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A Sleazy and small Microstrip UWB symmetric polyhedral slotted patch antenna with enhanced performances and multiband characteristics

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Abstract— The given paper presents an Ultra Wide Band (UWB) which is sleazy, simple, cheap and concise on a rectangular micro strip patch. The rectangular micro strip patch has been stepped twice at the bottom and the ground plane is cut shorted at the top center. The substrate is FR4 substrate with the dimension of (30x32x1.6) mm with permittivity 4.4. The antenna has been designed in HFSS v11.0 software. The simulated results are shown in this paper. The designed antenna provides an impedance bandwidth between 2.1-19.1 GHz (for S_{11}<-10 dB). The designed antenna exhibits stable VSWR values (1.0-2.0) and stable E and H plane for given bandwidth. The designed UWB antenna resonates at 6 different frequencies. This antenna can be operated for multiband applications in UWB technology. The antenna provides better UWB characteristics suitable for UWB applications.

Keywords*— Bandwidth; FCC; Group delay; Multiband; UWB; Radiation Pattern***.**

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I. INTRODUCTION

In this technological new age of telecommunications, almost all of the design engineer of telecommunication field must be aware of the rule made by Federal Communications Commission (FCC).The commission have allotted a special frequency spectrum from 3.1 GHz to 10.6 GHz for the use of Ultra Wide Band technology. Moreover this band is declared as unlicensed frequency. Thus every design engineer must look forward to design an antenna which can operate over such a large frequency band. Number of research is carried out on this topic. Efforts are done to design an antenna which can accommodate all 14 bands of UWB frequency with desired limits. Till now researches have successfully acquired the designs to achieve impedance bandwidth over entire allotted band. But these fail to provide multiband characteristics (i.e. these antennas are resonant at not more than two frequencies). [1]. It is foretold that this UWB technology will promise ultra high speed data transmission with very low power consumption. It can also be foreboded that these antennas can be applied in various applications like imaging in medical procedures, indoor and radar positioning systems, see through almost all objects. Printed microstrip antennas are practically cheap, small size, readily available, which makes them eye catching for the purpose of research and development sectors [3].

Microstrip antennas come with few drawback especially narrow bandwidth and low profile. Numerous researches have evolved for enhancing this narrow impedance bandwidth. Methods like introducing regular or irregular slot in the radiating patch or truncating patch and ground plane or increasing the height of substrate or increasing the height of the radiator patch. Introduction of slot includes slots of any shape, U- shaped [5], ring shaped, squared shaped, triangular shaped, circular shaped, or irregular shaped. Other methods are like stacked patch, or meandered one.

In the present paper, a simply tinny, sleazy and compact printed microstrip fed patch antenna is discussed. The antenna exhibits a wide impedance bandwidth between 3.3-16.9 GHz. The antenna discloses 7 resonating frequencies. The VSWR characteristics for desired range are acceptable and thus it satisfies the UWB system requirement. The outline of this paper consists of following things. Section consists of antenna configuration. Section consists of design and analysis of proposed antenna. And finally section is the conclusion of this paper.

II. ANTENNA CONFIGURATION

The proposed antenna is designed by considering x-y planes as the plane of radiator patch. The substrate used in the design is FR4 substrate with the thickness of 1.6 mm. The thickness of radiator patch and Ground Plane is 0.5 mm. The radiator and ground plane are located over the substrate of dimensions 30 X 32 X 1.6, all dimensions in millimeters. The radiator patch and ground plane material is nothing but the copper. At the bottom the antenna is truncated twice along the edges, whereas the ground plane is given a rectangular cut at the center top.

The antenna is symmetric in x-y plane. At the center there is a slot, an irregular slot, which is symmetric. This slot is made by arranging four equilateral triangles one over the other and

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subtract from the radiator patch. The centroids of these equilateral triangles are consecutively equidistance by the factor of 2 mm along y axis. The feeding used for this antenna is inset feeding. The top view and side view of given antenna is shown in the figure1. The detailed dimensions of proposed antenna are specified in the figure itself.

Now for designing any type of antennas there are number of simulating software. Names of this software are HFSS, CST, NEC, and Cad Feko etc, out of which HFSS v11.0 is presently used to design this antenna. HFSS (i.e. High Frequency simulation software) is better amongst all. The design steps are simple and understanding and quick to analyze. It gives results which almost are same to practical modeling and analyzing.

