ISSN (e): 2250 – 3005 || Volume, 07 || Issue, 10|| October – 2017 ||
International Journal of Computational Engineering Research (IJCER)

# Slots and Notch Loaded Rectangular Stacked Microstrip Antenna for Multiband Operations

**Saiyed Salim Sayeed, J.A.Ansari, Mukesh kumar, Gulman, Abhishek**
*Dept. Electronics and Communication University of Allahabad, India 211002*
*Corresponding Author: Saiyed Salim Sayeed*

**ABSTRACT**
This paper presents a slot loaded compact stacked multiband patch antenna. The designed antenna consists of two patches. The stacked patch is made on Bakelite substrate and feed patch is made on FR-4 substrate. The multiband behavior of antenna is due to stacked structure, loaded slots and notches on feed patch of the antenna. The designed antenna operates at resonating frequencies of 1.27 GHz, 1.72 GHz, 3.66 GHz, 4.7 GHz, 5.34 GHz, 5.88 GHz and 6.6 GHz with fractional bandwidth of 4.88%, 6.56%, 2.73%, 3.61%, 4.49%, 5.78% and 6.36% respectively, is suitable for mobile communication (1.2/1.7 GHz), WiMAX (3.5/4.8GHz), WLAN (5.2/5.8 GHz) and satellite communication (6.5 GHz). Experimental results show that the antenna gives good gains and radiation efficiencies over the operating bands. There is a good agreement between the measured and simulated results.
***Keywords***: *Minimum* Defected ground structure, stacked patch, multiband, WiMAX, WLAN, microstrip patch antenna, IE3D.

---

Date of Submission: 22-08-2017 Date of acceptance: 06-11-2017

---

## I. INTRODUCTION

During last decade the antenna engineering has been extensively used in wireless communication. The microstrip antennas are the antennas that have been extensively used for transmitting and receiving electromagnetic waves. Since these antennas are easily integrate with printed circuit boards. The microstrip structures was came in existence in the 1953's . These antennas were fabricated and experimental measured 1970's for dual band applications. Nowadays, microstrip patch antennas have been used extensively in all communication devices, since these antennas have been improved for multiband operations. The use multiband microstrip antennas have increased for wireless communication due to its lighter weight, compatibility with host surface and low cost [1-4].

The multiband antennas has been reported by various researchers for wireless communication such as reactively loaded microstrip antenna [5] has been reported for 3.12, 3.25, 3.38, 3.515 and 3.64 GHz. Staked annular ring microstrip antenna [6] and a dual band slot-loaded patch antenna [7] have been presented. A defected ground microstrip antenna [8] has been reported for 2.4/5.2/5.8 GHz (WLAN applications) and 2.5/3.5/5.5 GHz (WiMAX Applications). A compact antenna resonating at three distinct resonating frequencies has been reported for Bluetooth/WiMAX/WLAN applications [9]. A quad-band circular slot antenna has been reported for GPS 1.575(1.525-1.625 GHz), WIMAX3.5(3.3-3.6 GHz), WLAN2.45 (2.4-2.485 GHz) and WLAN5.2/5.8 (5.15-5.825 GHz) [10]. A wireless communications antenna operated for 900/1800MHz for Global System for Mobile Communication (GSM),2.4/5.2/5.8 GHz for Wireless Local Area Networks (WLANs),2.5/3.5/5.5 GHz for Interoperability for Microwave Access (WiMAX), 700/2300/2600 MHz for Long Term Evolution (LTE) has been reported [11]. A hepta-band frequency reconfigurable antenna for mobile handsets has been used for GSM 850/900/1800/1900 and UTMS [13].

