IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 3, March 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.488

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903097|

Design and Fabrication of Triangular Edge Slot Microstrip Patch Antenna Using 5G Communications

D.Sarathy,M.E., M.Kumaresan, S.Naresh, G.Selvaraj

AP, Dept. of ECE., GRT Institute of Engineering and Technology, Tiruttani, India

B.E Student, Dept. of ECE., GRT Institute of Engineering and Technology, Tiruttani, India

B.E Student, Dept. of ECE., GRT Institute of Engineering and Technology, Tiruttani, India

B.E Student, Dept. of ECE., GRT Institute of Engineering and Technology, Tiruttani, India

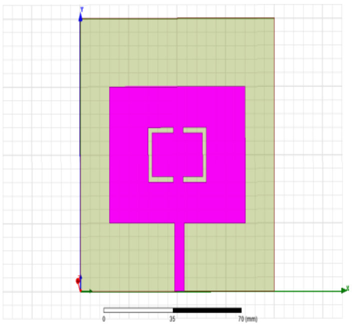
ABSTRACT: This project presents the design of a polarization rectangular micro strip patch antenna for multiband 5G communication. Nowadays, the polarization reconfigurable micro strip patch antenna is one of the excellent candidates for portable wireless device. Simply because of its low profile, light weight, and low cost. However the requirement of polarization bandwidth is becoming greater in present wireless communication system. This frequency is presented for wireless application band which is covering from 2GHZ to 12GHz and 28GHz to 38GHz.There are several steps to design this antenna including determining the antenna specific characteristics, antenna simulation construction and antenna analysis. The EM (electro magnetic) simulation of the filter design was completed on high frequency structure simulator software and fabricating on FR4 substrate by using the etching process. The design is formed on FR-4 Epoxy material used as a dielectric material with its dielectric constant= 4.4 and thickness of 1.5mm. After fabricating the MSA, the fabricated results were taken and are shown within the report. The proposed antenna makes the fabrication process easy and also suitable for the application in the multiband communication.

KEYWORDS: Reconfigurable patch antenna, p-i-n diodes, x-shape slot antenna.

I. INTRODUCTION

Polarization reconfigurable antennas are attractive for many researches in wireless communication and also rapid development in mobile communication. It can be expands the capability of communication system. In this reconfigurable multifunctional antennas despite being single and compact.

A polarization reconfigurable dielectric resonator antenna (DRA) fed by a compact coplanar waveguide (CPW)-to-slot line feeding structure of the vertical and horizontal polarizations of the DRA are excited by CPW feed and slot line feed, which are switched by two p-i-n diodes [1].



Microstrip feed line

Fig1 the geometric proposed antenna

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903097|

Fig 1.1 substrate model

This proposed antenna has the merits of concise Structure and low cost and supports wide applications in wireless communication systems [2]. Good directivity and about 6.5dB gain are obtained in past literature [3]. A novel reconfigurable microstrip antenna with radiation pattern selectivity and polarization diversity is presented by controlling the two states of switches [4]. The authors introduce the utilization of ferromagnetic compounds into an antenna design and investigate the capability of controlling the antenna properties by means of an external magnetic field and also patch antenna design with a part of the dielectric substrates replace by YIG compound in past literature [5]. In this paper a single feed reconfigurable polarization printed monopole antenna is presented. The proposed antenna consists of a monopole patch and a narrow L-shaped slot created on a ground plane. Good omnidirectional pattern is achieved through this design [6].

Some system a linear-polarization (LP)/circular-polarization (CP) switchable reconfigurable antenna using a Radio Frequency Micro- Electro-Mechanical-System (RF-MEMS) switch is proposed and a novel package platform is introduced [7]. The AR bandwidth of the antenna can be further improved by increasing the substrate thickness, which may help reduce the sensitivity of its performance to fabrication tolerances [8]. In this two polarization are orthogonal to each other at the same frequency is used [9].

The computed return loss for each case is better than 10dB over the 2.4-2.484GHz frequency range [10].
In this communication, to present the design of a single feed rectangular microstrip antenna with reconfigurable polarization capability and to analyze its simulation results. The basic structure utilizes an X shaped slot at the center of a rectangular cross-shaped patch. The X shape is chosen to induce symmetric current distributions for TM10 and TM01 modes as well as to obtain greater area reduction [13]. The polarization can be switched between CP (LHCP&RHCP) and LP (Horizontal & Vertical) by changing the shape of the slot according to the ON or OFF state of the PIN diode without changing the geometrical parameters and is devoid of any impedance matching. Furthermore the antenna has an added advantage of reduced size with low levels of cross-polarized radiation in LP state and CP state.
In addition, the antenna is simple because it requires only four PIN diodes as well as less area to occupy the patch and dc-bias circuit compared to conventional polarization diversity antennas available in literature.

II. ANTENNA GEOMETRY

The geometry of the proposed antenna is shown in Fig. 1.1. The antenna is fabricated on a substrate of thickness h (1.6 mm) and relative permittivity ε_r (4.4). An X-slot of arm length l_X mm and width w_X is then carved at the center of the cross patch. The antenna is coupled using a 50 Ω microstrip line fabricated using the same substrate material. The dimension of the ground plane is 100×100 mm^2. Four PIN diodes are inserted into the center of the slot is oriented normal to the feed line. There is a printed crossed section in the center of the X-slot that connects both the diodes to the patch. For the proper biasing of the diodes, three narrow slot lines are carved in the patch.
Three small SMD capacitors C1, C2 and C3 are soldered at these slot lines which block the dc bias current as well as provide good RF continuity. The PIN diode requires a bias voltage of 1.1 V which is supplied from a battery through chip inductors. The dc bias circuit, used to control the ON/OFF state of diodes, is located on the right side of the patch.

III. RESULTS AND DICUSSION

Table 1 Switching condition

Antenna	DI	D2	D3	D4	Type of Polarization
1	ON	OFF	ON	OFF	Horizontal
2	OFF	ON	OFF	ON	Vertical
3	OFF	ON	ON	OFF	RHCP
4	OFF	ON	ON	OFF	LHCP

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903097|

The fundamental resonant modes (TM_{10} and TM_{01}) of the un-slotted cross shaped patch are (2-3) GHz with orthogonal polarizations. The appropriate selection of the slot size modifies the horizontal and vertical electrical lengths of the patch equally so that the two resonant frequencies are lowered to 2.32 GHz and 2.39 GHz. The simulated surface current distribution of the cross patch antenna with X-slot is depicted in Fig. 2. It is well evident from the figure that the insertion of the slot increases the current path thereby lowering the resonant frequency. The X- slot length is optimized to achieve maximum area reduction using Ansoft HFSS. The antenna exhibits good radiation characteristics for both resonant frequencies with an area reduction of 77% and 64% for the first and second frequency respectively when compared to a standard rectangular patch operating at the same frequencies. Four PIN diodes are inserted at the center of the X-slot to achieve the reconfigurable polarization capability. The orthogonally polarized tri frequency cross patch antenna can be reconfigured for different polarization with respect to the bias voltage applied to the diodes. The bias circuit consists of three dc block capacitors, RF chokes, two switches and input voltage. The dc bias lines are connected to the patch through RF chokes. The ON state of the diode is represented by a series resistor, R=1.35 Ω, while the OFF -- state is represented by a capacitor of C=0.35 pF. Three dc block capacitors of C=33 pF are chosen to isolate the RF components from the dc signal and RF choke inductor isolate the RF signal from flowing into the dc signal. The ON/OFF states of the diodes are controlled with respect to the potential applied to the terminals, which is described in Table I.

Antenna feeding is a very important design factor and it directly affects antenna properties, system level performance, and realistic prototyping. Among many feeding methods, three are more suitable for slot antennas. The three feeding methods are

- Simple probe
- Coplanar Waveguide (CPW)
- Microstrip Line (ML) feed

Finally the microstrip line feed is used because it is simple and ease in matching .The slot antenna geometry is as follows: the ground plane is backed by a cavity filled with a substrate with require relative permittivity. Ansoft's High Frequency Structure Simulator (HFSS) was used to design and study antenna properties.

