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MICROSTRIP ANTENNA ARRAY WITHOUT AND WITH SQUARE EBG STRUCTURE

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ABSTRACT

The microstrip antenna is the most popular for low price and compact design. In this paper, a microstrip antenna (MSA) mounted over a high impedance electromagnetic bandgap (EBG) substrate using square structure, also presents a reduced size of microstrip antenna with Square EBG structure. The combination of the microstrip antenna fabricated on the top of the substrate FR4 with Electromagnetic Band Gap (EBG) structures at radiating edge of patch is proposed is and investigated. A half/quarter/sixth part of patch antenna with microstrip feed is designed as a reference antenna. First, the miniaturization is investigated by reducing the size of the reference antenna through. The high gain behavior with further miniaturization is achieved by using serial feed 4x1 patch array with square EBG technique. The antenna has been designed on FR4 substrate and thickness h=1.6 mm, and has a compact structure with a total size of 60x60mm square is 118.0 mm × 175.0 mm × 1.6 mm. The proposed antenna exhibits 80MHz impedance bandwidth from (2.45-2.53GHz) with around 8.3dB gain. The characteristics of antenna like return loss, VSWR, radiation pattern and gain of the proposed antenna are described and simulated with the help of HFSS. The measurement results are in close agreement with the simulation results. The proposed Square EBG antenna is compact, low profile, and offers very high gain required for long way Communication system.

KEYWORDS: Microstrip patch, Antenna array, EBG structure, Square and Circle unit cell, WLAN band and half/quarter/eighth part of patch.

I. INTRODUCTION

The microstrip patch antenna has very important role in world of a wireless communication systems .There is always a large demand for high performance, low cost and small size wireless communication systems. In order to get all these requirements, a patch antenna is preferred because of its various advantages such as small size, low price, ease for fabrication and light weight. The multi-element smart antenna array has attracted attention of the researchers due to its wide range of applications in the field of wireless communication. Different multi-element antenna prototypes are designed and implemented for the applications in the base stations (BS) to improve the quality of transmission and enhance the cellular capacity, coverage and reliability [1-5]. On the other hand, recent advances in the study of the electromagnetic band gap (EBG) structures has established these structures to be simple solutions towards improving the antenna performance [6]. The performance improvement occurs due to the stop bands of these periodic structures. These structures provide a simple and effective solution to the problems of surface and leaky waves [7]. Several types of microstrip based EBG structures have been analysed for the variety of applications. These structures are studied by utilizing both finite difference time domain and finite element method techniques [8].

In this article, we propose a new analytical method based on transmission line theory to design the EBG of the microstrip patch antenna in particular to enhance its performance. We describe a serial feed 4x1 patch array antenna with EBG structure with wide impedance bandwidth and high gain. This structure has been further investigated and integrating regular circle and rectangle shaped EBG structure at edge of resonating patch and a significant improvement has been observed in both radiation pattern at the designed frequency.

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II. PROPOSED ANTENNA DESIGN

A hexagonal microstrip patch antenna is designed to operate at 2.47GHz. After that to reduce the size of antenna the half hexagonal antenna is obtained. Further to develop a light weight antenna, the miniaturization is done approximately upto 1/6 th part of the hexagonal antenna with the help of FR4 substrate material with the length and width of the patch are 39mm and 28.2mm the reduced size 4X1 patch array with EBG is designed. The feed point is 7.5mm from the centre of the patch as shown in Fig1.

Figure 1 shows the hexagonal microstrip patch antenna design and figure 2 shows the design of the reduced size of the hexagonal antenna. Simulation of the antenna has been carried out in HFSS. The designs of reduced size of the hexagonal antenna with and without EBG is as follows with their simulation results.

