

Frequency Reconfigurable Microstrip Patch Antenna for Wireless Applications

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1. Abstract

A simple frequency reconfigurable microstrip patch antenna (MPA) having three PIN diode switches is proposed in this paper. The switches are essential for producing three reconfigurable frequency states and are placed below the patch in slot area. The simulation results show that the proposed antenna exhibits directional radiation patterns at all frequencies. The performance of the antenna is represented by the help of simulated reflection coefficient along with the radiation patterns. The proposed antenna is having the dimension of 60 mm × 68.5 mm with the reflection coefficient (S_{11}) value less than -20 dB and gain greater than 4.84 dB for all the states. The antenna is suitable for wireless applications.

Keywords—Frequency reconfigurable, Microstrip patch antenna, PIN diodes.

3. Literature Survey

A frequency-reconfigurable microstrip patch antenna is proposed in [1] which employs switching of frequency in the range 1.98-3.59 GHz at nine different frequency bands. Similarly fabrication of a frequency reconfigurable MPA is accomplished for the production of six different frequencies with three switches [2] and a wideband to three narrow bands antenna with frequency reconfigurability is designed in [3]. A novel reconfigurable slot antenna is proposed in [4] which permits different bands of resonance frequency controlled electronically with the help of three switches to obtain seven different states. Two E-shaped antennas with different operational frequencies is presented in [5].

The proposed antenna is designed and simulated using ANSYS HFSS vs 15.. Fig. 1 represents the front geometry and Fig. 2 shows the rear view of the proposed antenna. For design of the antenna low cost FR4 substrate with thickness 1.52 mm, permittivity 4.4 and loss-tangent ($\tan \delta$) 0.002 are used. The proposed antenna is having width $W = 60$ mm and length $L = 68.5$ mm. The patch is having the dimension of $a = 20$ mm × $b = 28.5$ mm. The position of the feed point is at $c = 6$ mm from the center in order to achieve good return loss value. The ground plane is having a slot below the patch where $d = 14.8$ mm. The total length of the slot is $g = 27$ mm. Three switches, S1 & S2 and S2 & S3, are placed with a distance $e = 11.5$ mm apart from each other on the lower slot of the patch as shown in Fig.2.

5. Results

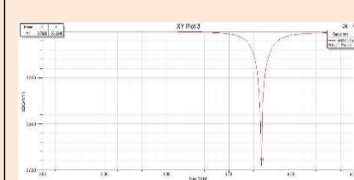


Figure 3. S_{11} plot for D1 state

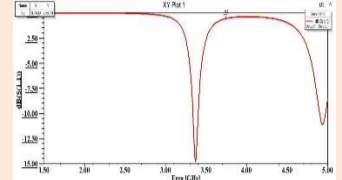


Figure 4. S_{11} plot for D2 state

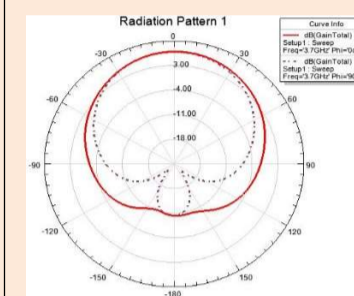


Figure 5. Radiation Pattern for D1 state

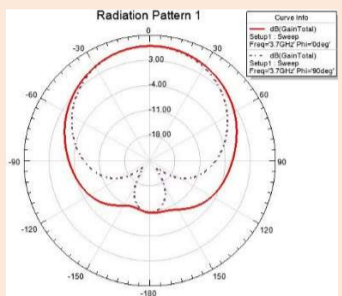


Figure 6. Radiation Pattern for D2 state

TABLE II. ANTENNA PARAMETERS

State	Gain (dB)	Frequency (GHz)	S_{11} (dB)
D1	5.84	3.73	-34.93
D2	6.01	3.37	-20.60
D3	4.84	3.37	-41.25
D4	5.66	3.21	-43.16
D5	5.68	3.37	-38.98
D6	6.00	3.37	-38.46

2. Introduction

Adaptability and multi-functionality is the future of all communication systems. It is necessary for cost-efficient and reliable systems that will be used for complex problem solving. The reconfigurable antennas have achieved importance in multifunctional devices due to their multiband operation. These antennas have the ability of modifying their geometry and behavior in order to adapt to any sort of change in surrounding conditions. The MPAs are very popular for implementation of the above because of the planar geometry and well-defined ground plane above which integration of different switches, control circuitry, tunable materials can be possible. Currently, frequency reconfigurable antennas are major area of research due to multipurpose functionalities.

In this article, a frequency reconfigurable MPA is presented in which two slots are placed underneath the patch. The antenna structure has three switches which are placed in the lower slot of antenna in order to produce six different frequency bands.

The antenna can be used for cognitive radio systems where sensing and reconfigurability are key metrics of working. It can also be used for WiMAX applications with necessary modifications. The proposed antenna is low in cost, the substrate is easily available and there is flexibility in fabrication. It can put into practical use with the current form of technology in the world.

4. Design

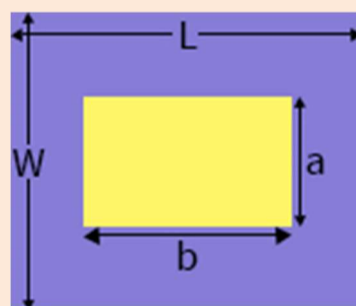


Figure 1: Structure of the proposed antenna (top view)

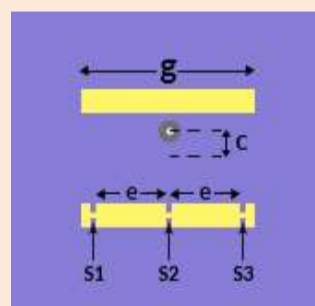


Figure 2: Structure of the proposed antenna (bottom view)

The proposed structure with the slots yields six resonant frequency bands. The reconfiguration of frequency is possible due to the operating condition of switches. The patch acts as a radiator with frequency of resonance at 3.7 GHz, when all diodes are at ON condition. Similarly, at OFF condition of all diodes, the patch behaves as a feed network to the slot with resonating frequency at 3.74 GHz. Here the switches provides a control on slot effective length, thus producing four other bands of frequency.

TABLE I. CONFIGURATION OF SWITCHES

Condition	Switch-S ₁	Switch-S ₂	Switch-S ₃
State-D1	Switch OFF	Switch OFF	Switch OFF
State-D2	Switch ON	Switch OFF	Switch OFF
State-D3	Switch ON	Switch OFF	Switch ON
State-D4	Switch OFF	Switch ON	Switch OFF
State-D5	Switch ON	Switch ON	Switch OFF
State-D6	Switch ON	Switch ON	Switch ON

6. Conclusion & References

Conclusion

The proposed design can be operated in three frequencies by using three PIN diode switches. The simulation results show acceptable results for the proposed antenna with the reflection coefficient (S_{11}) value less than -20 dB and gain greater than 4.84 dB for all the states. The radiation patterns are directional at all frequencies. The antenna can be useful for cognitive radio systems, WiMAX applications etc. Low cost, easy availability of the substrate and flexibility in fabrication makes the proposed structure suitable for wireless applications.

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