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Research Article

Frequency Reconfigurable U-Shaped Microstrip Patch Antenna and its Wireless Application

Satish Kumar Yadav†*, A. Ashok† and A. K. Jaiswal†

†Department of Electronics and communication Engineering, SSET, SHIATS-DU, Allahabad, India

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Abstract

A U-Shaped Microstrip Patch Antenna is presented with operating frequency as 5.25GHz. This antenna is capable of switching to two different frequencies 4.3030 GHz and 4.8486 GHz. There is one p-i-n diode used to achieve frequency reconfigurability and wireless application. A comprehensive parametric study has been carried out to understand the effects of various dimensional parameters and to optimize the performance of the antenna. A substrate of low dielectric constant is selected to obtain a compact radiating structure that meets the demanding bandwidth specification. The obtained results have better working characteristics like return loss, voltage standing wave ratio (VSWR), gain and directivity. The reflection coefficient at the input of the optimized U-shaped microstrip patch antenna is below −10 dB over the entire frequency band. Return loss, Directivity, Gain and VSWR are measured -20.892dBi, 8.1190dBi, 8.1522dBi and 1.3648 respectively. These values are best suited for designing the antenna.

Keywords: *Directivity, Reconfigurable, Microstrip patch antenna, diode, polarization.*

1. Introduction

The patch antenna is a type of radio antenna with a low profile, which can mounted on a flat surface. It consists of a flat rectangular sheet or patch of metal mounted over a larger sheet of metal called a ground plane. The concept of reconfigurable antenna firstly appeared in D. Schaubert's patent Frequency-agile polarization diverse microstrip antenna and frequency scanned arrays in 1983.This invention relates generally to microstrip antennas and microstrip antenna arrays and is particularly directed to microstrip antennas and arrays which are frequency agile over a relatively large spectrum of frequencies. The invention also provides polarization diversity in frequency agile microstrip antennas and arrays. This invention is also particularly directed to microstrip antenna arrays that are frequency agile, have polarization diversity and can be electronically scanned. The frequency agility is achieved without changing the physical dimensions of the antenna elements. [Daniel H. Schaubert *et al,* 1979] The rapid development of wireless communication devices and systems, the reconfigurable antennas are gaining great attention. It is illuminated using a primary feed horn placed at a particular distance from the array this paper proposes the use of slots in the reflect array elements to scatter the incident field in a proper direction from the individual elements. Different types of slots in the patch element are used and their dimensions have been varied in order to observe the relationship between maximum attainable linear phase range and the loss performance Microstrip antennas provide very lucrative features such as small size, lightweight, low cost, conformability to planar and non-planar surfaces, rigid, and easy installation. [Ghanshyam singh *et al*, 2012] They have a wide range of application in wireless communication especially in mobile communication devices and are becoming more general due to low cost and versatile designs.

Slots in the ground has been introduced by inserting one PIN diode between these slots By inserting P-i-N diode between slots, which work like a switch has been proposed A frequency reconfiguration scheme was simulated by switching between the diodes for on/off-state and for the fabricated structure switching was shown an ideal diode that is replaced by microstrip line for on-state and open circuit for off-state. In this scheme, the frequency reconfiguration was achieved for two different resonant frequencies the loading effect of the PIN diodes in the antenna is also characterized by a full wave analysis and transmission line theory and comparisons between the real and ideal switches are also studied.

Per design goals, it is demonstrated that the reconfigurable slot antenna has the same radiation pattern at all frequencies. Also, the measured radiation patterns agree with the theoretical ones. [Shailander singh khangarot *et al,*2015] The polarization characteristics and the efficiency behaviour of the antenna as a function of frequency are investigated

*Corresponding author: **Satish Kumar Yadav**

using both theoretical and experimental data some design guidelines are provided and possible design improvements are discussed The strict requirements of a constant input impedance gain radiation pattern and polarization can only be met, if both the passive structure and the tuning mechanism are carefully designed and effectively integrated into the final design.[Abdul Qadir khan *et al, 2016*] Therefore these issues are discussed Focuses on the passive antenna structure and its properties. The switching mechanism, its loading effect on the antenna and the final reconfigurable antenna are discussed.[Gardner *et al,* 2008]

