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RECONFIGURABLE PATCH AND GROUND PLANE MICROSTRIP ANTENNA TO ENHANCING BANDWIDTH

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ABSTRACT

In this paper the reconfigurable patch and ground plane used as a technique for enhancing band width of microstrip antenna, traditional rectangular patch microstrip antenna is used as a comparison for result with the proposed antenna design. The design is a periodic structure on patch with defected ground plane to allow the surface wave and multi modes are excited. The result is simulated using HFSS. The bandwidth of the traditional rectangular patch antenna is about 0.13 GHz, while the proposed antenna gives us about 0.92 GHz. The proposed antenna can be used in the C-band wireless communication.

Keyword: bandwidth enhancement, reconfigurable antenna, microstrip antenna, C band.

INTRODUCTION

Microstrip is a tool to transmitting and receiving an electromagnetic energy from sufficient source. This device is a composite material consist of two different material differ by its constitutive parameters dielectric constant, permeability and conductivity. The structure of antenna contain substrate of dielectric constant in the range of 2 to 16 [1], sandwiched by tow conductors surface. The top surface is patch and the other is called ground plane, as shown in Figure-1.

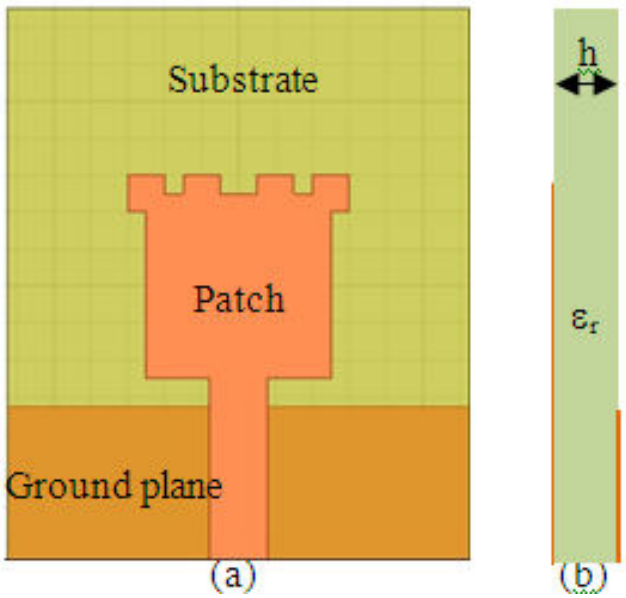

Figure-1. Microstrip antenna (a) top view and (b) side view.

The main disadvantage of this type of antenna is narrow band width, patch antennas have a very high antenna quality factor (Q). Q represents the losses associated with the antenna and a high Q results in narrow bandwidth and low efficiency. The microstrip antennas are often realized with bandwidth of the order of 1% to 5%, the bandwidth is defined more concisely as a percentage $(f/f_0) \times 100\%$, where f and $f_0$respectively represent the width of the range of acceptable frequencies and the resonant frequency of the antenna. For broadband antenna design the following considerations are necessary in antenna geometry.

- Larger substrate thickness or lower permittivity of the dielectric to obtain low Q.
- Feed impedance must be matched.
- Optimization of patch geometry.
- Suppression of surface waves in a thick substrate.

Height of substrate effect on the return loss efficiency, while the width of the patch effected directly on the resonant frequency, the effect of the thicker substrate is study from many researchers using different substrates for several applications in the communication using different height and of substrate and varying the height to get improvement in the bandwidth with different patch shapes such as rectangular, circular, fractal and other [2-5]. In the technique of optimizing of patch geometry, reconfigurable, the bandwidth is achieved by introducing the metamaterial phenomena instead of the single patch antenna, metamaterial is used for enhance the parameters of microstrip patch antenna. Metamaterials are artificially structured to have properties which are not found in nature. They are built by periodically arranging unit cells and these unit cells are contain small metallic resonator which interact with external electromagnetic wave [6-11]. Reconfigurable antenna have advantages when compared with the conventional antennas, it provides diversity feature of radiation pattern, frequency and polarization which used in various application in the same time improving bandwidth and gain [12].

In this paper we present new proposed antenna mixed between reconfigurable patch and ground plane to achieved wide band width for C-band applications.

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ANTENNA DESIGN

Proposed antenna is designed on the FR4 substrate with dielectric constant $\varepsilon_r = 4.4$ and tangent loss of $\tan\delta = 0.02$, with height of 1.6 mm. the dimensions of the substrate are W_s=80 mm and L_s=60 mm. Patch dimension are 50×50 mm^2, as shown in Figure-2.

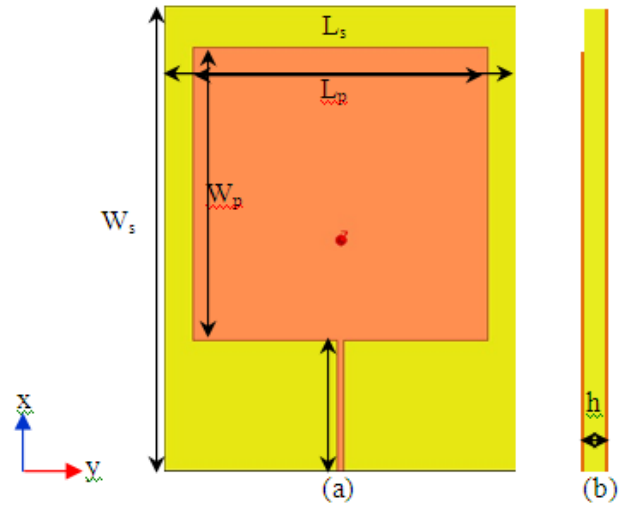

Figure-2. Rectangular patch microstrip antenna (a) top view and (b) side view.

The proposed antenna is consist of reconfigurable patch which is consist of periodic structure of unit cell of co-cantered circles and + sign as shown in Figure-3.

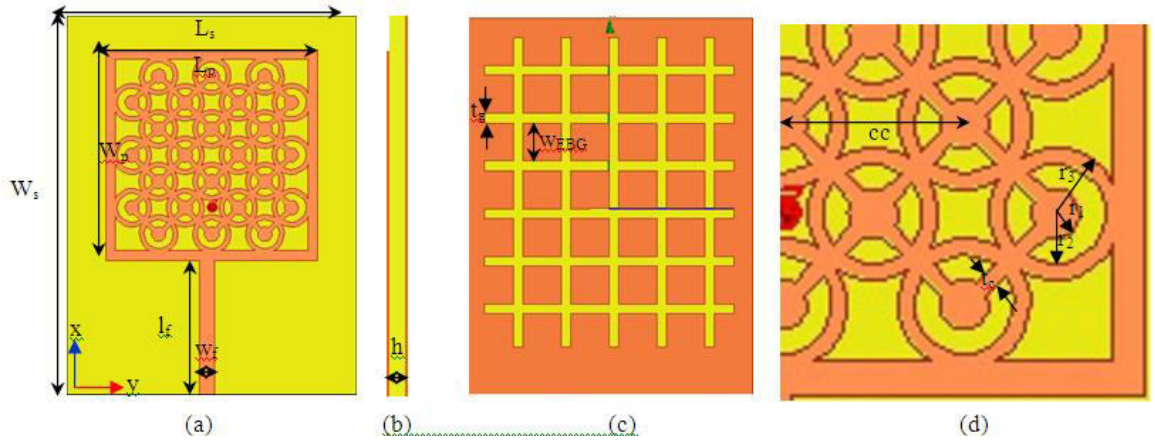

Figure-3. Reconfigurable patch and ground plane Microstrip antenna (a) top view, (b) side view, (c) ground plane and (d) unit cell.

The dimensions of the proposed antenna are depicted in the Table-1.

Table-1. The dimensions of the proposed antenna (all dimensions in mm).

Parameter	Value	Parameter	Value	Parameter	Value	Parameter	Value	Parameter	Value
W_s	80	W_p	40	w_f	3	t_g	2	r_1	1.5
L_s	60	L_p	40	l_f	29	w_g	8	r_2	3
r_3	4	H	1.6	t_c	1	Cc	11	w_{EBG}	8

The result done by High Frequency Structure simulation HFSS based on the finite element method as simulation tool to calculate the antenna performances such as return loss, radiation pattern and gain.

RESULTS

The conventional rectangular patch microstrip antenna as shown in Figure-2 is simulating via HFSS to get the performance such as return loss and radiation pattern. Figure-4 shows the return loss of the antenna in the range of the C-band from 6-8 GHz.

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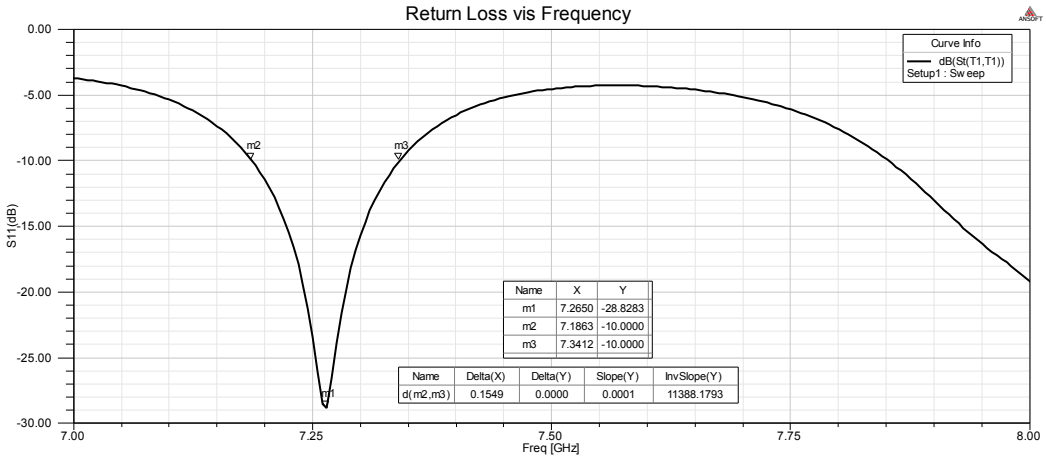

Figure-4. Return loss (S_{11}) vis. frequency for rectangular patch microstrip antenna.

As shown from the figure above the resonant frequency of good impedance matching about -20 dB with bandwidth 155 MHz is about 2.1%. The radiation pattern at the resonant frequency is illustrated in Figure-5.

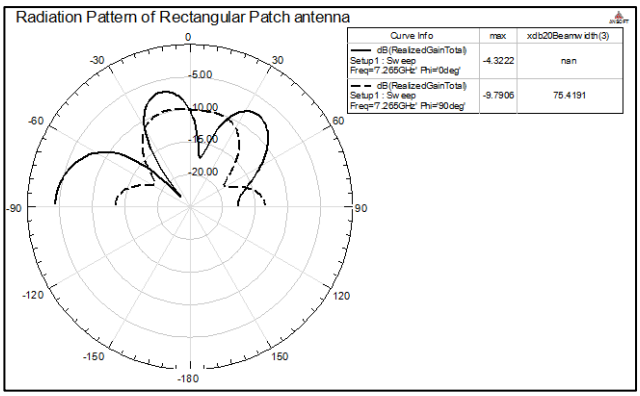

Figure-5. Radiation pattern of the rectangular patch microstrip antenna.

