Design of Frequency and Polarization Reconfigurable Antenna using Defective Ground Structure

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Abstract- *A monopole antenna with frequency and polarization reconfiguration is dispensed here to achieve the requirement of IEEE 802.11 standard, CDMA, mobile communication and reduce the interference. This is a simple structure antenna, which consists of radiating rectangular patch, two switches (PIN diodes), defective ground structure, and a 50Ω micro strip feed line. By controlling two p-i-n diodes it can be switched between 3 different states: linear polarization, one state for left hand circular polarization (LHCP) and other for right hand circular polarization (RHCP) and also will get frequency band at (1.71-1.91) GHz and (2.18-2.40) GHz. The proposed antenna furnishes a simple structure, a very good axial ratio and reconfigurable solution for wireless communication applications.*

I. INTRODUCTION

In recent days' reconfigurable antennas are very important to enhance the performance of communication system. To give much consideration regarding the plan of reconfigurable antenna on the grounds that working frequency, polarization and radiation design have distinctive property. The aim of reconfigurable antenna is to fullfill distinct communication and reduces the interference [1]. Frequency reconfigurable antenna, pattern reconfigurable antenna and polarization reconfigurable antenna [2] are sundry kinds of reconfigurable. Polarization reconfigurable antenna are utilized inside a similar tower, this gives decreasing impedance issues and giving sifting. Diverse sorts of polarization are utilized as a part of assortment applications.

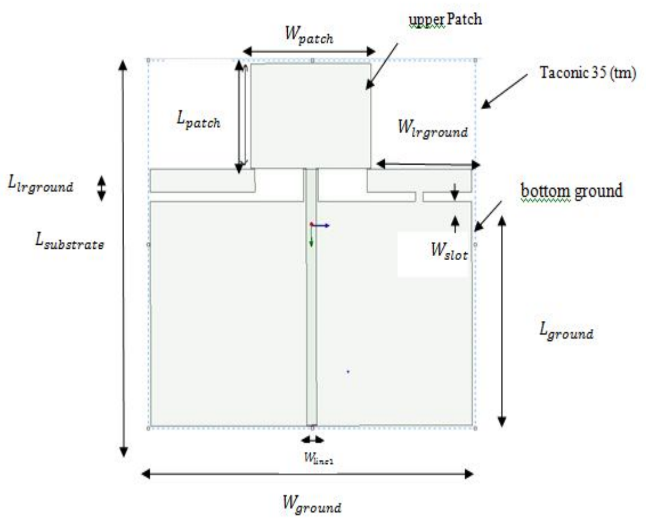

Figure 1. Geometry of the proposed antenna

Much research has been done to centre, on these applications as of late. Many antennas are proposed to attain switching between linear polarization (LP), right hand circular polarization (RHCP) and left hand circular polarization (LHCP) [3]-[5]. In [4], two crisscross monopoles having 90^0 or 90^0 stage diverse get just circular polarization, phase in [5] two linear polarizations are obtained by using coplanar waveguide and slot line mode. In these techniques separate linear and circular polarization are achieved. In [6], a polarization reconfigurable antenna for dual band operation at 2.4 GHz and 5.4 GHz. By switching PIN diodes, the antenna radiates horizontal, vertical or 45^0 linear polarization. Other reconfigurable antenna dipole antenna by using AMC structure are exhibited in [7] and [8], where their polarizations can be switched between RHCP, LHCP and LP in similar frequency range. These antennas are not suitable for most wireless applications and the antenna structure is very complicated. A frequency and pattern are reconfigured by using five p-i-n diodes and operates at three different modes is dispensed in [9]. In [10], a circular patch antenna with four bow-tie shaped slots is recommended that can accomplish four linear polarization at a 45^0 turn by reconfiguring the slot radiators. Lamentably, the measurements of the reception apparatus are relatively large which makes it difficult to be used in arrays.

The work exhibited here presents a simple monopole antenna with frequency and polarization antenna, which includes radiating square patch, two switches (PIN diodes), defective ground structure and 50Ω micro strip feed line. By controlling the diodes, the linear polarization, right hand circular polarization and left hand circular polarization are operated.

II. ANTENNA DESIGN

The structure of the proposed antenna is outlined in Fig. 1. It consists of radiating rectangular patch, two switches (PIN diodes), defective ground structure and a 50Ω micro strip feed line, which are printed on Taconic substrate with the thickness of 1.55 mm and the loss tangent of 0.009. There are several losses are responsible for the dissipation of incident power they are dielectric losses, conductor losses, and reflection losses. So by using this substrate we can reduce these losses and for clear signal. The bottom ground is defected and it consists of left ground, right ground and bottom ground to achieve different polarization. There is a slot between left ground and bottom ground and between right ground and bottom ground. The rectangular patch is fed by a 50Ω microstripline and is connected to a standard SMA connector. The defective ground structure is designed to resonate at low frequency for different application. The substrate is abbreviated at the far end from the feed point to improve the performance. Two p-i-n diodes are assembled between left ground, right ground and bottom ground.

By controlling ON/OFF states of these two p-i-n diodes (D_1, D_2), the antenna's operation mode can be changed. When D_1 is OFF and D_2 is OFF, the antenna can operate at linear polarization mode. When D_1 is ON and D_2 is OFF, the antenna can operate at left hand circular polarization. When D_1 is OFF and D_2 is ON, the antenna can operate at right hand circular polarization. These modes operate at two different frequency bands at 1.9 GHz and 2.4 GHz. The states of the diodes and their reconfigurable modes are distributed in Table I.

Table 1. STATES OF DIODES AND OPERATING MODES

States	Diode 1 (D_1)	Diode 2 (D_2)	Operation Mode
1	OFF	OFF	Linear Polarization
2	ON	OFF	LHCP
3	OFF	ON	RHCP

III. RESULTS

As new technologies are developed and mature, antenna engineers will work to include them in new designs. It is hoped that the needs of reconfigurable antennas can also spur development in several areas. Certainly, the maturation and validation of RF-MEMS technology is being pushed to a certain degree by demands for low-cost, high-reliability reconfigurable circuits and antennas. Additionally, pursuit of new and novel tunable materials with improved loss and bias characteristics will make reconfiguration more practical and cost-effective. Finally, the development of new kinds of mechanical actuators and electronic tuning methods can result in reconfigurable antennas with an even broader range of capabilities than those discussed here. With imagination, ingenuity, and enterprise, reconfigurable antennas can lead the way to new levels of wireless system performance.

From skyworks SMP1345-079LF PIN diode is used, here it is modeled as at ON state 1.5 ohm series resistance and at off state 0.17 pF series capacitance based on the datasheet. Feed line is covered by a 470 pF capacitor for serve dc block. Simulate frequency plot of three states is shown in fig. 4.1. The antenna resonates at (2.18-2.40) GHz frequency band of state 1 as rectangle part of defective ground and patch, as well as resonates at (1.71-1.91) GHz band of frequency for both state 2 and state 3. The polarization result is defined y using axial ratio plot. This parameter is majorly used to describe the nature of polarization. The axial ratio is defined as the ratio between the minor and major axis of the polarization. Have an equal major and minor axis it transforms in to a circle, and say that the antenna is circularly polarized. In that case the axial ratio is equal to unity (or 0 dB). The axial ratio of a linearly polarized antenna is infinitely big since one of the axes is equal to zero. For a circularly polarized antenna, the closer axial ratio is 0 dB, the better.

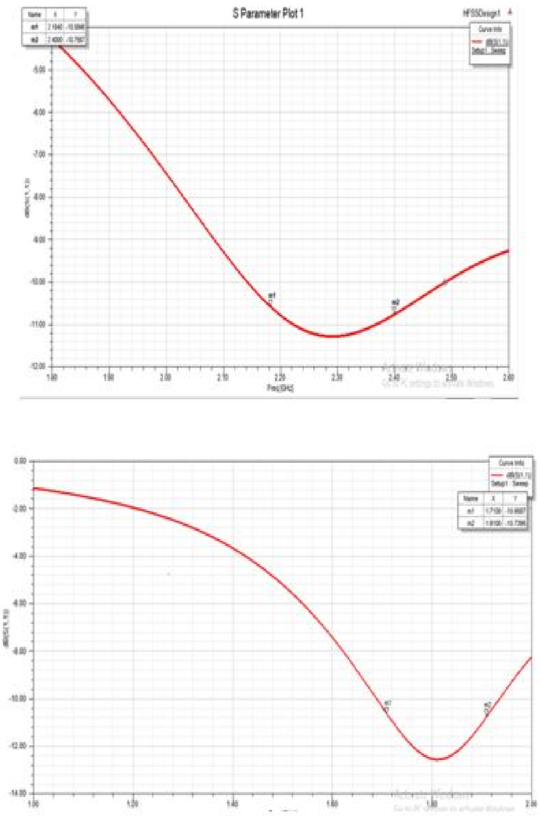

Figure 2. Simulated S_{11} of different operation states

Here axial ratio plot is designed and three states are achieved. Fig. 3 shows the axial ratio plot of three states. Linear polarization is achieved at frequency band of (2.18-2.40) GHz and for circular polarization is frequency band of (1.71-1.91) GHz is achieved.

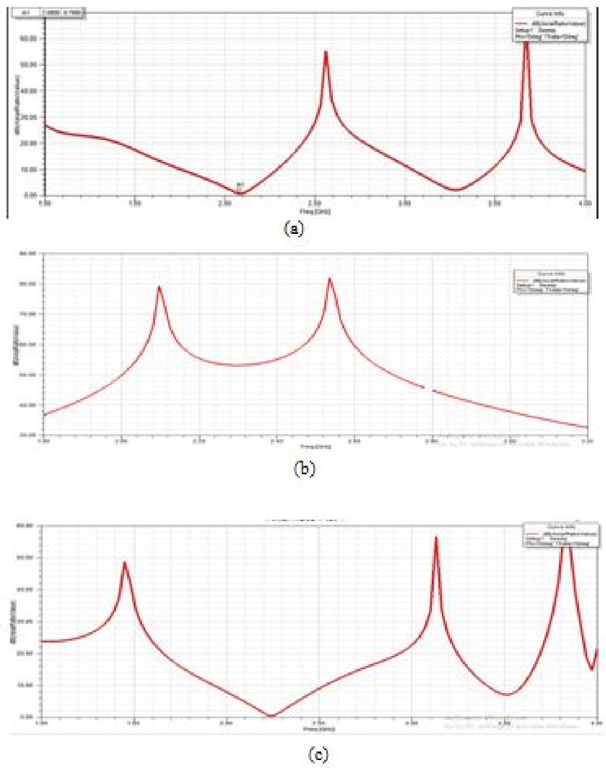

Figure 3. Axial ratio plot of three states

IV. CONCLUSION

A monopole antenna with frequency and polarization reconfiguration is designed. It is used to achieve the requirement of IEEE 802.11 standard, CDMA, mobile communication and reduce the interference. This is a simple structure antenna, which consists of radiating rectangular patch, two switches (PIN diodes), defective ground structure, and a 50Ω micro strip feed line. Three modes are operated by controlling two p-i-n diodes. Three polarizations (LP, RHCP, LHCP) are worked at (1.71-1.91) GHz and (2.18-2.40) GHz. The proposed antenna furnishes a simple structure, a very good axial ratio and reconfigurable solution for wireless communication applications. This technique reduces interference also.

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