Design of Circularly Polarized Reconfigurable Antenna for Ultra Wideband Applications

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ABSTRACT

The advancement in the antenna technology and the growth in high density wireless networks have led to design of antennas with smaller size in dimensions, lower price, lighter in weight ,reconfigurable, multiband and wideband in nature . The study of reconfigurable antennas has made tremendous progress in recent years. This proposed work is an attempt to design an antenna that can dynamically change frequency, pattern, polarization to modifiable structures that can be adapted. Here we have used reconfigurable technique due to which it can be switched among different frequency bands. Ansoft HFSS Software is used for design, simulation and analysis. The design is modified to work for multiband and wideband antenna The antenna is designed to work in 3GHz-7GHz frequencies and is left circularly polarized to avoid losses during communication. PIN diodes have been used to achieve reconfigurability. The results are obtained for the modal driven model . The simulated and measured results are in terms of return loss, gain, radiation pattern and bandwidth are presented.

Keyword: - *Reconfigurable antenna, Wireless communication system, PIN diode*

INTRODUCTION

Antennas are the key components in any wireless communication system. Reconfigurablity has become an important and desired feature of modern, agile, radio-frequency system for wireless and satellite communication, sensing and imaging.A reconfigurable antenna is an antenna capable of modifying its frequency and radiation properties dynamically, in a controlled and reversible manner. The current state of advancements in the development of antennas focuses on compact multiband, multifunctional and cost effective antenna is increased. The reconfigurable antennas is capable of offering a variety of features like change in operating resonant frequency, polarization, and radiation pattern. Thus reconfigurable antennas are based on antenna geometry modification with change in electrical behaviour thereby adapting to change in environmental conditions. This reconfigurability aspect demands complex system requirements.

PIN DIODE

*A **PIN diode** is a diode with a wide, undoped intrinsic semiconductor region between a p-type semiconductor and an n-type semiconductor region. The p-type and n-type regions are typically heavily doped because they are used for ohmic contacts. The pin diode switch is modelled is using HFSS as resistor of proper value for ON state and capacitor as OFF state. Antenna resonates at multiple frequencies under different switch configurations because of the switch incorporation in its geometry. Thereby multiband and wide band characteristics are obtained.*

The SMP1320 series of plastic packaged, surface mountable PIN diodes are designed for high volume switchapplications from 10 MHz to beyond 2 GHz. The lowcurrent performance of these diodes (0.9 Ωmaximum at 10 mA and 2 Ωtypical at 1 mA) make the SMP1320 seriesparticularly suited to battery operated circuits.

Availablein a selection of plastic packages and in a variety ofconfigurations including a low inductance (0.4 nH) SOT-23 (SMP1320-007), the small footprint SC-79 and theminiature SC-70.

Absolute Maximum Ratings

Characteristic	Value
Reverse Voltage (V_R)	50 V
Power Dissipation @ 25°C Lead Temperature (P_D)	250 mW
Storage Temperature (T_{ST})	-65°C to +150°C
Operating Temperature (T_{OP})	-65°C to +150°C
ESD Human Body Model	Class 1B

Electrical Specifications at 25°C

Parameter	Condition	Typ.	Max.	Unit
Reverse Current (I_R)	V_R = 50 V		10	µA
Capacitance (C_T)	F = 1 MHz, V = 30 V		0.30	pF
Resistance (R_S)	F = 100 MHz, I = 1 mA	2.0		Ω
Resistance (R_S)	F = 100 MHz, I = 10 mA		0.9	Ω
Forward Voltage (V_F)	IF = 10 mA	0.85		V
Carrier Lifetime (TI)	IF = 10 mA	0.4		µS
I Region Width		8		µm

*The packaging we are using is **SOD 323 pakage and the model no is 1320-011.**The resistance of modeled pin diode is 0.9 Ω Resistance, 0.3 pF Capacitance and inductance is 0.7 nH.*

