Investigation on a Dual band Compact Microstrip Antenna

Priyabrata Biswas, Srija De, Sunandan Bhunia, Sushanta Biswas, Partha Pratim Sarkar

Abstract—This article presents the design of a microstrip antenna with circular radiating patch and rectangular slot loaded square ground plane. The antenna without slot resonates at 8.35 GHz frequency and after loading the slots on the ground plane resonates at 1.4 GHz and 9.65 GHz frequencies. 97% compactness has been achieved with respect to the reference antenna. Around 2dBi gain has been obtained. The antenna exhibits good Omni directional 2D and 3D radiation patterns. Simulation is done using Ansoft Designer Software.

Index Terms— Compact, Co-axial feed, Circular patch, Dual band, Microstrip, Slot Loaded, Dual slot,

1 INTRODUCTION

ADVANTAGES of microstrip antennas are simple structure, low profile, low cost and it can also be integrated easily with other microwave components and millimeter-wave integrated circuits. These antenas are easily fabricated. They are conformable and can be mounted even on curved surfaces [1],[2]. These antennas are applicable for mobile and satellite communication systems. Compact size of antenna being the key factor for advancement of modern communication systems, increases the need of microstrip antennas. Hence efforts to improve the performance of conventional antennas started in a great way [3],[4]. Use of several meandering slots increases the excited surface current paths in the ground plane which lowers its resonance frequency[5]. Patch antennas can also be modified to radiate at two or more frequencies or several bands at a time [6],[7]. Cutting narrow slot in the ground plane at appropriate location purturbs the fundamental resonant frequency of the patch; which changes its resonance mode to a new frequency to achieve required antenna. Improved bandwidth is another requirement which has been achieved by applying suitable slots in the patch geometry. In communication systems like GPS, circular polarization is an additional requirement which can be acieved either by selecting proper feed location or by patch elements stacking [8]. Hence in this direction several works are going.

In this paper, a single layer co-axial feed dual frequency circular patch microstrip antenna embedded on a double slotted rectangular ground plane is proposed. With such an arrangement, antenna resonates at two frequencies of 1.4 GHz and 9.65 GHz and shows much improved performance than a conventional circular patch antenna. The simulation studies are carried by using Ansoft designer software. This antenna can be used in WiMAX and WLAN applications and almost 97% size reduction has been achieved by cutting the equal sized rectangular slots in the ground plane.

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2 ANTENNA DESIGN

The geometry of the designed linearly polarized compact antenna is shown in fig.1. The layout of the antenna has been

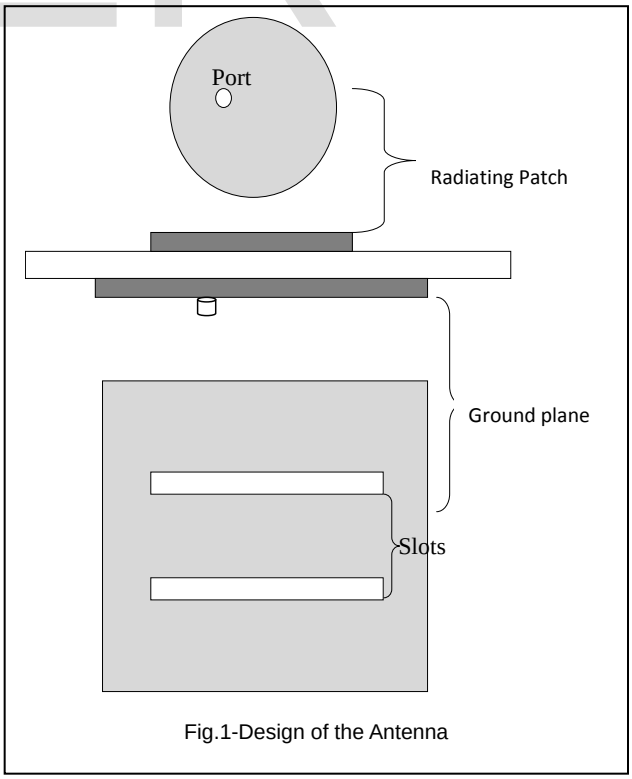

Fig.1-Design of the Antenna

drawn in Ansoft designer software. A circular patch of radius 10mm is fed through a coaxial feed. For best matching of input impedance, the radiating patch is positioned at the centre with respect to ground plane of the antenna. Two rectangular slots are embedded in the ground plane at the centre position. These patches are printed on FR4 substrate, of permittivity €=4.4 and thickness 1.6 mm. The side of the square ground plane is 40 mm. The dimensions of the slots are given in the Table 1.

