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Research Article

Frequency Reconfigurable Microstrip Patch Antenna for Wireless Applications using P-i-N diode

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Abstract

Wireless communication systems is increasing day by day and a number of antennas or a single antenna with multiple functions has become inevitable. In this paper, micro strip patch antenna is designed for frequency configurable using P-i-N diode. In this design, 4-P-i-N diode is used for switching application. The analyzed result of E-plane pattern and an equal gain H-plane pattern are obtained in all cases. This antenna has an attractive feature for important applications like Personal Communications Service (PCS), Mobile Satellite Service (MSS), Wireless Local Area Network (WLAN) and Worldwide Interoperability for Microwave Access (Wi-MAX).

Keywords: *Reconfigurable antenna, Wi-MAX, PCS, MSS, P-i-N diode, WLAN.*

1. Introduction

A Microstrip antenna is attractive candidate in the variety of commercial scale application such as mobile and spacecraft application due to their numerous advantages such as low cost, light weight and easily printed onto circuit board [Diwedi *et al* 2014]. Microstrip antenna is attractive candidate for wireless communication system due to their numerous advantages such as low cost, light weight and easily printed onto circuit board[chaube *et al* 2012]. A microstrip line-fed rectangular patch with a partial ground plane base equipped with two PIN diodes is proposed to get both frequency and pattern reconfigurability [Cleetus *et al* 2014]. A patch is printed over the low dielectric constant substrate above the ground and the feed is printed beneath the high dielectric constant substrate below the ground. Patch and feed line are electromagnetically coupled through an aperture made on the ground [Raina *et al* 2012]. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure[Kumar *et al* 2013]. The source of the radiation of the electric field at the gap of the edge of the Microstrip element and the ground plane is the key factor to the accurate calculation of the pattern for the patch antenna[Bodhaye *et al* 2013]. Using microwave substrate of high dielectric constant, patch dimension can be reduced, but the antenna shows poor efficiency due to surface wave generation[Roy *et al* 2007]. Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation[Dhanwade *et al* 2014]. In this paper, a microstrip line-fed rectangular patch with a partial ground plane base equipped with four pin diodes. Each proposed to get at 5.15GHz. and patterened reconfiguribility. Four p-i-n diode switches are mounted over the slot in the ground plane. Many switching cases are considered.

2. Antenna Geometry

All The geometrical structure of the antenna, including dimensions, is shown in Figure 1. The antenna is based on a FR4-epoxy substrate with dimension of 50mm X 28mm with the dielectric constant, εr of 4.4 and a thickness of 1.6mm. The patch which is rectangular is of 17.56mm X 13.2mm dimension, and is fed using a 3mm-wide microstrip line. The ground plane is constructed in such a way that, a rectangle of dimension 39mm X 18.5mm is subtracted from the full ground plane at the position(5.5,9.5,-1.6). Later, Four symmetrical 1.4mm-wide rectangular slots are created onto the ground plane. The slots are at 7mm and 12mm respectively from the antenna's symmetry axis. Four 1.4mm X 2.5mm PIN diodes, PD1, PD2, PD3 And PD4 are mounted across the slots, as indicated in Fig. 1. In the simulation, uses 1.5Ω for the ON state and 0.35pF for the OFF state of the PIN diodes.

*Corresponding author **Vijay shanker** is a Research Scholar**; Dr. Anil Kumar and Ekta Singh Chauhan** as Assistant Professor; **A. K. Jaiswal** as Professor

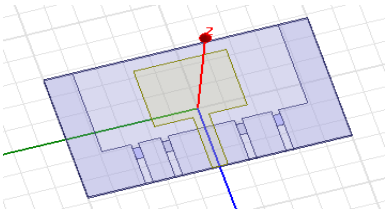

Fig.1 Proposed Design of Antenna

3. Result and discussion

The switching conditions considered to achieve the desired frequency and pattern reconfigurability are given. It computed operating frequency (*fr*), Return loss (S11), peak gain (G0) and Operable band of frequencies are also given in fallowing figure. The obtained result will be given as fallowing:

Table 1 Experimental procedure parameters

Case	1	2	3	4	5
PD1/PD2/PD3/PD4	OFF/OFF/OFF/OFF	ON/0N/OFF/OFF	ON/OFF/OFF/ON	ON/0FF/OFF/OFF	ON/ON/ON/ON
F (GHz)	5.15	5.15	5.15	5.15	5.15
Return loss	-44.46	-28.66	-52.51	-31.36	-53.86
Go(dB)	5.28	4.46	5.15	5.16	5.13
OPRABLE BAND	4.1212-6.1818	4.1212-6.1818	4.1212-6.1818	4.1212-6.1818	4.1212-6.1818

The obtained result will be given as fallowing:

The good return loss characteristics and high bandwidth exhibited at 5.15GHz frequency. it makes that this antenna is suitable for wireless applications. The design of reconfigubrable microstrip patch antenna with p-i-n diode gives a gain and return loss respectively 5.28dB and -44.46dB at resonating frequency at 5.15 GHz, when all diode are in OFF condition. Gain (5.13) and return loss (-53.86) decreases and increases respectively at same resonating frequency, when all diode in ON conditions. Bandwidth centered at this frequency is extended from 4.1212GHz to 6.1818GHz for both cases.