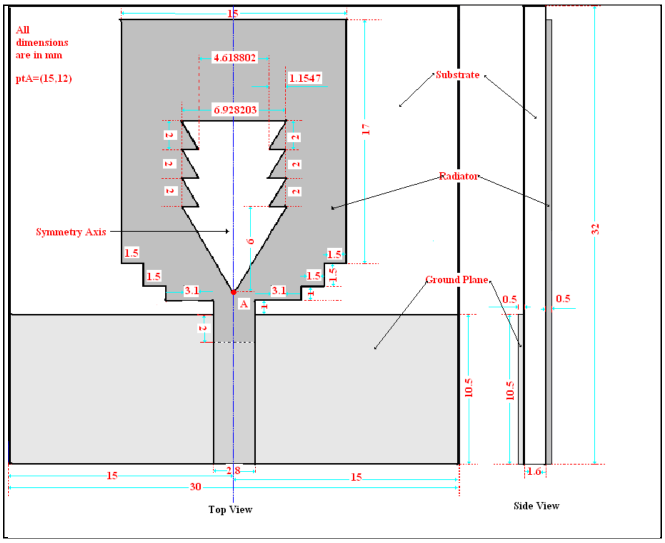

Figure 1: Geometry of proposed Microstrip antenna.

III. ANTENNA DESIGN AND ANALYSIS

The HFSS software that is used to design the antenna is one of the best software for antenna simulation, because of reliable use, i.e. the modification in already designed structure is very simple and you don't need to redesign the same structure.

A. *Steps in Designing Antenna*

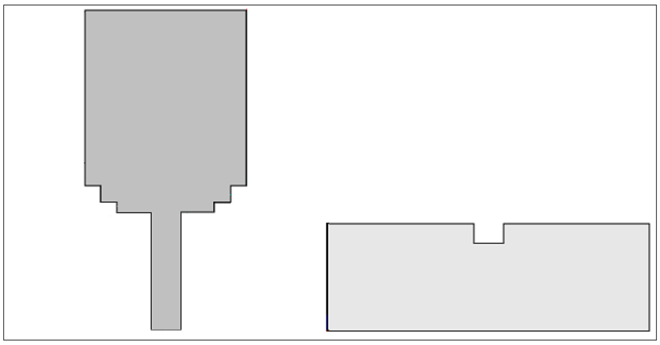

Figure 2: Separate view of radiator (left) and ground plane (right).

While designing the given antenna the detailed dimension of overall structure is depicted in figure 1. The internal symmetric polyhedral is obtained by series assigning of equilateral triangles one over the other and combine it. Once the specified polyhedral structure is obtained, subtract it from the radiator patch. The coordinates are specified in figure 1. The actual designed structure of antenna in HFSS software is shown in figure 4.

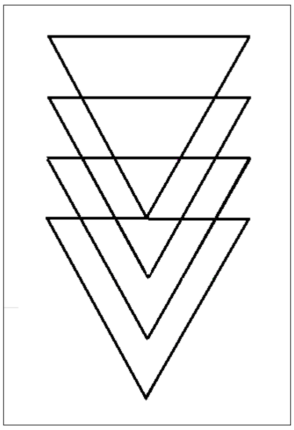

Figure 3: Alignment of triangles in obtaining polyhedral slot.

