Design and Analysis of Microstrip Line Fed 'U' Shaped Patch Antenna for Wide Band Applications

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Abstract: ***In this paper, a rectangular micro-strip patch antenna with linear polarization has been used to analyzed and simulate structure for the wireless application. The proposed antenna has been simulated at the 2 GHz frequency. This frequency band is suitable for WLAN/ Wi-MAX and other wireless communication applications. This compact antenna is fed by micro-strip feed line. This antenna is simulated by IE3D zeland software. To analyze the proposed antenna, simulated results on return loss, Gain vs. frequency graph, radiation pattern, smith chart and VSWR graph is presented.***

Keywords: IE3D, Enhance bandwidth and antenna efficiency, compact Microstrip Patch, gain, line feed

1. Introduction

Micro-strip 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 Micro-strip 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 Micro-strip 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. Micro-strip antenna is used in wireless communication. In designing Micro-strip antenna, it is very important to determine its resonant frequencies accurately because Micro-strip antenna has narrow bandwidths and can only operate effectively in the vicinity of the resonant frequency [4]. The micro strip antennas are the present day antenna designer's choice. Generally patch of the micro-strip antenna are square, rectangular, circular, triangular, and elliptical [5]. Low dielectric constant substrates are generally preferred for maximum radiation. The conducting patch of micro-strip antenna can take any shape but rectangular and circular configurations are the most commonly used. Other configurations are complex to analyze and require heavy numerical computations. A micro-strip antenna is characterized by its Length, Width, Input impedance, and Gain and radiation patterns.

The broadband antenna are required to be compact, low profile directive for high transmission efficiency and designed to be discreet, due to these well met requirements couple with the ease of manufacture and repeatability makes the micro-strip patch antennas very well suited for broadband wireless applications [5].

The four most popular configurations to feed micro-strip antennas are the micro-strip line, coaxial probe, aperture coupling, and proximity coupling [5]. In this paper the micro-strip line is fed for the antenna.

2. Antenna Design Specification

The top view and geometry of proposed antenna of the proposed antenna is presented in figure 1 and figure 2. The proposed antenna design comprises a ground plane of 45.84x56.08 mm and patch of 36.24 x 46.48 mm. A slot of trapezium shape is etched on rectangular patch as shown in figure 2. The substrate used here is FR4 (Glass Epoxy) with substrate thickness of patch h = 1.6 mm and has relative dielectric constant εr = 4.2. Micro strip line of 50Ω is used for feeding the patch [6].

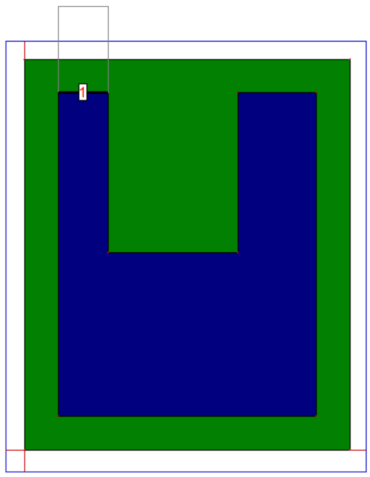

Figure 1: Proposed Antenna

3. Antenna and Design Simulation

All the dimensions of proposed antenna should be calculated very carefully by using the equation 1 to 6. Design frequency 2 GHz is taken. The radiating patch is fed by a Micro-strip line feed along y axis at the upper right side. The geometry of proposed antenna is shown in figure 1. For designing of Micro-strip antenna the length and width are calculated as below [7].

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

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

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

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).

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

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

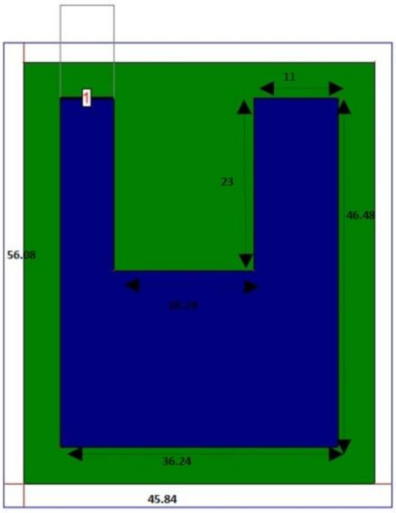

Figure 2: Geometry of the proposed Microstrip antenna

Table 1: Antenna design parameters

S. No.	Parameters	Value
1.	H	1.6mm
2.	ε_r	4.2
3.	Wg	56.08mm
4.	Lg	45.84mm
5.	W	46.48mm
6.	L	36.24mm
7.	L1	18.24mm
8.	L2	11mm
9.	W1	23.48mm
10.	W2	23mm

