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Research Article

OPTIMIZATION OF BAND NOTCH CHARACTERISTIC IN ULTRA WIDE BAND MICRO STRIP PATCH ANTENNA FOR WIRELESS APPLICATIONS

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A B S T R A C T

In this paper, band notch characteristics with reduced ground plane effect in Ultra wide band antenna is proposed. This newly simulated structure is proposed for fabrication. The antenna is suitable for operating frequency range in UWB band and it is shown that return loss of this antenna at four resonant frequencies at 2.5GHz, 5.5GHz 8.5GHz and 10.5 is better than -10 dB. The VSWR obtained is less than 2.0 of this multiband antenna with the compact size and large bandwidth. The return loss values of first band is -16.1 dB second bands is -45 dB third band is -24dB and fourth band is -20dB with radiation efficiency is 82 % and directivity 3.65 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.

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 centre 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. The bandwidth of the micro strip antenna can be enhanced by modifying the ground plane [6].

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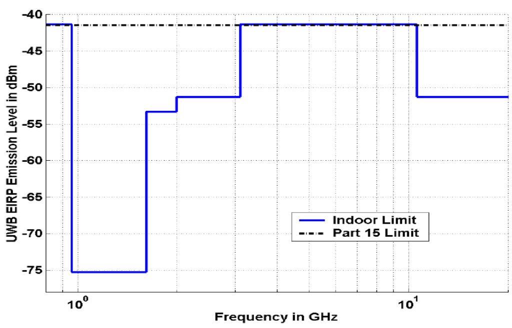


Fig 1 UWB Spectral Mask per FCC (Modified) Part 15 Rules [1]

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 $\varepsilon_r = 4.4$ 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 four band in the range of 2.1 GHz to 3.25 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 3.25 GHz = 1.25 GHz, Second 5.2 GHz to 6.2 GHz = 1.0 GHz, third 7.8Ghz to 9.0 GHz and fourth 9.10 GHz to 11.1GHz This antenna is resonant at four centre frequencies first is 2.5 GHz with Absolute Bandwidth 1.0 GHz and second is 5.5 GHz with

Absolute Bandwidth 2.0 GHz third is 8.5 GHz and fourth is 10.5 GHz for UWB applications.

Table 1 Antenna designing parameters

W sub	L sub	Wg	Lg	Ws	Ls	Wp	Lp
50	50	50	18	12	4	30	30

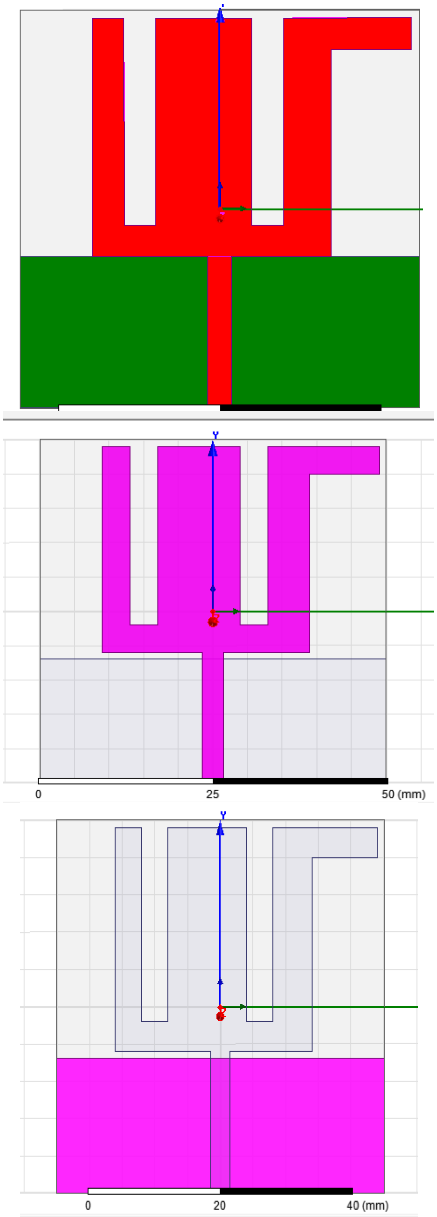


Fig 2 Geometry of rectangular patch Top View & Bottom View

Simulation Results

Fig. 3 and Fig.4 Shows that parametric study of S11 parameter for multi band patch antenna with optimized ground length Lg = 18mm. This antenna is suitable for operating frequency of 2.1-3.25GHz, 5.2 -6.2 GHz, 7.8-9.0 GHz and 9.10 – 11.1 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, third and fourth band is -16dB,-45dB -24 dB and -20.1dB respectively.

