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Design and Development of Frequency Reconfigurable U-Slot MSPA for WLAN/ WiMaX/ISM Applications

Mallikarjun C Sarsamba, Raju Yanamshetti

Abstract: ***In this article we presented a creative design of the frequency reconfigurable micro strip patch antenna that is used for WLAN applications. Use PIN diode in the designed U-slot micro strip patch antenna and acting as a switch. The PIN diode was mounted on U-slot and when a particular frequency band is worked. The suggested work on the simulation is performed in HFSS. The simulation test shows strong effects on the reconfigurable frequency of the WLAN / WiMaX / ISM program.***

Key words: Frequency Reconfigurable, Micro strip antenna, U-slot, PIN diodes.

I. INTRODUCTION

Through the development in networking technology, interest in reconfigurable antennas is increasing, especially for their applications in specific wireless communication systems. You may adjust their properties to get the desired spectrum of wavelengths, direction of radiation, or polarisation. Tunable antennas have many advantages over wireless antennas, such as smaller size, equivalent levels of radiation in all different frequency ranges, efficient utilization of electromagnetic spectrum, and frequency discernment that helps to lessen the antagonistic effects of co-channel interference and jamming. Find a compact triple band in this paper 2.7 GHz, 3.2 GHz, and 5.3 GHz lightweight micro strip patch antenna with two U-shaped slots and a small ground plane. It was designed for potential use of WiMAX technology [1, 15]. In this post, we suggest a new, lightweight, and reconfigurable patch antenna with variety of frequencies. By changing the switching mode of two PIN diodes from ON-ON to OFF-OFF; this antenna can be adjusted to switch between two different mobile communication systems, respectively 3 G and 4G [2]. This letter incorporates a very low slot-moved UWB reconfigurable antenna for use in applications with cognitive radio (CR). The proposed antenna functions in two modes: UWB network sensing mode and narrow / wideband communication mode for different applications. UWB antenna mode is achieved by producing three UWB frequency resonances.

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* Correspondence Author

Mallikarjun C S*, Assistant Professor in E&CE Dept. VSM'S SRKIT Nipani.

Dr. Raju Yanamshetti, Professor and Head of Electronics and Communication Engineering department in P.D.A. College of Engineering Gulbarga.

Different switching states of 5 p-i-n diodes have narrow / broad touch bands [3]. This letter allows for LTE (2.3 GHz), AMT (4.5 GHz), and WLAN (5.8 GHz) implementations with a lightweight frequency reconfigurable slot antenna. To perform dual-operation, a U- slot with short ends and an L- slot with open ends are inserted in the land plane. Fast reconfiguration of three frequency bands can be accomplished by mounting two PIN diodes inside the slots over a frequency ratio of 2.62:1[4]. This paper introduces a new concept of frequency-reconfigurable antenna, using an aperture-coupled technique as feeding technique and stacked patch technology. Usually, the proposed antenna consists of three substrates layers (RT-Rogers 5880), with a filled air space between substrates for the feed line with layer 2. Setting the switches to ON or OFF mode to change the length of the feed line [5] implements four PIN diode switches (BAP51-02). It offers a slot antenna that can be reconfigured again with 3 switchable frequencies. The advantage of this design is that three switches from separate groups allow the electronic selection of the frequency resonances. Thereby seven separate states are achieved, and at the same time three, two or one resonances are conceivable. The antenna will support Bluetooth 2.4-GHz and/or WiMAX 3.5-GHz and/or 5.8-GHz WLAN systems using three sickle- slots in the ground plane and three pairs of p-- diodes that are soldered between three metal strips in the slots and ground plane[6]. A reconfigurable frequency antenna with a microstrip pad is suggested. Six reconfigurable frequencies are generated at three switches. These switches are positioned in slot places underneath the pad. A reflector is placed behind the antenna. The spatial radiation differences were observed to be at all frequencies. Simulated experiments are used to show the antenna performance. It has been found that the spatial radiation differences are being obtained at all wavelengths. Simulated experiments are used to show the usefulness of antennas. The predicted return losses are described and compared with the proposed antenna's radiation levels with and without a reflector [7]. This paper presents a new, unequal U- antenna and is often reconfigurable. The U-slot antenna built with two lumped variable varactors can switch between 2.3 GHz and 3.6 GHz at six different frequencies. The tiny slots in the ground plane are used to reduce the effects of parasites on biasing circuit antenna performance. The uneven U-slot supplied by an L-shaped feed line would be 30 per cent the height of the conventional U-slot antenna [8]. We introduce a dual-band, reconfigurable microstrip antenna for WLAN applications, based on printed split-ring modules.

The written split-ring resonator components have an electrically compact configuration which can be tuned to provide single or dual band output with an integrated switch. In all frequency ranges the antenna also exhibits consistent radiation patterns [9]. For multiband implementations, a frequency-switchable, written dipolar antenna is suggested. The dipole's electric duration can be altered by adjusting the location of the pin diodes so that the antenna can work within three different frequency ranges. The greater / lesser frequency of the current direction, the smaller / larger resonance frequency, may be obtained. Within this range three resonant frequencies are chosen from 200 to 1400 MHz and all resonant frequencies are appropriately balanced [10]. This offers a lightweight double slot frequency antenna for wireless communication. The suggested antenna consists of a double slot for frequency reconfigurability, with six RF PIN diodes positioned at separate positions on the ground plane. This offers a small double slot frequency antenna, which for wireless communication can be reconfigured. The planned antenna consists of a double slot with six RF PIN diodes for the frequency reconfigurability located at different positions on the ground plane [11]. This paper introduces a technique for using microstrip patch antenna implementations from the S-band and C-band. This suggested research sets forth the frequency reconfigurable microstrip patch antenna with three ground level slots. On the ground plane slot, two switches (copper strip) are positioned to create three different frequency bands at 3.06, 3.26 for (S-) and 4.27 GHz(C-) respectively [12]. Reconfigurable antennas are generally named for nowadays because of their durable nature. A new, reconfigurable patch antenna frequency is added around a rectangular patch with two metallic rings in this article. Reconfigurability of sound can be done by changing the radiating surface of the antenna [13]. This article discusses WLAN / WiMAX implementations with a compact, low- planar microstrip triple- antenna. This paper attempts to combine WLAN and WiMAX networking criteria into one device simultaneously by developing a single antenna that can cause triple band operation [14]. The organization of paper is first part is introduction, second section is conventional antenna, third section is modified u-slot antenna, fourth section is proposed antenna, fifth section is result and discussion and sixth section is conclusion.

