iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** V **Month of publication:** May 2017

DOI:

Volume 5 Issue V, May 2017
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Bandwidth Improvement of Slotted Patch Antenna Using Pin Short

Mahendra Singh Meena[1]

[1]*Assistant Professor, Department of Electronics and Communication Engineering, Amity School of Engineering and Technology, Amity University Haryana*

Abstract: FR4 is an inexpensive and easily available substrate material, which can be used to design efficient and cost effective microstrip patch antenna. This paper focuses on increasing the bandwidth of the microstrip patch antenna. Paper discusses about design of a rectangular patch antenna, having coaxial probe as a feed. To get the improved bandwidth, a rectangular slot has been digged along with a pin short, which changes the interaction of radiation. A huge increase in bandwidth is observed using the proposed design; almost 3 fold. All the simulation work is done using IE3D simulating software from Zeland has been used.

Key words: FR4, rectangular antenna, slot, pin short

I. INTRODUCTION

A Microstrip or Patch Antenna is a low profile Antenna that has a number of advantages over other antennas. It is lightweight, inexpensive, and easy to integrate with accompanying electronics. While the antenna can be 3D in structure (wrapped around an object, for example), the elements are usually flat, hence their other name, Planar Antennas. A Planar Antenna is not always a patch antenna. But the use of conventional rectangular microstrip patch antenna alone is very difficult because of its low gain and narrow bandwidth. So to overcome these problems various methods have been tried, some of them are listed in next section. This paper proposes a method in which slots are digged in patch antenna using pin short. Configuration of paper is as follows: Next section is literature review, which is followed by proposed design and in the last some conclusions are drown based on simulation done.

II. LITERATURE REVIEW

The *Gordon et.al* described that the band width of microstrip antennas can be increased by using thick substrate but with thick substrate coaxial probe feed introduces inductive component due to which unavoidable impedance mismatch occurs. So the solution to impedance mismatch was found in the form of capacitive feeding mechanism which can be used for annular ring MPA elements, consisted a small capacitor patch in the same layer as in the radiating element. [1]

A. *Gordon et.al* experimented on following three designs

1) Rectangular radiating elements,

2) Circular radiating elements and

3) Annular ring radiating elements

Feeding mechanism was common in all three designs. The position of the probe feed was decided to be in the center of the small patch. Design tool used was IE3D 12th version Zeland, substrate was FR4 with thickness 1.6 mm having dielectric constant 4.4. Height of patch from ground was taken as 15 mm, ground plane was taken as square of 150x150 mm and probe diameter 0.9 mm.

Experimental Results are shown below:

Resonant frequency- 1800MHz

10 dB return loss Band Width-

	Rectangular	Circular	Annular Ring
Simulated	25.9%	26.8%	25.9%
Measured	*26.4%*	*27.9%*	*26.1%*

B. *Gain*

	Rectangular	Circular	Annular Ring
Simulated	8.5dBi	8.8 dBi	8.0 dBi
Measured	8.2 dBi	8.6 dBi	8.5 dBi

Volume 5 Issue V, May 2017
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

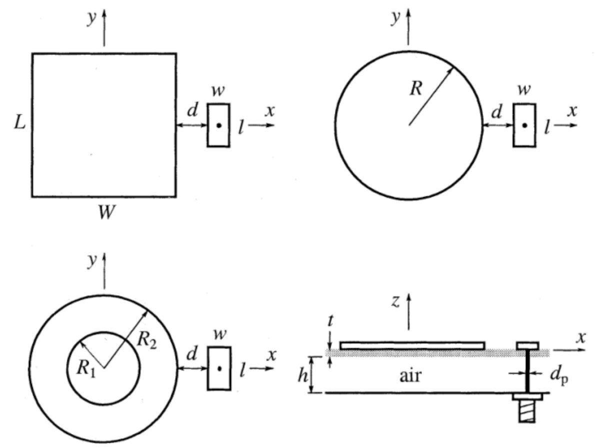


Figure 1 Structure of proposed antenna design for (a) rectangular,(b) circular and (c) annular ring radiating elements (d) side view of anteena.

