Frequency and Pattern Reconfigured Multi Band CPW Antenna for Wimax and X-Band Applications

R Agilesh Saravanan, B T P Madhav, M Venkateswararao, V.S.Sahiti, V Swetha, V.K.Priyanka, P.S.Anand

Abstract: This article presents a novel reconfigurable antenna in which both frequency of the antenna and its pattern are reconfigured. A T- shaped rectangular patch which is attached by two longitudinal slits is present in the antena. The slits have been related to a pin diode to obtain the required frequency bands and pattern reconfiguration. The antenna is designed with 70*70 substrate dimension having FR4 as a material and designed using HFSS 18 The frequency reconfiguration can be seen in between at 4.5GHz /5.8GHz/11.4GHz and 13.6GHz which are used for the WLAN and vehicular communications. Along with that a pattern reconfiguration of about -15^0,15^0,30^0 degrees tilt in the angle is observed in the radiation patterns at the same bands. Prototype antenna is fabricated and tested in the real time electromagnetic environment and results measured are shown like that of the simulated results in HFSS.

KeyWords: Frequency,pattern-reconfigurable, multiband operation.

I. INTRODUCTION

A dual-mode polarized three sector reconfigurable broadband antenna has been designed which is used in mobile communications having operating frequency range 1.7 to 2.7 GHz with 2 radiation modes (omnidirectional or sectorial) which can be attained by changing feeding scenario. The advantages of this antenna are it meets the base station antenna requirements at dual modes in terms of gain, it is small, and it has wide bandwidth and stable radiation pattern [1]. By using reconfigurable antennas, we can radiate dual or more patterns by varying element excitations and number of antennas used can be reduced, therefore cost of hardware is reduced. The applications of array antennas are in radars and communication systems.

There are many methods to attain reconfigurable nature like multi-mode feeding techniques for parabolic antennas, alternating projection approaches and stochastic optimization algorithms. Here phase differentiated antenna array is designed using common excitation amplitude distribution and uniform spacing for attaining reconfigurable nature, therefore complexity of designing feed network is reduced. In this paper new multiple pattern model is designed using linear programming under many conditions like uniform spacing and common excitation amplitudes. This model has been examined on linear array, rectangular grid and random placed planar antenna. This model reduces the number of antennas significantly [2] . The antenna has two U-shaped resonators with PIN diode which is placed on suitable location in order to attain reconfigurable nature and switch from single to dual band operation. PIN diode fabricated is BAR 50-02v. By controlling PIN diodes, we can resonate the antenna in dual bands. The proposed antenna is for WIMAX (3.2/3.5 GHz) and WLAN (5.2/5.8 GHz) applications. The attained gain ranges from 2.3 to 3.9dBi in its operating band [3]. To have switchable nature PIN diodes are located on each two double split ring resonators (DSRR). The advantage of this antenna is it has wide impedance bandwidth of 2.58 – 15.5 GHz with sharp dual band notch functionalities for WIMAX and HIPERLAN applications. Peak gain is 4.96dB and has omnidirectional radiation pattern. The design is good for UWB and radio applications [4]. A wide range of standards in today's electronics like mobiles and other personal devices, there is a rise in demand to use antennas that work at multiple frequencies and with variable radiation pattern [4-7]. This resulted in the use of 'Reconfigurable Antennas'. A reconfigurable antenna can dynamically change frequency, radiation pattern and polarization without any change in its physical characteristics like length and size. A reconfigurable patch antenna in which frequency varied is proposed. Two meandered slots are designed on rectangular patch. It can switch in four bands by using two PIN diodes. The size of antenna is 11.51mm to 8.37mm and FR4 substrate is used.

Revised Manuscript Received on April 06, 2019.

P.S.Anand, Antennas & Liquid Crystals Research Center, Dept. of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur District, India.

R Agilesh Saravanan, Antennas & Liquid Crystals Research Center, Dept. of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur District, India.

B T P Madhav, Antennas & Liquid Crystals Research Center, Dept. of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur District, India.

M Venkateswararao, Antennas & Liquid Crystals Research Center, Dept. of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur District, India.

V.S.Sahiti, Antennas & Liquid Crystals Research Center, Dept. of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur District, India.

V Swetha, Antennas & Liquid Crystals Research Center, Dept. of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur District, India.

V.K.Priyanka, Antennas & Liquid Crystals Research Center, Dept. of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur District, India.

*Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication*

By using four combinations of two PIN diodes antenna can be set to 0.80GHz, 7.34GHz, 7.844GHz and 8.18 GHz covering a range of frequencies of 1.80GHz. The advantages of this antenna are low level cross polarizations, fast switching, low operating voltages and ease of integration factors. The designed antenna has ability of hopping of frequency over continuous range [5]. The antenna's radiation pattern mis changing can helps in avoiding noise resources or intentional jamming and improving security by directing signals towards intended users [3]. These antennas also satisfy the requirements of modern wireless communications which demand enhanced performance of antenna and decreased interference [3-6]. A compact triple band notch UWB antenna is proposed which is used in UWB applications. By using inverted U-shaped metallic strip at slotted ground plane leads to band rejection of 8GHZ. By using slots on rectangular patch second rejection at 3.6GHz and third rejection at 5.5 GHz for WLAN applications are generated. In order to add the switchable nature to our antenna two PIN diodes are inserted at suitable slots. Changing combinations of PIN diodes our antenna will reconfigurable at three different frequency responses [6]. The reconfigurable antennas are controlled by integrating RF with PIN diode, MEM switch or a varactor diode. These antennas have already found their place in industrial, academic and military purposes. But, today, they are also being used in satellite networks, cordless systems, tactical radio relay and point to multipoint base stations. In this paper UWB slot antenna with CPW feed with single reconfigurable notch band functionality is proposed. Two short circuited quarter wavelength resonators are kept at top layer and close to ground plane to create single notch. By varying the length of resonators, the switching reconfiguration is achieved to prevent interference from WLAN and ITU. By deploying two ideal switches and by selecting length of resonators central frequency of notch band is attained. The advantages of using quarter wavelength resonator are stable radiation pattern, high rejection level and simple to tune the central frequency of notch band and occupy less space [7-15]. In this paper single feed reconfigurable monopole antenna is designed. It has 2 patches rectangular and inverted U-shaped patches. Three PIN diodes are placed on particular slots to attain reconfigurable between four frequency bands of WIFI, WIMAX and GPS. Micro strip feed is used to excite antenna. To have impedance matching we can change the dimensions of length and width of the patch. DC biased circuits are used to bias the PIN diodes to reconfigure the frequency [15-22].

Here, an antenna that is low-profile and which can be frequency and pattern configurable antenna has been designed. The antenna has a footprint of 70 mm × 70 mm operating at multiband and it can reconfigure in both frequency and pattern.

II. ANTENNA DESIGN AND CONSTRUCTION

This section of the paper deals about the designing of the proposed antenna with frequency and pattern reconfiguration properties. The proposed antenna has been designed through various iterations which are shown below in the figure1. The designed antenna comprises of a patch which is rectangular in shape with two level slots, one of which is at the top of antenna and the other at its base). Subsequently, there are three individual rectangular strips which are capacitively coupled. Also, the feed is associated with the base strip. Moreover, they can be associated/disengaged utilizing a couple of PIN diodes, viz., D1, D2, D3, and D4 conveyed at the end of each slot, which, thusly, comprises the electrical length of the patch of the patch antenna. Certain mixes of the PIN diode state give shaft tilt of up to 30° on the left of antenna and the right-hand side.

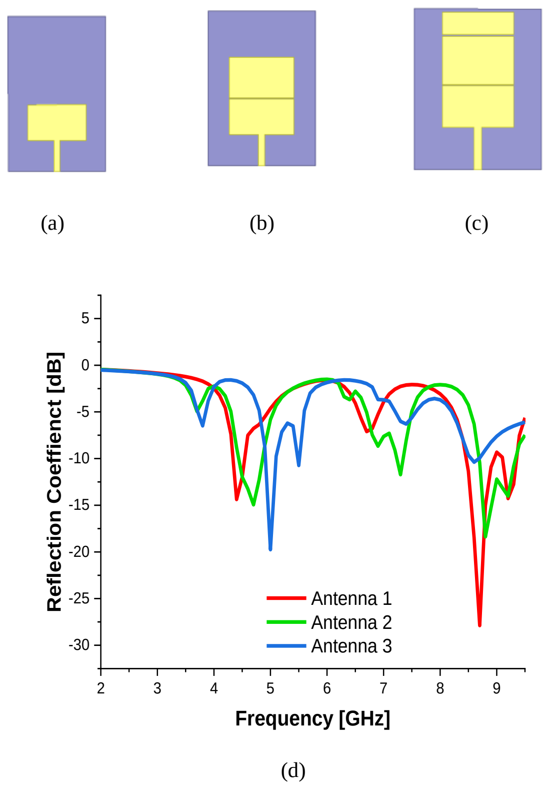
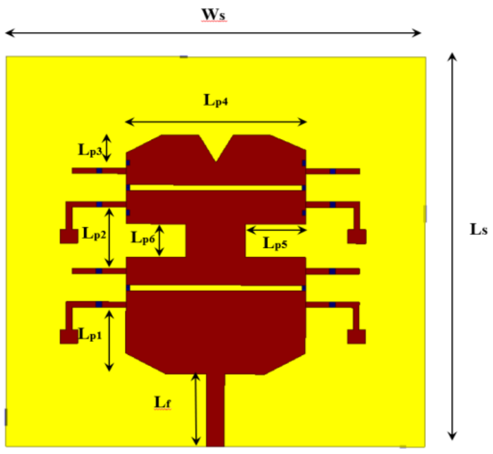
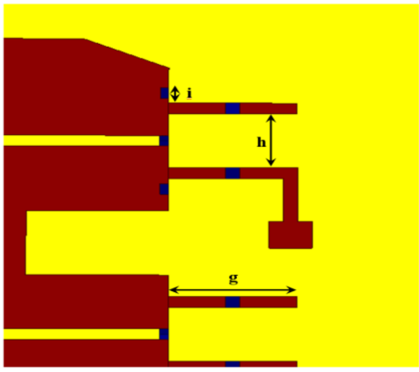


