INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 3)
Available online at: www.ijariit.com

I and Z shape rectangular patch antenna used for WLAN, Wi-MAX and satellite application

Harpreet Singh
harpreet.rai87@gmail.com
Guru Gobind Singh College of Modern Technology, Kharar, SAS Nagar, Punjab

Mukta Sharma
mukta121@gmail.com
Guru Gobind Singh College of Modern Technology, Kharar, SAS Nagar, Punjab

ABSTRACT

In the current scenario small, compatible and affordable microstrip patch antennas are developed in wireless communication industries keep on improving antenna performance. One of an important concept to design antenna is that antenna has a small size. For WLAN and WI-MAX applications, one may want that antenna must have a small size and must be capable to resonate at multiple frequency bands. There is a number of techniques that can be useful for designing of the antenna which includes making use of fractal geometry, use of slot and DGS. In this research work, I shape along with Z shape slots are inserted on the patch. The dimension of ground and path that are considered in this research work are 32.6mm×27.6mm and 18mm×23mm respectively. Then the performance parameters like gain, return loss, Bandwidth, radiation pattern and NSWR are measured for simple as well as for DGS antenna. The substrate used for the proposed antenna is FR4 with relative permittivity 4.4 and loss tangent is 0.02. The simulation is carried out in HFSS software. At lat the comparison of proposed with existing work is provided.

Keywords: *Rectangular patch antenna, Multiband, Wireless, WLAN, Defected ground structure (DGS).*

1. INTRODUCTION

There is a large demand for the design of an antenna that can operate on multiple frequency bands in Wireless communication system. Wireless LAN is operate at 2.4 / 5.2 / 5.8 GHz frequencies and WiMAX standard uses frequencies 2.5 / 3.5 / 5.5 GHz band. Microstrip patch antennas are preferred for their extraordinary features [1]. Such as antenna with small size, light weight, low cost, strong compliance and so on Flat and non-planar surfaces, simple and inexpensive manufacturability using modern printed circuit technology, robust when mounted on a rigid surface, compatible with microwave monolithic integrated circuits design and so on. In addition, the microstrip patch antenna is very versatile in the selection of specific patch shapes and patterns resonance frequency, polarization, pattern and impedance [2]. Microstrip patch antennas have a huge range of applications in WLAN and WiMAX applications due to their low platform design. A number of researches have been done in the field of patch antenna to improve the bandwidth of patch antenna but the design becomes very complex. Therefore, a simple antenna that comprises of I shape and Z shape slot has been inserted on the patch. The Defected ground structure (DGS) his used to increase the B.W of the designed antenna [3].

The aim of this paper is to present a novel geometry of microstrip patch antenna used for GPS, Bluetooth, WLAN, WI-Max and satellite applications. The antenna geometry consists of I and Z shape slot inserted on the radiating patch. The copper material is used for the patch with a rectangular shape. The rectangular shape is the mostly used shape among others because it is easy to design. Initially, the antenna is designed by using I and Z shape with the simpler rectangular ground. Then the performance parameters like VSWR, radiation pattern, gain, return loss are measured. The antenna is simulated in HFSS software. Then, to increase the bandwidth the ground with small length is used, which is also known as defected ground structure (DGS) [4].

The remaining paper is structured as follows: the antenna design procedure is discussed in section 2, simulation results are discussed in section 3 followed by conclusion and references.

