Circular Slot Loaded Rectangular Microstrip Patchantenna for WLAN/ Wimax Applications

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Abstract— In the present paper a circular slot rectangular microstrip loaded antenna is proposed. The obtained bandwidth of rectangular microstrip antenna is improved up to 46.92%. The proposed antenna has frequency band in the frequency range 1.979 GHz to 3.192 GHz this frequency band is suitable for WLAN / WiMAX and other wireless communication applications. The microstrip antenna suffers from narrow bandwidth hence the present work provide an alternative solution to increase the bandwidth. The gain has been improved up to 4.68dBi and antenna efficiency is 97.63%. The proposed slot loaded Microstrip antenna is fed by 0.3 mm line feed. The proposed antenna is simulated by IE3D Zealand simulation software based on method of moments.

Key words: Circular slot, enhance bandwidth, compact Microstrip Patch, gain, line feed

I. INTRODUCTION

Microstrip patch antenna possesses 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 drawback of microstrip antenna is its narrow bandwidth and lower gain. The need for antennas to cover very wide bandwidth is of continuing importance, particularly in the field of electronic warfare and wideband radar and measuring system. In the present work the bandwidth of microstrip antenna is enhanced by circular slot cut patch fed by probe of radius 0.3 mm. The proposed slot loaded antenna is shown in Figure 1. The frequency band of proposed antenna is between 1.979 GHz to 3.192GHz which is suitable for WLAN/WiMAX and other communication applications [2-5]. The proposed antenna has been designed on glass epoxy substrate (εr = 4.4) [6].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 2.04 GHz.

II. ANTENNA DESIGN

For designing a rectangular Microstrip patch antenna, the length and width are calculated as below [8][10]

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

Where c is the velocity of light, ε_r is the dielectric constant of substrate, f_r is the antenna design frequency, W is the patch width, and the effective dielectric constant ε_{reff} is given as [8][10]

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

At h=1.6mm

The extension length ΔL is calculated as [8] [10]

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

By using the above mentioned equation we can find the value of actual length of the patch as [8][10]

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

The length and the width of the ground plane can be calculated a [8][10]

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

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

III. ANTENNA DESIGN SPECIFICATIONS

The design of proposed antenna is shown in figure1. The proposed antenna is designed by using glass epoxy substrate which has a dielectric constant 4.4 and the design frequency 2.04 GHz is taken. The calculated patch width and length are 44.74 mm and 33.55 mm respectively. The ground plane length and width are taken 54.34 mm and 43.15 mm respectively. Height of the dielectric substrate is 1.6 mm and loss tangent tan δ is .0013. Antenna is fed through 50Ω microstrip feed line. Simulation work is done by using IE3D simulation software. All the specifications are given in the table1. (all lengths in mm and frequency in GHz).

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. Design frequency is 2.04 GHz taken. For making the proposed microstrip antenna the rectangular shaped patch is taken with fix dimensions. The geometry of proposed antenna is shown in figure.1. During the designing of proposed antenna on IE3D ground plane is starting from (0,0) at lower left corner.

S. No.	Parameters	Value
1.	design frequency f_r	2.04 GHz
2.	dielectric constant ε_r	4.4
3.	substrate height	1.6 mm
4.	patch width	44.74 mm
5.	patch length	33.55 mm
6.	ground plane width	54.34 mm
7.	ground plane length	43.15 mm
8.	a	15 mm
9.	b	3.98 mm
10.	c	26 mm
11.	d	3.98 mm
12.	e	5 mm
13.	r	9.9 mm

Table1: Antenna design specifications

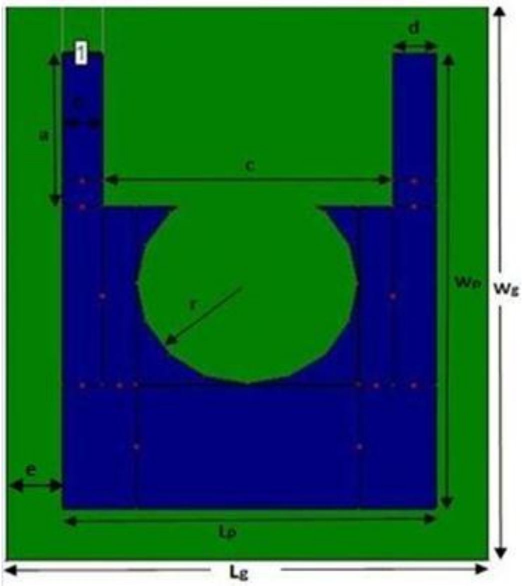

Fig. 1: Geometry of proposed Microstrip antenna.

