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# Analysis and Design of Microstrip UWB Antenna with Bandwidth Enhancement

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***Abstract***

*In this paper, a unique ultrawideband antenna with increased information measure is given. Experimental results show that the antenna achieves smart electric resistance match from 2 to 14 ghz with the voltage standing wave ratio (VSWR) but two. From HFSS13 simulations, dimensions of antennas square measure chosen for higher performance. It is shown that come back loss of the antenna at answer frequency 7 ghz is a smaller amount than-10 db. The antenna is intended on Epoxy FR4 substrate. It covers nearly UWB band 3.1 to 10.6 ghz that is fcc determined. The projected microstrip antenna is very appropriate for applications of broadband systems.*

***Keywords****: Return loss, VSWR and ultra-wideband antenna*

## INTRODUCTION

The trend of communications systems has lead designers to want lightweight weight, robustness, and straightforward integration of antenna. In 2002, Federal Communication Commission (FCC) approved unaccredited use of UWB band starting from 3.1 ghz to 10.6 GHz. Since then, the planning of broadband antennas has become a lovely and difficult space within the analysis of the system design. In general, the antennas for UWB systems ought to have sufficiently broad operative information measure for ohmic resistance matching and high-gain radiation in desired directions. Among the UWB antenna style within the recent literature, the monopole tabular antenna sort is wide used because of its wide information measure, easy structure and low value. It is become one in every of the foremost appreciable candidates for UWB application. Many styles of monopole tabular UWB antenna are projected. However, some of these antennas involve complex calculation and sophisticated fabrication process. Therefore, we propose a simpler method to design the UWB antenna based on microstrip rectangular patch calculation using simple transmission line model [1].

## REVIEW OF THE STATE-OF-ART

The UWB technology has undergone exceptional achievements throughout the past few years. In spite of all the promising prospects featured by UWB, there are a unit still challenges in creating this technology live up to its full potential. One specific challenge is that the UWB antenna. In recent years, many types of UWB antennas are planned and investigated [2, 3]. They gift a straightforward structure and UWB characteristics with nearly spatial relation radiation patterns. Many factors have to be compelled to be thought of whereas coming up with the antenna, as well as information measure, directionality, polarization, power gain, graph and come loss. For productive transmission and reception of an immoderate band signals, an antenna ought to fulfill following demand.

- Covers an extremely wide band, (3.1 to 10.6GHz).
- Has high radiation efficiency.
- Has linear phase.
- Offers low dispersion.
- Has a VSWR < 2 for entire band.
- Has minimum power loss due to dielectric and conductor losses.

• Has electrically small size.
• Holds a reasonable impedance match over the band for high efficiency.
• Has a non-dispersive characteristic in time and frequency, to provide narrow pulse duration to enhance a high data rate.
• Has the reflected power < -10db.

There is a unit many kinds of microstrip antennas, the foremost common of that is that the microstrip patch antenna antenna. A patch antenna may be a narrowband, wide-beam antenna fictitious by etching the antenna component pattern in metal trace secured to an insulating nonconductor substrate with a nonstop metal layer secured to the other aspect of the substrate that forms a ground plane [4]. Common microstrip antenna radiator shapes area unit sq., rectangular, circular and elliptical, however, any continuous form is feasible. Some patch antennas avoid a nonconductor substrate and suspend a metal patch in air higher than a ground plane victimisation nonconductor spacers; the ensuing structure is a smaller amount strong, however, provides higher information measure. Because such antennas have a very low profile, are mechanically rugged and can be conformable, they are often mounted on the exterior of aircraft and spacecraft, or are incorporated into mobile radio communications devices.