From the previous figure the maxima of E- and H-plane are -4.2 dB and -5.1 dB respectively with directivity of 14.2 dB. In case of improving bandwidth the proposed antenna is introduced by reconfigurable both of the conductor sides of the microstrip antenna patch and ground plane as shown in Figure-3. The dimension of the proposed antenna is depicted in table 1; the return loss of the proposed antenna is illustrated in the Figure-6. As shown from the figure 6 the bandwidth is improved with the new technique, the bandwidth is about 920 MHz with 12.7% with increased by 10%. The difference is significant by compare this result with the conventional antenna. This increase is due to allow more modes to be excited by introducing many small resonators as a hole patch. Figure-7 show the result of the radiation pattern at 7.265 GHz for the proposed antenna. To show the enhancement in the bandwidth by introducing the new technique we present the graph gathering two graph. It's clear to show that the improvement is significant as shown in Figure-8. As shown from Figure-7 the gain is improved compared with Figure-5.

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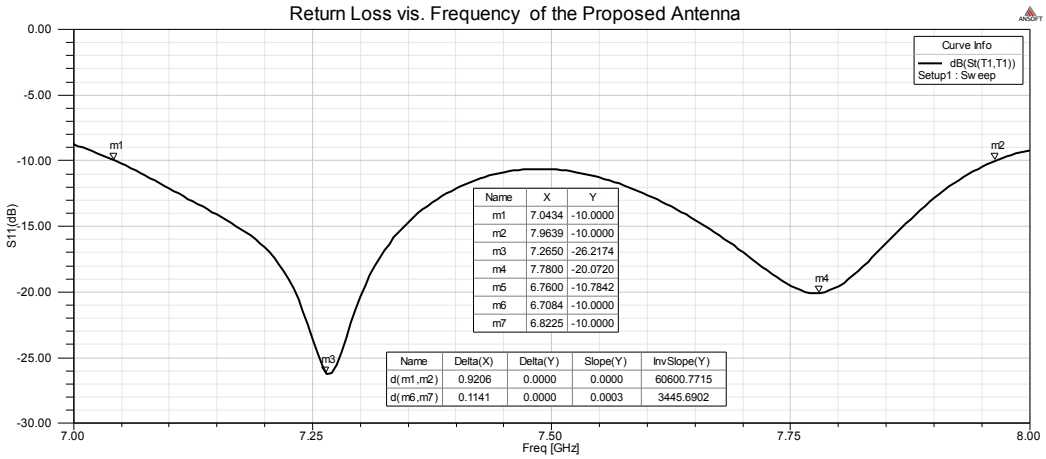

Figure-6. Return loss (S_{11}) vis. frequency for proposed antenna.

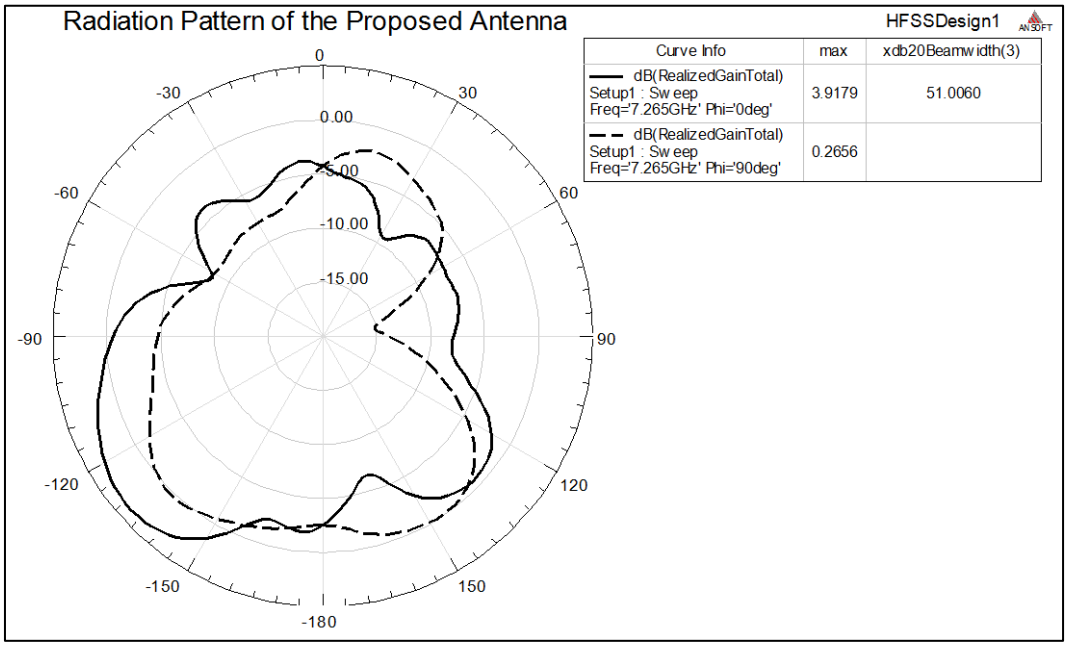

Figure-7. Radiation pattern of the proposed antenna.

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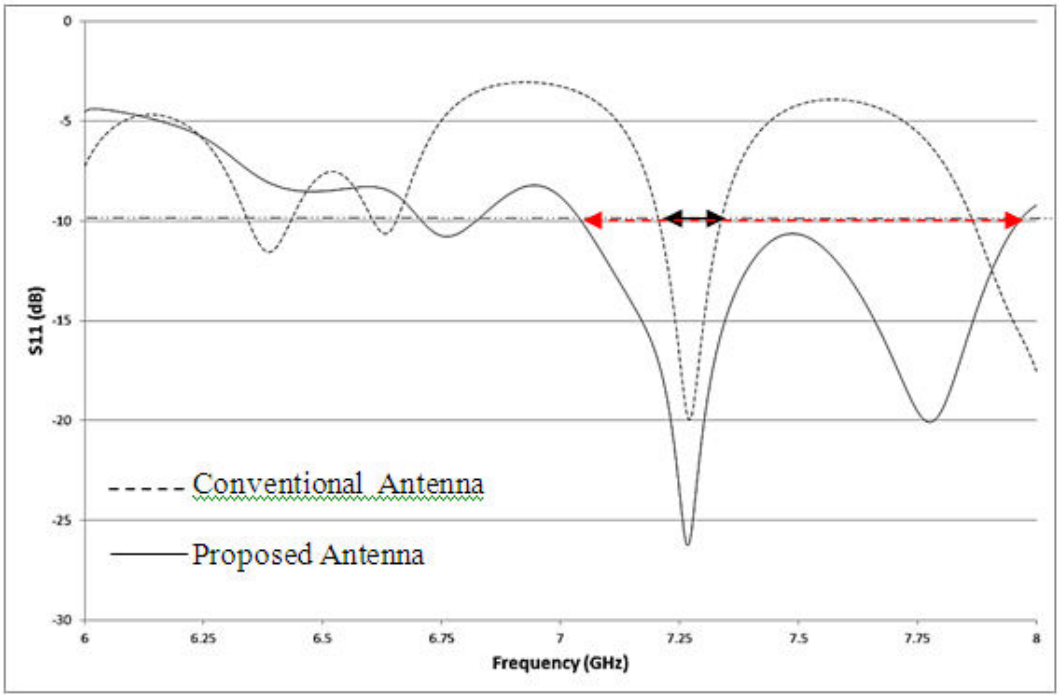

Figure-8. Return loss (S_{11}) vis. frequency for conventional and proposed antennas.

CONCLUSIONS

In this paper we present the technique of optimizing patch and ground plane of the rectangular patch microstrip antenna to improving the antenna performance we examine which is the bandwidth of antenna and we conclude that the technique is increased both bandwidth and gain as compared between Figure-5 and Figure-7. This antenna can be used for the wireless communication in the C-band applications.

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