In this work, a stacked DGS microstrip antenna for multi-frequency operation is designed. The radiating element is modified by loading slots and notches on feed patch. With the use of DGS, the designed antenna avoids a large surface-wave loss and finds applications in mobile communication (1.2/1.7 GHz), WiMAX (3.5/4.8GHz), WLAN (5.2/5.8 GHz) and satellite communication (6.5 GHz).The designed antenna is simulated using ZELAND IE3D simulation software. The antenna configuration and simulated results as well as the constructed prototype and measured data are discussed in Sections II and III.

## II. ANTENNA CONFIGURATION AND STRUCTURE

All Designed antenna structure shown in figure -1. It consist of two radiating patches, feed patch on FR-4 substrate with dielectric constant of 4.4 and loss tangent of 0.02 Fig. 1(a) and stacked patch on Bakelite substrate with dielectric constant of 4.8 and loss tangent of 0.3045 [cf. fig. 1(c)]. Both the patches have same dimension of 30mm x 40 mm. The dimension of ground plane is 30mm x 46mm. A U-shaped DGS is loaded on the ground plane of Bakelite substrate as shown in fig. 1(b). The U-shaped DGS has three slots, two vertical symmetrical slots with dimension of 2mm x 17mm and a horizontal slot with the dimension of 2mm x 12mm. The microstrip line feed is used to give the power to antenna. The slots, notches and parasitic patch introduced in the antenna generate new resonating frequencies.

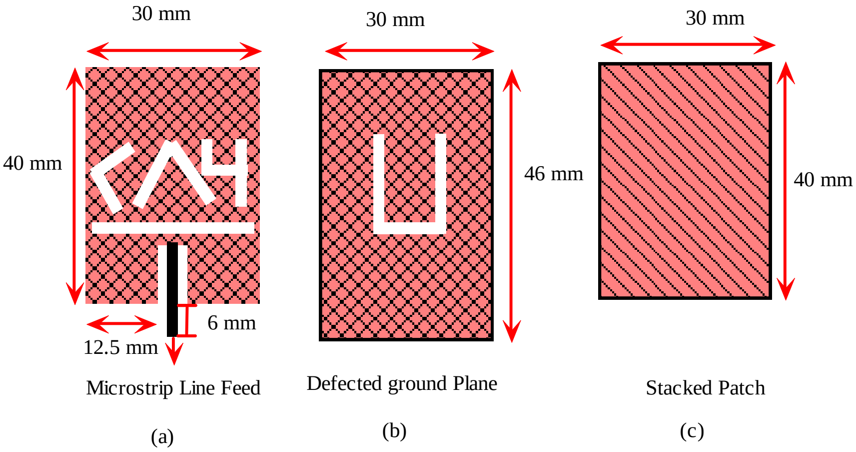


Fig. 1 (a,b and c)

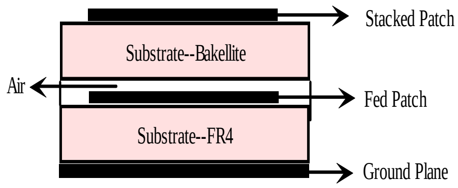


Fig. 1(d)

Figure 1(a) side view of proposed antenna, (b) radiating patch of the antenna, (c) Stacked patch (d) Side view of the proposed antenna.

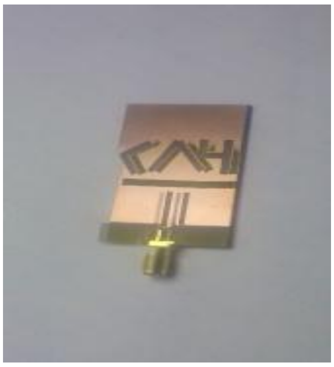

Fig. 2(a)

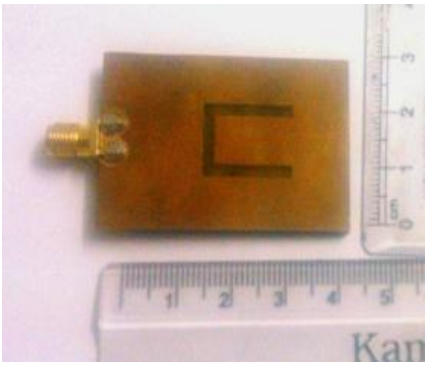

Fig. 2(b)