2. RELATED WORK

Chitra et al. [5, 2013] presented a double L-slot microstrip patch antenna array used for WIMAX (Worldwide Interoperability for Microwave Access) and WLAN (wireless local area network) applications. The proposed antenna comprises two L-slots embedded on patch surface due to which the size as well as weight decreases and can be used for hand held devices. Mehra et al. [6, 2017] presented a rectangular patch antenna designed to operate for multi-bands. Four L-slots have been cut at the corner of the patch and a slot has been inserted at the center of the patch.FR-4 lossy substrate material with relative permittivity ε_r=4.3 and thickness of 1.6mm has been used to design the antenna. CST microwave studio software has been used to observe the performance of the antenna. The results show that antenna has resonated at frequencies of 2.4GHz, 3.8GHz, 4.9GHz, 6.5GHz, 7.2GHz and8.1GHz. Rahmatia et al. [7, 2017] proposed two antenna design, the1st antenna design is made of two material, aluminum and iron that resonates at TV channel frequency (450MHz-950MHz) in Jakarta, Indonesia. The second antenna design is a rectangular microstrip antenna with line feed method for radar application like weather radar working on S-band at the 3GHz frequency. The performance parameters like the bandwidth return loss, and radiation of both antenna have been observed. Sun et al. [8, 2012] presented a rectangular microstrip patch antenna fed by microstrip line and obtained a large bandwidth. A square slot has been introduced along with a rectangular slot to the ground of the patch and obtained a large bandwidth. RT/duroid 5880 substrates with relative dielectric constant (εr) 2.2 and height of 1.6mm have been used. Matin et al. [9, 2010] proposed a wideband dual layer rectangular U-Slot patch antenna. The designed antenna finds applications in Wi-MAX and WLAN. The antenna has a wideband quality that depends on a number of parameters like U-slot dimensions, circular probe-fed patch etc. The features of the proposed antenna are measured and compared with other designs. Tiwari et al [10, 2014] proposed a coplanar waveguide fed slot antenna (DGS) defected ground structure to enhance the gain and to reduce the surface wave. This antenna used in WLAN including WLAN 802.11 and WIMAX applications.

3. ANTENNA DESIGN

Multiband rectangular patch antenna has been designed using I and Z shape on patch surface. The schematic structure of proposed antenna is shown in the figure below. The microstrip feed line is used as it is one of the simplest feed lines and is attached with the patch at an impedance of 50 Ω.

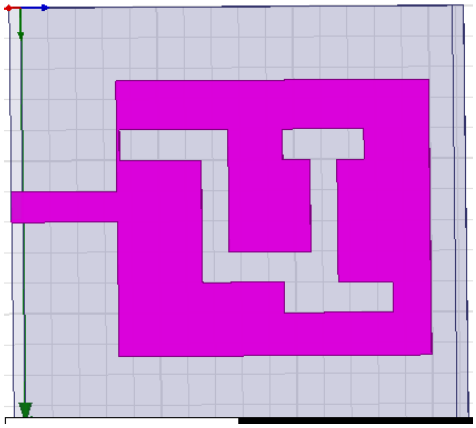


Figure 1 Proposed antenna

Parametric analysis can be obtained by varying substrate thickness, feed point, and other parameters. Design and simulation have been carried out using HFSS software. After simulating this antenna, it is found that antenna resonates at four frequencies 242 GHz, 4.00 GHz, 5.44GHz and 7.29GHz respectively.

Table -1: Dimension of rectangular patch antenna

Variable	Value
Length of ground	32.6
Width of ground	27.6
Thickness of substrate	0.035
Feeding technique used	Microstrip patch antenna
Substrate used	FR4
Feed Point	12,0,1.635
Length of the feed line	7.8
The width of the feed line	2

Defected ground structure (DGS) geometry is applied on the designed shown in figure 2 In this geometry, the length of the ground is reduced. The DGS structure is shown in the figure below:

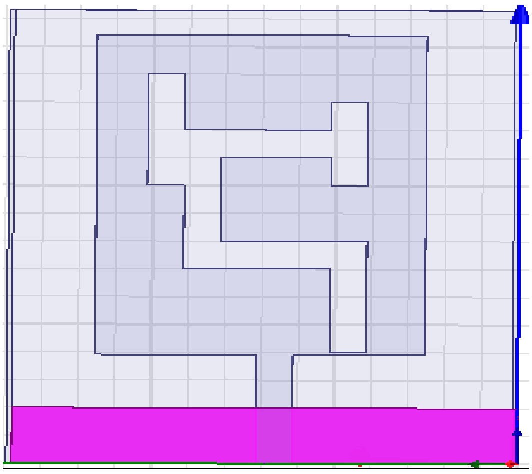


Figure 2: DGS geometry applied to the proposed antenna

Here, the width of the ground is reduced from 32.6 mm to 4mm. which helps to reduce the weight, size of the antenna and also the Bandwidth of the antenna increased. Feed point has been chosen in such a way that impedance matching takes place.

