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NOTCH BAND OPTIMIZATION IN MONOPOLE ANTENNA USING DEFECTED GROUND STRUCTURE

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ABSTRACT

An Ultra Wide band(UWB) antenna with single and dual notch bands is presented. Proposed antenna comprises of two L-shaped open ended slots with a defected ground structure. By changing the radii of circular discs and length of slots in the ground, single and dual band notch characteristics are achieved. It operates from 2.9GHz – 9.8GHz frequency and has a size of 22 X 26 mm^2. This antenna gives omni directional radiation pattern with a gain of 3.85 dB. It can be operated at different frequency bands i.e.; 3.3-3.8-GHz Wi MAX,5.15-5.85-GHz WLAN frequencies and C-band frequencies for satellite communication.

I.INTRODUCTION:

Ultra wide bandinnovation has experienced numerous developments in recent years. Printed monopole antennas have received expanding consideration in UWB application since they display extremely appealing benefits for example, wide impedance data transmission, basic structure, and Omni directional radiation design [11]. However there still stay many difficulties in making this innovation alive up to its maximum potential [11].The commercial use of ultra wide band (UWB) was first approved by Federal Communication Commission (FCC), which has bought drastic change in telecommunications. UWB can be designed between 3.1 to 10.6GHz frequencies for a wide band antenna with a bandwidth greater than 500 MHz [1, 10]. Wireless communication requires simple, low profile, minimal effort antennas. Ultra wide band (UWB) antenna meets all the essentials, where various UWB antennas have been intended for use in wireless communication systems [5]. UWB is short distance radio communication which can perform high speed communication with velocities of more than 100 Mbps. Current communication systems require a solitary antenna to cover Several allotted wireless frequency bands. Additionally, design of a multi-band antenna also covers the ultra wide band (UWB) range without falling apart [4].Many other narrowband communication systems, such as the IEEE 802.11 wireless local area network (WLAN) focused at 5.5 GHz, where the UWB applications may be effected by possible electromagnetic interference. To avoid this, UWB antennas have been proposed by numerous significant band-notched techniques [2]. Monopole antennas have

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great prospect for UWB applications because of their appealing benefits such as low power utilization, high insusceptibility to multipath fading, quicker than Bluetooth and wi-fi, simple fabrication and low profile. [7, 6]The main parameters of this antenna include return loss, radiation pattern, gain and VSWR. In order to satisfy the requirements such as impedance bandwidth it is difficult for an antenna to operate in UWB band[10] .There are some other narrow band services called Wireless Local area Network and Wi-MAX operating at frequencies 5-6GHz and 3.3-6 GHz.[1].The feature of our antenna is monopole with Omni directional radiation pattern. In this antenna single and dual band notched function is provided by cutting L-shaped slot in radiating patch [3].By inserting a rectangular slot in the ground plane notch bands will be obtained [8]. Notched frequency can be easily adjusted by modifying the length of L-shaped slots. The similar techniques were also proposed in [3][5][8] by introducing the new slots like L and U, UWB antennas are designed by adopting the reconfigurable notch band. This technique has been found and demonstrated as a very effective technique in giving band-notched characteristics of UWB antenna [8]. UWB antenna outline in the current literature, the monopole antenna type is widely utilized because of its bandwidth, basic structure. It has turned out to be one of the most impressive candidates for UWB application. A few outlines of monopole planar UWB antenna have been proposed. However it may, some of these antennas include complex calculation and advanced fabrication process. So, we propose a simple design to plan the UWB antenna based on micro strip rectangular patch.However, there exist some narrow bands for other communication systems over the designed frequency band, such as WLAN (5.15 ~ 5.825 GHz), Wi-MAX (3.3 ~ 3.6 GHz) and C-band satellite communication (3.7 ~ 4.2 GHz), which may cause electromagnetic interference with the UWB system [9]. To tackle this problem, the UWB antenna with band-notch characteristic has mainly concentrated and presented in this paper.

