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UWB APPLICATIONS CARRIED BY DUAL BAND NOTCHED BUTTERFLYSHAPED PRINTED MONOPOLE ANTENNA

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Abstract: The paper titled above, describes about a microstrip line fed monopole butterfly shaped printed antenna along with dual modified U shaped slots, which basically use for rejection for dual bands WiMAX and WLAN having frequencies of about 3.5 GHz and 5.5GHz respectively from the UWB range that lies in between 3.1-10.6 GHz. The wings of butterfly shaped antenna has been developed with the help dual rotated ellipse fed by microstrip line. The performance has been characterized by VSWR, radiation patterns, impedance bandwidth and gain. The proposed antenna is useful for wireless application and also helpful to analyze the bending effect of antenna which is use for wireless body area networking effect.

Keywords: butterfly shaped, U shaped slot, notch, WiMAX, WLAN, UWB, impedance, bandwidth.

I. INTRODUCTION

The UWB antennas play vital role in wireless application. Characteristics like large bandwidth, low power consumption security features and huge data transmission rate, are major benefits of UWB antennas. The fundamental problem associated with UWB antennas is that the other communication system bands viz. WiMAX and WLAN bands interfere with the transmission bandwidth of the UWB antennas. Hence, it is imperative to introduce filters to stop these bands. The cost and complexity of the UWB antennas increases due to presence of filters, hence an alternative method is adopted to filter out the unwanted bands. In this method, in the radiator part either integration of slots done or grounding the plane phenomenon performs that allows the filtering characteristics in the UWB antenna without increase in cost and much complexity.The present paper comprises both fabrication and simulation process for the antenna of proposed titled. The antenna radiates over UWB range with multiple resonance characteristics. The interference occurs by the coexisting

communication bands viz. 3.5 GHz named WiMAX band and along with 5.5 GHz named WLAN bands. These bands are reduced by integrating the pair of modified U-shaped slots on

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the four arm butterfly shaped radiator. The proposed UWB antenna with dual notch characteristics provides filtering of multiple frequency bands. The antenna has been analyzed to make significant size reduction, while maintaining omnidirectional radiation patterns to achieve desired characteristics. The obtained Bandwidth Impedance of about 2.8-11.9 GHz for the above titled antenna. The designed antenna also shows notched characteristics for dual band of about 3.35-4.0 GHz and 5.2-6 GHz respectively and rejects 3.5 GHz and 5.5 GHz bands, which are desired WiMAX and WLAN bands. Parameters given as follow like, gain, radiation pattern and reflection coefficient are taken into account for analysing the design of required antenna. The following factors like designing, parametric analysis and fabricated results have been discussed in section II, section V and section VI respectively.

II. DESIGINING PROCEDURE

In this section dual band notch butterfly shaped antenna's designing procedure is presented. The FR-4 dielectric substrate is use for fabrication purpose. Following parameters like thickness, loss tangent and dielectric constant, having values 1.542 mm ,0.025 and 4.4 mm, respectively taken for designing the geometry of required antenna. The feeding has been done for four arms butterfly shaped printed antenna with the help of 50-ohm feed line. For impedance matching the fed line width Wc and length Lc is taken and their dimensions are listed in table 1. The gap is placed in between patch of butterfly shaped structure and partial ground plane that is use for providing impedance match for the required circuit. The pair of modified U-shaped slots of different lengths are taken for designing purpose, which is of about half of quarter wavelength. When these slots placed over the diverse location of four arms butterfly shaped patch, dual band notches created for the required 3.5 GHz, named WiMAX (3.4-3.69 GHz) and 5.5 GHz, named WLAN (5.15-5.825 GHz). The simulation process has been done by HFSS Simulation software. The dimensions are summarized in Table 1 for the proposed antenna.

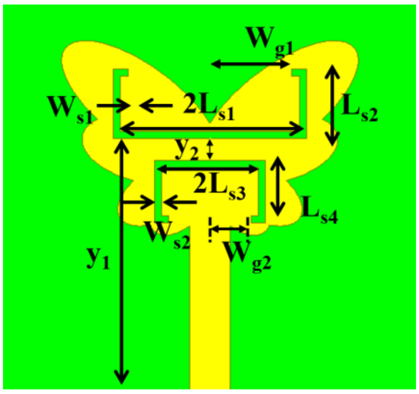

Fig 1: Proposed antenna geometry

A. *Parameters use for microstrip fed butterfly shaped monopole U shaped slot antenna.*

For simulation purpose of desired butterfly shaped monopole antenna, the designing parameters are discussed in this section and presented in table 1.