Figure.1 Proposed antenna interations (a) Antenna1 (b) Antenna2 (c) Antenna3 and (d) Reflection Ceofficient Results of the Iterations.

The suggested antenna is appeared in figure2. An FR4 substrate consists of 1.6 mm thickness having a dielectric constant of 4.3 and loss tangent 0.025 is used to produce the antenna. The volume of the antenna is 50×50×1.6mm^3. All the reproductions are done using CSTMicrowaveStudio2015, and estimations are finished utilizing Keysight's E5071C ENA arrangement vector organize analyzer. There are seven working states of this antenna of which three states correspond to frequency reconfiguration with radiation designs coordinated along 0°. Rest of the four states give bar tilts in two different ways for two respective fixed frequencies. The Antenna construction is done by using the dimensions given in the table1.



(a)



(b)

Figure 2. proposed antenna (a) Front View (b) Diode Placement in the Antenna.

Table1. Dimensions of the proposed antenna.

Variable	Dimension (mm)	Variable	Dimension (mm)
Ws	70	Lp4	30
Ls	70	Lp5	10
Lf	13	Lp6	6
Lp1	12	g	5
Lp2	11	h	1
Lp3	6	i	9

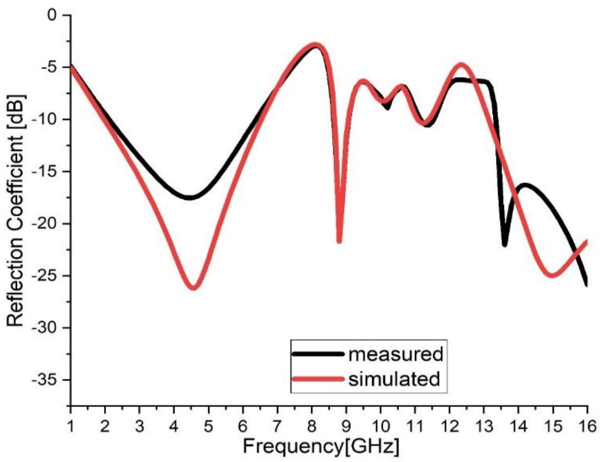


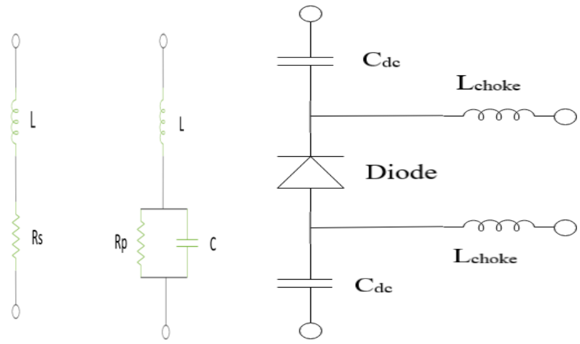
Figure3. Simulated and Measured Results

III. RESULTS AND DISCUSSION

The model antenna is manufactured and tried for impedance and radiation qualities. BAR64-03W pin diode is used to reconfigure the antenna attributes. The results of this suggested antenna have been discussed in two subsequent sections such as frequency reconfiguration(2.1) and pattern reconfiguration(2.2)

3.1 Frequency Reconfigurability:

To achieve the frequency reconfiguration, we use the PIN diodes introduced in the slots between the rectangular patch structures. The PIN diode model we use is the BAR64-03W5627. The "ON" and "OFF" conditions of the PIN diode are shown in the figure3. Also, the DC biasing voltage circuit is shown, and this circuit is used to connect the PIN diodes to prevent the dc blocking capacitor provides the isolation between the DC voltage and the RF signal. The inclusion of Rf Choke is used to block RF signal and allow DC current to pass through.



