UWB U- Shaped Planar Printed Antenna Loaded with L-Slot and Tuning Stubs

M. Neelaveni Ammal[1], B. Ramachandran[2], P. H. Rao[3]

[1, 2] Department of Electronics & Communication Engineering, SRM University, Chennai-603203, India
[3] Senior Member - IEEE, SAMEER, Center for Electro Magnetics, Chennai-600113, India
(neelaveni.m & ramachandran.b}@ktr.srmuniv.ac.in, phrao@cem.sameer.gov.in

Abstract - This paper presents an UWB planar printed compact monopole antenna comprising of U-shaped notch loaded with L-slot and tuning stubs. It has a partial ground plane to achieve an excellent impedance matching to increase the impedance bandwidth. The simulated results show that the proposed antenna exhibit UWB for 3.84 GHz to 11.61 GHz with –10dB return loss and VSWR < 2. Antenna gain and radiation pattern plots for different frequencies are also investigated. The performance characteristics of the proposed antenna are simulated using Ansoft HFSS software.

Index Terms - planar antenna, ultra wideband, partial ground plane.

I. INTRODUCTION

The Federal Communications Commission (FCC)[1] regularized rules for the commercial use of Ultra wideband systems, operating in the frequency range of 3.1 GHz to 10.6 GHz. Ultra wideband systems offer attractive features such as large bandwidth, transmission of high data rates, immunity to multipath interference, low power consumption and simple configuration [2]. Because of these attractive features, the researches on ultra wideband systems have been increasing fastly.

With the fast growing interest in the area of wireless communication systems, the challenging aspect is designing Miniaturized antennas. Planar printed antennas have been preferred for ultra wideband applications because of the features of small size, light weight, low profile, low cost and compatibility with integrated circuits [3]-[4].

Reviewing the literature shows various methods can be used to enhance the impedance bandwidth. Those methods include cutting slots on the patch, putting parasitic patches near the radiator, embedding a quarter wavelength tuning stub within a slot on the patch and inserting a slit on the patch. In [5] - [9], different planar antennas with microstrip line feeding for ultra wideband applications are presented. In some cases, U-slot is reported [10]-[11]. In [12], antenna is fed by CPW .

In this paper, a new planar printed antenna for UWB applications is proposed. A new technique has been reported by introducing tuning stubs along with the U- shaped radiating element. The antenna consists of L-shaped slot to provide significant impedance bandwidth.

This paper is organized as below. Section II presents the geometry of the proposed antenna. In Section III, results are discussed and Section IV concludes the paper.

II. ANTENNA GEOMETRY

The geometry of the proposed antenna with its dimensional parameters is illustrated in Fig. 1. The antenna is located in xy plane and the normal direction is parallel to z axis. Based on the dimensions mentioned in Table I, the antenna is designed on RT/ Duroid 5870 substrate with a relative permittivity (ξ_r) of 2.33, Loss Tangent (tan δ) of 0.0012, thickness of 0.7mm and ground plane width of 5.2mm. The U-shaped radiating patch consists of L-shaped slot that is fed by microstrip line.

Table I Geometrical dimensions of the proposed antenna

parameter	value(mm)	parameter	value(mm)
a	24	l	1
b	28	m	11.1
c	5	n	1.7
d	2	p	6
e	2.85	q	5
f	5	w	5.2
g	5	h	0.7
i	2.65	s	3
j	3	t	1.5
k	1.1		

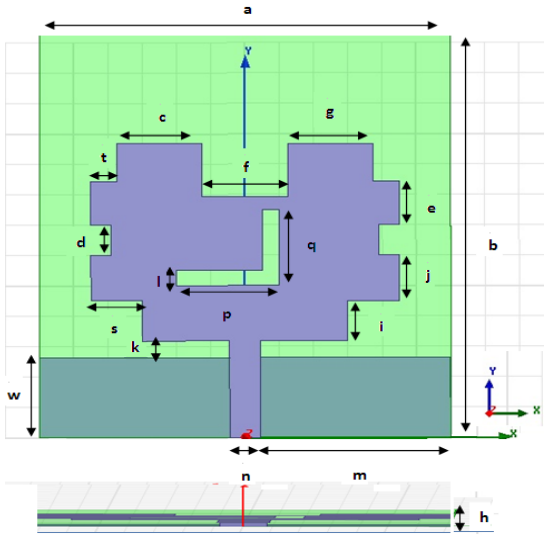


Fig. 1 Antenna geometry of the proposed antenna

III. RESULTS AND DISCUSSION

One of the important parameters in the design of antenna is the size of the ground plane, because the bandwidth is heavily dependent on the ground plane size. The return loss of the antenna improves gradually when the length of the ground patch reduces gradually and good result is obtained.