II. CONVENTIONAL ANTENNA DESIGN AND STRUCTURE

In this section the traditional MSPA diagram is seen in figure. 1.A typical micro strip patch antenna modeling substrate FR-4 epoxy and permittivity (πr=4.4), the height of the substrate is 1.6 mm. The area length and thickness: 60mmx60 mm. The definition square patch antenna diameter and length is equal to 29.5mmx29.5 mm. The feeding procedure used as a quarter wave equivalent to 50 impedance. The thickness and length of the quarter wave feed line 8.75 mm and 0.5 mm, 50 percent impedance matching length and thickness 6.50 mm and 3.164 mm. Traditional return loss as shown in figure.2 and traditional radiation pattern as shown in figure.3.

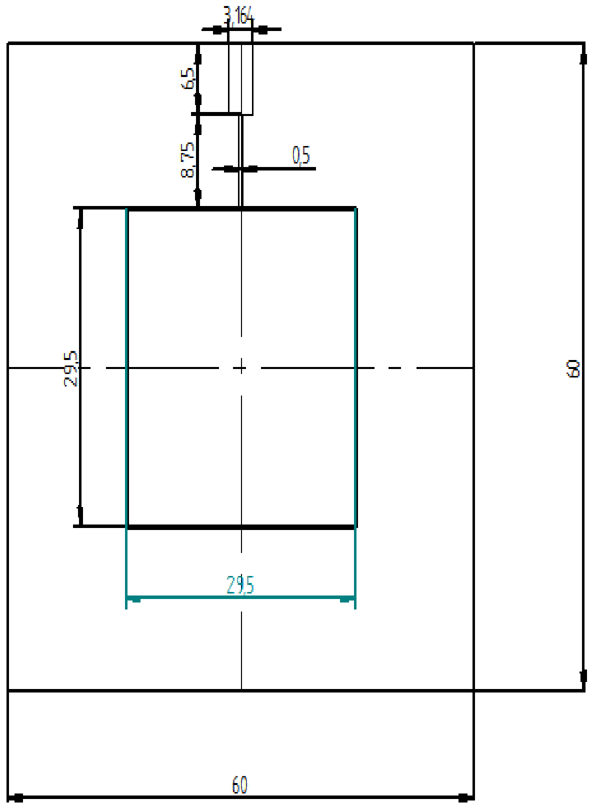

Fig1. Conventional Antenna

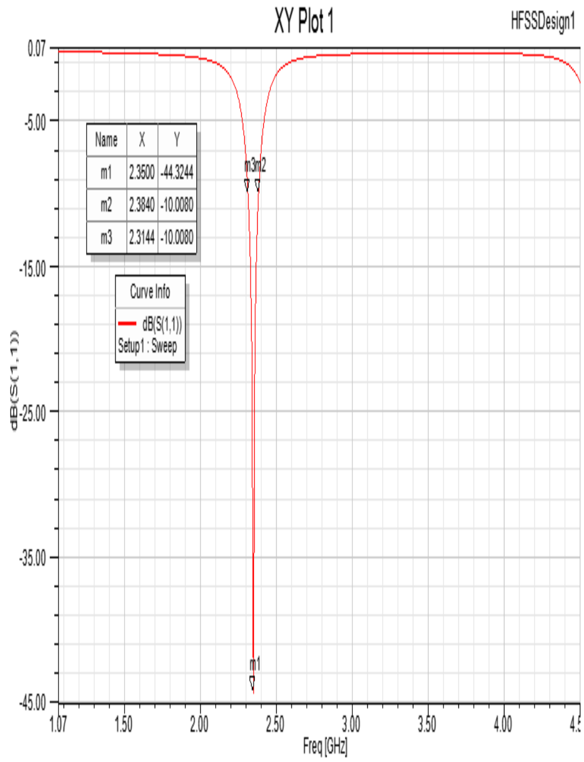

Fig 2.Conventional Antenna Simulated Returns Loss for 2.35 GHz

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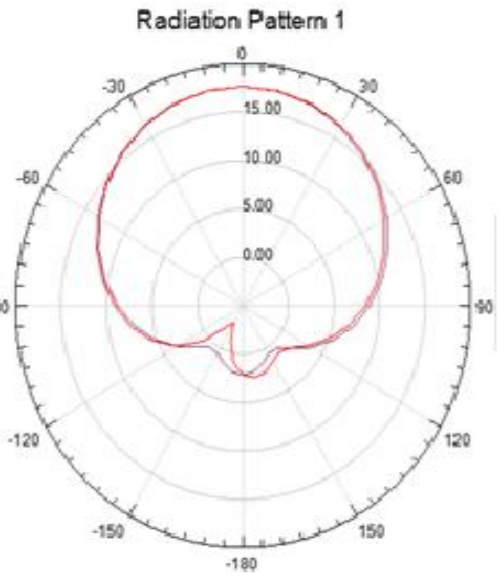

Fig.3ConventionalAntennaRadiationPattern2.35GHz

III. MODIFIED U-SLOT ANTENNA

In this segment, the standard micro strip patch configuration has been modified by incorporating U-slot MSP antenna as shown in fig. 4.A modified U-slot MSP antenna modeling the FR-4 epoxy substrate and permittivity (εr=4.4), the substrate height is 1.6 mm. The length and width of the ground 60mmx60mm.The design square patch antenna length and width equal to 29.5mmx29.5mm.The U-slot dimensions length and width 20mmx1mm.The feeding technique used as a quarter wave 50Ω impedance matching. The quarter wave feed line length and width 8.75mm and 0.5mm, 50Ω impedance matching 6.50mm and 3.164mm.The modified U-slot MSPA return loss as shown in figure.5 and radiation pattern as shown figure.6.

