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Defected Ground Structured Microstrip Patch Antenna with Quad L – Shaped Slot for Gain Enhancement at 4.8 GHz Frequency

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ABSTRACT
A microstrip patch antenna with L-shaped slots and defected ground structure is discussed in this paper. This antenna is designed with FR4 epoxy as a substrate having dielectric constant 4.4 and the thickness of the substrate is 1.6mm. A Conventional microstrip patch antenna is first taken into consideration, thereby L shaped slots are cut near to the four edges. In order to further improve the antenna characteristics, the defective ground is considered. The designed antenna is simulated in HFSS software. The performance parameters of the antenna such as Return loss, VSWR and gain are studied, with return loss -36.61 dB, VSWR as 1.03 and gain of 10.28 dB for 4.8442 GHz frequency. Also, comparison of these parameters among conventional antenna, a slotted patch antenna and slotted patch with the defected ground is made and the important findings are tabulated.

General Terms
Antenna Performance, Gain characteristics

Keywords
Patch antenna, L slots, defected ground structure, truncated ground, C band applications.

1. INTRODUCTION
Nowadays, the importance of wireless communications is growing rapidly. To meet the present day requirements, there is a need for very high-speed data rate achieved over a wide area. This can be achieved using WiMAX technology. WiMAX technology stands for Worldwide Interoperability for Microwave Access [1]. Hence there is a necessity to design an antenna efficiently working in this range. A microstrip antenna is widely used for this purpose because of its light weight, robustness, low cost of production and low profile nature. It can also be used in mobile phones and other wireless gadgets [2]. It has its applications in satellite communications, radar communications and in the areas of guidance weaponry as well [3]. A microstrip patch antenna has a substrate that is sandwiched between two conducting materials, one material being the patch and the other is the ground. The antenna can be fed through stripling feed between the patch and the ground. The fringing fields [4] produced between these two conducting materials are responsible for the radiation. In spite of several advantages, the microstrip antennas have some disadvantages like narrow bandwidth and less gain. To improve these characteristics several techniques have been applied in the past few years. One of those techniques is cutting slots along the conducting material. Implementation using H and U slots are discussed in [5-8]. The use of microstrip patch employing dual H and dual U slots is discussed in [9]. Use of DGS (Defected ground structure) for K and Ka band was discussed in [10]. As the name itself indicates, the structure of the ground is intentionally made defective or faulty. This helps in effective coupling of inductance and capacitance with the transmission line [11]. In general, DGS deals with modifications in the ground plane. A gap induced or a slot cut in the ground plane provides a necessary coupling effect in an efficient manner [12-13].

In this paper, Section 1 deals with the necessary introduction to the antenna configurations considered. Section 2 deals with the conventional MPA (microstrip patch antenna) and the slotted MPA. Section 3 gives the results from the antenna configurations considered in the previous section. Section 4 proposes the quad-L slotted MPA with DGS (defected ground structure) and Section 5 deals about the observations and results from Section 4 and finally findings are tabulated and the last section concludes the paper.

2. ANTENNA DESIGN
2.1 Conventional Microstrip Patch Antenna
The conventional microstrip patch antenna is constructed with a rectangular patch and FR4 epoxy as a dielectric substrate having relative permittivity 4.4. The W x L (in mm) are considered to be 18.26 mm X 13.74 mm. These values are taken by using the conventional microstrip patch antenna equations discussed in [13]. The substrate height is considered to be of a value of 1.6 mm. The antenna is fed with strip-line feeding. The conventional patch antenna is shown in fig.1 below.

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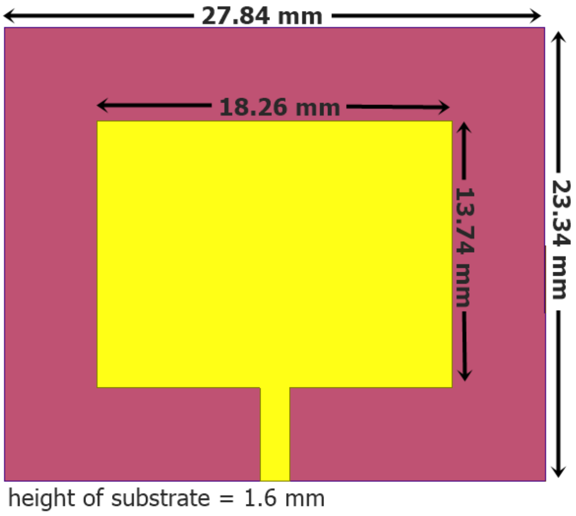

Fig.1 Conventional Antenna

2.2 Quad L – Shaped Slot Microstrip Patch Antenna

In order to improve the radiation characteristics, slots are introduced to the conventional MPA. Two L shaped slots are cut on the conventional antenna. The dimensions and position of these slots are chosen in such a way that the patch antenna is optimized for better performance. The length of each slot is taken to be 2 mm and the slot width is considered to be 0.5 mm. Fig.2 below shows the design structure of the slotted antenna.