The goal of the proposed antenna design is to achieve good performance in the return loss. The simulated result of return loss shows that the center frequency of bandwidth at 7.72GHz and the bandwidth at –10dB ranging from 3.84GHz to 11.61GHz as shown in Fig. 2. To achieve this, suitable antenna geometry is needed. Thus the antenna design parameters such as patch shape, slot, size of the tuning stubs and width of the feed are investigated to obtain good return loss and impedance bandwidth. The variation of VSWR with frequency as depicted in Fig. 3 indicates that an excellent matching between antenna and feedline. The VSWR is less than 2 over the entire bandwidth.

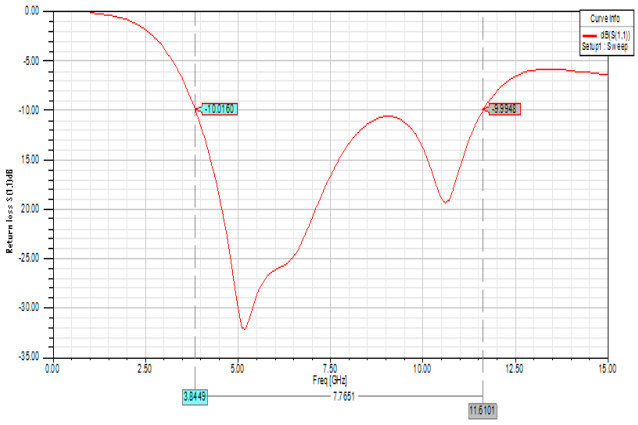


Fig. 2 Simulated return loss curve for the proposed antenna

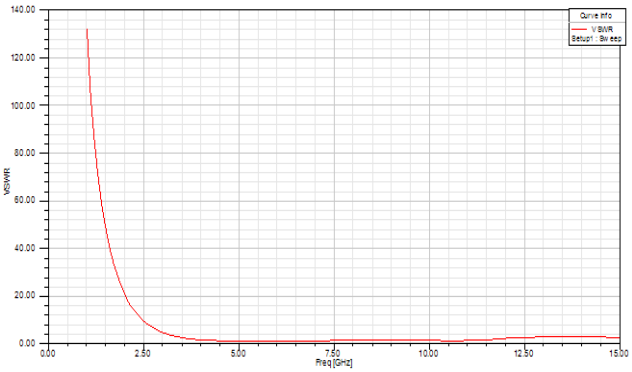


Fig. 3 Simulated VSWR curve of the proposed antenna

Fig. 4 shows three dimensional radiation pattern of the proposed antenna. Fig. 5 shows gain of the proposed antenna. The gain varies upto 3.22 dBi. The simulated radiation patterns of the proposed antenna in H-Plane and E-Plane at 4.2GHz, 7.5GHz and 10GHz are depicted in Fig. 6a and 6b. From the radiation pattern diagrams, it is observed that in H-plane, radiation pattern is Omni directional in the lower frequencies of UWB range and it is distorted in higher frequencies. In E-plane, the pattern is bidirectional.

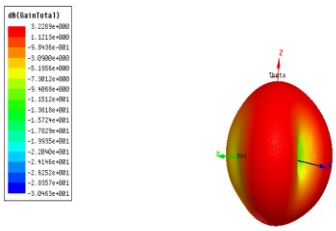


Fig. 4 Simulated 3D radiation pattern of the proposed antenna

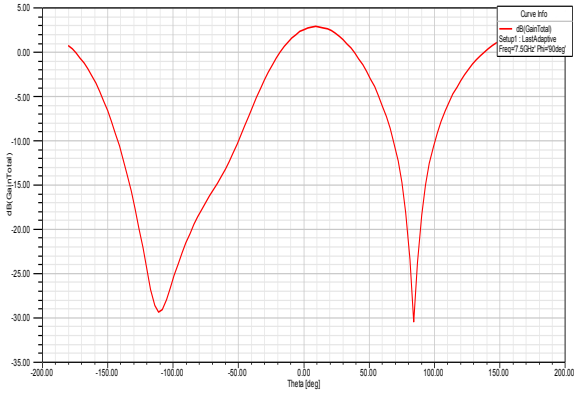
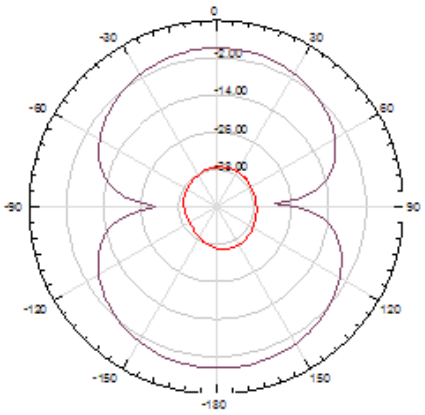
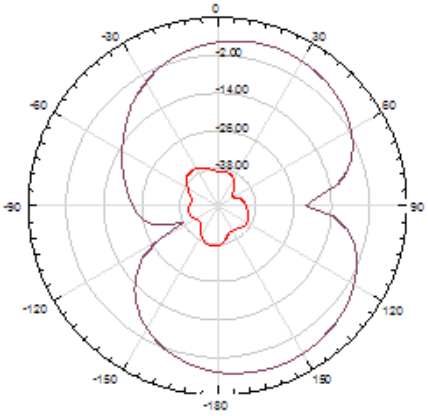