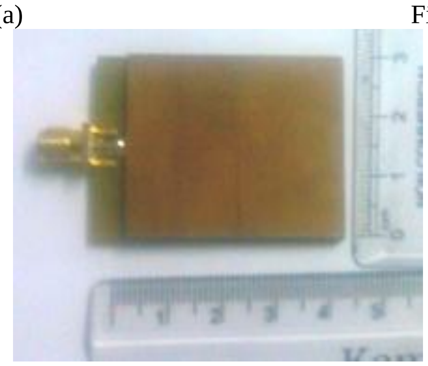

Fig. 2 (c)

Fig. 2(d) Mesurement set-up of the antenna

**Figure. 2** Photographs of the fabricated prototype proposed antenna shown above in figure (a), (b) and (c) Vector Network Analyzer used for antenna testing at IIIT (Indian Institute Of Information Technology) Allahabad, U.P. India shown in fig. 2 (d)

Current flow in the feed patch and stacked patch is based on the phenomenon of electromagnetic coupling. Current distribution shows the radiation mechanism of proposed antenna [cf. fig. 3]. It is observed that maximum current is concentrated along the feed radiator and middle of the stacked radiator which is responsible of maximum radiation.

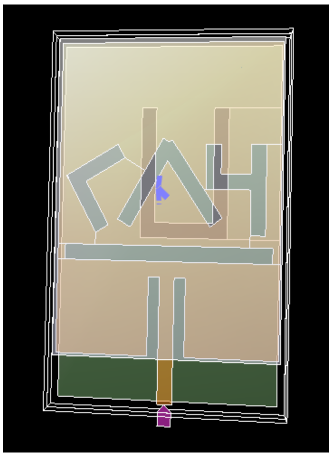

**Fig. 3(a)**

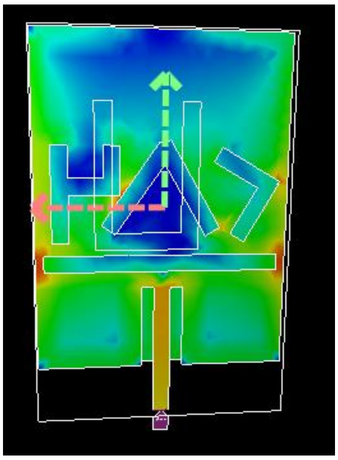

**Fig. 3(b)**

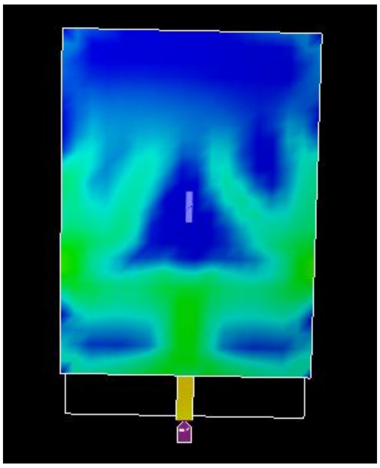

**Fig. 3(C)**

**Fig. 3 (a)** Geometrical display, (b) and (c) are the current distribution of the radiating patch and the stacked patch respectively of proposed antenna with Bakelite as top substrate and FR-4 as bottom substrate shown above.

### Design specification of proposed antenna

| | |
|---|---|
| Dielectric Material (Substrate) Used | FR-4 |
| Dielectric Constant of Substrate Used | 4.4 |
| Loss Tangent of Substrate Used | 0.02 |
| Stacked Substrate Material Used | Bakellite |
| Dielectric constant of Stacked Substrate | 3.4 |
| Loss Tangent Of Stacked Substrate | 0.03045 |
| Length of Patch | 30 mm |
| Width of Patch | 40 mm |
| Length and width of Strip Line | 6 mm x 2 mm |
| Length and Width Of Ground Plane | 30 mm×46 mm |
| Length and Width of Stacked Patch | 30 mm × 40 mm |

## III. RESULTS AND DISCUSSION

The proposed antenna configuration is simulated using IE3D Simulation Software [12]. The return loss of the designed antenna is shown in figure 4. The designed antenna has multiband operations. The designed antenna operates at resonating frequencies of 1.27 GHz, 1.72 GHz, 3.66 GHz, 4.7 GHz, 5.34 GHz, 5.88 GHz and 6.6 GHz with fractional bandwidth of 4.88%, 6.56%, 2.73%, 3.61%, 4.49%, 5.78% and 6.36% respectively. It is concluded that antenna has good gain. The simulated and experimental gain of proposed antenna is shown in figure 5. The measured and simulated gains are in close agreement. The Antenna has higher efficiency. The designed antenna has radiation efficiency up to 83 %, as shown in figure 6. The radiation pattern of the designed is shown in figure-7. The proposed antenna is circularly polarized at all resonating frequencies.

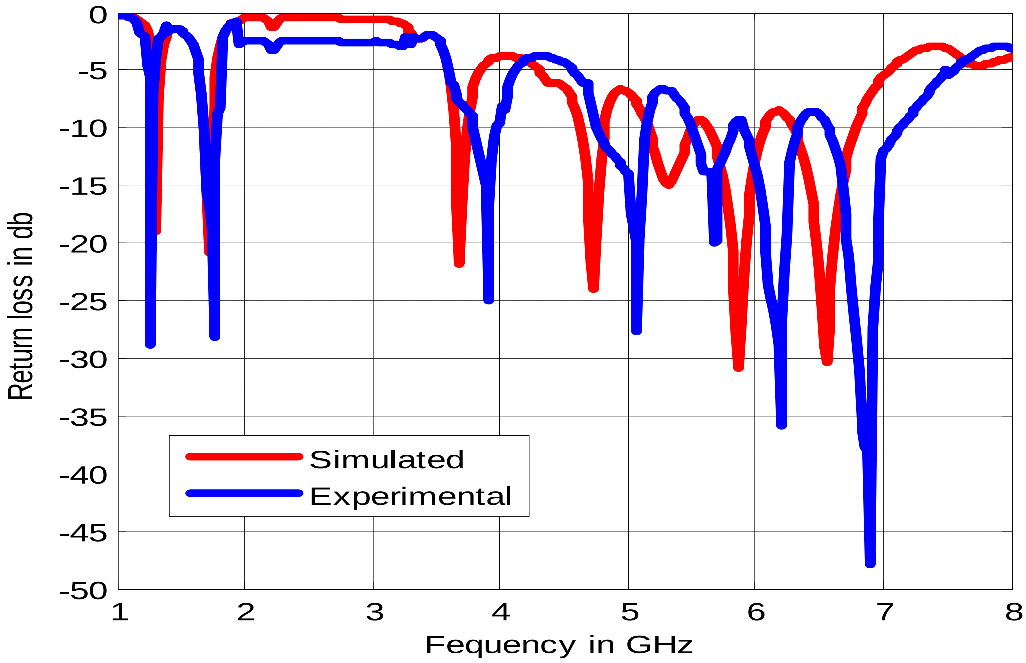


Fig.4

**Figure-4** shows the Comparison of the Return loss vs. frequency of proposed antenna. It is observe that experimental and simulated results are in good agreement.