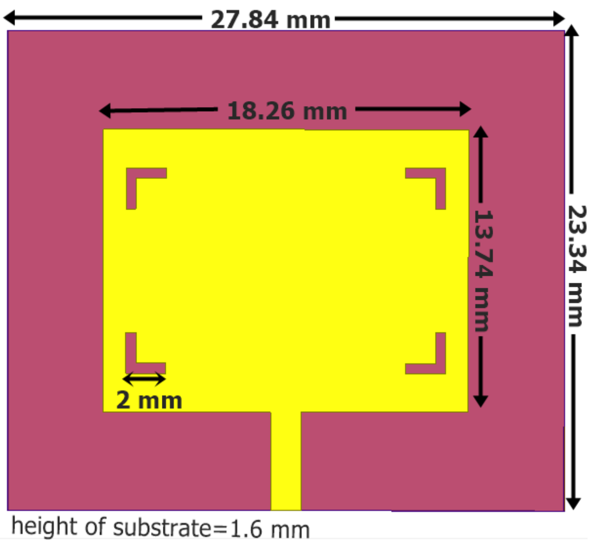

Fig.2 Quad L-Slotted Patch antenna

3. OBSERVATIONS FROM THE CONVENTIONAL MPA AND SLOTTED MPA

Simulations are carried out in HFSS software Firstly, the S11 parameter is calculated. As the microstrip antenna has only one port S11 parameter can be treated as return loss. The return loss of an antenna should be always less than -10dB.

The return loss for conventional MPA is found out to be -32.17 dB. Fig.3 shows the return loss of the conventional antenna.

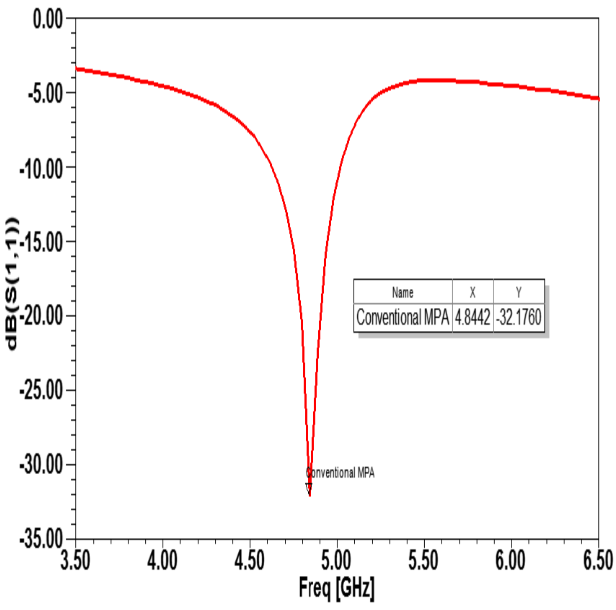

Fig.3 Return loss of conventional MPA

The VSWR is then calculated which is found out to be 1.05. The VSWR should be less than 2 for good agreement of the patch antenna. This is shown in fig.4 below.

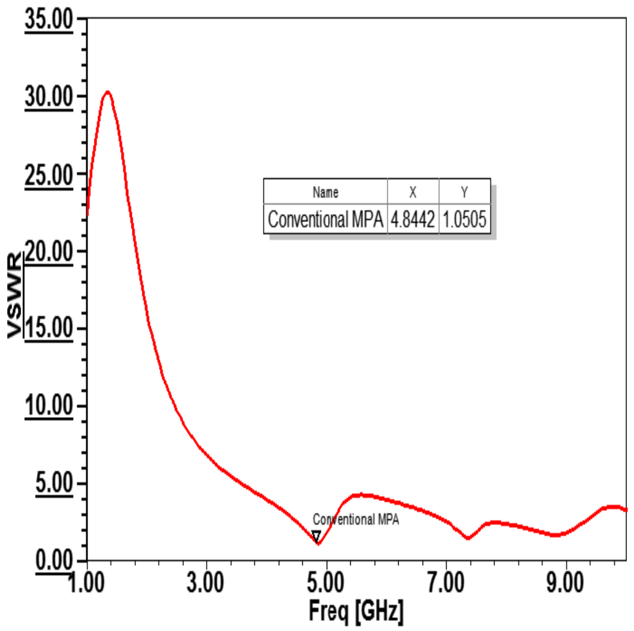

Fig.4 VSWR of conventional MPA

Now L-shaped slots are cut on the patch and the corresponding return loss and VSWR are calculated. The following fig.5 and fig.6 shows the return loss and VSWR plots for the slotted MPA.

