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Reconfigurable Circular Ring Antenna for Wireless Application

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Abstract- This paper elucidates the comparison between simulated and fabricated results of the designed frequency reconfigurable microstrip patch antenna which is used to operate on wireless application. The designed antenna is compact in size of 40 X 40 X 1.67 mm^3 including the ground plane and both antenna structures are designed on FR-4 substrate of thickness h=1.6 mm. By using PIN diode switching property, designed antenna shows reconfigurable characteristics which is working for two distinct frequency. This antenna is working for four frequency bands after linking with diode, two for ON state and two for OFF state. In ON state it has resonant frequencies 5.55GHz and 6.5GHz while in OFF state it working for 5.65GHz and 6.6GHz. With the help of electromagnetic (EM) simulation software, designed structures were simulated and using VNA results like vswr, return loss are achieved.

Index Terms— *Multiband, microstrip, feed line, resonance frequency, slit, slot.*

I. INTRODUCTION

Now a days demand of wireless communication devices increasing every second and it is still growing. In wireless communication, microstrip antennas are extensively used. As microstrip antennas are smaller when compared with other antennas and these wireless devices desire antennas of smaller dimension. Antennas which are used in these wireless applications must be of low profile, light in weight, low volume and have a broad bandwidth [1]. Microstrip antenna is that antenna which completes all these requirements. Though having disadvantage of narrow bandwidth traditional microstrip antennas would not be able to match modern mobile communication requirements. Affixing thick substrate to a U-shaped slot on a microstrip patch [2] is one of the mode proposed to elevate the impedance matching bandwidth of probe feed microstrip patch antenna. Slots of Different types in the patch element and their diverged dimensions are used in order to observe the relationship between maximum attainable linear phase range and the loss performance. To maximize the performance of antenna, reconfiguration capability of antenna is used.

By utilizing reconfiguration capability of antenna, two or more antennas can be replaced by one antenna [3]. In modern wireless communication systems reconfigurable antenna adds striking feature as multiple advantages can be gained by single antenna [4]. Variety of reconfigurable antennas, such as a switchable planar fractal structure [5], selective directors [6, 7] and the annular slot with switchable shorting points [8] are reported by researchers. Moreover, in some pattern-reconfigurable antenna designs that stem from the spiral structure [9–10] to provide a huge range of radiation patterns the length of the spiral arm is changed. Reconfigurable antennas are far more different from smart antennas with reference of the reconfiguration mechanism that lies inside the antenna rather than in an external beam forming network.

This paper brings forward the comparison between simulated and fabricated results of the designed frequency reconfigurable microstrip patch antenna for wireless applications. This paper presents a dual band antenna for wireless communication systems. For dual band applications, a reconfigurable antenna is designed with circular and rectangular slots in radiating element and circular and rectangular slot in ground. This structure is modified by connecting a diode to get reconfigurable condition. In both switching condition of diode designed antenna is working for dual band. For easy fabrication and to maintain the cost, designed antenna is planar in structure. This antenna is working for four different bands and the condition of frequency reconfigurable helps in designing compact system. Microstrip technology is used for designing the antenna and is favorable for different wireless communication.

The organization of this paper is as follows. In Section II, basic design of antenna is described. In Section III, the simulated results and fabricated results of designed frequency reconfigurable antenna are presented and compared; finally, the paper is concluded in Section IV.

II. ANTENNA STRUCTURE

A frequency reconfigurable patch antenna is designed. This antenna is designed and simulated on FR-4 dielectric substrate

