Bandwidth Enhancement of Microstrip Patch Antenna by Slot Loading For WLan/Wimax & Bluetooth Applications

Sarvesh Kumar[1] Shahanaz Ayub[2] Rajat Srivastava[3]
[1,2,3]Department of Electronics and Communication
[1,2,3]B.I.E.T. Jhansi

Abstract— In the present work the rectangular microstrip antenna is loaded by two rectangular slots so that the bandwidth of rectangular microstrip antenna is improved up to 60.53%. The proposed antenna has frequency band in the frequency range 1.82 GHz to 3.40 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. It exhibits gain of 2.80dBi, directivity of 3.15dBi and antenna efficiency of 92.28% at 1.9GHz resonant frequency. The suggested slot loaded Microstrip antenna is fed by 0.3 mm probe feed. The proposed antenna is simulated by IE3D Zealand simulation software based on method of moments.

Key words: Rectangular slots, enhance bandwidth, compact microstrip Patch, gain, probe 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 slot loading and patch is fed by probe of radius 0.3 mm.

Bluetooth device are an essential part of very short distance data transfer link. It is mainly used in our daily life appliances such as mobile phone, radio and laptops and Microstrip patch antenna plays an important role in these devices [2].

The proposed slot loaded antenna is shown in Figure 1. The proposed antenna provided maximum bandwidth when the probe feed is placed at the point (x=15.8, y=5.5). The ground plane of proposed antenna started at lower left corner(x=0, y=0). The frequency band of proposed antenna is between 1.82-3.40 GHz which is suitable for WLAN/WiMAX and other communication applications [3-5]. 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 3.02 GHz.

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

The mathematical formula is used to calculate the dimensions of ground plane and micro strip patch in the form of length and width.

The formula of calculating the width of Patch antenna is given as [7, 8]:

$$W = \left(\frac{c}{2 f_r}\right)\left(\frac{\varepsilon_r + 1}{2}\right)^{-.5} \qquad (1)$$

Where: c = 3×10^8 ms^{-1}, ε_r =4.4, fr =2.2GHz
Formula of effective dielectric constant is given as [7, 8]:

$$\varepsilon_{eff} = \left(\frac{\varepsilon_r + 1}{2}\right) + \left(\frac{\varepsilon_r - 1}{2}\right)\left(1 + \frac{12W}{H}\right)^{-.5} \qquad (2)$$

Where: h=1.6mm Formula of extension in length is given as [7, 8]

$$\Delta L = .412H\left(\frac{\varepsilon_{eff} + .3}{\varepsilon_{eff} - .258}\right)\left(\frac{\left(\frac{W}{H}\right) + .285}{\left(\frac{W}{H}\right) + .8}\right) \qquad (3)$$

The formula of calculating the length of Patch antenna is given as [7, 8]

$$L = \left(\frac{c}{2 f_r \sqrt{\varepsilon_{eff}}}\right) - 2\Delta L \qquad (4)$$

The length and the width of the ground plane can be calculated as [7] [8]

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

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 3.02 GHz is taken. The calculated patch width and length are 30.69 mm and 21.59 mm respectively. The ground plane length and width are taken 29.19 mm and 39.29 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 (lengths in mm and frequency in GHz).

IV. ANTENNA DESIGN PROCEDURE

The dimensions of proposed antenna should be calculated by using the equations 1, 2, 3, 4, 5 and 6. Design frequency is 3.02 GHz taken. For making the proposed microstrip antenna introducing two rectangular slot of dimensions (19, 4) and (10, 2). The geometry of proposed antenna is shown in figure. During the designing of proposed antenna on IE3D ground plane is starting from (0.2, 0.2) at lower left corner.

A. *Table 1: Antenna design specifications*

S. No.	Parameters	Value
1.	design frequency f_r	3.02
2.	dielectric constant ε_r	4.4
3.	substrate height	1.6
4.	patch width	30.69

5.	patch length	21.59
6.	ground plane width	39.29
7.	ground plane length	29.19
8.	a	5
9.	b	19
10.	c	4
11.	d	4
12.	e	10
13.	f	2
14	g	5

