Performance Analysis of Rectangular Microstrip patch to achieve UWB bandwidth of an Antenna

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ABSTRACT

A compact monopole microstrip rectangular patch antenna having defected ground plane(DGP) with notches is presented in this paper. Ultra-wide band (UWB) patch antenna is feed by microstrip line feed. Parametric study have been conducted by changing the gap distance between radiating patch and DGP and changing the feed position. Optimum results are observed when gap between the radiating patch and DGP is 0.5mm and for offset feeding of microstrip feed line. The obtained reflection coefficient is less than -10dB for a frequency range of 3GHz to 10.66 GHz. The antenna has been designed on a FR4 substrate with dielectric constant $^{\circ}_{r} = 4.4$, loss tangent (tan ä) = 0.02.The radiation pattern is directional in E-plane and nearly omnidirectional in H-plane. Efficiency decreases at the higher frequency edge due to the lossy substrate. The UWB antenna is simulated using CAD FEKO 6.2 suit electromagnetic simulator using MoM (Method of Moment).

***Keywords**: Patch antenna, Ultrawideband, Radiating patch, Defected Ground plane, Method of Moment*

1. Introduction

The U.S. Communication Commission (FCC) authorized the unlicensed use of the ultrawideband (UWB: 3.1–10.6 GHz) in February 2002[1]. As the micro strip antennas are having various advantages as are low profile, conformable to planer & non planer surfaces, simple, low cost also easy to manufacture using modern printed circuit technology they are widely used in various applications. The radiating patch can be of square, rectangular, circular or any other configuration. But square, rectangular, circular & strip line shape are most common because of their radiation characteristics, especially low cross polarization [2]. For many years significant research activities and interests have been aroused in wideband applications for different communication applications [3-5]. Recently various academic and industrial ûelds also shown their interest to explore various UWB antennas [6].

The main challenge in UWB antenna design is achieving the wide impedance bandwidth while still maintaining high radiation efficiency. A planar antenna is also desirable given that there are several additional constraints and challenges for the design of a UWB system antenna. In this article we present a rectangular compact planer monopole antenna having pair of notches on at patch corners & defected ground plane with microstrip feedline.

2. Antenna Design

Fig. 1 shows the configuration of monopole antenna with pair of notches at lower corner edges of rectangular patch and a defected ground plane having pair of notches.

The proposed antenna, has the dimension of 25 mm X 38 mm (W_{sub} X L_{sub}), is constructed on FR4 substrate with thickness of 1.6 mm and relative dielectric constant of 4.4 having loss tangent (tan ä) of 0.02. The width W_f of the micro strip feed line is fixed at 2 mm. On the upper surface of the substrate, a rectangular patch with size of W_p X L_p is printed. The rectangular patch has a distance of to the ground plane printed on the back surface of the substrate. By cutting the two notches L_1 X W_1 and L_2 X W_2 of suitable dimensions at the monopole's two lower corners, it is

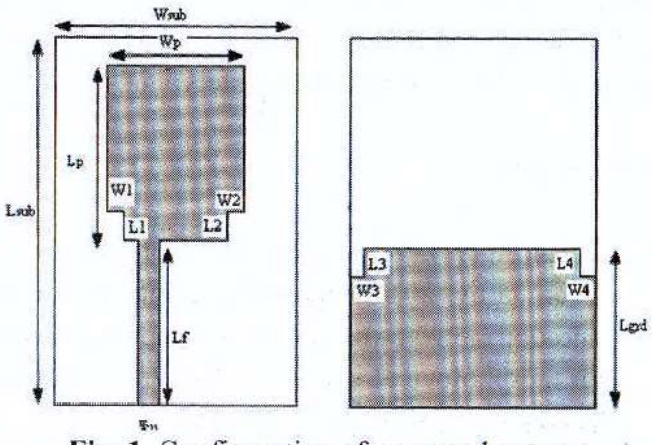


Fig. 1. Configuration of proposed antenna

observed that much enhanced impedance bandwidth can be achieved for the proposed antenna. This thing occurs because of two notches affects the electromagnetic coupling between patch and ground plane.

In addition to this, to obtain the more enhanced bandwidth the pair of notch is obtained on the ground plane of L_3 X W_3 and L_4 X W_4. Also the gap between patch and ground plane of L_5 and position of microstrip feedline is obtained by the way of simulation. This parameter is important to determine the sensitivity of impedance matching.

The optimized dimensions of proposed antenna are as follows: W_{sub} =25mm, L_{sub}=38mm, W_p=14mm, L_p =18.25mm, W_f =2, L_1 =L_2 =L_3 =L_4 =3mm, W_1 =W_2 =W_3=W_4=1.5mm, F_L =17mm, L_{grd}=16.5mm. This is found that using these dimensions the antenna satisfies requirements of UWB antenna from 3GHz to 10.66Ghz.

3. Result & Discussion

In this section, theoretical results of proposed compact planar antenna having notches at lower corner of patch and DGP are presented which is simulated and designed using CADFEKO simulation software version 6.2 [7]. The notch pair at the lower corner of the patch designed to obtain the proper enhanced bandwidth of the antenna and its size is fixed at L_1 X W_1. By varying the distance between radiating patch and ground plane it is observed that at distance greater than 1mm higher edge frequencies of antenna has got rejected, by performing parametric analysis obtained gap is of 0.5mm.

To have the proper impedance matching the micro strip feedline is used having fixed feed width of W_f and helps to reduce the inductive nature of the antenna

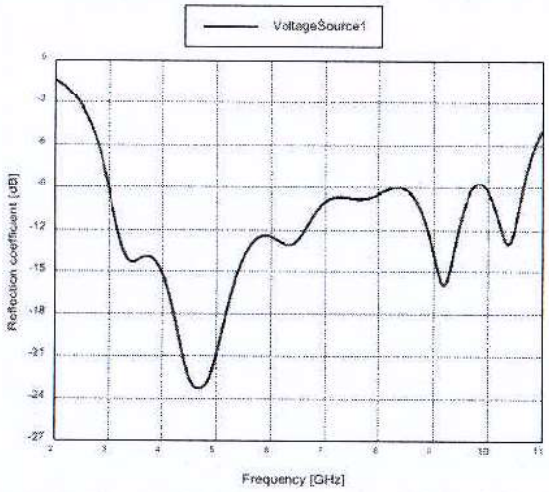


Fig. 2. Simulated Reflection coefficient for UWB application

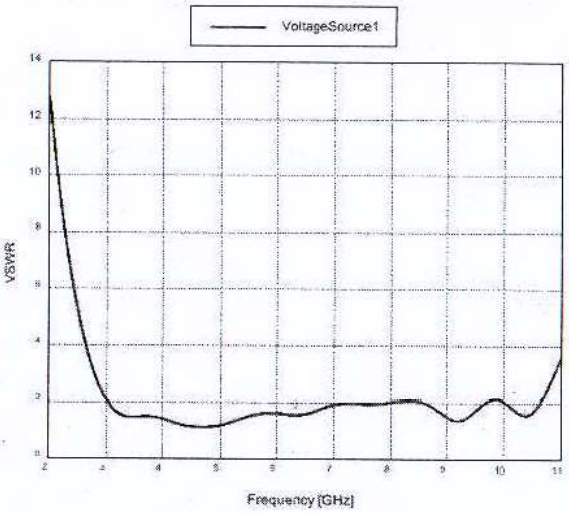
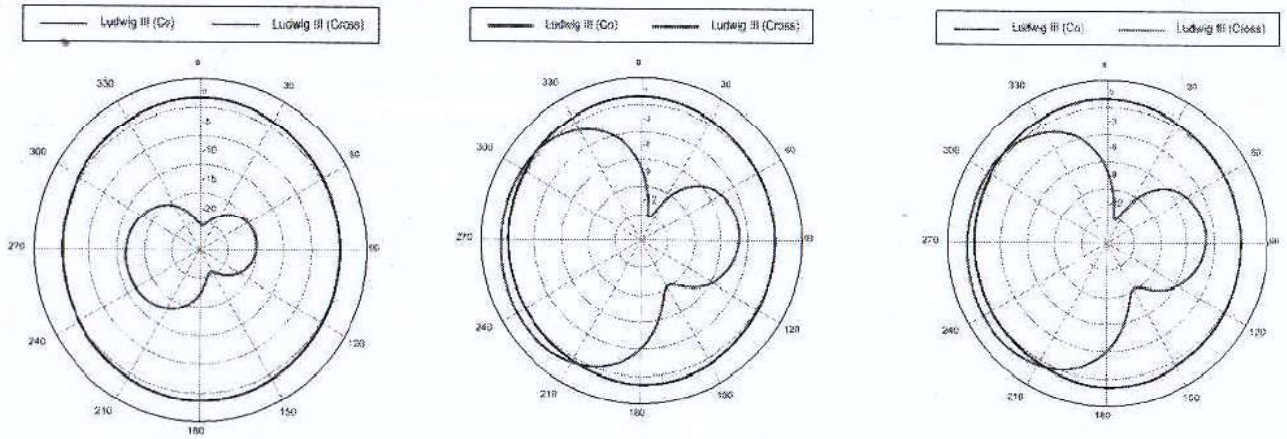
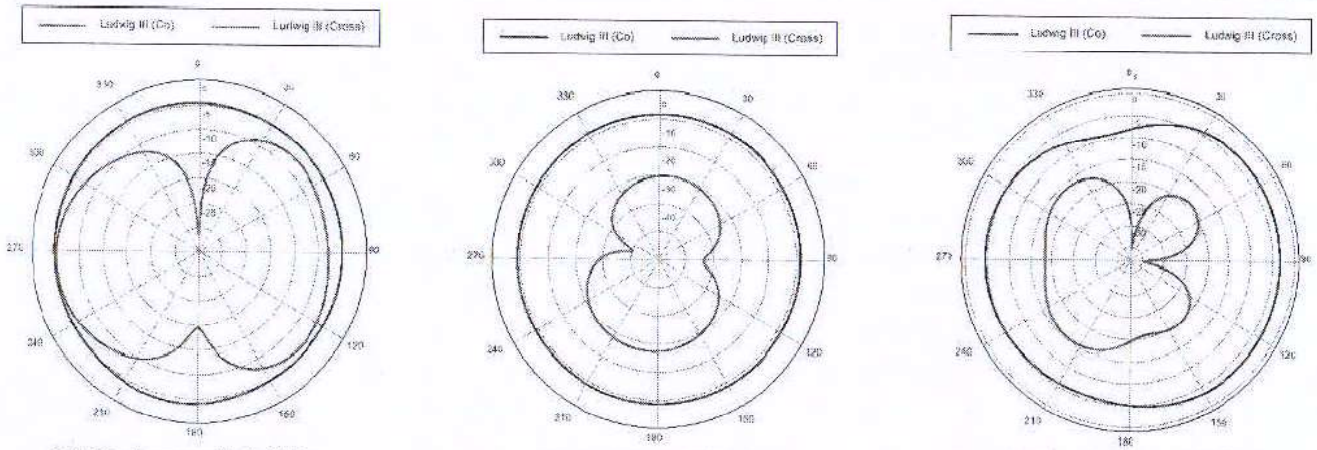


Fig. 3. Simulated VSWR obtained for the range of 3 GHz-10.66 GHz.



(a) E plane at 3.5 GHz (b) E plane at 5 GHz (c) E plane 7.4 GHz

Fig. 4a. Simulated Radiation pattern obtained along the x–z plane (E-plane) at 3.5 GHz, 5 Ghz & 7.4 GHz



(d) H plane at 3.5 GHz (e) H plane at 5 GHz (f) H plane at 7.4 GHz

Fig. 4b. Simulated Radiation pattern obtained along y-z plane (H-plane) at 3.5 GHz, 5Ghz & 7.4 GHz

with increasing the characteristics impedance. In this design the offset feeding technique is used to obtain the proper impedance matching by the way of simulation. Figure 2 & 3 shows the simulated reflection coefficient and VSWR of the proposed antenna simulated results show that this antenna exhibits a wide impedance bandwidth from 3GHz to 10.66 GHz.

In figure 4. various radiation patterns obtained for E-plane and H-plane at 3.5GHz, 5GHz and 7.4GHz frequencies are shown. The Ludwig co-polarization and cross polarization is obtained for both E-plane and H-plane. In figure 4(a),(b) and (c) the radiation pattern for E-plane along the *x-z* axis at 3.5 GHz, 5GHz & 7.4GHz is shown. While in figure 4(c),(d) and (e) the radiation pattern for H-plane along the *y-z* axis at 3.5 GHz, 5GHz & 7.4GHz is shown. Typical eight shaped pattern is obtained at lower edge frequencies and As the frequency increases the number of lobes starts varying for some cases the number of lobes starts increasing[8].

4. Conclusion

The compact planar rectangular microstrip patch antenna has been designed and simulated using CADFEKO 6.2 simulator version for ultrawideband application. The pair of notches are obtained on both patch and ground plane to enhance the bandwidth by the way of parametric analysis. The reflection coefficient is obtained is of below -10dB and obtained frequency is 3GHz to 10.66GHz also VSWR<2 for the same. The radiation pattern is directional in E-plane and nearly omni directional in H-plane. Efficiency decreased at the higher frequency edge due to the lossy substrate. The results and discussion proves that the designed antenna is a good component for hand held UWB applications.

5. References

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