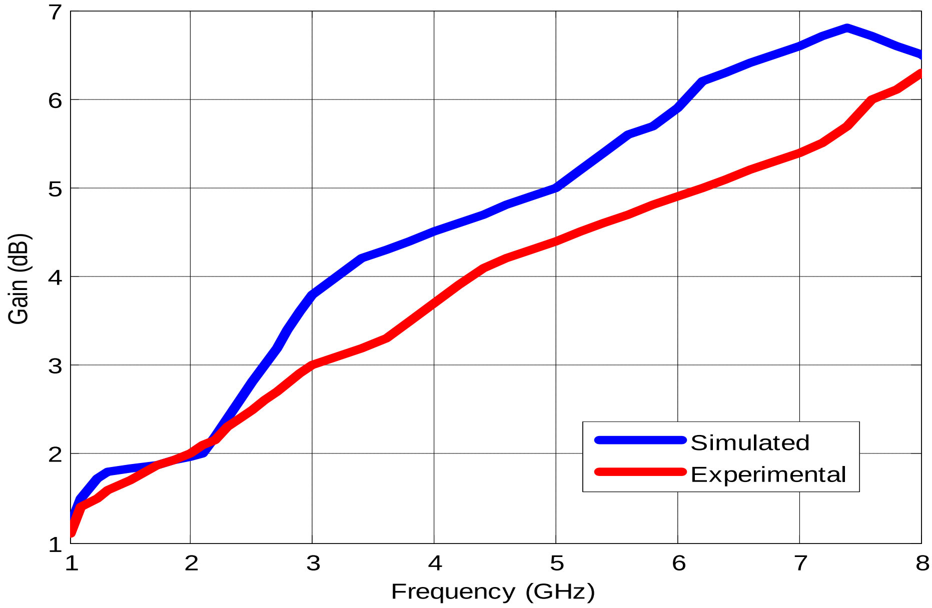


Fig. 5

Figure-5 shows the Comparison of the gain vs. frequency results of the proposed antenna.It is observe that Experimental and simulated results are in good agreement.

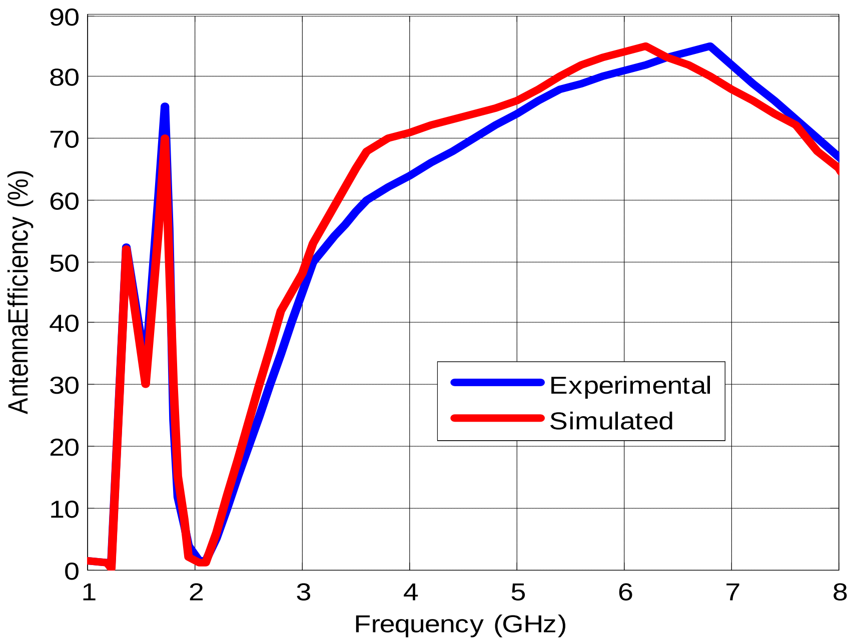


Fig. 6

Figure- 6. Shows the Comparison of the efficiency vs. frequency results. It is observe that experimental and simulated results of the proposed antenna is in good agreement.

