A Simple Reconfigurable Elliptical UWB Antenna with Dual Band Rejection

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***Abstract:** This paper offerings a reconfigurable elliptical UWB antenna with dual band rejection characteristics. This antenna is modelled on 38 X 40 mm^2 FR4 substrate. It has ability in wisely handle the issue of interferences comes from the Wi-MAX 3.3GHz-3.7GHz, X-Band satellite communication uplink frequency 7.9GHz-8.4GHz. Two U-Shaped slots one is 28mm created on the patch and another 11.1mm placed on the feed line to achieve band rejection at Wi MAX and X-Band satellite uplink band. Two PIN Diodes are placed on the slots to get on demand band rejection. The antenna is constructed and simulated using HFSS. The planned antenna has VSWR< 2 from 3-11 GHz.*

***Index Terms:** UWB antenna, U-shaped slot, Band rejection, Reconfigurable antenna.*

I. INTRODUCTION

The Federal Communication Commission (FCC) was approved frequency band 3100MHz to 1060MHz for commercial usage in 2002. But this frequency band will origin obstruction to the current wireless communication systems like Wi-MAX for example the World-wide Interoperability for Microwave Access (Wi-Max) for IEEE 802.16 using 3300MHz–3700MHz band ,WLAN (5150MHz-5350MHz) and (5725MHz-5825MHz), X-Band satellite communication Uplink frequency band of (7900MHz-8400MHz) and downlink frequency band of (7250MHz-7750MHz). To reject those bands permanently several methods are proposed in [1]-[3]. In [1] Triple band stop characteristics are gained by placing CLL Which are capacitively loaded Loop resonators, by this it can eliminates WLAN frequency band. In [2] the narrow Wi-Max, WLAN band notching is achieved by placing slots and subs along with radiating element. In [3] the designed antenna is distinctly used for Radar applications by eliminating the three narrow bands Wi-MAX, WLAN and ITU with the help of slots. However, the permanent band elimination is not always important. To improve UWB link efficiency requires band abolish on demand. A compressed ultra-wideband (UWB) antenna with switchable band-notched characteristics was designed in [4]. An alphabetical letter T-shape was designed on the ground is utilized to thicken the frequency band of antenna and dual arc-shaped slots are inserted on the patch helps to achieve band rejection. While coming into [5] three rectangular slits are created on circular shaped radiating patch. Besides, by inserting two triangular spaces formed on an adjusted ground plane and two PIN diodes are attached across the circular slot to get reconfigurability at the Wi-Fi and Wi-Max bands, by changing the state of the diode we can achieve the reconfigurability.

The antenna in [6] is a simple round emission patch edifice with semi- ground plane. The band-rejection is practiced by organizing straight open stub in the feed line to keep up a key separation from the clashing of Wireless Local Area Network (WLAN) that works in the UWB recurrence band. One RF switch is placed on the open stub to initiate and disengage the conforming band-notch by ON and OFF conditions of switch .In [7] the notched-band frequency tin be consistently tunable inside a specific range by fluctuating the voltage on the varactordiodes in the U-shaped slots and in [8] the utilization of a stepped impedance resonator and a winding stub, properties is recognized by the organizing two diodes into the winding formed stub and the ventured impedance resonator to control their resonances by that we can accomplish band-dismissal reconfigurability.

A minor UWB antenna with dual band notches was presented in [9]. Two identical C model strips are created besides feedline and same model slot is created on the circular patch to gain Wi-Max and WLAN band rejection.

In this Work an elliptical mono pole antenna with two U-shaped slots are presented. Two slots are created on patch and feedline to achieve Wi-Max and X-Band satellite communication uplink frequency band rejections. To improve efficiency of UWB link reconfigurability is proposed by placing the diode across the slits. Band rejection is controlled by altering the state of the PIN-Diode. In the following sections the antenna design is given first and then operation and design explained through the simulation results. In section III results are mentioned for the four states.

II. ANTENNA DESIGN

The geometry of the planned Elliptical mono pole antenna is described in fig1. This antenna is measured on 1.6mm FR-4 substrate with di-electric constant 4.4 and loss tangent 0.02. This antenna is fed by 50Ω micro strip line with a width of 2mm and a radiating elliptical patch with axis of L3 and W3.The ground plane with two similar triangular slots are created on the bottom layer of the substrate to achieve impedance matching.

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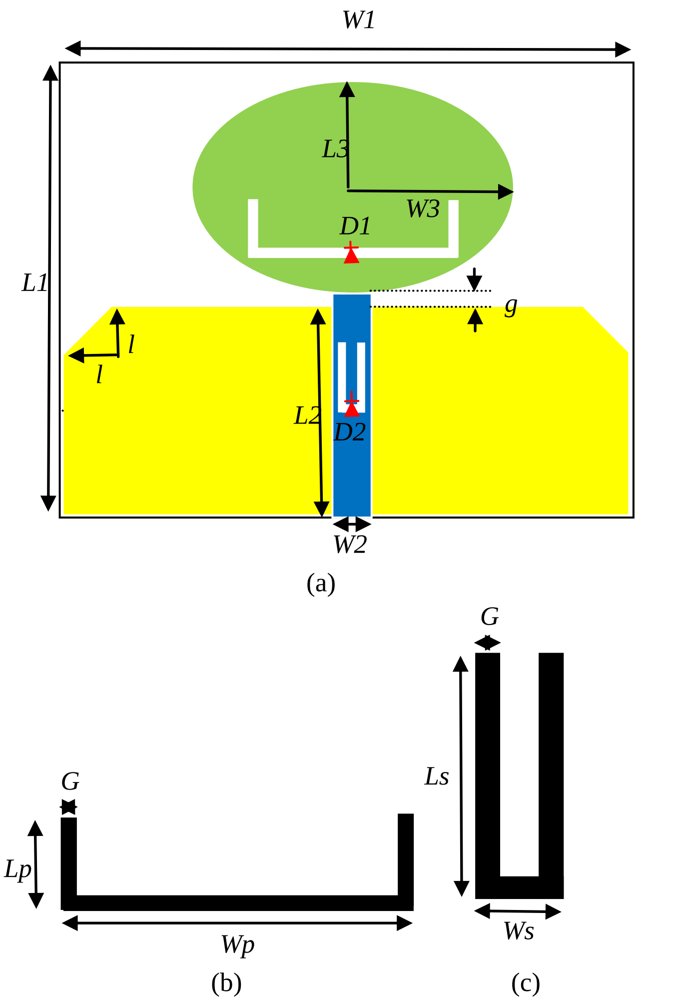

Fig. 1. Elliptical Ultra-Wide Band antenna design: (a) 2 D layout of antenna (b) First slot on elliptical patch (c) Second slot on the feed line.

The proportions of the antenna is known in the table

Table 1 Measurements of the planned antenna

Design Parameters	Dimensions(mm)
L1	38
W1	40
L2	19
W2	2
L3	8.5
W3	17
Ls	5.45
Ws	1
Lp	4
Wp	20
G	0.35
g	1
l	6

The lengths of corresponding slots were obtained by following the mathematical equation

$$L = \frac{c}{2f_0\sqrt{\epsilon_{eff}}}$$

Where L - length of the slot, f_0 - working frequency of antenna, ε_{eff} - effective di-electric constant and c - speed of light. The length of first slot on elliptical patch was (Lp+Wp) 28mm and second slot on feedline was (Ls+Ws) 11mm.

The two PIN diodes are placed on slot to obtain reconfigurability. In OFF state the diodes will acts as an insulator and opposes the current flow in slots. By, this phenomenon we make the slots to work as band rejection filters. In ON state the diodes will acts as conductor. So, there will be no band rejection property. The equivalent circuit of ON and OFF state of diode is shown in figure 2. In this equivalent circuit L=0.45nH, Rs=1.5Ω, R_p=2.5kΩ and C_T=0.25pF.

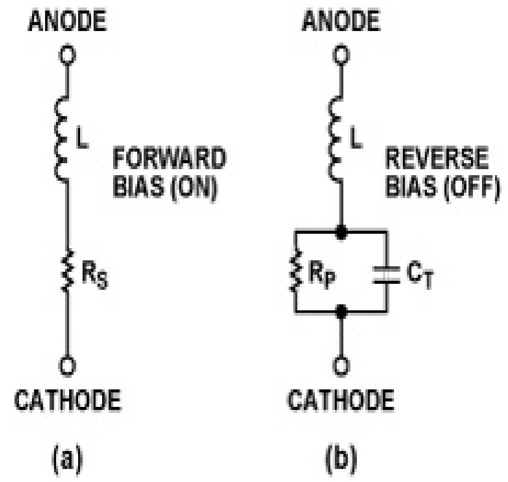

Fig. 2. Equivalent circuit model of PIN Diode (a) ON condition (b) OFF condition

III. RESULTS AND DISCUSSION

The performances of planned antenna under different states of diodes is shown in Figure 3. The VSWR (Voltage Standing Wave Ratio) greater than 2 has band rejections at 3200MHz-3800MHz and 7900MHz-8500MHz.The reconfigurability characteristic of antenna is used to work same antenna for different applications. While executing diodes are replaced with rectangular patches.

We have four working states of antenna are, when D1 and D2 are in OFF conditions, slots on the patch will become active and helps in refusing of WLAN band frequencies 3300MHz-3700MHz and X-Band satellite communication uplink frequencies 7900MHz-8000MHz. When D1 is in OFF and D2 is in ON, we will lost the WLAN band. In next state D1 is in ON and D2 is in OFF, it allows all UWB frequencies except X-Band satellite uplink frequency band. In last state both diodes are in ON condition, we will get UWB antenna frequency band from 3300MHz to 1100GMHz. The Table 2 illustrations the diode arrangement of the planned antenna.

Table 2. Band Rejection with different states of PIN Diodes

States	Diode Configuration		**Stop Bands**
	D1	D2	
1	OFF	OFF	Wi-Max and X-Band Uplink

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2	OFF	ON	Wi-Max
3	ON	OFF	X-Band Uplink
4	ON	ON	No Band Rejection

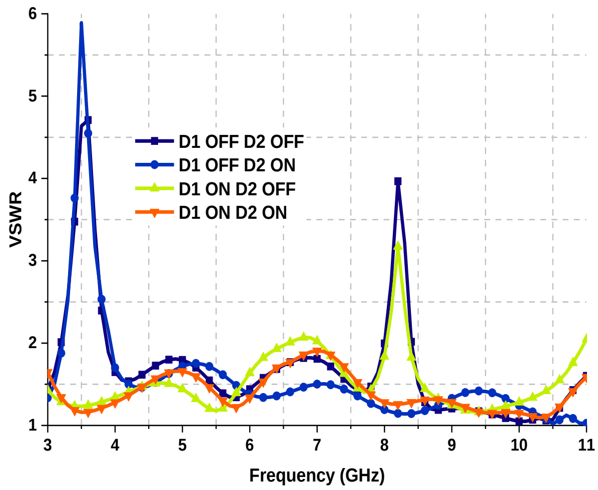
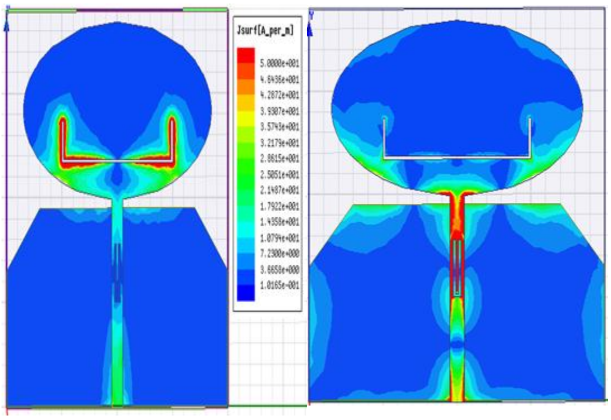


Fig. 3. Simulated VSWR of antenna for different states of D1 and D2

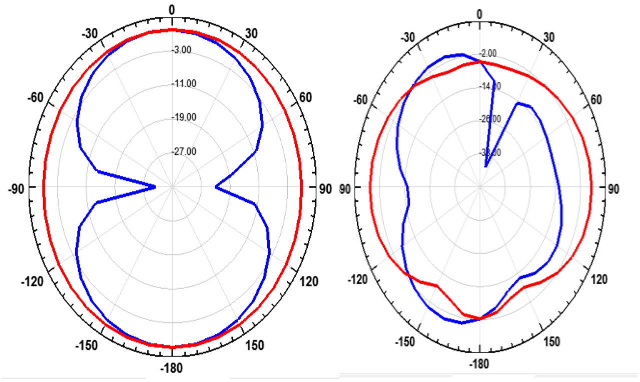
In order to get clarity on the working mechanism of purposed antenna, the simulated current distributions under two different conditions are strategized in Fig.6. Fig.6(a) and 6(b) describes that the surface currents at 3500MHz and 8000MHz are spread over elliptical single pole and feedline of the antenna.



(a) (b)

Fig. 4 Current Distribution of purposed antenna (a) at 3.5GHz (b) at 8GHz

Figure 5 shows the simulated radiation patterns at 3GHz and 8GHz when the diodes are in OFF state. As we observe that the radiation pattern is in omni-directional for both frequencies. Figure 6 indicates that the peak gain of dual band rejection antenna is between 3-7 dB except two notched bands.



(a) (b)

Fig. 5. Radiation Pattern (a) at 3GHz (b) at 7GHz

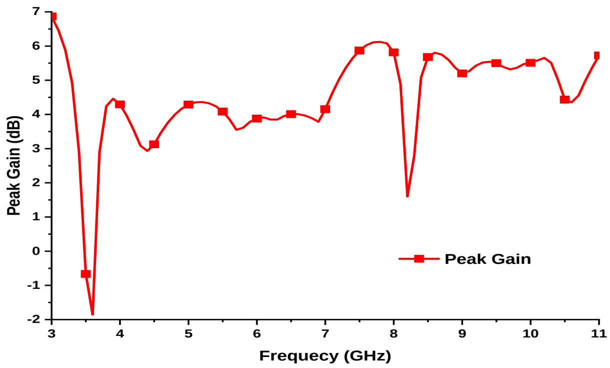


Fig. 6.Simulated peak gain of the proposed antenna

IV. CONCLUSION

This paper presented an elliptical UWB slot antenna with on-demand band rejection features for wireless applications. It has been investigated that by slot created on the ground plane can enhance the bandwidth from 3-11 GHz. Two PIN Diodes on the slotted patch and feedline will generate single and dual band rejections which are minimizes the interferences with current Wi-Max and X-Band satellite uplink frequency bands.

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