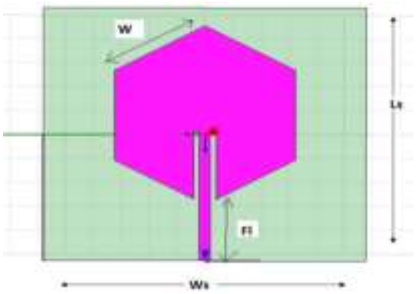

Fig.1. Hexagonal microsrtip antenna

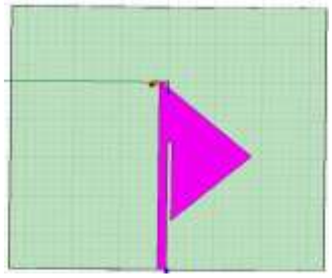

Fig.2 Reduced sized antenna

III. PROPOSED 4 x 1 MICROSTRIP ANTENNA EBG ARRAY

The microstrip patch antenna array is simulated by arranging these two microstrip line feed patch antennas in linear configuration. Each patch element is excited individually using separate port and the integrated response i.e. overall radiation pattern of the 4x1 element linear array antenna is simulated using HFSS software.

Figure 3 shows the configuration of the proposed EBG 4x1 Array antenna which consists of one rows of circular & square shaped EBG cells surrounding the antenna patch. The Square shaped EBG single cells area (5mmx5mm) as that of square shaped EBG 4 cells.

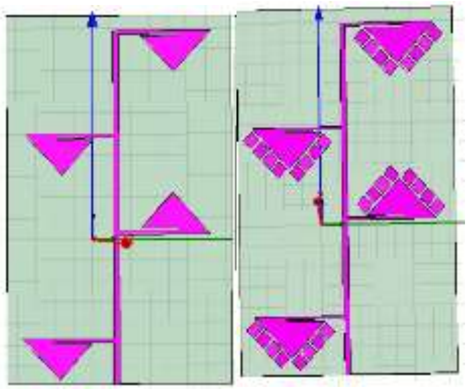

Fig.3 (a).Without EBG (b) With Square EBG

IV. SIMULATION RESULTS FOR REDUCED SIZE 4x1 MICROSTRIP ANTENNA

The microstrip antenna array is simulated by arranging these two microstrip line feed patch antennas in linear configuration. Each patch element is excited individually using separate port and the integrated response i.e. overall radiation pattern of the 2 element linear array antenna is simulated using HFSS software.

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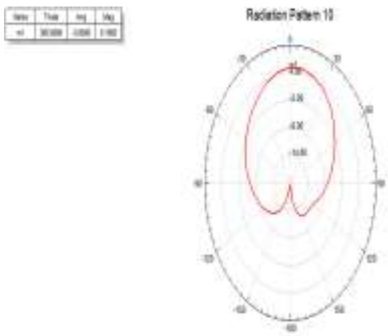
Figure: 4 shows the Directivity of reduced size 4X1 array without EBG antenna, which is 6.4.



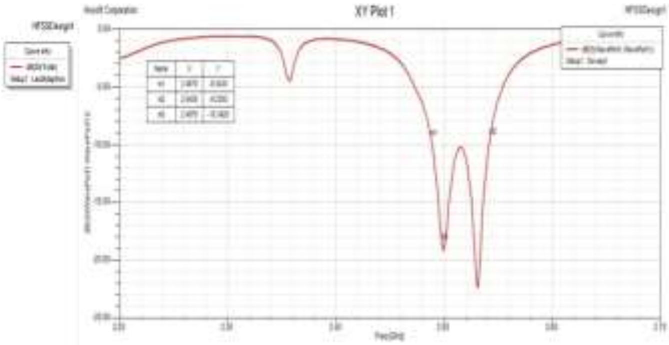
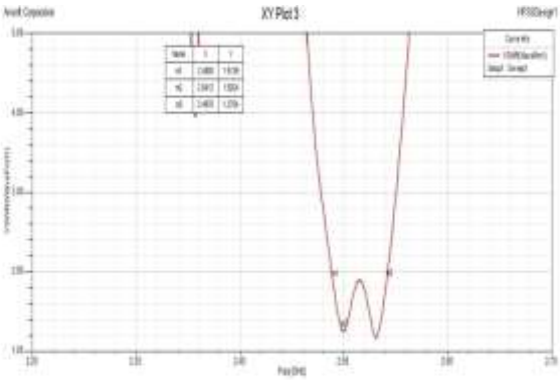


Fig.4. Radiation pattern of Reduced size 4X1 array without EBG ***Fig.5. Return loss of Reduced size 4X1 array without EBG***

As shown in figure: 5 the value of Return loss of reduced size 4X1 array without EBG antenna is -18.34.