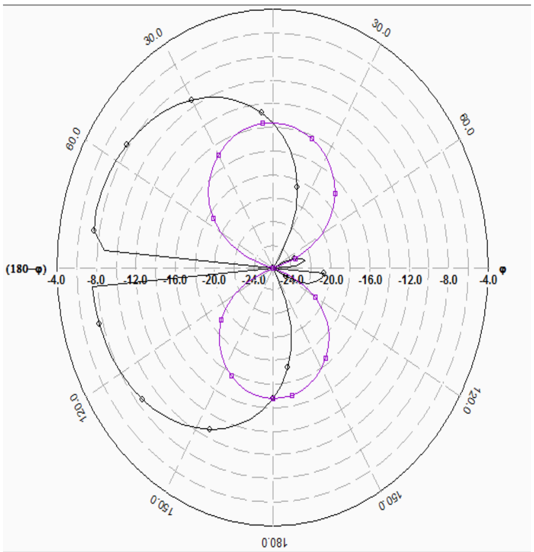


Fig. 7 (a)

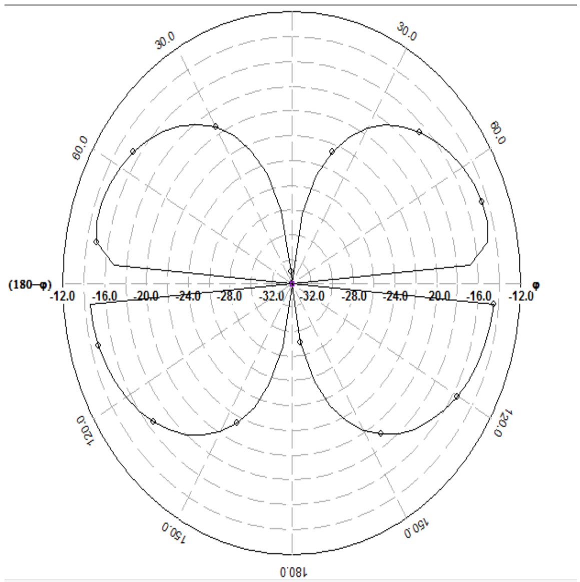


Fig. 7(b)

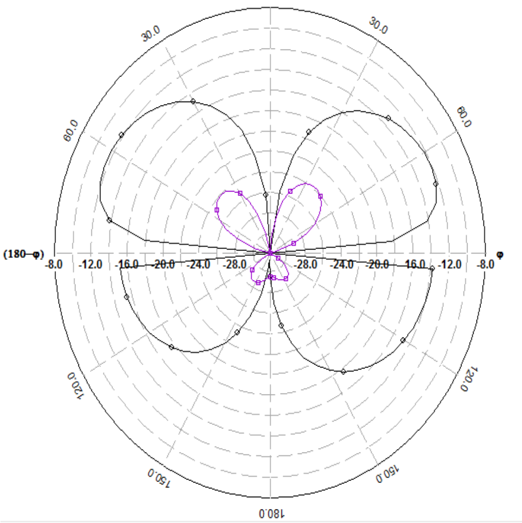


Fig. 7(c)

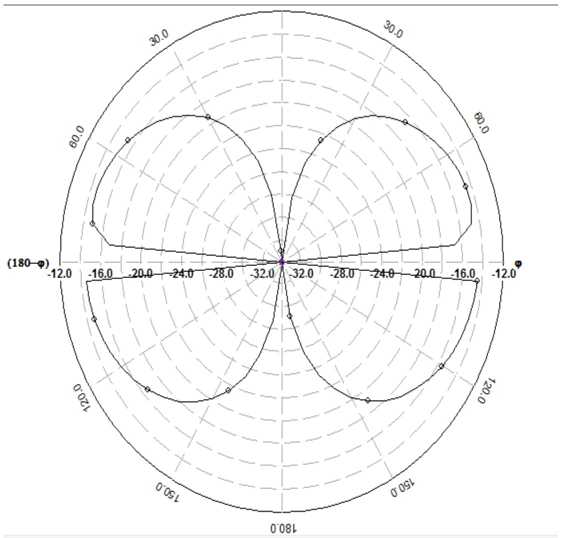


Fig. 7(d)

