Enhancement of Bandwidth of a Microstrip Antenna using Modified Radiating and Ground Planes

Sukabya Dan, Manoj Pain, Debasree Sarkar, Partha Pratim Sarkar

Abstract— Microstrip patch antennas have some drawbacks like low efficiency, narrow bandwidth (3% - 6%), low gain. But due to their low cost, low profile, light weight, manufacturing simplicity and ease of implementation, microstrip patch antennas are widely used in various types of applications in communication systems. This paper presents the enhancement of bandwidth of microstrip patch antenna using multiple numbers of slots on patch and ground plane. The antenna has been designed on FR4 substrate with dimension 20mm x 20mm having dielectric constant 4.4 and height h=1.6mm. The operating frequency band of designed microstrip patch antenna is 4.06GHz - 5.26GHz with 27.97% bandwidth across resonance frequency at 4.29GHz and the Gain at resonance is 1.26dBi. The antenna is fed by 50Ω coaxial line. The proposed configuration is simulated and analyzed using Ansoft Designer Nexxim Version 2.2.

Index Terms— Microstrip patch antenna, Bandwidth enhancement, Return loss, Radiation pattern, VSWR, Resonance, Ansoft Designer Nexxim Version 2.2.

1 INTRODUCTION

A simple Microstrip patch antenna consists of a radiating metallic patch on one side of a dielectric substrate and a metallic ground plane on the other side. The top view and side view of a square patch antenna are shown in Fig.1 and Fig.2 respectively

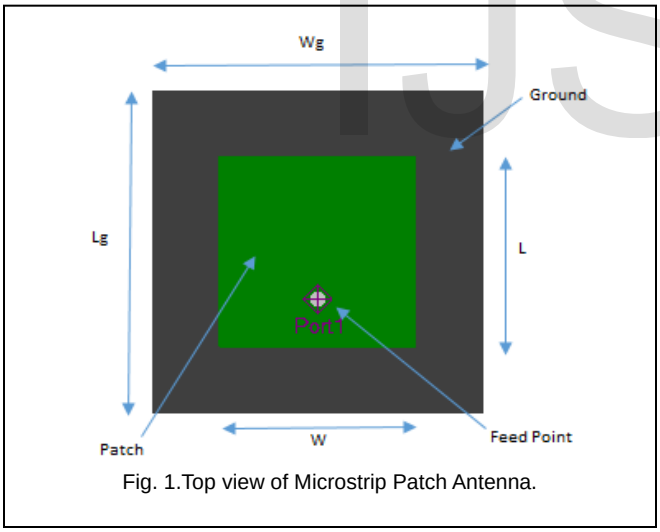


Fig. 1.Top view of Microstrip Patch Antenna.

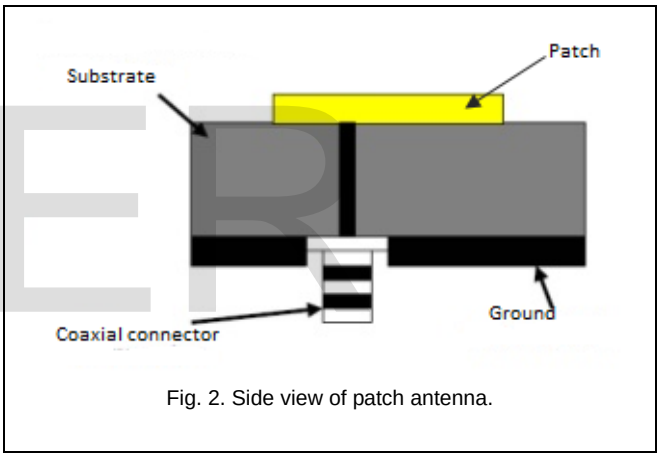


Fig. 2. Side view of patch antenna.

Microstrip patch antennas are widely used in microwave frequency because of their simplicity and compatibility with printed circuit technology, making them easy to manufacture at low cost but the major drawbacks of Microstrip patch antennas are narrow bandwidth and low gain[1]. There are many techniques that can be used to enhance the bandwidth and gain of Microstrip patch antenna[2]. Using thick substrate with low dielectric constant and slotted patch can enhance the bandwidth and gain of antennas.[3]

In this paper we have used multiple slot technique[4] on patch and ground plane i.e. we cut multiple number of rectangular and triangular slots in patch and ground plane. By cutting slots the quality factor Q of the patch resonator is reduced, which is due to less energy stored beneath the patch and higher radiation[2]. It can be also shown that the existence of slots in ground plane decreases the effective area and reduces the conductor loss, as a result Q-factor decreases[4]. By

- *Sukabya Dan, M.Tech Student in University of Kalyani, India. E-mail: sukabya_dan@rediffmail.com.*
- *Partha Pratim Sarkar, Senior Scientific Officer in University of Kalyani, India. E-mail: parthabe91@yahoo.co.in*

decreasing the Q-factor Bandwidth is increased accordingly. The proposed configuration is simulated and analyzed using Ansoft Designer Nexxim Version 2.2. which is based on Method Of Moment technique. The Return loss, gain, VSWR, Radiation pattern are used to analyze the proposed antenna.

