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A Novel Modified Ground Plane Microstrip Patch Antenna for Enhanced Bandwidth Applications

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Abstract — *In this paper, simple structure of Ultra-wideband antenna has been proposed. The proposed antenna is designed to operate from 3.1 GHz -14 GHz. The antenna consists of T-slots and notches on the patch. The purpose of the T-slots and notches are used to enhance the operating bandwidth. Apart from that the partial ground plane is used to optimize the bandwidth of the return loss. The performance of the antenna has been investigated in this paper. All the simulations were carried out by CST microwave studio. Details of the designed antenna and the results are presented and discussed.*

Keywords — *Ultra wideband (UWB), T-slots, Partial ground, patch antenna, Return loss.*

I. INTRODUCTION

The scheme of microstrip antenna was discovered in 1953[1] and a copyright in 1955[2]. Ultra-wideband (UWB) technology has been considered as one of the most favorable wireless technology that has a potential of revolutionizing high data rate transmission. Various type of monopole antenna has been developed for ultra-wideband application, such as rectangular patch, circular disc [3-4] etc. The FCC (Federal Communications Commission) furnished a ruling in 2002 that allowed intentional UWB emissions in the frequency range between 3.1GHz and 10.6GHz [5]. Various techniques of bandwidth enhancement have been introduced such as adding slot to the patch [6], using partial ground plane [7] and etc. In this paper a small-scale T slots UWB antenna is presented. In this paper, three techniques have been applied to design the proposed antenna: (i) two steps of notches situate at the two lower corners of the patch, (ii) a partial ground plane having triangular cut at edges and rectangular cut, (iii) T slot, which can guide to a good impedance matching. By choosing these parameters, the proposed antenna can be tuned to operate in the (3.1 -10.6) GHz frequency range. Utilization of corner cut approaches has been formerly used to boost the impedance bandwidth for microstrip patch antennas [8-12]. The simulation results in this paper are obtained using CST microwave simulation. Approach of triangular cut at edges has been used to enhance the impedance bandwidth for microstrip patch antenna.

II. ANTENNA DESIGN

The pattern and arrangement of the antenna in this paper are displayed in figure 1. In this paper the microstrip shape is utilized because it expresses many advantages, such as being compact, economical, and light weight. Moreover, a lower bandwidth is a drawback of this shape. Our target is to modify the shape and including the approach to improve the bandwidth. As follows, concise analysis of the parametric studies to attain the best values of return loss and bandwidth is discussed. Fig.4, 5, 6 shows the shape of the suggested antenna. As shown in figure1, the antenna has a small –scale dimensions of 30 mm x 30 mm (W_S x L_S), designed on FR4 substrate with thickness of 1.6 mm and relative dielectric constant (ε_r) of 4.7. The patch is fed by a microstrip line of 2 mm width (w_f). On the front side of the substrate, a rectangular patch with size of 15 mm x 12 mm (w_pxL_p) is imprint. The dimensions for the ground are 30mm x 5mm (Wg x Lg).

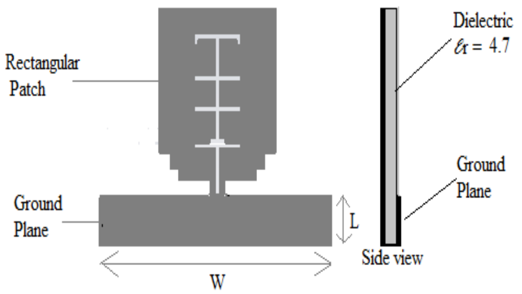

Figure 1: Original Shape

To achieve a compact size design, the minimum size of the ground plane is advantageous. The parameter to study is the length of the ground plane. From the results shown in figure 2(a), the length of the ground plane will have significant effect on bandwidth and return loss. We have chosen the length of 5 mm for a broader bandwidth and comparatively small size. Next we discussed the parameter Wg (the width of the ground plane), and the results as a function of Wg are shown in figure 2(b).

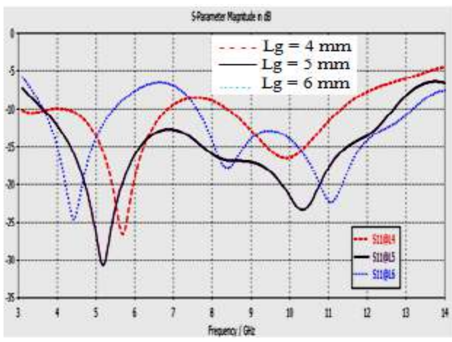

Figure2 (a): Return loss as a function of length of ground plane.

The increase in width gives the lower return loss at low frequency. The width of the ground plane will have only slight effect on the bandwidth. Hence we have

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selected the width of 30 mm for compact size .From the above parameter selection the result for the return loss is shown in figure 3 where the antenna is applicable from 3.540 GHz to 12.055 GHz, providing a bandwidth of 8.515 GHz. The rectangular slot technique [13-15] is employed to improve the impedance matching in the ultra wideband frequency. This method introduces two similar slots at the center of the ground plane, shown in figure 4, in order to modifying the antenna impedance and minimizing the return loss. The dimensions of the rectangular cut are 5mm x 3 mm (Wc x Hc).

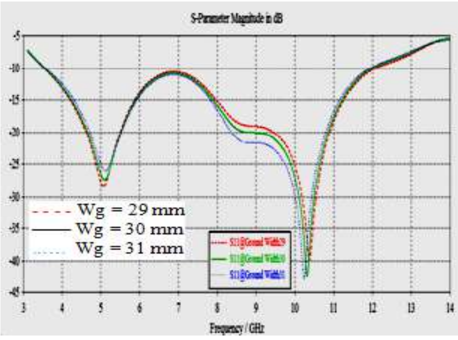

Figure2 (b): Return loss as a function of width of ground plane.

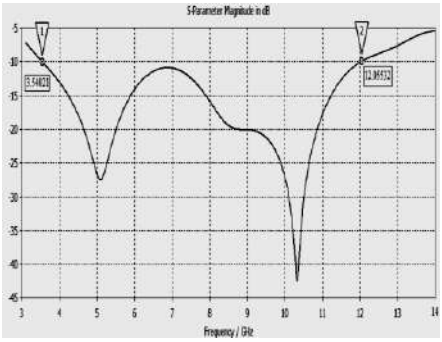

Figure3: Return loss with parameter Wg=30 mm, Lg= 5mm. The resultant bandwidth is approximately 8.515 GHz

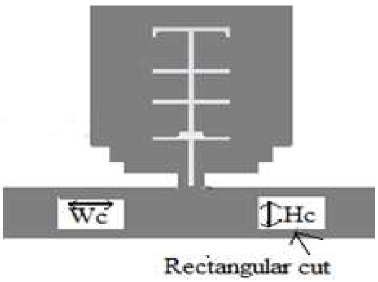

Figure 4: Antenna with two rectangular slots

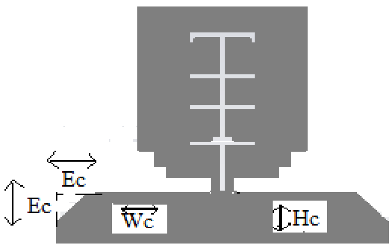

Figure 5: Antenna with diagonal edges

To further enhance the bandwidth of the antenna, we removed the top corners of the ground plane, resulting in symmetrical diagonal edges. The resultant antenna is shown in figure 5 with the parameter Ec (4 mm) related with the cut area. The parameter Wc, Hc of (7 mm x 2 mm) seems to offer a relatively low return loss and an appropriate wide bandwidth. The resultant antenna is shown in figure 6 with changed rectangular slot size.

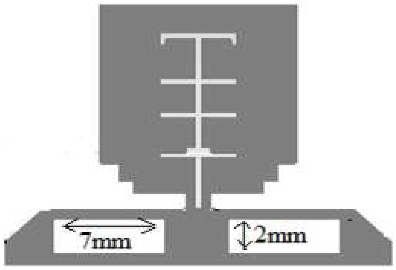

Figure 6: Antenna with changed dimensions of rectangular slots.

In addition to diagonal edges and rectangular slots, if we selected the rectangular slot with dimensions (7 mm x 2 mm), this antenna achieves the highest bandwidth. The result is shown in figure 7. This antenna can be used from 3.266 GHz to 13.322 GHz, providing a bandwidth of 10.056 GHz.

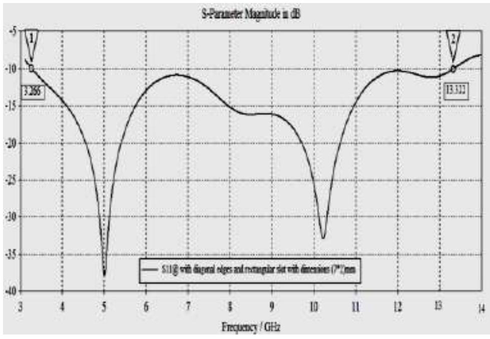

Figure7: return loss of antenna with diagonal edges and rectangular slot having dimensions (7 mm x 2 mm).The resultant bandwidth is approximately 10.056 GHz

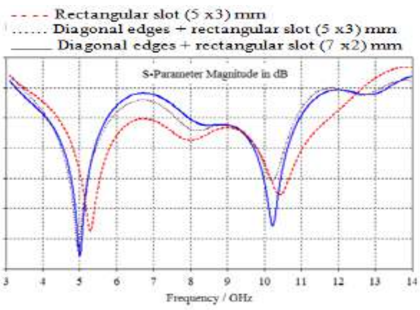

Figure8: comparison of return losses among the antenna with modified ground plane (of figure 4, 5, 6).

Compared with the result in figure 3, associated with the original shape, the proposed antenna of figure 6 can increase the bandwidth for approximately 1.54 GHz. A comparison among the antenna with modified ground plane (see figure 4, 5, 6) is shown in figure 8.

The results show that ground plane modification introduces an extra return loss dip, resulting in the optimal bandwidth.

III. CONCLUSION

In this paper, a rectangular patch antenna having T-slots has been presented. The bandwidth properties of the antenna were analyzed in detail.The original shape antenna of figure 1 is applicable from 3.540 GHz to 12.055 GHz, providing a bandwidth of 8.515 GHz. The behaviour of the antenna affected by the size of partial ground plane, slot and diagonal edges. The proposed low- cost and compact size antenna is providing a maximum 34.08 % wider bandwidth (3.266 GHz to 13.322 GHz) than the FCC recommended standard of 3.1-10.6 GHz. The simulation results show that a UWB can be obtained by optimizing these parameters.

REFERENCES

[1]. G. A. Deschamps, "Microstrip Microwave Antennas," 3 rd USAF Symposium on Antennas, 1953.

[2]. H. Gutton and G. Baissinot, "Flat Aerial for Ultra High Frequencies," French Patent no. 703 113, 1955.

[3]. C. A. Balanis, "Antenna Theory - Analysis and Design," 2nd edition, John Wiley.

[4]. Kin-Lu Wong, "Planar Antennas for Wireless Communications," Wiley, December, 2002.

[5]. Andreas F. Molisch, "Ultra-Wideband Antennas and Propagation for Communication, Radar and Imaging," Wiley, 2007.

[6]. Jia-Yi Sze and Kin-Lu Wong, "Slotted Rectangular Microstrip Antenna for Bandwidth Enhancement IEEE Transaction On Antenna and Propagation, Vol.48, No.8, August 2000.

[7]. A. H. M Zahirul Alam, Md Rafiqul Islam and Sheroz Khan, "Design and Analysis of UWB Rectangular Patch Antenna", APACE 2007 on applied electromagnetic, 1-3 Dec, 2007.

[8]. A. K. Sharma and A. Mittal, "Diagonal slotted diamond shaped dual circularly polarized microstrip patch antenna with dumbbell aperture coupling," in proceedings of the 8th European conference on wireless technology, pp. 463-465, 2005.

[9]. N. Prombutr, J. Pakeesirikul, T. Theatmongkol, ands. Suangool, "Dual-band coplanar waveguide antenna design by using U-slots with diagonal edges," in Proceedings of the 21st international Technical conference on circuits, systems, computers and communications, vol. 3, pp. 117-120, Chaingmai, Thailand, 2006.

[10]. M. A. Alkanhal and A. F. Sheta, "A novel dual- band reconfigurable square ring microstrip antenna," Progress in Electromagnetic research, vol.70, pp.337-339, 2007.

[11]. Z. N. Chen, "small printed Ultra wideband Antenna With Reduced Ground Plane," IEEE transactions on antennas and propagation, vol. 55, no. 2, ,pp. 383-388, February 2007.

[12]. Hindawi Publishing Corporation International Journal of Microwave Science and Technology Bandwidth Enhancement of UWB Microstrip Antenna with a Modified Ground Plane N. Prombutr,1 P. Kirawanich,1 and P. Akkaraekthalin 2. Volume 2009, Article ID 821515, 7pages doi:10.1155/2009/821515 Research Article.

[13]. F. G. Kharakhili, M. Fardis, G .Dadashzadeh, A. Ahmadi, and N. Hojjat, "Circular slot with a novel circular microstrip open ended microstrip feed for UWB applications," Progress in Electromagnetic research, vol.68, pp.161-167, 2007.

[14]. Y. Song, Y.C. Jiao, G. Jhao and F.S. Zhang, "Multiband CPW-FED triangle shaped monopole antenna for wireless applications," Progress in Electromagnetic research, vol.70, pp.329-336, 2007.

[15]. S. Sadat, M. Houshmand, and M.Roshandel, "Design of a microstrip square-ring slot antenna filled by an H-shape slot for UWB applications," Progress in Electromagnetic research, vol.70, pp.191-198, 2007.