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Rectangular Monopole Antenna with U-notches for UWB Applications

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Abstract: ***Printed rectangular monopole antenna with small U-notch in the radiating patch and ground plane is presented and discussed. To obtain the wide band response, small U-notches in the radiating patch is introduced. The impedance bandwidth of the proposed antenna is ranging from 3.09 GHz to 13.82 GHz which covers the Federal Communication Commission (FCC) range. The antenna is fed via a microstrip line matched at 50 Ω impedance. The proposed antenna performance is studied and analyzed using Mentor Graphics IE3D simulation software. Good return loss, bandwidth and radiation pattern characteristics are obtained in the frequency band of interest.***

Keywords: ***Monopole antenna, Ultra Wide Band, impedance bandwidth, microstrip line, radiation pattern***

I. INTRODUCTION

As wireless communication applications require more and more bandwidth, the demand for wideband antennas increases. For instance, ultra wide band (UWB) radio will utilize the frequency band of 3.1 GHz to 10.6 GHz which was defined by FCC [1]. After the FCC's ruling in February 2002, the researchers all over the world designed and proposed many UWB antennas, which are compact, low cost, light weight and easily integrated with RF/Microwave circuits in the UWB systems [2]. UWB technology promotes extensive employment in various modern warless systems, such as: through wall imaging, medical imaging, vehicular radar, indoor and hand-held UWB systems and so on. This is due to its potential advantages, such as high data rate, high resolution positioning, excellent immunity to multipath interference, high transmission security, low power consumption and reduced hardware complexity [3]. It is well known fact that planar monopole antennas present really appealing physical features, such as, simple structure, small size and low cost. Additionally, planar monopoles are compact broadband omnidirectional antennas and are non-dispersive. Due to all these interesting characteristics, planar monopoles are extremely attractive to be used in emerging UWB applications, and growing research activity is being focused on them [4-5].

In this paper, a simple and compact microstrip line-fed planar UWB antenna is proposed. The UWB characteristics can be achieved by embedding the U-notch in the radiating patch and ground plane of the antenna. Also L-shaped notches are cut in the edges of the main radiator. The UWB bandwidth, appropriate gain and stable radiation patterns are obtained.

II. ANTENNA DESIGN

The geometry of the proposed Printed Rectangular Monopole Antenna (PRMAL) with L- shaped notches at the lower corners with U-shaped notch on the ground plane fed by 50 Ω microstrip line is shown in Fig. 1(a) and with U-shaped notches at the top of the radiating patch along with L-shaped notches in the ground plane i.e., Printed Rectangular Monopole Antenna with L-shaped and U-shaped notches (PRMALU) is shown in Fig. 1(b) respectively.

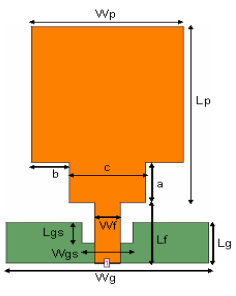

Fig. 1(a) Geometry of PRMAL

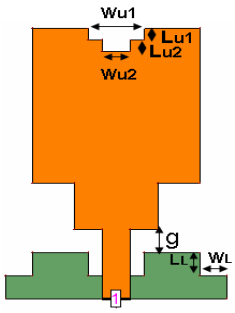

Fig. 1(b) Geometry of PRMALU

The size of the antenna substrate having length 26 mm and width 16 mm is designed. In that the length of the radiating patch L_p=17.5 mm and width of the patch W_p=12 mm is fed by a microstrip line of width W_f=2mm and length L_f=6mm. The ground plane size is L_g x W_g= 4 mm x 16 mm. The U-notch in the ground plane having length L_{gs}=2 mm and width W_{gs}=4mm is used. The glass epoxy substrate is having thickness h=1.6mm and permittivity ε_r = 4.4 is used. The notches at the top of the radiating patch are having length L_{u1}=1mm, L_{u2}=1mm and width W_{u1}=1 mm, W_{u2}=1mm respectively. L shaped notches having dimensions a=4 mm, b=3 mm and c=6 mm.