4. SIMULATION RESULTS

In this section, the results are measured by simulating the antenna in the HFSS software. The parameters such as return loss, gain, VSWR, radiation pattern of the antenna are discussed in detail. The frequency range used for the antenna ranges from 1 to 8 GHz.

4.1 Experiment-I

The experiment is conducted on simple patch antenna with slotted I and Z shape on patch antenna and the observed performance parameters are discussed in detail as shown in the figure below.

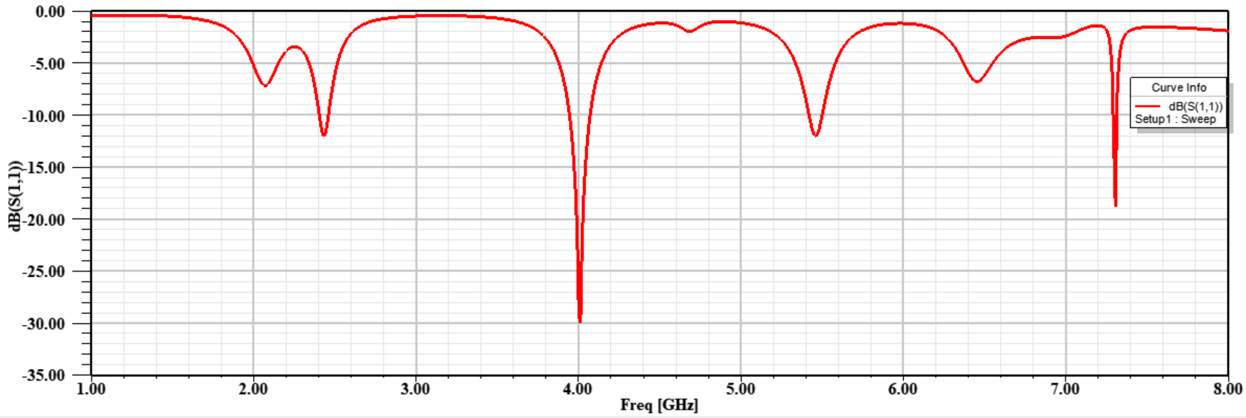


Figure 3: Return loss of proposed antenna

The above figure represents the return loss obtained for the proposed work. The antenna resonates at four frequencies 2.42 GHz, 4.00 GHz, 5.45 GHz, 729 GHz with return loss values -12.00,-29.95,-12.10 and -18.76 respectively.

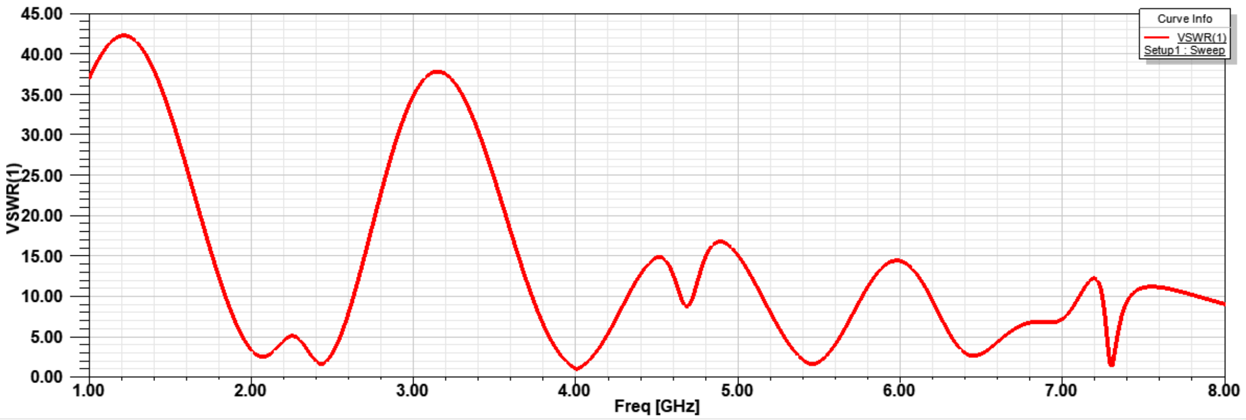


Figure 4: VSWR

The VSWR obtained for the proposed antenna is shown in figure above. It is clear from the figure above that for the four resonant frequencies described above the value of VSWR is less than 2. This indicates that the power is transmitted from a source to load. When the value of VSWR is <2 it means that the impedance matching is good.

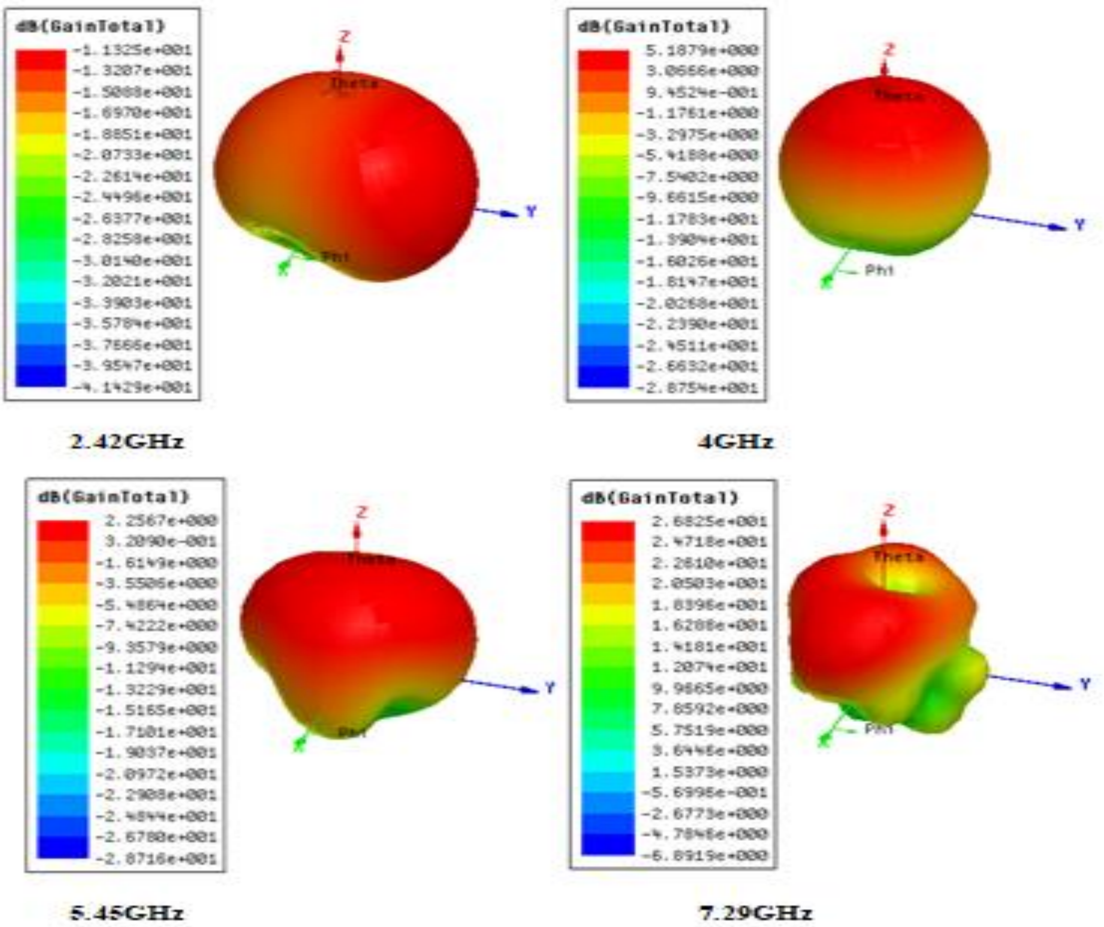


Figure 5: Gain of the proposed antenna

The above figure represents the gain obtained for the proposed antenna resonates at four different frequencies. Gain at frequency 2.42 GHz is negative which means that antenna radiates less at this frequency than other frequencies.

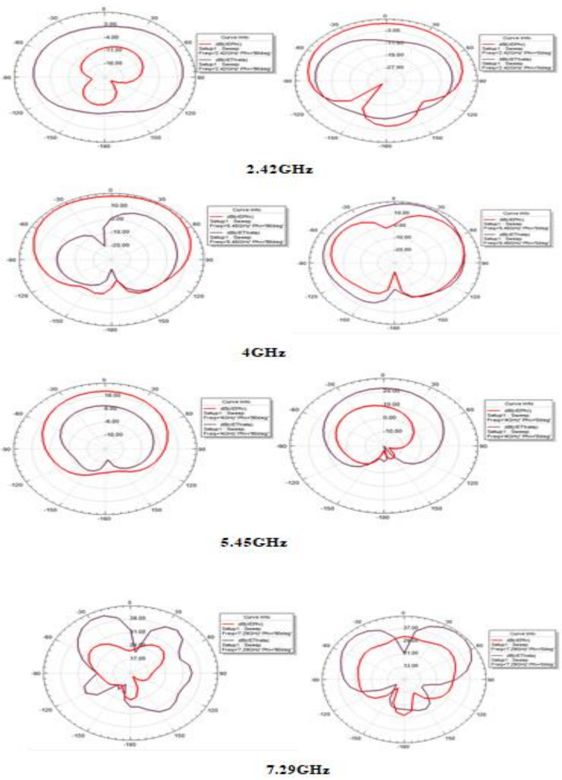


Figure 6: Radiation pattern at phi=0 degree (ZX plane) and phi=90 degree (YZ plane)

The above figure represents the azimuth plane and elevation plane of the proposed work. Here, E phi is the co-polar component and E theta is the cross-polar component. It is clear from the above figure that the co-polar and cross-polar components are differ by –18dB &-27dB, -20dB &-20dB, -18dB & -10 dB, 17dB & 13dB for frequencies 2.42 GHz, 4 GHz, 5.45 GHz and 7.29GHz respectively.

4.2 Experiment –II

In this section, the results obtained after applying DGS (Defected ground structure) has been explained in detail. The performance has been measured in terms of gain, VSWR, bandwidth and returns loss.

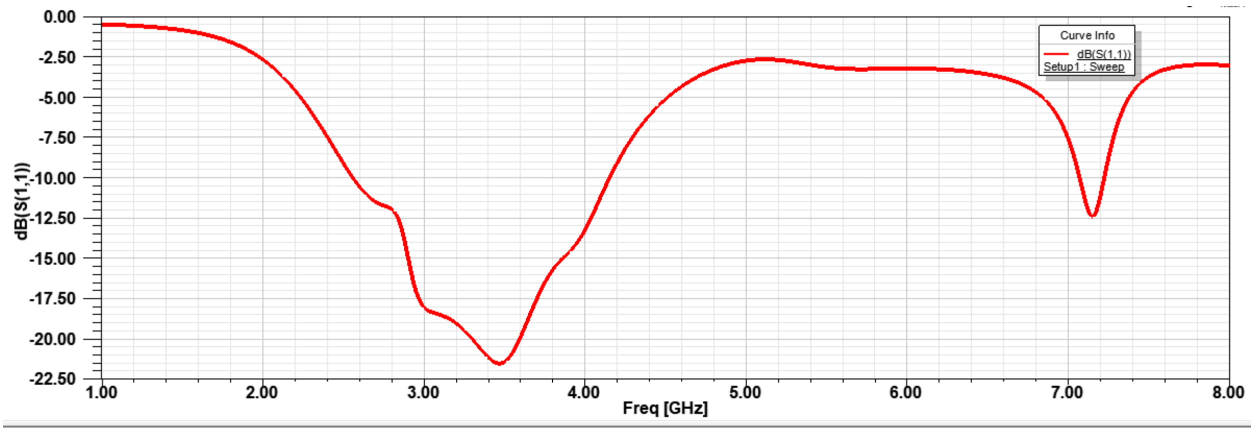


Figure 7: Return loss with DGS

The above figure represents the return loss obtained for the proposed work when DGS is applied on the ground surface. It is clear from the figure above that when ground size reduced the Bandwidth increased. The antenna resonates at two frequencies 3.46 GHz and 7.14 GHz with a return loss of -21.59dB and -12.38dB. For the first frequency band, the lower frequency is 2.54 GHz whereas the upper frequency is 4.14GHz. Therefore the B.W is calculated by using the formula written below and it becomes equal to 1.62 GHz.

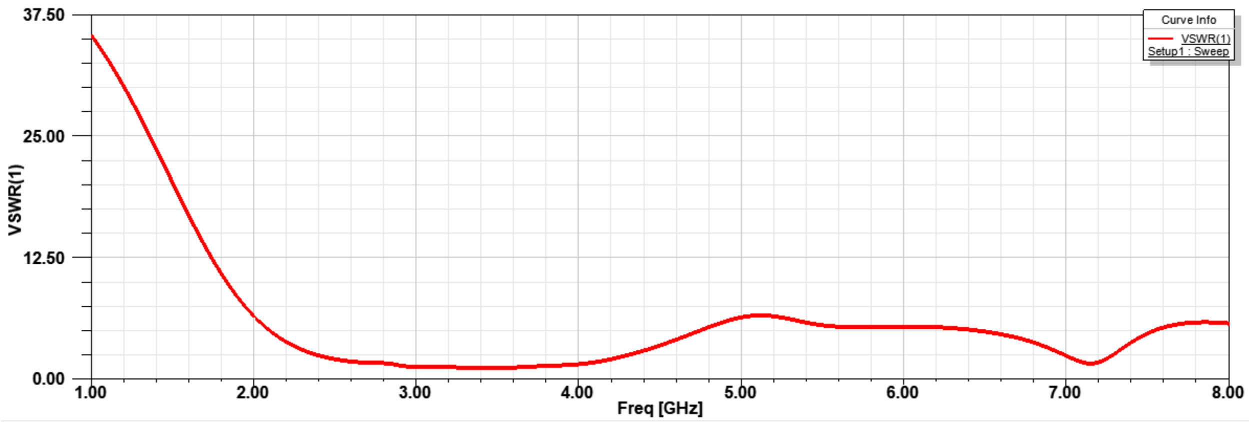


Figure 8: VSWR with DGS

The above figure represents the VSWR of the proposed antenna when DGS is inserted on the ground plane. The VSWR of the proposed work is less than 2 which is the requirement of the perfect antenna in which small power is reflected and maximum power is delivered to the load.

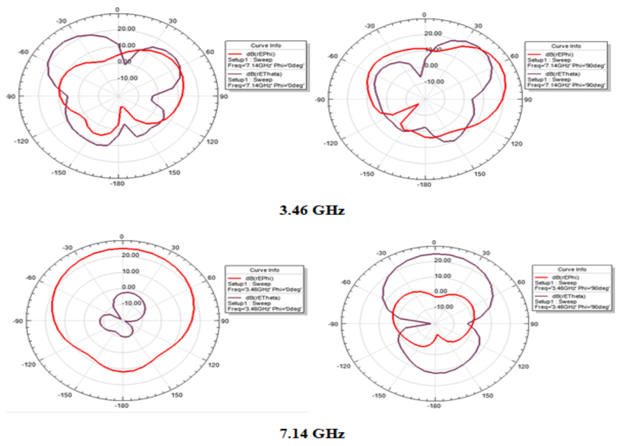
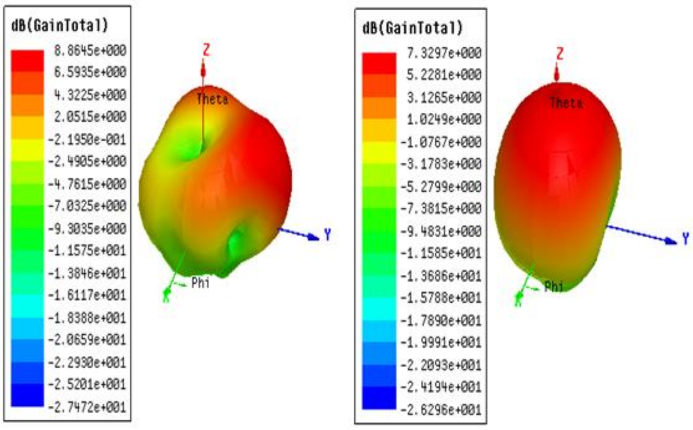


Figure 9: Radiation pattern at phi=0 degree (ZX plane), Phi=90 degree (YZ plane)

The above figure represents the azimuth plane and elevation plane of the proposed work at two resonant frequencies 3.46GHz and 7.14GHz.Here, E phi is the co-polar component and E theta is the cross-polar component. It is clear from the above figure that the co-polar and cross-polar components differ by -10dB.



3.46GHz **7.14 GHz**

Figure 10: Gain with DGS

Above figure represents the gain obtained at 3.46 GHz and 7.14 GHz respectively. The 3D pattern of the gain is represented along with the color bar on the left. The color bar indicates the maximum value of the gain with red color and a minimum value of gain with blue color. The observed +ve gain means that the antenna radiates properly.

5. CONCLUSION

In this research work, I shape and Z shape slots are inserted on the patch of the antenna. And the simulated results show that the design can be implemented for Wi-MAX, WLAN, and B1uetooth. The radiation Pattern of the far field has been shown for the proposed antenna for both directivity and gain at resonant frequencies are shown in the result section. From the results analysis, it is concluded that antenna resonates at four frequencies with higher return loss and gain values. The bandwidth of the proposed antenna increased up to 1.64 GHz by reducing the ground plane. Also, the gain and VSWR has been increased from the existing antenna. The proposed antenna finds application s in router, cordless phone, Bluetooth earpiece, baby monitor, car alarm, microwave oven, Zig-Bee / IEEE 802.15.4 Wireless Data Networks works on 2.42 GHz. 4 GHz used in S-band, WLAN applications covers ranges from 2.4 to 5.7 GHz and also used in radio and satellite applications.

6. REFERENCES

[1] Rajan, S. P., & Poovizhi, M. (2016). Design of Patch Antenna Array for Radar Communication. Journal of Chemical and Pharmaceutical Sciences, ISSN, (0974-2115), 38-40.
[2] Singh, G. (2010). Design considerations for rectangular microstrip patch antenna on electromagnetic crystal substrate at terahertz frequency. Infrared Physics & Technology, 53(1), 17-22.
[3] Lee, K. F., & Luk, K. M. (2011). Microstrip patch antennas (Vol. 1). London: Imperial College Press.
[4] Mak, C. L., Luk, K. M., Lee, K. F., & Chow, Y. L. (2000). Experimental study of a microstrip patch antenna with an L-shaped probe. IEEE Transactions on Antennas and Propagation, 48(5), 777-783.
[5] Chitra, R. J., & Nagarajan, V. (2013). Double L-slot microstrip patch antenna array for WiMAX and WLAN applications. Computers & Electrical Engineering, 39(3), 1026-1041.
[6] Mehra, K., & Jain, A. (2017, July). Design and analysis of L-slots with rectangular slot multiband microstrip rectangular patch antenna. In Computer, Communications, and Electronics (Comptelix), 2017 International Conference on (pp. 549-552). IEEE.
[7] Rahmatia, S., Fransiska, D. E., Pratama, N. I. H., Wulandari, P., & Samijayani, O. N. (2017, August). Designing dipole antenna for TV application and rectangular microstrip antenna working at 3 GHz for radar application. In Cyber and IT Service Management (CITSM), 2017 5th International Conference on (pp. 1-6). IEEE.
[8] Sun, X. B., Cao, M. Y., Hao, J. J., & Guo, Y. J. (2012). A rectangular slot antenna with improved bandwidth. AEU-International Journal of Electronics and Communications, 66(6), 465-466.
[9] Matin, M. A., Saha, M. P., & Hasan, H. M. (2010, May). Design of broadband patch antenna for WiMAX and WLAN. In Microwave and Millimeter Wave Technology (ICMMT), 2010 International Conference on (pp. 1-3). IEEE.
[10] Tiwari, V., Vyas, K., & Goyal, N. (2014, May). Gain enhancement of a CPW-Fed horse shoe shaped slot antenna with defected ground structures for WiMax/WLAN applications. In Recent Advances and Innovations in Engineering (ICRAIE), 2014 (pp. 1-5). IEEE.