European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 7, Issue 4, 2020

Design and Implementation Of EBG Antenna Structure Using Aperture Coupled Feeding Technique For C- Band Applications

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Abstract. In this paper it has been described that electromagnetic band gap (EBG) structure design is applied in the antenna structure in order to enhance the performance of the antenna especially for improving the gain and radiation pattern. Microstrip patch antenna is used due to the advantages such as unchallenging and economically viable fabrication, light weight, low profile and can easily integrated with microwave circuit. This project involves the study of simulation results and fabrication process of EBG structure in the microstrip patch antenna using aperture coupled feeding technique . The simulation is done by using microwave Studio suite CST. From the simulation process, the designed microstrip EBG antenna shows considerable enhancement in performance in terms of radiation pattern, gain and return loss, S11 and works in the frequency range of 5.4GHz to 6.9GHz. Improvement in the mutual coupling is also shown in the designed aperture coupled microstrip EBG antenna and thus makes it suitable for wide angle scanning active phased array antenna. Other than that, the EBG structure also can be applied as a band reject especially for ultra wide band application which operates at very wide frequency ranges. By using aperture coupled microstrip EBG antenna of this design the overall gain performance is improved.

Keywords: EBG structure, aperture coupled feeding technique, return loss, gain performance, efficiency

1. Introduction

The research and development in the field of electromagnetic band gap (EBG) structure is booming in the antenna community. The unique property of this structure is its ability to suppress the propagation of surface wave in specific operating frequency defined by the EBG structure itself. The electromagnetic band gap structure is applied in the antenna structure in order to elevate the performance of the antenna especially to maximize the gain and radiation pattern. In this project, microstrip antenna concept is applied because it is unchallenging and is economical during fabrication, gauzy weight, low profile and can easily integrated with microwave circuit. In this project various EBG structure and the integration of the EBG structure with various antenna design is studied through the simulation and fabrication process. The simulation is done using CST software. In the fabrication process the photo etching technique is applied and the antenna fabrication is done using FR4 board as substrate which has relative permittivity 4.7 and tangent loss 0.019. The designed EBG structure is simulated and it is found to work in the frequency range of 5.4GHz and 6.9GHz. The designed antenna can be used in various C band applications.

There is humungous industrial demand in the field of wireless communication system and the miniaturization of those wireless systems, therefore antenna design becomes more challenging. Satellite communications, aerospace, radars, biomedical applications and reflector feeds widely use microstrip patch antennas, due to its inherent characteristics such as light weight, low profile, economically viable, mechanically robust, compatibility with integrated circuits. They also suffer from certain setbacks such as narrow bandwidth, low gain and excitation of surface waves, etc. These drawbacks limit their applications in other fields.

2. Antenna Configurations and Design Aspects:

The proposed aperture coupled EBG microstrip patch antenna is shown in figure 1. The antenna consists of top layer, bottom layer and the ground plane. The dimension of top layer and bottom layer is 27.50*27.50mm. The dimension of radiating patch on the top layer is 8.50mm which is etched in all the four corners with an arc of radius 3.54mm. The ground plane is situated in the middle of top and bottom layer with the dimension of 27.50*27.50mm containing a linear aperture slot in the middle. The feed line is given on the back of the bottom layer. The micro strip feed of 50ohm is excited using SMA connector.

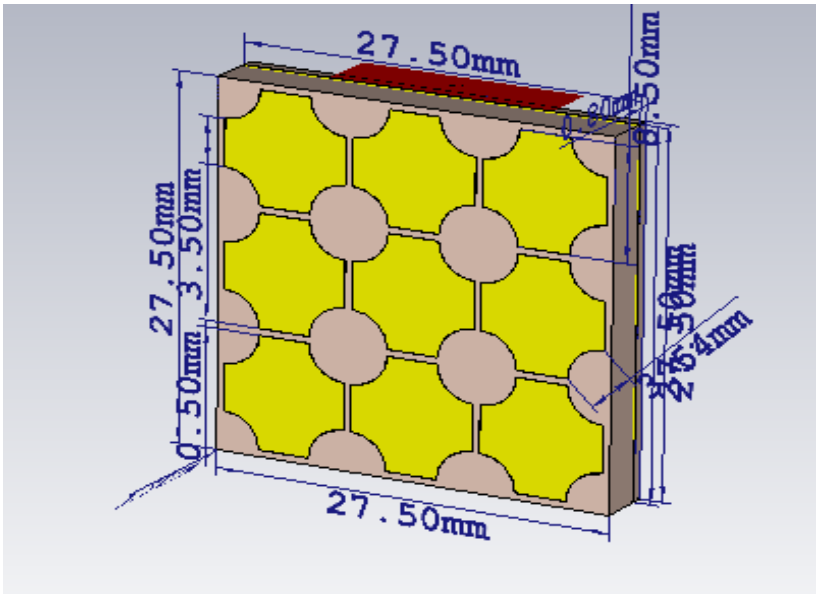

Fig 1: EBG aperture coupled antenna

The top and bottom substrate is made of dielectric material called FR-4 which has a dielectric constant of 4.7. The thickness of the substrate is 3.2mm. The radiating patch is made of copper which has a thickness of 0.0354mm. The same copper patch is used in the ground plane also.

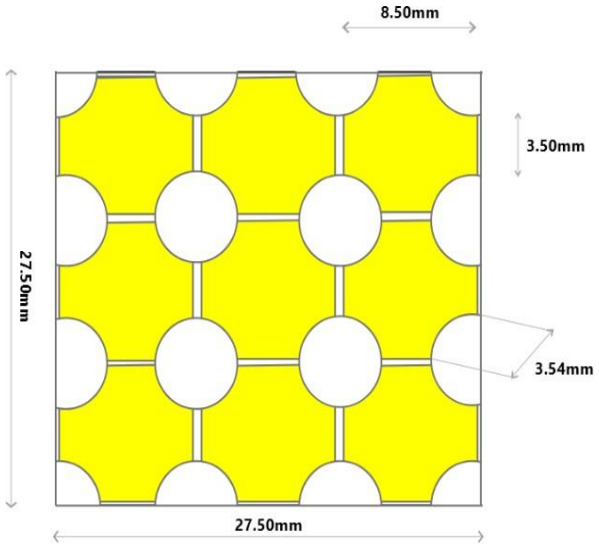

Fig 2**:**Layout of top substrate

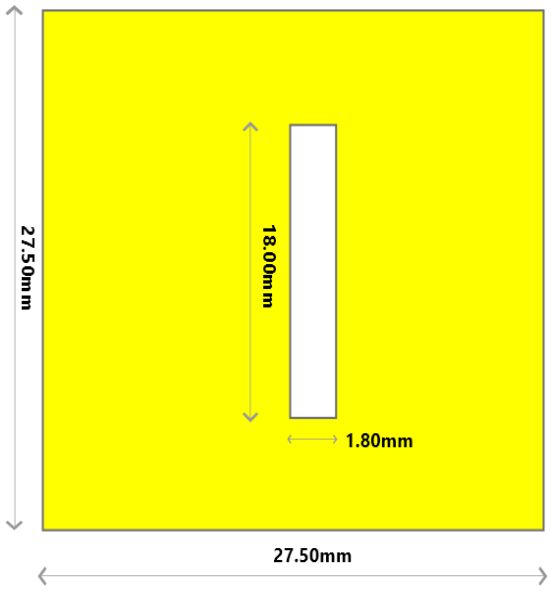

Fig 3: Layout of Ground plane

The top layer is shown in figure 2, the ground plane is displayed in figure 3 and the bottom layer is displayed in figure 4. The ground plane consists of a liner aperture slot of dimension 1.80*18 mm which is etched in the middle of the ground plane. The bottom layer consists of a feed line of dimension 1.51*21.40 mm which is made of copper to maintain a characteristic impedance of 50 ohm.

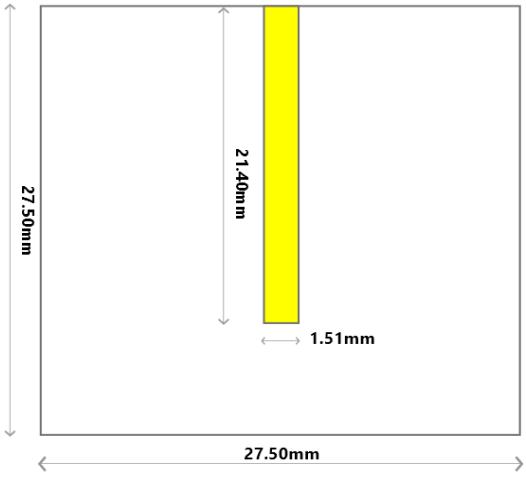

Fig 4: Layout of bottom layer

3. Simulation Results

The designed aperture coupled EBG microstrip patch antenna is simulated using Computer Simulation Software (CST) Microwave Studio antenna design software. The simulated results show that the designed antenna works at the frequency of 5.4 GHz and 6.9 GHz with the return loss of -25.34 dB and -26.4 dB as shown in figure 5.