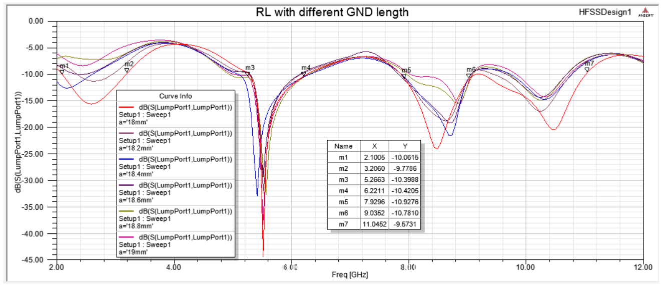


Fig 3 S_{11} of Patch antenna with different ground plane effect Lg.

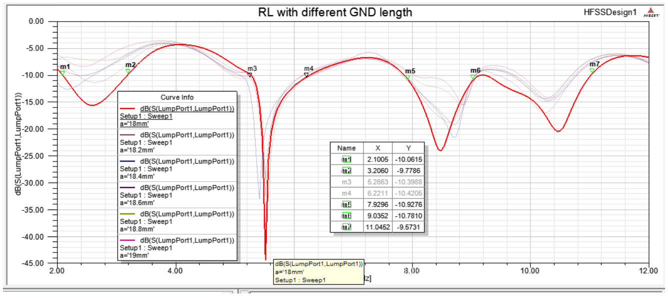


Fig 4 S_{11} of patch antenna with Lg=18mm.

Fig. 5 shows the relationship between VSWR with frequency for proposed design. In this the value of VSWR is ≤ 2 for four different centre frequencies first is 2.5 GHz with Absolute Bandwidth 1.0 GHz and second is 5.5 GHz with Absolute Bandwidth 1.0 GHz and third is 8.5 GHz with absolute bandwidth 1.2 GHz and fourth is 10.5 GHz with absolute bandwidth 2.1 GHz for UWB applications.

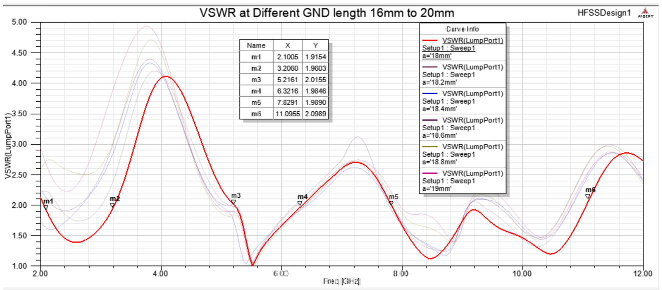
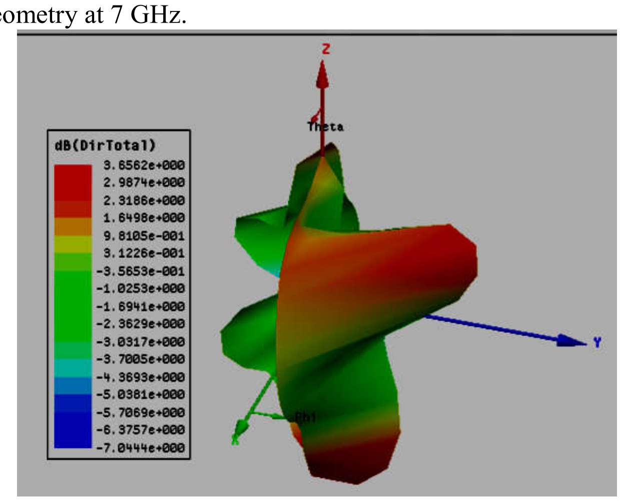


Fig 5 VSWR of Multi Band Notch Patch Antenna

The Plot curve of Directivity, Gain in 3D Polar are shown in fig. 6, Radiation efficiency and radiation pattern are shown in fig.7, the current distribution of proposed design is shown in fig. 8. The simulated values of directivity are 3.65dB with 2.64 dB antenna gain and 82% radiation efficiency calculated for proposed geometry. The uniformly current distribution and bidirectional radiation pattern are obtained for proposed geometry at 7 GHz.



