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Efficient Microstrip Rectangular Slotted UWB Monopole Antennas with etched Ground Plane for wireless LAN and similar Applications

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Abstract-

As we are stepping into 5G communication era, it is impossible to imagine a consumer device like cellular phones, laptops etc, without wireless functionality or internet connectivity .This is making every electronic company to looking forward to the enormous possibility of micro strip patch antennas and their potential as they are compact, mass produce-able, low profile and light weight. In the current article, a printed monopole and proven its exhaustive simulation results covering broad band techniques and these results matching UWB frequency band from 3.10GHz to 10.56Ghz.

Key Words: UWB, monopole, Microstrip line.

I INTRODUCTION

Every month ,devices are coming with improved functionalities .The consumer devices manufacturers are looking for improved wireless communication technologies for short distance communication like Wi-Fi (wireless fidelity protocol communications), Bluetooth device to device communication. Ultra-Wideband (UWB) is a class of devices or signal frequency that has covering large absolute bandwidth or large relative bandwidth [1]-[4]. The Federal communications Commission (FCC) ,a worldwide policymaker on frequency utilizations, has given provision to use a bandwidth of 3.1 GHz to 10.6ghz with a radiating power ranging from -40dBm /kHz or lower than this.

The present research work on a UWB antenna , which was already developed ,a circular patch UWB antenna by doing innovative physical modifications for better performance .After significant modifications ,it have proved to be improved antenna in the field of broadband communication techniques. During initial stage of improvements, we have encountered numerous problems like impedance mismatch, and bandwidth mismatch .But we have rectified these challenges by adjusting etching of ground plane, modifying substrate width and ground plane and adjusting GAP G between the ground planes and radiating patch. After several iterations, reached to an optimum dimensions of patch antenna which is shown in the Fig. 2(a)[4]-[8].

II. Structural DESIGN OF UWB ANTENNA

The proposed UWB mono-pole antenna is mainly designed for Ultra Wide Band Applications like WLAN, Bluetooth etc. Its dimensions fixed at substrate material permittivity 4.4 with a thickness 1.6 mm. Standard theoretical antenna dimension calculators were used to finalize the approximate values of antenna like substrate thickness, width , and length and radius of circular patch and microstrip transmission line. A 50 Ω transmission line is used to connect the patch antenna to set the input impedance of antenna to 50 Ω .WE have arrived to best set of values of dimensions ,slightly different from theoretical values as an achievement after numerous iterations of change of dimensions.

Proposed UWB monopole Rectangular Slotted UWB antenna is constructed from the circular disc UWB Monopole antenna with significant improvements and adjustments in the shape and size as shown in the Fig. 1(a).

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Microstrip line:
W=2.60 mm,
L = 27.50 mm &
Thickness =0.035mm.

Patch
Radius =12.01mm &
Thickness =0.0351mm

Substrate:
W = 461 mm,
L = 521mm &
Thickness =1.6mm.
Ground Plane:
W = 460.11mm,
L = 26.20mm &
Thickness =0.505mm.

Where "g" is gap between the ground plane and planar.

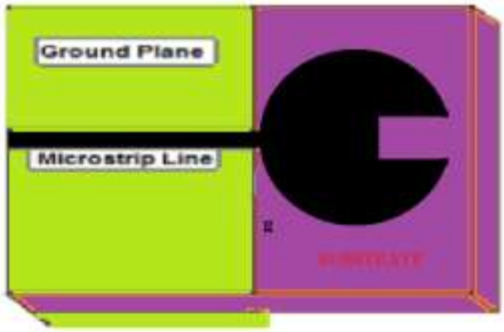

Fig. 1(a): UWB Antenna.

The table below comparison of various antenna parameters .S-parameter s11 is less than -10dB frequency range theoretical parameter comparison. Exhaustive repeated simulations, finally reached a nice set of dimensions were proposed for antenna. Gap-g and impedance matching around 50-OHMs antenna impedance for greater radiation efficiency were studied exhaustively in below table and simulated antenna dimensions. The table given below shows all parameters evaluated by theoretical formulas, after placing a gap between ground plane and radiating patch in table -1.

TABLE I

g mm	F_{low} GHz	F_{high} GHz	Antenna Impedance Ω	P_{acc} W	P_{rad} W	Max U W/Sr	Peak Gain	η %
0.52	**2.82**	**12.45**	**50**	**0.96**	**0.87**	**0.13**	**1.51**	**88.29**
0.85	**2.68**	**17.22**	**50**	**0.913**	**0.79**	**0.125**	**1.58**	**87.11**

The study proved after simulation ,by a plot of frequency vs return loss in fig.1(b), demonstrating the bandwidth below -10dB ranges from 3.5 GHz to 11.7 GHz which includes the UWB bandwidth i.e. between 3.18GHz & 11.6 GHz, and also from fig.1(c) ,the graph between frequency and impedance of antenna ,study reveals the real part of antenna is coinciding at 50 Ohms at all given resonant frequencies in UWB band ,where maintaining zero as imaginary part of antenna.

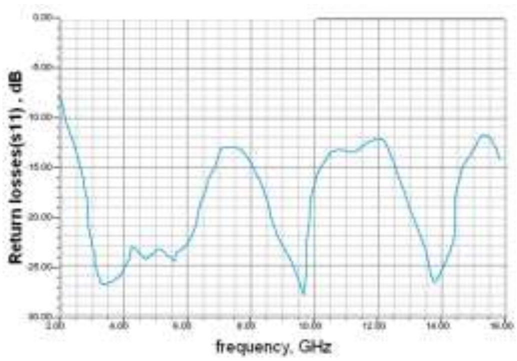

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Fig. 1(b): s_{11} versus frequency plot (BW is from 2.8GHz to 15 GHz).

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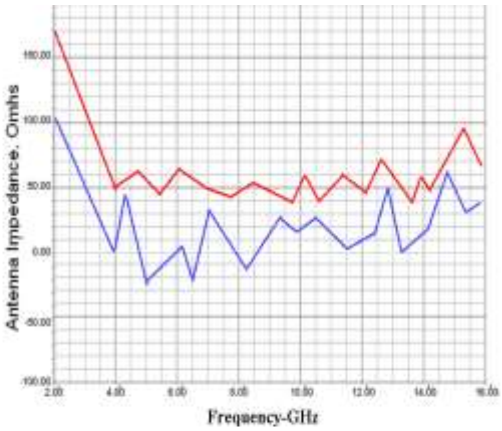
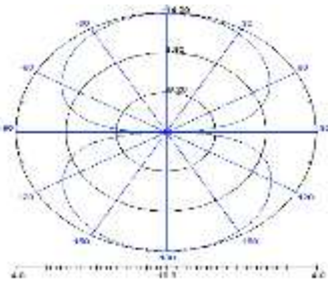


Fig. 1(c) : Antenna impedance versus frequency (real part → red color and imaginary part → blue color) of circular Planar UWB monopole Antenna.

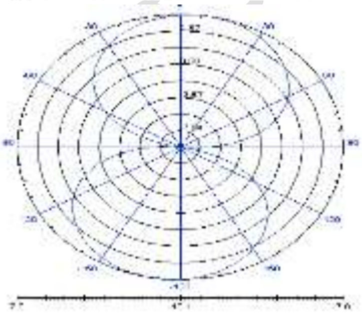
H-Plane radiation patterns and E-Plane radiation patterns of present antenna at different frequencies are shown in the figures Fig. 1(e) and Fig. 1(d).E-Plane pattern is looking like doughnut or '8' shaped observed at lower frequency range of proposed patch antenna with a minute distortion at other higher frequencies of UWB frequency band and

It can be observed that the E-Plane pattern is like a doughnut or '8' shaped at lower frequency range of UWB band and is almost same with a little distortion at higher frequency end of UWB band and the antenna radiation pattern resembling slight transition from a simple doughnut at the first resonance and at the higher resonances but had Omni-directionality displaying a tilt (from 5 to 10 degrees), which is the result of ground plane reduction.

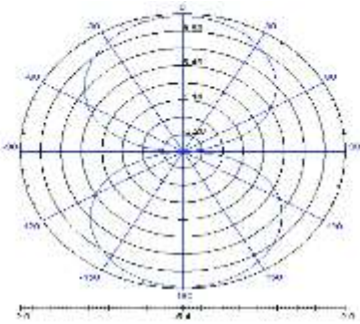
The below graphs shows radiation patterns (h-plane) of proposed antenna with a patch like circle with a 'g-value" 1mm is absolute Omni-directional pattern all along UWB band.



(i) At 3GHz (ii) At 5 GHz



(iii) At 7.5GHz (iV) At 10.6 GHz



(V) At 12 GHz

Fig. 1(d): E-plane radiation patterns studied at various frequencies.

The Fig.6 shows 3D-patterns happening at different frequencies at 3GHz, 5GHz, 7.5GHz, 10.6GHz and 12 GHz in HFSS simulator. A doughnut shape resembles at lower frequencies and little distorted at higher frequencies at 10.66Ghz and 12.53GHz.