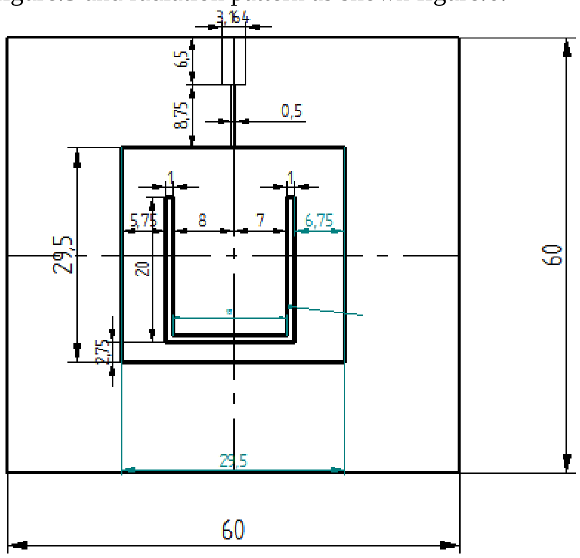

Fig.4 Modified Using U-Slot

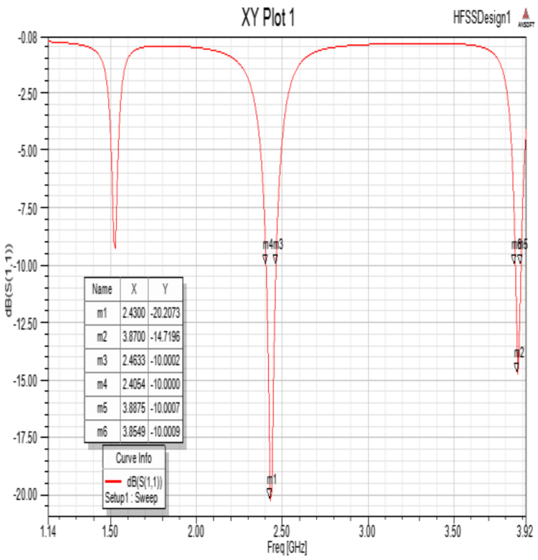

Fig.5 Modified Using U-Slot Antenna Return Loss 2.43, 3.87 GHz

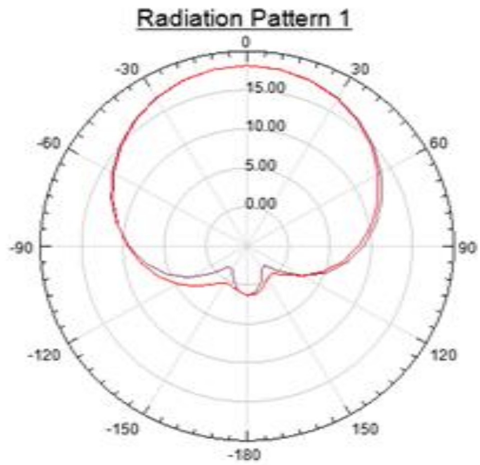

Fig.6 Modified Using U-Slot Radiation Pattern

IV. PROPOSEDRECONFIGURABLEANTENNA

Configuration of the reconfigurable antenna with U-slot frequency is shown in figure 7.The antenna consist of a square patch with a U-slot, two PIN diodes across the slot and an quarter wave fed line. The micro strip patch antenna is fabricated on a FR-4 epoxy substrates with a thickness of 1.6mm and relativity permittivity of 4.4mm.The patch has a dimension of (WxL) 29.5mmx29.5mm.The quarter wave feed line has length and width 8.75mmx0.5mm and 50Ω impedance match length and width 6.50mmx3.164mm.The length and width of all sides of U-slots 20mmx1mm.The proposed antenna return loss when two diodes are on as shown in figure.8, the radiation pattern two diodes are on as shown in figure.9. With the assistance of the modeling program Ansoft HFSS.

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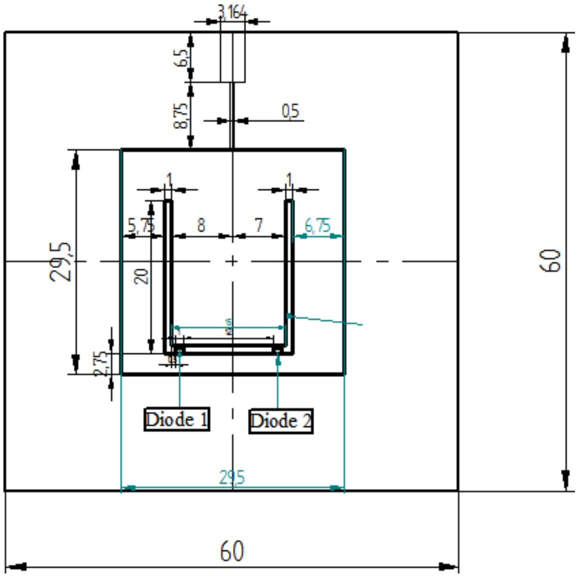

