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A Novel Planar Octagonal Shape UWB monopole Antenna for Multipath Environments

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Abstract— A Novel Planar Octagonal shape with partial ground UWB monopole antenna for multipath environments .The simulated UWB antenna designed using FR4 substrate with 1.6mm thickness demonstrates very good impedance matching with a measured bandwidth greater than 120% for a VSWR ≤ 2, and a good return loss (<-10dB) along with a stable radiation pattern in the entire frequency spectrum assigned for UWB applications. The operating range of proposed antenna is from 3.1 to 10.6 GHz. The antenna is having size of 36×34×1.6 mm^3 and consists of transmission line edge feed and underlying ground plane. Explanation of the proposed antenna design and results are presented and discussed below.

Index Terms —Antenna, HFSS, Frequency Band 3.1-10.6 GHz, Micro-strip Patch, Octagonal shape, UWB, VSWR,

1 Introduction

As more and more bandwidth is requirement of wireless communication applications so the demand for wideband antennas increases. For instance, ultra wideband radio (UWB) will utilize the frequency-band of 3.1-10.6 GHz. Micro-strip patch antennas have the advantages of low cost and compatibility with printed circuit board (PCB) technology, making it possible to integrate the antenna with the RF circuits on the same board. This allows a compact module design. However, a micro-strip patch antenna has a limited bandwidth. Bandwidth is limited since the substrate height is limited [1]. To overcome this drawback, the ground plane was truncated and the patch became a planer monopole with underlying truncated ground. The design was optimized using electromagnetic simulation with the HFSSv11simulation software. The design goal was to maximize the bandwidth. The proposed antenna covers more than the bandwidth allocated for UWB wireless communications (3.1 GHz-10.6 GHz). In addition, this design has a planar profile and can easily be integrated in small mobile phones, hand held wireless units, and various remote sensing devices. We have designed and simulated the proposed antenna on FR4.

The simulated results show reasonable agreement. In this design, a3.1 to 10.6 GHz frequency range was intended with S11 <-10 dB and VSWR<2. In this paper Section I, II, III, IV gives details about the introduction, antenna design, design and analysis, conclusion, electromagnetic distribution, conclusion, references respectively.

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2 Antenna Design

The geometry of the proposed antenna is shown in Fig1. As shown the figures, the antenna consists of an octagonal shape patch with transmission line edge feed and underlying ground plane. The design parameters are shown in Table1.The FR4 antenna was designed and simulated on a 1.6 mm thickness FR4 substrate with an overall size of 36×34×1.6 mm3. The dielectric constant is 4.4 and the tangent loss is 0.02.

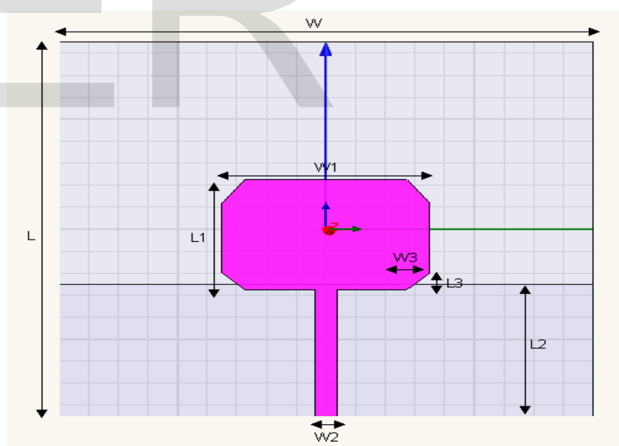

Fig1. Antenna Design Parameter

TABLE 1
DESIGN PARAMETER

S.No	Name	Size(mm)
1	L	36
2	W	34
3	L1	10
4	W1	14
5	L2	12
6	W2	1.6
7	L3	1.5
8	W3	1.527

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3 Designing and Analysis

The antenna was designed and simulated on a FR4 substrate with an overall size of 36 mm by 34 mm. The dielectric constant is 4.4 and the loss tangent is 0.002. The idea of this design approach depends on the following three main Transmission Line principles. Which are as follows (I) Increasing the bandwidth of the antenna by decreasing the Quality factor (Q). Decreasing the quality factor of the microstrip antenna is an effective way to increase the antenna's impedance bandwidth [2]. Quality factor depends on the reflection coefficient; decrement in Quality factor means decrement in the quantity of reflection back into the "neck" of the UWB monopole in the direction of the source. When you make the radiating element very wide, the Q factor at the lowest operating frequency becomes low.(II)Smooth Impedance Transition (No Step Impedance)Wherever there is an impedance transition, it should be smooth (i.e. it should change gradually with distance along the wave propagation path). The point where the patch starts and the angle between the lower edges and the ground plane are very important, as here the wave should not experience step impedance transition. There must be a gradual change from the microstrip transmission line impedance to the imaginary characteristic impedance of the patch. (III) A large part of the current wave flows along the patch edges instead of its middle. When the current wave in the feed line approaches the entrance of the patch, it splits. Large part of the current wave will flow along the edges (with certain angle θ). We observed this during the simulation where we manually changed the meshing at the edges, close to the underlying ground plane, to help the simulator. This current wave will experience increasing characteristic impedance when traveling sideways, as the distance between the patch edge and ground plane increases. Characteristic impedance of the patch edges increases as the distance between the patch edges and the underlying ground plane increases.

