Gain Enhancement of Microstrip Antenna using Ebg Structure for Wi-Fi Application

Bharamappa Kattimani, Jagadeesha S

Abstract— A microstrip patch antenna is low profile antenna mounted over a high impedance electromagnetic bandgap (EBG) substrate is proposed. In this paper, Microstrip patch antenna with rectangular EBG structure is proposed and studied. The proposed antenna has compact structure with a total size of 29.44x38.036mm^2. The designed antenna resonates at Particular Single frequency with improved return loss, VSWR and gain. The resonant frequency of the antenna 2.4GHz without and with EBG and improved return loss of -17.61dB and -18.30dB. With rectangular EBG the antenna gives improved gain of 2.09 dB. The Proposed antenna is simulated by using Simulation software ie.(IE3D) and simulated results are in good with practical antenna characteristics.

Keywords— EBG, Microstrip patch antenna, Return loss, Gain.

I. INTRODUCTION

Nowadays, people demand multiband and wideband wireless phone supporting more than one network, having different frequencies and simultaneous transmission of video, audio and data. These services are possible with the help of microstrip antennas having multiband characteristics. Modern wireless communication system also requires low profile, light weight, high gain, ease of fabrication, high efficiency, simple in structure to assure reliability and mobility characteristics this kind of such antennas satisfy above requirements. The microstrip antenna can also be used for wi-fi and military application [1-2].There many disadvantages in Microstrip antenna to overcome those by using a metamaterial to apply with the microstrip antenna [2]. The metamaterial refers to an engineered material whose behaviors or properties are naturally non-existent another metamaterial suitable for the electromagnetic applications is the electromagnetic band gap (EBG) structure [3].

Revised Manuscript Received on October 15, 2019
Bharamappa Kattimani, Department of E&C, VSM'[S]SRKIT Nipani
Dr. Jagadeesha S, Department of E&C, SDMIT Ujire
navyabk2012@gmail.com

By loading the EBGs periodically on the substrate, a band gap can be created for frequencies around the operating frequency of the
antenna. Such structure can stop the propagation of surface waves, which can be excited along the high dielectric substrate material [4-5]. Various types of Electromagnetic band gap structure are utilized to improve the performance of microstrip antenna.[6-7].The inclusion of EBG in microstrip antenna design allows gain enhancement,enhanced directivity, relative bandwidth improvement and size miniaturization [8]. EBG structures possess unique electromagnetic properties that have led to a wide range of applications [9].

II. DESIGN & RESULT

A. *Basic patch Antenna with EBG*

A probe fed patch antenna is design on 1.6 mm thick substrate with dielectric constant of 4.4 Fig (1) The size of the patch is 29.44x38.036mm^2. The probe is linked to a 50Ω give for point to go with the patch antenna with a diameter of 1.2 mm. The resonant frequency for the proposed antenna (without & with EBG structure) is 2.4 GHz. Base form of patch with and without EBG is designed using IE3D simulated software.