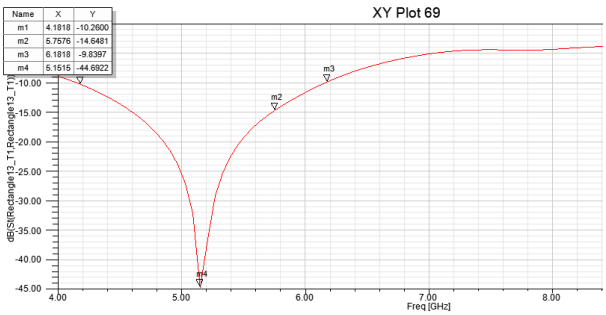

Fig.2: Return Loss

The gain obtained in the proposed design are 5.28dB at resonant frequency 5.15GHz given below:

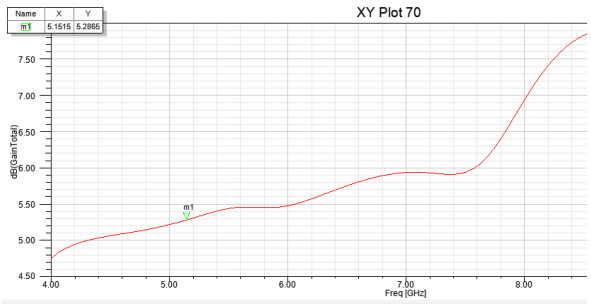

Fig.3: Gain

The H-plane pattern in both cases show similar characteristics as at 5.15 GHz but with a null in one of the ±90 direction. This is a favorable characteristic for handheld devices, which indicates minimum radiation from the antenna in that direction which faces the head. This is highly recommended from the point of adverse effects of radiation from handheld devices. The H-plane pattern is 180º switchable. The E-plane patterns are omnidirectional in cases which are very much suitable for wireless applications like WLAN and WiMAX. The radiation pattern of the antenna design in bellow:

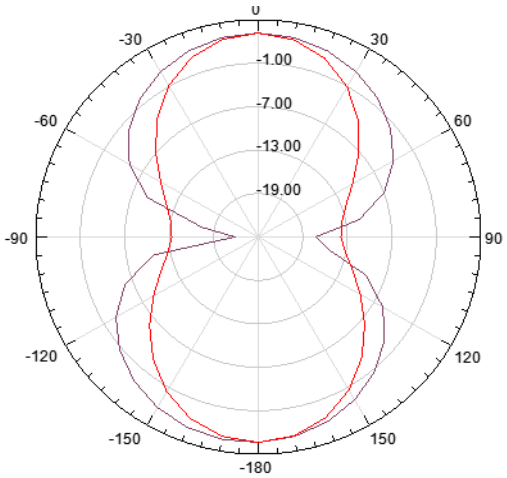

Fig.4: Radiation Pattern

Conclusion

The proposed antenna structure uses four PIN diodes, mounted over two slots in the ground plane so as to obtain both frequency and pattern reconfigurability. In the switching scenario, the antenna is operable over the 5.7 GHz band. Also, a parameter study is performed on the ground plane of this structure and could find that these structures can have improved gain, radiation efficiency and bandwidth values. This antenna finds its applications in PCS, MSS, WLAN and WiMAX.

References

R. Garg (2001), Microstrip antenna design Handbook,Artech House, London.

J.S. Roy (2007) New Dual-Frequency Microstrip Antennas for Wireless Communication, Volume 10, Number 1,113-119.

T.K. Raina, Mrs. Amanpreet Kaur (2012) Design of Aperture Coupled Micro-Strip Patch Antenna for Wireless Communication Applications at 10Ghz (X BAND), International Journal of Electronics Engineering, 4 (1), pp. 25– 28.

A. Chaube, Dinesh Kumar Singh (2012) slot loaded proximity coupled Microstrip antenna for wireless communication Application, international journal of engineering sciences & emerging technologies, April 2012 ISSN: 2231 – 6604 volume 2, issue 1, pp: 37-45.

B.Mazumdar, U.Chakraborty, A.Bhowmik, S.K.Chowdhury & A.K.Bhattacharjee (2012), A Compact Microstrip Patch Antenna for Wireless Communication,Global Journal of researches in engineering Electrical and electronics engineering,Volume 12 Issue 5 Version.

Nilima Bodhaye, Devashri Marotkar (2013), Design of Reconfigurable Multiband Microtstip Patch Antenna for Wireless Communication, Volume-1, Issue-1

Praveen Kumar, Samjeeva Rao (2013), Effect of Feeding Techniques on the RadiationCharacteristics of Patch Antenna: Design and Analysis Vol. 2, Issue.

Ratnesh Diwedi, Prashant Purohit (2014), Broadband Capacitive Coupled Microstrip Antenna with I-shape Slot for Wireless Communication System Vol. 3, Issue4.

RMS Cleetus, T. Sudha (2014), Design and Analysis of a Frequency and Pattern Reconfigurable Microstrip Patch Antenna for Wireless Applications.

P.C. Dhanwade (2014). L.S.Admuthe, Mrs. P.P. Dhanawade, Simulation of Rectangular Patch Antenna with Jeans Substrate.