4 Electromagnetic Simulation

The proposed antenna is simulated and optimized using the HFSS simulation software. Figure 2 shows the simulated –S11parameter of the FR4 antenna. It covers the whole UWB Band with VSWR < 1.2. Figure 3 shows the VSWR of antenna. Figure 4 shows the Smith Chart. Figure 5, 6, 7 shows the H, E, and E-H planes radiation pattern. Figure 8, 9 shows the radiation pattern and the current distribution pattern.

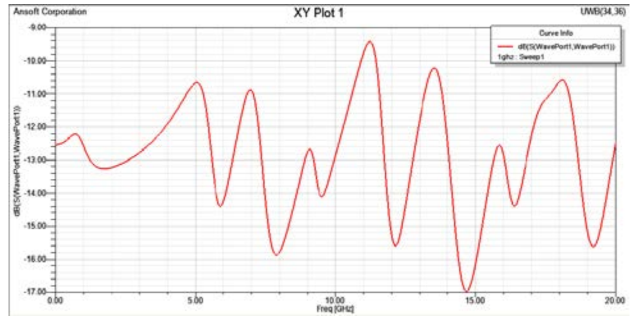


Fig2. Simulated Antenna –S11parameter

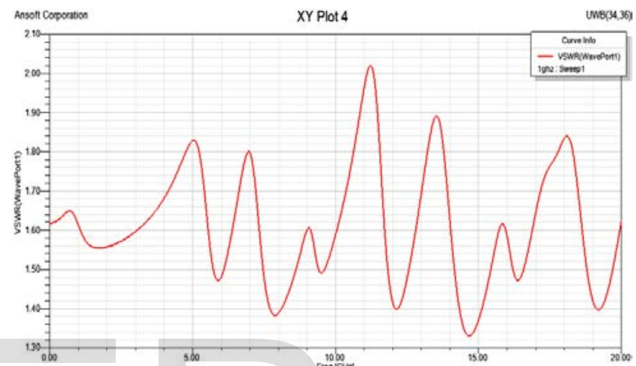


Fig3. Simulated Antenna VSWR

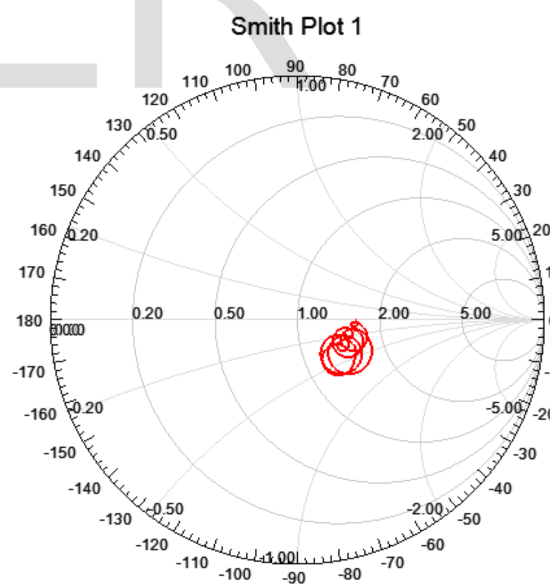
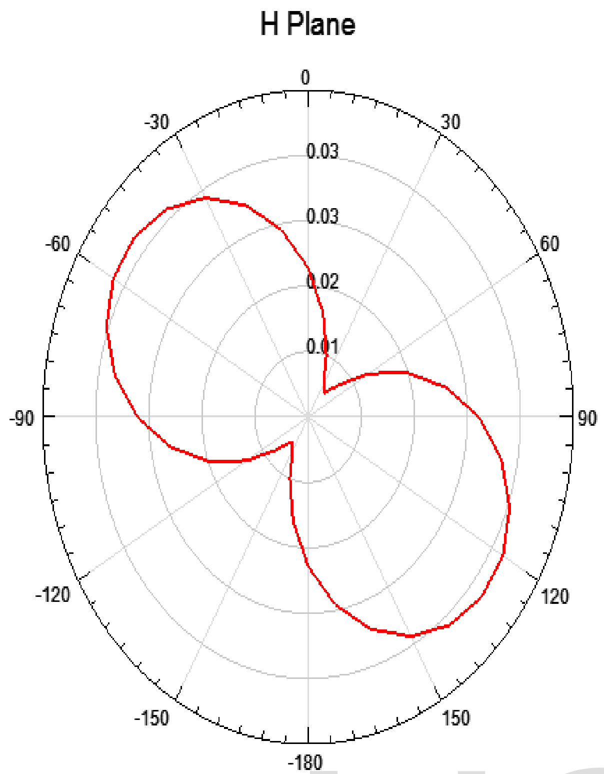