FREQUENCY RECONFIGURABLE ANTENNA:-

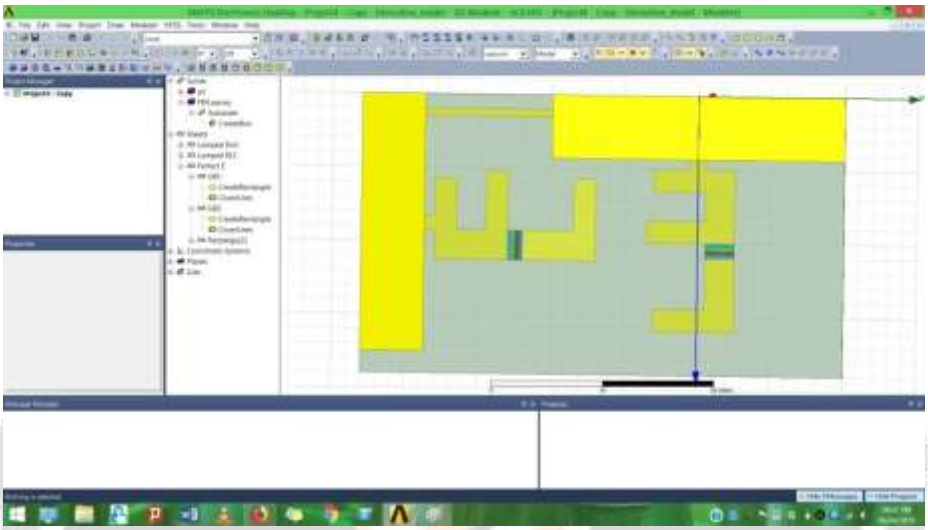
Frequency reconfigurable antennas gain interest especially in future wireless communication systems due to flexibility in many applications. This paper reviews three different configurations of frequency reconfigurable antenna. The first configuration is the narrowband to narrowband frequency reconfigurable using slot type of antenna and microstrip antenna. The second configuration is the wideband to narrowband frequency reconfigurable antenna, planar monopole contribute to the wideband characteristic while a slot antenna is for narrowband. The third configuration used tunable electromagnetic band-gap (EBG) to configure the band notched frequency. The designed structures simulated performances and analysis are discussed in this paper. The analysis is also focused on the performance of the diode as a switch to reconfigure the frequencies.

Antenna Structure :

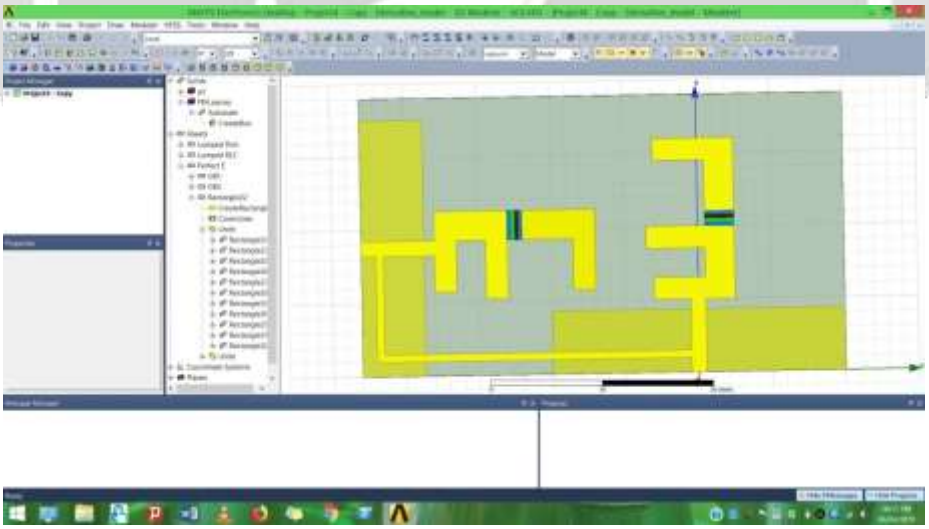
Reconfigurable antennas have multiple operating modes but only a single geometry which makes them highly versatile. To design ultra-wide band antenna the operating frequency is chosen as 3.20-7.7 GHz taking into consideration satellite transmission and reception, 5G wireless communication ,WiFi devices, cordless telephones, surveillance and weather radar systems which can be further modified to work as MIMO antenna. Other shapes can also be used like dipole, square, circular, elliptical, triangular etc. as per requirement. Such shapes are commonly used because of their ease of analysis as well as fabrication. The antenna performance relies highly upon size and shape.