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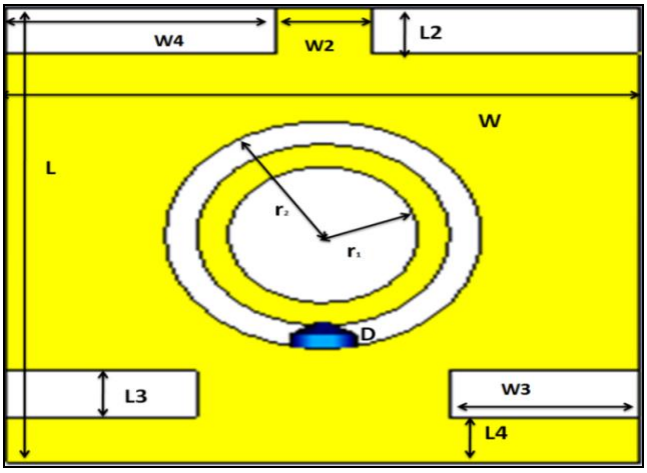
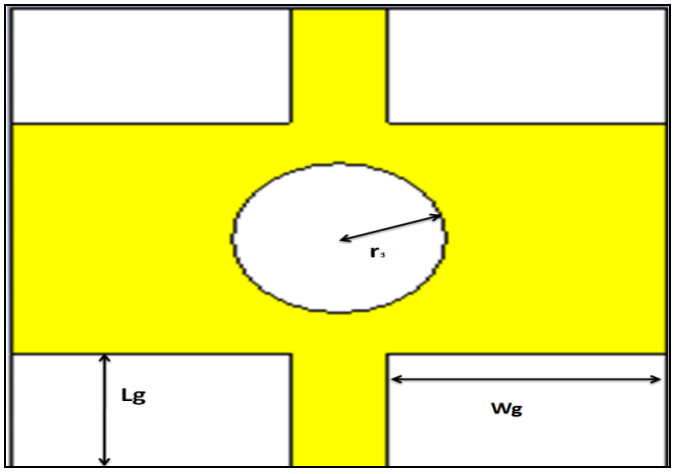
that have dielectric constant (ε_r=4.6) and height of the substrate is 1.6 mm. In this structure two four rectangular slots and two cylindrical slots on patch and four rectangular slots and one cylindrical slot in ground plane for making ground defective [11]. The CST simulation software is used for designing and simulation of the proposed antenna. The antenna is compact in size with dimensions 40 X 40 mm^2 and operating on two bands.

With the use of one circular slot it is operating for one band and with second circular slot we got another band. The reconfigurability condition is gained when diode is connected. While diode is in off state it is working for the two bands one with resonant frequency 5.5GHz and another with 6.5GHz and in ON state it is working at 5.65 GHz and 6.6 GHz resonant frequencies [11]. Microstrip line feeding is used to provide feed. Front view and back view of proposed antenna are shown in Fig. 1(a-b).

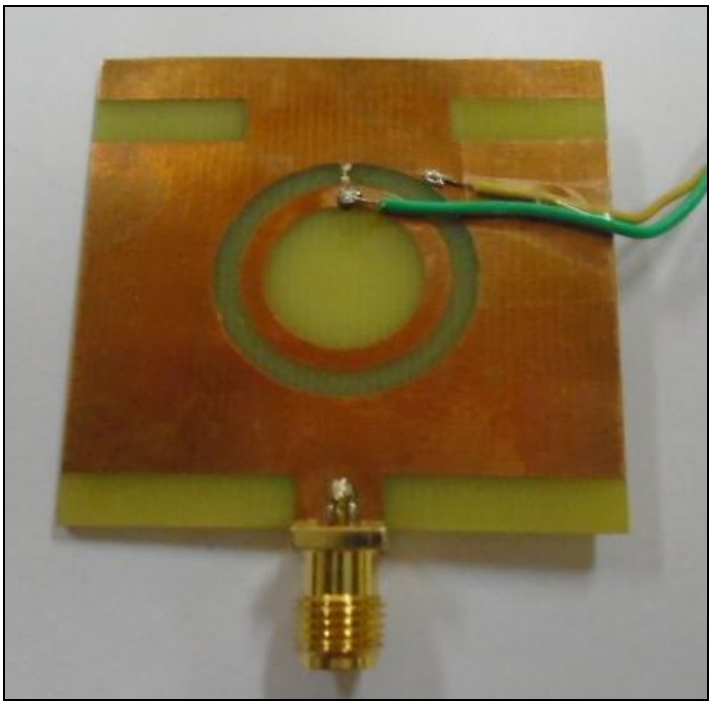


(a)