Fig4. Antenna Smith Chart



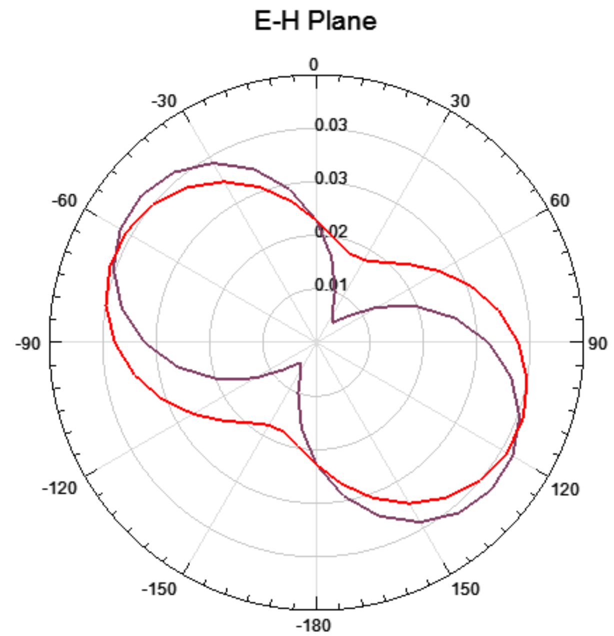
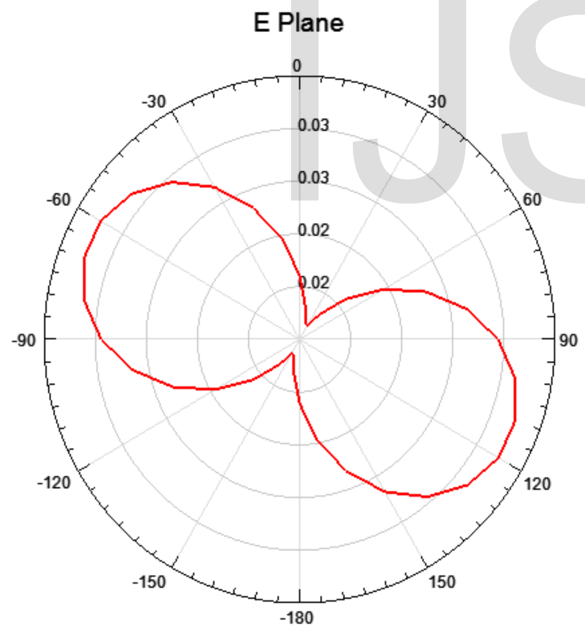


Fig5, 6, 7. Antenna's H Plane, E Plane, E-H Plane both at 3 GHz.



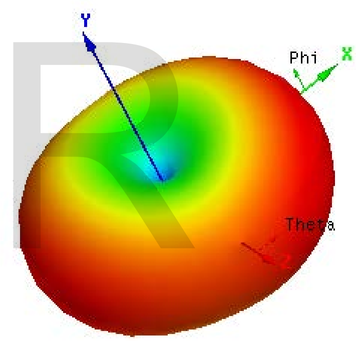


Fig8. Antenna radiation Pattern

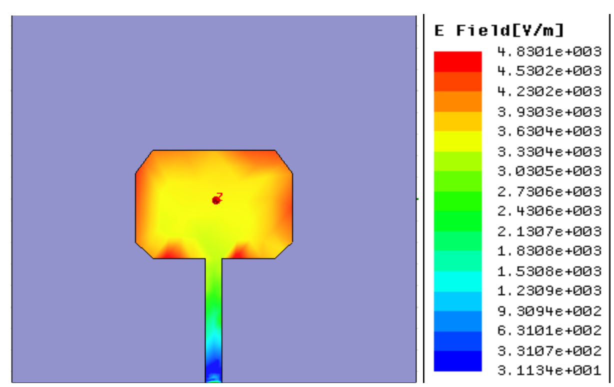


Fig9. Antenna Current Distribution

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5 Conclusion

In this paper, we have introduced a new approach for designing a novel octagonal planer UWB monopole antenna for Ultra wideband multipath environments applications. This approach enhances the most important antenna parameters for indoor application VSWR and Return Loss. The measured bandwidth of both antennas exceeds 137%which has not been previously achieved by any PCB antenna.

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