DESIGN OF A MICROSTRIP-FED MONOPOLE ANTENNA WITH A WIDE SLOT GROUND PLANE FOR UWB APPLICATIONS

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ABSTRACT

*In this paper, the design of a microstrip-fed monopole antenna with a wide slot ground plane for uwb applications is presented. A wide slot ground plane is inserted in the ground plane and etched. The substrate used is fr4 epoxy with a thickness of 1.6mm. The size of the antenna is 30*30mm, hence it's a compact one. The trapezoidal patch placed on the upper surface of the substrate. The radiating strip connected to microstrip line feed tapered at one end. The simulation results shows that a return loss of less than -10dB and a VSWR value less than 1.58 through the bandwidth 3 to 12.5 dB is obtained. The simulation software used is high frequency structural simulator (HFSS).*

Index Terms— Planar Monopole, Trapezoidal Patch, Ultra wide bandwidth, high frequency structural simulator.

1.INTRODUCTION

The rapid development in Ultrawideband (UWB) wireless communication technology, the UWB antennas have been attracted the researchers in personal and general applications. The FCC (federal communication commission) allocated the use of frequency range from 3.1to 10.6 GHz for UWB applications. The microstrip patch antennas are considered for UWB applications. The characteristics of these patch antennas are low profile, compact i.e., small size, in expensive, conformable to planar and non-planar surfaces and omnidirectional radiation pattern. The use of monopole antenna is a feasible one, as it can be implemented in a smaller area. Using the wide slot provides wide band radiation performance and it can also be easily fabricated.

There are various techniques have been handled by many researchers to design patch antenna for UWB applications. A square/rectangular monopole mounted above the circular ground plane in [1]. A rectangular patch with slotted ends used in [2]. Different techniques have been adapted to attain the band notch function to cut off undesired frequency band from 5 to 6 GHz in [3], [4], [6]. A tapered slot with a rectangular patch is used in [5]. A semi-circular patch with a rectangular patch with two steps above the patch and a small circular hole in the patch with semi-circular strip to attain the band notch function in [7].

In this letter a microstrip-fed monopole antenna with a hexagonal shaped wide slot used in the ground plane to fit the desired UWB application. By using the wide slot a smoothly tapered transition is employed to effectively obtain impedance matching over the UWB bandwidth. The bent junctions round the patch are connected to a microstrip feed tapered at one end to enhance the bandwidth. This design attains the successful increment of -10dB and VSWR of less than 1.58 through the bandwidth 3 to 12.5 dB; it covers the entire UWB frequency range. This design supports the lower and higher frequency range, inspite of its small size.

2. ANTENNA STRUCTURE AND PARAMETERS

The simulated Antenna design is shown in Fig.1. The overall size of the antenna is 30 *30mm; it's a compact one. The metal strip mounted on the other side of the substrate, is of fr4 epoxy with a thickness of 1.6mm and relative permittivity of 4.4. Inorder to obtain better performance the antenna should attain the loss tangent of 0.02. The hexagonal shaped slot is etched on the other side of the substrate. The metal strip consists of microstrip feed line which itself act as a radiating element. This structure is connected to a matching network of 50- Ω impedance. To reduce reflection caused by sudden changes in the width patch, the feed line is tapered at one end. The point in which the metal strip is connected to the feed line is the most critical section of the design. By optimizing any changes can increase the upper frequency and hence decreases the reflection in the higher frequency.

Inorder to radiate the energy perpendicular to the plane of the antenna, the slot is etched on the ground plane. Also, the ground plane which suppresses the back radiations and helps to enhances the gain. The feed line used is microstrip line feed it reduces the spurious radiation, as the substrate used is fr4, the thickness is not so high. The bandwidth provided by the feed line is narrow, the radiator patch which overcomes this drawback and provides wide band width. The simulation is done using HFSS software version 12. It works in FDTD (finite difference time domain) or FEM (finite element method).

