ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 3, March 2017

Ultra-Wideband Printed Monopole Antenna for WLAN & Satellite Communication

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ABSTRACT: This project introduces a slot loaded CPW feed ultra wideband (UWB) printed monopole antenna (PMA) with dual band notched characteristics. The antenna uses three rectangular slots to create dual band notched characteristics in WLAN and uplink and downlink of X-band satellite communication. The proposed antenna has novel suitability to utilize it for both uplink and downlink satellite communication band notching applications. It has the characteristics of less compact in size with VSWR less than two. Micro strip have attractive merits such as compact size, low-cost, ease of fabrication, wide impedance bandwidth and good Omni-directional radiation that make it favorite for UWB applications[1]. In recent years researchers have improved various challenges of UWB antennas like impedance, band-width, radiation patterns, matching characteristics and size of antennas. But UWB systems are highly sensitive to electromagnetic interferences with existing narrow -band wireless communication systems. Hence it is necessary to design antennas with multiband filtering characteristics to avoid interferences.

The geometry and configuration of the proposed antenna has simulated and optimized using Ansoft HFSS Software.

KEYWORDS - CPW antenna, UWB antenna, Band-Notch antenna, planar monopole antenna.

I. INTRODUCTION

Present era is witnessing a very rapid growth of wireless communication for which antennas with large bandwidth are in huge demand, so that several applications are covered using a single antenna. The ultra wideband printed monopole antennas are good possible choice for their use in UWB wireless technology because of their wide impedance bandwidth and nearly omni-directional azimuthal radiation pattern. UWB antenna systems are highly receptive to electromagnetic interference so, it is necessary to design antennas which are less sensitive to electromagnetic interference. The exceptionally large bandwidth of a UWB antenna makes it feasible for the use of wireless LAN with higher data rates. UWB includes sub narrowband applications like Wi-MAX operating in 3.3-3.6 GHz band, C band (3.8 - 4.2 GHz), wireless LAN (5.40-6.00) GHz band and X band satellite communication system operating in (6.40-8.30) GHz band. These bands could be avoided by using band-stop filters[12], but this approach will increase the weight of system, complexity and economic. Hence it is necessary to design an antenna with dual band notched characteristics which can be used for both wireless LAN and satellite communication. Earlier different methods like, different types of slot on the radiating patch or on the ground plane, split-ring resonators, tuning stubs, meandering, folded strips, electromagnetic band gap (EBG) structure etching on patch/ground plane have been proposed and presented to design UWB antenna with band notch characteristics. Etching of U slot[11], V- shaped slot, C- shaped slot [2], S- shaped slot in feed line [3], a quasi-complementary split ring resonator (CSRR) in feed line [4], a quarter- wavelength tuning stub in a large slot on the patch [5], or compact folded stepped impedance resonators (SIRs) or capacitively loaded loop (CCL) resonators in feed [6-7], a parasitic slit along with tuning stub used [8], C shaped slot on patch and L shaped stub on ground[11], semi-circular slot on patch [9], open ended rectangular slots on patch [10].

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In this paper, we have proposed an ultra-wideband printed mono-pole antenna with dual notched bands for (5.00- 5.85) GHz band (WLAN) and (6.60-8.50) GHz band (X-band satellite communication). Proposed antenna is employed with three slots to create dual-band notched characteristics.

II. ANTENNA DESIGN AND ANALYSIS

The design and configuration of the proposed antenna has been simulated and optimized using Ansoft HFSS 13.0. Here the dimensions of the antenna consider to be The antenna is designed by using RogerRT/ TMMA4 material with thickness of 1.6mm which have dielectric constant of 4.5 and loss tangent of 0.002 the width of the microstrip feed line is 3mm has been used to achieve 50ohm characteristic impedance. Ground with narrow edge and three rectangular slots S1,S2 and S3 created on the radiating patch. Here the two slots S2 and S3 are identical with equal dimensions which are used to form a notch that is used for X-band satellite communication. The slot S1 forms notch for wireless LAN applications. The length of designed antenna has been calculated by the formula,

$$L = \frac{c}{2f\sqrt{\frac{\epsilon_r + 1}{2}}}$$

Where, c is the speed of light in vacuum,

ϵ_r Is the dielectric constant of the substrate,

f is the proposed notch centre frequency.