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 rectangular microstrip antenna is increased by cutting a circular slot shape on rectangular patch. The fractional bandwidth of proposed antenna is 46.92% respectively. The efficiency of proposed antenna is found to be 97.63%. The maximum gain of the antenna has been improved up to 4.67 dB and the VSWR of the antenna is in between 1 to 2 in each frequency band.

The simulation performance of proposed micro strip patch antenna is analyzed by using IE3D version 9.0 software at select design frequency of 2.04 GHz. The performance specifications like gain, radiation pattern etc of proposed antenna is shown in the figures 2 to 7.

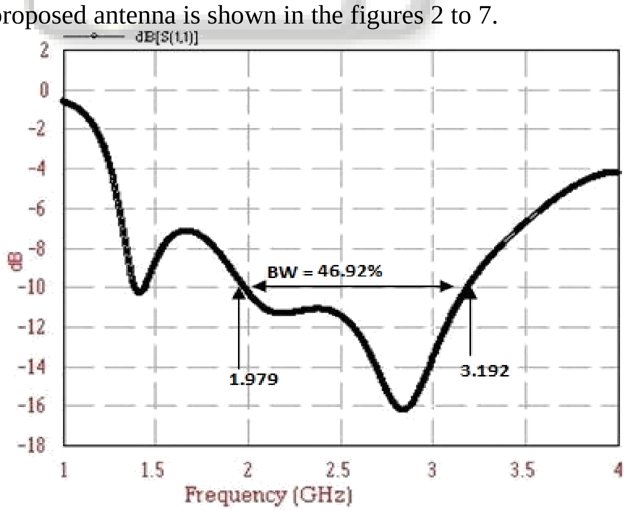

Fig. 2: Return loss v/s frequency graph.

The S11 Return loss shows the fractional bandwidth 46.92 at 2.8 GHz frequency

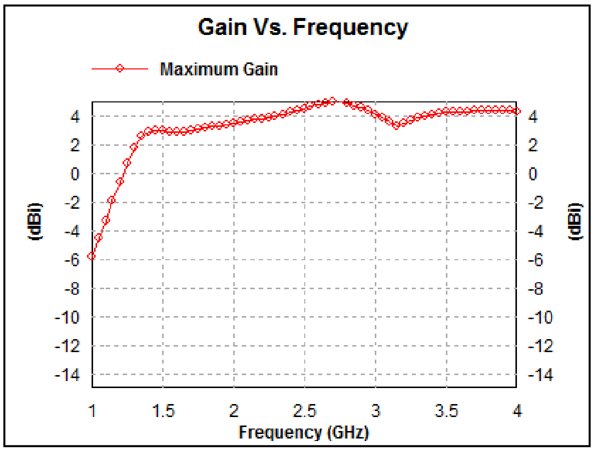

Fig. 3: Gain vs. frequency plot.

The maximum gain is obtained up to 4.67 dB at 2.8 GHz after simulation as shown in the figure

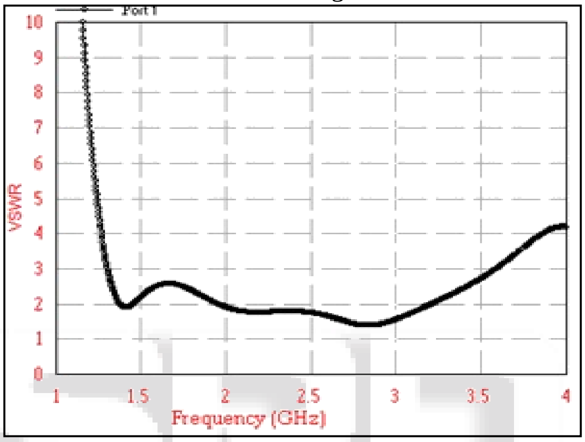

Fig. 4: VSWR of proposed antenna

VSWR is the ratio of maximum voltage to minimum voltage on transmission line. The VSWR is lies between 1-2