(a) (b)

Figure4. (a) Diode ON and OFF conditions representation (b) DC Blocking circuit.

Table2. Diodes Components and their values.

Component	Value
Rs	2.1Ω
Rp	300kΩ
L	1.8nH
C	0.2pF
Cdc	20pF
Lchoke	33nH

At the point when every one diode is altered HIGH (or in ON state), the closures at which they are cut shorted electrically. Hence, In this a solitary patch which is having a rectangular shapes and has two cuts gives five-band resonance at 5.4/8.8/10.2/11.5/14.5 GHz (Case I). The activity of the reconfigurable antenna is clarified by accepting underlying condition with diodes in OFF state.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Whenever the diode D1 and diode D2 are separated from every other state turned ON (State II), the cut at lower end will be shorted with respect to the center strip. The strip that is shorted, which has electrical length 32 mm which is directly related to the wavelength being 4.5 GHz encourages and excites to give response at 4.5 GHz. Moreover, the frequency band at 8.8 GHz is resounded as the coupling which is capacitive, that is in between the two strips, above and below the upper cut. So also, when the diodes cases are shifted for both D3 and D4 are If they turned ON while others are in OFF state (State IV), the upper side is short circuited with the center strip along the edges. The strip which is shorted at lower slit consists of electrical length of 15 mm comparing to a large portion of the wavelength of 5.2 GHz and is eager to make reverberation at 8.8 GHz. The band at 8.8 GHz is resounded gives an account for the capacitive coupling between the strips above and underneath the lower cut. Consequently, a multiband reconfiguration is accomplished utilizing a basic rectangular fix antenna.

Table3: Operating bands of the Antenna for different diode conditions

State	Diode Switching Conditions				First Resonant Band	Second Resonant Band	Third Resonant Band	Fourth Resonant Band
	D1	D2	D3	D4				
1	OFF	OFF	OFF	OFF	4.5(2.09-6.36)	8.8(8.65-9.06)	11.3(11.11-11.48)	17(13.31-20)
2	OFF	OFF	OFF	ON	8.8(8.65-9.04)	10.1(10.05-10.16)	11.20(11.06-11.29)	13.7(13.39-20)
3	OFF	OFF	ON	OFF	5.7(4.43-5.81)	7.0(6.70-7.51)	8.9(8.68-9.08)	10.2(10.09-10.23) 11.2(11.04-11.50) 13.5(12.97-20)
4	OFF	OFF	ON	ON	8.8(8.67-9.07)	11.2(11.03-11.62)	13.5(13.27-20)	----
5	OFF	ON	OFF	OFF	4.8(2.85-6.21)	8.8(8.65-9.06)	11.4(11.03-11.60)	15.4(13.39-20)
6	OFF	ON	OFF	ON	8.8(8.62-9.05)	11.4(11.10-11.61)	14.3(13.25-20)	----
7	OFF	ON	ON	OFF	5.6(3.41-6.49)	8.9(8.65-9.08)	10.1(10.07-10.20)	11.4(11.06-11.63)
8	OFF	ON	ON	ON	4.5(1.99-6.51)	8.8(8.64-9.05)	11.5(11.12-11.69)	13.9(13.37-18.29)
9	ON	OFF	OFF	OFF	8.9(8.70-9.08)	14.6(13.03-20)	----	-----
10	ON	OFF	OFF	ON	4.6(1.99-6.53)	8.8(8.66-9.06)	11.3(11.09-11.38)	15.0(13.15-20)
11	ON	OFF	ON	OFF	4.6(2.75-5.82)	8.9(8.64-9.09)	11.5(11.35-11.58)	11.2(13.10-20)
12	ON	OFF	ON	ON	3.7(1.36-6.46)	8.9(8.66-9.09)	11.4(11.16-11.55)	13.9(13.14-20)
13	ON	ON	OFF	OFF	6(5.87-6.58)	9(8.81-9.12)	10.2(10.18-10.29)	11.5(11.22-11.64) 17.5(13.00-20)
14	ON	ON	OFF	ON	5.8(4.52-6.30)	8.9(8.62-9.08)	10.2(10.11-10.23)	11.5(11.19-11.60) 14.5(13.11-20)
15	ON	ON	ON	OFF	5.5(3.77-6.28)	8.9(8.70-9.09)	11.4(11.20-11.64)	14.5(13.16-20)
16	ON	ON	ON	ON	5.4 (2.83-6.71)	8.8(8.65-9.07)	10.2(10.18-10.21)	11.5(11.27-11.58) 14.5(3.08-20)

