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Design and Implementation of Inverted U-Shaped Slot Loaded Proximity Coupled Equilateral Triangular Microstrip Antenna for Triple Band Operation

Mahesh C. P[1], P. M. Hadalgi[2]

Research Scholar, Department of P.G. Studies and Research in Applied Electronics, Gulbarga University, Gulbarga, Karnataka, India[1]

Professor, Department of P.G. Studies and Research in Applied Electronics, Gulbarga University, Gulbarga, Karnataka, India[2]

ABSTRACT: This paper presents the design and development of proximity coupled equilateral triangular microstrip antenna using inverted U- shaped slot loading for triple band operation. The antenna operates between 2.75 GHz to 8.38 GHz range. The antenna gives a maximum impedance bandwidth of 6.50%. The substrate used for design of antenna is glass epoxy material ($\in r$ =4.2). The microstripline feed arrangement is incorporated to excite the antenna. The proposed antenna shows broadside radiation characteristics. The design of the antenna is described. The simulated results are presented and discussed. These antennas are useful for the applications such as WIFI (wireless fidelity), IMT (International mobile telecommunication) and in radar.

KEYWORDS: Inverted U-shaped, Proximity coupled, Equilateral Triangular, radiation patterns, return loss, VSWR.

I.INTRODUCTION

Antennas play a very important role in the field of wireless communications. Some of them are Parabolic Reflectors, Patch Antennas, Slot Antennas, and Folded Dipole Antennas. Each type of antenna is good in theirown properties and usage. We can say antennas are the backbone and almost everything in the wireless communication without which the world could have not reached at this age of technology. Patch antennas plays a very significant role in today's world of wireless communication systems. A microstrip patch antenna [1] is very simple in the construction using a conventional microstrip patch antenna fabrication technique. The most commonly used microstrip patch antennas are rectangular, square, ellipse, circular etc., patch antennas. The equilateral triangular radiating patch antennas are used as simple and for the widest and most demanding applications [2].

In recent years, the Microstrip patch antenna designers has proposed many techniques to improve the antenna parameters such as microstripline feeding approaches of proximity coupled feeding and aperture coupled feeding etc., to improve the gain, bandwidth, VSWR, radiation characteristics, multiband operation, etc., slot loading techniques [3-5].In [3] the proposed antenna loading with multi slits for compact multi-band single feed triangular microstrip antenna to investigate tri-band operation has been studied. A new design for broad band triangular microstrip patch antenna using probes fed are proposed in [4], the proposed antenna which shows the resonant frequency between X and Ku band applications. In [5] the antenna designed by using U-slot on stacked patch for achieving dual and triple band operation and this antenna are used in X-band applications has been studied.Moreover, the above methods are complicated. To overcome difficulties, in this paper a simple microstripline proximity coupled feeding technique is used to achieve the triple band operation with wide impedance bandwidth, VSWR and broad side radiation characteristics.

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II. ANTENNA DESIGN CONSIDERATION

In this article the proposed antenna has been designed for the frequency of 3 GHz using the relations present in the literature for the design of equilateral triangular microstrip antenna. The simple commercially available glass epoxy substrate material with substrate S_1 and S_2 having thickness of 0.32 cm is used to simulate the antenna. The Fig. 1 shows the top view geometry of inverted U-shaped slot loaded proximity coupled equilateral triangular microstrip antenna (IUSPCETMSA) and Ansoft HFSS simulated antenna module of IUSPCETMSA as shown in Fig. 2.

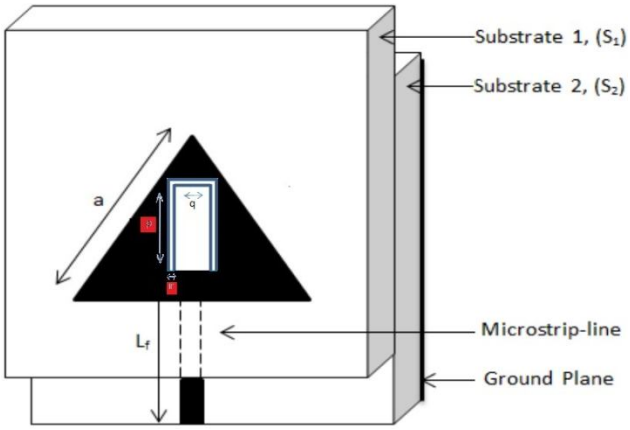

Fig. 1 Top view geometry of IUSPCETMSA

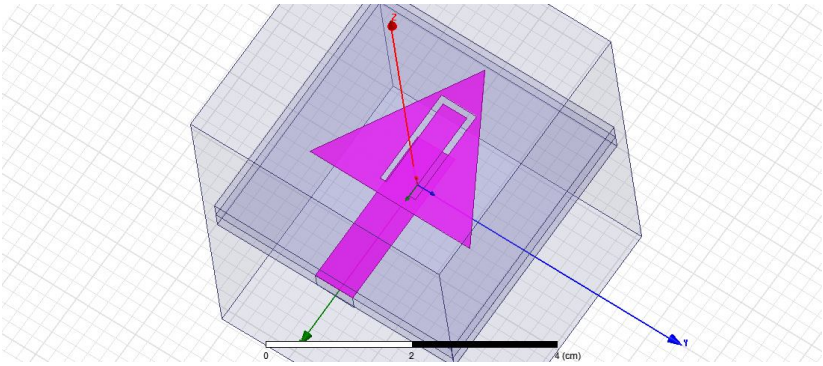

Fig. 2 Simulation antenna module of IUSPCETMSA

The equilateral triangular radiating patch with inverted U-shaped slot loaded on top surface of substrate S_1, where p, q and r are the dimensions of the U-shaped slot respectively. The microstripline feed of L_f and W_f is etched on the top surface of substrate S_2. The glass epoxy substrate material S_2 is placed below substrate S_1 such that the tip of the feed line and the center of the radiating patch consider one over the other. Here the bottom surface of the substrate S_2 acts as the ground plane. The dimensions of the ground plane Lg and Wg are calculated from equation (1). All the specifications of the proposed antenna are given in Table. 1.

$$Wg=Lg=6h+a \qquad (1)$$

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Table 1: Simulated parameters of the proposed antennas

Antenna Parameters	**Dimensions in cm**
Side length of equilateral triangle (a)	2.70
Width of the feedline Wf	0.63
length of the feedline Lf	2.5
Width and Length of the ground plane (Wg and Lg)	4.6
Thickness of substrate S_1 and S_2	0.64
p	1.5
q	0.4
r	0.1

III. SIMULATION RESULTS AND DISCUSSION

The characteristics of proposed IUSPCETMSA is designed and simulated by using Ansoft HFSS simulation software. The variation of return loss versus frequency characteristics of IUSPCETMSA antenna as shown in Fig.3. From this graph it is seen that, the antenna resonates very close to its designed frequency of 3GHz. The impedance bandwidth over return loss less than -10dB is calculated by using the equation (2).

$$BW = \left[\frac{f2 - f1}{fc}\right] \times 100\ \% \qquad (2)$$

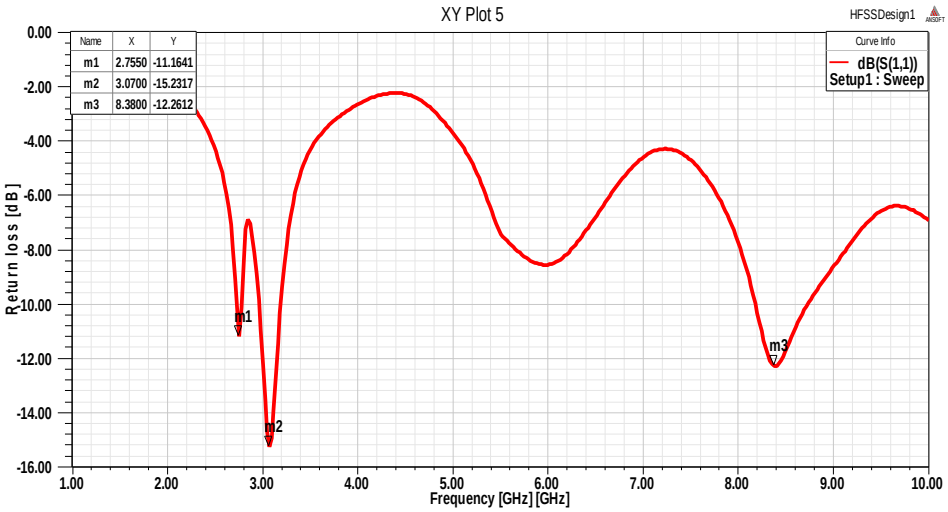

Fig.3. Simulation return loss versus frequency of IUSPCETMSA

From the Fig. 3 it is found that, the proposed antenna resonates at three frequency points i.e., 2.87GHz, 3.07GHz and 8.38GHz with impedance bandwidth of 1.81%, 4.95% and 6.50% and the minimum return loss is found to be -11.16dB, -15.23dB and -12.26dB respectively. It is clear that the antenna operates between the frequencies 2.75 to 8.38 GHz which covers WIFI, IMT and radar frequency ranges. The VSWR of the proposed antenna shown in Fig. 4 and is found to be 1.78 (2.87GHz), 1.41 (3.07GHz) and 1.64 (8.40GHZ) respectively.