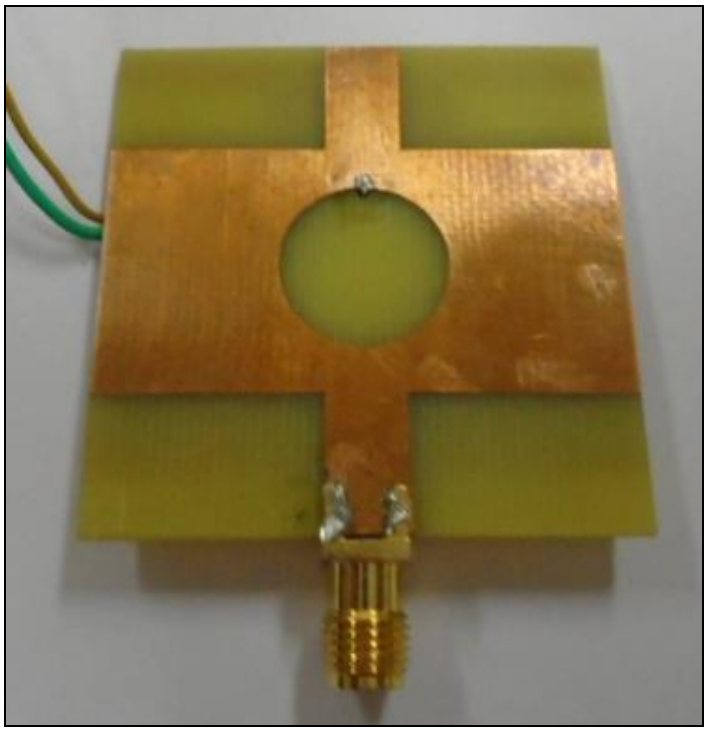


(b)

Fig. 1 Proposed frequency reconfigurable antenna design (a) Front view (b) Back view



(a)



(b)

Fig. 2 Fabricated frequency reconfigurable antenna design (a) Front view (b) Back view

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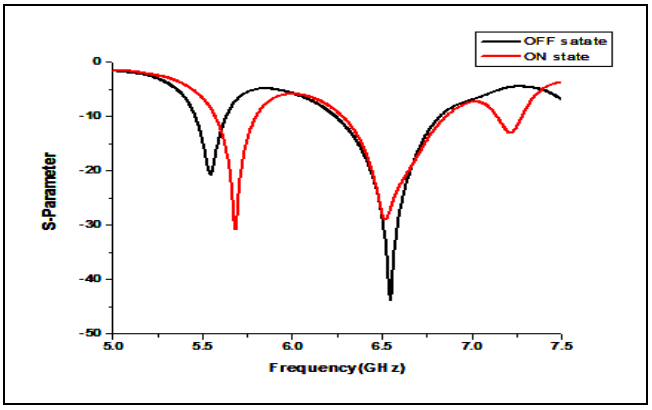
Placement of diode is very important because at different places value of results varied and at this position results gained are very good. Fig. 2 shows front view and back view of fabricated frequency reconfigurable microstrip patch antenna. All parameters of the antenna are given in TABLE I.