Fig. 7 Proposed Reconfigurable Antenna

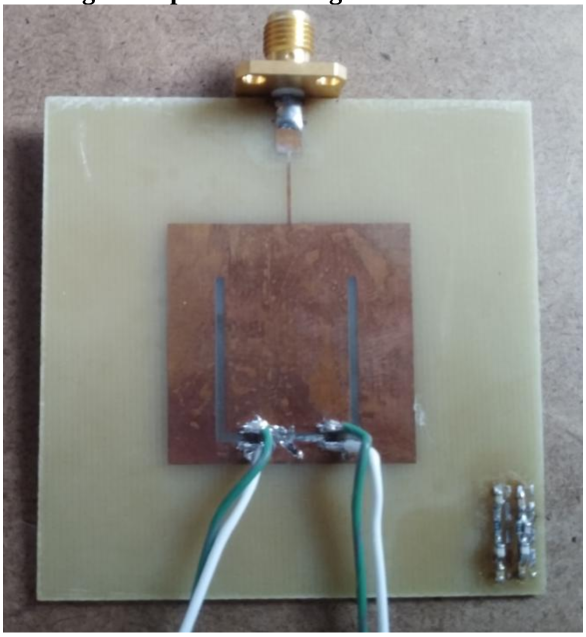

Fig.8 Experimental Measuring U-slot Antenna

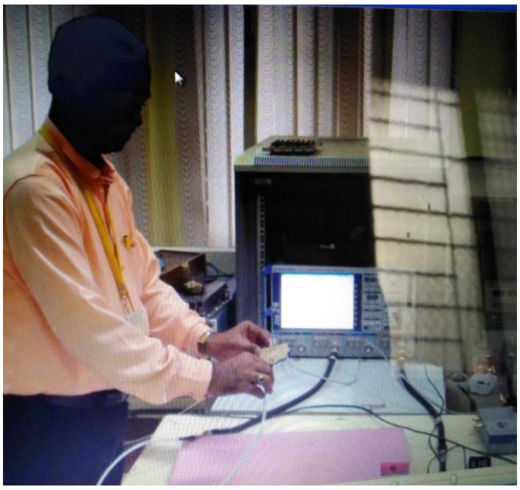

Fig.9 Experimental Setup Using VNA

- **Diode D1 and D2 –ON**

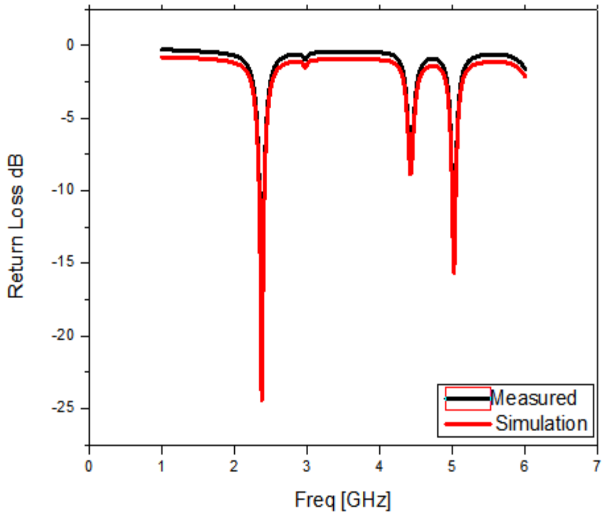

Fig.10 Proposed reconfigurable antenna return loss Simulation and Measured at 2.3,4.99GHz (Both the diode D1,D2 turns ON)

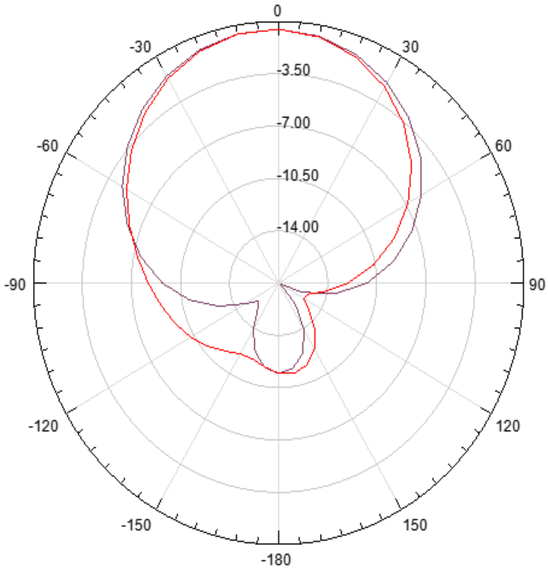

Fig.11 Proposed Reconfigurable Antenna Radiation Pattern 2.3 GHz (Both the diode D1, D2 turns ON)

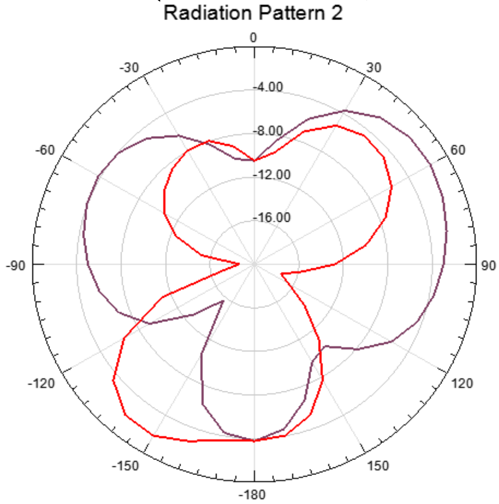

Fig.12 Proposed reconfigurable antenna Radiation pattern 4.99GHz (Both the diode D1, D2 turns ON)

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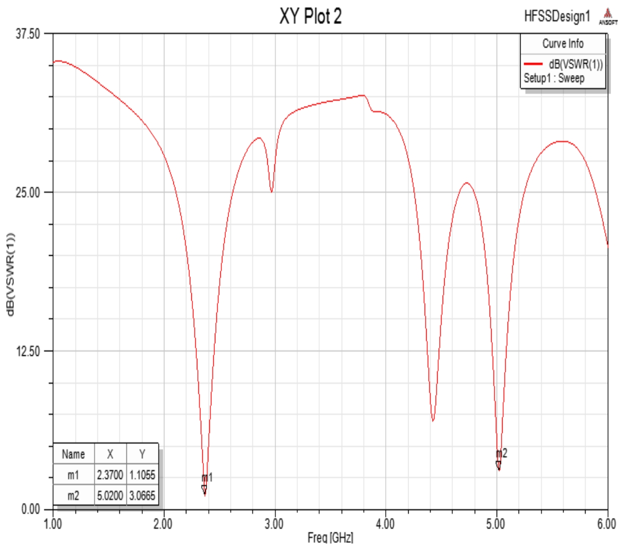