By using the above formula the calculated length of the slot S1 is Lw1=15.78mm. The same formula has been is used toss calculated slot length of S2 and S3 as S2=S3=12.73mm. In order to reduce the coupling effect between the slots an optimized practical length are required. The optimized length of these slots are S1=15mm, S2 and S3 is 10.25mm to create notches at WLAN band and X- band.

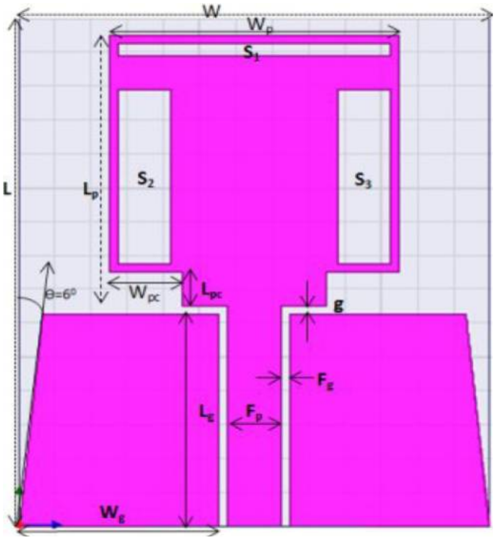
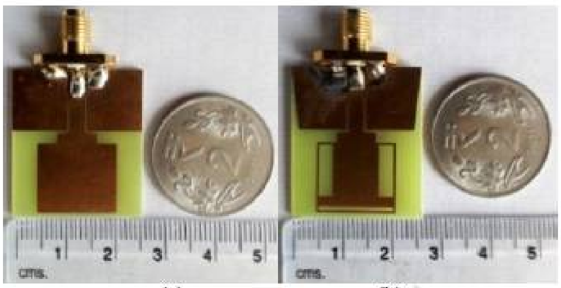


Fig: Design and Configuration of UWB dual notch antenna



(a) (b)
Fabricated design of UWB antenna, (a) Primary design (b) Proposed design with two notch bands

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Optimization of Dimensions:

<table>
<tr><td></td><td>W</td><td>L</td><td>Wp</td><td>Lp</td><td colspan="2">Wg</td><td colspan="2">Lg</td><td>Wgnd</td><td>Lgnd</td></tr>
<tr><td>mm</td><td>26</td><td>30</td><td>16</td><td>16</td><td colspan="2">11</td><td colspan="2">12.5</td><td>26</td><td>30</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Fp</td><td rowspan="2">Fg</td><td rowspan="2">Wpc</td><td rowspan="2">Lpc</td><td colspan="2">S1</td><td colspan="2">S2</td><td colspan="2">S3</td></tr>
<tr><td>Sw1</td><td>Sl1</td><td>Sw2</td><td>Sl2</td><td>Sw3</td><td>Sl3</td></tr>
<tr><td>mm</td><td>3</td><td>0.5</td><td>4</td><td>2</td><td>14</td><td>0.75</td><td>2.85</td><td>9</td><td>2.85</td><td>9</td></tr>
</table>

The VSWR of the proposed antenna can measured by replacing the three slots one after the other and the combined VSWR is also taken into consideration. We can observe that the notched characteristics are obtained at a frequency of 5.00GHz to 5.85GHz due to slot S1 shown in the figure(a) similarly the characteristics are obtained at a frequency of 6.60GHz to 8.850GHz due the slots S2 and S3 are shown in the figure(b).