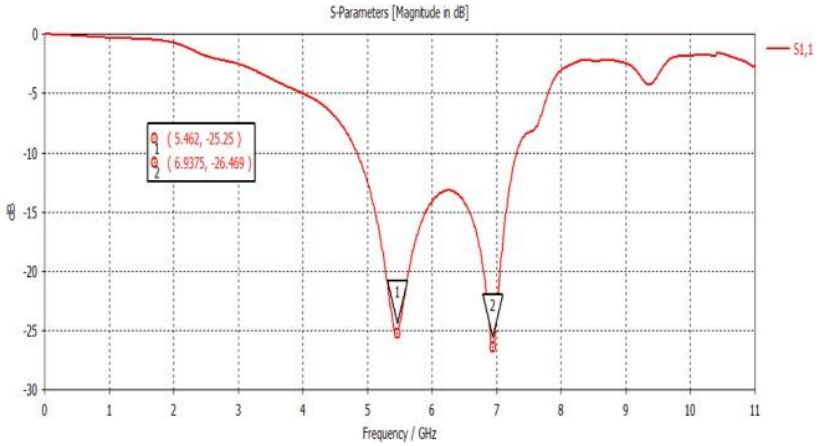

Fig 5: Return loss of EBG Patch antenna

The VSWR of the designed antenna is found to be at 1.11dB and 1.01dB for the frequencies 5.4GHz and 6.9GHz.The VSWR result is shown in figure 6.

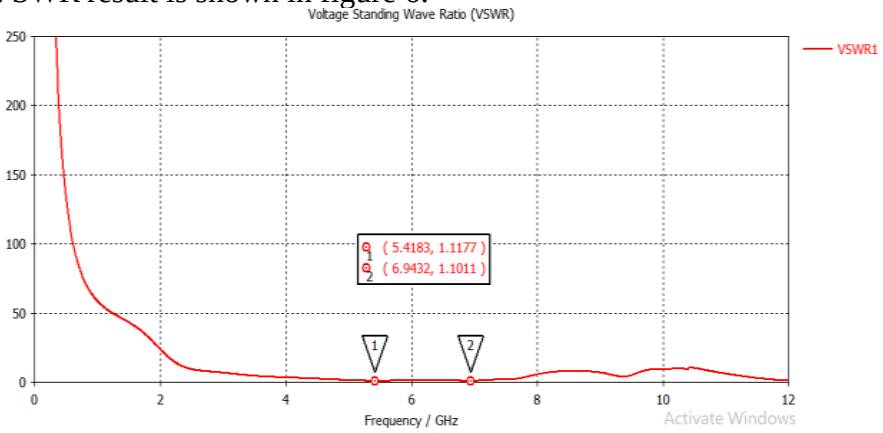

Fig 6: VSWR of EBG Patch antenna

The gain and directivity of the designed antenna is measured and is displayed in the following figures,