Fig.13 Proposed reconfigurable antennaVSWR 2.3 and 4.99GHz (Both the diode D1, D2 turns ON)

- **Two diodes D1,D2-OFF**

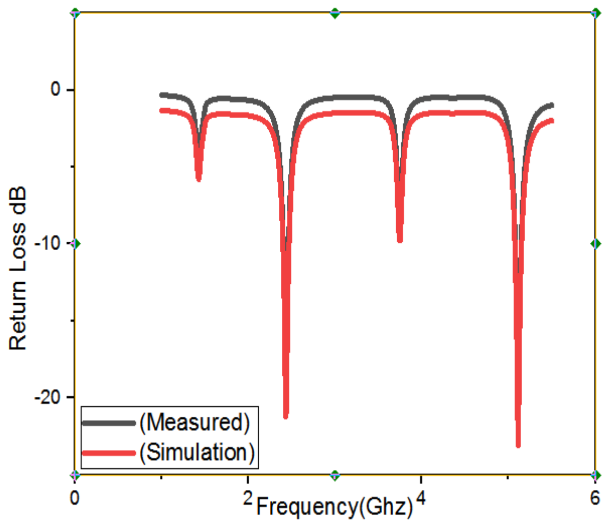

Fig.14 Proposed reconfigurable antenna return loss Simulation and Measured at 2.3,4.99GHz (Two diodes D1,D2-OFF)

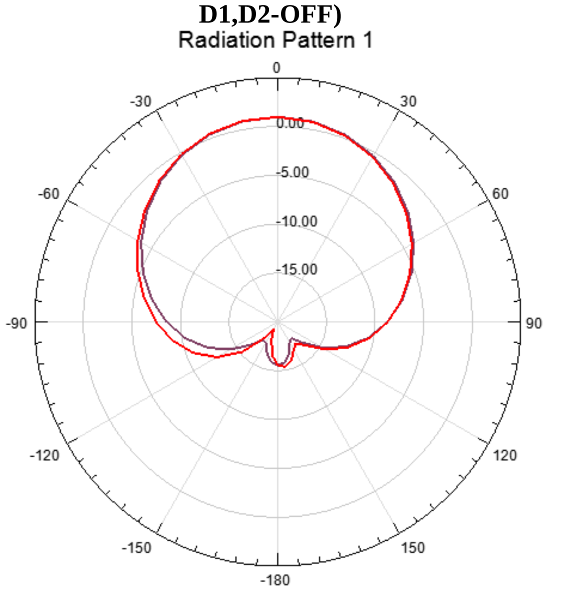

Fig.15 Proposed reconfigurable antenna Radiation pattern 2.43GHz (Two diodes D1, D2-OFF)

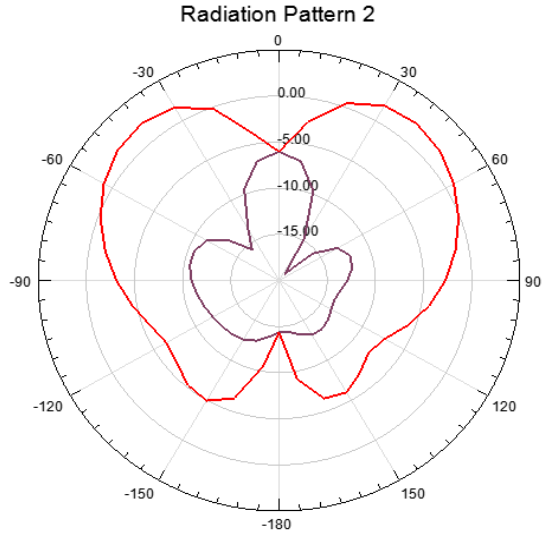

Fig.16 Proposed reconfigurable antenna Radiation pattern 5.11GHz (Two diodes D1, D2-OFF)

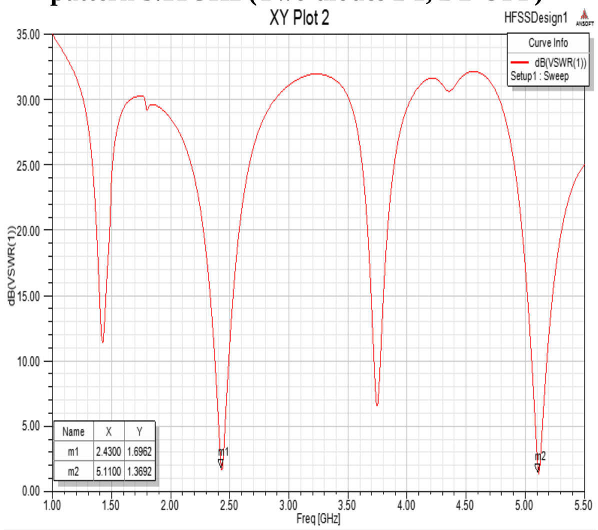

Fig.17 Proposed reconfigurable antennaVSWR 2.43 and 5.11GHz (Two diodes D1, D2-OFF)

- **Diode D1-ON, D2-OFF**

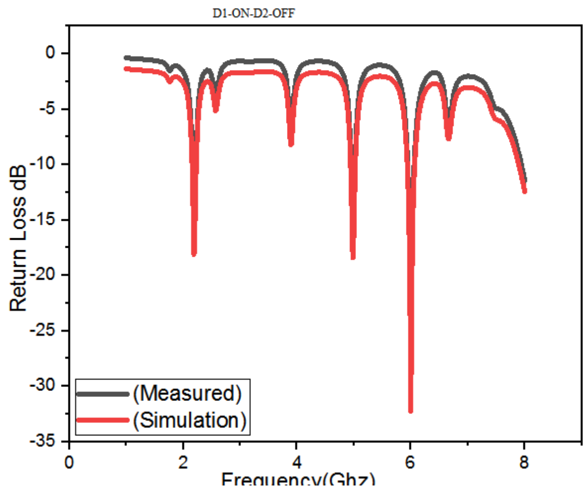

Fig.18 Proposed reconfigurable antenna return loss Simulation and Measured at 2.2, 4.98,6 GHz (DiodesD1-ONandD2-OFF)