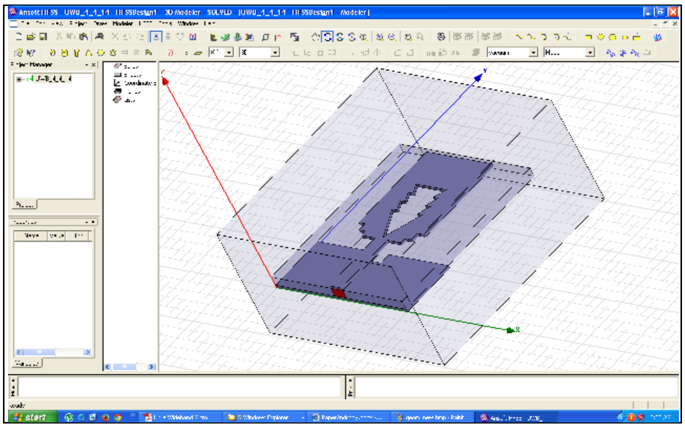

Figure 4: Prototype of proposed antenna designed in HFSS v11.0

B. *Return Loss*

An acceptable impedance bandwidth is displayed by the antenna between 2.9 GHz to 19 GHz. The return loss of antenna lowers approximately beyond -20 dB. The overall impedance bandwidth lies below -10dB (i.e. S_{11}<-10dB). At some frequencies the return loss just touches the -10 dB line. The antenna exhibits 76different resonant frequencies with the width greater than 500 MHz .These values of resonant frequencies are highlighted by 3.2 GHz for S_{11}= -15.07 dB, 5.4 GHz for S_{11}=-36.63, 8.34 GHz for S_{11}=-20.12 dB, 10.8 GHz for S_{11}=-19.76 dB, 14.4 GHz for S_{11}=-21.73 dB and 17.64 GHz for S_{11}= -42.4 dB. Therefore we can allege that antenna provides satisfaction in the impedance bandwidth required by Ultra Wide Band Applications. These frequencies are mainly because of the patch length, *L*, step at the bottom part of the patch, *step*2 and *step*1, symmetric polyhedral slot at the patch antenna, notch at the ground plane and the cyclical occurent of the first resonant frequency, respectively[1].

From figure 4 we observe that the return loss values reach -10 dB line and again fall below the -10 dB line. This antenna exhibits multiband characteristics. This means that sequentially antenna can operate over different resonant frequencies.

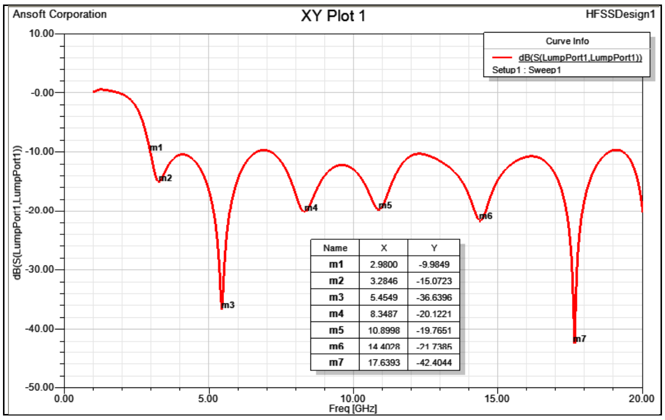

Figure 5 Return loss

C. Radiation Pattern

Antenna provides almost an Omni directional radiation pattern. Given below is the 3D radiation pattern of designed antenna. From the radiation pattern is seen that most of the radiation pattern is along z-x plane and y direction, whereas there is comparatively less radiation along x-y plane and y-z plane. The figure shows 3d radiation pattern of antenna.

D. VSWR plot

The figure shows the VSWR plot. From figure 6a we get the VSWR values at especially 6 different resonant frequencies, while figure 6b depicts VSWR values at over all frequency range. The plot shows that the values lie between 1.01 and 1.25. For any antenna the VSWR must be ideally equal to 1 and practically between 1.0 and 2.0.

So we can say that antenna exhibits better VSWR characteristics.

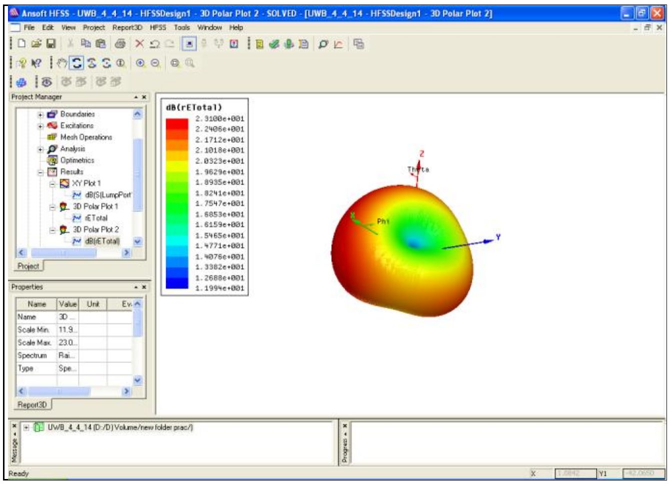

Figure 6: Radiation Pattern.