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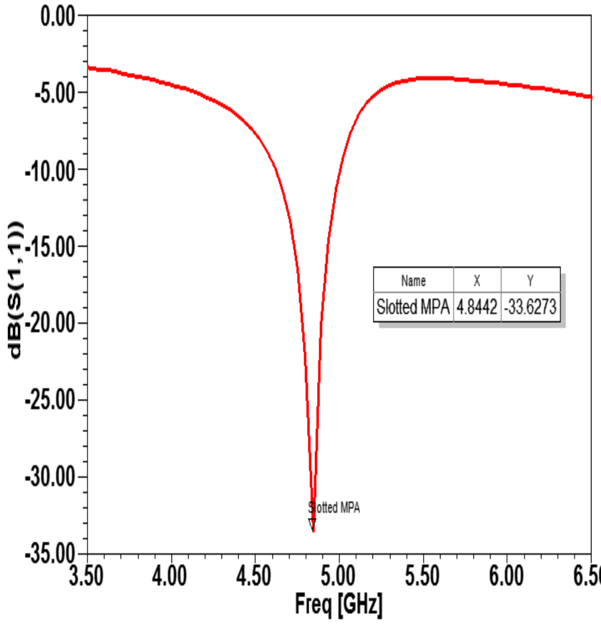

Fig.5 Return loss for Quad L slotted MPA

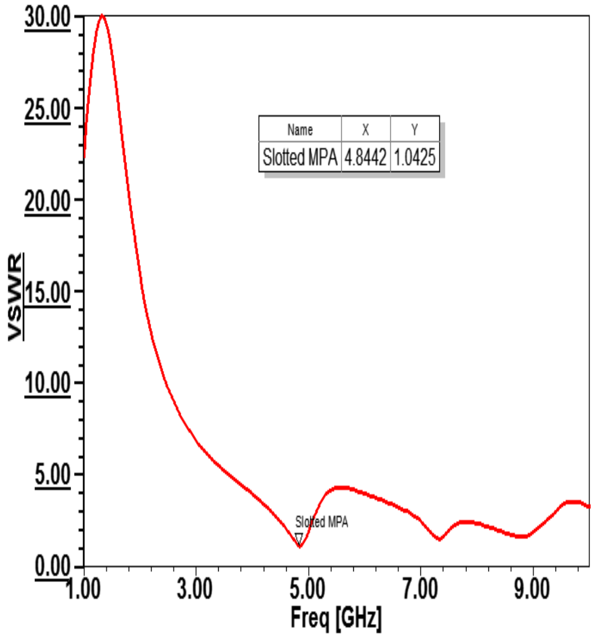

Fig.6 VSWR plot for Quad L slotted MPA

4. PROPOSED DESIGN

To go for further improvement in the gain characteristics and overall antenna characteristics, defected ground is introduced to the L slotted MPA. The defected ground in this consideration is truncated ground in which a horizontal L shaped Slot is cut in the ground plane. Its dimensions are considered to be W x L (in mm) 26.26 mm x 21.74 mm.

The proposed L slotted MPA with the defected ground is shown in fig.7 below.

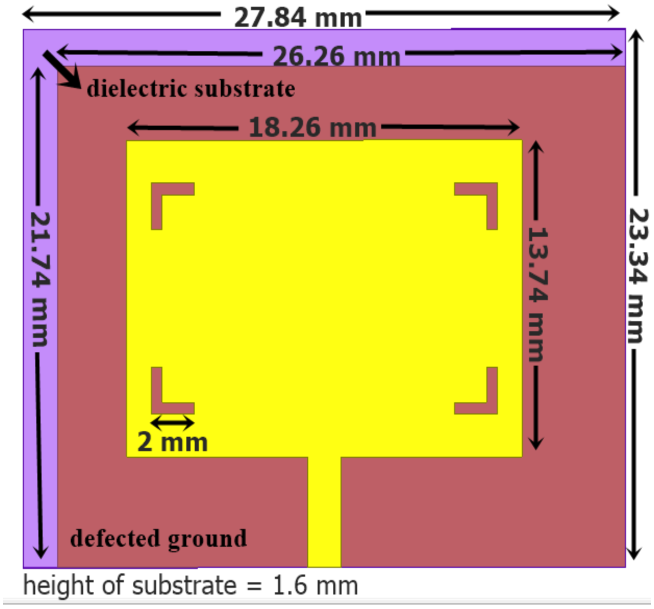

Fig.7 Proposed Quad L-Slotted MPA with DGS

5. OBSERVATIONS FROM THE PROPOSED ANTENNA

The simulated results for L slotted MPA with DGS is shown in fig.8 and fig.9. The results are simulated after cutting an L-shaped slot in the ground. From this result it is clear that the return loss is improved from -33.62 dB (Slotted MPA) to -36.61 dB which is a significant improvement.

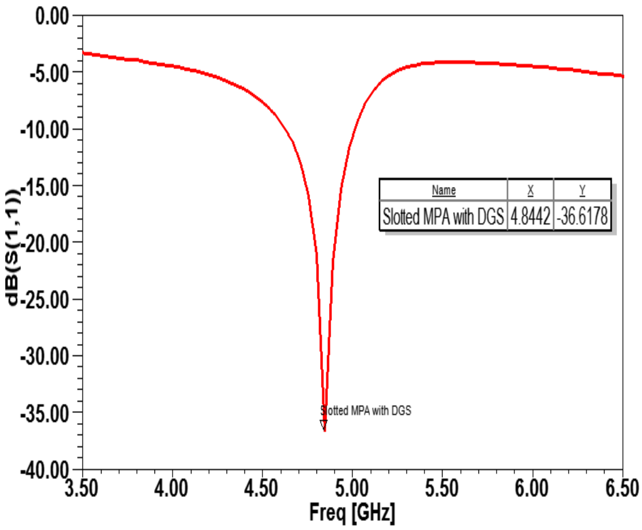

Fig.8 Return loss plot for the proposed slotted MPA with DGS

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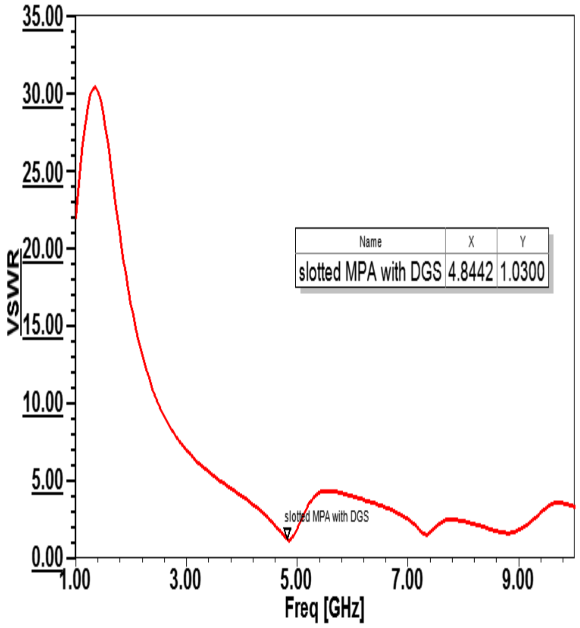

Fig.9 VSWR Plot for the Proposed Slotted MPA with DGS

The gain plots are compared are compared for all the three versions of the considered microstrip patch antenna. These are given in fig.10 below.

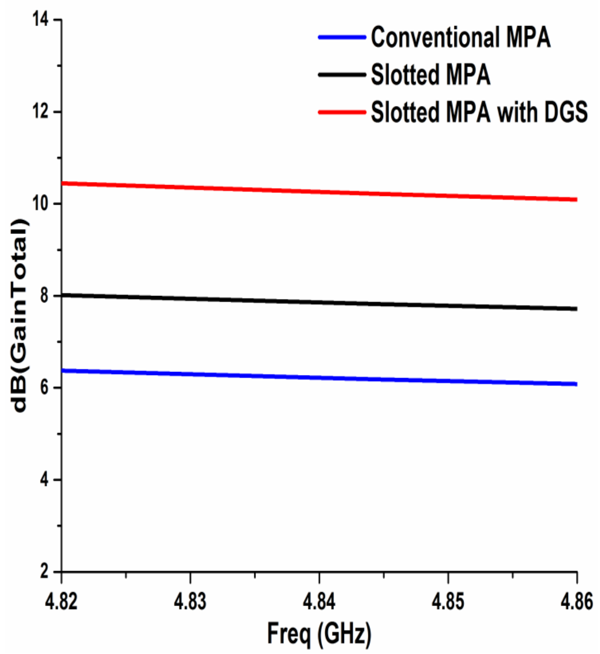

Fig.10 2D Gain comparison plot for the three MPA configurations

All the antenna parameters computed for the three configurations of the considered MPA structures are tabulated below in Table 1.

Table 1: Comparison table for the considered antenna configurations

Parameter	Conventional MPA	Slotted MPA	Slotted MPA with DGS
Center Frequency (GHz)	4.8442 GHz	4.8442 GHz	4.8442 GHz
Return loss (dB)	-32.17 dB	-33.62 dB	-36.61 dB
VSWR	1.0505	1.042	1.03
Gain (dB)	6.23 dB	7.88 dB	10.28 dB

6. CONCLUSIONS

This paper presents the design of a compact slot antenna for single band operation. The patch includes L-shaped slots. The proposed antenna uses a defected ground structure with an L – shaped slot cut in the ground plane, which helps in improving the performance of the antenna. This proposed antenna operated at 4.84 GHz resonant frequency with a return loss of -36.61 dB and VSWR value of 1.03. The gain for the proposed antenna was found out to be 10.28 dB. Significant improvement in the return loss, VSWR and gain are observed with respect to L shaped MPA with DGS when compared to conventional MPA and Slotted MPA. Therefore, the proposed antenna can suitably find its usage in the C – band applications which cover 4 GHz to 8 GHz frequency range.

7. REFERENCES

[1] Majid, A.F. and Mukhlis, Y., 2017, November. Design of circular ring microstrip patch antenna with an H-shaped slot on the ground plane for WiMAX. In Informatics and Computing (ICIC), 2017 Second International Conference on (pp. 1-7). IEEE.

[2] Kiruthika, R., Shanmuganantham, T. and Gupta, R.K., 2016, December. A fan shaped triple band microstrip patch antenna with DGS for X-band applications. In Control, Instrumentation, Communication and Computational Technologies (ICCICCT), 2016 International Conference on (pp. 292-297). IEEE.

[3] Raviteja, G.V., 2018. Design and analysis of a novel dual trapezoidal slot-based rectangular microstrip antenna for wide area network using WiMax application. Microwave and Optical Technology Letters, 60(4), pp.1057-1060.

[4] Derneryd, A., 1978. A theoretical investigation of the rectangular microstrip antenna element. IEEE Transactions on Antennas and Propagation, 26(4), pp.532-535.

[5] Yang, Z., Zhang, H., Zhou, N. and Wu, B., 2014, August. A dual band U-shaped slot antenna for WLAN and WiMAX applications. In PIERS Proceedings (pp. 1486-1489).

[6] Lee, C.I., Lin, W.C., Lin, Y.T. and Lee, Y.T., 2010, July.A novel H-shaped slot-coupled antenna for the integration of power amplifier. In PIERS Proceedings (pp. 385-389).

[7] Ismail, S.N.S., Rahim, S.K.A., Ibrahim, A., Sabran, M.I. and Mohamad, H., 2015, November. Dual band inverted h-shaped slot monopole antenna for WLAN applications. In Communications (MICC), 2015 IEEE 12th Malaysia International Conference on (pp. 197-200). IEEE.

[8] Lee, K.F., Yang, S.L.S. and Kishk, A.A., 2008. Dual band multiband U-slot patch antennas. IEEE Antennas and Wireless Propagation Letters, 7, pp.645-647.

[9] Raviteja, G.V., An X-Band based 2 X 1 Microstrip Antenna Array with Combined H and Dual U Slot Design Operating at 11 GHz Frequency. Communications, 7, pp.15-20.

[10] Rameswarudu, E.S. and Sridevi, P.V., 2016, February. Bandwidth enhancement defected ground structure microstrip patch antenna for K and Ka band applications. In Advances in Electrical, Electronics, Information, Communication and Bio-Informatics (AEEICB), 2016 2nd International Conference on (pp. 407-410). IEEE.

[11] Belekar, V.M., Mukherji, P. and Pote, M., 2017, March. Improved microstrip patch antenna with enhanced bandwidth, efficiency and reduced return loss using DGS. In Wireless Communications, Signal Processing and Networking (WiSPNET), 2017 International Conference on (pp. 2471-2474). IEEE.

[12] Upadhyay, D. and Dwivedi, R.P., 2014, September. Antenna miniaturization techniques for wireless applications. In Wireless and Optical Communications Networks (WOCN), 2014 Eleventh International Conference on (pp. 1-4). IEEE.

[13] Kaur, N. and Sivia, J.S., 2016, May. On the design defected ground plane based L slotted microstrip patch antenna for C band applications. In Research Advances in Integrated Navigation Systems (RAINS), International Conference on (pp. 1-4). IEEE.