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Microstrip Antenna Using Dummy EBG

Arpit Nagar[*1], Aditya Singh Mandloi[2] and Khem Singh Solanki[3]

[*1,2,3] *Dept. of Digital Communication*
Govt. Ujjain Engineering College, Ujjain

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Abstract — micro strip patch antennas have been studied extensively over the past two decades because of its low profile structure, light weight and low cost. they have many advantages over conventional antennas, which make them suitable for a wide variety of applications. however, major drawback for this type of antennas low efficiency , narrow bandwidth and surface wave losses. to improve surface wave losses uses electromagnetic band gap structures & for bandwidth improvement we use dummy EBG patern on feed line.

Keywords: Dual Patch Antenna, Dummy EBG, Improve Bandwidth.

I. INTRODUCTION

Micro strip patch antennas have several advantages over conventional antennas including their low profile structure, light weight and low cost. As such they have been widely used in a variety of applications. However, one of the major drawbacks of this antenna is the low bandwidth. In this paper, bandwidth of a dual patch antenna is improved by etching dummy EBG pattern on the feed line.

Various types of EBG structures have been studied. In one of the first applications by using EBG materials to antennas, a planar antenna mounted onto an EBG substrate was considered to increase the overall radiation efficiency of the device. Increasing antenna directivity was studied using an EBG structure. A compact spiral EBG structure was studied for micro strip antenna arrays. As the spiral EBG structure is very compact and useful in wireless communications, hence it, when used on feed line, was also studied to improve the performance of a triple band slot antenna.

Bandwidth of a dual patch antenna is improved by etching dummy EBG pattern on the feed line. Effects of different positions of the feed line on the bandwidth are also studied. By uses dual patch antenna with dummy electromagnetic band gap for improving bandwidth.
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II. OBJECTIVE

The objective of this paper is to study the dual array patch antenna examined in and improve its Bandwidth by etching patterns that are similar in nature on the feed line. This pattern will be referred to as dummy EBG pattern because of its resemblance in certain properties and behavior to a conventional EBG structure. A good improvement in bandwidth (48.8% increases with a bandwidth of0.381 GHz versus the reference bandwidth of 0.256 GHz) is obtained for the antenna having dummy EBG pattern on the feed line when compared to the reference antenna for all the feed line positions.

Corresponding Author: *Arpit Nagar*

III. MICRO STRIP ANTENNA

At 1953, micro strip antenna was proposed by G.A. Decamps. By the early 1980s basic micro strip antenna elements and arrays were fairly well established in terms of design and modeling. Micro strip antenna antennas also known as printed antennas. The micro strip antenna offers low-profile, conformable to planar and non-planar surfaces, simple and inexpensive to fabricate using modern printed-circuit technology, mechanically robust when mounted on rigid surfaces and very versatile in terms of resonant frequency, polarization, patterns and impedance. Major disadvantages of micro strip antenna are their low efficiency, low power, poor polarization purity, poor scan performance, very narrow frequency bandwidth and existence of surface waves.

Micro strip patch antenna is consisting a radiating patch on one side of dielectric substrate and a ground plane at another side. A simplest configuration of micro strip antenna is shown below:

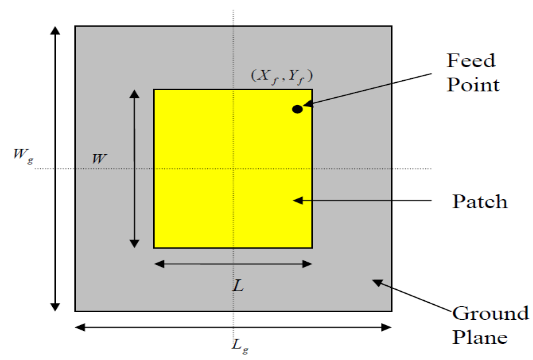


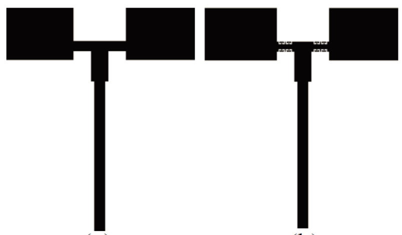
Fig 1

Conductor of length L and width W on a dielectric substrate with permittivity εr , thickness or height of the dielectric being h. The length for the patch depends on the height, width of the dielectric substrate. The rectangular patch antenna is designed so as it can operate at the

resonant frequency. The frequency of operation of the patch antenna of Figure 1 is determined by the length L.
The center frequency will be approximately given by

$$f_c \approx \frac{c}{2L\sqrt{\varepsilon_r}} = \frac{1}{2L\sqrt{\varepsilon_0 \varepsilon_r \mu_0}}$$

The above equation says that the patch antenna should have a length equal to one half of a wavelength within the dielectric (substrate) medium.
The patch can be various shapes for example square, rectangular, circular, triangular and any other configurations.

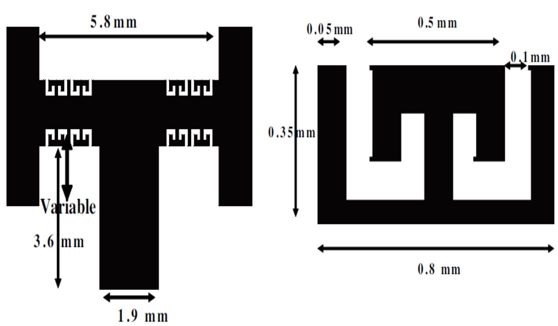


(a) (b)

Figure2.Rectangular patches antenna array structure. (a) Reference antenna without EBG pattern
(b) Dummy EBG pattern antenna.

IV. DESIGN CONSIDERATIONS

The structure of the rectangular patch antenna array is shown in Fig. 2, where Fig. 2(a) shows one of the many designed antenna array without dummy EBG pattern while Fig. 2(b) shows the antenna array with the dummy EBG pattern. In the rest of paper Figs. 2(a) and 2(b) will be referred to as the reference antenna and dummy EBG pattern antenna respectively and these terms will be used interchangeably. Figure 3 depicts the magnified view of the feed line for the dummy EBG pattern antenna



(a) (b)

Figure3:- Magnified view of the feed line for dummy EBG pattern antenna. (a) Magnified view of feed line, and (b) magnified view of EBG pattern. here fig 3(a) shows the magnified view of the feed line with 8 dummy EBG pattern and Fig. 3(b) shows the single element of the EBG pattern used for design, simulation and measurement. Physically, the implementation of EBG structures will suppress the local surface waves (or currents) to focus the current distribution and to better-match the impedance (because of the smaller patterned resonant elements and their different combinations). Therefore, the sizes at resonances will have to change according to the corresponding operating wavelength. The etched patterns of the feeding lines will also aspect the performance. In this paper, we will not discuss on the patterns of the EBG structures due to the limited length.

Similarly, dummy EBG pattern antenna is also designed by etching a 2-by-4 array of similar patterns on the feed line connecting the two patches of the dual patch antenna. The EBG-array pattern is built on a 0.381 mm thick substrate with the relative permittivity of 2.33. The period of the proposed pattern is 0.8 mm, which is operating at a frequency of about 14.8 GHz. As such, the period of this pattern is about 4% of wavelength at the stop band frequency, which satisfies the conventional definition for an EBG structure. The dimensions of the dummy EBG pattern have been shown in Fig. 3(a). Variations of the reference antenna and the dummy EBG pattern antenna are then designed by changing the feed line positions connecting the twin patches of the antenna. The variable distances of the feed line are highlighted in Fig. 3(a).

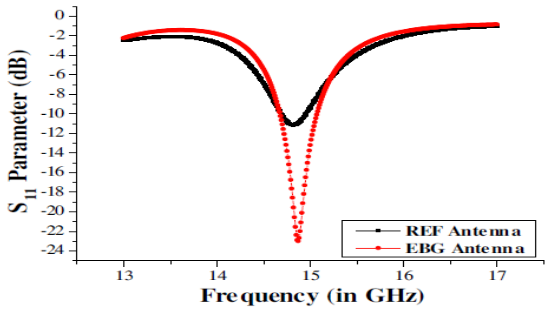
V. S-PARAMETERS & BANDWIDTHS

To gain an insight into the effects of feed line position and the EBG pattern used on the antenna performance, we compared antenna performance of reference antenna and dummy EBG pattern antenna as shown in Figs. 2(a) and 2(b), respectively. The S11-parameter and bandwidth values (with respect to ¡10 dB line) are obtained and compared for many different feed positions of the feed line connecting the twin patches. For illustration purpose, 4 best cases have been shown in this paper. Measurement results are then obtained for the case where we obtain a maximum percentage improvement in bandwidth when the bandwidth of the EBG pattern antenna is compared with that of the reference antenna for the same feed line distance.

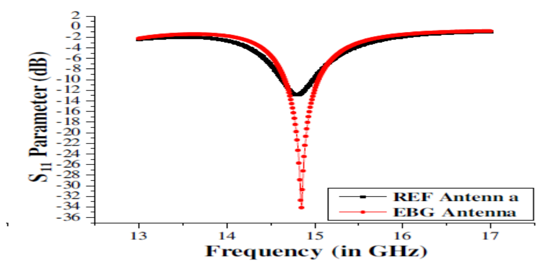
The S11-parameters versus frequency (in GHz) are obtained for the reference antenna and the dummy EBG pattern antenna for different feed positions, as shown in Fig. 4. Different feed position distances are considered; and for the illustration purpose in this paper only 4 best cases have been shown Fig. 4 subsequently.

S11 -parameters for the reference antenna and the dummy EBG pattern antenna when feed line is positioned at a distance of (a) 1.0 mm, (b)1.1 mm, (c) 4.05 mm, and (d) 4.1 mm measured from the bottom of the patch is obtained in Fig. 4. For these four cases, the bandwidths of the reference antenna and dummy EBG pattern antenna are found to be (a) 0.2682 GHz and 0.3987 GHz, (b) 0.3551 GHz and 0.3849 GHz, (c).4399 GHz and 0.4643 GHz, and (d) 0.4289 GHz and 0.4575 GHz, respectively. In addition, we have obtained the results of the S11-parameter and bandwidths for another case, where the feed line is shifted to a distance of 1.05 mm measured from the bottom of the twin patch. It is found that the bandwidths of the reference and dummy EBG pattern antenna are 0.3199 GHz and 0.3932 GHz, respectively. During this procedure, we have to tune a matching circuit to obtain consistent resonant frequency for each case so that the comparison is fair and reasonable.

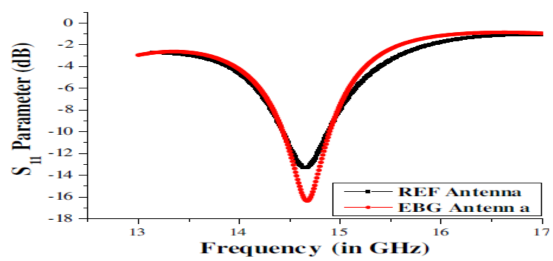
From Table 2, we observe that as we change the position of the feed line and the corresponding matching circuit from the lower edge towards the upper edge of the twin patch, the bandwidth of the reference antenna is improved without the use of the dummy EBG pattern. On the other hand, for the antenna with the dummy EBG pattern, there is not much variation in the bandwidth. The sensitivity of bandwidth to the change of feed line position is reduced by using the dummy EBG pattern.



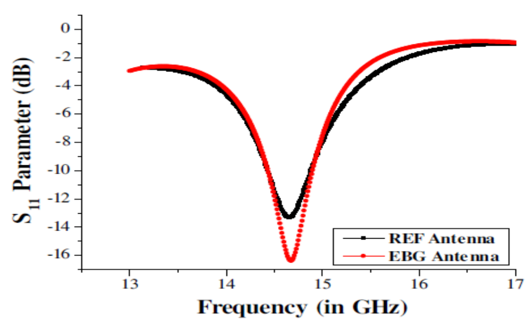
(a)



(b)



(c)



(d)

Figure 4.S11-parameter comparison of reference antenna with dummy EBG pattern antennas for 4 different cases (4 feed positions) versus frequency (in GHz). Feed line positions of (a) 1.0 mm,
(b) 1.1 mm, (c) 4.05 mm, and (d) 4.1 mm

Table1. S11 parameters measured at the central frequency.