Table-1:Dimension of the Antenna

Radius of the circular patch	10mm
Side of the square ground plane	40 mm
Length of the slot	30 mm
Width of the slot	2 mm

3 Results and Discussions

Reflection coefficients of reference antenna, single slotted antenna and double slotted antenna have been presented in the same diagram for comparison. From figure 2 it has been shown that the reference antenna resonates at 8.35 GHz, while single slotted antenna and double slotted antenna resonates at 6.4GHz and 1.4 GHz respectively. Calculated radii of reference antenna without slot resonating at 6.4 GHz and 1.4 GHz is 1.3 cm and 5.96 cm. That means if one wants to design an antenna without single or double slot at ground plane to resonate at 6.4 GHz and 1.4 GHz, its radii will be 1.3 cm and 5.96 cm respectively.

Hence, compactness for

Single slotted antenna = [{π(1.3)2 - π(1)2}/π(1.3)2] x 100% = 41%.

Double slotted antenna = [{π(5.96)2 - π(1)2}/π(5.96)2] x 100% = 97%.

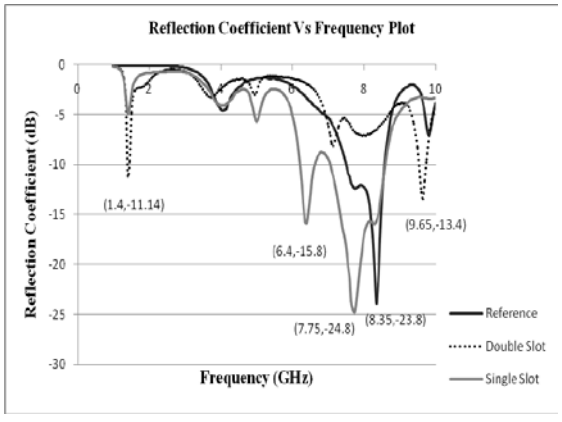

Fig.2. Reflection Coefficient Vs Frequency Plot of the Reference, Single Slotted and Double Slotted Antenna

From the Fig 2 it has been shown that the designed double slotted antenna resonates at two different resonant frequencies i.e 1.4 GHz and 9.65 GHz. The simulated gain vs frequency plot is shown in fig 3.

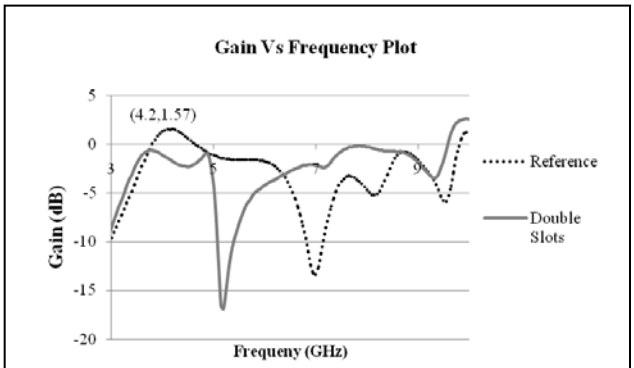

Fig.3. Gain Vs Frequency Plot of the Reference, Single Slotted and Double Slotted Antenna