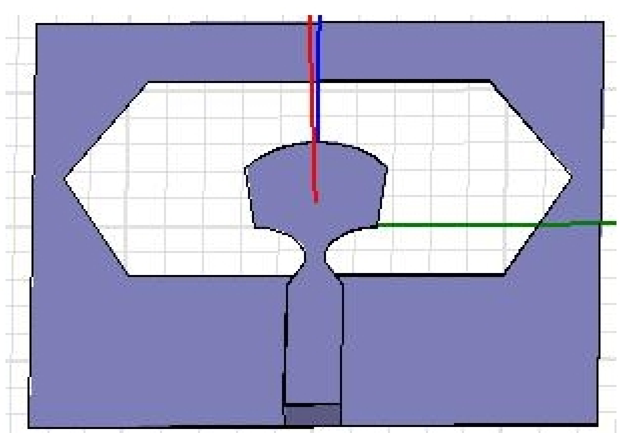


Fig. 1. Simulated design of the proposed antenna.

3.ANTENNA DESIGN AND PARAMETRIC STUDY

The antenna design consists of several parameters. The ground plane with a size of 30*30mm is designed. To insert the slot in the ground plane, the dimensions are, the lower end width=19.7, length=11.2 from the lower end, upper end width=17.8, length =25 from the lower end connected to the center position of width=26.8, length=17.8 from the lower end. The FR4 substrate with thickness 1.6 etched on the upper surface of the ground plane. The round face of the radiator patch of width=7.5mm connected to the other face with a width=6.5mm, resembles like a trapezoidal one with bent junctions.

The patch forms round end connected to the feed line with tapered at one end. The antenna is matched with lumped port.

4.RETURN LOSS AND VSWR

The return loss from the frequency 3 to 12.5GHz is obtained. The simulation results with a maximum resonance of -42dB is obtained is shown in Fig. 2.

The VSWR value of 1.58 is obtained as shown in

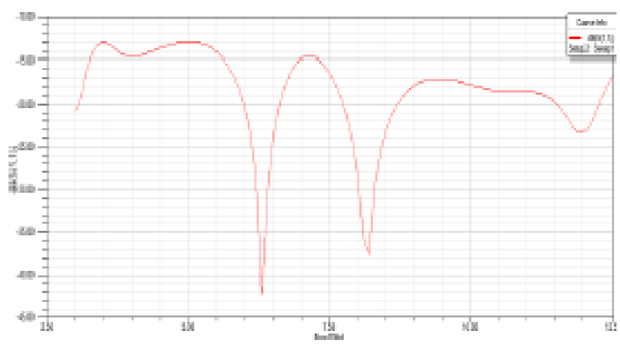


Fig. 2. Return loss

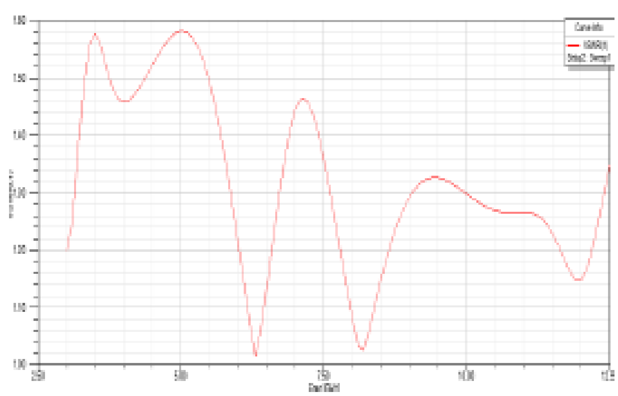
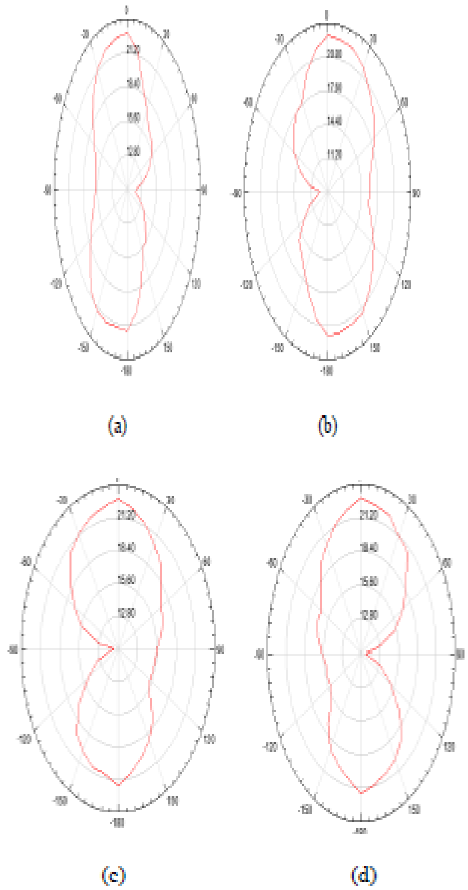