IIANTENNA TOPOLOGY

Fig.1 demonstrates the measurements of proposed antenna which has outlined on the bases of micro strip antenna (MPA). It comprises of a conducting patch on one side of a dielectric substrate and a ground plane on opposite side. The antenna is fabricated on a FR-4 epoxy substrate with relative permittivity (εr) 4.4 and thickness 0f 0.8mm, length L1=26mm, width W1=22mm. The measurements of proposed antenna are taken by placing three circular discs of radius R1=6.2mm, R2=R3=5mm on a conducting patch with a dielectric substrate of FR4 epoxy. The proposed antenna is micro strip feed with resonant frequency of 5.5 GHz, Data Impedance of 50Ω, Dielectric loss tangent (tan δ) of 0.02. The antenna parameters like Return loss, Voltage standing wave ratio (VSWR), Radiation pattern, gain at corresponding frequencies are simulated and observed using High Frequency Structural Software (HFSS).

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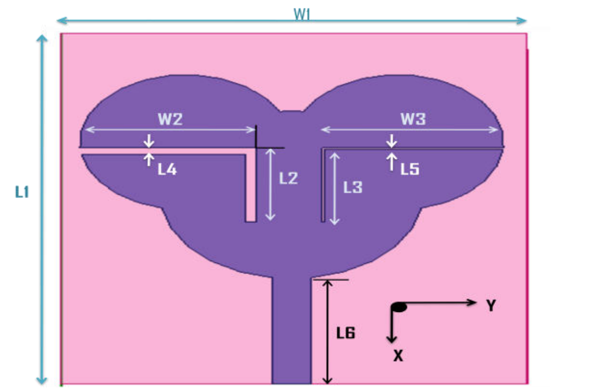
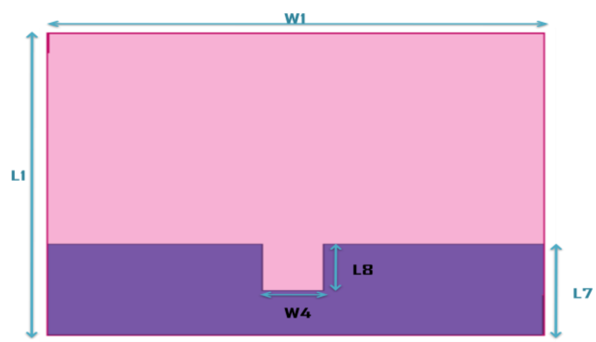


Fig.1 (a) Top View



(b)Defected Ground plane

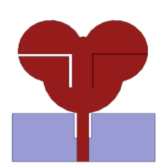
The above figure shows the proposed monopole antenna design which consists of radiating patch, micro strip feed line, defected ground with a rectangular slot. The top view of substrate consists of three circular discs along with two L shaped Slots are presented. Three circular discs are united and two L shaped slots with same length are considered as a patch. By changing the Length of the L slots, notch bands can be obtained easily. The schematic view of ground plane with defected ground structure consists of a rectangular slot. However, the ground plane configuration has an impact on the characteristics of antenna and the bandwidth can be enhanced easily. The rectangular slot in the ground plane is etched to improve the impedance bandwidth. The measurements of the slots on the patch are tabulated below:

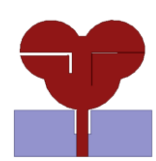
Dimensions	Specifications(mm)
L_2	5.5
W_2	8.4
L_3	5.5
W_3	8.6
L_4	0.5
W_4	1.8
L_5	0.1
L_6	7.9
L_7	7.8
L_8	4

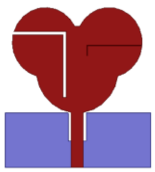
Table 1: Antenna Dimensions

Effects of notches due to various slots

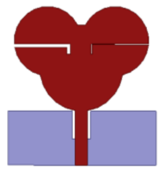
There are six models along with the proposed antenna where the first three models gives single notch and the last three models give double notches in the return loss. By varying the ground slot, L slots and radius of circles single notch with an operating band of 5.04 and double notch with a bandwidth of 5.17 were obtained.