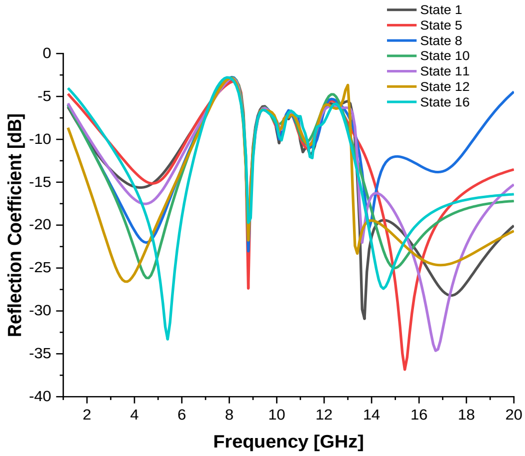


Figure5. Reflection Coefficient of different states of the Antenna.

Table 4. Bands and Gain at the bands for the specified diode conditions.

State	Diode Switching Conditions				B.W At 1st Band	Gain at 1st Band	B.W at 2nd Band	Gain at 2nd Band	B.W at 3rd Band	Gain at 3rd Band	B.W at 4th Band	Gain at 4th band
	D1	D2	D3	D4								
1	OFF	OFF	OFF	OFF	4.27	3.4135	0.41	4.9355	0.37	3.0835	6.69	7.4842
5	OFF	ON	OFF	OFF	3.36	-0.19	0.41	4.475	0.57	3.5726	6.61	6.9893
8	OFF	ON	ON	ON	4.52	3.4490	0.41	5.0313	0.57	4.2745	4.92	4.1304
10	ON	OFF	OFF	ON	4.54	0.8909	0.4	4.5360	0.29	3.9424	6.85	4.5536
11	ON	OFF	ON	OFF	3.07	0.7696	0.45	4.8084	0.23	2.7508	6.9	4.3675
12	ON	OFF	ON	ON	5.1	2.6672	0.43	4.8225	0.39	2.7334	6.86	4.2362
16	ON	ON	ON	ON	3.88	0.6367	0.42	4.5568	0.03	3.1775	0.31 16.92	1.5115 4.3317

3.2 Pattern Reconfiguration:

The pattern reconfiguration is accomplished by altering the current course in the patch radiator. In a regular antenna framework, the adjustment in period of its excitation current results in tilting of the pattern of antenna. In any case, for this situation, the excitation source is kept steady and the way that the current ventures have been changed. Consequently, in the pattern reconfiguration expresses, the current travel extra separation prompting way distinction, which further delivers a stage contrast. The pattern reconfiguration is inferred as a subclass of State I and State V. In State I, diodes D1, D2, D3 and D4 are maintained in OFF state. In the event that anybody of these diodes is turned ON, the receiving wire radiation pattern can be tilted up to 15°. The bearing of tilting relies upon the fact whether the diode is switched ON or not. With the diodes D3 and D4 being ON and OFF respectively, the radiation pattern's main beam moves to +15° (State XI). Also, when the diodes D4 and D3 are ON and OFF respectively, the tilt of main beam will be around – 30° (State X). Amid both these cases, the reception apparatus gives double recurrence reaction 6.9 and 0.4 GHz. A comparative trademark is additionally inferred under State X. When the diodes D1 and D2 are ON and OFF respectively, the main beam will tilt to +15° (State XIII), while with D1 OFF and D2 ON, the heading of the main beam movements to – 15° (State XIII). Along these lines, amid States X and XI, the reconfiguration of pattern is accomplished at 3.07 and 5.1 GHz. In State III, in a similar way, the current goes from left side to the right bringing about beam arrangement along +15°, and in State XVI, the bearing of the flow of current will be turned around prompting beam development along – 15°.

Table 5. Efficiency of the Antenna in different Stages.

State	Diode Switching Conditions				Efficiency (%) At Resonant Bands			
	D1	D2	D3	D4	1	2	3	4
1	OFF	OFF	OFF	OFF	44.75	48.27	33.52	42.39
5	OFF	ON	OFF	OFF	23.07	47.49	37.28	44.02
8	OFF	ON	ON	ON	41.38	49.53	37.33	42.53
10	ON	OFF	OFF	ON	28.37	46.93	33.52	45.17
11	ON	OFF	ON	OFF	28.19	48.80	33.71	39.05
12	ON	OFF	ON	ON	26.78	48.71	34.16	42.01
16	ON	ON	ON	ON	25.63	46.29	35.67	30.97/38.92