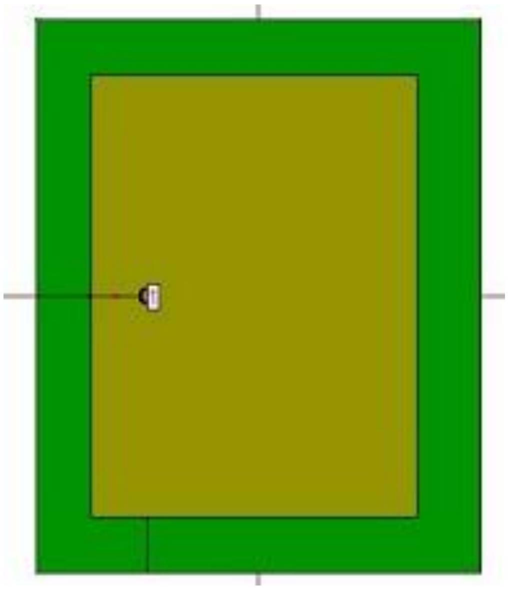

Fig1 (a) Geometry of patch antenna

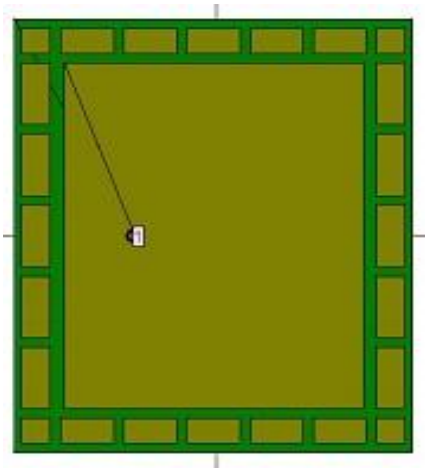

Fig 1(b) Geometry of Patch with EBG

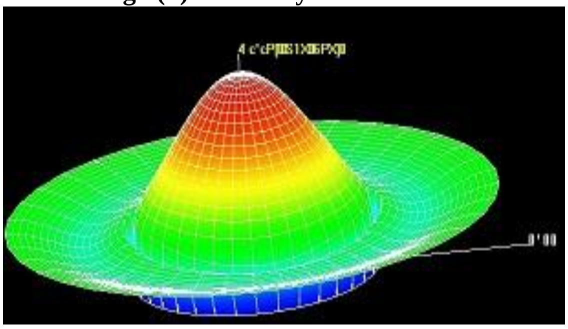

Fig 1(c) 3D View of Base antenna

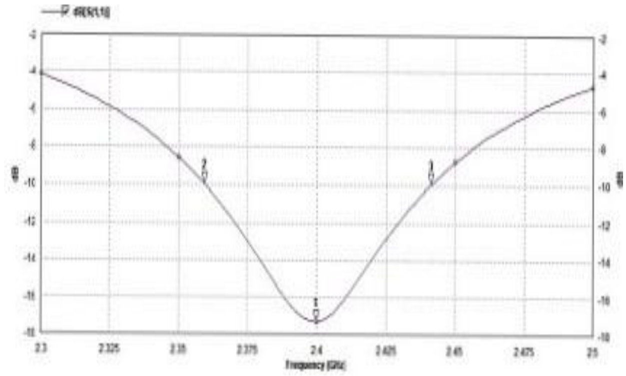

Fig 2(a) Simulated result of Base antenna

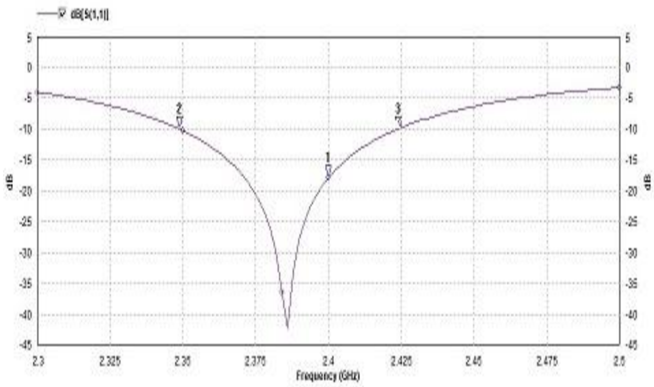

Fig 2(b) Simulated result of patch with EBG

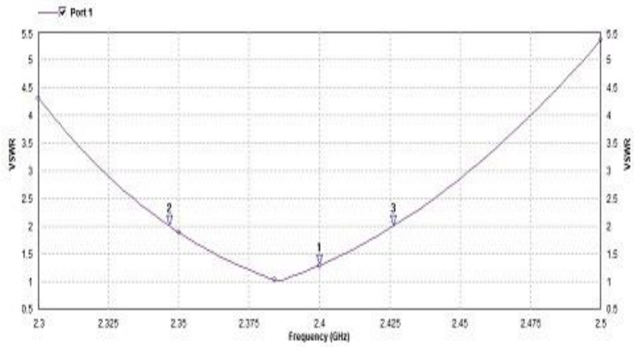

Fig 2(c) VSWR of Base antenna with EBG

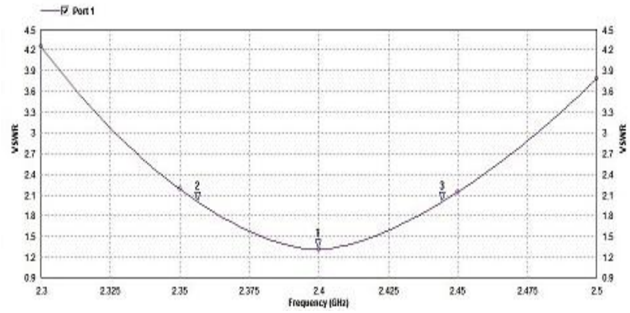

Fig 3(a) VSWR of Base antenna

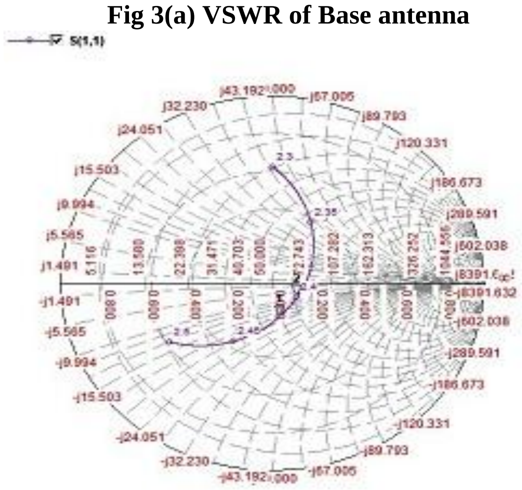

Fig 3(b) Smith Chart of Base antenna

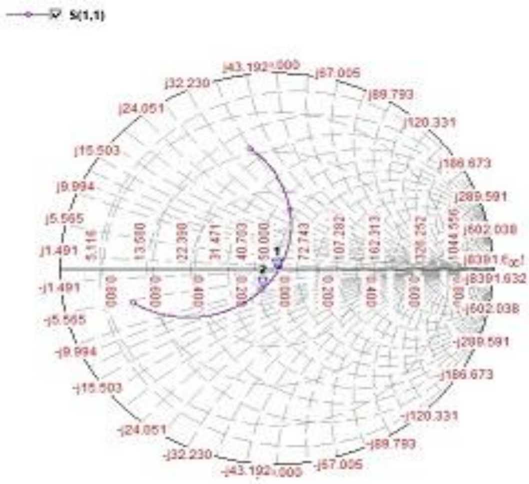

Fig 3(c) Smith Chart of Base antenna with EBG

The fig 4(a) & 4(b) indicates that Basic top and bottom view of microstrip antenna has size of 29.44x38.036mm2.

The total length of the patch is equally divided into five EBG slots the length of each slot = 5.088mm and its width = 2.8mm. Similarly the total width of the patch is divided into five EBG and each of length = 6.8072mm and with =2.8mm. The gap between the EBG slot=1mm, four corner EBG length=2.8mm and width=2.8mm . The Co-axial Probe feed is used to feed the antenna with feed locations are x, y (-9.75mm , 0) from the origin which is shown in Fig 4(c). The proposed designed antenna geometry is implemented practically by using glass epoxy dielectric substrate material with its dielectric constant of 4.4 and its height is 1.6mm.

Fig 4(a) & 4 (b): Fabricated antennas with top view and bottom view of Basic microstrip antenna

Fig 4(c) & 4 (d): Antenna with Electromagnetic band gap

6 GHz spectrum analyzer, a 12.4 GHz tracking generator, and a 6 GHz directional coupler. By connecting these devices together (with the included cables) the system functions as a scalar network analyzer, providing the tools you need to perform VSWR and return loss measurements at frequencies up to 6GHz. Simulated design antenna performance characteristics behavior in terms of return loss, VSWR, smith-chart, radiation pattern etc are compared with practical antenna characteristics.

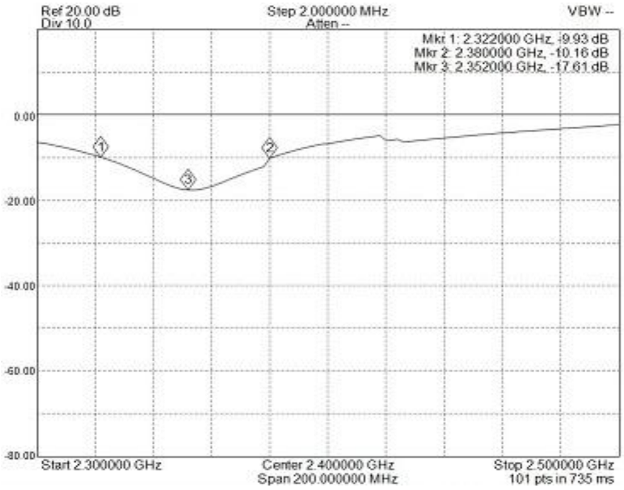

Fig 5(a) Practical Simulated result of Base antenna

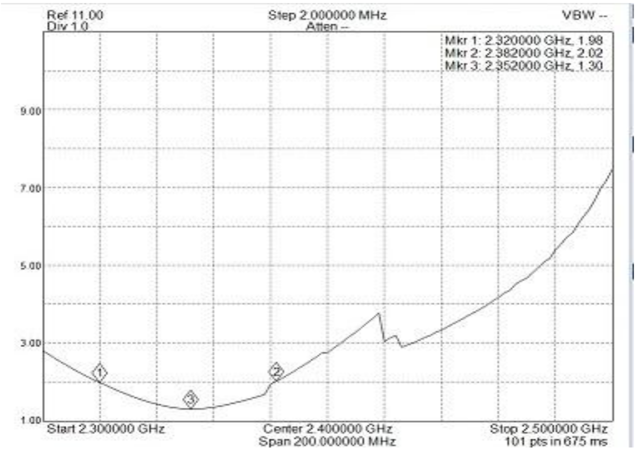

Fig 5(b) Practical VSWR result of Base antenna

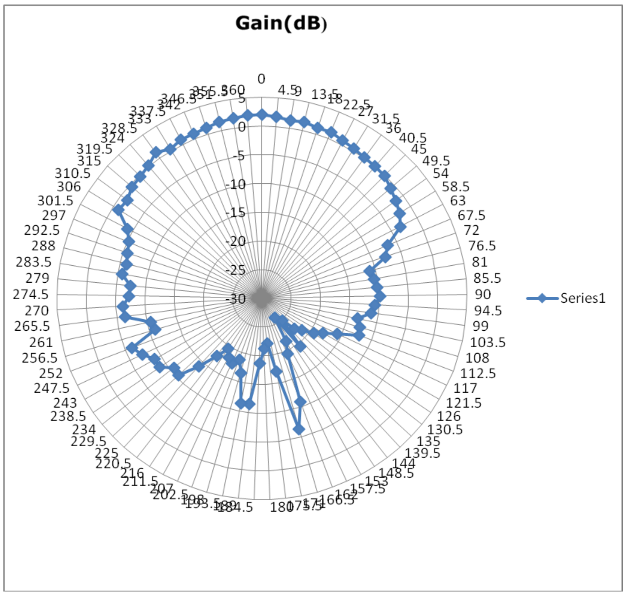

Fig 5(c) Practical Radiation pattern of Base antenna

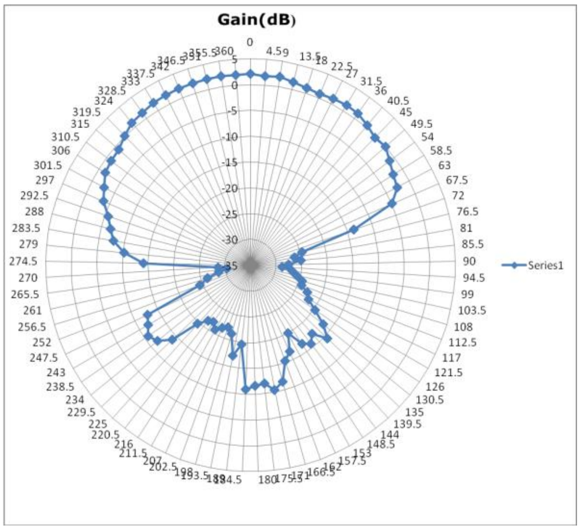

Fig 6(a) Practical Radiation pattern of patch with EBG

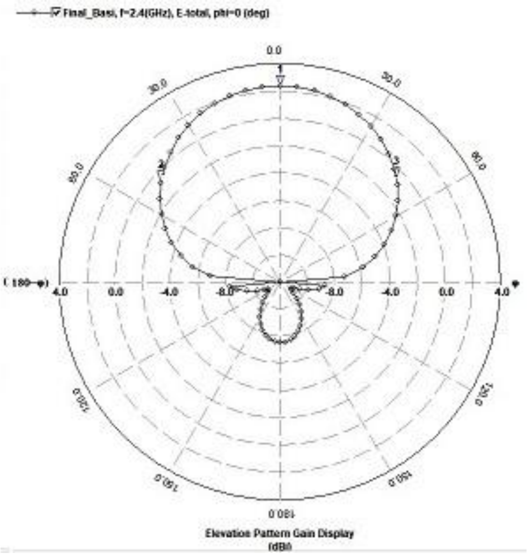

Fig 6(b) Gain plot in polar of Base antenna

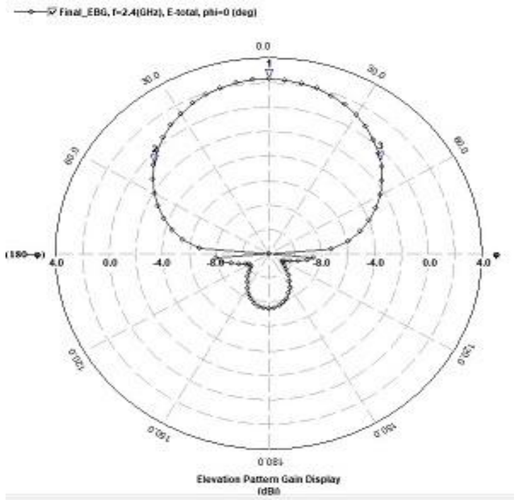

Fig 6(c) Gain plot in polar of patch With EBG

The simulated and practical Return loss value of proposed antenna is shown in fig 2(a) & 5(a). And also VSWR characteristic of antenna is as shown in fig 3(a) & 2(c). measured and simulated results are achieved .The results are shown in table 1 The results indicate that the proposed antenna performance with Electromagnetic band gap structures is improved ie, the Return loss & gain are enhanced.

Table 1: Results of proposed antenna with & without EBG

Prototype antenna	Resonance frequency Fr(GHz)		Return loss (db)		Gain (db)	
	Sim	Prc	Sim	Prc	Sim	Prc
Base antenna without EBG	**f_1=2.4**	**f_1=2.35**	**-17.28**	**-17.61**	**2.35**	**1.99**
With EBG	**f_1=2.4**	**f_1=2.34**	**-17.9**	**-18.3**	**2.27**	**2.09**

We have observed that with EBG there is an development in directivity of all antennas. The base antenna gives directivity of 5.23 dB without EBG and 6.32dB with EBG. Also the radiation patterns have been studied for all the antennas with EBG arrangement and it is shown in fig 5(c) to 6(a). It is observed that the radiation patterns are broadside.

The characteristic of proposed antennas were simulated by using software IE3D and verified experimentally by using Scalar network analyzer. For all cases, the simulated results are obtained and are compared to the experimental results. They are shown in figure 5(a) &5(b). From the results it is clear that simulated results are in good agreement with measured results.