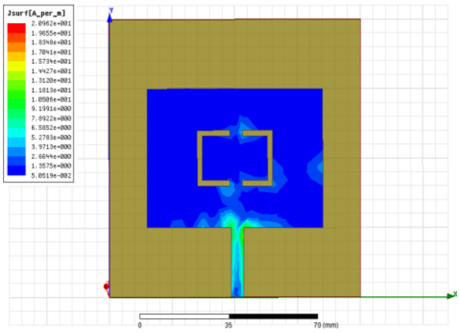


Fig 2(a)

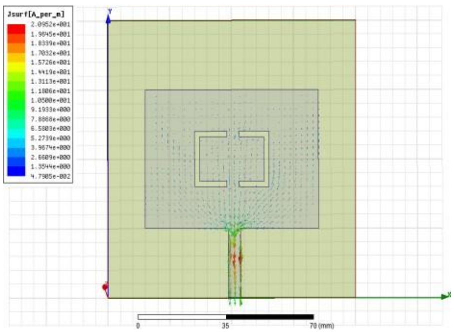


Fig 2(b)

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903097|

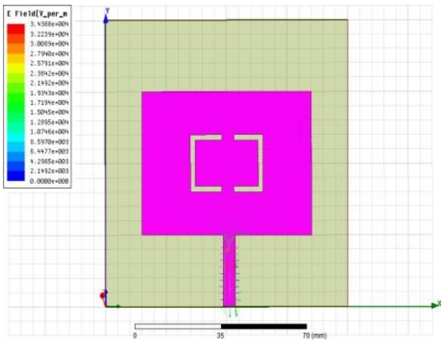


Fig 2(c)

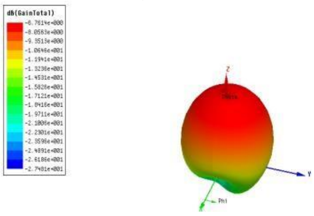


Fig 2(d) Gain dB

Fig 2.Simulated vector field current distribution for both vertical and horizontal polarization of an antenna at 2-3 GHZ

A vector field is an assignment of a vector to each point in a subset of Euclidean space. A vector field in the plane, for instance, can be visualized as a collection of arrows with a given magnitude and direction each attached to a point in the plane.

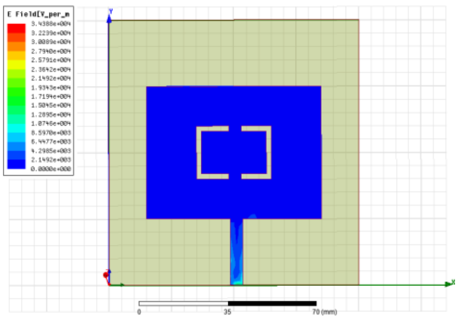


Fig 3(a)

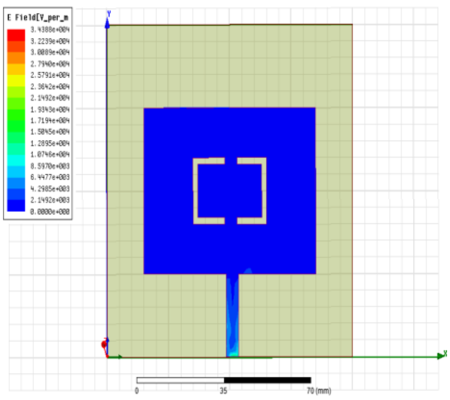


Fig 3(b)

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903097|

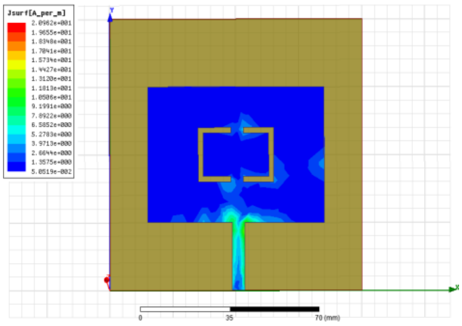


Fig 3(c)

Fig 3.Simulated magnetic field current distribution for both vertical and horizontal polarization of an antenna at 2-3 GHZ

When a current field represents force, the line integral of a current field represents the work done by a force moving along a path, and under this interpretation conservation of energy is exhibited as a special case of the fundamental theorem of calculus.

The return loss is another way of expressing mismatch. It is a logarithmic ratio measured in dB which compares the power reflected by the antenna to the power that is fed into the antenna from the transmission line. The relationship between SWR and return loss is given as follows:

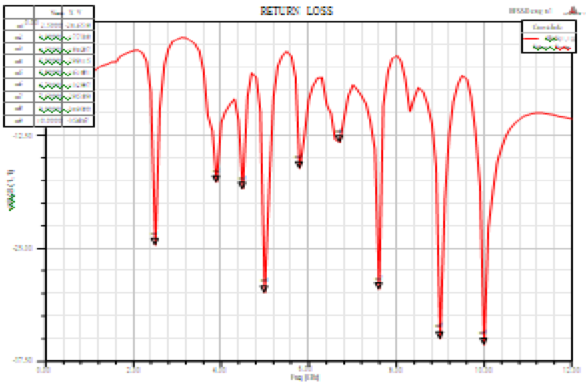


Fig 4.Return Loss

Voltage Standing Wave Ratio (VSWR) is a measure of how well an antenna is matched to the transmission line it is connected to.

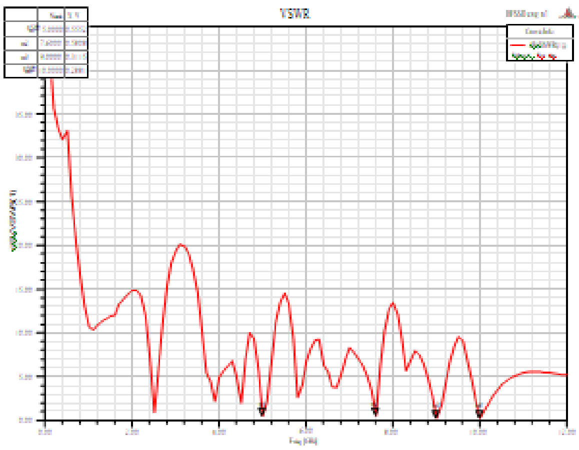


Fig5. VSWR

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903097|

The energy radiated by any antenna is contained in a transverse electromagnetic wave that is comprised of an electric and a magnetic field. These fields are always orthogonal t o one another a nd orthogonal to the direction of propagation. The electric field of the electromagnetic wave is used to describe its polarization and hence, the polarization of the antenna. In general, all electromagnetic waves are elliptically polarized. In this general case, the total electric field of the wave is comprised of two linear components, which are orthogonal to one another. Each of these components has a different magnitude and phase. At any fixed point along the direction of propagation, the total electric field would trace out an ellipse as a function of time. This concept is illustrated in Figure 6, where, at any instant in time, Ex is the component of the electric field in the x- direction and Ey is the component of the electric field in the y-direction. Generally the polarization is categorized into two types such as

1. Linear polarization
   Horizontal and Vertical polarization
2. Circular polarization
   Left hand side and right hand side polarization

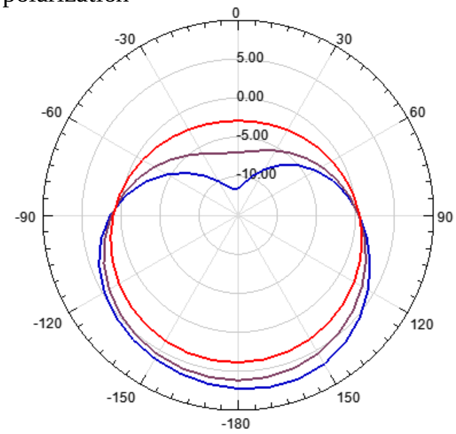


Fig 6.Radiation pattern for RHCP

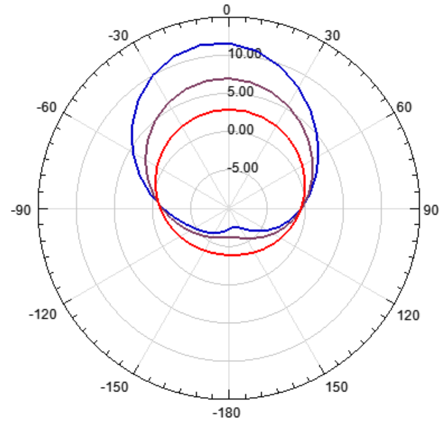


Fig 7.Radiation pattern for LHCP

IV. CONCLUSION AND FUTURE WORK

A reconfigurable microstrip patch antenna with switchable slots for polarization diversities has been presented in this communication. The antenna can produce both linear and circular polarization by controlling the bias conditions of two PIN diodes. The proposed design achieves a cross polar level better than-10 dB in both linear and circular polarization broadside radiation characteristics and moderate gain. The first phase is study and understands the parameter that showed the behavior and how it can be used and interfaces with other circuit. The microstrip patch antenna consist four major parts: the conductive patch, the dielectric substrate, the ground plane and the feed line. The most widely used

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903097|

patch conductive for low cost, low-profile patch antenna is coppers. To design and simulate patch antenna by using high frequency structure simulator. There are three methods that are widely used in the analysis, design, and modeling of patch antenna is transmission, cavity and full-wave models.

In future, we are going to fabricating patch antenna by using FR4. To test and analyze patch antenna by using signal generator, network analyzers and etc.

REFERNCES

[1] Jian Liu, Zhenghe Feng (2020), "Polarization Reconfigurable Dielectric Resonator Antenna with a CPW-to-Slot line Feed," IEEE transactions on antennas and propagation, vol. 43, no. 11

[2] CAO Sai-Xiong, YANG Xue-Xia, GONG Bo, and SHAO Bing-Cheng (2019)," A Reconfigurable Microstrip Antenna with Agile Polarization Using Diode Switches,"IEEE

[3] Xue-Xia Yang, Bing-Cheng Shao, Atef Z. Elsherbeni, ",A Polarization Reconfigurable Patch Antenna With Loop Slots on the Ground Plane",IEEE TRANSACTION 1536-1225/$31.00 © 2019

[4] Wenquan Cao, Bangning Zhang, Aijun Liu, Tongbin Yu, Daosheng Guo, and Kegang Pan, "A Reconfigurable Microstrip Antenna With Radiation Pattern Selectivity and Polarization Diversity", IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS, VOL. 11, 2018

[5] T. Zervos, A.A. Alexandridis, F. Lazarakis M. Pissas D, Stamopoulos E.S. Angelopoulos, K. Dangakis," Design of a polarisation reconfigurable patch antenna using ferrimagnetic materials", IET Microw.
Antennas Propag., 2018, Vol. 6

[6] M.H. Amini#1, H.R. Hassani #2, S. Mohammad ali nezhad#3 A Single Feed Reconfigurable Polarization Printed Monopole Antenna

[7] Tony J. Jung, Ik-Jae Hyeon, Chang-Wook Baek, Member, IEEE, and Sungjoon Lim, Member, IEEE, " Circular/Linear Polarization Reconfigurable Antenna on Simplified RF-MEMS Packaging Platform in K-band", 2018 IEEE

[8] Billy Wu∗ and Michal Okoniewski , "A Novel Scheme for Realizing a Microstrip Antenna with Switchable Circular Polarization", 6th European Conference on Antennas and Propagation (EUCAP)

[9] Y.J. Sung, "Frequency and polarisation reconfigurability from an open-loop square ring antenna", IET Microw. Antennas Propag., 2018, Vol. 6

[10] Ali Ramadan, Mohammed Al-Hussein, Karim Y. Kabalan and Ali El-HajjGeorgios, Atmatzakis and Christos G. Christodoulou (2018)," A Directional Polarization Reconfigurable Microstrip Antenna," IEEE transactions on microwave.

[11] Jorge A. Ruiz-Cruz, Mohamed M. Fahmi, Siamak A. Fouladi, Raafat R.Mansour "Waveguide Antenna Feeders With Integrated Reconfigurable Dual Circular Polarization", IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 59, NO. 12, DECEMBER 2018

[12] Kim B., B. Pan, S. Nikolaou, Y.-S. Kim, J. Papapolymerou, and M. M. Tentzeris (2017),"A novel single-feed circular microstrip antenna with reconfigurable polarization capability," IEEE Trans. Antennas Propag., vol. 56.

[13] S. Long, M. McAllister, and S. Liang, "The resonant cylindrical dielectric cavity antenna," IEEE Trans. Antennas Propag., vol. 31, pp.406-412, May.2016.

[14] S.-H. Hsu and K. Chang, "A novel reconfigurable microstrip antenna with switchable circular polarization," IEEE Antennas Wireless Propa .Lett., vol. 6, pp. 160–162, Oct. 2007.

Y. B. Chen, Y. C. Jiao and F. S. Zhang, "Polarization reconfigurable CPW-fed square slot antenna using pin diodes" Microw. Opt. Technol. Lett., vol. 49, pp. 1233–1236, Jun. 2007.

INNO SPACE

SJIF Scientific Journal Impact Factor

Impact Factor:
7.488

INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

निस्केयर
NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING