

**DESIGN OF MICROSTRIP PATCH ANTENNA ARRAY WITH UNSLOTTED
AND SQUARE-SLOTTED SPIRAL EBG STRUCTURE**L.Keerthana¹, M.Jegajothi² and T.K.Shanthi³*Department of Electronics and Communication Engineering,**^{1,2,3}Alagappa Chettiar Government College of Engineering and Technology, Karaikudi -630 003, Tamilnadu*

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 square-slot two decoupling structures including a row of Spiral 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 show that the significant improvement in isolation of -38.95 dB and -45.98 dB is obtained by placing the proposed spiral EBG structure between the two square-slotted radiating patches. The proposed antenna enhances the return loss of -12.88 dB at the 4.5 GHz and -17.29 dB at 8.8 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).

Keywords – Spiral EBG, Microstrip patch antenna

I. 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 consists 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 spiral EBG structure and square-slot is presented. First, Unslotted spiral EBG microstrip patch antenna and three cross slots is analyzed and the square-shaped slot is cut in the microstrip patch antenna [7]. A row of spiral EBG structure and spiral-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 -38.95 dB and -45.98 dB with in the operating bandwidth [9]. The objective of this work is to design and developed square-shaped microstrip patch antenna, which can work both the frequencies as 4.5 GHZ and 8.8 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.

II. ANTENNA DESIGN AND CONFIGURATIONS

The concrete shape of the proposed spiral EBG unit cell structure is shown in the Fig 1. The spiral EBG structure is placed on the Hilbert curve design. 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.

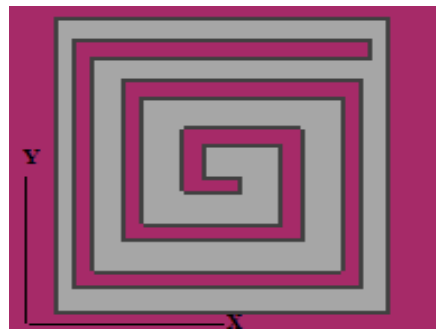


Fig. 1. Geometry of the spiral EBG unit cell

A. Unslotted spiral EBG structure

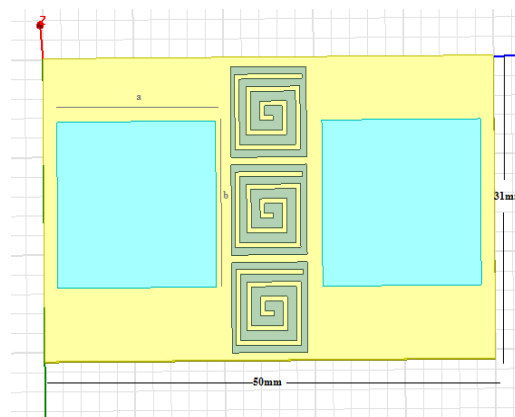


Fig. 2. Unslotted spiral EBG structure

To analyze the performance of the Unslotted spiral 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 spiral EBG structure is shown in the fig.2. Two rectangular patch antennas are placed on the top of 1mm thick substrate. Meanwhile, the unslotted spiral EBG structure is placed in the middle of two patch elements consist of three unit cells. The antenna array has a compact size of $31 \times 50 \text{ mm}^2$. The separation between two patches at final design parameters optimized for the antenna array with the Unslotted spiral EBG structure are as follows: $a=17.6 \text{ mm}$, $b=17 \text{ mm}$, $x=0.4 \text{ mm}$, $y=0.7 \text{ mm}$, $z=8.4 \text{ mm}$. In contrast to the array with the unslotted spiral EBG, the reference array only consists of two radiating patch.

B. Modified square-slot microstrip patch antenna

In order to further enhance isolation in the array with unslotted and square-slotted spiral EBG and three cross slots are proposed. The proposed structure can effectively reduce the mutual coupling. These square-slots are cut from the two patches of the spiral 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 square-slot microstrip patch antenna. The main reason for this is that three cross slots and square slot as to reduce the mutual coupling and increases the isolation. To feed a coaxial probe is used in this technique.

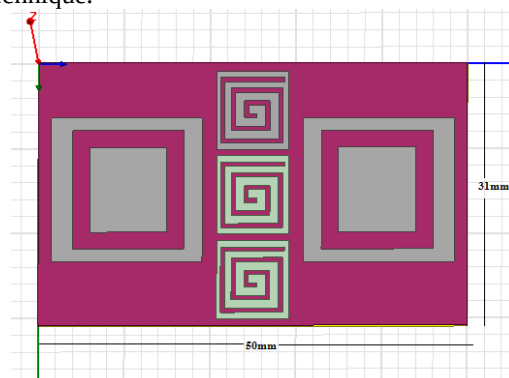


Fig. 3. Modified square-slotted microstrip patch antenna

III. RESULTS AND DISCUSSION

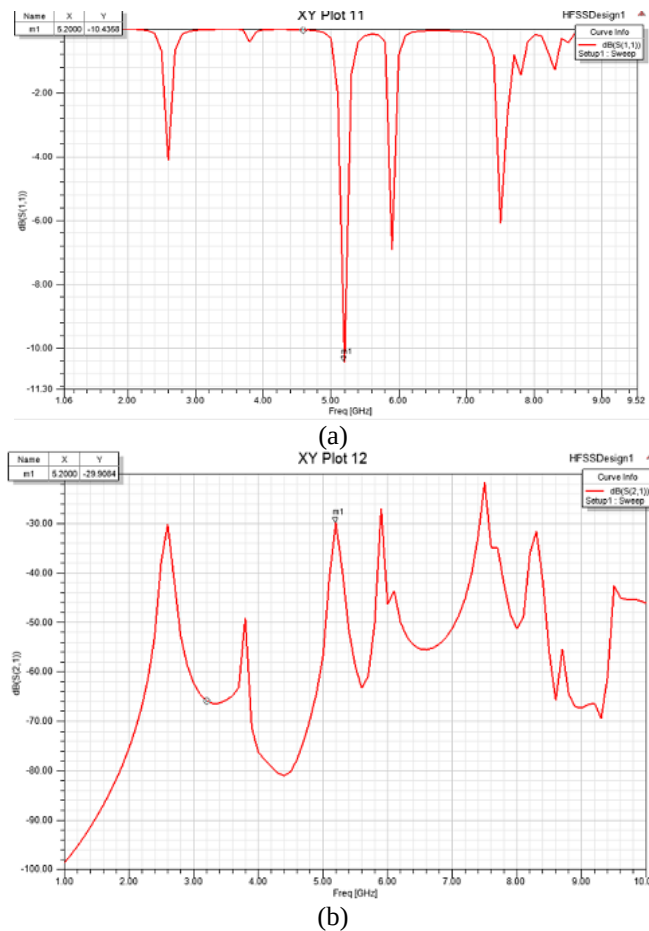


Fig. 4. (a) Simulated result of return loss for Unslotted spiral EBG (b) Simulated result of isolation for Unslotted spiral EBG

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 square-slotted microstrip patch antenna with spiral EBG structure.

Firstly, unslotted patch with spiral EBG is analyzed. In which, the simulation results at unslotted patch with spiral 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 in the frequency range of 5.2 GHz. Fig 4(a), (b), (c) shows the results at S_{11} , S_{21} and radiation pattern of unslotted microstrip patch with spiral EBG structure.

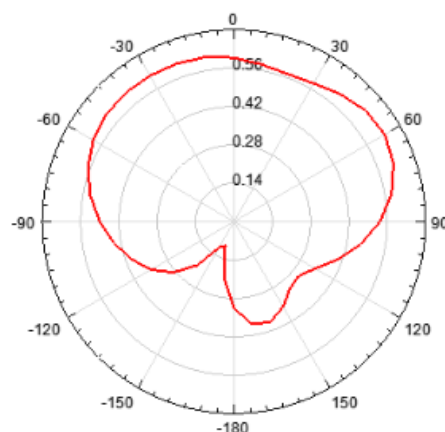


Fig. 4.(c) Radiation pattern of square slotted spiral EBG

Square-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 square-slotted microstrip patch antenna resonant at 4.6 GHz and 8.8 GHz frequency with the return loss is -12.88 dB and -17.29 dB respectively in the fig 5(b).

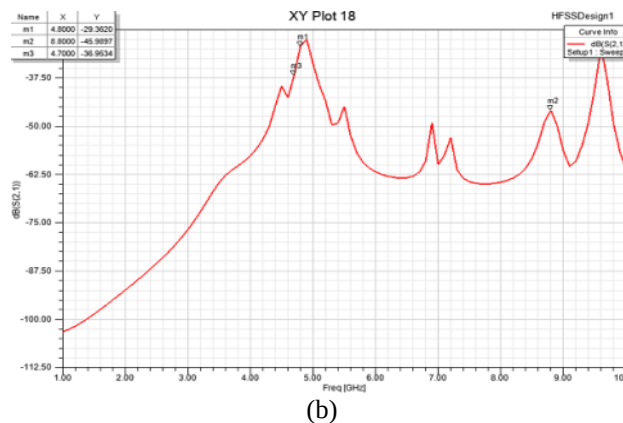
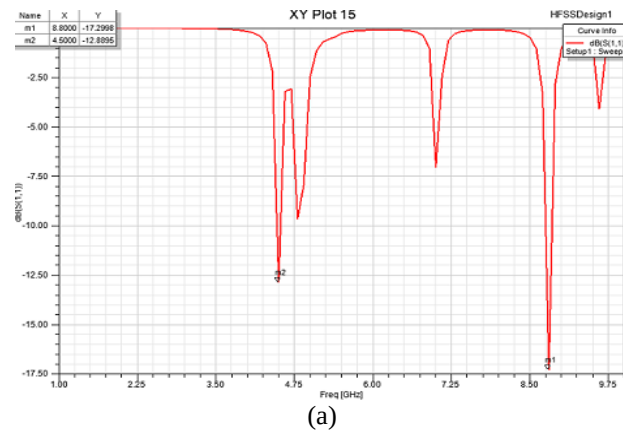


Fig. 5. (a) Simulated result of return loss for square slotted spiral EBG (b) Simulated isolation of the square slotted spiral EBG

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

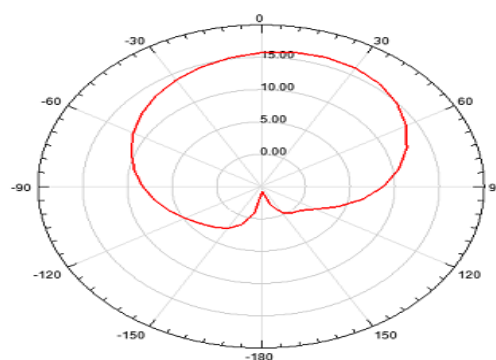


Fig. 5(c). Radiation pattern for square slotted MSA

IV. CONCLUSION

A spiral EBG structures and three cross slots are based on the Hilbert space filling curves has been designed. The antenna array is compact size due to the column of the spiral EBG structure. Moreover the design of square slot microstrip patch antenna is presented in this paper. The unslotted patch antenna is single band antenna and resonant at 5.2 GHz frequency with -10 dB bandwidth. By making spiral slot in the patch dual band response of antenna is achieved and performance of antenna also improved. The optimized square slotted microstrip patch antenna resonant at frequencies 4.5 GHz and 8.8 GHz with -10 dB bandwidth respectively. The results show that the comparing of unslotted and square slotted patch with spiral EBG to obtain the C and X band frequencies.

REFERENCES

- [1] "Antenna theory and Analysis and Design" Constantine A. Balanis, third edition -2005.
- [2] Swarajpanusa, Mithileshkumar, "Design and analysis of triple band F-slot microstrip patch antenna", International journal of computer applications, vol04, Oct 2014.
- [3] Shilpak Jose, Dr.S.Suganthi "rectangular microstrip patch antenna for wireless applications", IEEE 2015.
- [4] C.A.Balanis "Antenna Theory, Analysis and Design", John Wiley & sons Inc. u.k. 2013.
- [5] Bind K. Kanajia, Sachinkumar, Mukesh K. Khandelwal and A.K. Gautham "Single feed L-slot microstrip patch antenna for circular polarization", Springer 2015.
- [6] "Isolation enhancement in Microstrip patch antenna arrays", I. Malartamil prabha, R. Gayathri, IJOOTS-2014.
- [7] "Hexagonal shaped slotted microstrip patch antenna", Tanjgarge IJESC 2016.
- [8] "Isolation enhancement in patch antenna array with fractal UC-EBG structure and cross slot", Xuyang, Yingliu, senior member, IEEE, Yun-Xuexu & Shu-xigong, Member, IEEE 2017.
- [9] "Design and simulation Eu slot position of rectangular microstrip patch antenna for broadband applications" G. Aswankumar, I.B.A. Sarath 2016 IJESC.
- [10] "Numerical analysis of slot position of rectangular U-slot microstrip patch antenna" Harleenkaur, Balwinder Singh Dhaliwal 2016.