3.3 Radiation Patterns

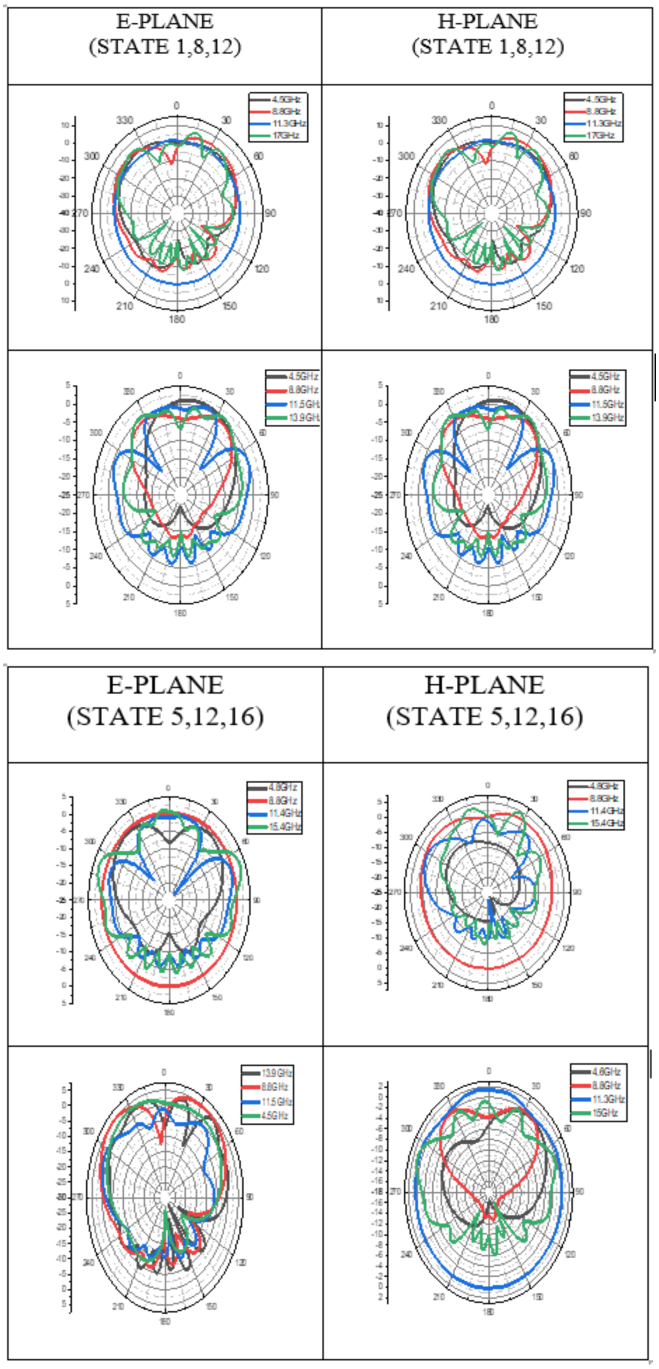


Figure6: Radiation pattern of the antenna.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Table 6: Comparison of proposed antenna with existing literature.

Work	Dimensions of the Antenna (mm^2)	Reconfiguration seen	Elements used	Features		
				B.W(MHz)	Gain(dB.)	η (%)
[23]	46 x 20	Frequency	4 MEMS	90/125/100	-0.15/3.14/2.57	55/90/75
[24]	58 x 30	Pattern	2 PIN Diodes and 1 FSS	150	9.1	NR
[24]	130 x 160	Frequency and Pattern	11 switches	200/150/150	5.6/4.6/3.3	88.7/87.7/89.5
[25]	80 x 45.8	Frequency and Pattern	5 PIN Diodes	580/290	1.9/2.1	71/51
[26]	120 x 120	Frequency and Pattern	12 PIN Diodes	63.4/88.3	9.15/10.52	94.9/94.8
[27]	34 x 36	Frequency and Pattern	2 Switches	100/70	4/5.6	NR
[28]	50 x 50	Frequency and Pattern	2 PIN Diodes	120/100/100	NR	NR
This work	70 x 70	Frequency and Pattern	4 PIN Diodes	240/70/50/240		71/83/87/89

IV. CONCLUSION

In this Paper, a pattern and frequency Reconfiguration antenna has been proposed. The antenna which operates at 4.5GHz /5.8GHz/11.4GHz and 13.6GHz is proposed. The antenna has applications in the field of wireless communication, telemetry and WLAN applications. The radiation pattern tilts up to -15^0 /0^0/$+15^0$. As this antenna can be reconfigured in both frequency and pattern, bands have been used effectively. The proposed antenna is used for the WiMAX and vehicular commination and x band applications in both frequency and reconfigurable applications.

