A Wideband Square Microstrip Patch Antenna with Notch for WLAN Applications

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Abstract— In this paper a simple square microstrip antenna design is loaded by three square notch. The bandwidth of proposed microstrip antenna is 47.12%.and antenna is resonating at 4.826GHz.The proposed antenna design has frequency band in the frequency range 4.433GHz to 7.166GHz. This frequency band is suitable WLAN and other wireless communication applications. The return loss of the antenna is -25.79dBi. The microstrip patch antenna suffers from narrow bandwidth hence the present work provide an alternative solution to increase the bandwidth. The gain and efficiency of proposed antenna are 5.584 dBi and 99.53% respectively. The proposed microstrip antenna is directly feed by 50 ohm microstrip line feed. The proposed antenna is simulated by IE3D simulation software based on method of moments.

Key words: Notch, Bandwidth, Microstrip, Patch, Gain, Microstrip Line Feed

I. INTRODUCTION

The expeditious development of wireless communication systems has increased the demand for compact microstrip antennas with large gain and wideband operating frequencies. Microstrip patch antenna has many advantages such as low profile, light weight, small volume and compatibility with microwave integrated circuit (MIC) and monolithic microwave integrated circuit (MMIC) [1] but the major disadvantage of microstrip antenna is its narrow bandwidth and lower gain. In the present work, the bandwidth of microstrip antenna is enhanced by making notch in patch which is directly feed by 50ohm microstrip line feed. The proposed slotted antenna is shown in Figure 1. The frequency band of proposed antenna is between 4.433- 7.166GHz which is suitable for WLAN and other communication applications [2-5]. The proposed antenna has been designed on glass epoxy substrate (ε_r=4.4)[7]. The substrate material has large influence in determining the size and bandwidth of an antenna. Increasing the dielectric constant decreases the size but lowers the bandwidth and efficiency of the antenna while decreasing the dielectric constant increases the bandwidth but with an increase in size. The design frequency of proposed antenna is 4.00GHz.

II. ANTENNA DESIGN

For designing a rectangular Microstrip patch antenna, the length and width are calculated as below [6,7]

$$w=\frac{c}{2fr}\sqrt{\frac{2}{\varepsilon r+1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where c is the velocity of light(3x10^8 m/s), ε_r is the dielectric constant of substrate(4.4), f_r is the antenna design frequency(4.00GHz), W is the patch width, and the effective dielectric constant ε_{reff} is given as [6,7]

$$€reff=\frac{\varepsilon_r+1}{2}+\frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} \qquad (2)$$

At h=1.6mm

The extension length ΔL is calculated as [6,7]

$$\frac{\Delta L}{h}=0.412\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+.264)}{(\varepsilon_{reff}-.258)(\frac{W}{h}+0.8)} \qquad (3)$$

By using the above mentioned equation we can find the value of actual length of the patch as [6,7]

$$L=\frac{c}{2fr_{\sqrt{\varepsilon reff}}}-2\Delta L \qquad (4)$$

The length and the width of the ground plane can be calculated a [6,7]

$$L_g=6h+L \qquad (5)$$

$$W_g=6h+W \qquad (6)$$

Here, Square patch is considered and to determine the length of square patch, the area of square patch is equated to area of rectangular patch for which Length and Width is obtained using above equation[8]

III. ANTENNA DESIGN SPECIFICATIONS

The design of proposed antenna is shown in figure1. The proposed antenna is designed by using glass epoxy substrate of a dielectric constant 4.4 and the design frequency 4.00 GHz is taken. The calculated patch width and length are 22.80 mm and 17.40 mm respectively. The proposed antenna design with a square patch of length and width 20 mm having equal area to rectangular patch of width 22.80 mm and length 17.40 mm. The square ground plane length and width are taken 30 mm. Height of the dielectric substrate is 1.6 mm and loss tangent is 0.0013. Antenna is feed through 50 ohm microstrip line feed. Simulation work is done by using IE3D simulation software. All the specifications are given in the table1.

IV. ANTENNA DESIGN PROCEDURE

All the dimensions of proposed antenna should be calculated very carefully by using the equations 1, 2, 3, 4, 5 and 6. For making the proposed microstrip antenna, the patch is loaded with three square notch of size 6mm x 6mm. The geometry of proposed antenna is shown in figure1. During the designing of proposed antenna on IE3D, ground plane is starting from (0,0) at lower left corner. The microstrip line feed of 50 ohm is placed at lower middle of the patch through a strip of length 3 mm and width 3 mm. The feed strip length of antenna is vary from 2mm to 4.5mm. The maximum bandwidth is achieved at feed strip length 3mm.

S. No.	Parameters	Value
1.	Deign frequency f_r	4.00 GHz
2.	Dielectric constant ε_r	4.4
3.	Substrate height h	1.6 mm
4.	Patch width Wp	20 mm
5.	Patch length Lp	20 mm
6.	Ground plane width Wg	30 mm
7.	Ground plane length Lg	30 mm

Table 1: Antenna design specifications.

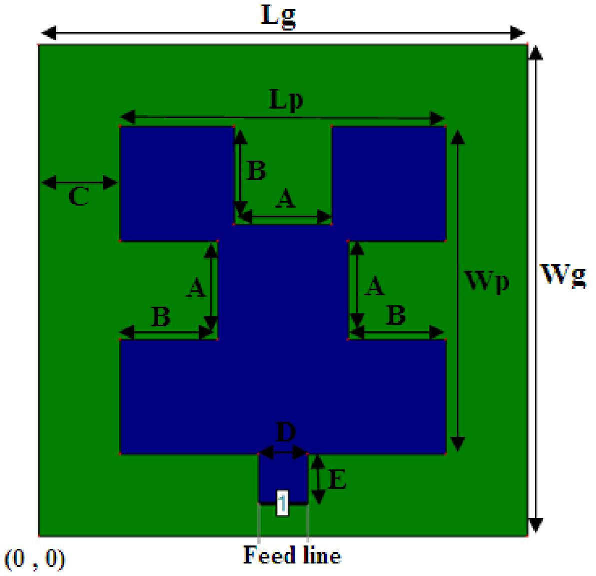

Fig. 1: Geometry of proposed microstrip antenna.

S.No.	Parameters	Value(mm)
1.	A	6
2.	B	6
3.	C	5
4.	D	3
5.	E	3

Table 2: Antenna parameters

V. SIMULATION RESULT AND DISCUSSION

The narrow bandwidth of microstrip antenna is one of the important features that restrict its wide usage. In the present work the bandwidth of square microstrip antenna is enhanced by square notch loading. The fractional bandwidth of proposed antenna is 47.12% and antenna is resonating at 4.826GHz. The efficiency of proposed antenna is found to be 99.72 %.The maximum gain of the antenna has been improved up to 5.584 dBi and the VSWR of the antenna is in between 1 to 2 in entire frequency band and 1.108 at resonance frequency.

S.No.	Feed strip length (mm)	Lower cutoff frequency (GHz)	Resonance frequency (GHz)	Higher Cutoff Frequency (GHz)	Fractional Bandwidth (%)
1.	2	4.405	4.630	4.966	11.97
2.	2.5	4.391	4.679	5.765	27.06
3.	3	4.433	4.826	7.166	47.12
4.	3.5	4.560	5.050	7.355	46.92
5.	4	4.714	5.155	7.145	40.99
6.	4.5	4.840	5.183	6.606	30.58

Table 3: Simulation results for different feed length.

The simulation performance of proposed micro strip patch antenna is analyzed by using IE3D software. The performance specifications like return loss, VSWR, gain, radiation pattern of proposed antenna is shown in the figures 2 to 7

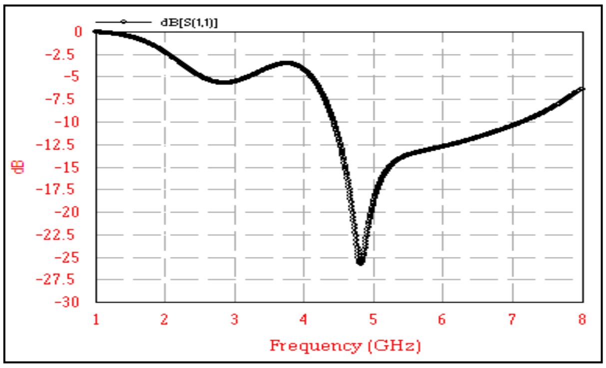

Fig. 2: Return loss v/s frequency graph.

