

Study on Bandwidth Enhancement of Microstrip Antenna

Madhumita Das, Sreyosee Mukherjee, Prasanna Kumar Biswas, Partha Pratim Sarkar

Department of Engineering & Technological Studies, University of Kalyani, Kalyani, West Bengal, India

ABSTRACT: In this paper the design of a broadband microstrip antenna is presented. The antenna consists of three U-shaped direct coupled patches & two gap coupled rectangular patches. The substrate used here is FR4_epoxy (dielectric constant 4.4). The band of the proposed antenna ranges from 5.46GHz to 6.29 GHz (considering -10 dB bandwidth) with resonating frequency of 5.87 GHz. So the percentage bandwidth is 14.12 %.The maximum gain achieved here is 3.7 dBi. All the results given here are simulated.

KEYWORDS: Microstrip antennas, broadband, direct coupled, gap coupled.

I. INTRODUCTION

Microstrip antenna basically consists of three layers; the topmost layer is called radiating plane and the bottom layer is called ground plane. Both these layers are made of metal. In between these two layers, a dielectric substrate is sandwiched. These antennas are lightweight, simple and low cost. Due to these advantages they are frequently used in telemetry and communication systems. [1-2] However, they also suffer from some disadvantages. In general, microstrip antennas show narrow bandwidth (1-5%) & lower gain. Several techniques like slotted patch antenna, thick dielectric substrate, direct coupled, gap coupled patches are reported for bandwidth enhancement. [3-5]

In this paper, a microstrip antenna with 3 direct coupled U-shaped patches with 2 gap coupled rectangular patches has been studied. Maximum percentage bandwidth achieved here is 14.12%. Maximum gain achieved is 3.7 dBi. The theoretical investigation has been done by Ansoft® simulator which works on METHOD of MOMENT.

II. DESIGN

The proposed antenna has been described below step by step starting from the reference antenna. Fig. 1 shows the structure of the reference antenna. The dimension of ground plane is 40mm X 40 mm. & the radiating plane consists of 3 square patches (11 mm X 11 mm, 10mm X 10 mm, 9 mm X 9 mm). Coaxial feed is given to the middle patch. The feed position is shown in figure 1. For all the designs throughout this paper, the feed position has been kept unchanged. The first modification is done in the reference antenna by introducing rectangular slits from each of the 3 patches. This is shown in figure 2. Next, two rectangular patches have been added above and below the middle U-shaped patch. This modified antenna along with the dimension of newly added patches is shown in figure 3.

As further modification, two U-shaped patches are joined using 2mm X 2mm metallic patch (fig. 4) and then second & third U-shaped patches are joined by a similar patch to constitute the final design, which is shown in fig. 5.

