A Reduced Size Rectangular Patch Antenna

[1]Chandrani Chakravarty, [2]Dr. Partha Pratim Sarkar
[1,2]Dept. of ECE, University of Kalyani, West Bengal, India
[2]Dept. of Engineering and Technology Studies, University of Kalyani, West Bengal, India

Abstract
A rectangular patch microstrip antenna with slot loaded ground plane is represented in this article. By embedding slots in the antenna's ground plane, it is observed that the resonant frequency of the microstrip antenna is significantly lowered, which can lead to a large antenna size reduction for a fixed frequency operation. The proposed microstrip antenna has rectangular slots on its ground plane which reduces its size by 84%and resonance frequency reduction by 74% compared to the conventional patch antenna. Antenna is simulated using Ansoft designer version 2.2.0; the antenna is fabricated on FR4 epoxy substrate.

Keywords
Microstrip Antenna, Patch Antenna, Compact Antenna

II. Introduction

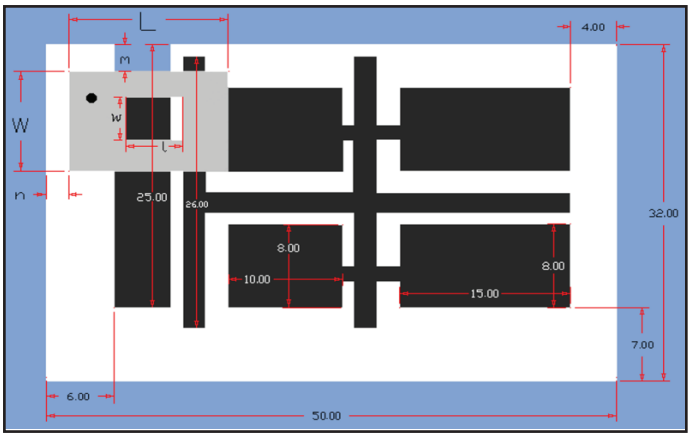

Fig. 1:

In last few decades in the field of wireless communication, MMIC design, Synthetic Aperture Rader (SAR), satellite communication and aircraft signaling system and many other area Microstrip patch antennas play a very important role due to some beneficial features like low profile, light weight, low production cost, easy fabrication conformability and its robustness. Microstrip antennas are relatively inexpensive to manufacture and design because of the simple 2-dimensional physical geometry. They are usually employed at UHF and higher frequencies because the size of the antenna is directly tied to the wavelength at the resonant frequency.

Contemplation on the advancement of size reduction technology of micro strip patch antennas raise a rapid pace in the development of various wireless communication systems in today's era. But it is desired that the reduced size antenna have equivalent operation in comparison with ordinary developed antennas. Though, many techniques are there to reduce the size of patch antenna like using dielectric substrates with high permittivity using shorting pins, increasing the electrical length of antenna by optimizing its shape, the most simple way to reduce the size of a patch antenna is either modifying its ground surface or modifying its radiating patch.

It has been observed that slot loaded ground plane and patch of a microstrip antenna decreases antenna resonant frequency [9]. Many types of shapes of slots and slits [2-3] embedded on microstrip antennas for their size reduction. These are introduced to increase the current path through the surface area, which in turn helps to decrease the resonant frequency [5] of a patch antenna [1-12]. In this paper an antenna has been represented with irregular defects on its ground plane. The proposed antenna has four rectangular slots which are connected through some narrow rectangular slots, etched on the ground plane. All the slots are properly positioned to get optimum results

III. Antenna Geometry

The antenna configuration is shown in fig 1. The patch has dimensions of W×L the substrate used here is FR4-epoxy with relative permittivity $\varepsilon_r = 4.4$ and thickness of 1.6mm
The ground plane dimensions are length of 32mm and width of 50mm. The antenna is coaxially probe fed at the optimum feeding location on patch at a distance of 4mm and 5mm from the edge of the width and length of the ground plane respectively. The ground is loaded with four rectangular shaped defects which again linked to each other through some other long and thin rectangular shaped slots. Their dimensions are taken of 8x10 mm2 for the slots which are closer to the patch and 8x15mm2 for those which are place at a distance from patch. The other measurements are given in the fig. 1 and the measurements regarding patch are given in the Table 1.