ACKNOWLEDGMENT

We are thankful to KLEF for their moral support and DST for their technical support through ECR/2016/000569, and EEQ/2016/000604

REFERENCES

1. Alieldin, Ahmed, Yi Huang, Stephen J. Boyes, and Manoj
2. Stanley. "A Reconfigurable Broadband Dual-Mode Dual-Polarized Antenna for Sectorial/Omnidirectional Mobile Base Stations." *Progress In Electromagnetics Research* 163, no. 3 (2018): 1-13.
3. Liu, Yanhui, Pengfei You, Chunhui Zhu, Xiaofeng Tan, and Qing Huo Liu. "Synthesis of sparse or thinned linear and planar arrays generating reconfigurable multiple real patterns by iterative linear programming." *Progress In Electromagnetics Research* 155 (2016): 27-38.
4. Braham Chaouche, Youcef, Farid Bouttout, Mourad Nedil, Idris Messaoudene, and Ismail Benmabrouk. "A Frequency Reconfigurable U-Shaped Antenna for Dual-Band WIMAX/WLAN Systems." *Progress In Electromagnetics Research* 87 (2018): 63-71.
5. AbouElEz, Ahmed E., Essam ElDiwany, Mohamed B. El Mashade, and Hussien A. Konber. "Modelling and Simulation of P-I-N Quantum Dot Semiconductor Saturable Absorber Mirrors." *Progress In Electromagnetics Research* 82 (2018): 39-53.
6. Alhegazi, Ammar, Zahriladha Zakaria, Noor Azwan Shairi, Imran Mohd Ibrahim, and Sharif Ahmed. "A Novel Reconfigurable UWB Filtering-Antenna with Dual Sharp Band Notches Using Double Split Ring Resonators." *Progress In Electromagnetics Research* 79 (2017): 185-198.
7. Baruah, Rocktotpal, and Nidhi Saxena Bhattacharyya. "A Frequency Reconfigurable Meandered Slot Cut Rectangular Patch Antenna Using PIN Diodes." *Progress In Electromagnetics Research* 77 (2017): 81-89.
8. Boutayeb, Halim. "Electrically Reconfigurable Radial Waveguides and Their Potential Applications in Communications and Radars Systems." *Progress In Electromagnetics Research* 75 (2017): 147-153.
9. Madhav, B.T.P., Manikanta Prasanth, A., Prasanth, S., Krishna, B.M.S., Manikantha, D., NagaSai, U.S. Analysis of defected ground structure notched monopole antenna, (2015), ARPN Journal of Engineering and Applied Sciences, 10 (2), pp. 747-752.
10. Madhav, B.T.P., Sanikommu, M., Pranoop, M.S., Bose, K.S.N.M.C., Kumar, B.S. Cpw fed antenna for wideband applications based on tapered step ground and ebg structure (2015) Indian Journal of Science and Technology, 8, pp. 119-127.
11. Ramkiran, D.S., Madhav, B.T.P., Prasanth, A.M., Harsha, N.S., Vardhan, V., Avinash, K., Chaitanya, M.N., Nagasai, U.S. Novel compact asymmetrical fractal aperture Notch band antenna (2015) Leonardo Electronic Journal of Practices and Technologies, 14 (27), pp. 1-12.
12. Mohan Reddy, S.S., Mallikarjuna Rao, P., Madhav, B.T.P. Asymmetric defected ground structured monopole antenna for wideband communication systems (2015) International Journal on Communications Antenna and Propagation, 5 (5), pp. 256-262.
13. Madhav, B.T.P., Kaza, H., Kartheek, T., Kaza, V.L., Prasanth, S., Chandra Sikakollu, K.S.S., Thammishetti, M., Srinivas, A., Bhavani, K.V.L.Novel printed monopole trapezoidal notch antenna with S-band rejection (2015) Journal of Theoretical and Applied Information Technology, 76 (1), pp. 42-49.
14. Lago, Herwansyah, Mohd Faizal Jamlos, Ping Jack Soh, and Guy AE Vandenbosch. "AMC-Integrated Reconfigurable Beamforming Folded Dipole Antenna with Parasitic and RF MEMS." *Progress In Electromagnetics Research* 69 (2016): 159-167.
15. A Atallah, Hany, Adel B. Abdel-Rahman, Kuniaki Yoshitomi, and Ramesh K. Pokharel. "Reconfigurable Band-Notched Slot Antenna Using Short Circuited Quarter Wavelength Microstrip Resonators." *Progress In Electromagnetics Research* 68 (2016): 119-127.
16. [16] Nazir, Isra, Inam Elahi Rana, Noor Ul Ain Mir, and Kanwal Afreen. "Design and analysis of a frequency reconfigurable microstrip patch antenna switching between four frequency bands." *Progress In Electromagnetics Research* 68 (2016): 179-191.
17. Sharma, Sonia, and Chandra Charu Tripathi. "A wide spectrum sensing and frequency reconfigurable antenna for cognitive radio." *Progress In Electromagnetics Research* 67 (2016): 11-20.
18. Koley, Santasri, Lakhindar Murmu, and Biswajit Pal. "A pattern reconfigurable antenna for WLAN and WiMAX systems." *Progress In Electromagnetics Research* 66 (2016): 183-190.
19. Hussain, Rifaqat, Muhammad Umar Khan, Wajih Abu-Al-Saud, Ali Hussein Muqaibel, and Mohammad S. Sharawi. "Characterization of Reconfigurable MIMO Antennas for Channel Capacity in an Indoor Environment." *Progress In Electromagnetics Research* 65 (2016): 67-77.
20. Wang, Fu-Wei, Lixin Guo, and Shu-Xi Gong. "Reconfigurable Radar Absorbing Structure Applied to the Antenna Radar Cross Section Reduction." *Progress In Electromagnetics Research* 64 (2016): 179-185.
21. Yang, Lingsheng, Yongan Zhu, and Kuniaki Yoshitomi. "CPW-Fed Reconfigurable Clover-Shaped Antenna with Switchable Circular Polarization." *Progress In Electromagnetics Research*60 (2015): 147-156.
22. Lim, Sheng-Loke, Eng Hock Lim, and Fook-Loong Lo. "Reconfigurable Stepped-Impedance Slotline Power Dividers." *Progress In Electromagnetics Research* 57 (2015): 109-116.
23. S. Soltani, P. Lotfi, and R. D. Murch, "A port and frequency reconfigurable MIMO slot antenna for WLAN applications," IEEE Trans. Antennas Propag., vol. 64, no. 4, pp. 1209–1217, Apr. 2016.
24. M. Bouslama, M. Traii, T. A. Denidni, and A. Gharsallah, "Beam switching antenna with a new reconfigurable frequency selective surface," IEEE Antennas Wireless Propag. Lett., vol. 15, pp. 1159–1162, 2016.
25. H.A.Majid, M.K.A.Rahim, M.R.Hamid, and M.F.Ismail, "Frequency and pattern reconfigurable slot antenna," IEEE Trans. Antennas Propag., vol. 62, no. 10, pp. 5339–5343, Oct. 2014.
26. P. K. Li, Z. H. Shao, Q. Wang, and Y. J. Cheng, "Frequency- and pattern reconfigurable antenna for multi standard wireless applications," IEEE, Antennas Wireless Propag. Lett., vol. 14, pp. 333–336, 2015.