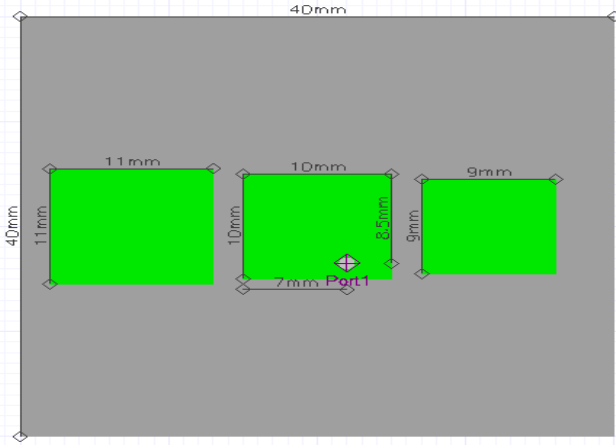


Figure 1: Reference Antenna

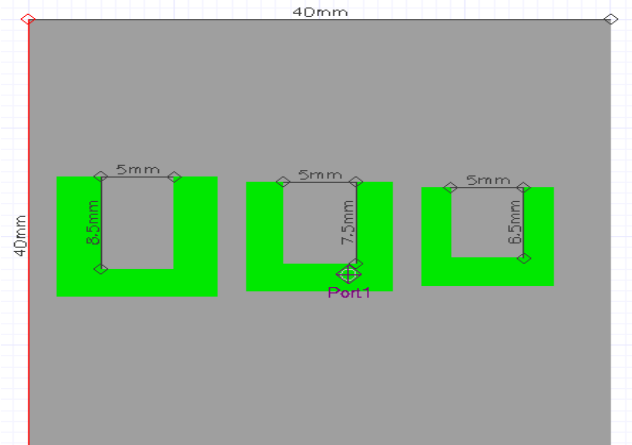


Figure 2: Rectangular Slits Introduced in Each of the 3 Patches

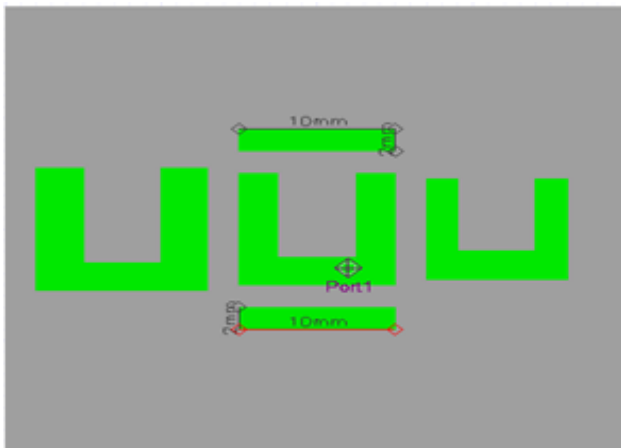


Figure 3: Two Rectangular Patches Added

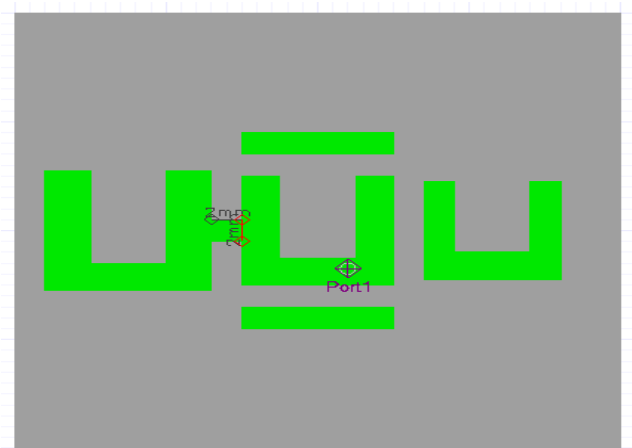


Figure 4: First 2 U-Shaped Patches Are Joined

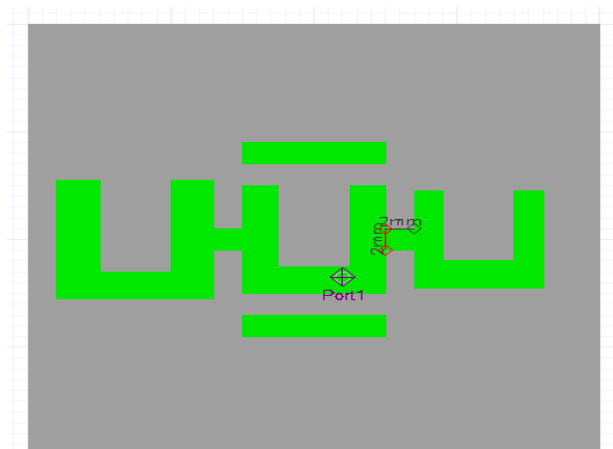


Figure 5: Final Proposed Antenna

III.RESULTS

For the reference antenna, when there was no slit in the patch, the resonant frequency was found at 8.83 GHz & percentage bandwidth was 6.34%. For the proposed final antenna, the resonating frequency was found at 5.87 GHz & percentage bandwidth increased to 14.12%. The cut-off frequencies, resonant frequencies, bandwidths, and percentage bandwidths for all the antennas are given in Table 1. The return loss & gain characteristics for these antennas are shown in figures 6-15.

TABLE I
SIMULATION RESULTS

Antenna Design No.	F_L (GHz)	F_R (GHz)	F_H (GHz)	%BW	Gain(dBi)
Reference antenna(fig.1)	8.55	8.83	9.11	6.35%	1.25
Antenna of fig. 2	7.69	7.81	8.23	6.91%	1.63
Antenna of fig. 3	7.78	8.11	8.26	5.92%	2.25
Antenna of fig. 4	5.35	5.92	6.08	12.33%	4.64
Final proposed antenna (fig.5)	5.46	5.87	6.29	14.12%	3.7