2. Material and methods

Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. The patch is generally made of conducting material such as copper or gold and can take any possible shape. Due to its planar configuration and ease of integration with microstrip technology, the microstrip patch antenna has been heavily studied. There are different structures of microstrip antennas, but on the whole we have four basic parts in the antenna are the patch, dielectric substrate, ground plane and the feed line. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. The rectangular and circular patches are the basic and most commonly used microstrip antennas. These patches are used for the simplest and the most demanding applications. The micro strip patch antennas are well known for their performance and their robust design, fabrication and their extent usage.

3. Proposed Antenna

The microstrip antenna with U-shaped patch is introduced by inserting two p-i-n diodes. The diodes inserted between slots works as a switch which have two switching condition i.e. ON and OFF. This shows two frequency bands for the operating frequencies 2.25GHZ, in the range of 4.3030GHZ to4.8486GHZ.

4. Antenna Configuration

The antenna structure in which substrate made of Taconic 35 with a relatiulty permitity of 35 and 3.2mm thickness are show in figure 1. The dimension used in substrate are 55x45mm for patch length (P) and width (q) are 18x5mm. For corresponding these frequencies. There are different switching condition which are given in the table1.The coaxial feeding technique has been used in the proposed antenna configuration.

Table 1 Switch Configuration Details

Configuration	S1	Resonant frequency (GHz)
F1	OFF	4.303
F2	ON	4.8486

Where,S_1=switch1

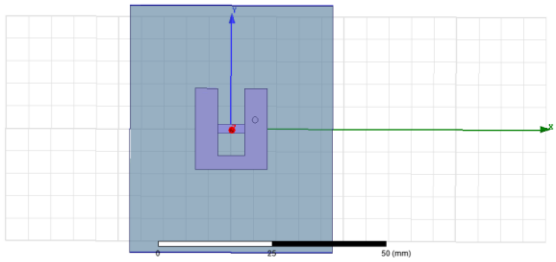

Fig.1 Proposed antenna design

To achieve frequency reconfigurability and wireless application, one switch is used in between the patch in order to change the effective length of the slot. A copper substrate is introduced when switch is at 'ON' condition absent of copper represents for 'OFF' condition.

5. Results and Discussion

For two different frequencies, the result of the proposed design has been investigated in switching phenomena at frequency (f_1)=4.3030GHz, diode is at 'OFF' switching and at frequency (f_2)=4.8486GHz,diode is at 'ON' switching condition. As shown in figure 2 For switch (S_1) 'OFF' at frequency F_1=4.3030GHz the return loss is -20.1434dBi and switch(S_2) 'ON' at frequency F_2=4.8486GHz, the return loss is -15.5588dBi.

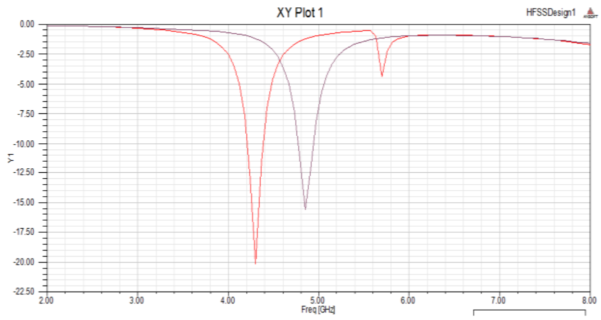

Fig.2 Return lass

As the about mentioned switching conditions for frequency F_1 and F_2 gain are 6.7731dBi, and 7.3134dBi, shown in figure 3.