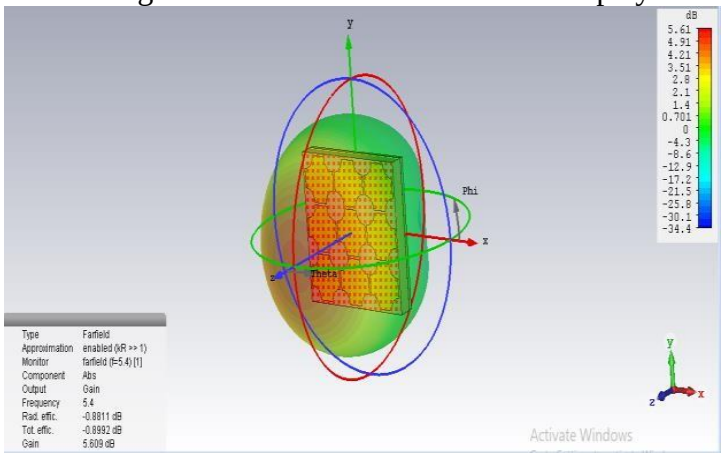

Fig 7: Gain at frequency 5.4 GHz

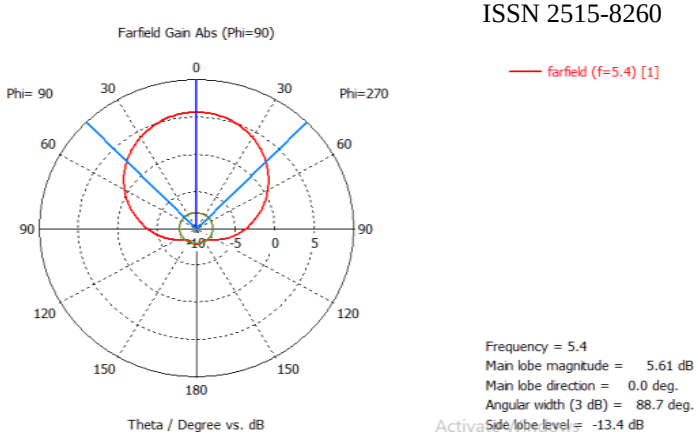

Fig 8: Polor plot of gain at 5.4GHz

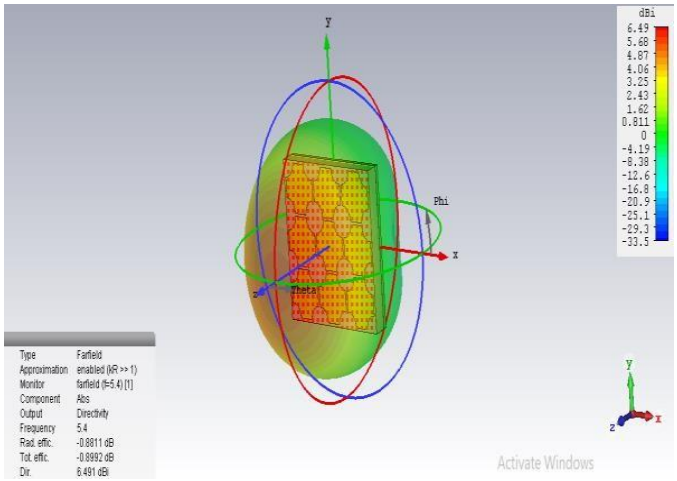

Fig 9: Directivity at frequency 5.4 GHz

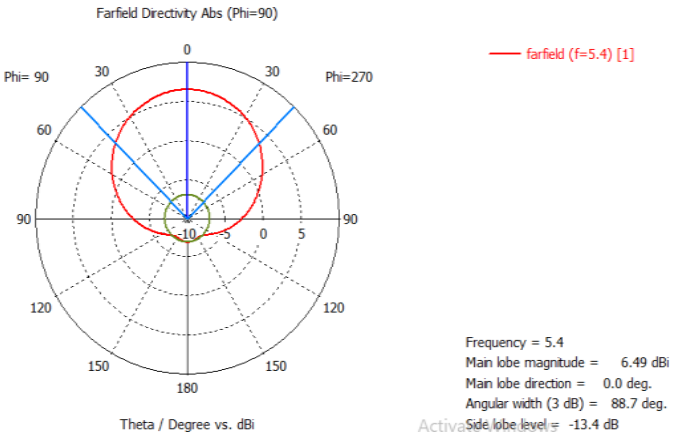

Fig 10: Polor plot of directivity at 5.4GHz

When the designed antenna is operating at the frequency of 5.4 GHz, the gain is 5.609dB and directivity is 6.491 dB.