Table 1: List of Parameters used for designing

Parameters	Value
substrate height	1.524 mm
dielectric constant	4.4
ground plane width, Wg	30 mm
feedline width, Wc	2.9 mm
ground plane length, Lg	10 mm
feed line length , Lc	16.6 mm
substrate length, Lsub	28 mm
Rad1 (ellipse 1)	3.35 mm
Rady1 (ellipse 1)	1.8 mm
Rot1 (ellipse 1)	-49 deg
Rad2 (ellipse 2)	4 mm
Rady2 (ellipse 2)	2 mm
Rot2 (ellipse 2)	-30 deg

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Rad3 (ellipse 3)	4.9 mm
Rady3 (ellipse 3)	2.5 mm
Rot3 (ellipse 3)	11 deg
Rad4 (ellipse 4)	6.8 mm
Ratio4 (ellipse 4)	2.8 mm
Rot4 (ellipse 4)	37deg
Ws1	0.5 mm
Ws2	0.5 mm
Wg1	5.9 mm
Wg2	3 mm
Y1	17.5 mm
Ls1	6 mm
Y2	0.4 mm
Ls2	7 mm
Ls3	4.5 mm
Ls4	4 mm

III. Parametric Analysis

This section basically consists parametric analysis for desired antenna, by varying some important parameters such as length of horizontal arm of modified slot (Ls3) of U shaped, width of modified slot (Ws2) of U shaped and the gap between lower and upper slots that is Y2. The single parameter is varied by the variation process at a time while other parameters are kept constant.

A. *Horizontal arm length Effect on modified U shaped slot (Ls3)*

The variation effect in length of horizontal arm for modified dual U-shaped slot Ls3 is presneted in Fig 2, by S paramter characterstics. Here the results describes that whenever Ls3 varies from 4 mm to 5 mm and the gap value is taken of about of 0.5 mm. The desired bandwidth for notch about 5.5 GHz band that is named by WLAN is gradually changes and shifted towards to the frequency of lower edge side.

At the same time notch frequency is unaffected for 3.5 GHz band that is named as WiMAX.The overall impedance bandwidth for the desired antenna is remain constant almost by this procedure.

From the obatined results, it can be conclude that the 5.5 GHz central frequency that is notched for band named WLAN can be controlled by varying Ls3. At Ls3 = 4.5mm,the antenna provdies the impedance bandwidth ranging from 2.8 GHz to 11.9 GHz along with dual band notches which are ranging in between 3.35-4 GHz and5.2-6 GHz respectively.

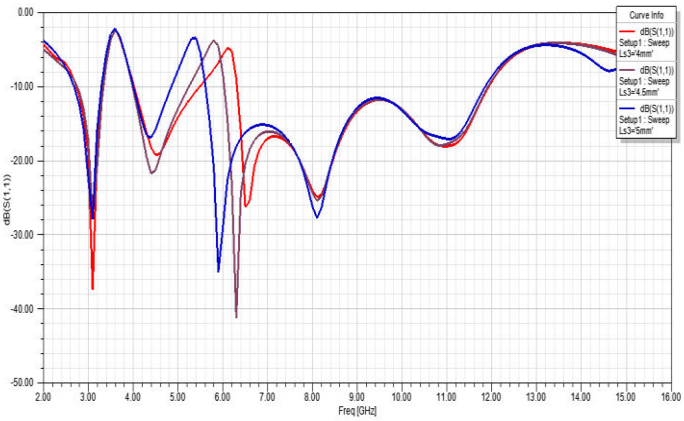

Fig 2: |S11| Parameters for butterfly shapeddual band-notched UWB antenna by varying values of Ls3.

B. *Effect of width of modified U shaped slot (Ws2)*

The variation effect of width for U-shaped modified slot Ws2 is presented in Fig 3 by S-parameter characterstics. The observed result shows that while Ws2 varies by 0.25 mm to 0.75 mm along with the gap value of 0.25 mm ,the notch bandwidth of about 5.5 GHz named WLAN band varies and tends to shift along frequency of lower edge side while the 3.5GHz that is named by WiMAX , notch frequency is almost unaffected. In addition, the overall impedance bandwidth is almost unaffected by this procedure.

From the obsereved results, the conclusioncan be made that the notched central 5.5 GHz frequency that is use for WLAN band can becontrolledby varyingWs2. The antenna provdies impedance bandwidth of about 2.8 GHz to 11.9 GHz along with two band notches which are ranging at 3.35-4 GHz and 5.2-6 GHz at the value of Ws2 = 0.5 mm.