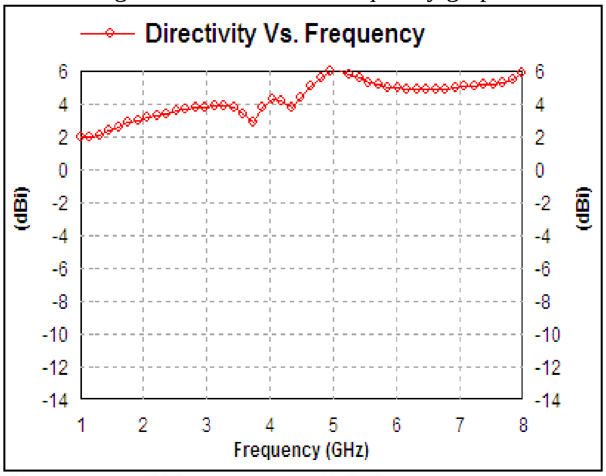

Fig. 3: Directivity Vs frequency graph

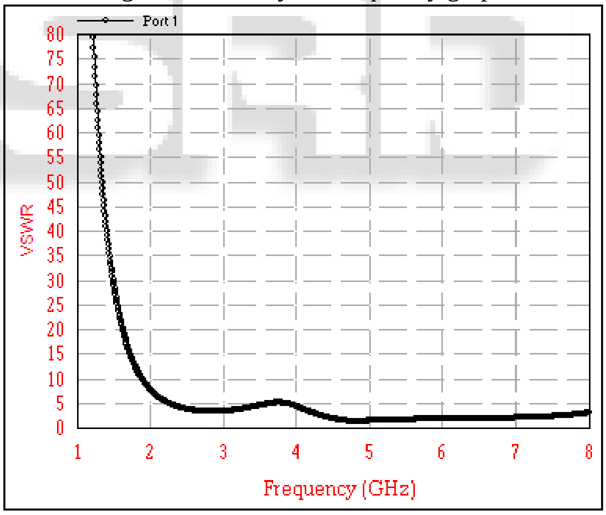

Fig. 4: VSWR of proposed antenna

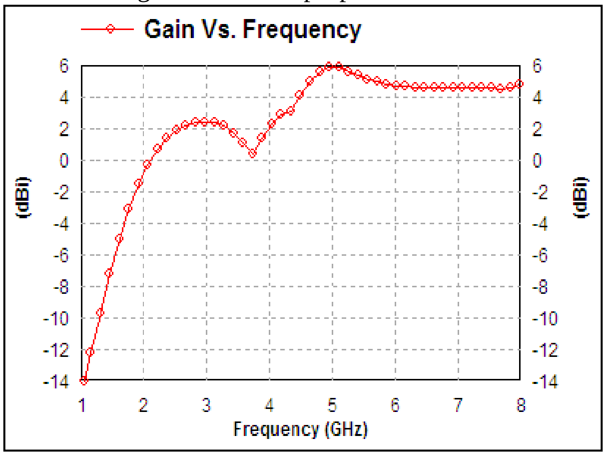

Fig. 5: Gain Vs frequency graph

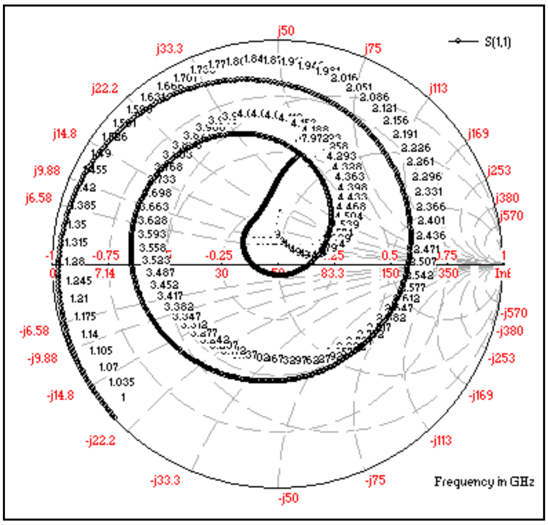

Fig. 6: Smith chart.

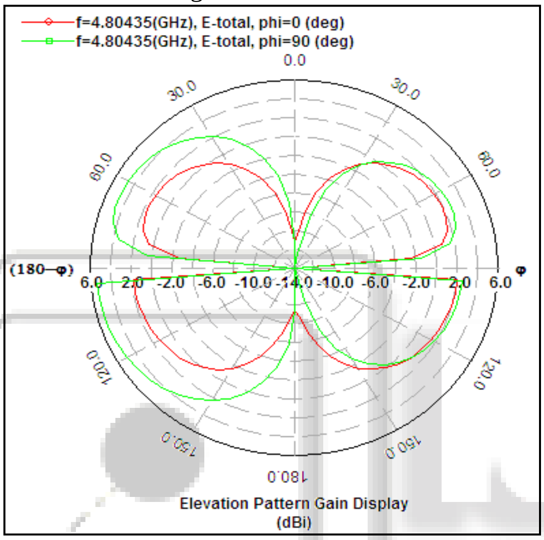

Fig. 7: 2D Radiation pattern of proposed antenna

VI. CONCLUSION

The characteristics of proposed antenna has been studied. In general, the impedance bandwidth of the traditional microstrip antenna is only a few percent (2% -5%) [9]. Therefore, it becomes very important to develop a technique to enhance the bandwidth of the microstrip patch antenna. Proposed antenna improved the fractional bandwidth upto 47.12% and antenna is resonating at 4.826GHz. The proposed antenna has been designed on glass epoxy (FR4) substrate to give a maximum radiating efficiency of about 99.72 % and gain of about 5.584dBi near resonance frequency.

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