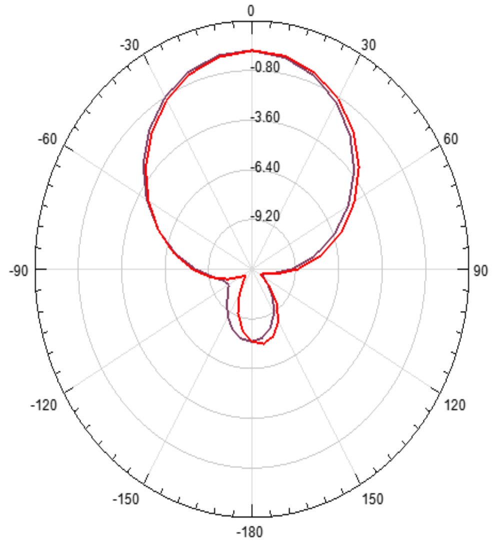

Fig.19 Proposed reconfigurable antenna Radiation pattern 2.2GHz (Diodes D1-ON and D2- OFF)

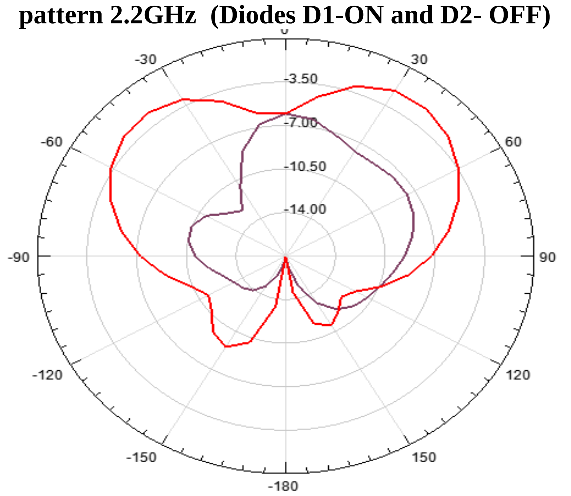

Fig.20 Proposed reconfigurable antenna Radiation pattern 4.98GHz (Diodes D1-ON and D2- OFF)

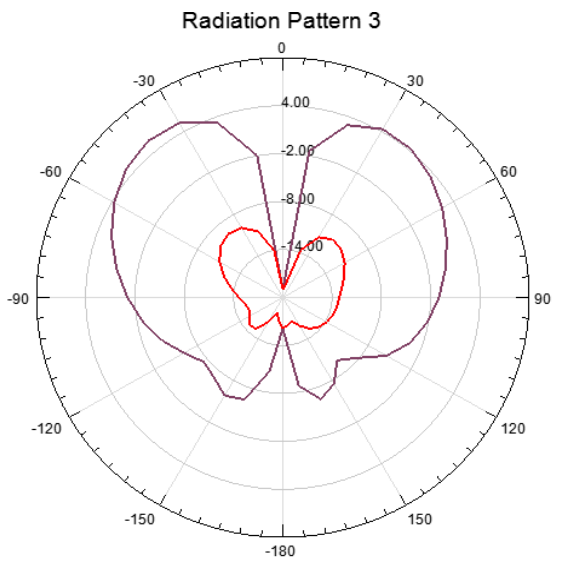

Fig.21 Proposed reconfigurable antenna Radiation pattern 4.98GHz (Diodes D1-ON and D2- OFF)

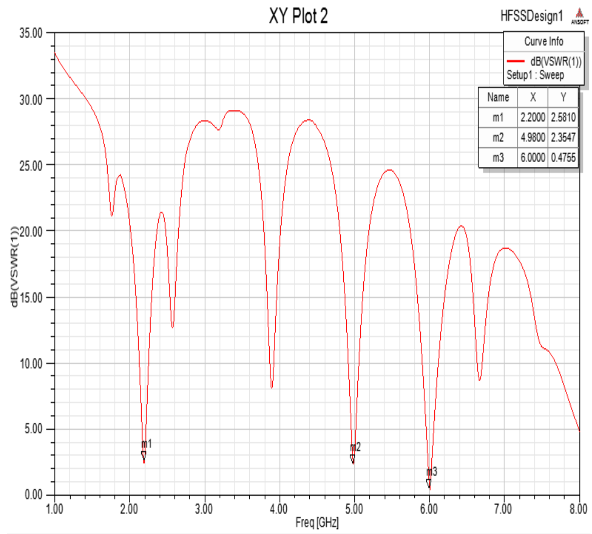

Fig.22 Proposed reconfigurable antennaVSWR 2.2, 4.98, 6GHz (D1-ON, D2- OFF)

- Diode D1-OFF,D2-ON

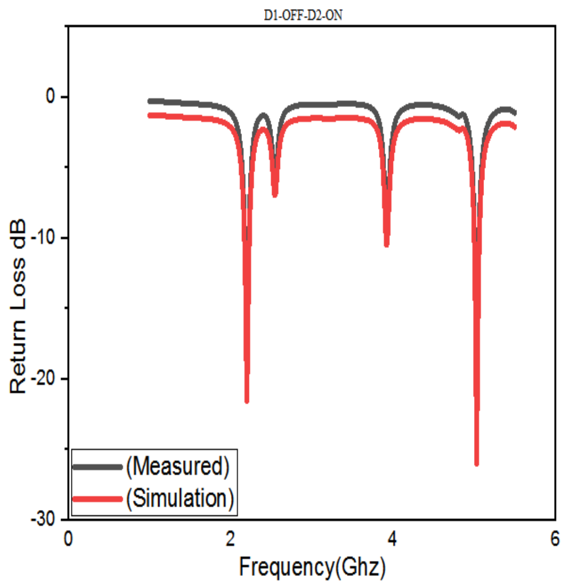

Fig.23 Proposed reconfigurable antenna return loss Simulation and Measured at 2.2,5.3 GHz (Diodes D1-OFF and D2-ON)