27. N. Ramli, M. T. Ali, M. T. Islam, A. L. Yusof, and S. MuhamudKayat, "Aperture-coupled frequency and patterns reconfigurable microstrip stacked array antenna," IEEE Trans. Antennas Propag., vol. 63, no. 3, pp. 1067–1074, Mar. 2015.
28. G. H. Huff, J. Feng, S. Zhang, and J. T. Bernhard, "A novel radiation pattern and frequency reconfigurable single turn square spiral microstrip antenna," IEEE, Microw.WirelessCompon. Lett., vol.13, no.2, pp.57–59, Feb. 2003.

AUTHORS PROFILE

R. Agilesh Saravanan is pursuing PhD degree in K L University, Vijayawada in the faculty of Electronics and Communication Engineering since 2017,Specialized in Signal Processing. He received his Master of Engineering Degree in Applied Electronics from Velammal Engineering College, Anna University,Chennai in 2014. He received his B.E. Degree in Electronics and Communication Engineering from Chettinad College of Engineering and Technology, Anna University, Chennai in 2012. He has been working as Assistant Professor in various Engineering College from 2014 till date. His present affiliation is with K LUniversity, Vijayawada designated as Assistant professor in ECE. His research interest are Ultrasound imaging, Sensor Array Processing and Compressed Sensing.

V. S. Sahiti was born in 1997 at Vijayawada. She is currently pursuing B.Tech in Electronics and Communication Engineering at KL Deemed to be University. Her areas of interest include Design of Reconfigurable Patch Antennas.

V. Swetha was born in 1998 at Jangareddy Gudem. She is currently pursuing B.Tech in Electronics and Communication Engineering at KL Deemed to be University. Her areas of interest include Reconfigurable Patch Antennas.

V. K. Priyanka was born in 1997 at Visakhapatnam. She is now pursuing B.Tech in Electronics and Communication Engineering at KL Deemed to be University. Her areas of interest include Reconfigurable Patch Antennas.

P.S. Anand was born in 1997 at Tuni. He is now pursuing B.Tech in Electronics and Communication Engineering at KL Deemed to be University. His areas of interest include Reconfigurable Patch Antennas.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication