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Optimization of Small Printed UWB Band Antenna with Reduced Ground Plane Effect

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Abstract— *In this paper, Multi Band with reduced ground plane effect in Ultra wide band antenna is proposed. These newly simulated structures are proposed for fabrication. The antenna is suitable for operating frequency range in UWB band and it is shown that return loss of the antenna at three resonant frequencies at 2.7GHz, 5.4GHz and 9.3 GHz is better than -10 dB. The VSWR obtained is less than 1.5 of this patch antenna with the compact size and large bandwidth. The return loss values of first band is -13.1 dB and for second band is -10.5 dB and for third band is -19.1dB with radiation efficiency is 83 % and directivity 3.43 dB. The measured results are also calculated with Vector Network analyzer. In addition parametric study of various parameters of proposed antenna will be able to provide antenna engineers with more design information.*
Keywords- *Ultra-wide band, Dual Band, Patch antenna*

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I. Introduction

FCC (Federal communications commission) allocated a block of radio spectrum from 3.1GHz to 10.6 GHz for UWB operations [1].UWB systems can support more than 500 Mbps data transmission within 10m [1]. Compact size, low-cost printed antennas with Wideband and Ultra wideband characteristic are desired in modern communications. The Ultra wide band antennas can be classified as directional and omni-directional antennas [3]. A directional antenna have the high gain and relatively large in size. It has narrow field of view. Whereas the omni-directional antenna have low gain and relatively small in size. It has wide field of view as they radiates in all the directions [3]. The UWB antennas have broad band. There are many challenges in UWB antenna design. One of the challenges is to achieve wide impedance bandwidth. UWB antennas are typically required to attain a bandwidth, which reaches greater than 100% of the center frequency to ensure a sufficient impedance match is attained throughout the band such that a power loss less than 10% due to reflections occurs at the antenna terminals. Various planar shapes, such as square, circular, triangular, and elliptical shapes are analyzed and reported. Compared with monopole based planar antennas, the design of ultra wide band circular ring type antennas is difficult because of effect of the ground Plane. The bandwidth of the micro strip antenna can be enhanced by modifying the ground plane [6]. Many designers have tried various ways to improve the structure of the traditional circular antennas, and many valuable results have been obtained.

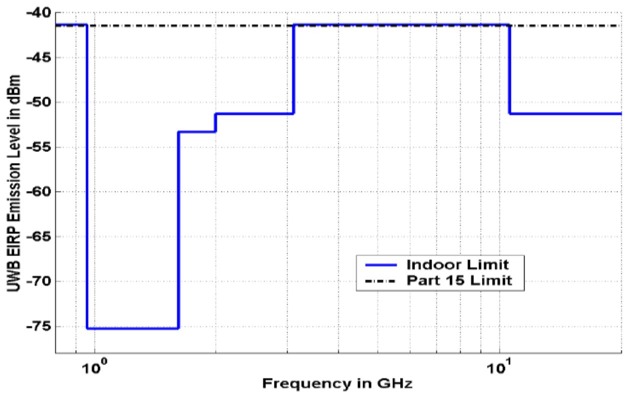

Fig. 1 UWB Spectral Mask per FCC (Modified) Part 15 Rules [1]

II. ANTENNA CONFIGURATION AND DESIGN

For the calculation of length and width of the patch antenna we used basic formulas for length and width of patch The ground plane is modified to enhance the bandwidth of the antenna. The proposed antenna designed on a FR4 substrate with dielectric constant ε_r = 4.4 and height of the substrate is h = 1.6 mm. The substrate has length L= 50 mm and width W = 50 mm. The substrate is mounted on ground of 18 mm length and 50 mm width.

The proposed design is capable for passes two band in the range of 2.1 GHz to 3.1 GHz in the range of ISM (2.4GHz-2.4835GHz), Bluetooth (2.4GHz-2.484GHz) and rejection of Wi max IEEE 802.16 (3.3GHz-3.7GHz) band at Absolute Bandwidth in GHz Below return loss of -10 dB is 2.1 GHz to 3.1 GHz = 1.0 GHz, Second 7.8 GHz to 10.8 GHz = 2.0 GHz. This antenna is resonant at two centre frequencies first is 2.6 GHz with Absolute Bandwidth 1.0 GHz and second is 9.8 GHz with Absolute Bandwidth 2.0 GHz for UWB applications.