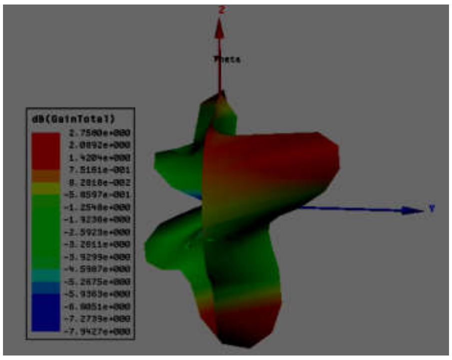


Fig 6 Directivity & 3D Polar Gain of patch antenna at 7 GHz

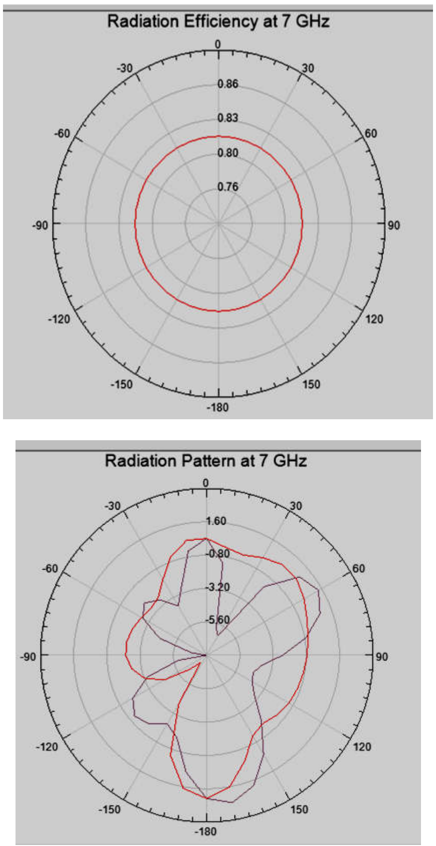
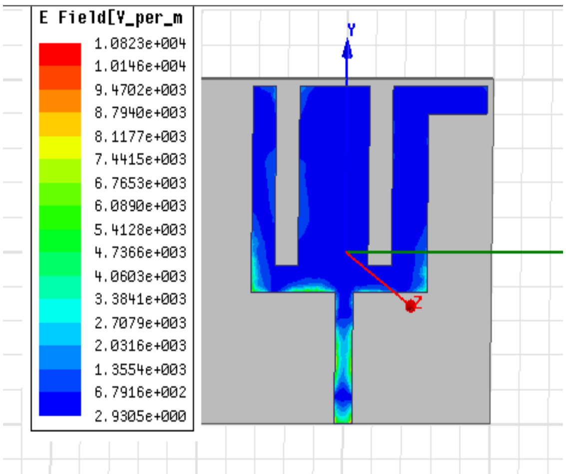


Fig 7 Radiation Efficiency & Radiation Patten at 7GHz



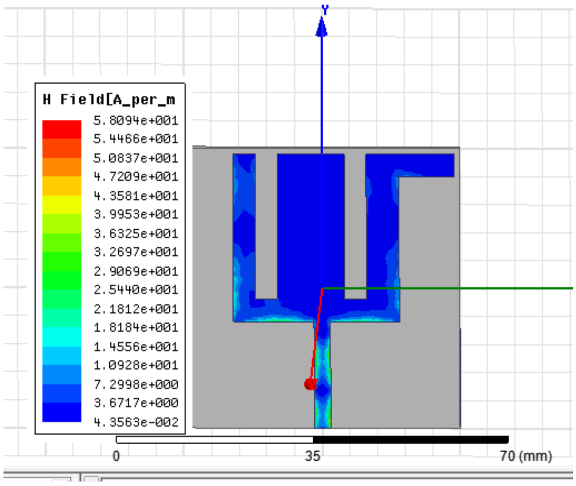


Fig 8 Measurement of Surface current distribution at 7 GHz

Ground-Plane/Substrate-Related effect: The three important points can be observed after the parametric analysis of ground plane with FR4 Subs tract. First, it is seen from that the impedance matching is very sensitive to the feed gap, especially at higher frequencies. Second, the length of the ground plane affects the impedance matching more significantly at higher frequencies than at lower frequencies this finding is consistent with the current distributions where more current is concentrated on the ground plane at the higher frequencies than at lower frequencies. Last, the impedance response is also affected by the dielectric constant in this study, a change in the dielectric constant leads to a shift in the characteristic impedance of the feeding strip from 50.

