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# Design of Microstrip Patch Antenna Array With Unslotted and U-slotted Fractal UC-EBG Structure

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ABSTRACT

In recent years, Antenna and wireless communications have attracted much interest in the academic and industrial worlds. In this paper, the design of microstrip patch antenna array with isolation by using U-slot two decoupling structures including a row of fractal uniplanar compact electromagnetic bandgap (UC-EBG) structure and three cross slots is proposed. Radiating patch lies on the Roger RO3010 which is having high dielectric constant of 10.2 and loss tangent of 0.003.By changing the structure dimensions and the substrate materials, different bandgap characteristics can be obtained. The proposed antenna is fed with coaxial probe. The simulation results shows that the significant improvement in isolation of -30.28 dB and -30.94 dB is obtained by placing the proposed fractal UC-EBG structure between the two U-slotted radiating patches. The proposed antenna enhances the return loss of -10.61 dB at the 6 GHz and -15.57 dB at 9.2 GHz frequencies. The obtained frequency is useful for C and X band applications. The proposed antenna were designed and simulated by using ANSYS HFSS (version 15.0).

## 1. INTRODUCTION

Microstrip antenna became very popular in the today worlds of wireless communication system. They are used for government and commercial applications to transfer the information from one place to another [1]-[2]. Microstrip antenna basically consist of a substrate radiating patches and ground [3]. Often the microstrip antennas are also called as patch antennas. The ground plane is placed at the bottom of the substrate and the two radiating patches and the feed lines are usually photoetched on the dielectric substrate [4].

Microstrip patch antennas are required for smart features such as low profile, light weight, low cost, high efficiency [5]. The two rectangular patches are most widely used configurations, due to suffer from the narrow bandwidth. Isolation improvement in antenna array poses complicated result in the antenna community. In antenna arrays, multiple antenna elements operate to designed at the same frequency to a common substrate, so that mutual coupling occurs and also it reduces the antenna gain, bandwidth and radiation efficiency [6].

In this paper, design of microstrip patch antenna array with fractal UC-EBG structure and u-slot is presented. First, unslotted fractal UC-EBG microstrip patch antenna and three cross slots is analyzed and the U-shaped slot is cut in the microstrip patch antenna [7]. A row of fractal UC-EBG structure and U-slots as the decoupling structures applied in the antenna array are proposed to improve isolation of the antenna array significantly. Also, the spacing between the two patch elements is obviously reduced [8].

Finally, the measured results show that the isolation is 30.28 dB and -30.94 dB with in the operating bandwidth [9]. The objective of this work is to design and developed U-shaped microstrip patch antenna, which can work both the frequencies as 6 GHZ and 9.2 GHZ enhances the return loss of -10 dB. The obtained frequency is useful for C and

X band applications such as Wi-fi, Wi-max and aircraft, spacecraft, RADAR applications. The proposed antenna were designed and simulated by using ANSYS HFSS (version 15.0) simulation software.

## 2. ANTENNA DESIGN AND CONFIGURATIONS

The concrete shape of the proposed UC-EBG unit cell structure is shown in the Fig 1. The fractal UC-EBG structure is placed on the Moore curve. The total length of the unit cell are ensured, the specific values like line width y and the spacing between the lines x can be determined.

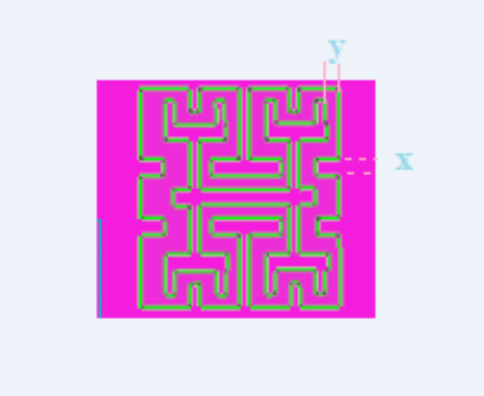



Fig :1. Geometry of the fractal UC-EBG unit cell

### *2.1. Unslotted fractal UC-EBG structure*

To analyze the performance of the unslotted fractal UC-EBG, an antenna array (1×2) is presented. The substrate with a high dielectric constant of 10.2,loss tangent of 0.003 is employed in the antenna array. The geometry of the antenna array with the unslotted fractal UC-EBG structure is shown in the fig.2. Two rectangular patch antennas are placed on the top of 1mm thick substrate. Meanwhile, the unslotted fractal UC-EBG structure is placed in the middle of two patch elements consist of three unit cells. The antenna array has a compact size of 31×50mm2.The separation between two patches at final design parameters optimized for the antenna array with the unslotted fractal UC-EBG structure are as follows: a=17.6mm, b=17mm, x=0.4mm, y=0.7mm, z=8.4mm. In contrast to the array with the unslotted fractal UC-EBG, the reference array only consists of two radiating patches.

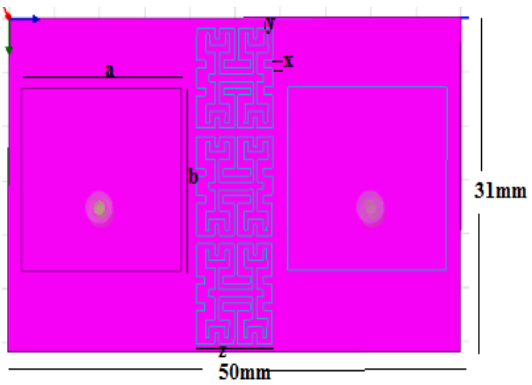



Fig.2. Unslotted fractal UC-EBG structure

### *2.2. Modified U-slot microstrip patch antenna*

In order to further enhance isolation in the array with unslotted and U-slotted fractal UC-EBG and three cross slots are proposed. The proposed structure can effectively reduce the mutual coupling. These U-slots are cut from the two patches of the UC-EBG structure.

Substrate selection is the first practical step in designing a patch antenna. Rogers RO3210(dielectric constant=10.2 and loss tangent=0.003mm) is used as substrate to design the proposed modified U-slot microstrip patch antenna. The main reason for this is that three cross slots and U- slot as to reduce the mutual coupling and increases the isolation. To feed a coaxial probe is used in this techniques.

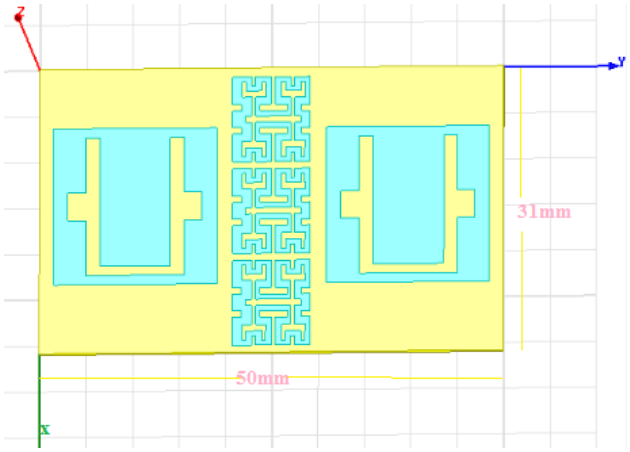



Fig.3.Modified U-slot microstrip patch antenna

### *2.3. Results and discussion*

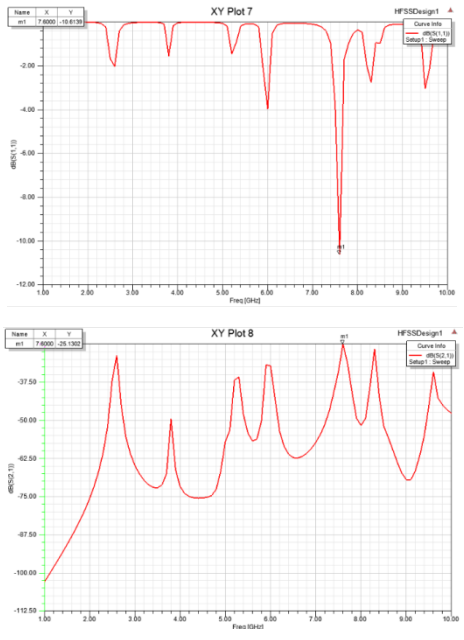



Fig. 4. (a) Simulated result of return loss for unslotted fractal UC-EBG (b) Simulated result of isolation for unslotted fractal UC-EBG

Utilizing HFSS (High Frequency Structure Simulator) the proposed design of antenna has been simulated and obtained some results. Three parameters are obtained which are return loss, frequency and radiation pattern by simulation process of unslotted and u-slotted microstrip patch antenna with fractal UC-EBG structure.

Firstly, unslotted patch with UC-EBG is analyzed. In which, the simulation results at unslotted patch with UC-EBG are performed by the two dielectric patches on the metallic substrate. In addition, the measured and simulated results between the two port is better than -10dB with the return loss is -11.06dB in the frequency range of 7.6GHz. Fig 4. (a),(b) shows the results at S11,S21 and radiation pattern of unslotted microstrip patch with UC-EBG structure.

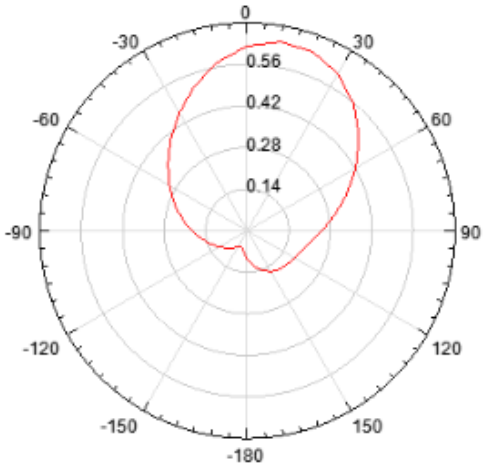
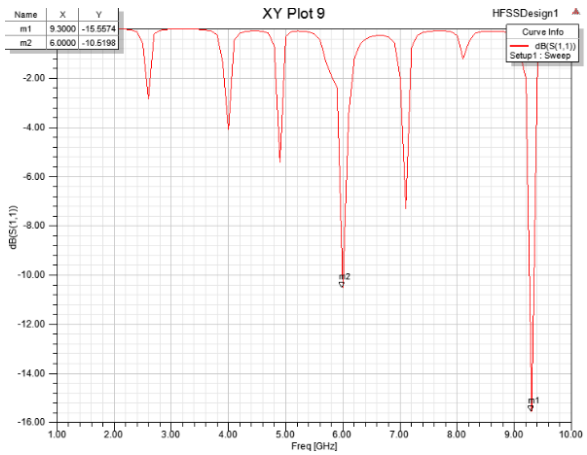



Fig. 4. (c) Radiation pattern of unslotted fractal UC-EBG

U-shaped slot is cut in the microstrip patch antenna with UC-EBG structure at different return loss was obtained in the fig.5 (a). The optimized U-slotted microstrip patch antenna resonant at 6 GHz and 9.2 GHz frequency with the return loss is -10.61 dB and -15.57 dB respectively in the fig 5(b).




(a)

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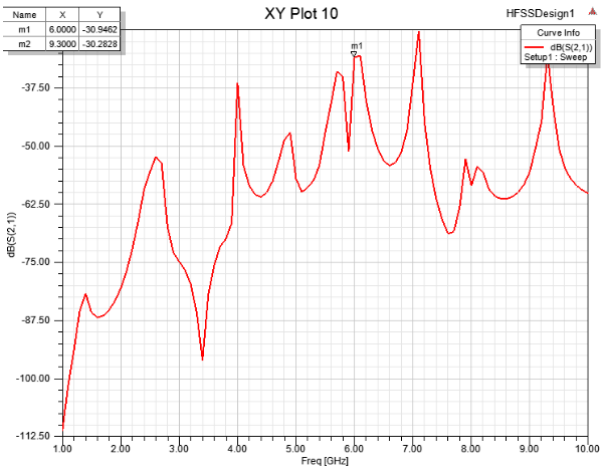


(b)

Fig. 5. (a) Simulated result of return loss for unslotted fractal UC-EBG(b) Simulated isolation of the unslotted fractal UC-EBG

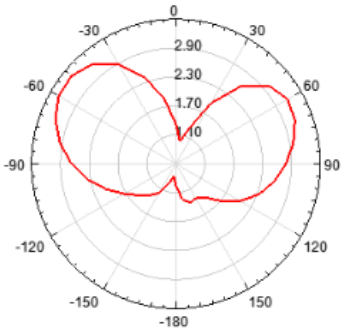


Fig. 5(c). Radiation pattern for U-slotted MSA

Fig 5(a),(b),(c)shows the results at S11,S21 and radiation pattern of U-slotted MSA with UC-EBG structure. The proposed UC-EBG with unslotted and U-slotted MSA can be easily integrated with the C and X band applications.

## 3. CONCLUSION

A fractal UC-EBG structures and three cross slots are based on the Moore space filling curves has been designed. The antenna array is compact size due to the column of the fractal UC-EBG structure. Moreover the design of U-slot microstrip patch antenna is presented in this paper. The unslotted patch antenna is single band antenna and resonant at 7.6 GHz frequency with -10 dB bandwidth. By making U-slot in the patch, dual band response of antenna is achieved and performance of antenna also improved. The optimized U-slotted microstrip patch antenna resonant at frequencies 6 GHz and 9.2 GHz with -10 dB bandwidth respectively. The results show that the comparing of unslotted and U-slotted patch with UC-EBG to obtain the C and X band frequencies.

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