4. IE3D Simulation Result and Discussion

The proposed antenna is successfully simulated on IE3D (9.0.0) software package of Zeland. The simulated impedance bandwidth is 64.69**%** is at **-10dB** return loss. The simulated -10 dB return loss is shown in figure 3. The VSWR is shown in figure 6. The simulated 3D radiation pattern of the proposed antenna is shown in figure 8. The simulated smith chart in figure 7. The simulated Gain, Directivity, and Efficiency of proposed antenna are shown in figure 4, 5 and respectively [6].

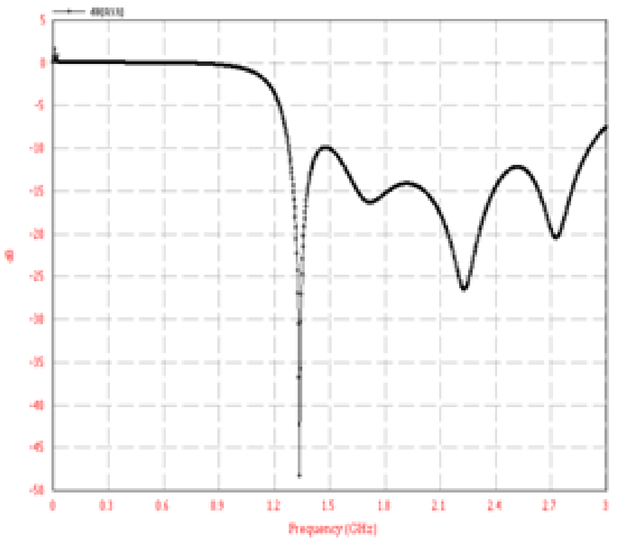

Figure 3: Return loss versus frequency graph

This fig shows the dual bandwidth of 10.77% and 64.69% covering the range from 1.282-1.428 GHz and 1.489-2.913 GHz.

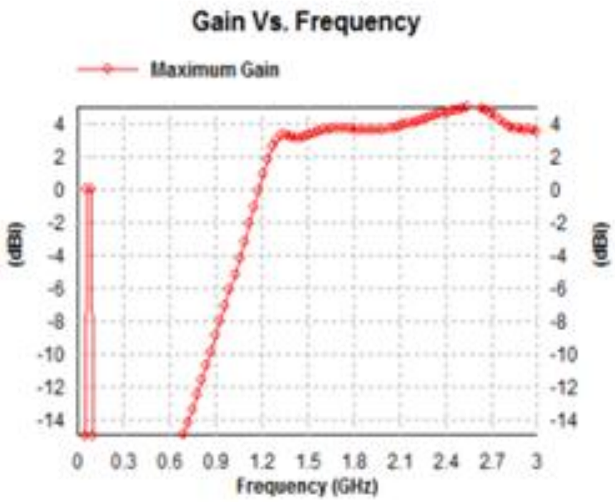

Figure 4: Gain versus frequency graph

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 4.92 dB at 2.57 GHz.

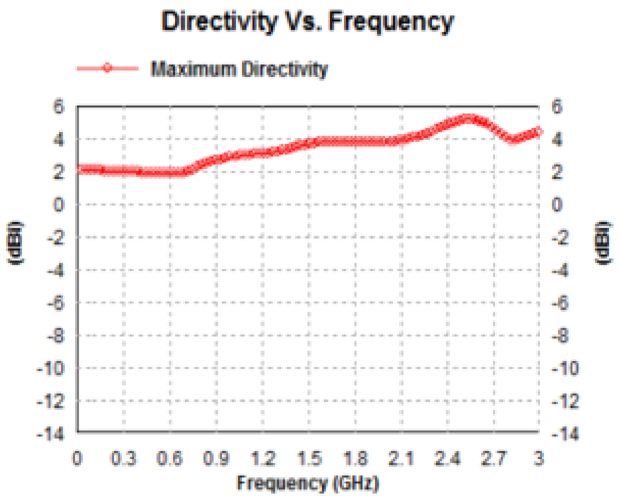

Figure 5: Directivity versus frequency graph

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 5.153 dB at 2.57 GHz as shown in figure 5

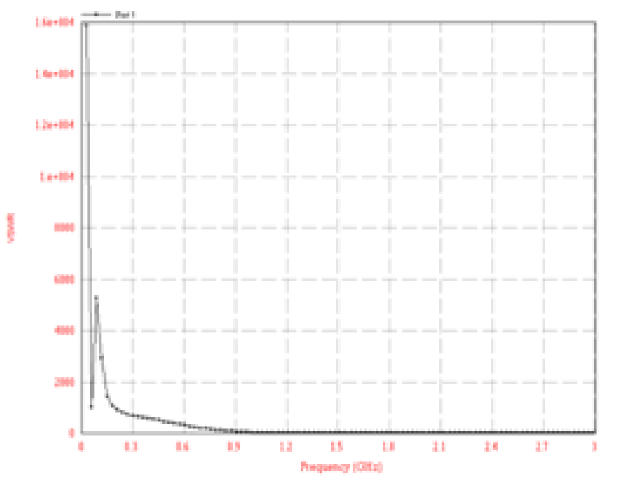

Figure 6: VSWR versus frequency graph

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

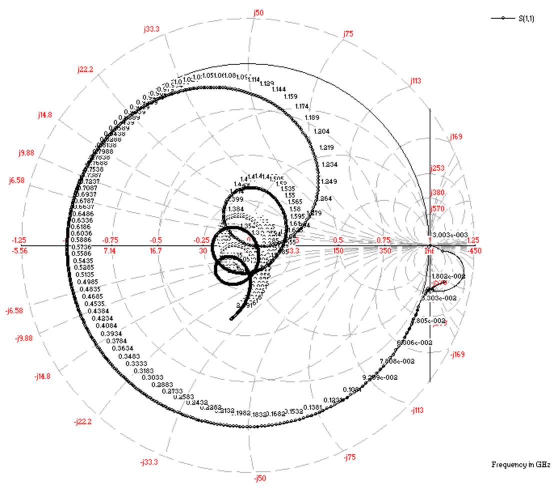

Figure 7: Smith chart

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.

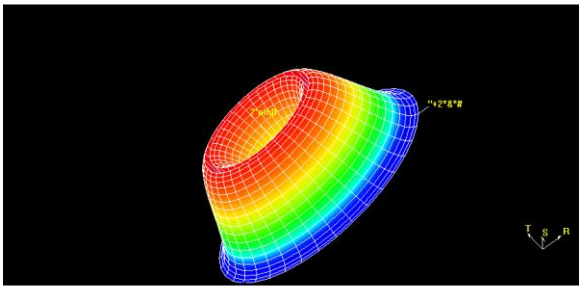

Figure 8: Simulated 3D radiation pattern of proposed Antenna

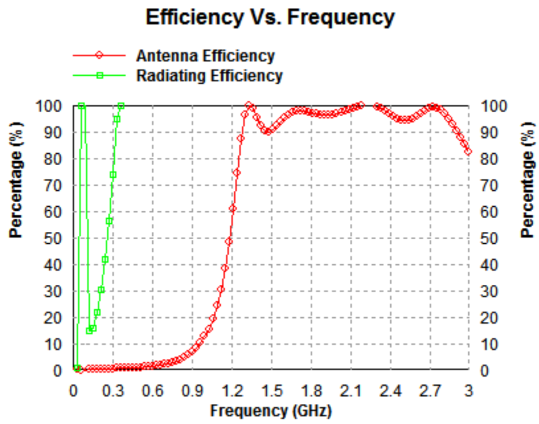

Figure 9: Efficiency versus frequency graph

It gives maximum antenna efficiency 99.77% and radiation efficiency 99.89.

5. Conclusion

The characteristics of proposed antenna are studied. It gives dual band of 10.77% and 64.69% which are very useful in very wireless applications like 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 99.77% and gain is 4.92 dB. Therefore we conclude that the proposed antenna is very efficient.

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