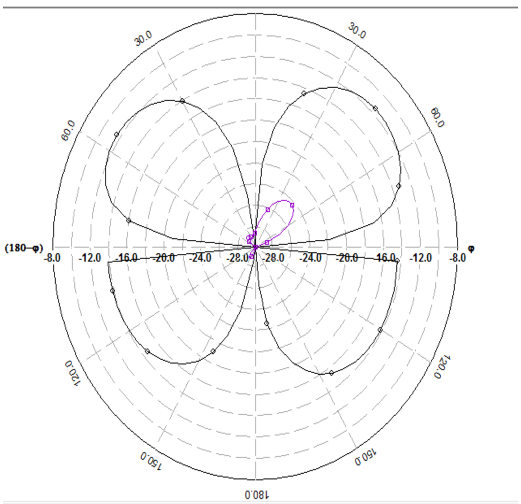


Fig. 7(e)

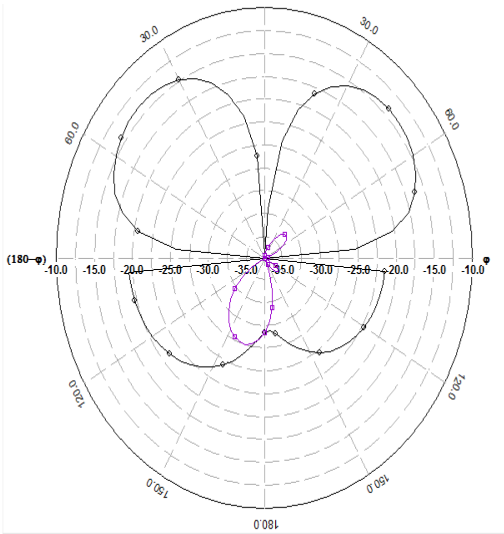


Fig. 7(f)

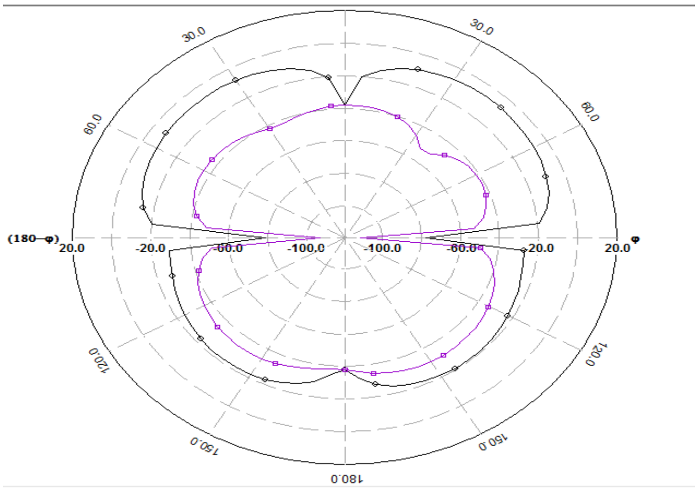


Fig. 7(g)

Figure **7-** Radiation pattern of the proposed antenna at resonating frequencies at 7 (a) 1.27 GHz, 7(b) 1.72 GHz, 7(c) 3.66 GHz, 7(d) 4.7 GHz, 7(e) 5.34 GHz, 7(f) 5.88 GHz and 7(g) 6.6 GHz is shown in above figure. Antenna-1 is the proposed antenna. Proposed antenna is circularly polarized.

## IV. CONCLUSION

In this paper, a novel rectangular-shaped stacked patch antenna is successfully fabricated for multiband applications. Designed antenna has good gain, fractional bandwidth, and efficiency and resonating frequencies of 1.27 GHz, 1.72 GHz, 3.66 GHz, 4.7 GHz, 5.34 GHz, 5.88 GHz and 6.6 GHz. The proposed antenna is applicable for mobile communication (1.2/1.7 GHz), WiMAX (3.5/4.8GHz), WLAN (5.2/5.8 GHz) and satellite communication (C-band).