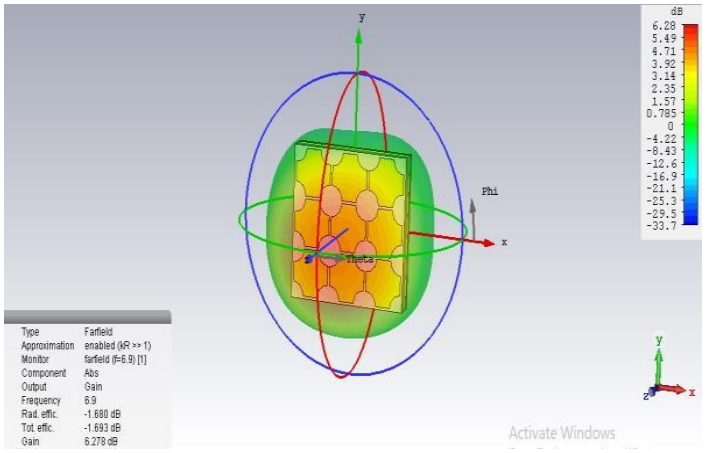

Fig 11: Gain at frequency 6.9 GHz

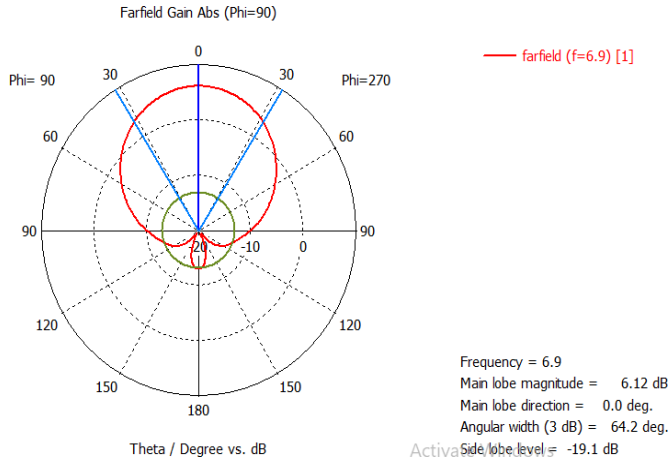

Fig 12: Polor plot of Gain at 6.9 GHz

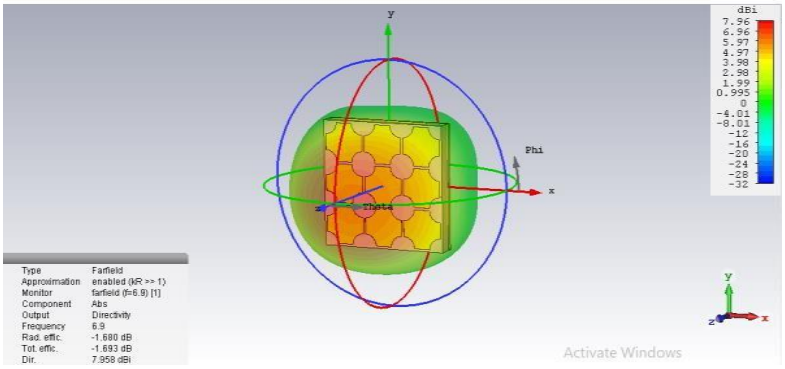

Fig 13: Directivity at frequency 6.9 GHz

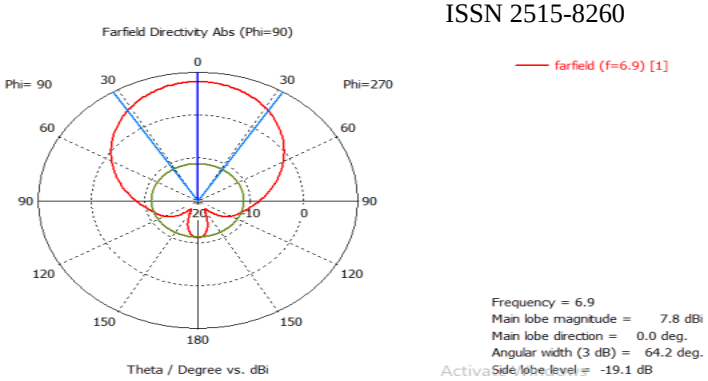

Fig 14: Polor plot of directivity at 6.9GHz

When the designed antenna is operating at the frequency of 6.9 GHz, the gain is 6.27dB and directivity is 7.95 dB.

4. Conclusion

The EBG structure incorporated on aperture coupled microstrip antenna has been designed successfully with distinctive structure, where the radiating patches on the top substrate are etched in unique shape using nickel and a linear aperture slots is positioned on the ground. On the top of that a new approach of new coupling method has been applied successfully based on aperture coupled technique. The designed antenna operates at two frequencies with gain and directivity of 5.6dB and 6.46 dB for frequency 5.4 GHz and gain and directivity of 6.27 dB and 7.95 dB for frequency 6.9 GHz. Thus by using this proposed system the gain parameters of the EBG antenna is successfully improved.

5. References

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