Fig. 3. VSWR

5. RADIATION PATTERN



(a) (b) (c) (d)

Fig. 4. Simulated E-plane radiation pattern (in dB) for (a)4.5, (b)8.8, (c) 10 and (d) 12.5 GHz

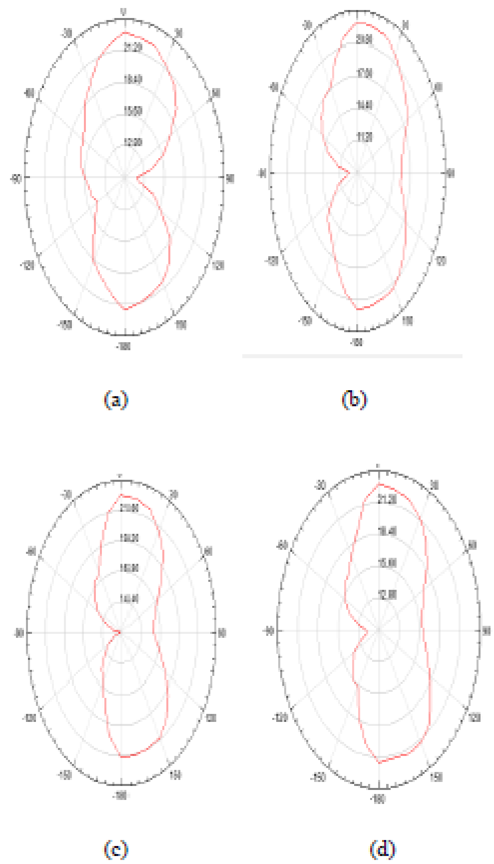


Fig. 5. Simulated H-plane radiation (in dB) for (a) 4.5, (b)8.8, (c)10, (d)12.5 GHz

The 3-D far-field computed radiation pattern in both E-plane and H-plane is shown above. The radiation pattern obtained is omnidirectional. This antenna behaves like a conventional monopole. When the frequency is increased, the radiation pattern gets disturbed, but still the pattern obtained is omnidirectional.

6.GAIN AND DIRECTIVITY

The maximum gain value obtained is 5.1857 and the calculated directivity is 5.5897. Therefore the simulated efficiency of the designed antenna is 92.287. The 3-D polar representation of gain and directivity, shown in Fig. 6 and Fig. 7. The gain value resembles with the radiation pattern with deviations. The directivity value obtained is constant throughout the entire frequency band.

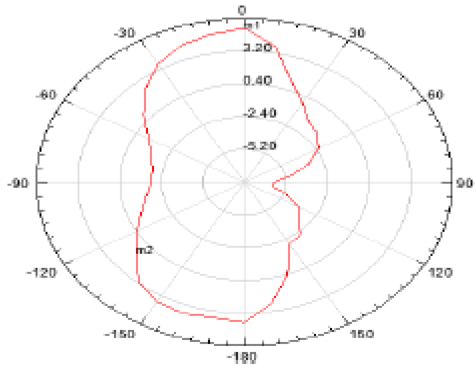


Fig. 6. Gain

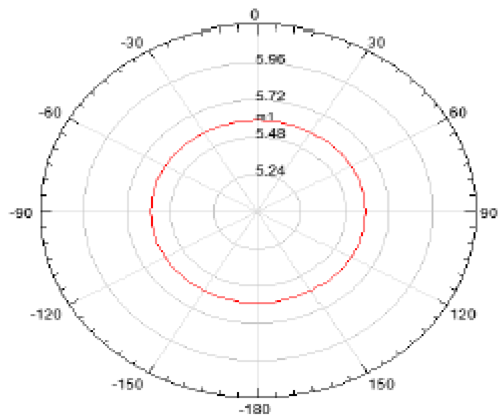


Fig. 7. Directivity

7.CONCLUSION

The proposed antenna shows that the frequency band of 3 to 12.5 GHz for VSWR less than or equal to 1.58 is obtained. This design supports both the lower and higher range. This design is a good candidate for mobile and personal UWB applications due to its compactness.

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