Feed line Distance (Measured From Bottom of twin Patch)	Reference Antenna	Dummy EBG Pattern Antenna
1.0 mm	¡11:15 dB	¡23:03 dB
1.05 mm	¡11:94 dB	¡26:76 dB
1.1 mm	¡12:92 dB	¡34:17 dB
4.05 mm	¡13:42 dB	¡15:18 dB
4.1 mm	¡12:44 dB	¡16:39 dB

Table2. Bandwidth (BW) comparison for reference and dummy EBG pattern antenna for 5 different cases (different feed line positions).

Case No.	Feed line distance from the bottom of the patch	Reference (BW)	Dummy EBG pattern antenna (BW)	BW % change referenced to antenna without EBG pattern
1	1.00 mm	0.2682	0.3987	48.7%
2	1.05 mm	0.3199	0.3932	22.9%
3	1.10 mm	0.3551	0.3849	8.4%
4	4.05 mm	0.4399	0.4643	5.5%
5	4.10 mm	0.4289	0.4575	6.7%

From Table 2, we see that for all the different cases where an additional case is considered, the bandwidth is improved very much from 5.5%, through 22.9%, to 48.7%. Patch antennas are usually a part of a complicated circuitry and circuit constraints can force the feed line to be placed near the lower edge of the patch. In such a case, placing feed line closer to the lower edge of the patch yields a lower bandwidth. However, by etching patterns that behave like EBG structures onto the feed line, a good improvement in bandwidth can be obtained. This provides more diversity to the structure and circuit. From Table 2, we observe that when the feed line is placed closer to the lower edge of the patch the percentage improvement is much greater in comparison when the feed line is placed closer to the upper edge of the patch. This shows that feed line plays an important role in the percentage improvement in bandwidth when the bandwidth of the dummy EBG pattern antenna is compared to the reference antenna for the same feed line position.

VI. FABRICATIONS AND MEASUREMENTS

The best increment in bandwidth is obtained when feed line is at a distance of 1.0 mm measured from the bottom of the twin patch. The reference antenna and the dummy EBG pattern antenna are then fabricated for this feed line position and measurement results are obtained. The fabricated antenna is shown in Fig. 5, where Figs. 5(a) and

5(b) depict the reference antenna and the dummy EBG pattern antenna, respectively. The S11-parameter versus frequency (in GHz) was obtained by measurement is shown in Fig. 6 and Table 3 tabulates the S11-parameters and bandwidth values for the two antennas.

From Table 3, the percentage increment in bandwidth for the dummy EBG pattern antenna when compared to the reference antenna when the feed line is positioned at a distance of 1.0 mm from the bottom of the patch is approximately 48.8%. The measurement and simulation results are found to be in good agreement.

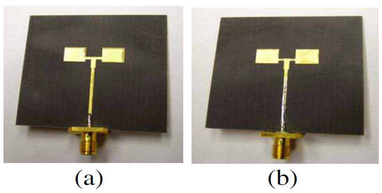


Figure5:- Fabricated antenna structures. (a) Reference antenna & (b) EBG patterned antenna.

Table3. Measurement results for antenna structures when feed line is at a distance of 1.0 mm measured from the bottom of the twin patch.

Antenna performance	Reference antenna	Dummy EBG pattern antenna
S11 Parameter	¡16:5 dB	¡20:8 dB
Bandwidth	0.256 GHz	0.381 GHz

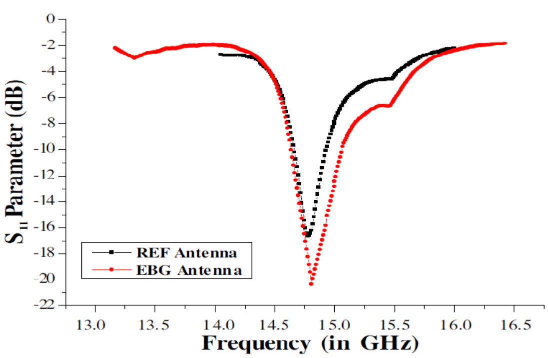


Figure6. S11-parameter versus frequency (in GHz) obtained by measurement for reference antenna and dummy EBG pattern antenna for feed line position 1.0 mm measured from the bottom of the twin patch.