Table 1 Antenna designing parameters

Wsub	Lsub	Wg	Lg	Ws	Ls	Wp	Lp
50	50	50	18	12	4	30	30

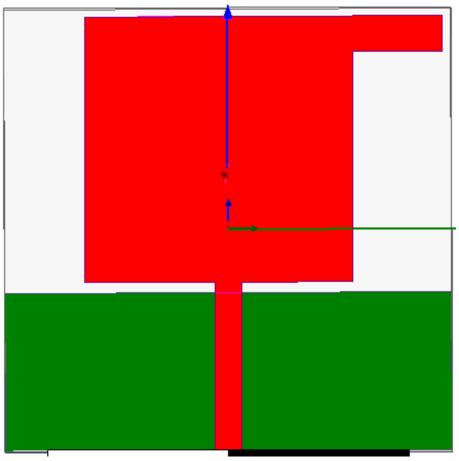

Fig. 2 Geometry of rectangular patch

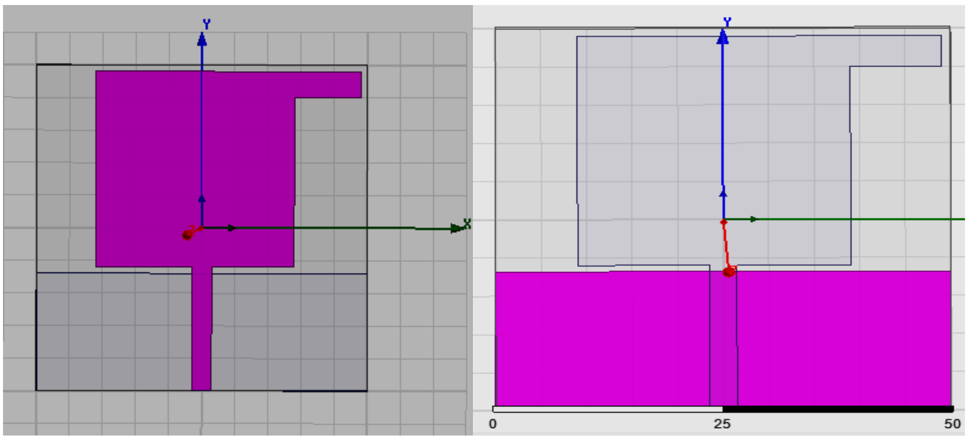

Fig. 3 Geometry of rectangular patch Top View & Bottom View

III. SIMULATION RESULTS

Fig. 5 and Fig.6 Shows that S_{11} and VSWR of multi band patch antenna with optimized ground length Lg = 18mm. This antenna is suitable for operating frequency of 2.1-3.1GHz, 5.1 -5.9 GHz and 7.8-10.8 GHz in UWB it is shown that return loss of the antennas is better than -10 dB. The VSWR obtained is less than 1.5 the patch antenna is found to have the compact size .The return loss value of first second and third band is -13dB,-11dB and -19 dB respectively.

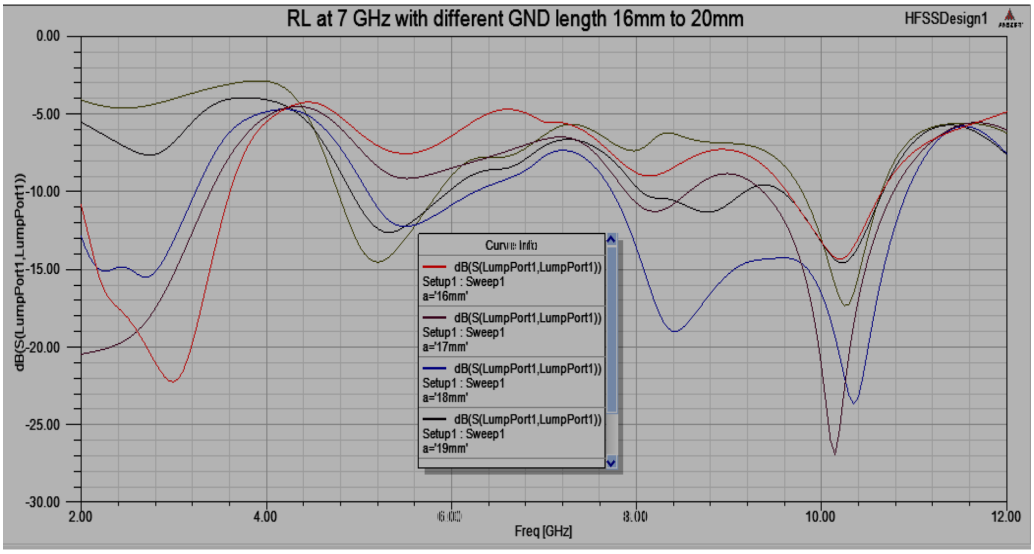

Fig. 5 S_{11} of Patch antenna with different ground plane effect Lg.

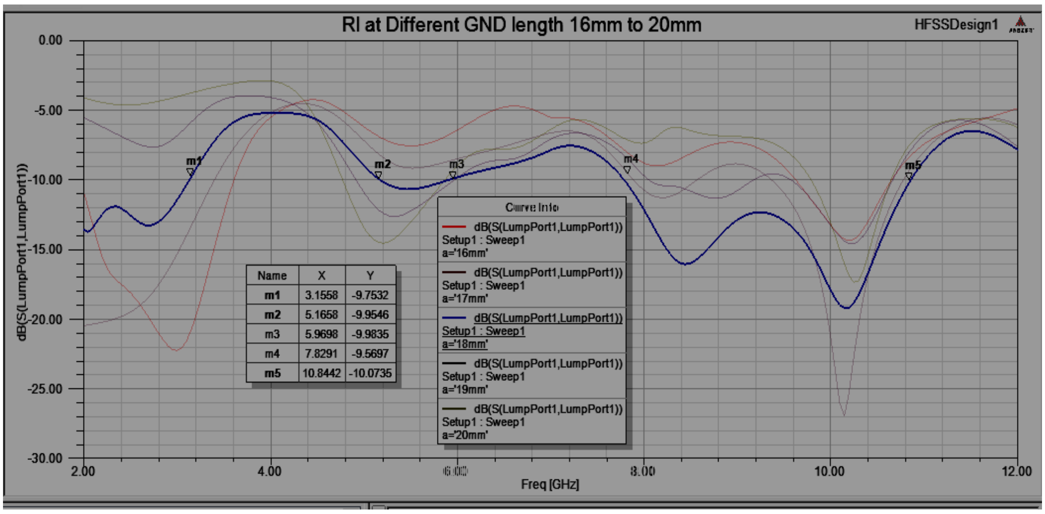

Fig. 6 S_{11} of patch antenna with Lg=18mm.

Fig. 7 shows the relationship between VSWR with frequency for proposed design. In this the value of VSWR is ≤ 2 for three different centre frequencies first is 2.5 GHz with Absolute Bandwidth 1.0 GHz and second is 5.4 GHz with Absolute Bandwidth 0.8 GHz and third is 9.8 GHz with absolute bandwidth 3 GHz for UWB applications.

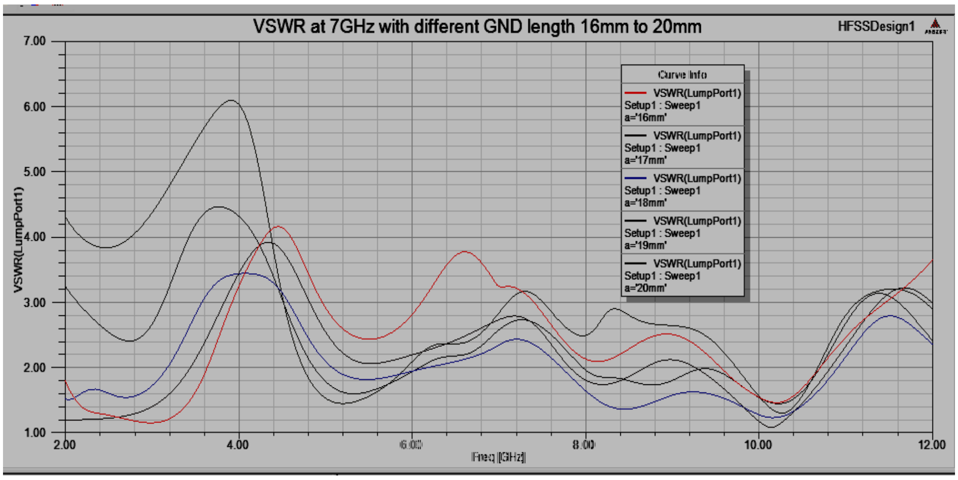

Fig. 7 VSWR of dual band patch antenna

The Plot curve for Directivity, Gain in 3D Polar, Radiation efficiency, E – H Plane, and radiation pattern are shown in fig.8, fig. 9, fig.10, fig.11, fig.12 and fig. 13 respectively. The simulated values of directivity are 3.43dB with 2.64 dB antenna gain and 83.2% radiation efficiency calculated for proposed geometry. The uniformly current distribution and bidirectional radiation pattern are obtained for proposed geometry at 7 GHz.

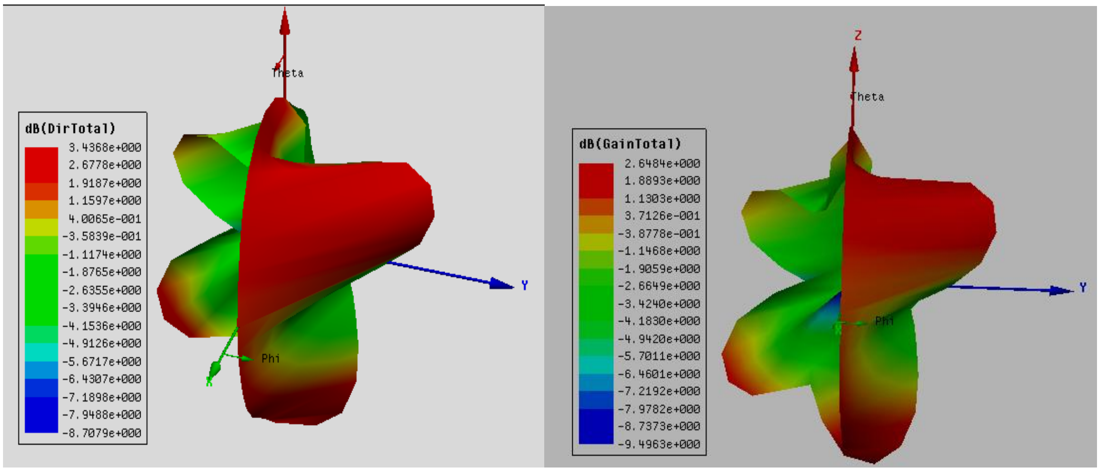

Fig. 8 Directivity of patch antenna at 7 GHz & 3D Polar Gain in db at 7GHz

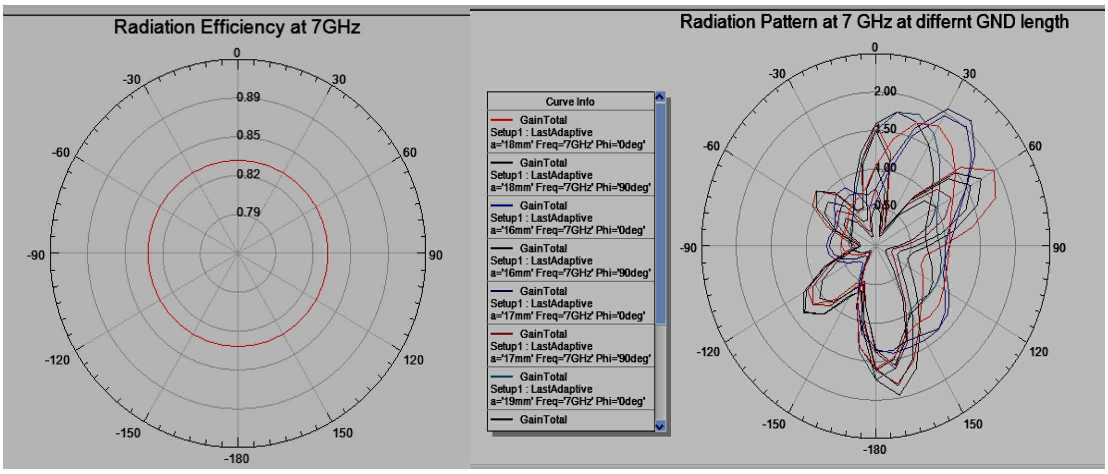

Fig. 10 Radiation Efficiency at 7GHz & Radiation Patten at 7GHz

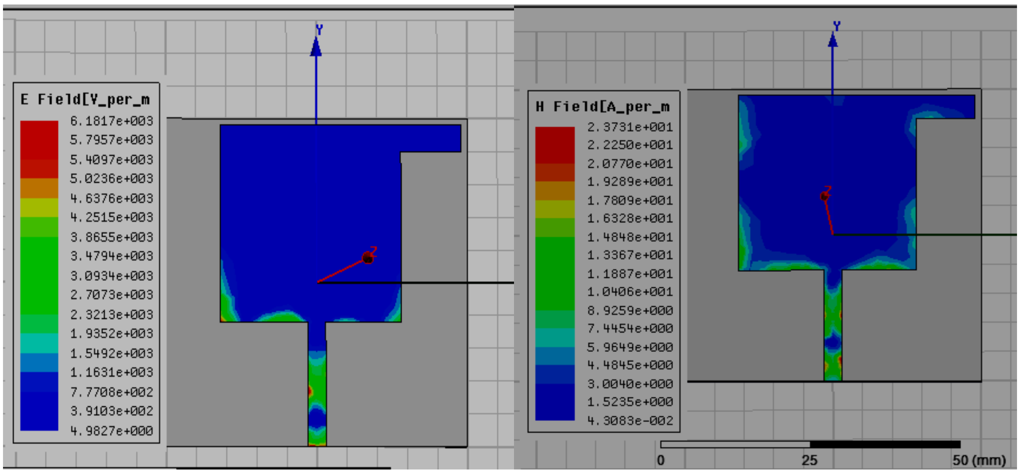

Fig. 11 E Field at 7GHz & H Field at 7GHz

IV. Fabrication

The antenna structure is fabricated on FR -4 substrate using Photolithography technique. The proposed design is tested on vector network analyzer. The top view and measurement set up of fabricated antenna is shown in Fig 14 and Fig. 15.

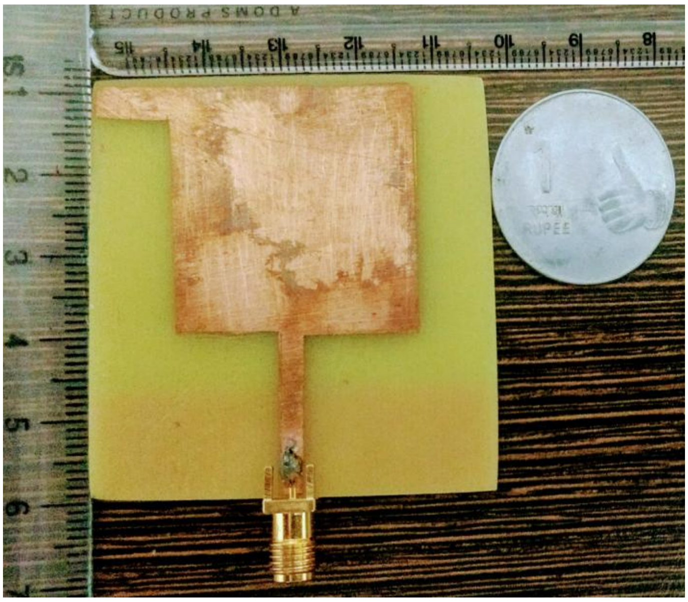

Fig. 14 Fabricated design of proposed antenna

V. Testing And Measuremet Set Up

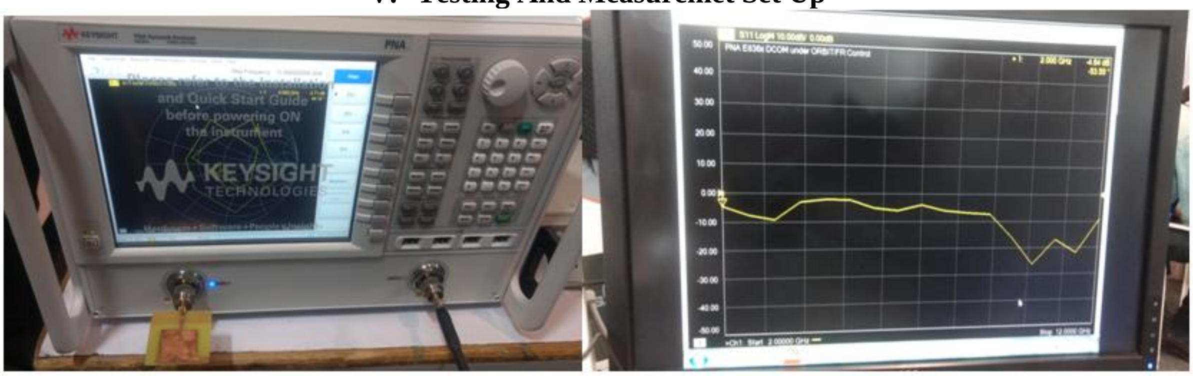

Fig. 15 Measurement set up of fabricated design & Measured Result of S_{11}at 7GHz

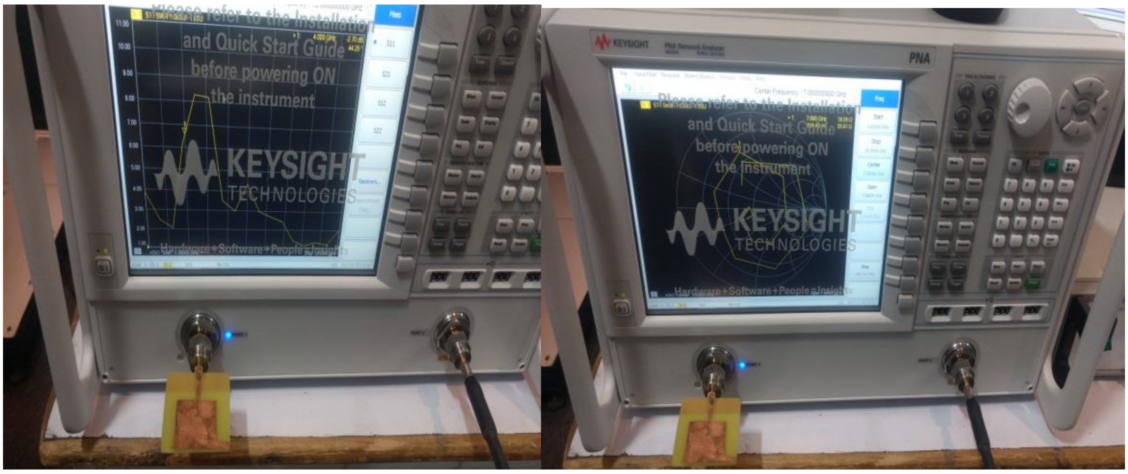

Fig. 16 Measurement set up of VSWR & input impedance at 7GHz

The measured result of S_{11} for proposed design are calculated by vector network analyzer and on the basis of measured results we conclude that this antenna is suitable for frequency band of 9 GHz to 12 GHz with two resonant frequencies at 10.1 GHz and 11.4 GHz with good return loss and VSWR values.

VI. Conclusion

In this paper, UWB band multi band patch antenna with band Notch Charectertic is simulated using HFSS-13. The proposed antenna has advantages of small size, easy fabrication and simple construction. The simulated results of proposed antenna shows that return loss is less than -10 dB and VSWR is less than 1.5. The measured results of this antenna show that the antennas can be good candidates for the operating frequency of 9 GHz to 12 GHz with two resonant frequencies at 10.1 GHz and 11.4 GHz with good return loss values. The gain of antenna is 2.64 dB and radiation efficiency 83.2 % calculated. Microstrip line feeding is used for transmission of EM wave.

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