Fabrication, Measuremet Set Up and Testing

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 9 and Fig. 10.

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 7.4 GHz to 10.2 GHz with resonant frequency at 8.25 GHz with good return loss and VSWR values.

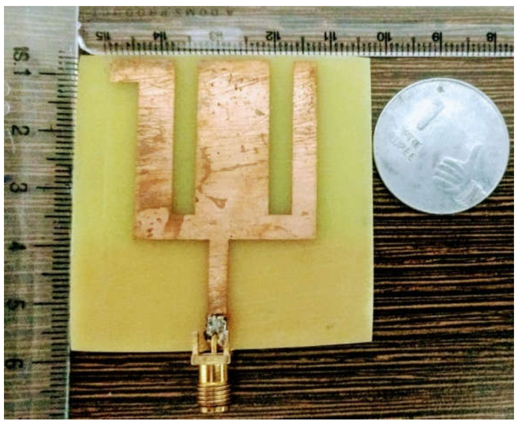


Fig 9 Fabricated design of proposed antenna

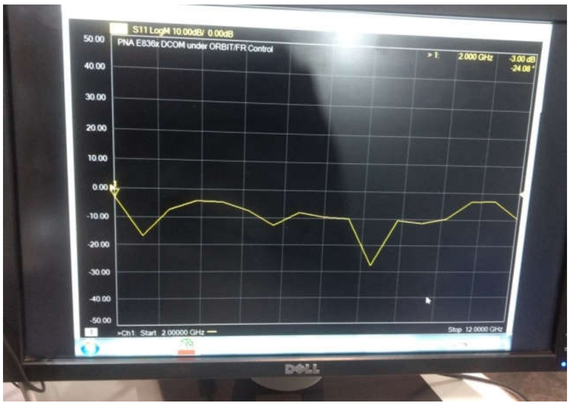


Fig 10 Measurement set up of S_{11}at 7GHz

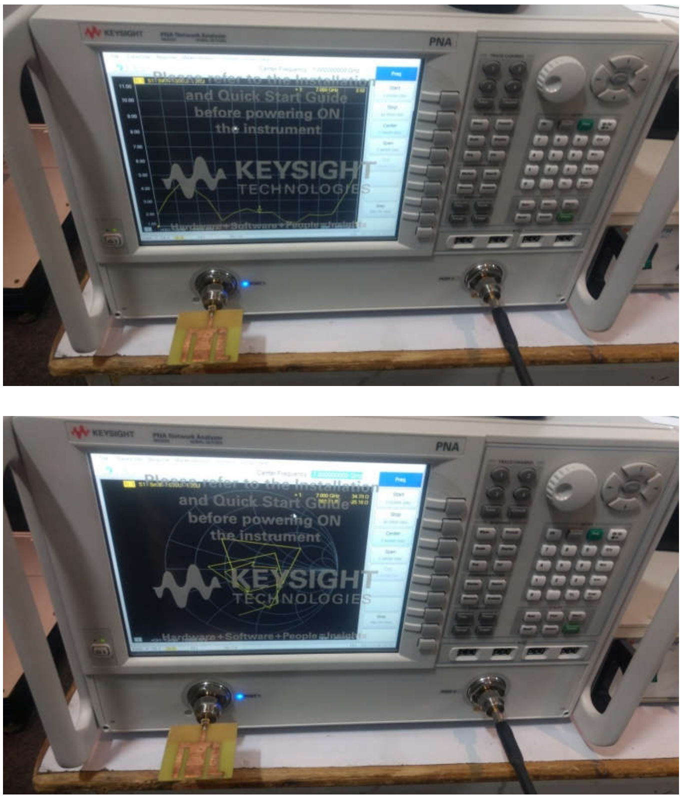


Fig 11 Measurement set up of VSWR & Input Impedance at 7GHz

CONCLUSION

In this paper, multi band patch antenna with band Notch Charectertic in UWB 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 four operating frequency of 2.3 -3.2 GHz, 5.4-6.2 GHz, 7.4-9.0GHz and 9.1-10.2 GHz with four resonant frequencies and good return loss values. The gain of antenna is 2.64 dB and radiation efficiency 82 % calculated. Microstrip line feeding is used for transmission of EM wave.

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