Model3



Model4

Results&Discussions:

The proposed design of antenna has been simulated using Ansoft HFSS. The antenna parameters like radiation patterns in E-plane (Ø-90^{o}) and H-Plane (Ø-0^{o}), Return Loss, VSWR, Gain have been computed utilizing HFSS and results for all six models can be compared & validated. Different comparisons of different simulated models are tabulated as follows:

S. No	Model	Operating Frequency (GHz)	Gain (dB)
1	Model 1	3.8018-4.5909 5.0254-9.7484	3.6185
2	Model 2	3.7412-4.5882 4.9059-9.7412	3.7506
3	Model 3	3.7789-4.5451 4.8539-9.8971	3.8723
4	Model 4	3.3901-3.9099 4.2249-4.9339 5.9975-9.4625	2.1320
5	Model 5	2.9555-3.0602 3.6531-4.1449 5.2427-9.7370	1.9542
6	Model 6	2.9412-3.0824 3.5294-3.6688 4.6235-9.8000	3.8528

Table 2 Models with operating Frequency and Gain

Return Loss for Single Notch

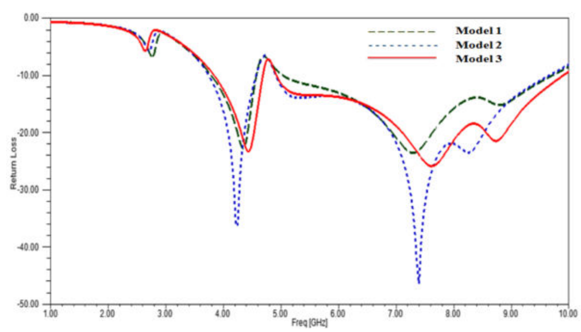


Fig. 2.1 Return Loss for Single Notch

Return loss is can be defined as the loss of power or the signal returned/reflected by a discontinuity which is present in a transmission line or optical fibre. This discontinuity can be a mismatch due to the terminating load or a device inserted in the line. It is usually expressed as a ratio in decibels (dB). Bands obtained for proposed antenna are 2.94 GHz - 3.08 GHz centre frequency 3.02 GHz and return loss 15.6dB, 3.52GHz - 3.66 GHz centre frequency 3.61 GHz and return loss 13.0dB, 4.62GHz - 9.80GHz centre frequency 7.55 GHz and return loss 23.5dB is achieved. From above graph, it is evident that model 3

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exhibits a minimum return loss of -47dB with two operating bands.

Return Loss for Double Notch

The simulation of the proposed antenna gives triple frequencies for dual notches at 3.0GHz, 3.6GHz and 7.5GHz.By comparing the return loss of the three models 4,5 and 6 two notch bands are obtained. However, return loss for model 4 and 5 is more significant compared to model 6.Two narrow band widths are obtained for model 6 within the range 2.9412-3.0824 and 3.5294-3.6688.

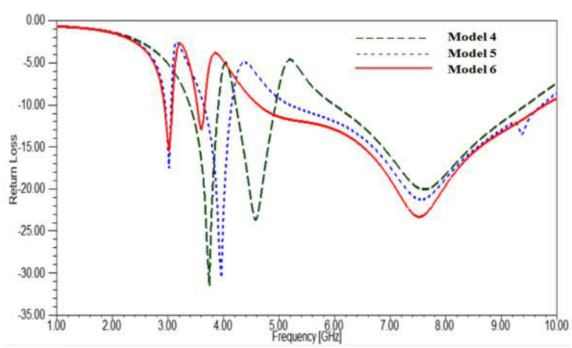


Fig. 2.2 Return Loss for Double Notch

VSWR for single and double notches

The VSWR (Voltage Standing Wave Ratio) is always a real and positive number for antennas. The smaller the VSWR is, the better the matching of the antenna to the transmission line which results in more power delivered to the antenna. The minimum VSWR is 1.0. In this case, no power is reflected from the antenna, which is ideal. The plot of VSWR Vs frequency for the different models are shown in the following figure