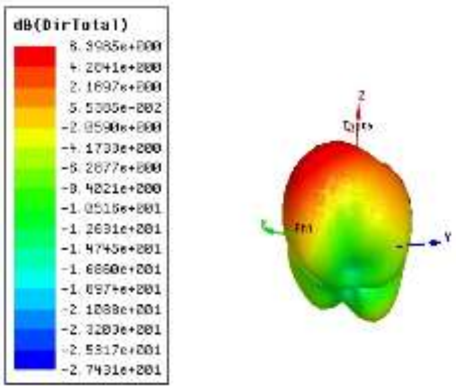
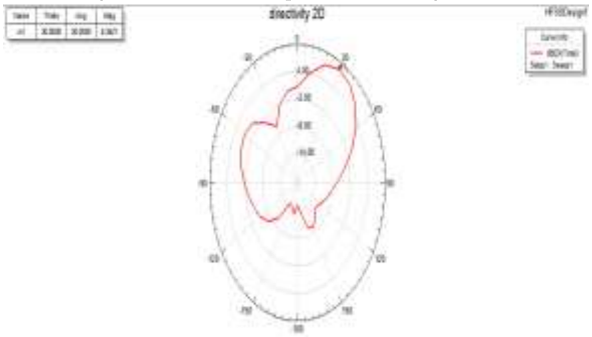


Fig.6. VSWR of Reduced size 4X1 array without EBG ***Fig.7. Directivity of Reduced size 4X1 array without EBG***

Figure: 6 Shows the VSWR Plot of reduced size 4X1 array without EBG antenna is 1.27. Figure: 7 Shows the directivity of reduced size 4X1 array without EBG antenna is 6.4.

V. SIMULATION RESULTS FOR 4 x 1 SQUARE EBG

The simulation results for 4 x 1 square EBG are shown below. The radiation pattern for 4 x 1 square EBG is shown in figure 8. Figure 9 shows the return loss. In the figure 10 VSWR is obtained. And figure 11 gives the directivity of 4 x 1 EBG square unit array.



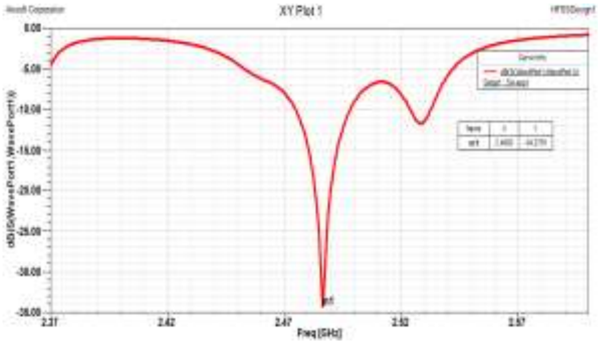


Fig. 8. Radiation Pattern of 4 x 1 EBG square unit array ***Fig.9. Return loss of 4 x 1 EBG square unit array***

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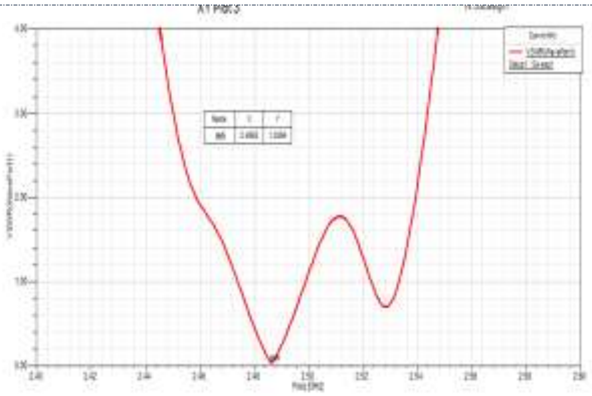

Fig.10. VSWR of 4 x 1 EBG square unit array

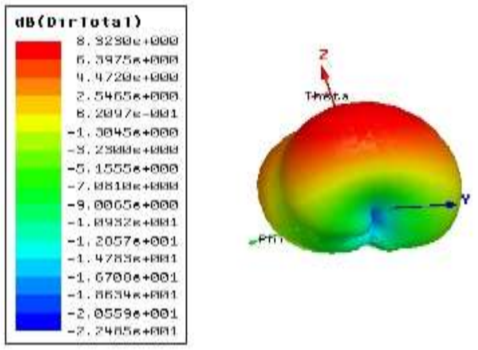

Fig.11. Directivity of 4 x 1 EBG square unit array

VI. COMPARISON TABLE FOR SINGLE ELEMENT, 4X1 WITHOUT AND WITH EBG STRUCTURE

The comparison of the parameters obtained for single element and 4x 1 array are shown in table 1.