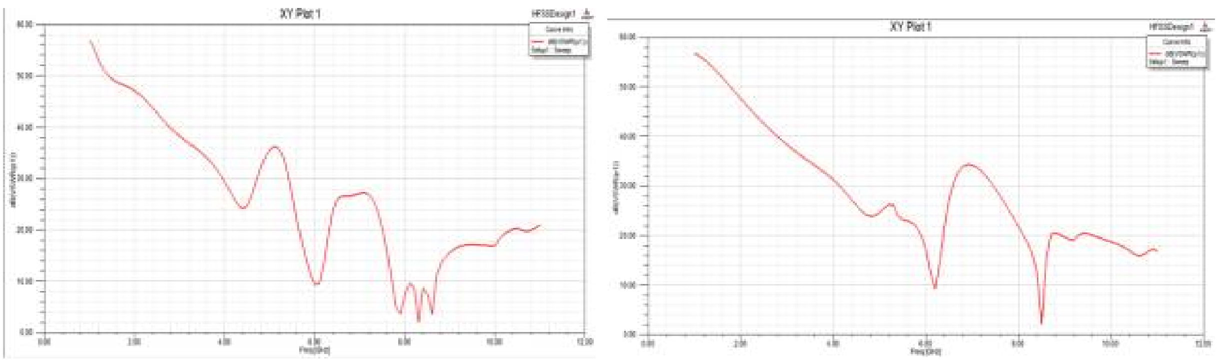

Fig: Notched characteristics due to slots S1,S2&S3 respectively

i. Optimization of length of the slot S1:

On varying the slot length S1 notched characteristics are obtained at different frequencies out which the characteristics obtained at the length Sw1=14mm gives the VSWR less than 2 which is the primary requirement for any antenna. Here the proposed length of the slot gives better notched characteristics in the frequency range of 5.425GHz-5.825GHz.

The below figure shows the VSWR characteristics of proposed antenna for different slot lengths are that optimized from 15.78mm to 13mm

DOI: 10.15680/IJIRCCE.2017. 0503133

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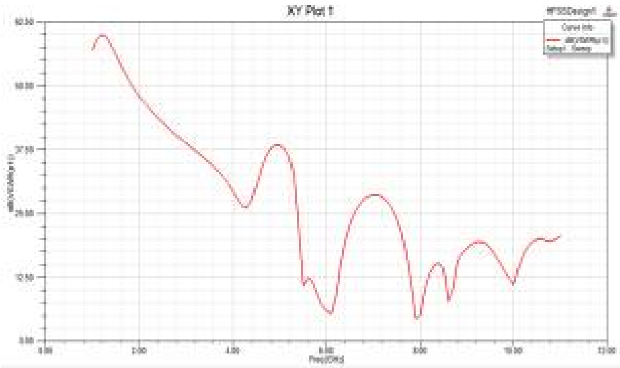
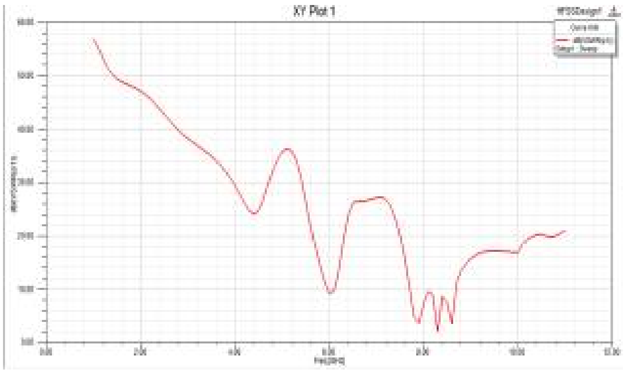
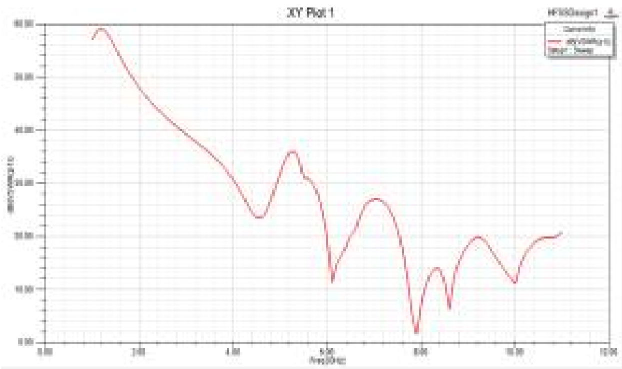