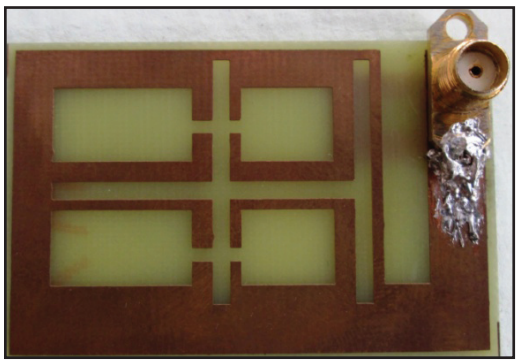

Fig 2 (i)

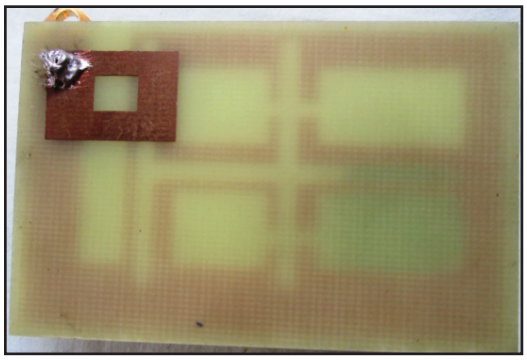

Fig 2 (ii)
Fig. 2: Photograph of the Designed Proposed Antenna

Simulation results, obtained using Ansoft designer v2.2.0, and measurement results of several of the simulated antennas are presented.

Table 1: The Dimensions of the Patch and its Position for the Proposed Antenna

S. No.	Antenna Dimensions	Data (mm)
1	Patch width(W)	24
2	Patch length(L)	9.5
3	Rectangular Slot on the patch, width(w)	4
4	Rectangular Slot on the patch, length(l)	5
5	Position of patch from the edge of the width of ground plane(m)	4
6	Position of patch from the edge of the length of ground plane(n)	5

IV. Results and Discussion

Return losses of the proposed antenna and the reference one were simulated by Ansoft designer. Return losses of the fabricated antenna is measured using vector network analyzer. The results are shown in the tabular form in Table 2.

The return losses for the designed antenna are shown in below in fig. 3 & 4. In fig. 3 it shows that the ref antenna obtained resonating frequency at 6.36GHZ and for fig. 4 the resonating frequency became 1.61GHZ. In fig. 4&5 the deviation occurred in the return loss due to transmission loss and conductor loss in the antenna.

It is observed from the results shown in the below that the proposed antenna with slotted ground showing the smaller resonating frequency than the reference one.