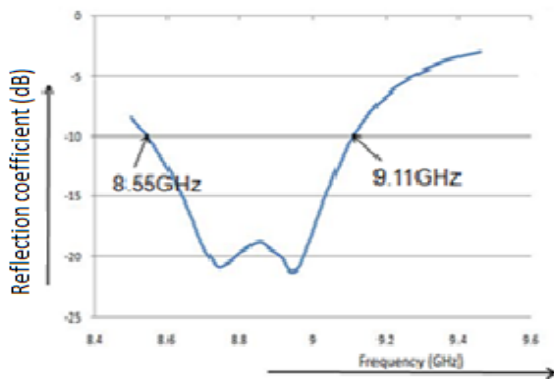


Figure 6: Reflection coefficient of reference antenna

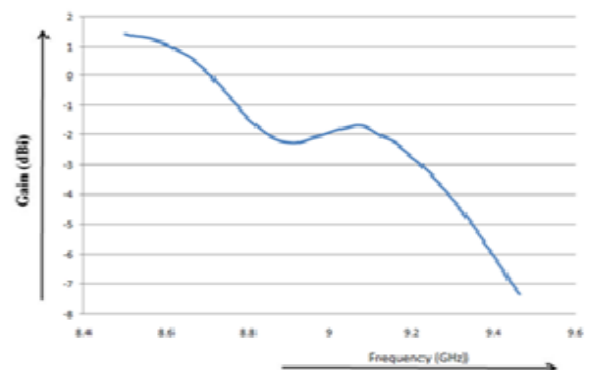


Figure 7: Gain characteristics of reference antenna

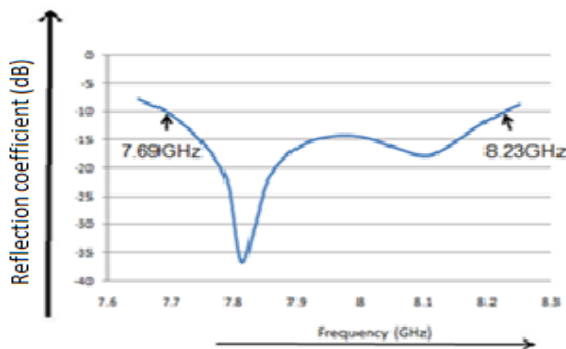


Figure 8: Reflection coefficient of antenna shown in fig. 2

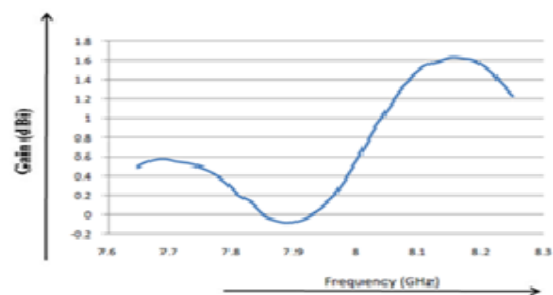


Figure 9: Gain characteristics of antenna shown in fig. 2

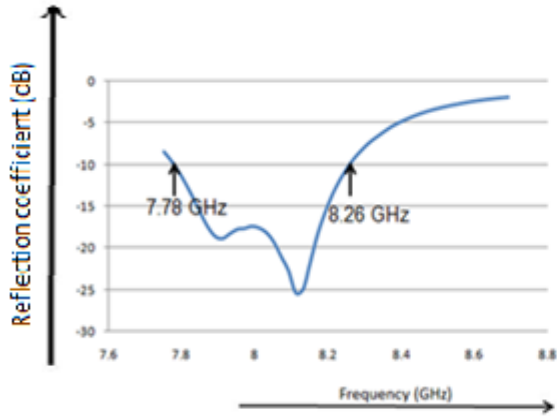


Figure 10: Reflection coefficient of antenna shown in fig. 3

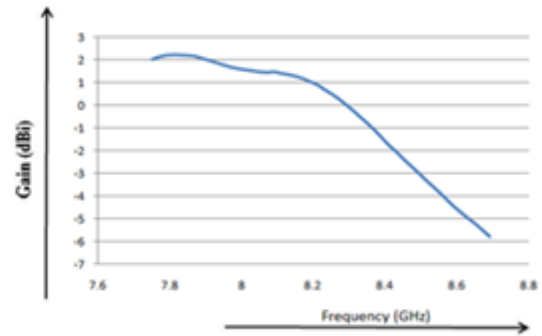


Figure 11: Gain characteristics of antenna shown in fig. 3

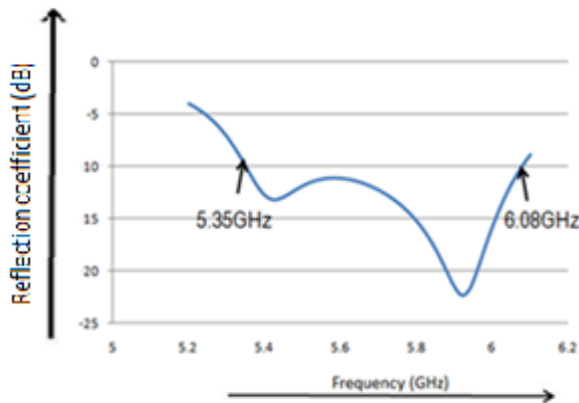


Figure 12: Reflection coefficient of antenna shown in fig. 4

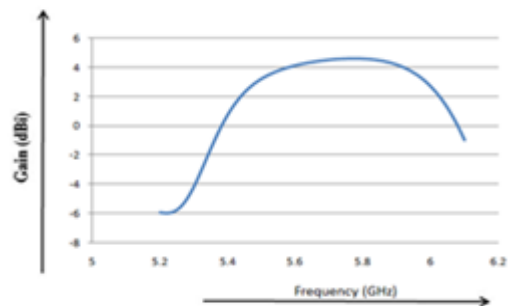


Figure 13: Gain characteristics of antenna shown in fig. 4

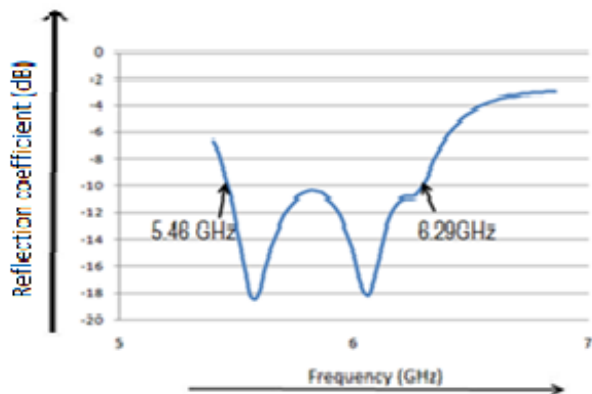


Figure 14: Reflection coefficient of final antenna shown in fig. 5

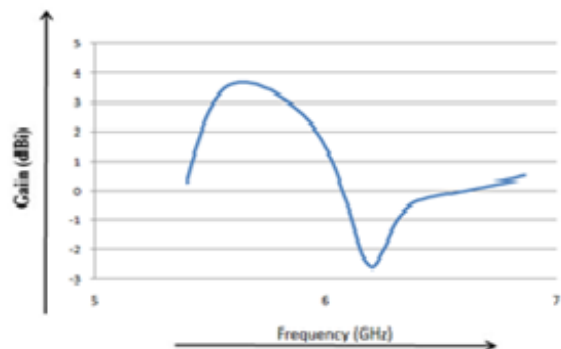


Figure 15: Gain characteristics of final antenna shown in fig. 5

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IV. CONCLUSION

