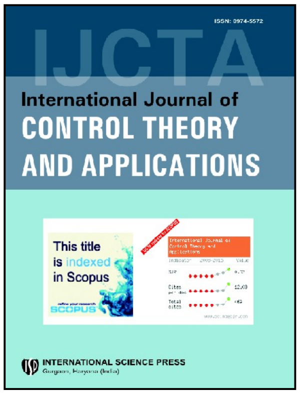

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Frequency Reconfigurable Bevel Shaped UWB Antenna with PIN Diodes

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Abstract: In this paper a compact UWB frequency reconfigurable antenna with bevel shape using PIN diodes is proposed. This antenna consists of two rectangular patches and DGS in the ground plane. Here these two rectangular patches are connected by using PIN diodes which are the key factors for achieving frequency reconfigurability. The ON and OFF state of diodes here enables and disables different frequency band notches and hence reconfigurability is achieved. This antenna is designed for multi band like WLAN, Wi-Fi, GSM, Wi-MAX, GPS and Bluetooth. The antenna structure proposed has VSWR below 2 and S11 less than -10db. The proposed antenna might have applications in wireless technological systems for multi band application.

Keywords: Bevel shape, Notch, PIN Diodes, Reconfigurable, Ultra Wideband (UWB)

1. INTRODUCTION

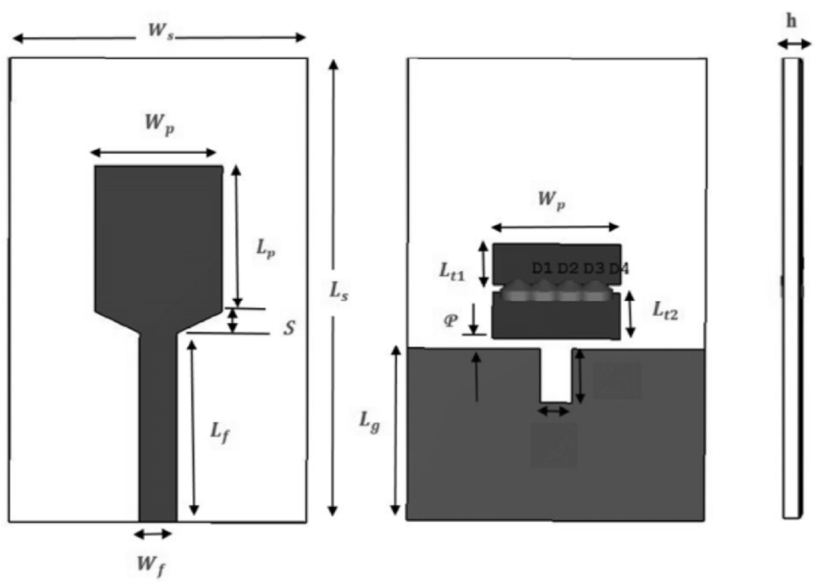
In radar and communication systems antennas are the pivotal components. For particular applications particular types of antennas are used. So as to obtain restrictions on system performance antenna characteristics are fixed. To adopt with changing system requirements antenna should be reconfigurable. Reconfiguration of antenna can be achieved by changing its polarization, frequency or radiation pattern characteristics by means of switching mechanisms like RF MEMS, pin diodes, varactor diodes etc [1-2]. Due to the advantage of low profile, light weight, low fabrication cost and ease of integration with RF device micro strip antenna are widely used to provide reconfiguration by adjusting the resonant frequency or by changing the shape of the radiating element frequency reconfiguration can be achieved. By controlling the states of switches frequency selectivity can be achieved. PIN diode, RF MEMS varactor diode can be used as switches [3-4].

In recent times UWB because of its admirable benefits such as multipath fading, resistance against jamming, low complexity, low cost, low power requirements and penetrating capability has become a very propitious wireless technology. For commercial applications the spectral mask of UWB is of Bandwidth 3.1 to 10.6GHz i.e. according to the FCC. Because of the omni direction radiation pattern, wide impedance bandwidth and small size printed monopole antennas are good for UWB systems. Various UWB printed monopole antennas with upgraded impedance bandwidth have been reported as in [5-6]. By using either ground switching or feed the selection of various modes in [7-8] was achieved. Multiband slot reconfiguration dipole antenna which can select a distinguishable frequency bands are proposed in [9-12]. It can switch to single, dual or triple band modes by using switches, RF MEMEs, varactor diodes. An open end straight slot line and PIN diodes to achieve frequency reconfiguration capability. To create short circuit and open circuit along the slot the PIN diodes are located at specific positions with DC bias network.

This paper presents a frequency reconfigurable antenna. The reconfigurability is achieved by changing the states of PIN diode. This antenna employs PIN diodes to switch to different applications line Wi-Fi, Bluetooth, Wi-max, WLAN etc with return loss less than -10 db and a gain more than 3db.

2. PROPOSED APPROACH

The construction of the proposed reconfigurable antenna is shown in the Fig.1 (a) and Fig 1(b). It is designed using FR-4 substrate having ε_r = 4.4 and a thickness of 1.5mm and loss tangent i.e. tan δ = 0.02. The perceptive dimensions on the top planeare obtained as in [11]. It is fed by microstrip line feeding technique.



(a) Front view (b) Back view (c) side view

Figure 1: Schematic diagram of proposed reconfigurable antenna with PIN diodes

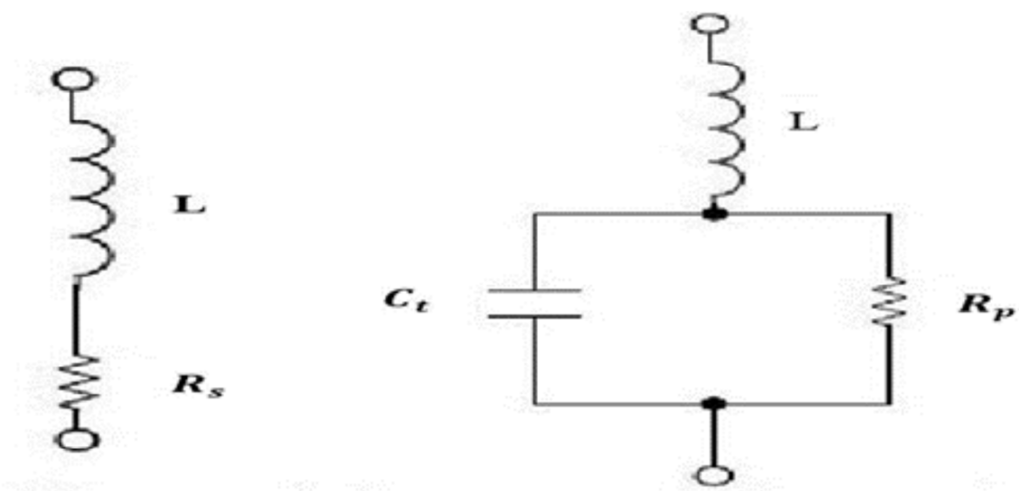
The dimensions of the proposed antenna are shown in table 1.

Table 1
Antenna Dimensions

Parameter	*Dimensions (in mm)*
L_2	43
W_2	28
L_p	13.5
W_p	12
L_f	17.5
W_f	3.5
S	2
L_{t2}	4.3
L_{t2}	3.8
L_k	5
W_k	3
P	1

The proposed antenna has beveling shape. It is fed by microstrip line feeding technique. Two patch parts are in ground plane which are connected by means of PIN diodes D1, D2, D3, D4 which are of length 0.7mm. These diodes are equally separated and placed between the two patches in the ground plane. To eliminate the effect of separation between two patches in ground plane, RF capacitors are used to block DC and provide RF wave connection. For the enrichment of impedance bandwidth a slit is added in the ground plane and the radiator is tapered from the fed line (4) as shown in fig 1 and fig 2. The effect of the (Ws, Ls) and (L1, W, h) are studied in [12].

ON and OFF states of the PIN diode is attained by properly biasing the diode. In forward bias, PIN diode is in ON state which provides low impedance and acts as short circuit and in reverse bias, PIN diode is in OFF state which provides high impedance and acts as open circuit. For ON state, an inductor L in series with resistance R_s is the equivalent circuit of PIN diode. For OFF state, the equivalent circuit of PIN diode is L in series with parallel connection of a capacitor C_t and resistance R_p.



(a) (b)

Figure 2: PIN diode equivalent circuit: (a) ON State, (b) OFF state

The simulation of the proposed antenna is carried out by using CST microwave studios. In the simulation RF PIN diodesBAR50-02V are used to make sure the accuracy of experiment by blocking DC.

3. SIMULATION RESULTS AND DICUSSION

The fulfillment of the proposed antenna is characterized by its electrical properties such as Returloss, VSWR and bandwidth. One way of expressing the mismatch in transmission line is Return loss. The return loss of proposed antenna is below -10db in both simulated and measured results. VSWR is a way to measure transmission line and it is related to return loss. VSWR of the proposed antenna is below 2db in both simulated and measured results. The range of frequencies over which antenna can operate exactly is the bandwidth of the antenna.

Different frequency bands and frequency reconfigurability of the proposed antenna can be achieved by changing the states of PIN diode. Table 2 shows the configuration of the diodes, where ON and OFF states are represented by '1' & '0' respectively. The simulated and measured return loss i.e. S_{11} at different states of the proposed antenna are shown in the figure 3 and 4 respectively. During diode ON state in different possible conditions of the four diodes different bands of frequencies are stopped.In that only four conditions are taken as they act as exactly when individual diodes are taken. The generalized configuration of diodes are mentioned in the following table.

Table 2
Configuration of diodes in different states

DIODES				*NOTCH BANDS*
D1	*D2*	*D3*	*D4*	
0	0	0	0	4.3 - 4.9GHz
0	0	0	1	4.4 – 5 GHz
0	0	1	0	4.4-4.98GHz
0	0	1	1	4.47-5.05GHz
0	1	0	0	4.40-5 GHz
0	1	0	1	4.47-5.11GHz
0	1	1	0	4.45-5.07GHz
0	1	1	1	4.54-5.02GHz
1	0	0	0	4.39-5.02GHz
1	0	0	1	5.20-5.91GHz
1	0	1	0	4.91-5.64GHz
1	0	1	1	5.02-5.78GHz
1	1	0	0	4.46-5.09GHz
1	1	0	1	5.8-6.7 GHz
1	1	1	0	4.52-5.20GHz
1	1	1	1	4.59-5.27GHz

Table 3
Generalized configuration of diodes in different states

DIODES				*NOTCH BANDS*
0	0	0	0	4.3 – 4.9 GHz
1	0	0	1	5.20-5.91 GHz
1	1	0	1	5.8-6.7 GHz
1	1	1	1	4.59-5.27 GHz

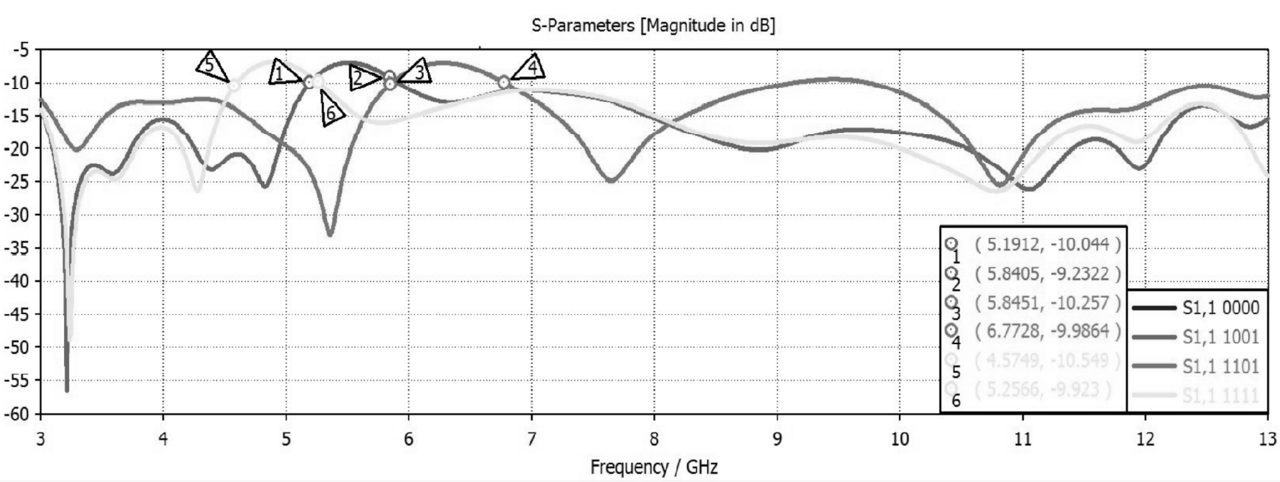


Figure 3: Simulated S_{11} of the proposed antenna

The average gain of antenna is about 3.2 dB and a maximum gain of 3.8 dB achieved using this antenna. Fig 4 and 5 shows the gain in 3D and gain plot in 2D. Compared to lower operating band, at higher operating band the gain is little bit high.

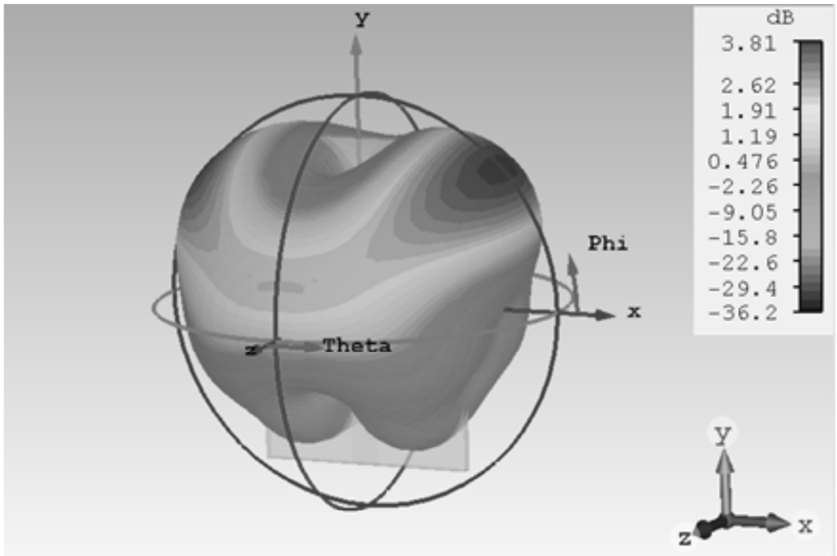


Figure 4: Gain of the proposed antenna

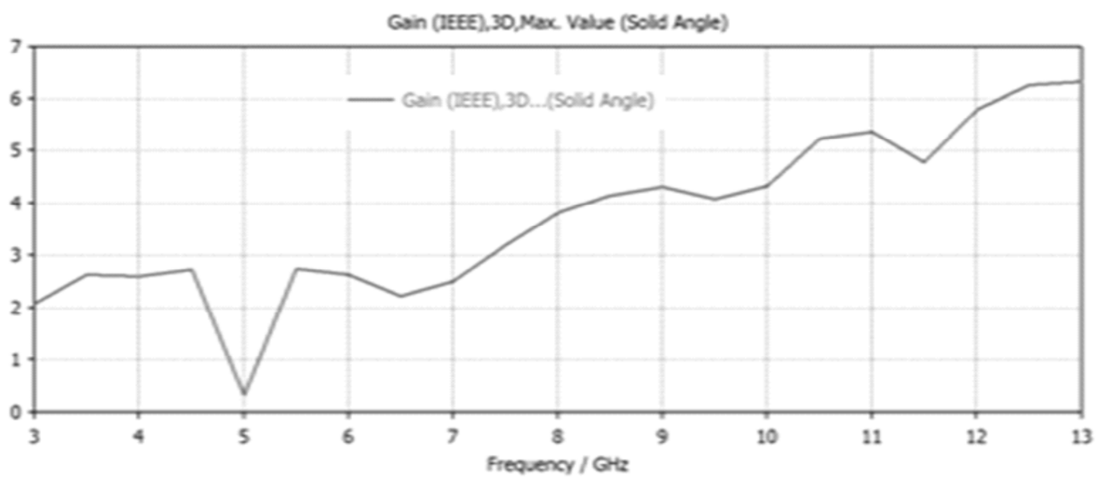


Figure 5: Frequency vs. gain of proposed antenna

The simulated radiation patterns i.e. E-plane & H-plane patterns of proposed antenna are shown in figure.6 at different frequencies. It is observed that the radiation patterns are almost same with bidirectional in H-plane and Omnidirectional in E-plane.

4. CONCLUSION

A bevel shaped frequency reconfigurable UWB antenna is proposed and its design with analysis and simulation results is presented in this work. Here frequency reconfigurability is achieved by changing the states of diodes that are connected in between the strips on the back side of the antenna model. By blocking different bands at

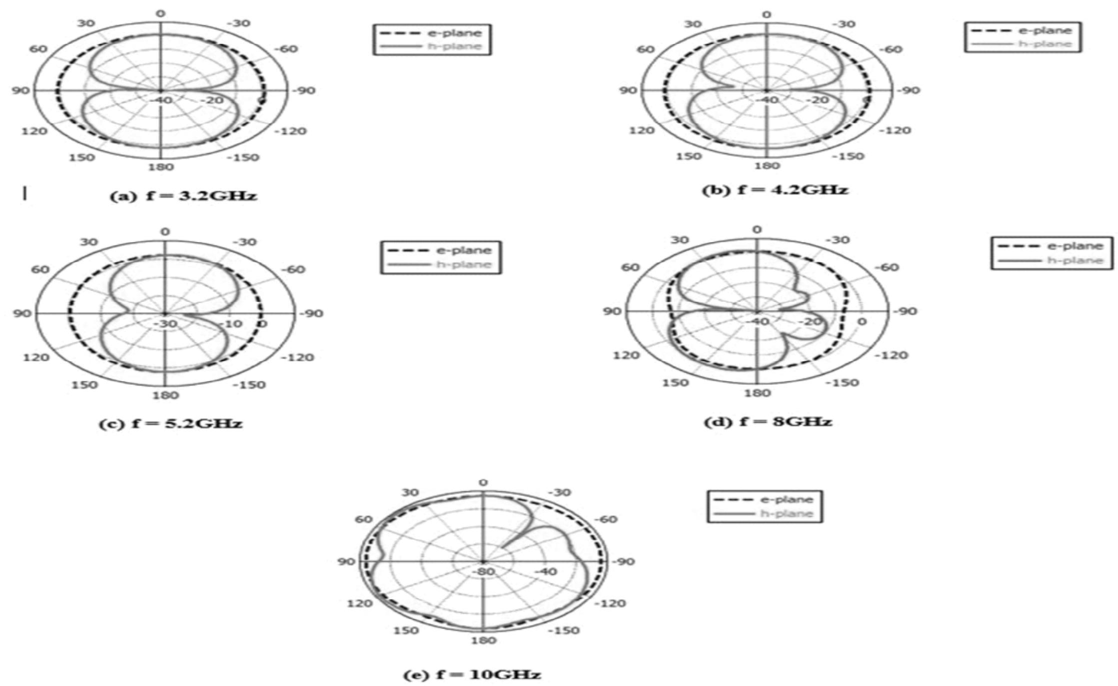


Figure 6 : E-plane and H-plane patterns of proposed antenna at different frequencies

different states with diodes positions, the desired operating bands can be highlighted. The switching of the frequency with the help of diode states are analyzed with respect to reflection coefficient, gain and the corresponding radiation patterns in this work.

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