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Research paper

Reconfigurable Smart Antenna for Wireless Communication Devices

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Abstract

In this paper a frequency reconfigurable antenna is proposed. The antenna uses electrical switching by means of PIN diodes to achieve reconfigurable properties. PIN diodes are located such that to increase the total effective surface area and simultaneously the surface current. Three slots are cut from antenna to alter the surface current and improve the resonant frequency of the antenna. The location of the PIN diodes is based on optimization in the response. Diode 1 is placed to excite another patch when it will be in ON state whereas diode 2 is used to make an interconnect. Antenna resonates at 0.915 GHz, 1.575 GHz and 2.4GHz depending on whether it is in ON or OFF state. Applications of the antenna include GSM900 (0.8GHz-0.955 GHz), GPS (1.575 GHz), WLAN (2-2.4GHz).

Keywords*: Frequency Reconfiguration;Reconfigurable antenna; Microstrip Antenna;PIN Diodes*

1. Introduction

With the rapid growth in wireless communications, there has been a dominant shift in design of the major components of wireless devices including antennas. A competent method for better utilization of the space selectivity functions is exhibited by smart antenna [1]. Reconfigurable antenna provides a favorable solution to the complex problem of frequency agile front ends. Reconfigurable antenna can be seen as the new scope for adaptability ahead of phased array antennas. Critical analysis of the frequency reconfigurable antenna can be found in [2]. These antennas are major topic of research as they have the ability to support more than one wireless standard and also ability to minimize volume requirement.
A single reconfigurable antenna is capable of achieving multiple objectives by dynamically changing its parameters such as polarization, frequency & radiations pattern. There are different approaches for realization of frequency reconfigurable antenna. By changing the active length of the antenna, we can alter the surface current, over the antenna. This can be achieved through electrical means by using switches, like PIN diodes, RF–MEMS and also by variable capacitive loading (varactor diodes). Frequency selective antenna with varactor diode is mentioned in [3]. In this paper we have proposed a frequency reconfigurable antenna based on PIN diodes. Reconfigurable antenna using PIN diodes are reported in [4]-[8].

2. Antenna Design

The proposed antenna is a planar microstrip patch antenna which uses PIN diode, MPP4203 from Microsemi Corporation. Figure 1, shows the schematic diagram of the proposed antenna. Its consist of upper layer of metallised patch conductor, and a bottom ground plane supported by microwave substrate printed circuit board. (PCB) ROGERS RT5880 of thickness 0.762 mm. The relative permeability of substrate is 2.2 with loss tangent 0.009. The patch is excited by microstrip line which is matched to 50 Ω. It generates the continuous excitation for the patch. Three slots are cut from the antenna in order to achieve a wide bandwidth and multiband performance. In Slot 1 another patch is introduced which is connected through PIN diode. This enables to sum up the total surface area of the patch antenna when the diode is ON, while in the OFF state this additional patch is non-conducting. The slot 2 is cut in "I" shape and a switch is introduced in between. Slot 3 is cut out from the patch as to form discontinuity making the antenna to resonate at multiple frequencies. Shorting pins are designed in order to remove the harmonic frequencies and to achieve more isolation between three frequency bands. Table 1 shows the dimensions of the designed antenna.

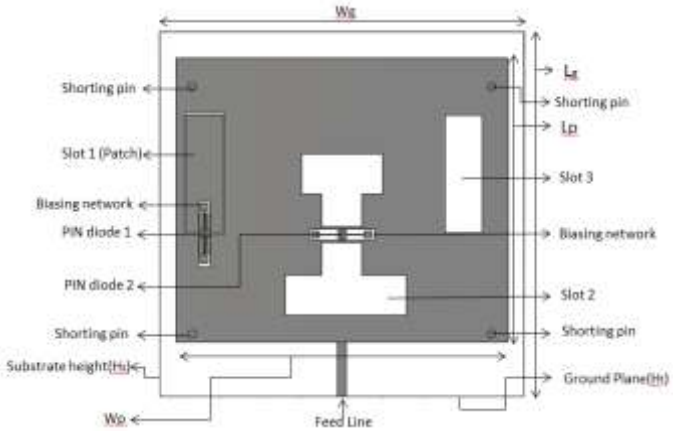

Fig. 1.Schematic diagram of the reconfigurable antenna

Table 1: Parametric values of the proposed antenna

Parameter	Description	Value (mm)
Wg	Width of the ground plane	89
Lg	Length of the ground plane	87
Wp	Width of the patch	82
Lp	Length of the patch	71
Hs	Height of the substrate	0.762
Ht	Height of the ground plane	0.017

2.1 Switching using PIN Diodes

PIN Diode, MPP4203 from Microsemi is used to perform electrical switching. Simulations were carried out on CST Microwave Studio, by taking the equivalent circuit model of PIN diode as shown in Figure 2. The biasing circuit is shown in Figure 1. Switching of antenna is carried out by DC battery of +1.3 V.

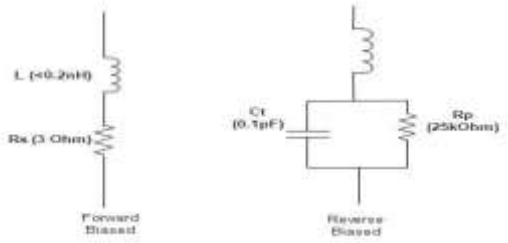

Fig 2:.Equivalent circuit of PIN diode.

3. Results

The fabricated antenna is shown in figure 3.The return loss of measured and simulated results is shown in figure 4 and figure 5 when diode 1(P1) and diode 2 (P2) is or OFF.

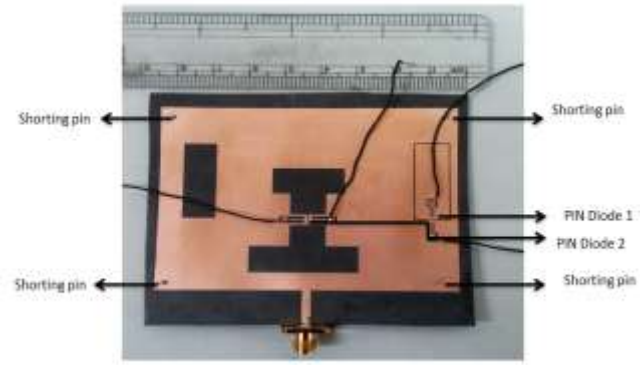

Fig 3:. Fabricated reconfigurable antenna with PIN Diodes

The antenna resonates at 0.915GHz, 1.575GHz and 2.4GHz with return loss as 13.7 dB, 15.8 dB and 30.1 dB (measured results) respectively when P1,P2 is ON. When P1 is ON and P2 is OFF there is slight shift in the frequency to right from 0.915 GHz to 0.93 GHz and from 2.4 to 2.434 GHz. The return loss when measured was found to be 10.1dB and 18.1 dB. VSWR (Voltage Standing Wave Ratio) of the antenna is 1.52, 1.4, 1.39 at 0.915GHz, 1.575GHz and 2.4GHz respectively.

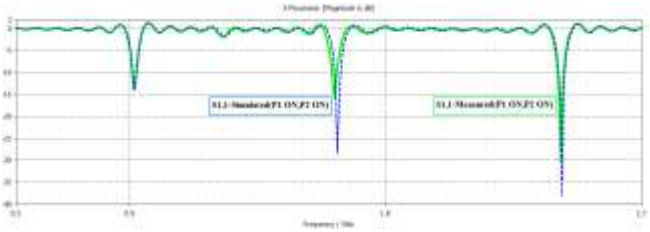

Fig 4. Return loss when P1 and P2 diodes are ON.

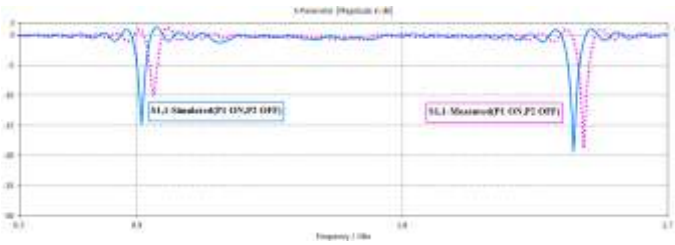

Fig 5:. Return loss when P1 is ON and P2 is OFF.

4. Conclusion

In this paper a frequency reconfigurable antenna is studied. Proposed antenna uses PIN diodes for achieving frequency reconfiguration. As the position of the switch is in ON or OFF state, resonance at multiple frequency is observed. Furthermore the response gets improved the when the size of the ground plane is increased as observed in simulations.

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