From the above simulated results, it can be observed that, the bandwidth was significantly improved compared to reference antenna, from 6.34% to 12.33%, when two gap coupled U-shaped patches were joined to make a direct coupled patch (fig. 5). Then, in the final proposed antenna, when the remaining gap coupled U-shaped patch was also joined with other two U-shaped patches, percentage bandwidth finally increased to 14.12%. So, for this design, direct coupling was more effective than gap coupling for bandwidth enhancement. The antenna can be used for C band applications.

REFERENCES

- [1] Girish Kumar, K.P. Ray, Broadband Microstrip Antennas, ARTECH HOUSE.
- [2] C.A. BALANIS, ANTENNA THEORY: ANALYSIS & DESIGN, 2ND EDITION, WILEY, HOBOKEN, NJ2008.
- [3] S.Majumdar, T. Mandal, S. Mahato, G.Sen, P. P. Sarkar, Analysis of a Novel Shaped Compact Microstrip Antenna for Ultra Wide Band Applications, IC3A-2013.
- [4] K. Mandal, P.P.Sarkar, High Gain Wide-Band U-Shaped Patch Antennas with Modified Ground Planes, IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 61, NO. 4, APRIL 2013, Page No. – 2279-2282
- [5] Chandran, P.P.; Viswasom, S., "Gain and Bandwidth Optimization of a Novel Microstrip Patch Antenna," Advances in Computing and Communications (ICACC), 2014 Fourth International Conference on , vol., no., pp.315,318, 27-29 Aug. 2014.