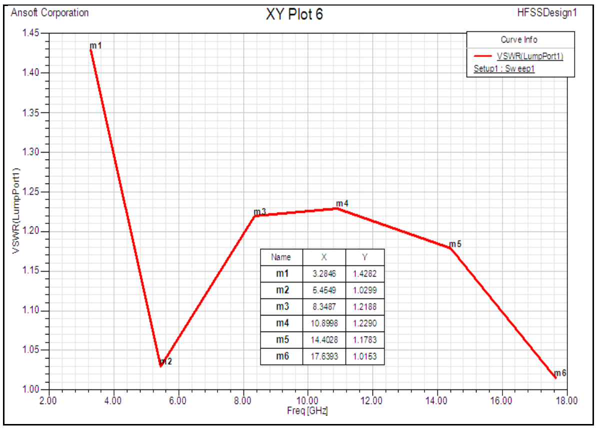

Figure 7(a): VSWR plot.

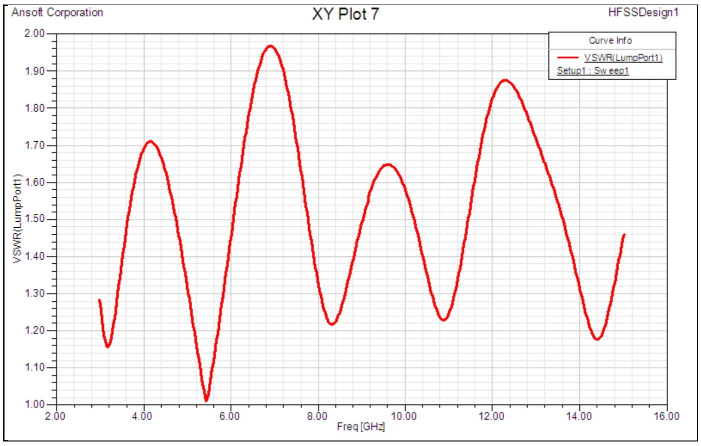

Figure 7(b): VSWR plot.

E. Group Delay

Group delay is one of the most important parameter to find out or analyze the performance of UWB technology. The shortest pulse width that can be transmitted by that particular antenna with minimal distortion is called as Group Delay of that antenna The group delay is almost below 0.1 ns for the given antenna. The group delay is plotted in figure 7.

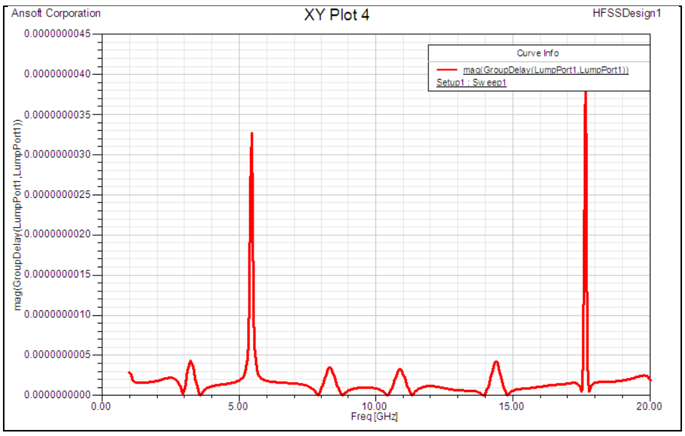

Figure 7: Group delay

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IV. CONCLUSION

A micro strip patch UWB antenna is designed, which provides the UWB bandwidth requirement (between 2.9-19.1 GHz). This antenna displays 6 different resonant frequencies with better return loss values. An acceptable VSWR characteristic is exhibited by designed antenna. The 3D radiation pattern is almost Omni-directional. Antenna exhibits acceptable group delay value. Antenna also has enhanced performance and multiband characteristics. Thus the proposed antenna can be used in the multiband applications of UWB technology.

Future Scope:

Till now almost all UWB antennas use one or two resonant frequencies in their operation. These frequencies may get saturated in the future. So there is need of antenna which can use almost all of the 14 bands decided for UWB technology by FCC. UWB antennas must use negligible energy resources. So research must be done to achieve it.

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