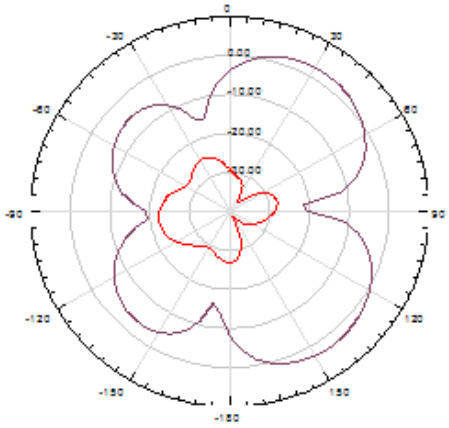
Fig. 5 Simulated gain curve for the proposed antenna



(i)

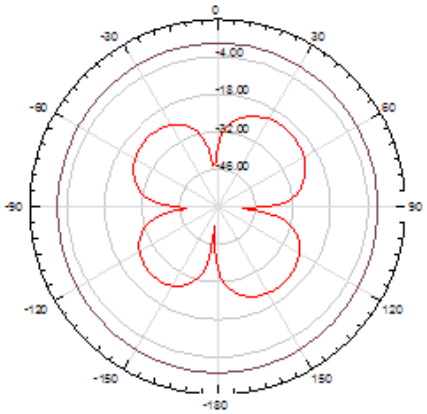


(ii)

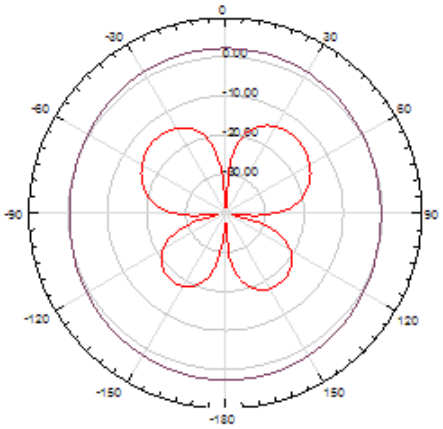


(iii)

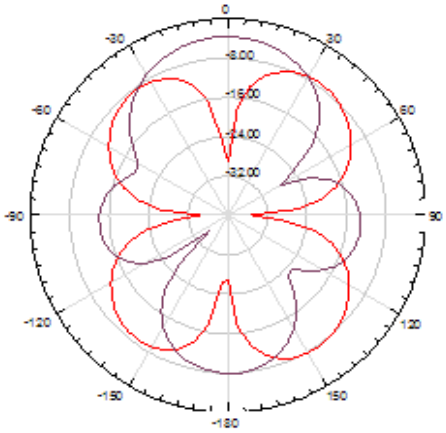
Fig. 6a E-Plane radiation pattern at (i) 4.2GHz (ii) 7.5GHz (iii) 10GHz



(iv)



(v)



(vi)

Fig. 6b H-Plane radiation pattern at (iv) 4.2GHz (v) 7.5GHz (vi) 10GHz

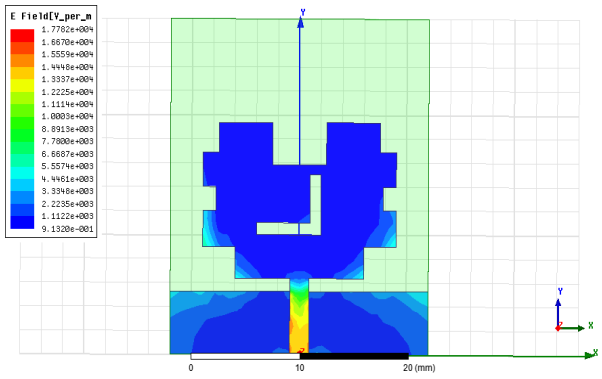


Fig. 7 Simulated electric current distribution of the proposed antenna

The simulated electric current distribution on the ground plane and radiating element are illustrated in Fig. 7. Electric current is distributed in the upper part of ground plane and in the lower portion of the radiating element along with the junction location of tuning stubs. From the diagram, it is clear that the upper part of ground plane is also considered as a radiating element.

IV. CONCLUSION

A new UWB planar printed antenna with simple structure and low profile has been proposed. Based on the results simulated using Ansoft HFSS, the frequency range obtained for −10 dB is 3.84 to 11.61GHz and VSWR < 2. The simulated −10dB return loss shows that the proposed antenna achieves impedance bandwidth ranging from 3.84GHz to 11.61GHz and the gain is about 3.22 dBi. The E-Plane and H-Plane radiation patterns at 4.2, 7.5 and 10 GHz are presented. The proposed antenna presents Omni directional radiation pattern in the H-Plane. The presented results show that the proposed antenna is suitable for UWB applications.

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