B. Geometry of Proposed Microstrip Antenna

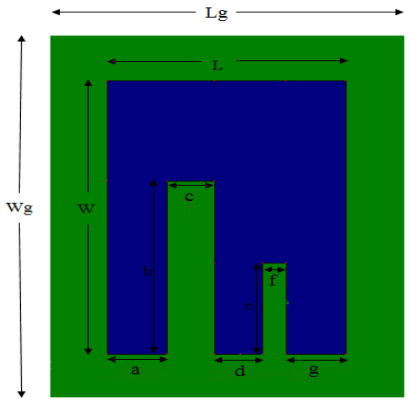

Fig. 1: Geometry of proposed Microstrip antenna

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 slot loading. The bandwidth of proposed antenna is 60.53% and the efficiency of proposed antenna is found to be 92.28%.The maximum gain of the antenna has been improved up to 2.49 dBi and the VSWR of the antenna is in between 1 to 2 in entire 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 3.02 GHz. The performance specifications like gain, radiation pattern etc. of proposed antenna is shown in the figures 2 to 8.

A. Return Loss Vs. Frequency And 3D Radiation Pattern

In the figure.2.graph of return loss v/s frequency is shown in which frequency band is (1.82 to 3.40) GHz and return loss is -26.41dB. And figure.3.shows 3d radiation pattern of proposed antenna.

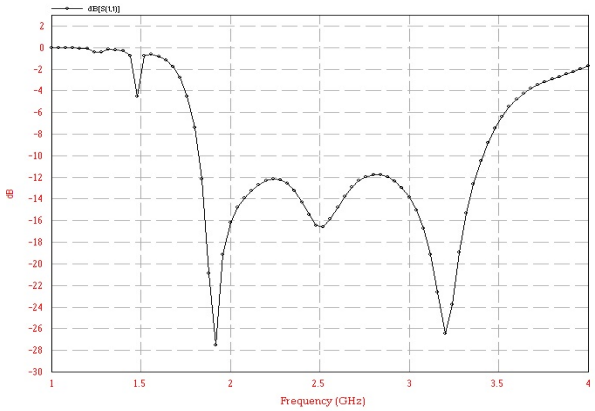

Fig. 2: Return Loss vs. Frequency Graph

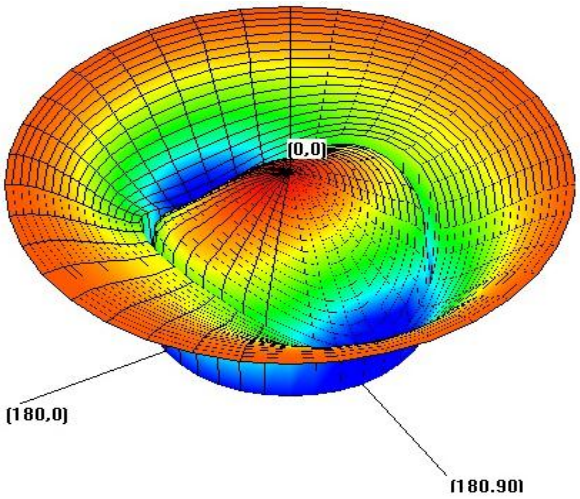

Fig. 3: 3D Radiation Pattern of Proposed Antenna

B. Gain vs. frequency and VSWR

In the figure.4.graph of the gain vs. frequency is shown in which maximum gain is 2.49dBi at frequency 1.8GHz.

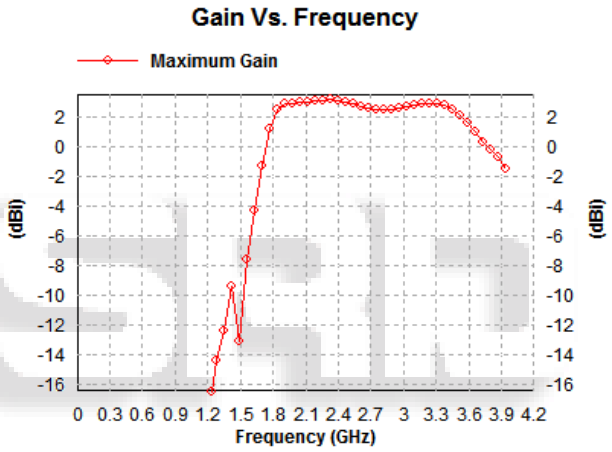

Fig. 4: Gain vs. frequency plot.

In the figure.5.graph of VSWR of proposed antenna is shown which lies in between 1-2 are over the entire frequency range.