TABLE I .KEY DIMENSIONS OF ANTENNA DESIGN

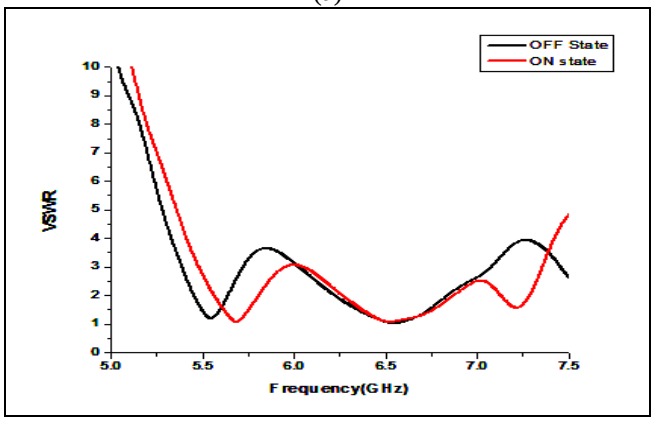
Antenna parameter	Value	Antenna parameter	Value
W	40mm	W4	17mm
L	40mm	W2	6mm
L_2	4mm	W3	7mm
L_3	7mm	D	diode
L_4	4mm	r_2	10mm
r_1	6mm	Lg	10mm
Wg	17mm	r_g	6mm

III.SIMULATED AND MEASURED RESULTS

Firstly, simulated results are explained and then simulated results are compared with the measured results in this section.



(a)

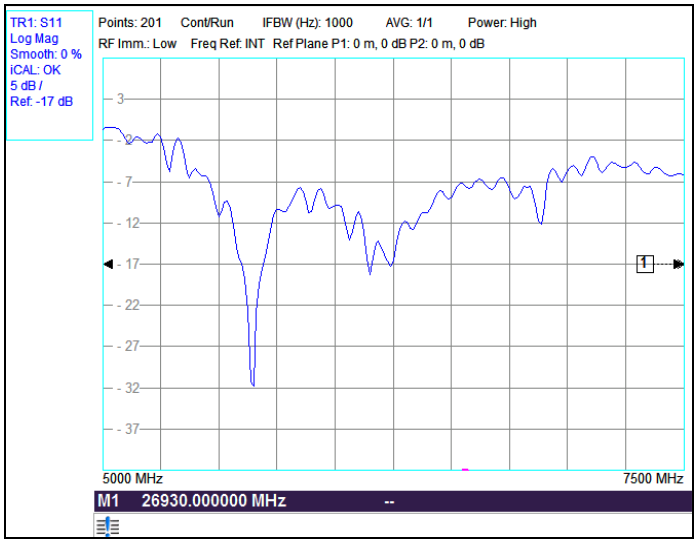


(b)

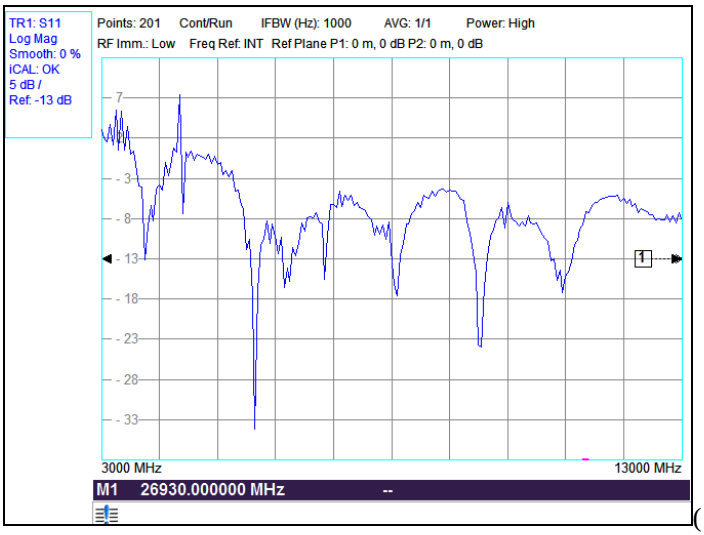
Fig. 3 Simulated results of designed antenna (a) Return loss (b) VSWR

For simulating this antenna Electromagnetic (EM) simulation software is used and it can also used to calculate and plot S_{11} parameters, monostatic RCS, insertion loss, current distributions as well as the radiation pattern. For this antenna two cases are considered, first is when diode is on and second when diode is off. In results, results like return loss and VSWR are discussed. These parameters are observed at 5.55GHz and 6.5GHz in on state and for off state at 5.65GHz and 6.6GHz.