Table4:- Other important antenna parameters.

Antenna performance	Reference antenna	Dummy EBG pattern antenna
Radiation efficiency	88.58%	88.95%
Antenna efficiency	81.71%	87.11%
Linear gain	9.71 dBi	9.94 dBi

In addition to the above parameters measured, we also measured the other important antenna parameters, namely, radiation efficiency, antenna efficiency, and linear gain; and they have been tabulated in Table 4 respectively for the reference and the dummy EBG pattern antennas. From Table 4,the dummy EBG pattern antenna maintains the same radiation efficiency as the reference antenna, but have better antenna efficiency and linear gain.

VII. RADIATION EFFECTS

Radiation patterns by measurement are obtained for reference antenna and dummy EBG pattern antenna for the feed line position 1.0 mm. Fig. 8 shows the radiation pattern for reference antenna when feed line is at distance of 1.0 mm, where Fig. 8(a) shows the E-plane pattern and Fig. 8(b) shows the H-plane pattern. Similarly, Fig. 9 shows the radiation pattern for the dummy EBG pattern antenna, where Fig. 9(a) illustrates the E-plane pattern and Fig. 9(b) depicts the H-plane pattern. The spikes in the pattern are because of the induced noise.

From Figs. 8 and 9, we observe that the corresponding E-plane and H-plane radiation patterns of reference antenna and EBG pattern antenna respectively do not significantly change much. This is expected as the dummy EBG pattern is etched on the feed line and radiation is due to the twin patches which do not change for the two antennas.

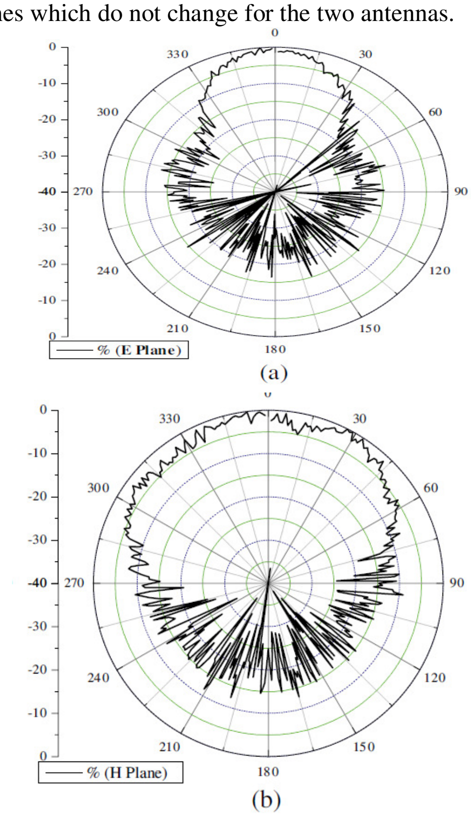


Figure8 Radiation pattern for reference antenna from measurement .(a) E-plane pattern, and (b) H-plane pattern.

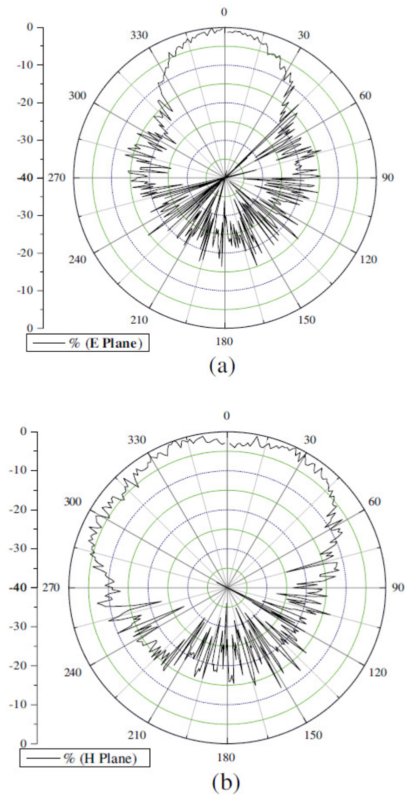


Figure: 9 Radiation pattern for dummy EBG pattern antenna from measurement. (a) E-plane pattern, and (b) H-plane pattern