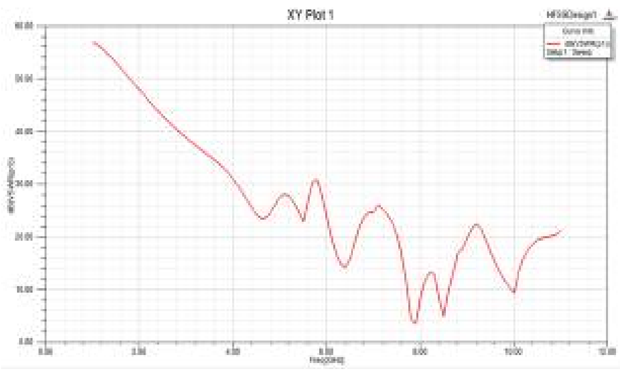
Sw1=15.78mm



Sw1=15mm



Sw1=14mm(proposed)

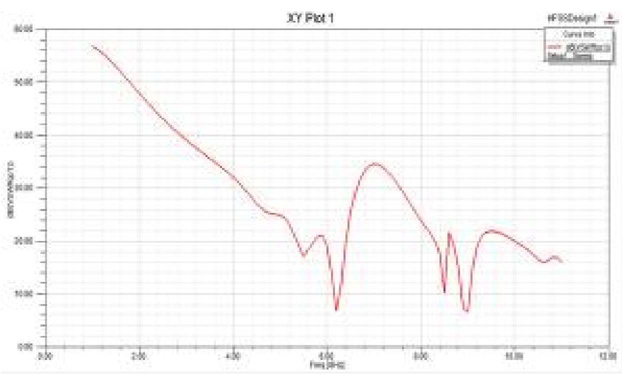


Sw1=13mm

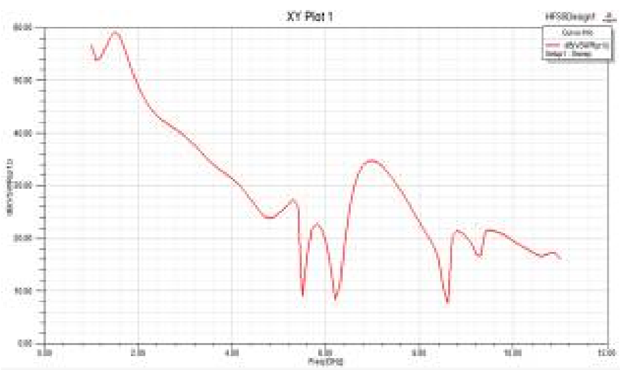
ii. Optimization of length of the slot S2:

Similarly on varying the slot length S2 & S3 notched characteristics are obtained at different frequencies out which the characteristics obtained at the length Sl2=Sl3=9mm gives the VSWR less than 2 which is the primary requirement for any antenna. Here the proposed length of the slot gives better notched characteristics in the frequency range of 6.60GHz-8.875GHz.

The below figure shows the VSWR characteristics of proposed antenna for different slot lengths that are optimized from 12.73mm to 9mm



Sw2=Sw3=12.73mm



Sw2=Sw3=12mm

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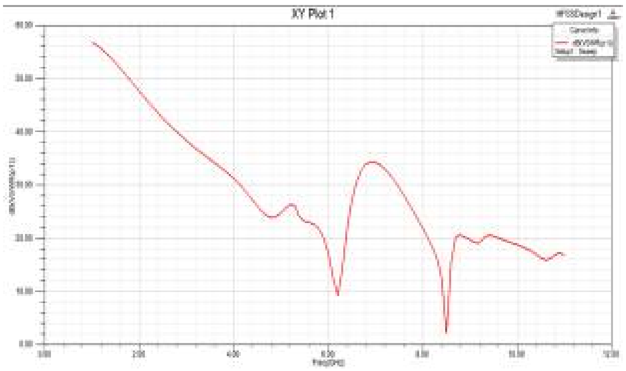
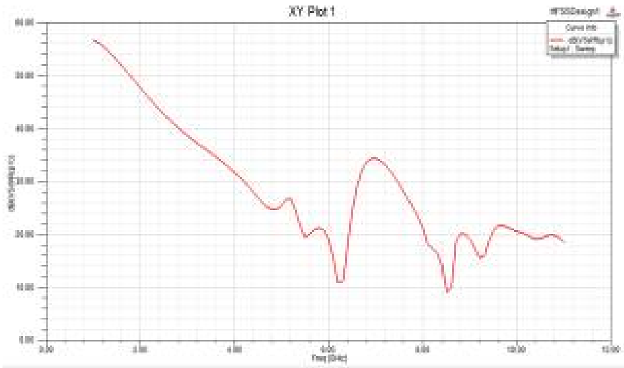