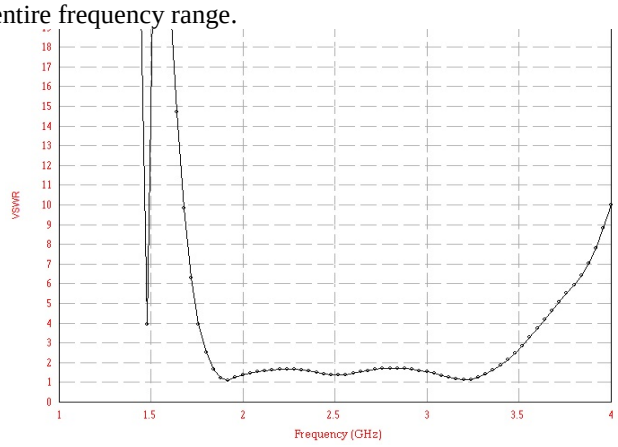

Fig. 5: VSWR of proposed antenna

C. Efficiency vs. frequency, smith chart and 2D radiation pattern

In the figure.6 Graph of Efficiency vs. Frequency is shown which represents the 92.283 % antenna efficiency at 1.8 GHz frequency.

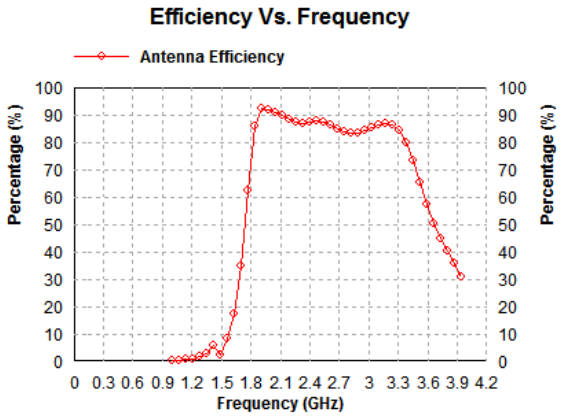

Fig. 6: Efficiency graph of proposed antenna

In the figure.7.graph of smith chart is shown.

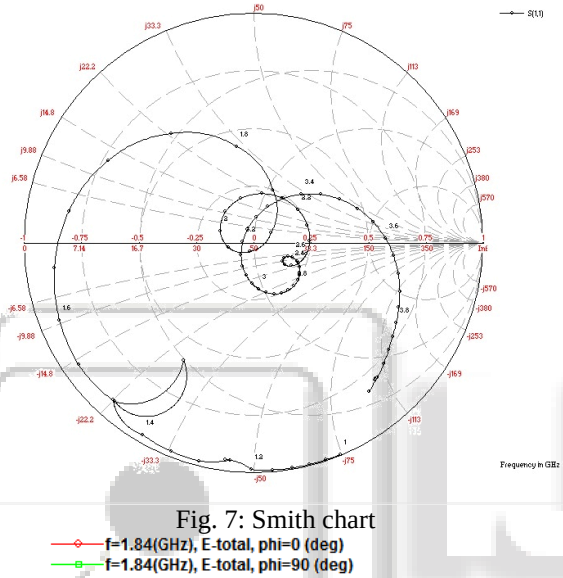

Fig. 7: Smith chart

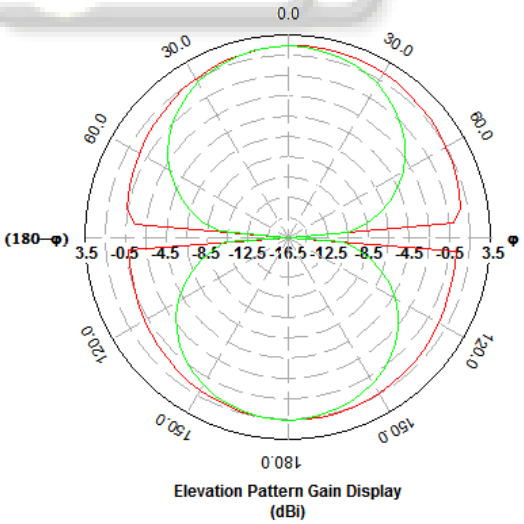

Fig. 8: 2D radiation pattern of antenna

VI. CONCLUSION

The characteristics of proposed antenna are studied. Proposed antenna improved the bandwidth up to 60.53%. The proposed antenna has been designed on glass epoxy substrate to give a maximum antenna efficiency of about 92.28% and gain of about 2.49dBi.

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