A new approach for design of the planar monopole UWB antenna was proposed in (uwb3) to achieve a good impedance matching and stable omnidirectional radiation pattern. Two compact antennas with circular ground and fractal ground were proposed in which drawbacks of conventional antennas were alleviated. Simulation and measured results show that in the proposed antennas, the radiation pattern has been improved noticeably. A compact eye-shaped UWB is proposed in (uwbantenna). A novel miniature technology for UWB antenna design is proposed by applying the eye-shape and the feeding part modification. The operating band (1.2-4.5 GHz) can reach as high as 142%. This antenna exhibited nearly constant group delay over a wide range of bands to reduce the distortion of the UWB pulse shapes.

## THE PROPOSED ANTENNA DESIGN GEOMETRY

The three essential parameters for the design of a Microstrip Antenna are:

### Frequency of Operation (*fo*)

The resonant frequency of the antenna must be selected appropriately. The ultrawideband antenna uses frequency band of 3.1 to 10.6GHz. Hence, the antenna designed must be able to operate in this frequency range. The resonant frequency selected for this design is 7.0 GHz.

### Dielectric Constant of the Substrate ($\varepsilon r$)

The dielectric material selected is Epoxy FR4 which has a dielectric constant of 4.4. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna [5, 6].

### Height of Dielectric Substrate (*h*)

For the microstrip patch antenna to be used in much application where size and weight matters, so it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.6 mm.

The antenna is designed from the basic rectangular microsrtip antenna and circular microstrip antenna. Some modification is done by using this two basic antennas to get the desired results. Step by step designing of the microstrip antennas is explained below.

The proposed microstrip antenna is illustrated in Figure 1. This antenna has a modified combination of rectangular and circular patch antenna fed by a microstrip line, with rectangular feedline and infinite ground.

*Fig. 1: Antenna Structure.*

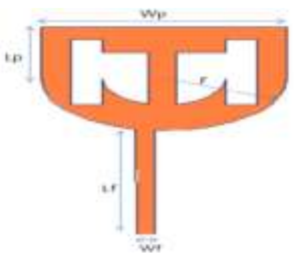

*Fig. 2: Top View.*

The most important design parameters that affect the performance of the modified patch antenna are the dimensions of the patch and the height of the

 

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branches. Thus, those parameters must be investigated to reach the optimum design. Before reaching the optimum design, we passed through many steps of simulation [7, 8]. We started with the design and the thickness of the substrate (t) is 1.6 mm. The patch printed on one side of the substrate and ground on the other side of substrate. It is etched on a rectangular (LxW) FR4 substrate with thickness t=1.6 mm and a relative dielectric constant $\varepsilon_r$=4.4 with dimensions 100 X 75 mm. The two slots are symmetrical in shape having same height and width of the two symmetrical identical branches. The width of the microstrip feed line is fixed at Wf = 3mm to achieve 50Ω impedance. The simulations are performed using the Ansoft HFSS 13 which utilizes the finite integration technique for electromagnetic computation.

## PARAMETRIC STUDY

### Bandwidth

The main characteristic of UWB antenna is bandwidth. There are two ways to express bandwidth: (1) The ratio of the upper frequency fH and lower frequency, fL. The UWB has approximately fH :fL=3:1. (2) The fractional bandwidth (fbw) of a system is the ratio of the bandwidth BW to the center frequency fc.

$$fbw = \frac{BW}{fc} = \frac{f_H - f_L}{f_c} = 2\left(\frac{f_H - f_L}{f_H + f_L}\right) \quad \text{............ (1)}$$

The bandwidth of the system is often described relatively to the center frequency, $f_c$ which is calculated in formula (2).

$$f_c = \frac{f_H + f_L}{2} \quad \text{.......................................(2)}$$

The Federal Communications Commission (FCC) issued are port and order to define a UWB systems in terms of -10dB power bandwidth meaning that upper and lower frequencies are those where the radiated spectral power density is -10dB down from the center frequency. According to FCC definition of UWB system, UWB antenna has bandwidth greater than 500MHz or a fractional bandwidth greater than 0.2 where fractional bandwidth is defined as in formula (1).

### Impedance Matching

Impedance is the ratio of the electric and magnetic fields. Impedance is complex value since the electric and magnetic fields are not necessarily in phase. If an impedance of a transmission line (Z0) and the antenna impedance (ZA) are not identical then there will be a mismatch to the antenna terminals and some of the incident signal will be reflected back to the source. This reflection is characterized with reflection coefficient (Γ) which is ratio of the reflected voltage (−V0) to the transmitted voltage (+V0 ).

$$\Gamma = \frac{-v_0}{+v_0} = \frac{ZA - Z0}{ZA + Z0}$$

The other parameter frequently used to characterize Impedance matching is Voltage Standing Wave Ratio (VSWR). The VSWR is defined as the ratio of the peak Voltage maximum to peak voltage minimum.

$$VSWR = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

For the perfect matching VSWR = 1, there is no reflection and return loss. In the real UWB system it is very hard to achieve a perfect match over a wide frequency match so it is define that have VSWR < 2 is still good matching system.

### Effect of Change of Ground Size

Size and shape of the ground affect the antenna parameter according to it. Following some Figures shows the effect on parameter of the antenna when ground dimension is 100 * 75mm and when ground is 40 * 75mm.

#### *Effect on s11 Parameter*

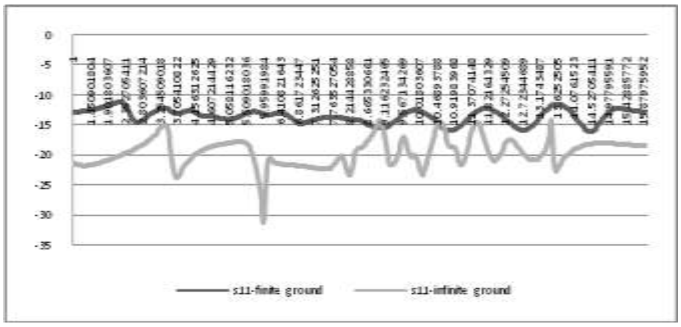



***Fig. 3:*** *s11 for Change in Size of Ground.*

### Effect on VSWR Parameter

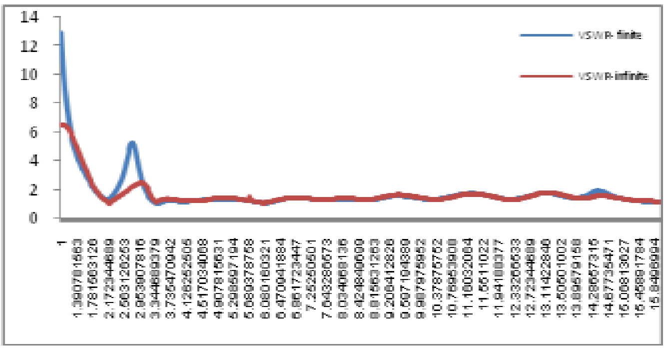



***Fig. 4:*** *VSWR for Change in Size of Ground.*

### Effect on Radiation Pattern

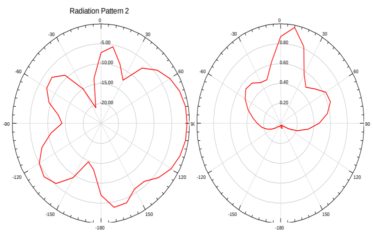



***Fig. 5:*** *VSWR for a) 40*75mm Ground b) 100*75mm Ground.*

## SIMULATED AND MEASURED RESULT

Figure 6 shows the simulated and measured return loss curves and Figure 7 shows the simulated and measured VSWR curve at 7.5GHz.