## REFERENCES

[1] Lee, Y. C., Sun, J. S., "A new printed antenna for multiband wireless applications," IEEE Antennas Wireless Propaation Letters, vol.8, pp. 402–404, 2009.
[2] A. Singh, J.A. Ansari, K. Kamakshi, A. Mishra and M. Aneesh, "Compact notch loaded half disk patch antenna for dualband operation," Annal Telecommunication," vol. 69, pp. 475-483, 2014.
[3] A. Deshmukh and K. .P. Ray, "Compact broadband slotted rectangular microstrip antenna," IEEE Antennas and Wireless Propagation Letters, vol. 8, pp. 1410-1413, 2009.
[4] P. Subbulakshmi, R. Rajkumar, "Design and characterization of corporate feed Rectangular Microstrip Patch Array Antenna," IEEE International conference on Emerging trends in Computing and Nanotechnology , ICECCN-2013.
[5] Binod K Kanaujia and Babau R Vishvakarma, "Reactively loaded annular ring microstrip antenna for multi-band operation," Indian Journal of Radio & Space Physics, vol. 35, pp. 122-128, 2006.
[6] J. S. Dahele, K. F. Lee, and D. P. Wong, ''Dual Frequency Stacked Annular Ring Microstrip Antenna,'' IEEE Trans. Antennas Propagat., Vol. AP-35, Nov. 1987, pp. 1281]12
[7] S. Maci, G. Biffi Gentili, P. Piazzesi, and C. Salvador, ''Dual Band Slot-Loaded Patch Antenna,'' Proc. Inst. Elect. Eng., Microwa¨es, Antennas, Propagat., Vol. 142, No. 3, pp. 225-232, 1995.
[8] Jing Pei, An-Guo Wang, Shun Gao, and Wen Leng, "Miniaturized Triple-Band Antenna With a Defected Ground Plane for WLAN/WiMAX Applications," IEEE Antennas Wireless Propag. Lett., vol. 10, pp. 298–301, 2011.
[9] L. Y. Cai, G. Zeng, and H. C. Yang, "Compact triple band antenna for Bluetooth/WiMAX/WLAN applications," in Proc. Int. Symp. Signals, Syst. Electron., Nanjing, China, Sep. 17–20, pp. 1–4, 2010.
[10] X. Sun, G. Zeng, H. C. Yang, Y. Li, X.-J. Liao, and L. Wang, "Design of an edge-fed quad-band slot antenna for GPS/WIMAX/WLAN applications," Progress In Electromagnetics Research Letters, Vol. 28, pp. 111-120, 2012.
[11] H. Liu, R. Li, Y. Pan, X. Quan, L. Yang, and L. Zheng, "A multi-broadband planar antenna for GSM/UTMS/LTE and WLAN/WiMAX handsets," IEEE Trans. Antennas and Propag., vol. 62, no. 5, pp. 2856–2860, 2014.
[12] IE3D Simulation Software, Version 14.05, Zeland Software Inc., USA, 2008.
[13] A. K. Behera, M. Agrawal, P. K. Bharti and M. K. Meshram, "A Hepta Band Frequency Reconfigurable Antenna for Mobile Handsets with impedance matching Techniques," International Journal of Advance in Microwave Techniques, vol. 1, no. 1, pp. 19-23, 2016.

International Journal of Computational Engineering Research (IJCER) is UGC approved Journal with Sl. No. 4627, Journal no. 47631.

Saiyed Salim Sayeed Slots and Notch Loaded Rectangular Stacked Microstrip Antenna for Multiband Operations." IInternational Journal of Computational Engineering Research (IJCER), vol. 7, no. 10, 2017, pp. 64-70.