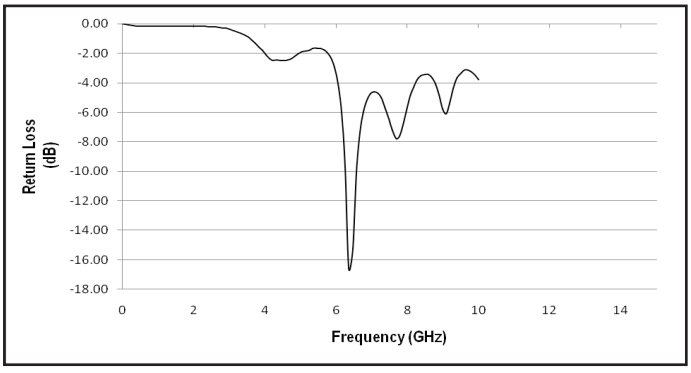

Fig. 3: Simulated Return Loss of the Reference Antenna

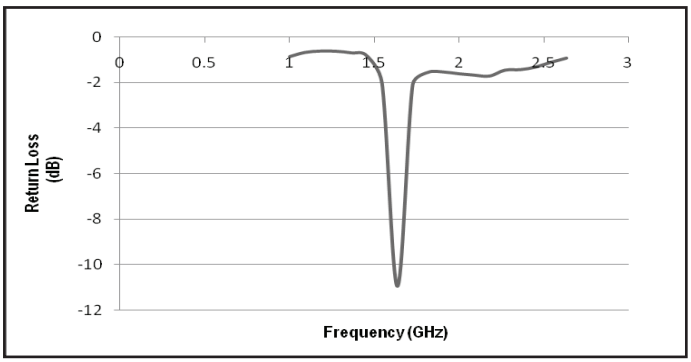

Fig. 4: Simulated Return Loss of the Proposed Antenna

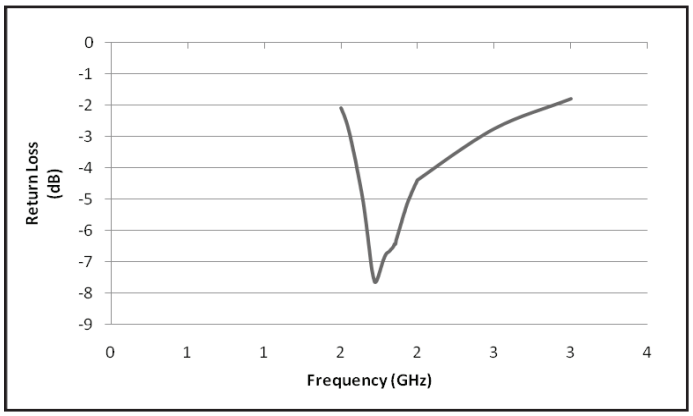

Fig. 5: Measured Return Loss for the Proposed Antenna

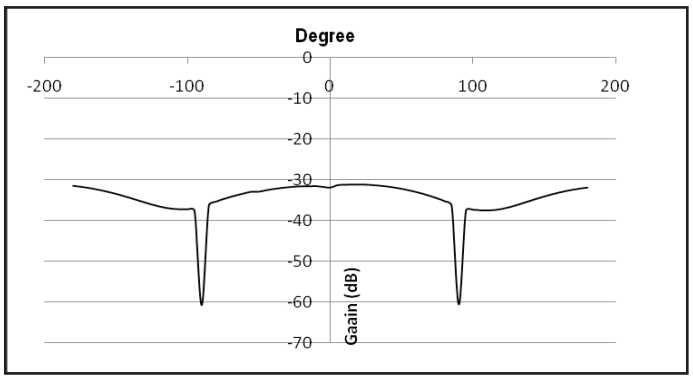

Fig. 6: Simulated Radiation Pattern of the Ref Antenna

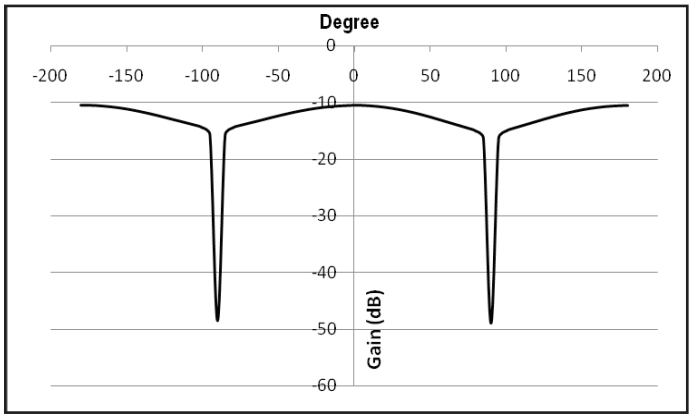

Fig. 7: Simulated Radiation Pattern of the Proposed Antenna

Table: 2

Antenna	Resonating frequency(GHZ)	Return loss (dB)	Bandwidth (MHZ)
Antenna ref.	6.36	-16.49	300
Antenna proposed	1.61	-17.78	30

Fig. (3 & 4) it is observed that the resonating frequency is shifted from 6.36GHZ to 1.61GHZ. since operating bandwidth decreases with the decrease in size of a microstrip patch antenna so it can be observed in Table 2 that as resonating frequency becomes lower it narrowing the bandwidth for the proposed antenna compared to the reference one. The radiation patterns for both the proposed and reference antenna are shown in fig. (6&7).

V. Conclusion

In this paper a defected ground with slotted rectangular patch has been proposed, where the defects lengthen the current path

on the ground plane. From the experimental result it is found that for the proposed design of the pattern the patch will resonate at much lower frequency than the reference one by 84% compared to the reference one

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Mrs. Chandrani Chakravarty obtained her M Tech degree from University College of Science, Agriculture and Technology,(formerly known as Calcutta University) Calcutta, Raja Bazar, in the year of 2010. She received her B-Tech from College of Engg. and Management, Kolaghat in the year of 2007. She is presently working as guest teacher in DETS in the department of Electronics and Communication engg. as well as started her research work in the field of microstrip antenna.

Dr. Partha Pratim Sarkar obtained his Ph.D in engineering from Jadavpur University in the year 2002. He has obtained his M.E from Jadavpur University in the year 1994. He earned his B.E degree in Electronics and Telecommunication Engineering from Bengal Engineering College (Presently known as Bengal Engineering and Science University, Shibpur) in the year 1991.He is presently working as Senior Scientific Officer (ProfessorRank) at the Dept. of Engineering & Technological Studies,University of Kalyani. His area of research includes, Microstrip Antenna, Microstrip Filter, Frequency Selective Surfaces, and Artificial Neural Network. He has contributed to numerous research articles in various journals and conferences of repute.He is also a life Fellow of IETE.