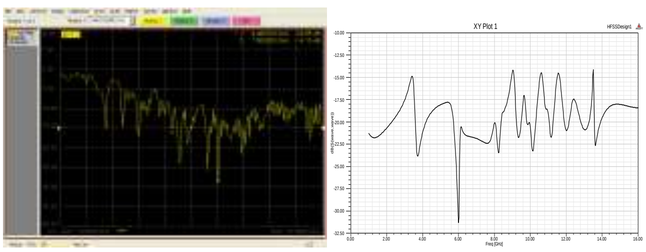



***Fig. 6:*** *Simulated and Measured S11 for Proposed Antenna.*

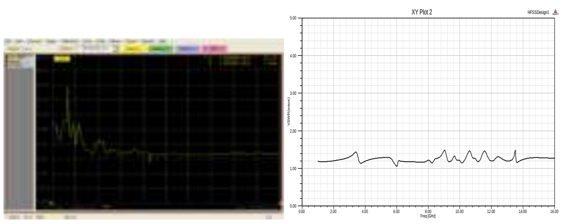



***Fig. 7:*** *Simulated and Measured VSWR for Proposed Antenna.*

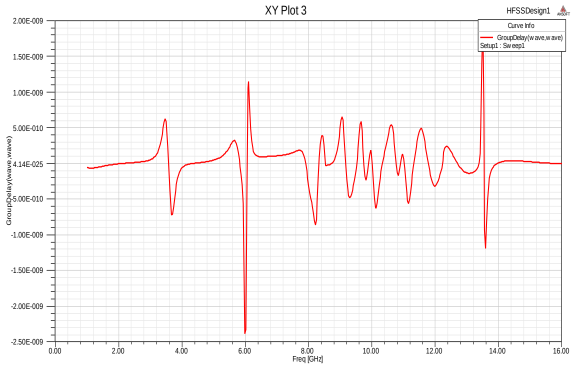
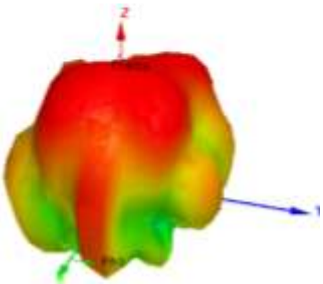



***Fig. 8:*** *Group Delay.*

The Figure 8 shows the group delay for the proposed design at centre frequency 7.5 GHz, which comes less than 1ns for the UWB band. The Figure 9 shows the simulated 3D polar plot for the proposed design showing more gain in z direction, and the Figure 10 shows the simulated radiation pattern having directivity in 0 deg.



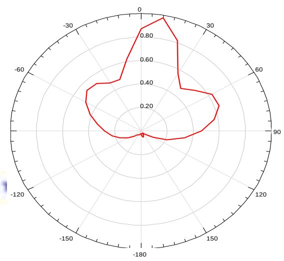


***Fig. 9:*** *3D Polar Plot.* ***Fig. 10:*** *Radiation Pattern at 0 deg.*

These simulations were performed using the Ansoft High Frequency Structure Simulation (HFSS). Figure 6 shows the simulated return loss curve with the optimal design, i.e., the simulated return loss bandwidth is from 1.8 to 14.3 GHz for which s11 is less than -10 dB and SWR is also less than 2 in this range as shown in the simulated result in Figure 7, which confirms to the UWB standards. Moreover a considerable increase in bandwidth is obtained relative to the design. This permits to use the antenna in more applications operating under UWB band.

## CONCLUSION

In this paper, an antenna is proposed having a wide bandwidth from 1.8 GHz to more than 16 GHz. The designed antenna has simple configurations and is easy to fabricate. It has been shown that the performance of this antenna in terms of its frequency domain characteristics is mostly dependent on dimensions and the height of substrate. It is demonstrated by simulation and measurement that the proposed antenna can yield an ultra wide bandwidth, and that the radiation patterns are slightly omni-directional over the entire -10 dB return loss bandwidth having VSWR less than 2 over that range of bandwidth. This antenna can be used for many applications including 3G, Wi-Fi, WiMAX, as well as UWB applications due to its wide bandwidth and simple structure.

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