VIII. CONCLUDING REMARKS

In this paper, the bandwidth of a dual patch micro strip antenna has been improved by using dummy EBG pattern on the feed line. Effects of changing position of the feed line connecting the two patches are also studied. It has been shown that the best increment in bandwidth can be obtained when feed line is closer to the lower edge of the patch. For our designed antenna, this distance is 1.0 mm, which gives a bandwidth increment of up to 48%. The overall gain and antenna efficiency are improved by using the EBG pattern on the feed line. Current distribution and radiation patterns are also obtained. This design can be easily extended for the frequency normalized structures and the patch antenna of required specifications can be then designed systematically.

IX. BIBLIOGRAPHY

[1]. Berenger, J.P., 1996. Three-dimensional perfectly matched layer for the absorption of electromagnetic waves. J. Com. [doi:10.1006/jcph.1996.0181]

[2]. Brown, E., Parker, C., Yablonovitch, E., 1993. Radiation properties of a planar antenna on a photonic-crystal substrate. J. Opt. Soc. Am. B, 10:404-407.

[3]. Enoch, S., Tayeb, G., Sabouroux, P., Guerin, N., Vincent, P., 2002. A metamaterial for directive emission. Phys. Rev

[4]. George Mathai and J.P. Shinde, " Design of Compact Multiband and EBG and Effect on Antenna Performance" International Journal of Recent Trends in Engineering, Vol 2, No. 5, November 2009.

[5]. Vivekananda Lanka Subrahmanya , Pattern Analysis of "The Rectangular Microstrip Patch Antenna" Master thesis-2009.

[6]. Seo, J. and J. Woo, \Miniaturization of microstrip antenna using iries," Electronics Letters, Vol. 40, 718{719, 2004.

[7]. Waterhouse, R., \Small microstrip patch antenna," Electronics Letters, Vol. 31, 604{605, 1995.

[8]. Slavova, A., A. Abdel Rahman, and A. S. Omar, \Broadband bandwidth enhancement of an Aperture coupled microstrip patch antenna," Digest of 2004 IEEE AP-S International Symposium on Antennas and Propagation, Vol. 4, 3737{3740, Jun. 2004.

[9]. Balanis, C. A., Antenna Theory: Analysis and Design, John Wiley & Sons, Inc., 1997.

[10]. Moradi, K. and S. Nikmehr, \A dual-band dual-polarized microstrip array antenna for base stations,"

[11]. Monavar, F. M. and N. Komjani, \Bandwidth enhancement of microstrip patch antenna using jerusalem cross-shaped frequency selective surfaces by invasive weed optimization approach," Progress In Electromagnetics Research, Vol. 121, 103{120, 2011

[12]. Pendry, J.B., 2000. Negative refraction makes a perfect lens. Phys. Rev. Lett., 85(18):3966-3969. [doi:10.1103/Phys- RevLett.85.3966]

[13]. Thèvenot, M., Cheype, C., Reineix, A., Jecko, B., 1999. Directive photonic-bandgap antennas. IEEE Trans. on Microwave Theory and Techniques, 47(11):2115-2122. [doi:10.1109/22.798007] Veselago, V.G., 1968. The electrodynamics of substances wity.

[14]. Chair, R., K.M., Luk, and K.F., Lee, 2000. "Miniature multilayer shorted patch antenna", Electronic Letters 36, pp. 3-4.

[15]. Arpit Nagar and Khem Singh Solanki, "Design & Analysis of Micro Strip Patch Antenna", ISROSET-IJSRNSC, Vol-1, Issue-1, pp(1-5), Feb-March 2013.