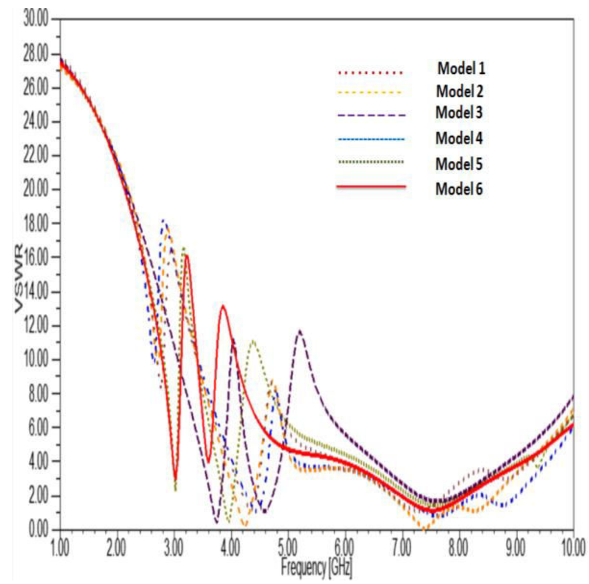
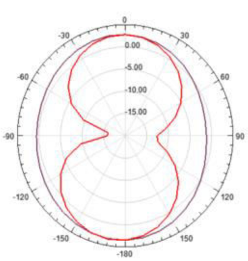
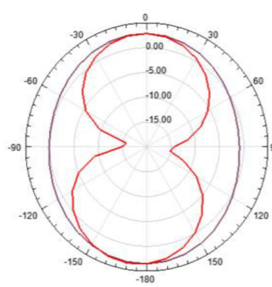


Fig. 2.3 VSWR for single and double notches

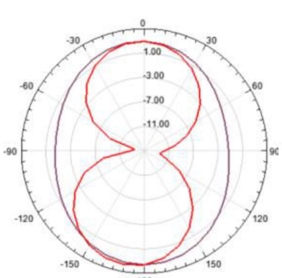
Radiation Patterns for single and double notches



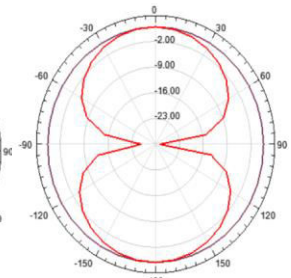
model 1



model 2



model 3



model 4

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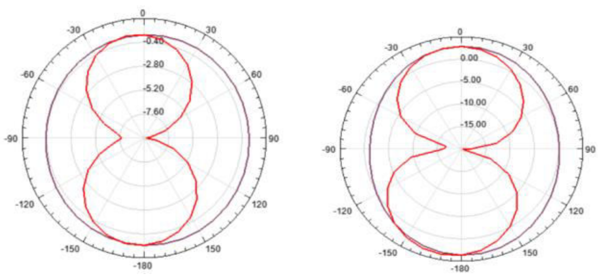

model 5 model 6

Fig. 2.4 Radiation Patterns for six models

The results above are the radiation patterns at maximum operating frequency for six models. The patterns shown below are those resulting from a perfect dipole formed with omni directional pattern. Omni directional antennas are commonly referred to as "omnis." The omni directional antenna radiates and receives equally well in all horizontal directions. The gain of an omni directional antenna can be increased by narrowing the beam width in the vertical or elevation plane.

Frequency Vs Gain Graph

In the below graph 4.GHz to 9.5GHZ positive gain can be considered, where the operating frequency is same and at 6.8GHz maximum gain of 3.8 is observed.

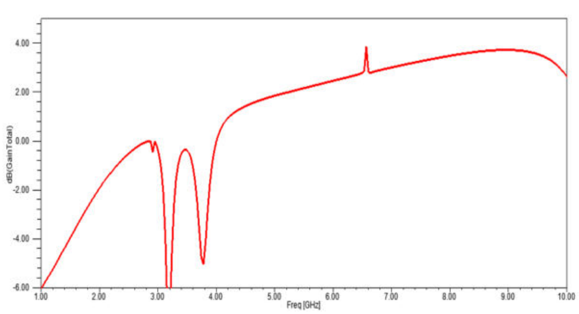

Fig. 2.5 Frequency Vs Gain Graph

CONCLUSION

A novel technique for enhancing bandwidth of a micro strip patch antenna with single and dual band characteristics along with a wide bandwidth capability for broad band applications is designed and discussed. Micro strip patch antenna for wireless applications covering 2.94 to 9.80 GHz frequency along with notches has been presented. The proposed UWB antenna provides high bandwidth, return loss up to -23.5 dB. The simulated result of design antenna shows good performance and thus can be used as various wireless applications such as Wi MAX, WLAN, C-band satellite communication and mobile communication.

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