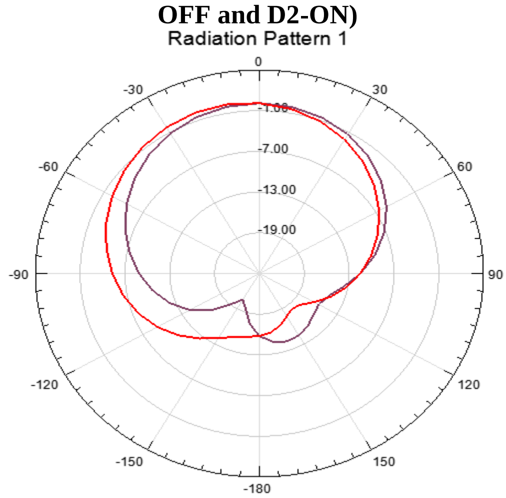

Fig.24 Proposed reconfigurable antenna Radiation pattern 2.2GHz (Diodes D1-OFF and D2- ON)

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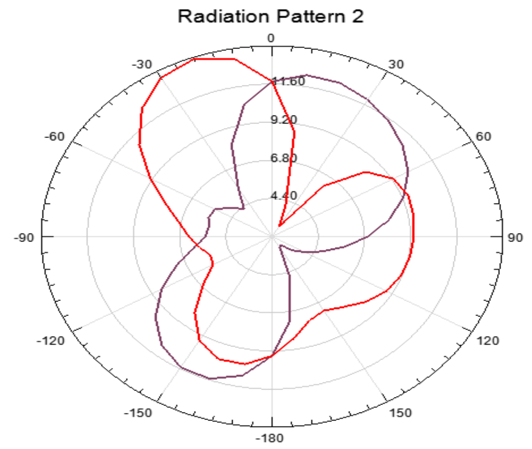

Fig.25 Proposed reconfigurable antenna Radiation pattern 5.3GHz (Diodes D1-OFF and D2- ON)

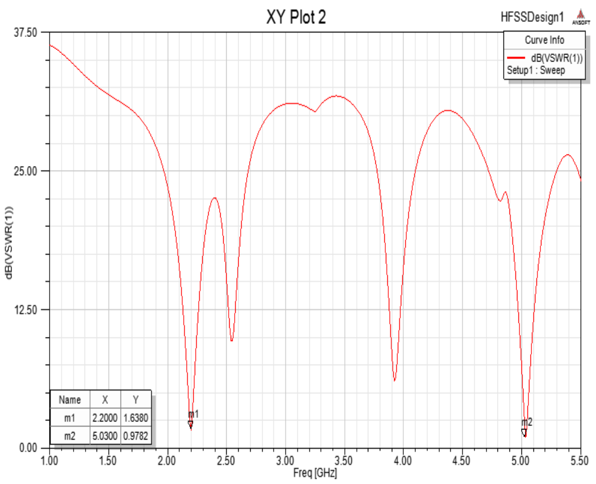

Fig.26 Proposed reconfigurable antennaVSWR 2.2, 5.3GHz (Diodes D1-OFF and D2- ON)

V. RESULT AND DISCUSSION

Comparison of simulated result and measured outcome of prototype antenna was discussed in this section. The simulation and measured values are obtained respectively via HFSS and VNA. The different antenna parameters for the proposed antenna's four switching states are listed as below.

(a)Return Loss

1.The return loss of first state i e D1 and D2-ON means both the diode on then return loss of simulation and measured is shown in figure.10.The measured values is slight different from simulation result because fabrication process. The simulation result shows red line and measured result black line.

2. The return loss of first state i e D1 and D2-OFF means both the diode off then return loss of simulation and measured is shown in figure.13.The measured values is slight different from simulation result because fabrication process. The simulation result shows red line and measured result black line.

3. The return loss of first state i e D1-ON and D2-OFF then return loss of simulation and measured is shown in figure.17.The measured values is slight different from simulation result because fabrication process. The simulation result shows red line and measured result black line.

4. The return loss of first state i e D1-OFF and D2-ON then return loss of simulation and measured is shown in figure.22.The measured values is slight different from simulation result because fabrication process. The simulation result shows red line and measured result black line.

The Radiation Pattern and VSWR shown in figures. The comparison result Bandwidth, Gain, Return loss and VSWR simulation and measured result.

Table I. Conventional and Modified Micro strip patch Antenna

State	Switch D1	Switch D2	Simulation Resonant Frequency (GHz)	Simulation Return loss in dB	Simulation Bandwidth %	Resonant Frequency Measured (GHz)	Return loss Measured in dB	Bandwidth Measured %
1	ON	ON	2.3 4.99	-28.553 -16.1337	8.98 5.05	2.2 4.5	-20.2222 -13.454	6.5 4.1
2	OFF	OFF	2.42 5	-27.6561 -22.9453	5.69 4.25	2.41 4	-20.5521 -18.4224	4.18 3.99
3	ON	OFF	2.46 4.91	-13.4781 -28.9404	4.54 5.19	2.2 4.4	11.0022 20.4251	4 4.98

4	OFF	ON	2.45 4.92	-20.7475 -37.9365	4.3 3.21	2.24 4.4	-18.5282 20.1553	3.98 2.8

Table II. Proposed Reconfigurable Micro Strip Patch Antenna

Type of Antenna	Resonant Frequency (GHz)	Return loss in dB	Bandwidth %
Conventional Antenna	2.35	-44.1473	2.96
Modified Antenna Using U-slot	2.43 3.87	-20.2073 -14.7106	2.38 0.842

VI. CONCLUSION

The experimental study shows that the frequency reconfigurable antenna is fairly easy to design and produce and very efficient to improve the operation of multiband frequencies, providing a better pattern of broadside radiation. The other parameter of the antenna including gain, VSWR and loss of return is found to be perfect for this antenna. This antenna is ideal as it uses low-cost substratum material and finds applications in WLAN, WiMAX and ISM band frequency ranges as in conventional wireless communication systems.