Sw2=Sw3=11mm



Sw2=Sw3=9mm
(proposed)

III. RESULTS AND DISCUSSION

Simulated and measured VSWR results of proposed antenna with three slots has been exhibited dual band notches at 5.00-5.85GHz and 6.60-8.850GHz and maintaining bandwidth with VSWR less than 2. The return loss, radiation pattern and 3D polar plots are shown below. The Fig.1 shows the return loss of the designed antenna, the three slots of antenna successfully exhibit three notches with the return loss of 26.63 dB. The Fig.2 shows the VSWR characteristics of the proposed antenna, the antenna has exhibiting two notches at two different frequencies 5.425GHz and 7.725GHz along with the Voltage standing wave ratio is nearly equals to 1.5. The first notch is occurred at the frequency range is 5.0-5.85GHz which is applicable for wireless LAN applications, and the second notch is occurred at 6.6-8.825GHz which is mainly for X-band satellite applications. The 2D radiation pattern and 3D polar are plots are represented in the Fig.3 & Fig.4 it indicates that the gain and directivity of the designed antenna from the figures we can observe that the gain of the antenna is 8.19dB.

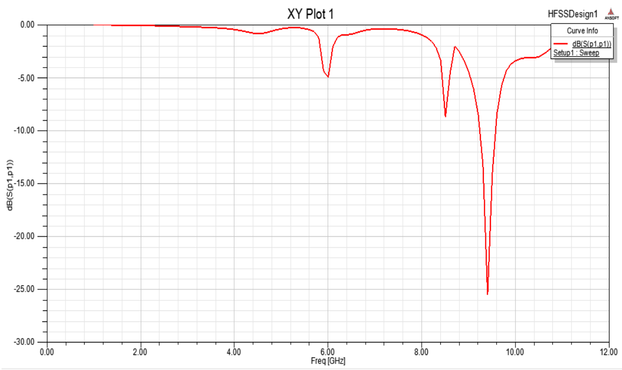


Fig.1: Return loss plot of the Propsed antenna

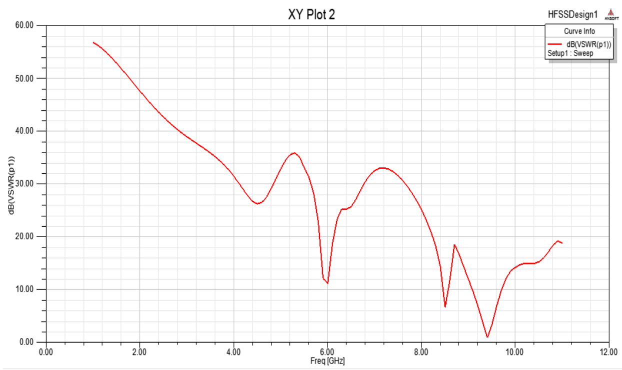


Fig.2: VSWR characterstics

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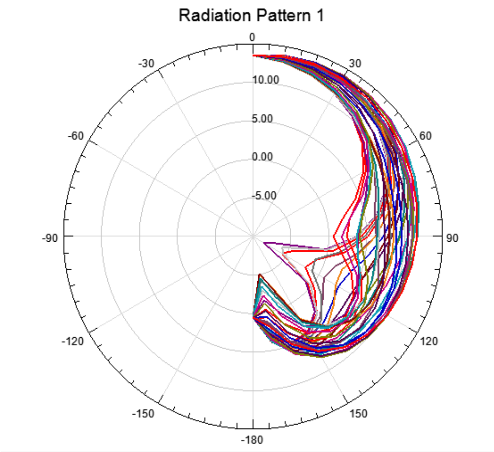

Fig.3: Radiation pattern of UWB antenna

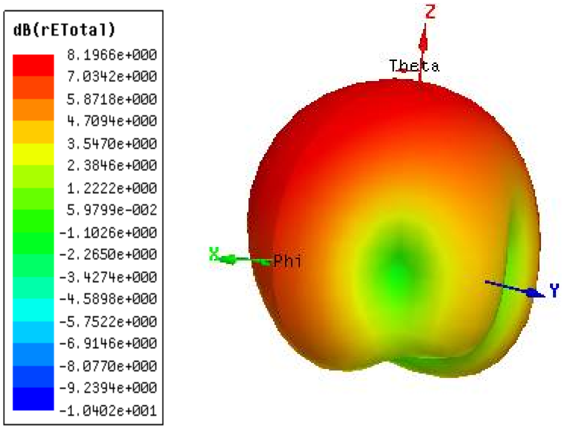

Fig.4: 3D polar plot

In order to observe the influence of slots S1, S2 and S3 in getting the notched bands, the vector current distribution on the radiating patch of the proposed antenna at three different frequencies have been shown in the Fig. 5. At a pass band frequency of 4.5GHz, the distribution of the current is uniform which have been shown in Fig.5.(a), whereas in Fig.5 (b) & Fig.5(c)stronger current concentrated near the edges of slots S1, S2 and S3 at the center frequency of the first notched band 5.425 GHz, and the second notched band 7.7 25GHz, respectively have been reflected the positive effect of the slots to obtain the band notched characteristics. From te results we can observe that the change in slot dimensions will affect the return loss and gain of the antenna.

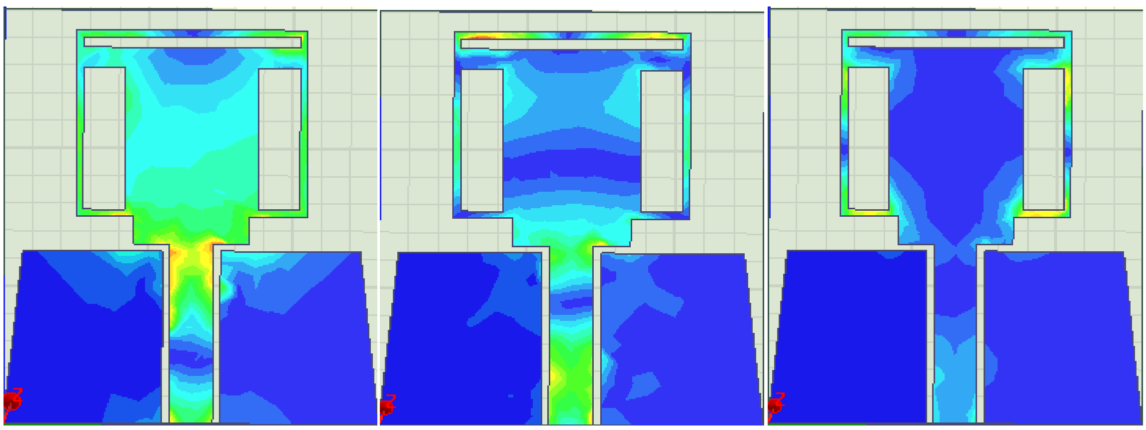

Fig.5: Current density distribution at the centre frequency of the first and second notches of the proposed antenna at 3.15GHz, 5.75GHz & 7.35GHz shown below

IV. CONCLUSION

An ultra wideband printed monopole antenna with measured results has been presented in this paper. Simulated and measured results are good in agreement. This antenna has simple structure and compact size of 26 x30 x1.6mm[2], which is easy to be implanted. Proposed antenna covers frequency band from 3.1 to 10.63 GHz. To prevent electromagnetic interferences with wireless LAN and X band satellite communication systems, dual band rejection structures are selected to produce sharp rejection. Result & analysis of this antenna indicates that it is applicable in several ways such as RF tagging & identification and wireless audio & video distribution.

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