Dheeraj et. al. proposed modified circular patch antenna to achieve 50.36% efficiency together with 4.10 dBi gain and 8.38% band width. Firstly they taken a circular patch and then an elliptical slot has been cut in it, after this, parallel to major axis of the inserted elliptical slot, splitting is applied and at last this elliptical hole is filled with an elliptical patch between two split halves of circular patch.
FR4 of thickness 1.59 mm and dielectric constant 4.4 was taken as substrate which had loss tangent of 0.0148. Main circular patch radius was taken 12 mm. For inside elliptical patch semi major axis is of 9 mm, semi minor axis is of 4.8 mm and eccentricity is 0.846. Splitting width of circular patch in two halves is 0.25 mm. Ellipse filling the elliptical slot has a = 8 mm and b = 3 mm.

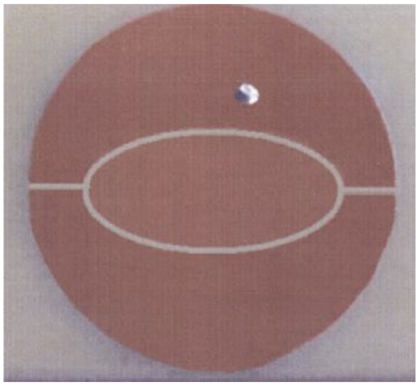


Figure 2 Split circular patch antenna with elliptical slot and filled with elliptical patch

C. Experimental Results are shown below

Geometries	Resonance frequency, GHz	Radiation efficiency %	Directivity dBi	Gain dBi	Bandwidth %
Circular elliptical ring	4.96	22.48	6.30	1.11	6.02
Gap coupled split circular patch antenna with circular slot	5.16	53.35	7.61	4.87	6.64
Gap coupled split circular patch antenna with elliptical slot and filled with elliptical patch	5.01	50.36	7.08	4.10	8.38

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Garima et. al. proposed concentric diamond shape slotted circular patch microstrip antenna which is useful for C band and space communication systems. Main disadvantage of microstrip antennas is efficiently at a single resonance frequency corresponding to their dominant mode, narrow bandwidth (1-2%) and low gain. They proposed antenna useful for satellite communication systems as it presents the desired performances, viz. improved bandwidth, gain and multiple operating frequencies needed for satellite communication systems. FR4 with having thickness of 1.59 mm, dielectric constant of 4.4 and loss tangent of 0.025 was used as substrate. Circular patch radius is 16.2 mm was fabricated. To improve bandwidth path of the patch current has been increased by digging a diamond shape slot having dimensions a= 6 mm and b= 10 mm as shown in figure

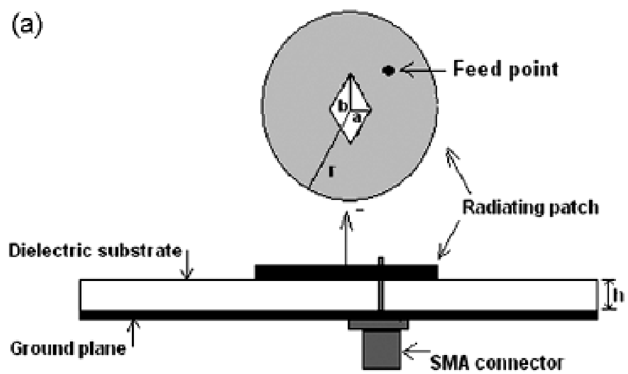


Figure 3: Design of proposed antenna

As a result resonating frequencies of 6.23GHz and 6.859GHz (simulating) and 6.66GHz and 7.42GHz (measured) were observed and bandwidth of 15.99% (simulated) and 13.58% (measured) along with Gain of 5.84 at 6.66GHz and 5.71 at 7.42GHz were observed, which is huge improvement over non-slotted design. [3]

To obtain improved bandwidth and circularly polarized radiation over conventional elliptical antenna, in this paper the elliptical shape patch antenna with truncated edges has been introduced. In [4] tow antennas were studied (1) a conventional elliptical antenna and (2) edges truncated elliptical antenna. FR4 with having thickness of 1.59 mm, dielectric constant of 4.4 and loss tangent of 0.025 was used as substrate. Ellipse patch with semi major axis a = 15 mm and semi minor axis b = 14.43 mm after truncation L_1= L_2=7.75 mm as shown in figure.