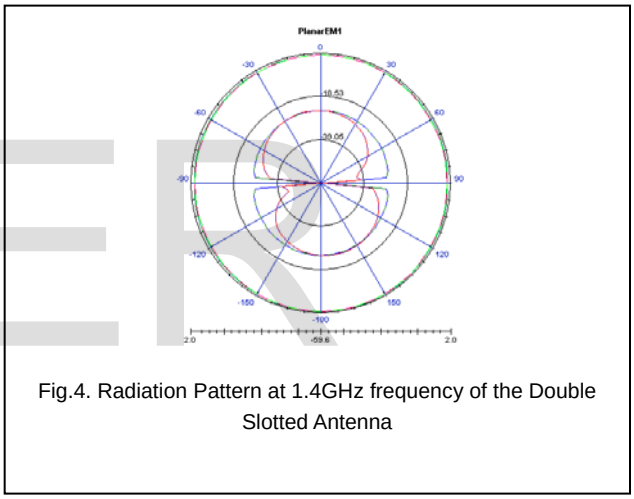

Fig.4. Radiation Pattern at 1.4GHz frequency of the Double Slotted Antenna

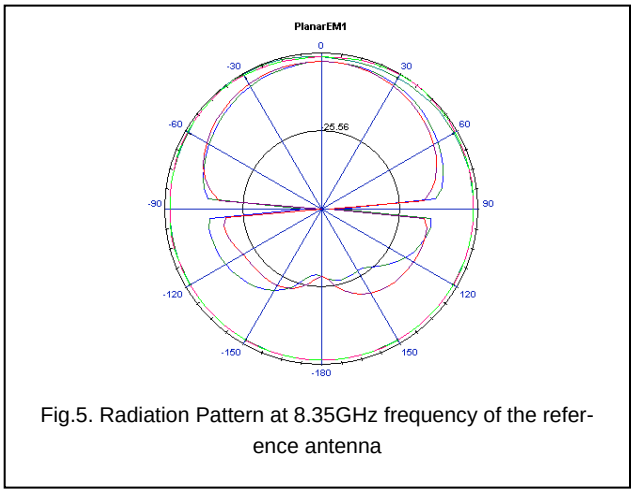

Fig.5. Radiation Pattern at 8.35GHz frequency of the reference antenna

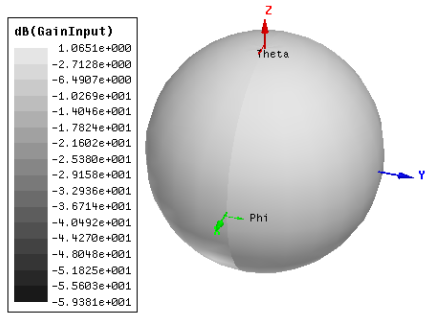

Fig.6. 3D Radiation Pattern at 1.4GHz frequency of the Double Slotted Antenna

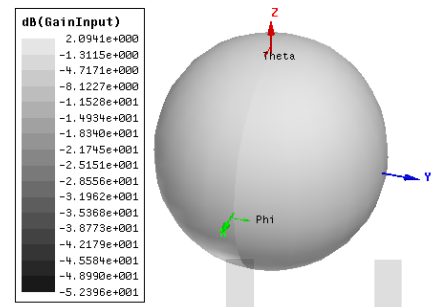

Fig.7. 3D Radiation Pattern at 8.35GHz frequency of the reference antenna

The gain of this double slotted antenna is 2 dBi. The simulated radiation patterns of the designed antenna at 1.4 GHz and 9.65 GHz resonant frequencies are shown in fig-4 and fig-5 respectively. Simulated 3D radiation pattern at 1.4 GHz and 9.65 GHz are shown in fig 6 and fig 7.

4 Conclusion

Reference antenna with square shaped ground plane and rectangular patch loaded with single and double slots at ground plane have been studied. Results show significant size reduction of the designed antenna. For double slotted antenna 97% size reduction is achieved and gain of that antenna is 2dBi. The theoretical 2D and 3D radiation patterns are also good. So the designed antenna may be used in compact handheld mobile phones.

Acknowledgment

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References

[1] Balanis, C.A.: Advanced Engineering Electromagnetics. Wiley, New York(1989)

[2] Bhunia, S., Biswas, S., Sarkar, D., Sarkar, P.P. "Experimental investigation on dual-frequency broad band microstrip antenna with swastika slot". Ind.J.Phys. 81,497-499(2007)

[3] Bhunia, S., Biswas, S., Sarkar, D., Sarkar, P.P., Gupta, B., Yasumoto, "Reduced size small dual and multi-frequency microstrip antenna", Microwave Opt. Technol. Lett. 50(4),961-965(2008)

[4] Sarkar, I., Sarkar, P.P. and Chowdhury, S.K.,"A New Multifrequency Compact Microstrip Antenna", Indian Journal of Physics , Vol.84, No.4 pp.413-418, 2010.

[5] Das, S., Sarkar, P.P. and Chowdhury, S.K., "Compact Multifrequency Slotted Microstrip Patch Antenna with Enhanced Bandwidth Using Defected Ground Structure for Mobile Communication", International Journal of Engineering Science and Advanced Technology, Vol.2, No.2, pp.301-306,2012.

[6] S.De, P.Samaddar, S.Sarkar, S.Biswas, D.Sarkar, P.P.Sarkar "Compact High Gain Multifrequency Microstrip Antenna" International Journal of Soft Computing and Engineering(IJSCE) ISSN:2231-2307, Volume-2, Issue-6, pp.337-339, January 2013.

[7] Srija De, Poulami Smaddar, Sushanta Sarkar, Sushanta Biswas, Debasree Sarkar and Partha Pratim Sarkar: "Compact Multi-band Microstrip Antenna with High Gain" © Springer India Information Systems Design and Intelligent Applications, Advances in Intelligent Systems and Computing, DOI 10.1007/978-81-322-2250-7_51,pp.519-524,2015.

[8] J.Wang, R.Fralich, C.Wu, and J. Litva, "Multifunctional aperture-coupled stacked antenna," Electron. Lett., vol. 26, no.25, pp. 2067-2068, 1990.