Cutting a Slot in a Rectangular Microstrip Antenna for WLAN/WiMAX Applications

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Abstract— In this present paper a two rectangular slot is cut in rectangular Microstrip patch antenna. The proposed antenna has been designed on glass epoxy substrate to achieve dual wide bandwidth of 10.69% and 51.18% covering the range from 1.204-1.34 GHz and 1.653-2.79 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 4.98dBi and antenna efficiency is 99.85%. The proposed slot loaded Microstrip antenna is fed by line feed. The proposed antenna is simulated by IE3D Zealand simulation software based on method of moments. The result yields that obtained antenna have resonance near at 1.8 GHz and it also shows remarkable improvement over Fractional Bandwidth.

Key words: Rectangular Slot, Enhance Bandwidth and Antenna Efficiency, 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 current focus on electronics packaging and interconnects has led to design of efficient, wide band, low cost and small volume antennas which can rapidly be incorporated into a broad spectrum of systems[2]. The Microstrip antenna became popular because of ease of analysis, fabrication & their attractive radiation characteristics due its light weight, low profile, low manufacturing cost, conformability, reproducibility, reliability, and Integration with solid-state devices and conformable to planar and non-planar surfaces. Microstrip antenna is used in wireless communication. In designing Microstrip antenna, it is very important to determine its resonant frequencies accurately because Microstrip antenna has narrow bandwidths and can only operate effectively in the vicinity of the resonant frequency [4].

II. Antenna Design Specification

In this paper the basic structures are shown in fig1 is a rectangular patch of dimension 39.43 mm × 50.71 mm and ground plane length and width is 49 mm × 60.3 mm. Antenna is designed for resonance at 1.8 GHz. The material used in design is Glass epoxy of $\varepsilon_r = 4.4$ and loss tangent 0.0013. The characteristics of proposed antenna such as return loss, bandwidth, directivity, gain and efficiency are investigated. These parameters are calculated by using Zeland IE3D electromagnetic simulator.

III. Antenna Geometry and Design

All the dimensions of proposed antenna should be calculated very carefully by using the equation 1 to 6. Design frequency 1.8 GHz is taken. The radiating patch is fed by a Microstrip line feed along y axis at the upper right side. The geometry of proposed antenna is shown in figure 1. For designing of Microstrip antenna the length and width are calculated as below [6].

$$W = \frac{c}{2f_r\sqrt{\varepsilon_r+1/2}} \quad (1)$$

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2}+\frac{\varepsilon_r-1}{2}\left[1+10\frac{h}{w}\right]-\frac{1}{2} \quad (2)$$

$$\frac{\Delta l}{h} = 0.412\frac{(\varepsilon_{eff}+0.300)\left(\frac{w}{h}+0.262\right)}{(\varepsilon_{eff}-0.258)\left(\frac{w}{h}+0.813\right)} \quad (3)$$

By using the above equations we can find the actual length of the patch

$$L = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}} - 2\Delta l \quad (4)$$

Now L and W are used to calculate the length and width of ground plane by using equation (5-6).

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

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

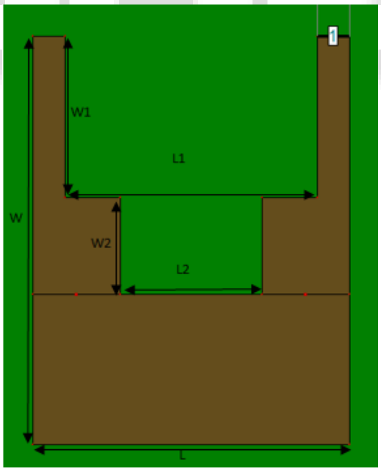

Fig. 1: Geometry of the proposed Microstrip antenna

S. No.	Parameters	Value
1.	h	1.6mm
2.	ε_r	4.4
3.	Wg	60.3mm
4.	Lg	49
5.	W	50.71mm
6.	L	39.43mm
7.	L1	31.4mm
8.	L2	17.6mm
9.	W1	20mm
10.	W2	11.98mm

Table 1: Antenna design parameters

IV. IE3D SIMULATION RESULT AND DISCUSSION

The simulation is done with the help of IE3D simulation software. In the present work the dual band is achieved at resonance frequency 1.8 GHz. It gives bandwidth of 10.69% and 51.18% respectively. It is increased by cutting two rectangular slots in rectangular patch. The efficiency of proposed antenna is found to be 99.38%. The maximum gain of antenna has been improved up to 4.98 dB and VSWR of the proposed antenna is in between 1 to 2 in each frequency band. The performance specifications like return loss, gain, directivity, radiation pattern etc of proposed antenna is shown in figure. 2 to 7.

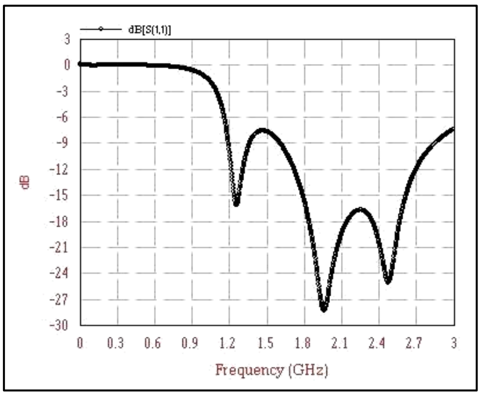

Fig. 2: Return loss versus frequency graph

This fig shows the dual bandwidth of 10.69% and 51.18% covering the range from 1.204-1.34 GHz and 1.653-2.79 GHz.