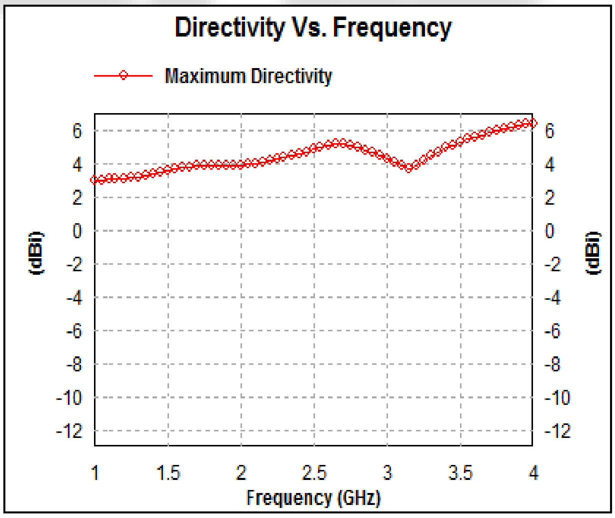

Fig. 5: Directivity vs frequency graph

The directivity of antenna is defined as the ratio of given radiation intensity in the given direction from the antenna to that of an isotropic antenna. The maximum directivity obtained is 4.78 dB at 2.8 GHz as shown in fig.5

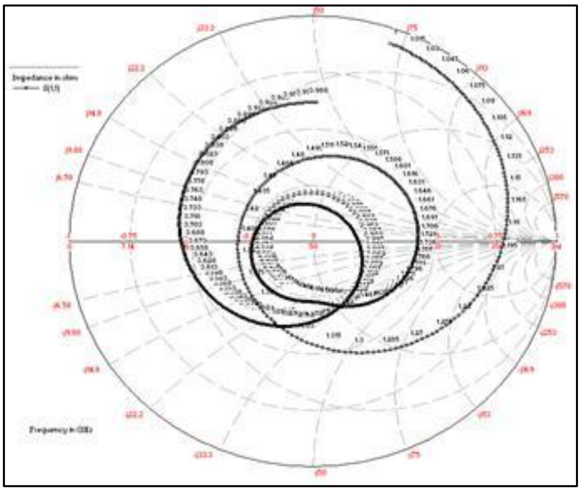

Fig. 6: Smith chart.

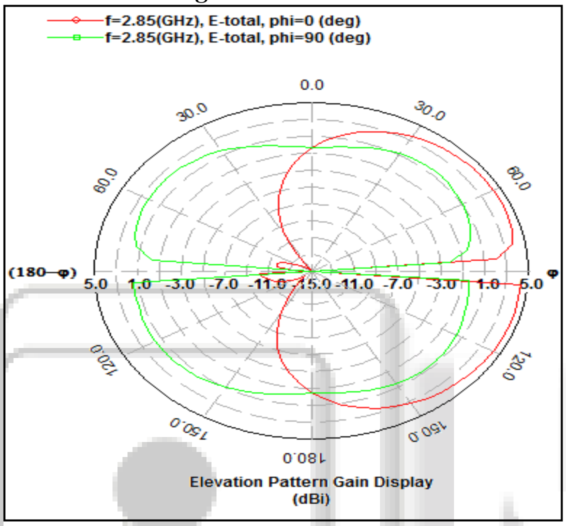

Fig. 7: 2D radiation pattern of antenna

From the 2D plot a bi-direction pattern is obtained from 0-1800in polar co-ordinate

VI. Conclusion

The characteristics of proposed circular shaped antenna are 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 antenna. Proposed antenna improved the fractional bandwidth up to 46.92%. The proposed antenna has been designed on glass epoxy substrate to give a maximum radiating efficiency of about 97.63 % and gain of about 4.67 dB.

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