III.RESULTS AND DISCUSSIONS

The antennas were simulated using Mentor Graphic's IE3D simulation software. Fig. 2 shows the simulated return loss characteristics of Printed Rectangular Monopole Antenna for different slots. By optimizing the parameters i.e., the length and width of the notches at the top and ground plane of the antenna, Ultra wide bandwidth is achieved. It has been observed that the antenna with L-shaped notches i.e., PRMAL (antenna 1) is giving the bandwidth of 3.09 GHz to 13.7 GHz. Then by inserting U-shaped notch at the top of the antenna (L_{u1} x W_{u1}) bandwidth resulted from 3.1 GHz to 13.84 GHz (antenna 2). It is observed that after placing U-notch at the top of the patch, the bandwidth is increased from 13.79 GHz to 13.84 GHz. Again, by inserting 1mm x 1mm U-notch in the big U-notch bandwidth found to be from 3.1 GHz to 13.85GHz (antenna 3). After by hatching L-notches at the corners of the ground plane, the antenna had shown the bandwidth from 3.08 GHz to 13.99 GHz. This gives maximum of 10.90 GHz bandwidth and shown in fig 2 and it is antenna 5. Measured bandwidth for PRMALU gives bandwidth from 3.06 GHz to 15 GHz and is shown in fig 3 with optimized antenna 5. The simulated and measured radiation patterns in the H-plane for 3.1 GHz, 5.8 GHz & 10.6 GHz are depicted in fig 4 for PRMALU. The results shows that the radiation patterns for the azimuth radiation patterns are almost omnidirectional. The antenna peak gain is illustrated in Fig. 6.

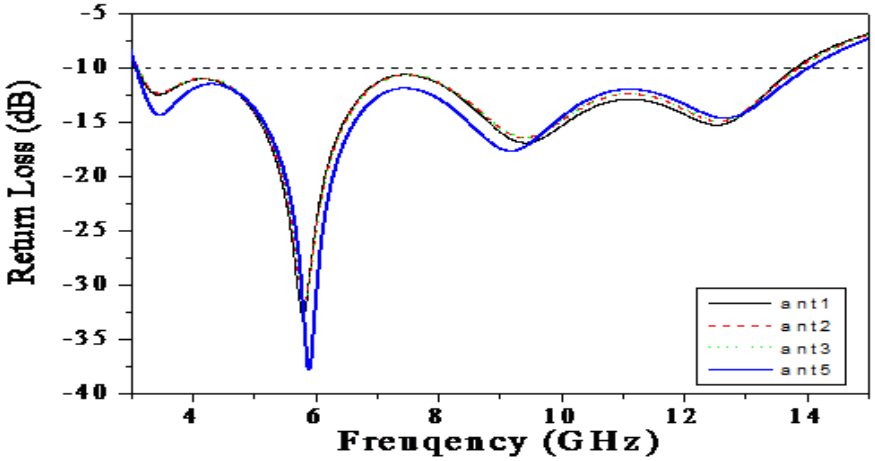

Fig. 2 Simulated Reflection Coefficient of proposed antennas.

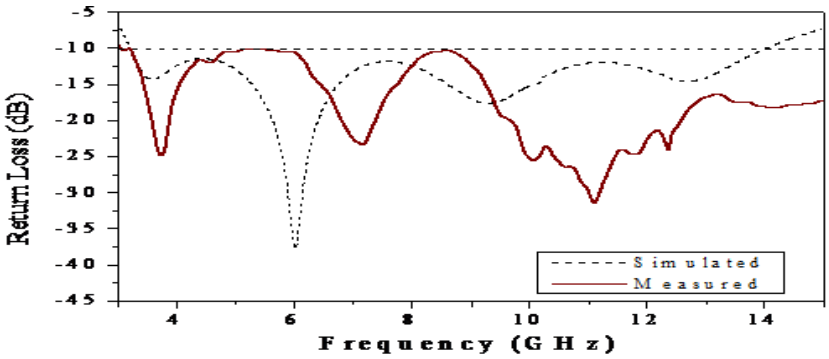

Fig. 3 Simulated & Measured Reflection Coefficient of PRMALU

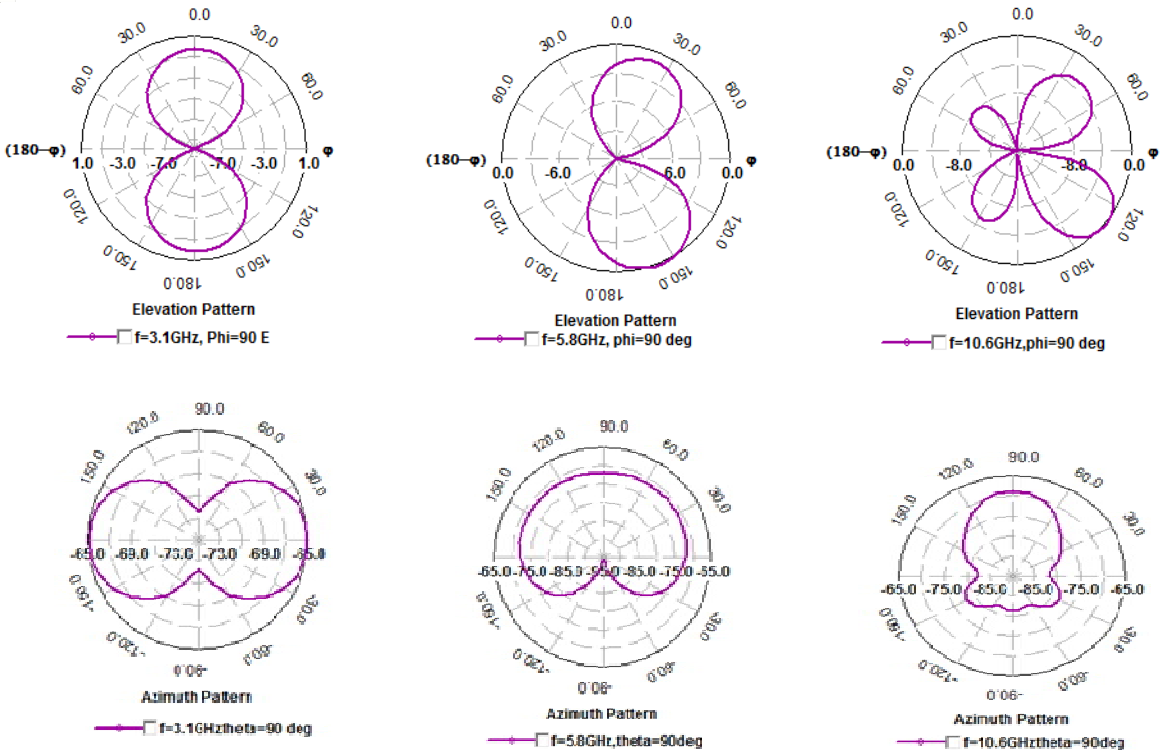

Fig. 4 Simulated Radiation patterns of PRMALU: Elevation pattern and Azimuth pattern

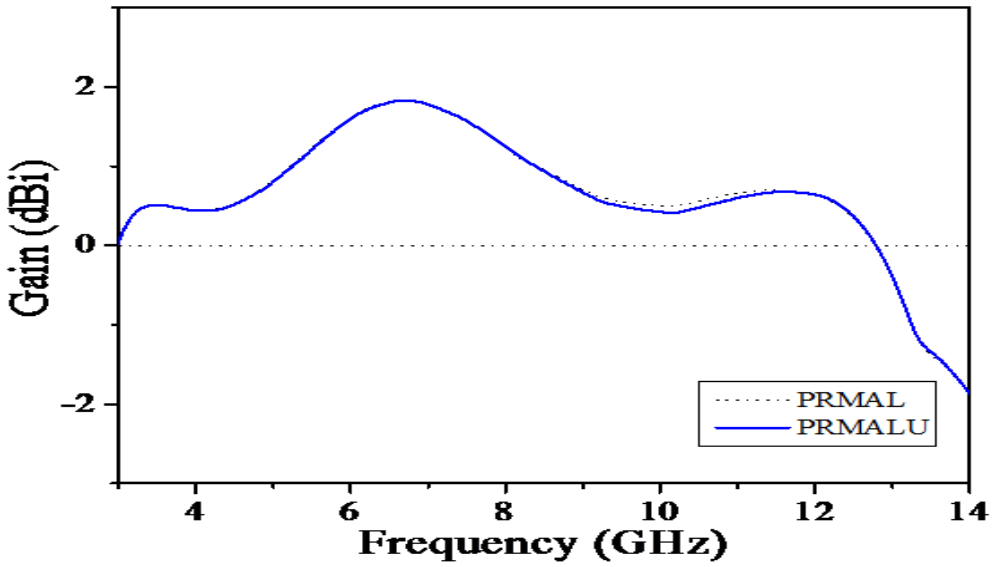

Fig. 6 Gain v/s frequency of proposed antennas

It is observed that the gain levels of the antennas are 0.1-1.9 dBi. The gain is constant throughout the UWB frequency band.

IV. CONCLUSION

A Printed rectangular monopole antenna with U-notches in the radiating patch and L-notches in the ground plane has been studied. Both antennas are exhibiting UWB frequencies. The Printed Rectangular Monopole Antenna with U & L notches giving ultra wide band frequency ranging from 3.08 GHz to 13.99 GHz. This covers FCC's UWB requirements. The antennas are compact in size and gives consistent radiation patterns over the UWB spectrum. The gain is almost constant in the frequency band of interest.

V. ACKNOWLEDGEMENT

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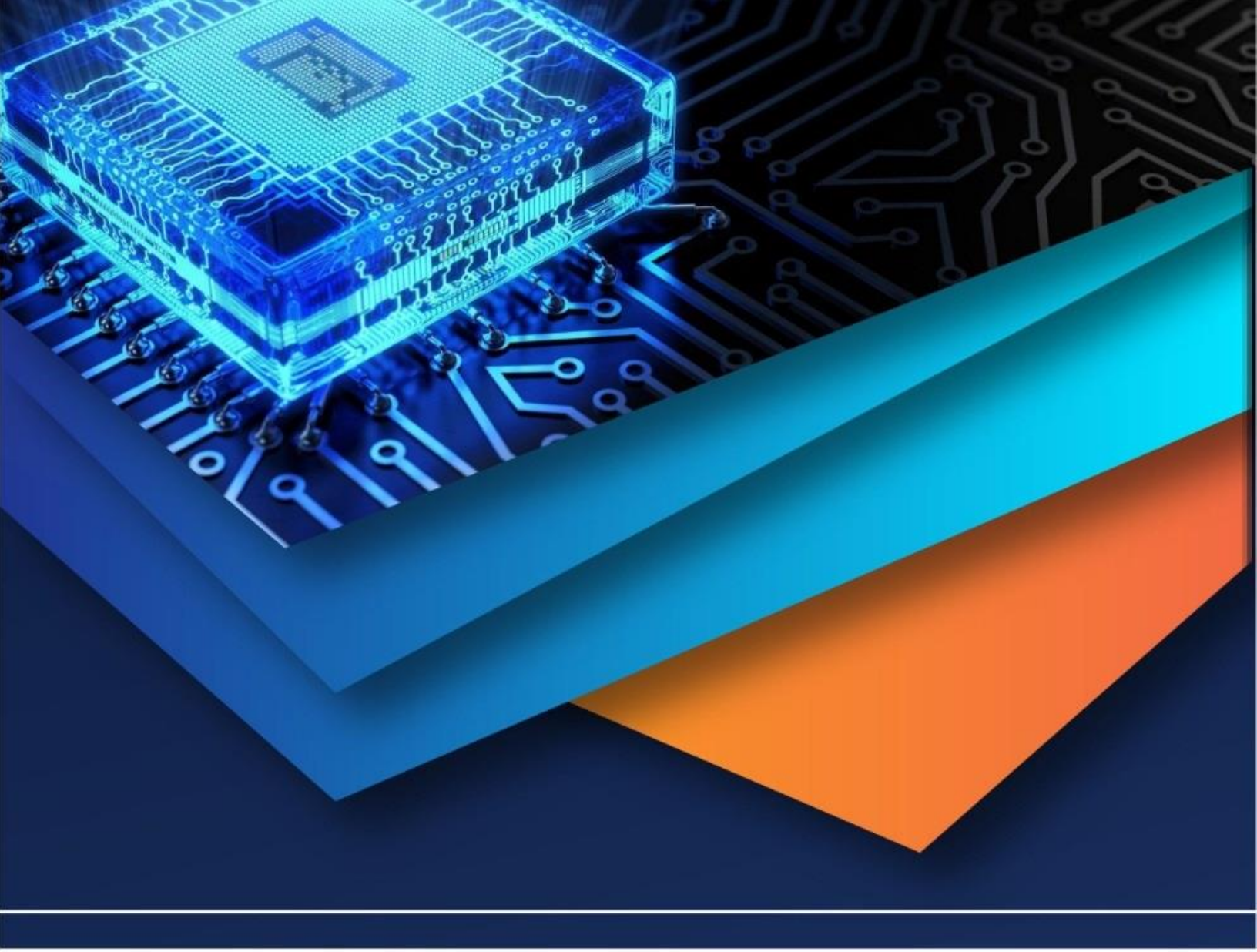

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