Different shapes were designed and analyzed and compared on the basis of gain, VSWR , S11 parameters and directivity. However our goal here was to achieve polarization so as to minimize losses during transmission and reception of signal. The FR4 is selected as substrate. The antenna elements are orthogonal, and have lower mutual coupling and hence the pattern of each element lies on a plane orthogonal to another.

The designed antenna has array dimensions of 66 x 38mm^2.It is fabricated on a 0.5mm FR4 substrate of permittivity 4.4.The antenna achieves frequency reconfigurability by using modeled pin diode with capacitance 0.1pF,inductance 0.7nH and resistance 3 ohm at 25 degrees.



Fig(a): bottom view



Fig(b): top view

Simulation Results :

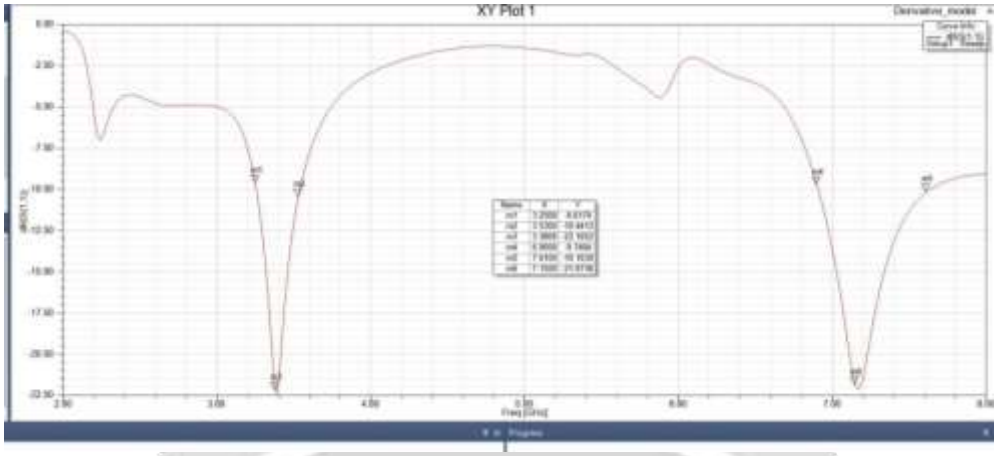


Fig. (a)S11 paremeter when both diodes off.

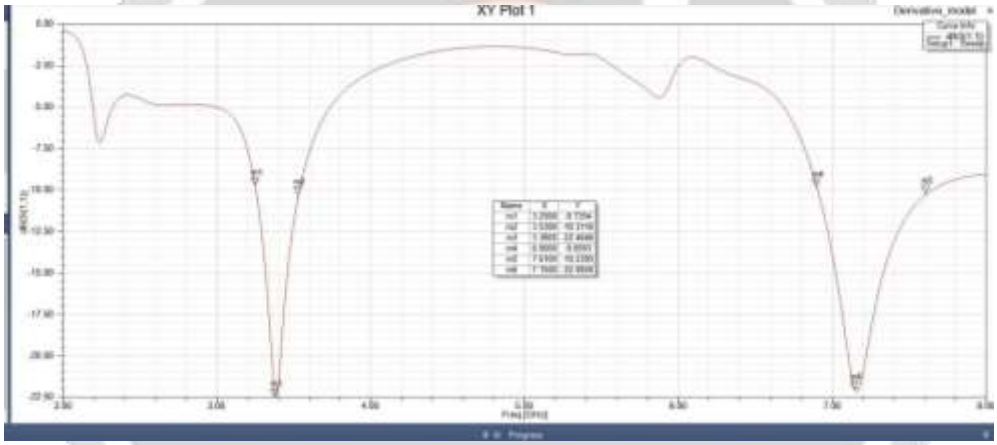


Fig. (b)S11 paremeter when diode 1 is on and diode 2 is off.