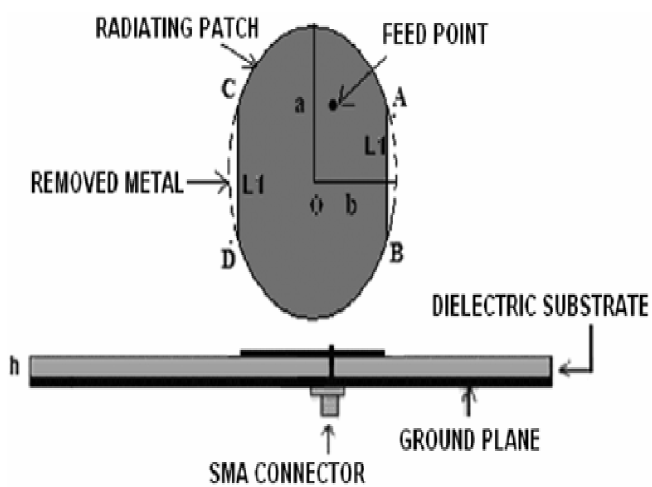


Figure 4 Edge truncated elliptical patch antenna

Results showed resonating frequency =2.71 GHz and 2.80 GHz (simulated) and 2.692 GHz and 2.802 GHz (measured) were measured. Input impedances = (62.30+ j11.71) ohm corresponding 2.692 GHz and (48.49+ j5.34) ohm corresponding 2.802 GHz resonant frequency, Minimum Axial ratio = 0.68 dB at 2.751 GHz, Gain = 1.71 dB at 2.751 GHz

III. PROPOSED DESIGN AND RESULTS

A. Design specification

To design this antenna, IE3D simulating software from Zeland has been used. The FR4 substrate having thickness of 1.59mm, dielectric constant of 4.4 and loss tangent of 0.025 is used. We have chosen FR4 because it is inexpensive and easily available substrate material.

B. Design dimensions

The rectangular patch of dimension of L×W = (20 mm × 30 mm) has been designed. We used coaxial probe for connecting microstrip patch antenna at coordinates (-5 mm, 8.325 mm) and same arrangement is used the conventional as well as the Slotted Rectangular microstrip patch antenna. To get the improved bandwidth, a rectangular slot of dimensions 7 mm×0.5 mm at point (-6.5, 6) has been digged and a pin short at (-5, -10) is used (as shown in figure).

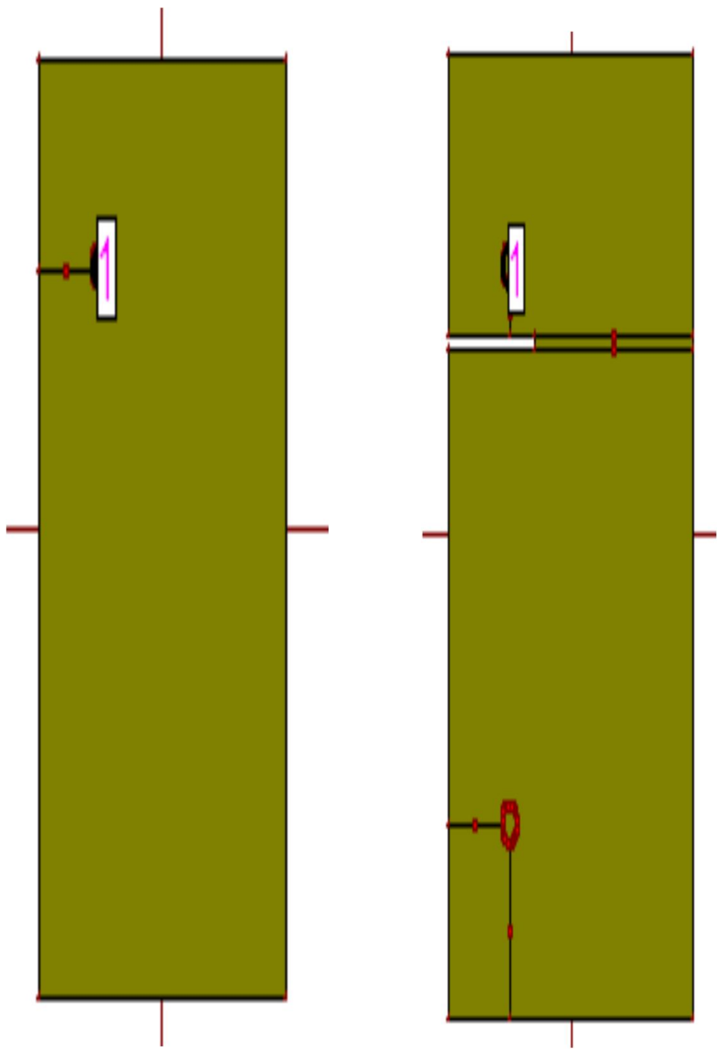


Figure 5 (a) Conventional Rectangular MPA (b) Slotted & Pin Shorted Rectangular MPA