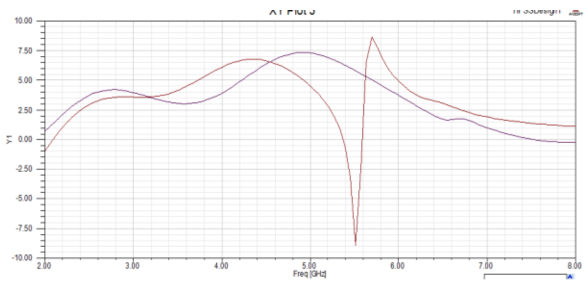

Fig.3 Gain Spectrum

Also for those mentioned switching conditions VSWR for frequency F_1 and F_2 are 1.7143dBi and 2.9240dBi.

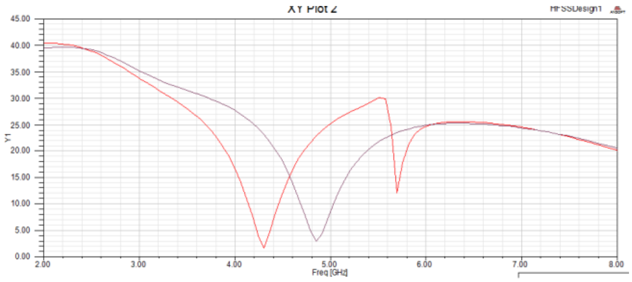

Fig.2 VSWR

The directivities are also simulated as 6.7467dBi and 4.361dBi for both frequency F_1 and F_2 as about mentioned switching condition.

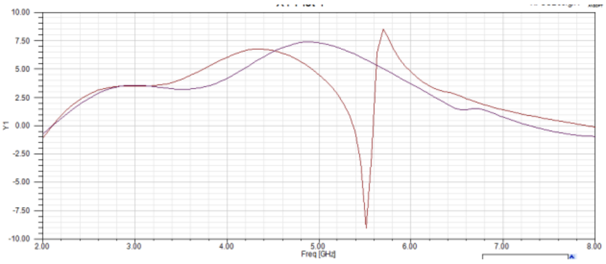

Fig..5 Directivity

For frequency F1 and F2 obtained radiation pattern are shown in figure 6 and figure 7.

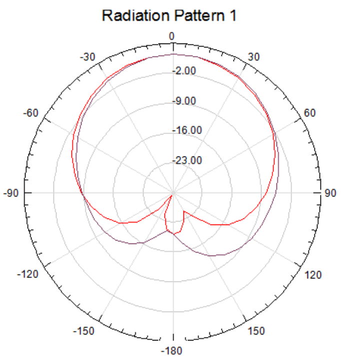

Fig.6 Radiation Pattern F_1

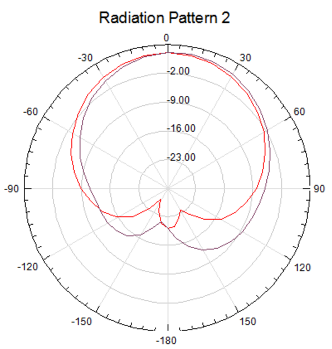

Fig.7 Radiation Pattern F_2

Conclusions

The U-shaped microstrip patch antenna has been designed which has the characteristics of frequency reconfigurability. By inserting one p-i-n diode frequency reconfigurability used in U-shaped patch are investigated. The results are obtained at two frequencies i.e. 4.3030GHz and 4.8486GHz. Designed antenna show relatively good antenna parameters i.e. return loss, gain, directivity as well as VSWR.

Future Scope

The simulation gave results good enough to satisfy our requirements to fabricate it on hardware which can be applied as requirement. The investigation has been limited mostly to theoretical studies and simulations due to lack of fabrication facilities. Microstrip Antennas, due to their great advantages, have increasingly wide range of applications in wireless communication systems as handheld aircraft, missiles, Navigational system, Mobile communications, The direct broadcast system(DBS), Satellite Communication System, Doppler and other radars, Radio altimeters, Command and control system, telemetry, Remote sensing and environmental instrumentation, Feed elements in complex antennas, Integrated antennas, Biomedical radiators and intruder alarms.

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