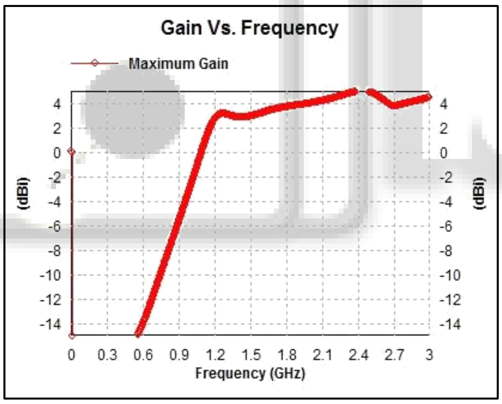

Fig. 3. Gain versus frequency graph

The gain is defined as the ratio of the intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically. This fig shows the maximum gain is obtained 4.98 dB at 2.4 GHz.

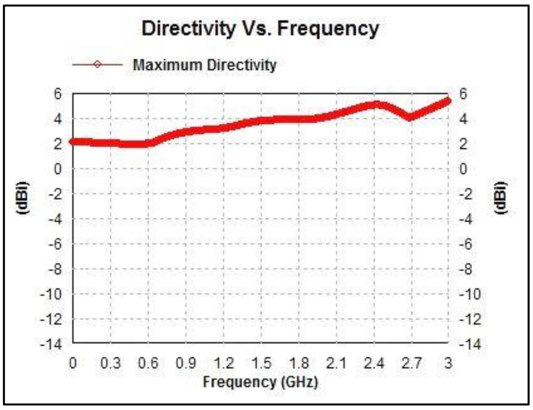

Fig. 4: Directivity versus frequency graph

The directivity of antenna is defined as the ratio of normalized power density at the peak of the main beam to the average power density is called directivity. The maximum directivity obtained is 5.004 dB at 2.4 GHz as shown in figure 4.

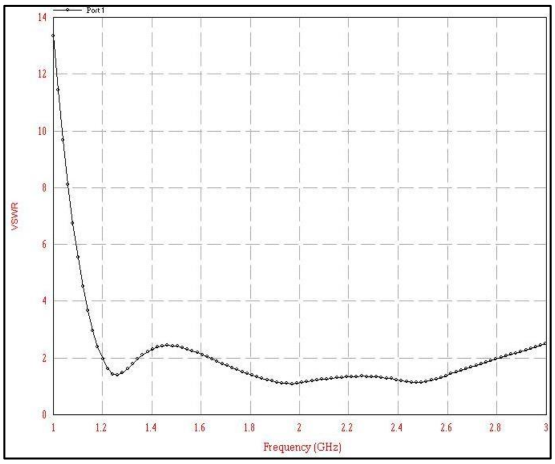

Fig. 5: SWR versus frequency graph

VSWR is defined as the ratio of maximum voltage to minimum voltage on transmission line. The vswr lies between1-2.

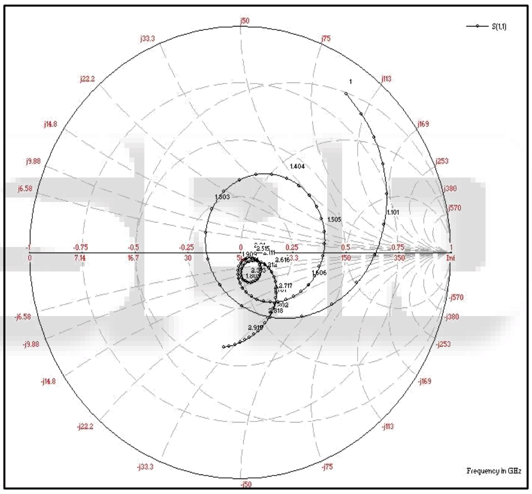

Fig. 6: Smith chart

The smith chart is a simply a representation of all possible complex impedances with respect to coordinates defined by the reflection coefficient. The smith chart can be used to simultaneously display multiple parameters including impedances, admittances, reflection coefficients, S_{nn} scattering parameters.

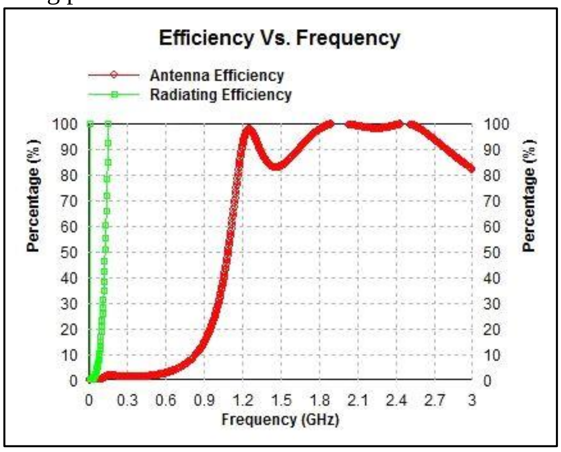

Fig. 7: Efficiency versus frequency graph

It gives maximum antenna efficiency 99.85% and radiation efficiency 99.89.

V. Conclusion

The characteristics of proposed antenna are studied. It gives dual band of 10.69% and 51.18% which are very useful in very wireless applications like UMTS, WLAN, WiMAX etc. The proposed antenna has been designed on glass epoxy substrate to give a maximum radiating efficiency of 99.89% and antenna efficiency 99.85% and gain is 4.98 dB. Therefore we conclude that the proposed antenna is very efficient.

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