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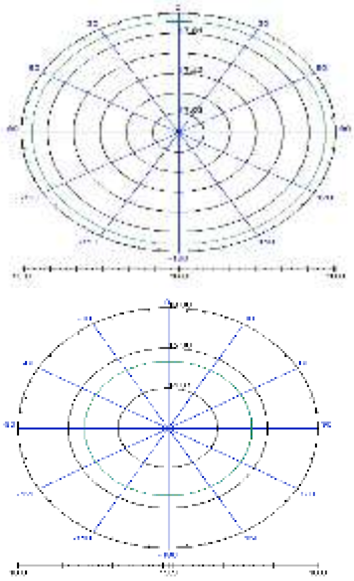
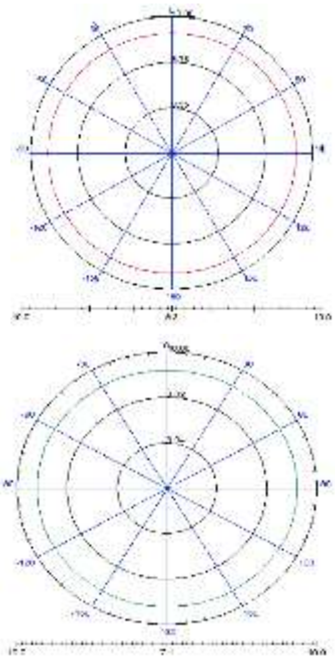
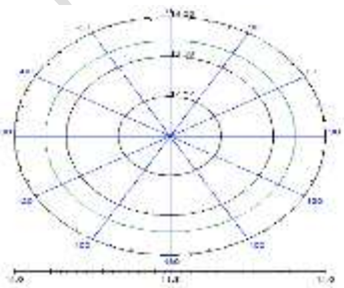


(i) At 3 GHz (ii) At 5 GHz

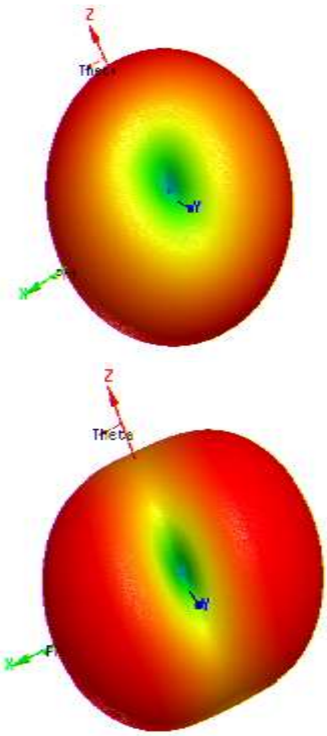


(iii) At 7.5 GHz (iv) At 10.6 GHz

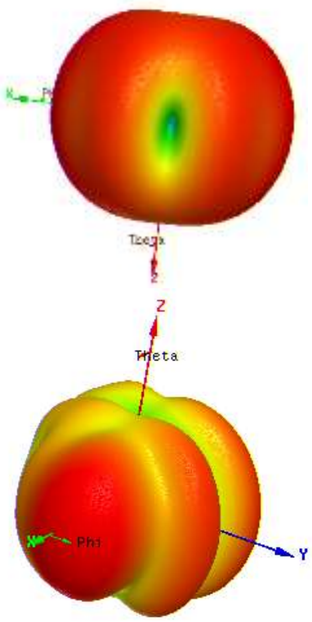


(v) At 12GHz

Fig. 1(e): H-plane radiation patterns at different frequencies.



(i) At 3 GHz (ii) At 5 GHz



(iii) At 7.5 GH (iv) At 10.6 GHz

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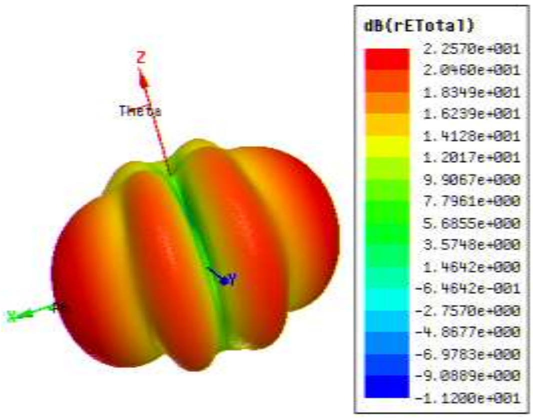

(v) At 12GHz

Fig. 1(g): 3D Radiation Plots at different frequencies.

By the series of experiments, the presented antenna displayed major change from doughnut to complicated patterns of radiations clearly shows its behavior ,most of the frequencies ,it is Omni directional due to partial ground plane i.e ‘g’-gap between the radiation patch and ground plane which is a notable factor for ideal impedance matching for antenna, since a properly designed impedance match leads very less reflections. The present antenna displays good impedance matching resulted in providing good radiation power and radiation intensity. After exhaustive simulation attempts , ”g-value” fixed at 0.85mm.

III. CONCLUSION

The present work illustrates efficiency improvements of “printed rectangular slotted disc UWB monopole antenna with the etched ground plane with favorably wide bandwidth .Patch antennas are robust to mechanical damages, easy to integrated in ICs(integrated circuits) when compared to all other types of antennas. Simulation results displaying accountable efficiency in gain and bandwidth .Radiation patterns are displayed; they were slightly resembling doughnut 8-shapes and observed minute tilt at higher frequencies. Main importantly, results showing Omni-directional pattern in all frequencies of Ultra Wide band. The present paper presented a suitable UWB antenna with software Ansoft High Frequency Structure Simulator simulation results.

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