REFERENCE

1. H. F. AbuTarboush, H. S. Al-Raweshidy and R. Nilavalan, "Triple Band Double U-Slots Patch Antenna for WiMAX Mobile Applications", Proceedings of APCC2008 copyright © 2008 IEICE 08 SB 0083.
2. Younes Karfa Bekali, Mohamed Essaaidi, "Compact Reconfigurable Dual Frequency Microstrip Patch Antenna for 3G and 4G Mobile Communication Technologies", Microwave And Optical Technology Letters/Vol.55,No.7,July 2013
3. Gunjan Srivastava, Akhilesh Mohan, Member, IEEE, Ajay Chakrabarty, Senior Member, IEEE. "Compact Reconfigurable UWB Slot Antenna for Cognitive Radio Applications", DOI 10.1109/LAWP.2016.2624736, IEEE Antennas and Wireless Propagation Letters.
4. Liping Han, Member, IEEE, Caixia Wang, Xinwei Chen, and Wenmei Zhang, Member, IEEE, "Compact Frequency Reconfigurable Slot Antenna for Wireless Applications", DOI 10.1109/LAWP.2016.2536778, IEEE Antennas and Wireless Propagation Letters.
5. N. Ramli1, M. T. Ali, A. L. Yusof, S. Muhamud - Kayat, and A. A. A. Aziz, "PIN Diode Switches for Frequency-Reconfigurable Stacked PatchMicrostrip Array Antenna using Aperture-Coupled Technique", 2013 Asia-Pacific Microwave Conference Proceedings.
6. Alireza Pourghorban Saghati, Mohammadnaghi Azarmanesh, and Reza Zaker, Member, IEEE,"A Novel Switchable Single- and Multifrequency Triple-Slot Antenna for 2.4-GHz Bluetooth,3.5-GHz WiMax, and 5.8-GHz WLAN", IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS, VOL. 9, 2010.
7. H. A. Majid, M. K. A. Rahim, M. R. Hamid, M. F. Ismail,M. R. Sani, "Frequency Reconfigurable Microstrip Patch Antenna", 2012 IEEE Asia-Pacific Conference on Applied Electromagnetics (APACE 2012), December 11 - 13, 2012, Melaka, Malaysia.
8. Zhen Ren, Wentao Li, Le Xu, and Xiaowei Shi, "A Compact Frequency Reconfigurable UN-Equal U-Slot Antenna with a Wide Tunabil-ITY Range". Progress in Electromagnetics Research Letters, Vol. 39, 2013.
9. S. C. Basaran,K. Sertel, "A Compact Frequency-Tunable Microstrip Antenna for Dual band WLAN Applications", 978-1-4673-5689-3/13/$31.00 ©2013 IEEE.
10. Seyyedpayam Abbasiniazare, Omid Manoochehri, Keyvan Forooraghi,"A Reconfigurable Printed Dipole Antenna Using RF PIN Diodes", Microwave and Optical Technology Letters/Vol.56, No5, May 2014.
11. R. Jothi Chitra, V. Nagarajan, "Frequency Reconfigurable Antenna Using PIN Diodes", 978-1-4799-2361-8/14/$31.00 ©2014 IEEE.
12. Babu lal Sharma, Girish Parmar, Mithilesh Kumar, "Design Of Frequency Reconfigurable microstrip Patch Antenna For S-Band and C-Band Applications", 978-1-4673-7231-2/15/$31.00 ©2015 IEEE.
13. Saad Shoukat, Sadiq Ullah, Sajjad Rahim, Babar Kamal, Usman Ali "Design of a Dual Band Frequency Reconfigurable Patch Antenna for GSM and Wi-Fi Applications", 978-1- 5090-1252-7/16/$31.00 ©2016 IEEE.
14. Lalit Kumar, Anil Kumar Gautam, Binod Kumar Kanaujia, Karumudi Rambabu " Design of Compact F-shaped slot Triple Band Antenna for WLAN/WiMAX Applications", DOI 10.1109/TAP.2015.2513099, IEEE Transactions on Antennas and Propagation
15. C. A. Balanis, Antenna theory Analysis and Design, 3rd ed. A John Wiley & Sons, Inc. Publication, Hobonken, New Jersey, 2005.

AUTHORS PROFILE

Mallikarjun C S: received B.E. Degree in Electronics and Communication Egg from Gulbarga University, Karnataka India, and VTU Belgaum M.Tech Degree in Power Electronics. He is a member of various organizations including IETE and IACSIT. He presented 10 articles in conference / journals of the National / International. He currently is working as an Assistant Professor in E&CE Dept. VSM'S SRKIT Nipani. Microwave Antenna, Smart Antennas, and Reconfigurable Antenna are his areas of interest.

Dr. Raju Yanamshetti: He got B.E. Degree in Electronics and Communication Egg from the University of Gulbarga, Karnataka India, 1986, and in1991 M.E. Degree in Power Electronics from Gulbarga.In1992hejoinedP.D.A.CollegeofEngineeringGulbarga.Hecompletedhis Ph.DinElectricalEngineeringfromJadavpurUniversityKolkatain2012.He is member of several organizations such as Institute of Engineers, IESTE, IETE, and ISOI and has several national and international publications. Currently he is serving as Professor and Head of Electronics and Communication Engineering department in P.D.A. College of Engineering Gulbarga. His main research interest includes Power Electronics, Instrumentation and control.

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