2 Antenna Design Specification

The dielectric material used for this design is FR4 EPOXY which has dielectric constant of ε = 4.4, loss tangent tanδ= 0.02, the height of the dielectric substrate is *h*=1.6mm. The reference patch antenna is designed having dimention 14mm x 14mm situated at the centre of a 20mm x 20mm dielectric slab. The antenna is exiced by coaxial feeding at the position of (0, -3.49). The reference antenna is resonating at 4.7GHz having %babdwidth of 5.11% and gain at resonance is 3.33dBi.

3 Antenna Design Procedure

Multiple numbers of rectangular and triangular slots are cut on patch and ground plane. Width of the slots is 0.67mm. The bottom view of the antenna is shown in Fig. 3.

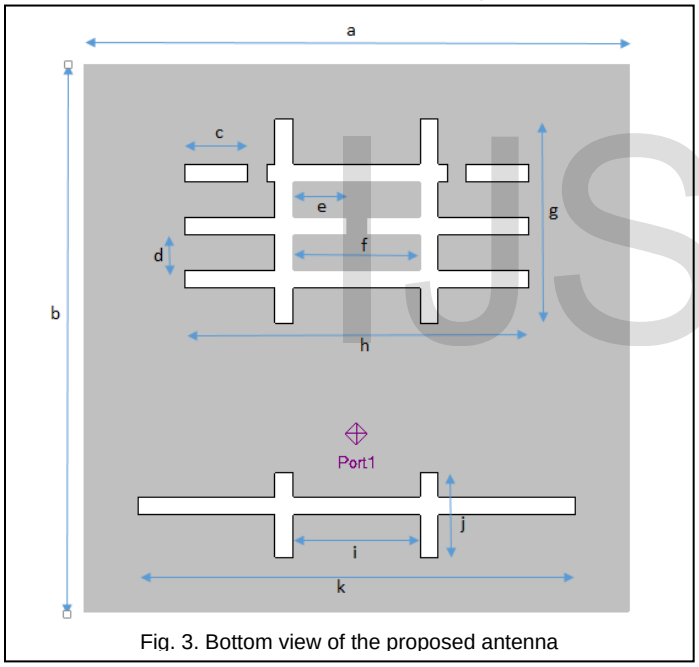


Fig. 3. Bottom view of the proposed antenna

The dimensions of the ground plane are given bellow in the Table 1.

Sl. No.	Parameters	Value in mm
1	a	20
2	b	20
3	c	2.28
4	d	1.29
5	e	2
6	f	4.67
7	g	7.45
8	h	12.58
9	i	4.67
10	j	308
11	k	16

Table 1

In the patch multiple numbers of triangular and rectangular slots are cut. The dimensions are givens in the Table 2.

Sl. No.	Parameters	Value in mm
1	l	12.60
2	m	5.8
3	n	5.83
4	o	1.29
5	p	2.63
6	q	7.67
7	r	0.74
8	s	0.42
9	t	3.75
10	u	2.6
11	v	2.46
12	w	5.32
13	x	14
14	y	14

Table 2.

The top view of the antenna is shown in Fig. 4.

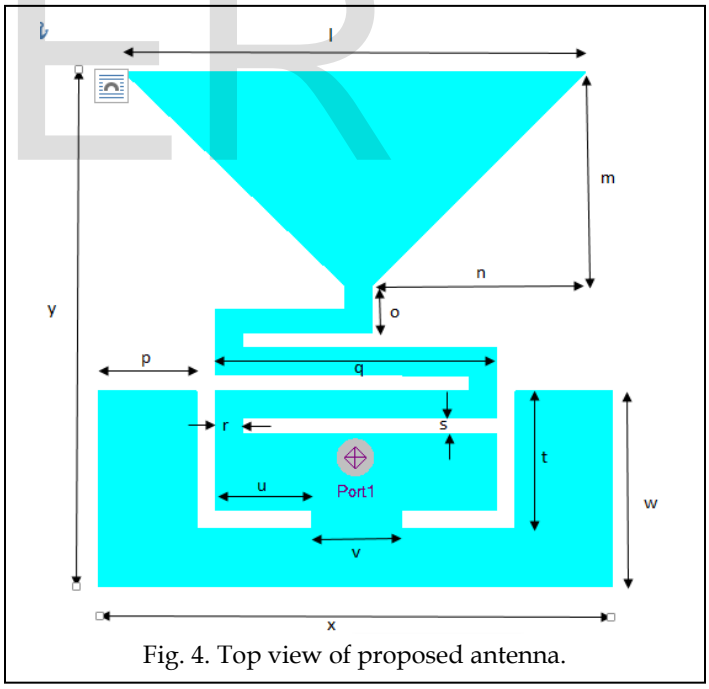


Fig. 4. Top view of proposed antenna.

4 Simulated Results

The antenna is simulated and analyzed by using Ansoft Designer Nexxim Version 2.2. The graph of reflection coefficient Vs frequency is plotted in Fig. 5. From the graph we have

found that the antenna is resonating at 4.29GHz having %bandwidht of 27.97% (5.26GHz - 4.06GHz). Fig. 6 shows the gain Vs Frequency plot. Gain of the proposed antenna at the resonance frequency is 1.26dBi.

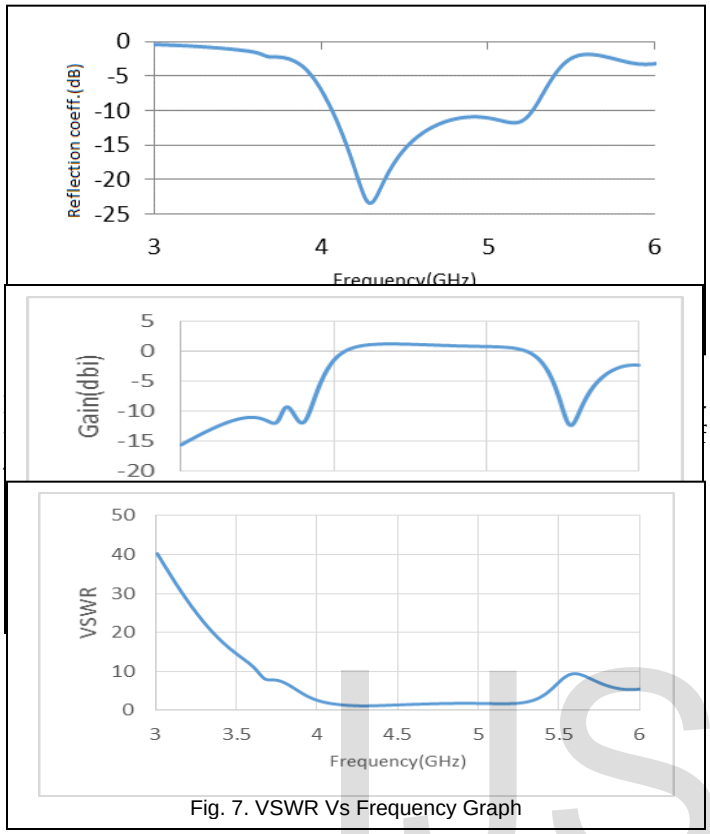
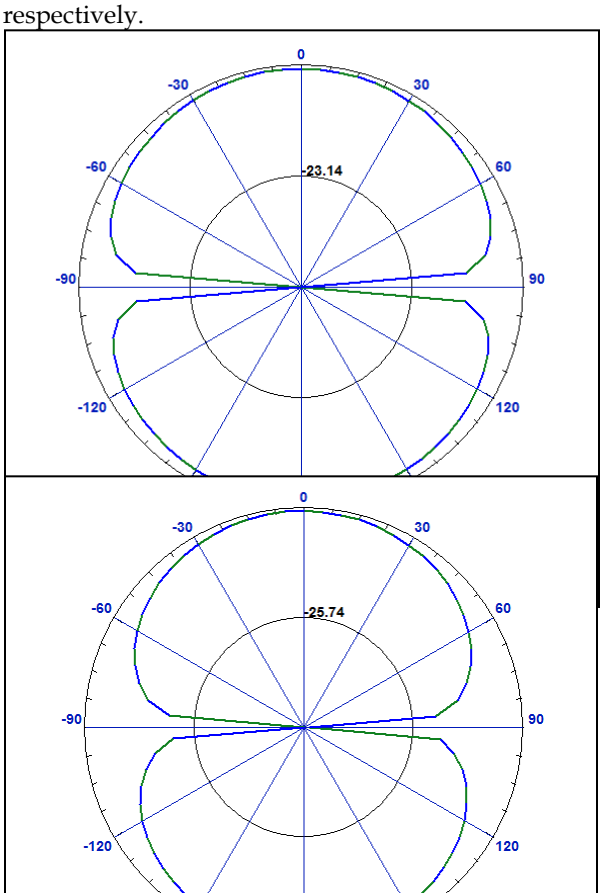


Fig. 7. VSWR Vs Frequency Graph

2D radiation pattern of antenna represents power radiating in different direction for specific values of φ. The Fig. 8 and Fig. 9 show the radiation pattern at *f*=4.29GHz for φ=0° and φ=90° respectively.



5 CONCLUSION

In this paper the bandwidth of the microstip patch antenna with 50Ω coaxial feed has been enhanced by cutting multiple numbers of slots in patch and ground plane. The enhanced bandwidth of the designed antenna is 1.2GHz (27.97% fractional bandwith), resonating at 4.29GHz. The operating frequency range of the antenna is 5.26-4.06GHz and gain (1.26dBi). This antenna may be used in C Band communication systems.

6 ACKNOWLEDGMENT

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