Fig. 3 shows the comparative graph of return loss and VSWR for both conditions. Return loss of the antenna should be less than -10dB and VSWR should be less than 2. Both criteria are satisfied by the proposed antenna at resonant frequency. Fig. 4 shows the measured results of return loss for both the conditions of the diode.



(a)



b)

Fig. 4 Measured results of return loss, when diode is (a) off and (b) on

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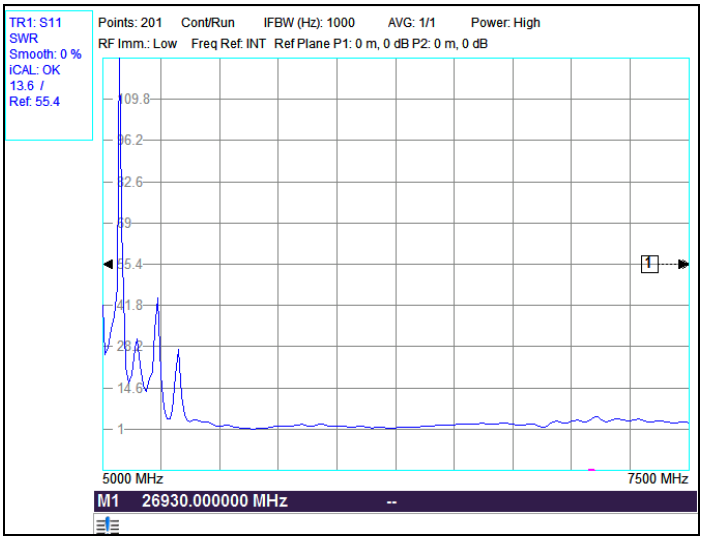
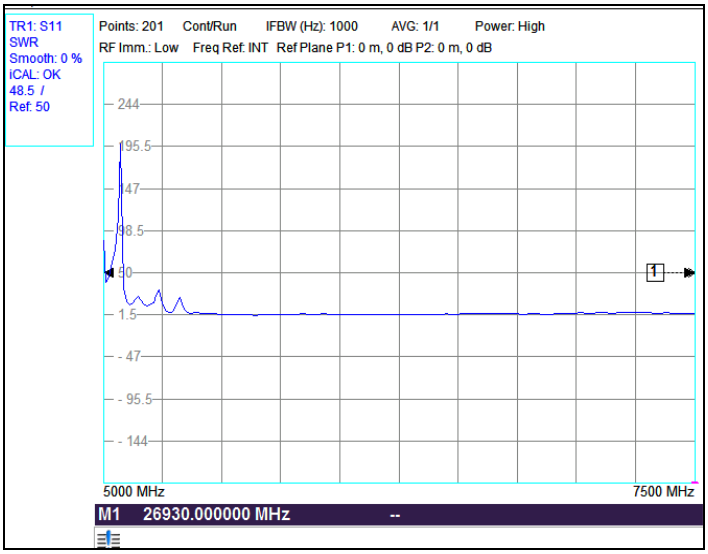
From the fig. 3 and fig. 4 simulated and measured results of return loss can be observed and it can be concluded that measured results for retun loss show close proximity to the simulated results of antenna at the resonant frequency. Fig. 5 shows the measured results of VSWR for both the antenna's condition.



(a)



(b)

Fig. 5 Measured results of VSWR, when diode is (a) off and (b) on

Comparison of VSWR results can be made by observing fig. 3 and fig. 5. Measured results of VSWR in fig. 5 satisfy the condition of VSWR that is it must be less than 2.

IV. CONCLUSIONS

In this paper a frequency reconfigurable microstrip patch antenna for wireless applications is presented and this antenna is compact with overall size 40 X 40 X 1.67 mm^3. The simulated and fabricated results are compared and both the results are very good and showing close proximity. Return loss of designed antenna is less than -10dB and VSWR is less than 2 at resonant frequency of antenna. DGS technique is used to improve the return loss and other characteristics of antenna structure. The designed structure is operating for two frequency band and has a vast range of applications, first band is working for WLAN application and second band is working for Radiolocation.

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