III. CONCLUSION

The performance of the microstrip patch antenna is enhanced with the EBG structure that has been investigated. The EBG structure established the effects of surface wave control and reduction on broadside radiation power. The Gain obtained is 2.09dB when antenna is rotated In Azimuth angle and Gain is 2.14dB when antenna in Elevation angle broadside radiation patterns is achieved. Measured values of resonant frequencies and return loss -18.30dB and VSWR 1.90 for these antennas have been set up to have the same opinion well with the simulated ones.

REFERENCES

1. Jagadeesha.S, Vani.R.M and P.V. Hunagund, "A Self-Similar Fractal Antenna with Square EBG Structure," International Journal of Engineering Research &Technology (IJERT) Vol. 2 Issue 2,February-2013 ISSN: 2278-0181.
2. Ruchika Gupta, Mithilesh Kumar, " Bandwidth Enhancement of Microstrip Patch Antennas by Implementing Electromagnetic Band gap(EBG) Structures," 2012 4th International Conference on Computational Intelligence and Communication Networks 978- 0-7695 -4850-0/12 $26.00 © 2012 IEEE DOI 10.1109/CICN.2012.58.
3. Praphat Arnmanee, "Gain Improvement of Microstrip Patch Antenna using Octagonal - Loop Meta surface Superstrate and Octagonal-Shaped EBG Structure for 2.4 GHz Band Application," 2018 15th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology 978-1-5386-3555-1/18/$31.00 ©2018 IEEE
4. Harish Kumar, Manish Kumar, Rajeev Kanth, "Study on Band Gap Behaviour of Electromagnetic Band – Gap (EBG) Structure With Microstrip Antenna ," ISBN 978-89-5519-163-9 Feb. 19~22, 2012 ICACT2012.

Retrieval Number: A9580109119/2019©BEIESP
DOI: 10.35940/ijeat.A9580.109119

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

5. Fangming Zhu, Ya Xia and Juanjuan Ye, "Performance Improvement of Microstrip Patch Antenna and Array with Electromagnetic Band Gap Structure," ICMMT 2008 Proceedings 978-1- 4244- 1880- 0 / 08 / $25.00 © 2008 IEEE.
6. Gnanam Gnanagurunathan and Krishnasamy T.Selvan, "Improved radiation characteristics of a patch antenna with square slot EBG," 2011 IEEE International RF and Microwave Conference (RFM 2011), 12th - 14th December 2011, Seremban, Malaysia 978-1- 4577-1631-7/$26.00 © 2011 IEEE.
7. B. Ramesh, Dr. V. Rajya Lakshmi,"Design Of A Rectangular Microstrip Antenna Using EBG Structure," International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 7, July – 2013 IJERTIJERT ISSN: 2278-0181.
8. S. Latha, P.M.Rubesh Anand, "Circular Polarized Microstrip Patch Array Antenna for Wireless LAN Applications,"978-1-4673-9338-6/16/$31.00_c2016 IEEE.
9. Fan Yang, Yahya Rahmat- Samii, " Microstrip Antennas Integrated With EBG : A Low Mutual Coupling Design for Array Applications VOL. 51, NO.10,OCTOBER 20030018-926X/03$17.00 © 2003 IEEE

AUTHORS PROFILE

Bharamappa kattimani received the BE and M Tech degrees from VTU Belagavi, He was working as Assistant professor in REC Hulkoti and VSM'SSRKIT Nipani from 2005 to till date.

Dr. S.JAGADEESHA received the BE and ME Specialization Power Electronics in 1999. He has completed Ph.D in the Department of Applied Electronics Gulbarga University, Gulbarga. He has had more than 20 years experience in teaching field. He is presently working as Professor E&C Dept. in SDMIT Ujire from 2011 to till date .He is a Professor and Research Guide for many Research scholars in VTU Belagavi. He has also served as Chairman and Co-Chairman of several national and international symposia. He has had pioneering research contributions in diverse areas of electromagnetic, antennas, measurement and diagnostics techniques, numerical and asymptotic methods, satellite and personal communications, human/antenna interactions, frequency selective surfaces, electromagnetic band-gap structures and the applications of the genetic algorithms, etc.

.