Table I. Comparison of characteristics obtained for single element, 2 x 1 and 4x1 array with and without EBG Structure.

Sr. no.	Type of MSA	Freq (GHz)	Return loss (dB)	VSWR	BW (MHz)	Directivity (dB)
1.	Single patch without EBG	2.48	-14.04	1.49	18	4.7
2.	2x1 patch without EBG	2.48	-16.88	1.33	30	5.4
3.	4x1 Patch array without EBG	2.48	-18.34	1.27	60	6.4
4.	4x1 Patch array with Square EBG	2.47	-34.32	1.03	80	8.3

VII. MEASUREMENT RESULTS

The Proposed 4x1 EBG array antenna has been fabricated and tested. These antennas have been tested using vector network analyzer Agilent technology N9923A series. The Measurement results of proposed fractal antenna getting bandwidth of 110MHz (from 2.42GHz to 2.53 GHz) at VSWR 2:1. The measured return loss 4x1 EBG patch antenna with Circle and Square unit cell has been shown in fig.12.

Fig.12. Fabricated Proposed 4x1 EBG Patch Array

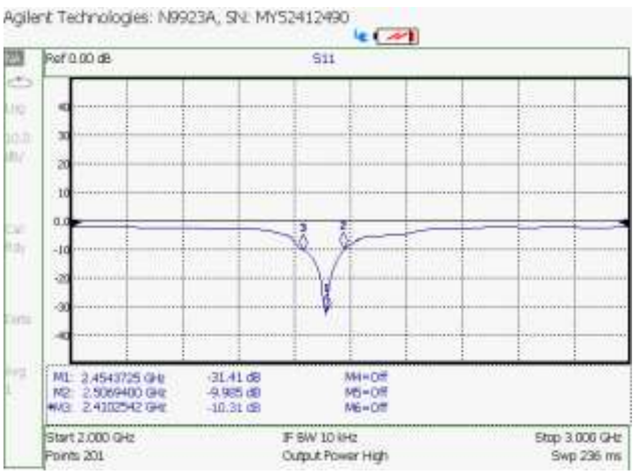

Fig.13. Measured Return loss of fabricated antenna

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A good agreement between experimental and simulated results is observed except some slight variation. This may be due to the tolerance in manufacturing, uncertainty of the thickness and/or the dielectric constant of the substrate and lower quality of SMA connector (VSWR = 1.3), larger tan delta= 0.02 of the substrate and soldering effects of an SMA connector. Fig.8 shows fabricated 4x1 Square EBG array antenna.