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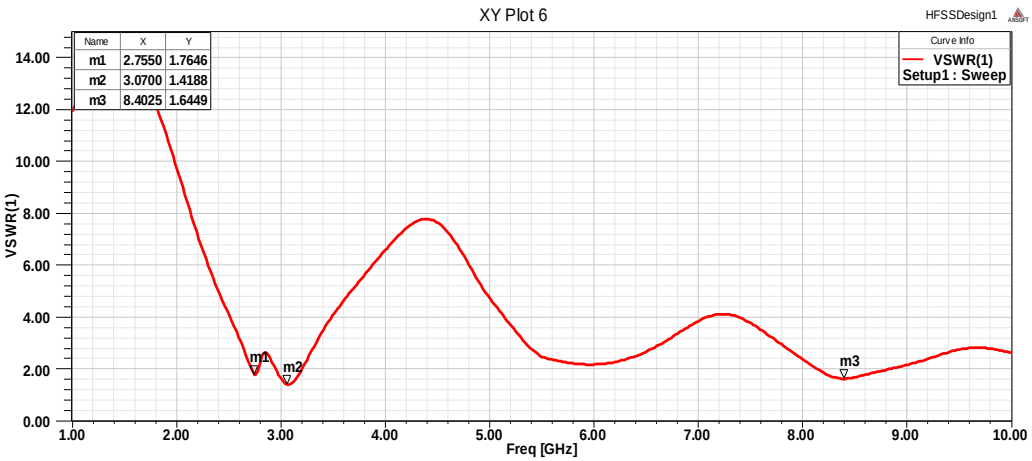
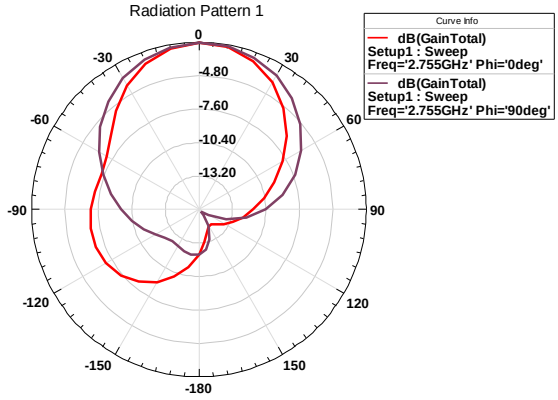
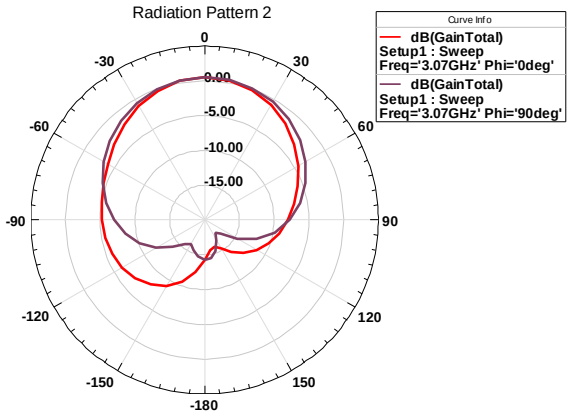


Fig.4. Simulation VSWR of IUSPCETMSA

The radiation patterns of the simulated IUSPCETMSA at their resonating frequencies are also studied and plotted. The E and H plane radiation patterns of the proposed antennas for φ at 00 and is as shown in Fig. 5(a), Fig. 5(b) and Fig. 5(c). This shows radiation patterns are broadside in nature.



5(a)



5(b)

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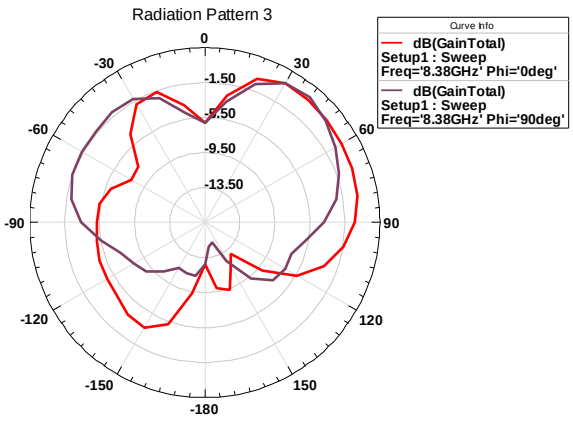

5(c)

Fig. 5.The simulated radiation patterns of IUSPCETMSA measured at 5(a) 2.75 GHz, 5(b) 3.07GHz, and 5(c) 8.38GHz

VI.CONCLUSION

From the detailed study it is concluded that, the proposed IUSPCETMSA antenna resonates at three frequency points, also gives a highest impedance bandwidth of 6.50%. The radiation patterns of the designed antenna are found to be broadside in nature and linearly polarised at each operating frequencies. This antenna may find applications in WIFI, IMT, radar and other wireless applications.

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