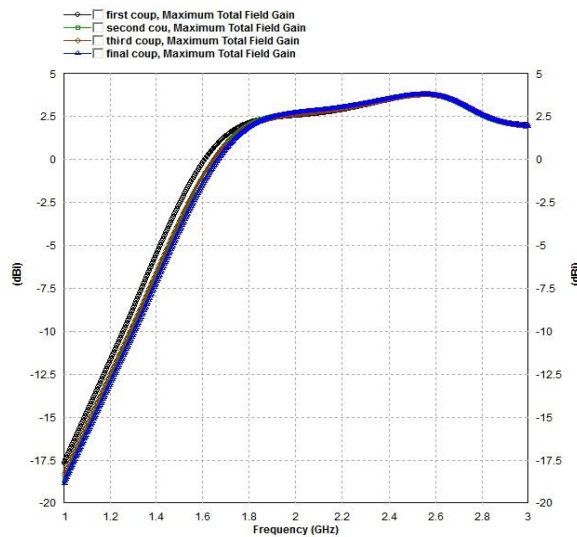


Fig.3 Comparison of Gain vs. Frequency graph of different couplings of microstrip patch antenna

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

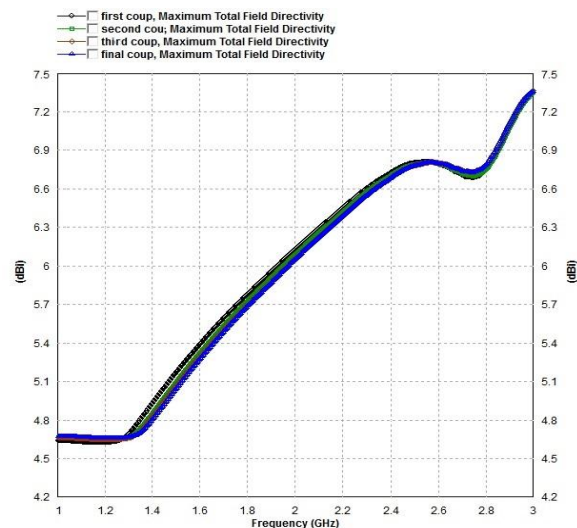


Fig.4 Comparison of Directivity vs. Frequency graph of microstrip patch antenna



The graph of radiation pattern of optimized antenna is shown in Fig.5.

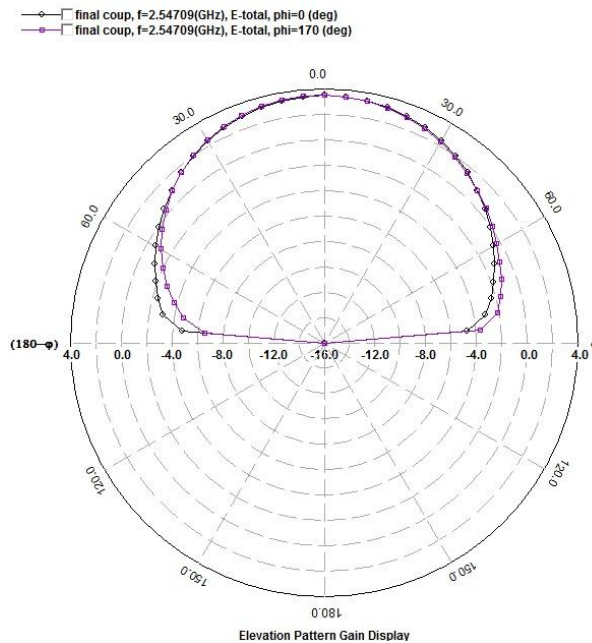


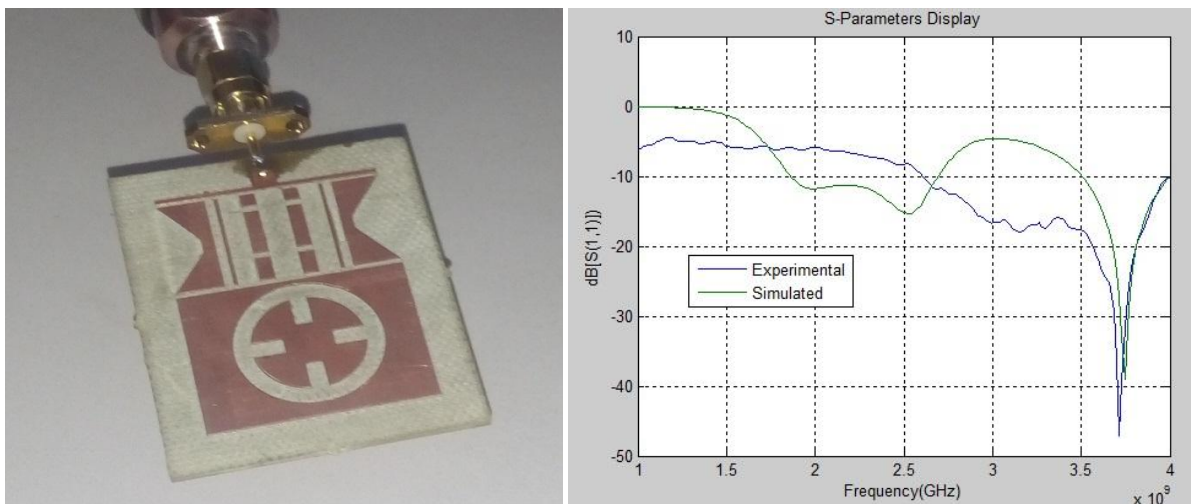
Fig.5 Radiation pattern

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

Table 2: Comparative data of different shapes of microstrip patch antenna

S.No.	Patch Shape	Lower Frequency (GHz)	Higher Frequency (GHz)	Resonant Frequency (GHz)	Bandwidth (%)	Gain (dBi)	Directivity (dBi)
1	First coupling	2.3466	2.7114	2.5711	14.4246	3.7374	6.8100
2	Second coupling	1.8376	2.7034	2.5551	38.1325	3.7301	6.8078
3	Third coupling	1.8577	2.7154	2.5591	37.5106	3.7609	6.8068
4	Fourth coupling	1.8537	2.7074	2.5470	37.4339	3.7447	6.8002

We have also simulated the practical design using analyser and thus we have seen that nature of simulated graph is same as that of experimental graph. Thus we are uploading the image of hardware and comparison of simulated and experimental graph.





V. CONCLUSION

From the analysis of four coupling of patch we have seen the optimized performance is obtained using fourth coupling. Thus by varying the parameters of coupling the overall simulation results of antenna is enhanced. The resonant frequency is also matched to left side which is approximate to our operating frequency. Thus the proposed antenna design can be used in wireless communication system.

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