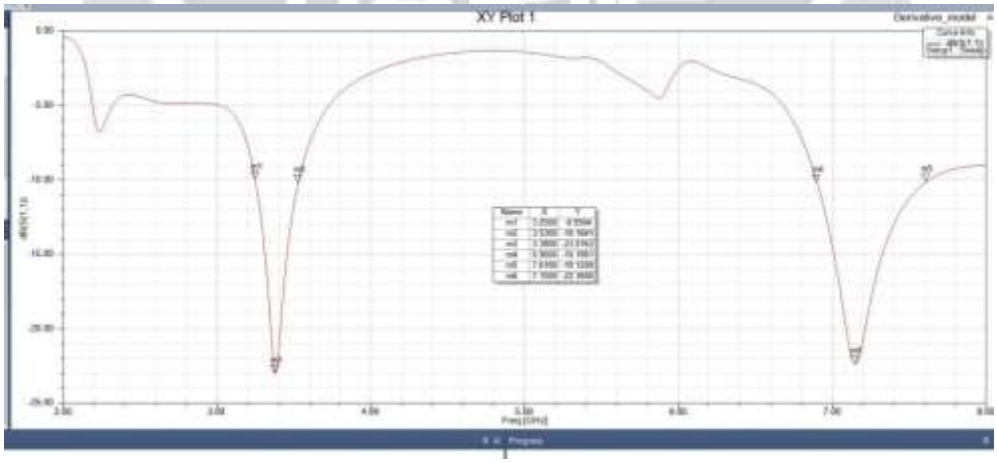


Fig. (c)S11 paremeter when diode 1 is off and diode 2 is on.

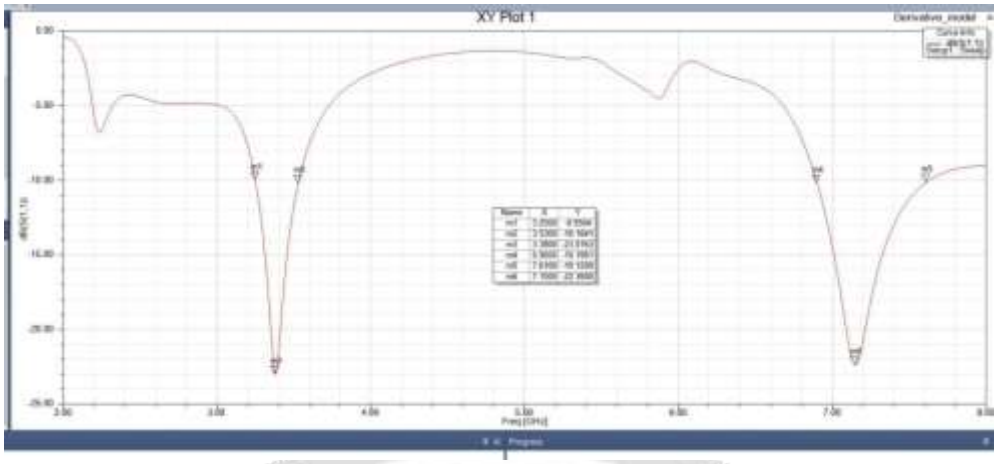
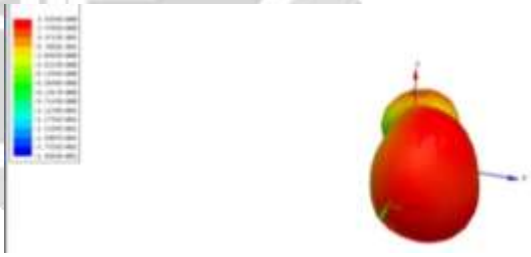


Fig. (d)S11 paremeter when both diodes on.

Table Bandwidth ranges after incorporating the switches in E-shaped antenna:

Sr. No.	Frequencies (in GHz)	Bandwidth (in MHz)	Switch 1	Switch 2	3D Gain Plot
1.	**3.25-3.53**	**280**	**OFF**	**OFF**	
	6.9-7.61	710			
2.	3.25-3.53	280	ON	OFF	
	6.9-7.61	**710**			
3.	3.25-3.53	280	OFF	ON	
	6.9-7.61	**710**			

4.	3.25-3.52 **6.87-7.56**	270 **690**	ON	ON	

4. CONCLUSIONS

This proposed work is an attempt to design an antenna that can dynamically change frequency, pattern, polarization to modifiable structures that can be adapted and a prototype of the proposed design is successfully implemented. The gain for this antenna is found to be have maximum value of 4.018 dB It has maximum directivity of 4.9385 dB. After inserting the PIN diode antenna is able to switch between narrowband to wideband frequencies whose values are 3.38 and 6.87 GHz. Due to its compactness and circular polarization, the proposed antenna represents an interesting alternative for mobile communication systems.

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