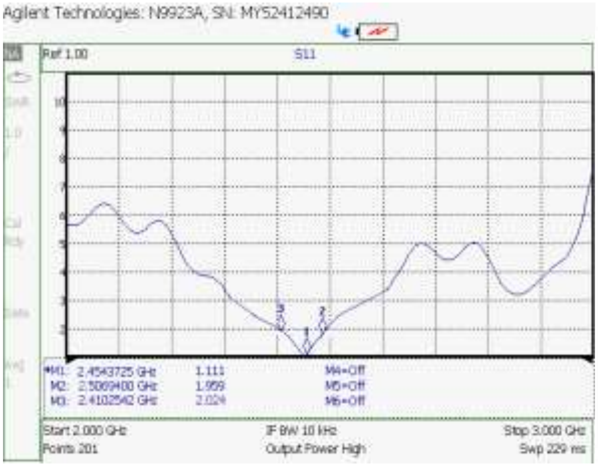

Fig.14. Measured VSWR of fabricated antenna

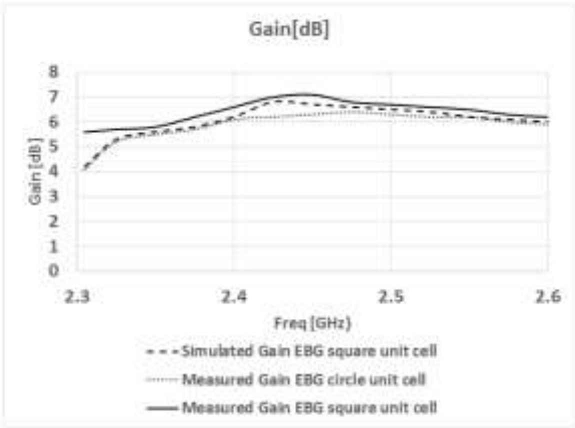

Fig.15 Measured Gain of fabricated antenna

The measured gain of this antenna has been shown in Figure 15.It conclude that the gain of square EBG is 7.0dB at 2.42GHz which is greater than without EBG structure.

VIII. COMPARISON TABLE FOR SIMULATED VS MEASURED RESULTS

Table II. Simulated Vs Measured Results

Sr. No.	Results	Freq (GHz)	Return loss(dB)	VSWR	Gain (dB)	Impedance (ohms)
1.	Simulated Results Square EBG	2.47	-34.27	1.15	6.8	52.0
2.	Measured Results Square EBG	2.45	-31.41	1.11	7.0	51.0

IX. CONCLUSION

To enhance the gain of microstrip antenna the miniaturized hexagonal antenna with the square EBG structure has been designed in this paper. It is found that microstrip patch antennas have exhibited distinctly higher gain as compared to the conventional patch antenna and also, the hexagonal microstrip patch antenna with square EBG exhibits higher gain than that of circular shaped EBG having the same area of unit cells. The proposed Reduced size 4X1 hexagonal microstrip antenna array with square EBG is electrically small, suitable to handle easily and it is applicable to WLAN band at 2.47GHZ. From the simulated and measured results, it is observed that the half/quarter/sixth part of Patch antenna structure the gain is increased and radiation pattern obtained with EBG are much better than without EBG. In this paper, with a serial feed array structure the high gain 8.3dBi has been achieved and also improved significantly by introducing square EBG structure. It is clearly observed that the impedance bandwidth and radiation efficiency are improved significantly by designing proposed 4x1 array with Square EBG structure.

X. REFERENCES

[1] Saurabh Kumar, Dinesh Kumar Vishwakarma," Miniaturized Dual Broadband Hexagonal SlotMonopole antenna", IETE JOURNAL OF RESEARCH, Apr 2016.
[2] P.KYritsi, D.C. Cox, R.A. Valenzuela, P.W.Wolniansky, "Effect of antenna polarization on the capacity of a multiple element system in an indoor environment", IEEE Trans.Inform. Theory, vol.49, pp.2867-2896, 2003.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

[3] Kalaye, B. M. B., J. Rashed-Mohassel, "A broadbandand high isolation CPW fed microstrip antenna array",Electromagnetic Waves and Applications, Vol. 22, No. 2/3, pp. 325-334, 2008.
[4] Bassilio, L. I., J. T. Williams, D. R. Jackson, M. A. Khayat, "A comparative study for a new GPS reduced surface wave antenna", IEEE Antenna Wireless Propagation Letter, Vol. 4. 2005.
[5] Gonca Cakir, Levent Sevgi, "Design, Simulation, Tests of a Low-cost Microstrip Patch Antenna Arrays for the Wireless Communication", Turk J Elec. Engin, VOL. 13. NO. 1, 2005.
[6] Cyril Cheype, Cedric Series, Marc Thevenot, Thierty Monediere, Alain Reineik, Bernard Jecko,"An Electromagnetic Bandgap Resonator Antenna", IEEE Transactions on Antenna and Propagation Vol. 50, No.9, pp. 1285- 1290, 2002.
[7] Y.Qian, R Cocciolii, D Sievenpiper, V Rodisic, E Yablonovitch, T Itoh, "Microstrip patch antenna using novel photonic band-gap structures", Microwave Journal, vol. 42, no. 1, pp. 66-76, 1999.
[8] R.Gonzalo et al., "Enhanced patch-antenna performance by suppressing surface waves using photonic-bandgap substrate", IEEE Trans. MTT., Vol. 47, pp. 2131-2138, 1999

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