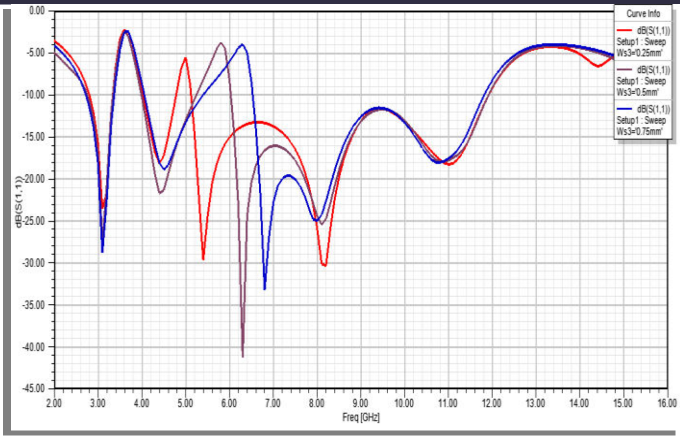

Fig 3: |S11| parameters for dual band-notched butterfly shaped UWB antenna by varying values of Ws2

C. Effect of gap between lower and upper modified U-shaped slots (Y2)

The S parameter of desired antenna by variation in gap between lower and upper modified U-shaped slots Y2 is presented in Fig 4. From the observed result it can be said that when Y2 changes its value gradually from 0.2 mm to 0.8 mm along with the gap value of 0.2 mm, both the bandwidth which are notched termed as 3.5 GHz named WiMAX and 5.5 GHz named WLAN band got change and start shifting towards to frequency of lower edge side. The upper edge frequency of the antenna which is proposed almost unaffected by this action but the lower edge frequency shifted towards lower side. From the observed results, it can be said that the central notch frequencies of about 3.5 GHz named WiMAX band and 5.5 GHz named WLAN band can be controlled by varying Y2. The antenna provides the impedance bandwidth of about 2.8GHz to 11.9 GHz along with dual band notches ranging 3.35-4 GHz and 5.2-6 GHz at Y2 = 0.4 mm.

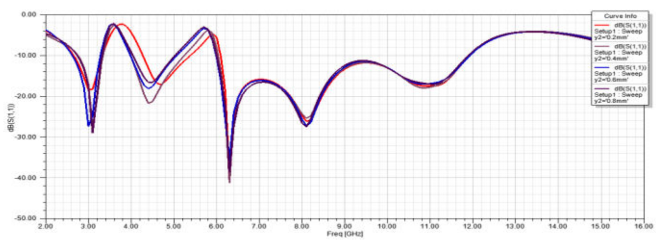

Fig 4. |S11| parameters for two band-notched butterfly structure based UWB antenna by varying values of Y2

IV. SIMULATION RESULT AND DISCUSSION

In this section |S11| parameter is presented is by Fig 5,which has been obatined for with (single/dual) and without band-notched characteristics for the required antenna. The simulated results suggest about that the impedance bandwidth is about 2.8-11.9 GHz and dual notched bands 3.35-4.0 GHz and5.2-6.0GHzobtained. At the same time from the result it can be observed that 3.5 GHz named WiMAX band and 5.5 GHz named WLAN band has been rejected. The analysis of VSWRs with respect to frequency for the above titled antenna with (single/dual) and without band-notched characteristics is presented in Fig 6, it can be obatined from the VSWR value that is less than 2 , lies over frequency for UWB ,except the values of about 3.5 GHz and 5.5 GHz in band notched region. In the 3.5 GHz name as WiMAX obatined value of VSWR is 7.6 and in the 5.5 GHz named WLAN, the VSWR is 4.2 obatined.

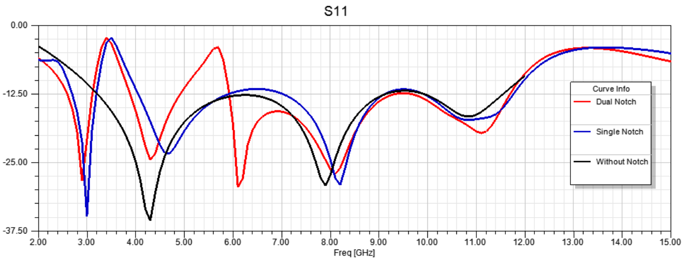

Fig 5: |S11| results against frequency ,with and without two band notch for the butterfly structure based UWB antenna

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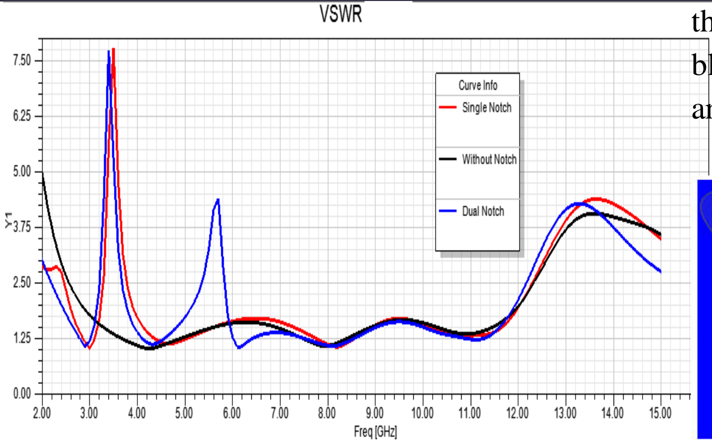

Fig 6: VSWR results for two band-notched butterfly structure based UWB antenna

In the same sequence of results description, the surface current distribution which is described in the Fig 7 (a) and (b), respectively for the 3.5 GHz and 5.5 GHz frequencies .It can be observed by the results that the surface current is mainly concentrated on the upper modified U-shaped slot notching element in Fig 7 (a). It suggest that the antenna does not radiate at around 3.5 GHz and notched band also created. Similarly, from Fig 7 (b) it can be seen that mainly surface current is concentrated over the lower modified U-shaped slot notching element. It also suggest that required antenna not radiates at 5.5 GHz and notched band is created. Therefore, the conclusion can be made that 3.5 GHz and 5.5 GHz band notches created by the upper and lower modified U-shaped slots, respectively. The verification of this concept can also be made with the help of gain curve which is presented in Fig 8. The gain curve which is presented for both with and without band notches. The peak gain is -10 dBi observed in 3.5 GHz that is notched region for required purpose at the same time, in 5.5 GHz region that is notched the obtained value of peak realized gain is -4.38 dBi . From Fig. 8, the conclusion can be made that in the UWB band good gain obtained and gain remains almost unchanged in the UWB range except notched region. Therefore, we can summarized that by cutting upper and lower modified U-shaped slots in the desired design patch, the characteristics will not blocked for the antenna except the regions which are notched here.

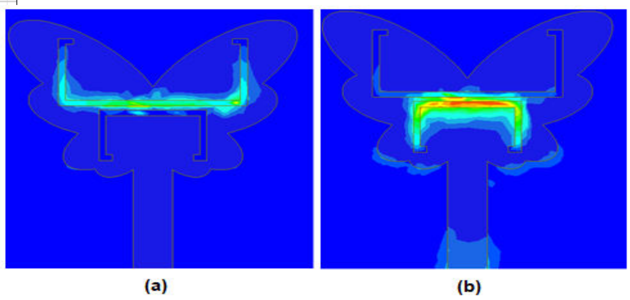

Fig 7: Surface current distributions for two band-notched butterfly shaped UWB antenna at the frequencies of
(a) 3.5 GHz and (b) 5.5 GHz

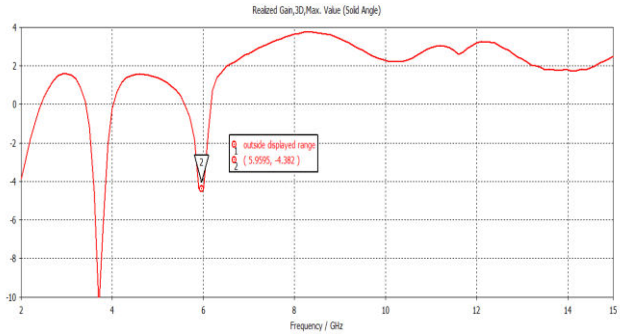

Fig 8: Realised gain with respect to frequency for two band-notched butterfly shaped UWB antenna

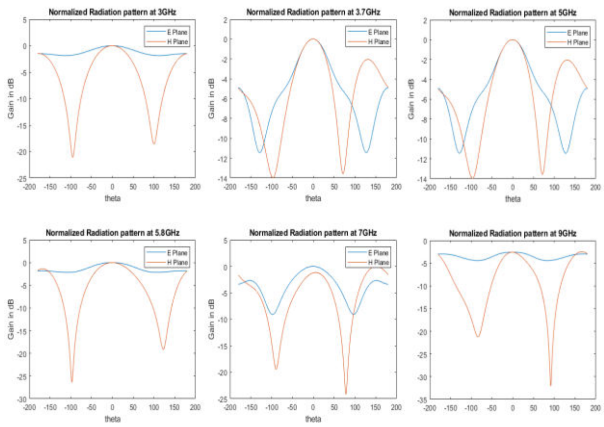

Fig 9: Radiation 2D patterns for two band-notched butterfly shaped UWB antenna

The 2D radiation pattern for proposed antenna in both the planes named by H plane and E-plane at the various frequencies values of about 3 GHz,3.7 GHz, 5 GHz, 5.8 GHz, 7 GHz and 9 GHz is shown

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with the help of Fig 9 . Here The observed result describes that the pattern obatin is omnidirectional at the lower frequencies values and at the same time upper frequencies basically shows nearly omnidirectional patterns .

V. FABRICATED RESULT AND DISCUSSION

This section consists the fabricated result for dual band notch butterfly shaped antenna. The fabricated structure for the proposed antenna is presented in Fig 10, which is developed on FR-4 substrate and vector analyzer result is presented in Fig 11, the impedance bandwidth result is also presented in Fig 12.

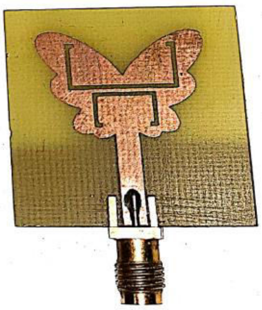

Fig 10: Fabricated design of four arm butterfly shaped dual notched

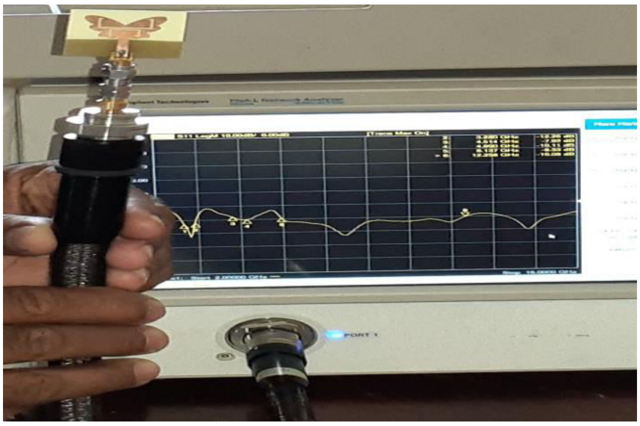

Fig 11: Testing result of dual notched

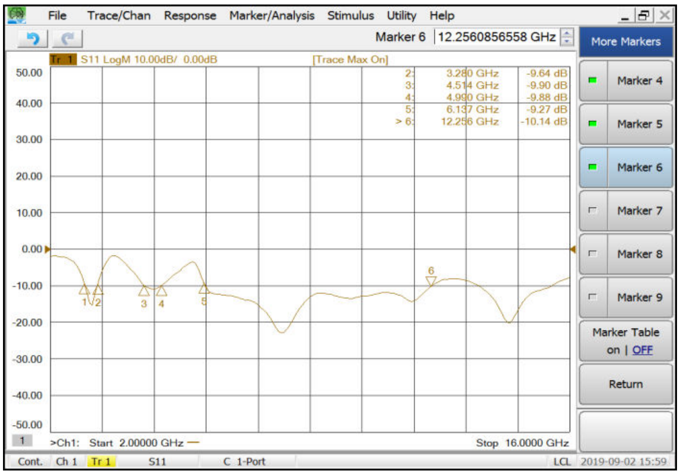

Fig 12: VNA result of four arm butterfly dual notch

VI. RESULT ANALYSIS

S.No	Antenna Design	Frequency range covered by Simulated Antenna	Frequency range covered by Fabricated Antenna with Notches
1	Butterfly shaped with Dual notch	2.8-3.35 GHz 4.0-5.2 GHz 6.0-11.9 GHz Notches: - 3.35-4.0 GHz 5.2-6.0 GHz	2.9-3.2GHz 4.5-4.9GHz 6.1-12.25 GHz Notches: - 3.2-4.5 GHz 4.9-6.1 GHz

VII. CONCLUSION

In this paper, the development of butterfly shaped modified dual U slot is presented. which is used for rejecting of 3.5 GHz band and 5.5GHz band from UWB range. By both the simulated and fabricated result, it can be concluded that the designed antenna is suitable for the UWB application except the 3.5 GHz named WiMAX and 5.5 GHz named WLAN band, the proposed

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and fabricated antenna provide impedance bandwidth2.8-11.9 GHz. The presented antenna is useful wireless applications and analysis the bending effect on antenna and can be useful for wireless body area networking.

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