C. Return loss and bandwidth

After simulation on different slot area with different coordinates of the patch. Conventional rectangular patch has return loss of -26.46 dB with 3.346 GHz resonant frequency, whereas return loss of single slotted and pin shorted patch is -40.15dB on 3.628GHz resonant frequency. Bandwidth is taken 10 dB down of return loss curve. Conventional patch had bandwidth 3.227% and after modification enhanced bandwidth of 11.24 % is obtained.

Volume 5 Issue V, May 2017
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

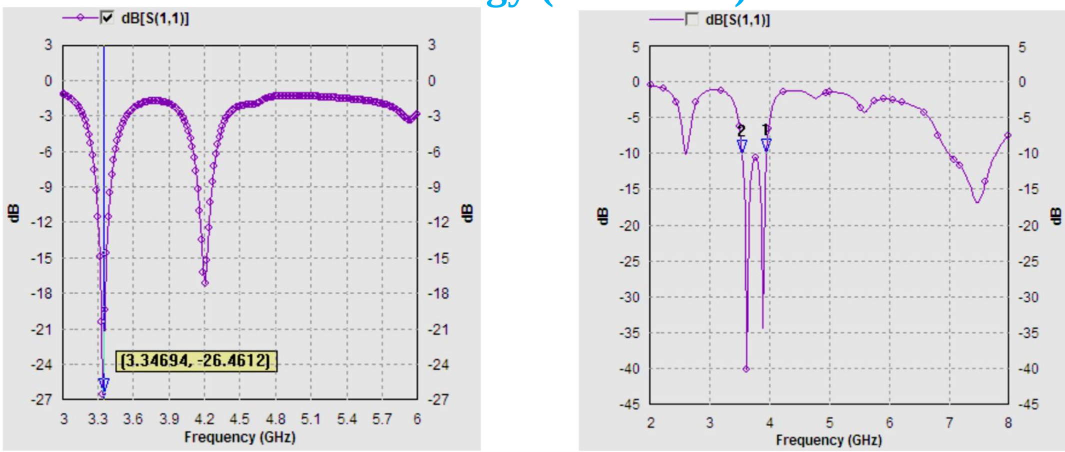


Figure 6 (a) and (b) Simulated frequency v/s return loss graph of rectangular patch and single slotted and pin shorted rectangular Patch.

D. Smith Chart

The smith chart is a transform of a complex rectangular plane with real number on the x-axis and imaginary on the Y-axis. The input impedance of antenna can be calculated using smith chart. The input impedance of modified patch is calculated to 49.31Ω + j0.76 at resonant frequency 3.628GHz.

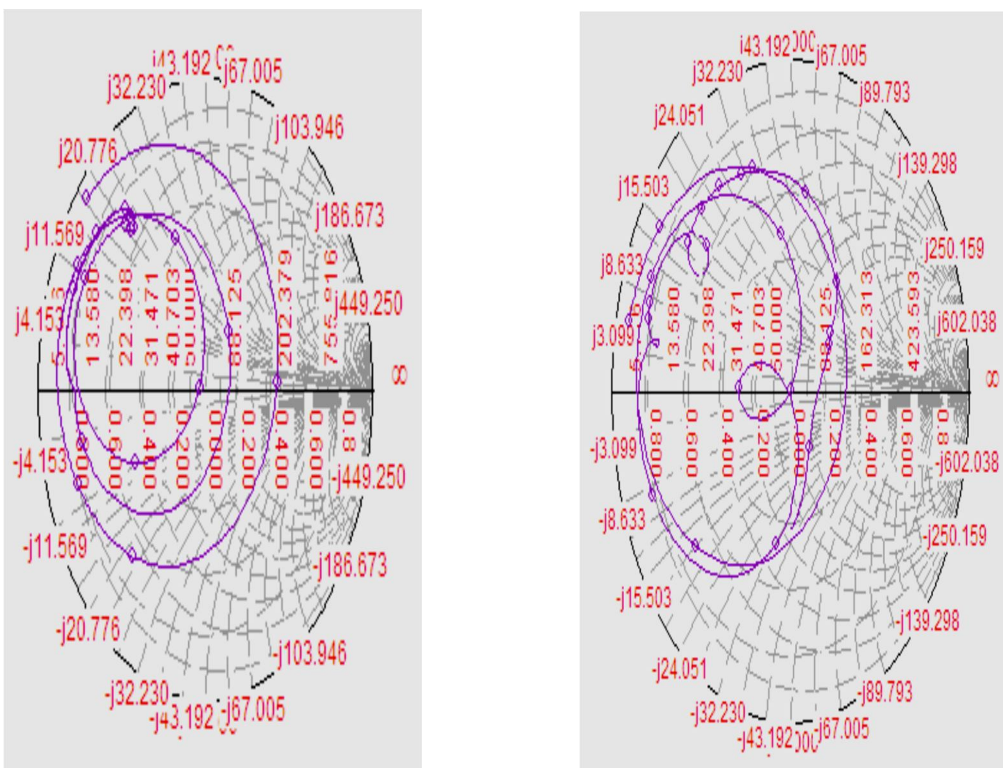


Figure 7 (a) and (b) simulated smith chart of conventional patch and single slotted, pin shorted rectangular patch

E. Radiation Pattern

It's graphical representation of radiated/ received power in certain direction. Since a microstrip patch antenna's radiation is normal to patch surface, the elevation pattern for φ = 0^0 and φ = 90^0 becomes important.

Volume 5 Issue V, May 2017
ISSN: 2321-9653

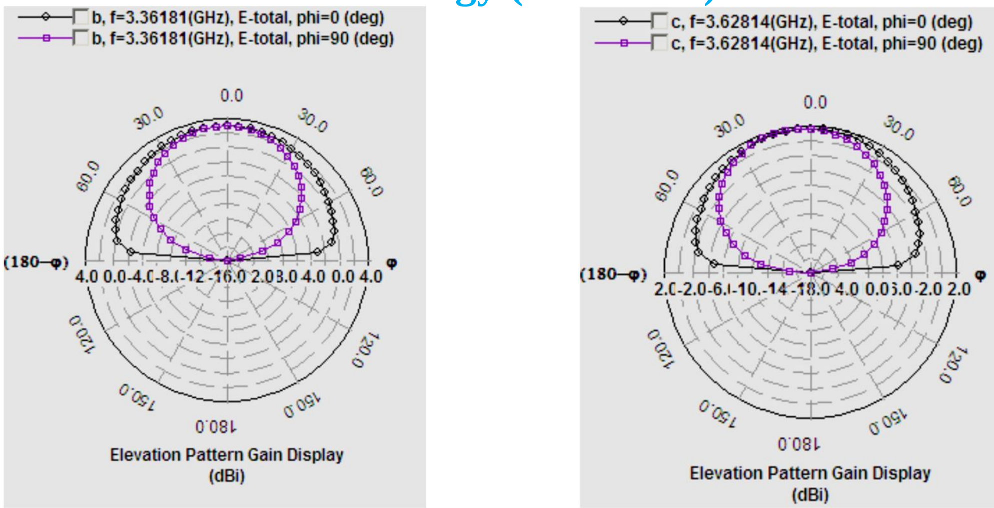


Figure 8 (a) and (b) Simulated radiation pattern of conventional patch and single slotted, pin shorted rectangular patch

The simulated E-plane and H-plane pattern of conventional patch and single slotted, pin shorted rectangular patch is illustrated in Figure 8 (a) and (b). Radiation pattern is uniform and smooth over a large band of frequencies and infinite ground plane would prevent any radiation towards back of the antenna.

Table 1: Comparison of without slot and with single slot circular MPA

Sr. no.	Characteristics	Conventional Rectangular Patch	Single slotted and pin shorted rectangular Patch
1.	Resonant Frequency (GHz)	3.346	3.628
2.	Return loss (dBi)	-26.46	-40.15
3.	Gain (dBi)	2.68	1.60
4.	Bandwidth (%)	3.227	11.24
5.	Antenna Efficiency (%)	40	30
6.	Radiation Efficiency (%)	42	30

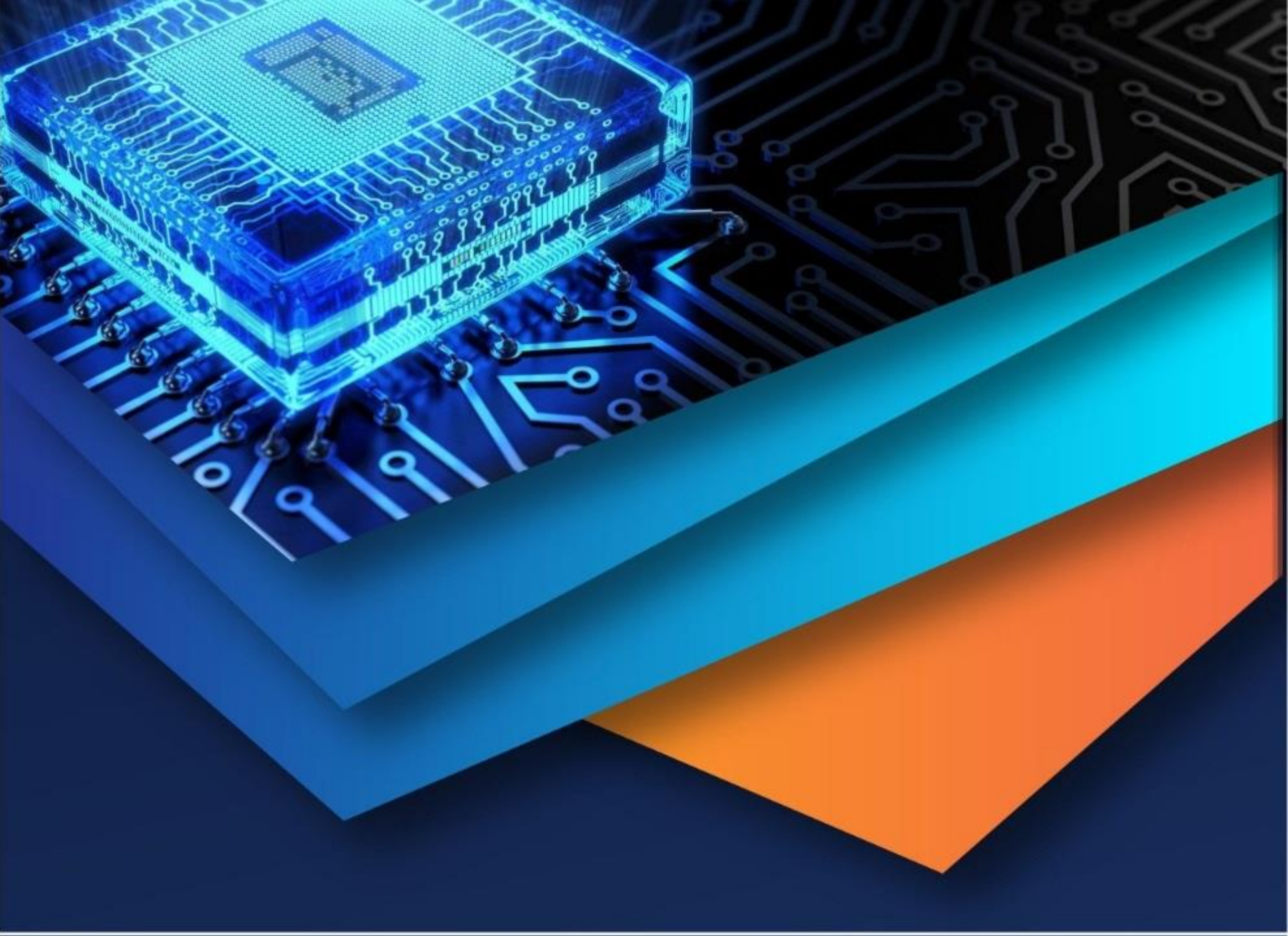
IV. CONCLUSIONS

The FR4 substrate with aforesaid properties and dimension has been used. To optimized the output different location of the slot have been tried, maximum bandwidth was observed for slot dimension 7mm×0.5mm at point (-6.5, 6) has been digged and a pin short at (-5, -10) is used. For the same dimensions conventional patch had bandwidth 3.227% and proposed design had bandwidth of 11.24 %. Radiation pattern is uniform and smooth over a large band of frequencies and infinite ground plane would prevent any radiation towards back of the antenna.

REFERENCES

[1] Gordon Mayhew-Ridgers, Johann W. Odendaal, and Johan Joubert, "Single-Layer Capacitive Feed for Wideband Probe-Fed Microstrip Antenna Elements" IEEE Transactions on Antennas and Propagation, Vol. 51, No. 6, June 2003
[2] Dheeraj Bhardwaj, Komal Sharma, D. Bhatnagar, S Sancheti & B Soni, "Design and analysis of a gap coupled split circular patch with elliptical slot filled with elliptical patch" Indian Journal of Radio & Space Physics, Vol. 39, April 2010
[3] Garima, D Bhatnagar, J S Saini, V K Saxena& L M Joshi, "Design of broadband circular patch microstrip antenna with diamond shape slot" Indian Journal of Radio & Space Physics, Vol. 40, October 2011.
[4] Pratibha Sekra, Sumita Shekhawat, Manoj Dubey, D Bhatnagar, V K Saxena & J S Saini, "Design of circularly polarized edge truncated elliptical patch antenna with improved performance", Indian Journal of Radio & Space Physics, Vol. 40, August 2011.
[5] Puneet Kumar, Mahendra Singh Meena, Ved Prakash , "Bandwidth Enhancement of a Patch Antenna by using Metamaterials for WLAN Application", Vol 01, Issue 04, June 2013, 105-109 (ISSN [2320-706X])
[6] K. D. Prasad, "Antenna & Wave Propagation", Satya Prakashan, New Delhi, 2005
[7] C. Balanis "Antenna Theory Analysis and Design", second edition, John Wiley, 1997.
[8] Mahendra Singh Meena and Nisha Achra, "A text book of Antenna and Wave Propagation, College Book Center, 2013, Second Edition

[9] R. Garg, P. Bhartia, I. Bahk, A. Ittipiboor, "Microstrip Antenna Design Handbook" Artech House, 2001.
[10] R. A. Sainati, "CAD of Microstrip Antennas for Wireless Antennas for Wireless Applications", Artech House, 1996.
[11] D.M.Pozar, "Microstrip Antennas", Proc. IEEE , Vol 80, pp 79-91
[12] Kin-Lu-Wong, "Compact and Broadband Microstrip Antenna", John Wiley & Sons 2002.
[13] Nasimuddin, Zhi Ning Chen, and Xianming Qing, "A Compact Circularly Polarized Cross-Shaped Slotted Microstrip Antenna", IEEE Transactions on Antennas and Propagation, Vol. 60, No. 3, March 2012
[14] Mahmoud N. Mahmoud and Reyhan Baktur, "A Dual Band Microstrip-Fed Slot Antenna", IEEE Transactions on Antennas and Propagation, Vol. 59, No. 5, May 2011
[15] Nasimuddin, Xianming Qing, and Zhi Ning Chen, "Compact Asymmetric-Slit Microstrip Antennas for Circular Polarization", IEEE Transactions on Antennas and Propagation, Vol. 59, No. 1, January 2011
[16] Kunpeng Wei, Zhijun Zhang, and Zhenghe Feng, "Design of a Coplanar Integrated Microstrip Antenna for GPS/ITS Applications", IEEE Antennas and Wireless Propagation Letters, Vol. 10, 20
[17] S N Mulgi, G M Pushpanjali, R B Konda, S K Satnoor & P V Hunagund, "Broadband aperture coupled equilateral triangular microstrip array antenna", Indian Journal of Radio & Space Physics, Vol. 38, June 2009.
[18] G. Mayhew-Ridgers, J. W. Odendaal, and J. Joubert, "New feeding mechanism for annular-ring microstrip antenna," Electron. Lett., vol. 36, no. 7, pp. 605–606, Mar. 2000.
[19] Yoon,W.S., Baik, J.-W., Lee, H.-S., Pyo, S., Han, S.-M., and Kim, Y.-S., "A reconfigurable circularly polarized microstrip antenna with a slotted ground plane", IEEE Antennas Wirel. Propag. Lett., 2010, 9, (1), pp. 1161–1164.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY