WIDE SLIT RECTANGULAR MICROSTRIP ANTENNA WITH SPIRAL EBG STRUCTURE

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Abstract

This paper introduces high impedance Electromagnetic Bang Gap (EBG) structure and investigates the performance of rectangular microstrip antenna embedded on a high impedance spiral EBG structure on ground plane. By loading EBG there is increase in bandwidth of the proposed antenna when compared with conventional RMSA. There is a suppression of surface waves which improves antennas radiation pattern and Back lobe level reduces.

Keywords: *Rectangular Microstrip antenna, wide slit, Electromagnetic Band Gap (EBG) structure, bandwidth.*

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1. INTRODUCTION

Microstrip patch antennas have been studied extensively over the past many years because of its low profile structure, light weight, and low cost in fabrication planar and non planar surfaces, compatibility designs, and mechanically robust flexibility when mounted on rigid surfaces[1].They are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers, etc. These low profile antennas are also useful in aircraft, satellite and missile applications where size, weight, cost, performance, ease of installation, and aerodynamic profile are strict constraints [2]. Some of the principal advantages of this type of antennas are low profile etc. However, a major drawback of these antennas is the narrow bandwidth [3].

There have been various efforts from researchers towards increasing its bandwidth. Recently, Electromagnetic Band Gap (EBG) structures have attracted much attention among researchers in the microwave and antennas communities due to their excellent pass and rejection frequency band characteristics [4-5]. In general, EBG structure is a periodic structure that forbids the propagation of all electromagnetic surface waves within a particular frequency band called the band gap. It permits additional control of the behavior of electromagnetic waves other than conventional guiding and/or filtering structures [6-7]. EBG has the potential to provide a simple and effective solution to the problems of surface and leaky waves.

In view of this, an effort is made to enhance the bandwidth of the rectangular microstrip antenna by using loading spiral EBG structure on the ground plane.

2. DESCRIPTION OF ANTENNA GEOMETRY

Fig. 1(a) shows the geometry of the proposed conventional RMSA. The antenna is designed by using low cost glass epoxy FR4 dielectric material with a relative permittivity $\varepsilon r=4.4$ with thickness h=1.6mm is chosen. The conventional RMSA is designed for 6GHz with dimensions L and W radiating part, which is excited by simple 50Ω microstrip feed having dimensions length Lf and width Wf using quarter wave length transformer of dimension length Lt and Wt for their impedance matching. The length Lg and Wg of the ground plane of the antenna is calculated by Lg=6h+L and Wg=6h+W and all the dimensions are shown in table 1.

The study is carried by keeping all the parameter of the RMSA radiating patch constant. The antenna is fed by stripline fed and the ground plane of the antenna is kept constant. For obtaining dual wide slits RMSA (DWS-RMSA), a pair of wide slits is incorporated in one of the radiating edge of the rectangular Microstrip antenna. The two wide slits are placed at equal distance from the centerline of the patch width. ls= 9mm and ws= 1mm are the slits length and slits width respectively w_1 is the separation between these two slits. The geometry of the DWS-RMSA is as shown in the Fig.2 (a). The photographic view of the top and bottom of antenna is as shown in Fig.2 (b).

Initially the ground plane of the RMSA is replaced by a high impedance spiral EBG structure. By keeping all the parameter of the radiating patch constant, the antenna is fed by stripline fed. The geometry of the proposed antenna RMSAEBG is as shown in the Fig. 3(a). The ground plane is loaded with four arms metalstrip below the radiating patch of the antenna connected to the spiral EBG structure with metalstrip width w=1mm and the gap between each metalstrip g=1mm is used to improve the impedance matching and reduce the antenna size. The photographic view of the top and bottom of the RMSAEBG antenna is as shown in the Fig. 3(b).All the dimension of the spiral EBG is as shown in table2.

Further the study is carried out by replacing the ground plane of the DWS-RMSA by a high impedance spiral EBG structure. The parameter of radiating patch DWS-RMSA is kept constant. The geometry of the DWS-RMSAEBG is as shown in the Fig. 4(a). The ground plane is loaded with four arms metalstrip connected to the spiral EBG structure below the radiating patch of the antenna with metalstrip width w= 1mm and the gap between each metalstrip g= 1mm is used to improve the impedance matching and reduce the antenna size. The photographic view of the DWS-RMSAEBG is as shown in the Fig. 4(b).

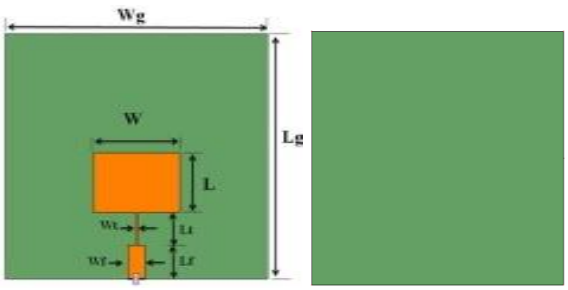

Fig-1 (a): Geometry of RMSA

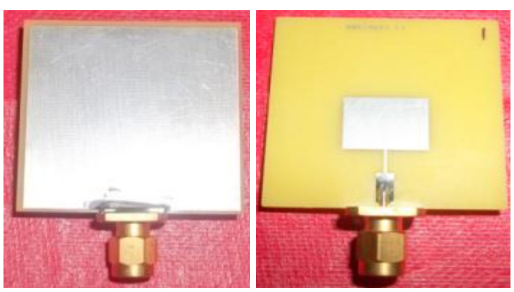

Fig-1 (b): Photographic view of top and bottom RMSA

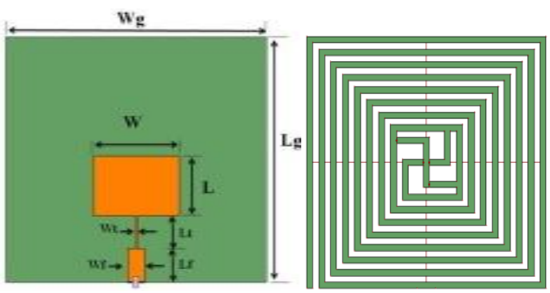

Fig-2 (a): Geometry of RMSA-EBG

Fig.2 (b) Photographic view of top and bottom RMSA-EBG

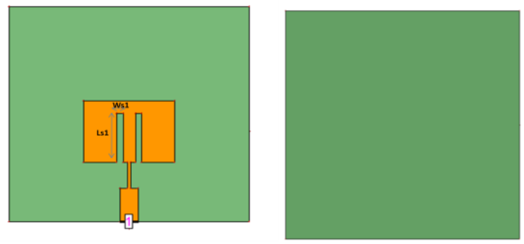

Fig-3 (a): Geometry of DW-RMSA

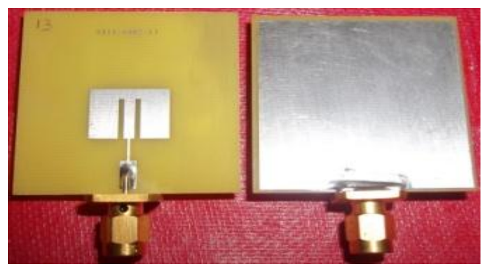

Fig-3 (b): Photographic view of top and bottom DW-RMSA

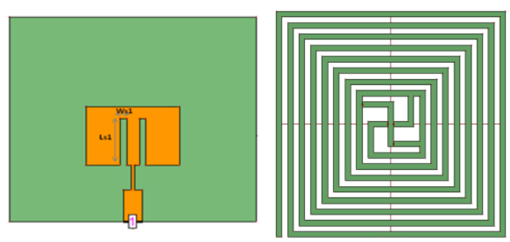

Fig-4(a): Geometry of DWRMSA-EBG

Fig-4(b): Photographic view of top and bottom DW-RMSAEBG

Table-1: Antenna parameters patch, ground plane

Parameters	Size (mm)
Length of the patch(L)	11.33
Width of the patch(W)	15.24
Length of the quarter wave transformer(Lt)	4.92
Width of the quarter wave transformer(Wt)	0.50
Length of the 50 Ω line(Lf50)	6.18
Width of the 50Ω line(Wf50)	3.06
Length of the ground plane(Lg)	40
Width of the ground plane(Wg)	40

3. EXPERIMENTAL RESULTS

The bandwidth over return loss less than -10 dB for the proposed antennas is measured. The measurements are taken on Vector Network Analyzer (Rohde and Schwarz, Germany make ZVK model 1127.8651). The variation of return loss versus frequency of RMSA is as shown in Fig 5. From this figure it is seen that, the antenna resonates very close to its designed frequency of 5.99 GHz. The overall bandwidth of the RMSA is 4.18%.The bandwidth is calculated by using the equation,

$$BW = \left[\frac{f2 - f1}{fc}\right] \times 100\,\%$$

Where, *f*1 and *f2* are the lower and upper cut-off frequencies of the band respectively, when its return loss reaches -10dB and f_C is the centre frequency between *f1* and *f2*.

Fig.6 shows a variation of return loss versus frequency RMSA-EBG which gives six bands. The overall bandwidth of RMSA-EBG is 86.99% this is due to the loading of the EBG structure on the ground plane of the RMSA. The variation of return loss versus frequency of DW-RMSA antenna is as shown in Fig.7 it gives a three bands. The overall bandwidth of DWRMSA antenna is 26.30% this is due to the dual slit in the radiating patch of the RMSA. DWRMSA-EBG gives five bands. The return loss versus frequency of DWRMSA-EBG is as shown in the Fig.8 the overall bandwidth of the antenna is 114.36%.The results are as shown in the table2.

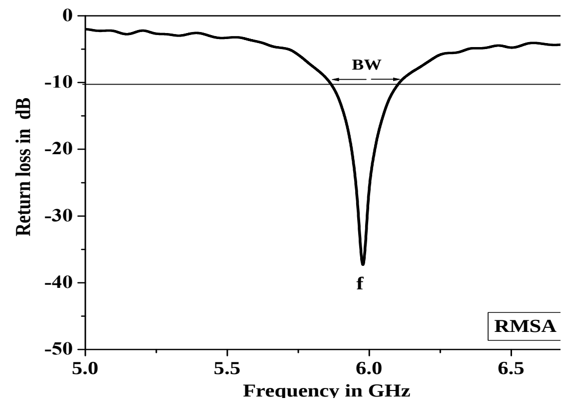

Fig-5: The return loss characteristics versus frequency of RMSA

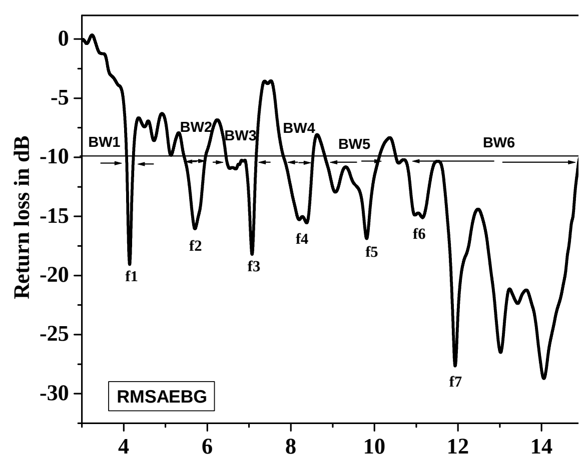

Fig-6: The return loss characteristics versus frequency of RMSA-EBG

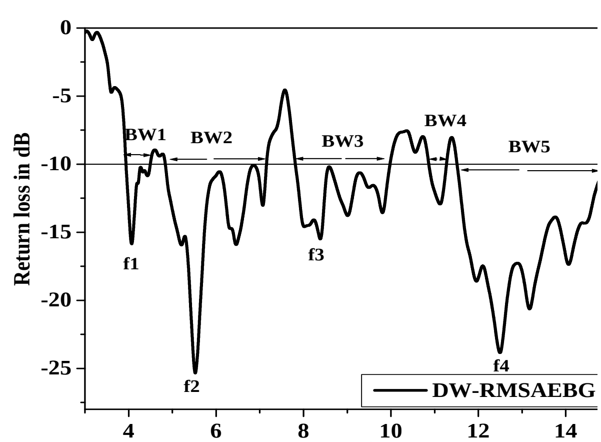

Fig-7: The return loss characteristics versus frequency of DW-RMSA

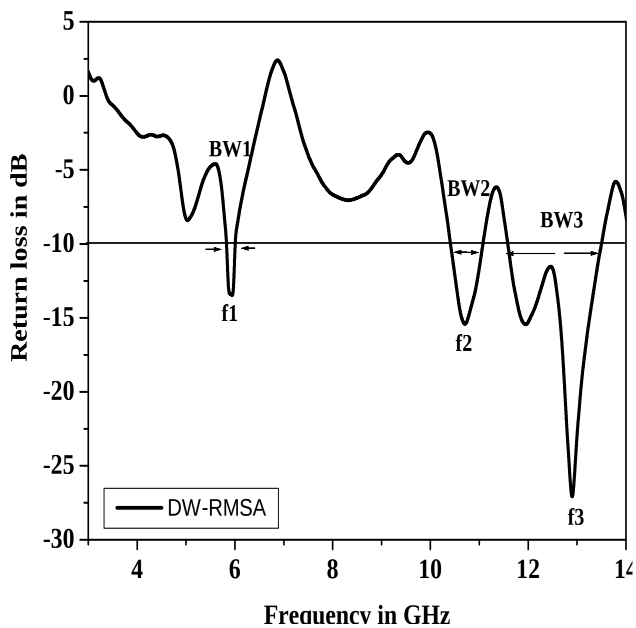

Fig- 8: The return loss characteristics versus frequency of DW-RMSAEBG

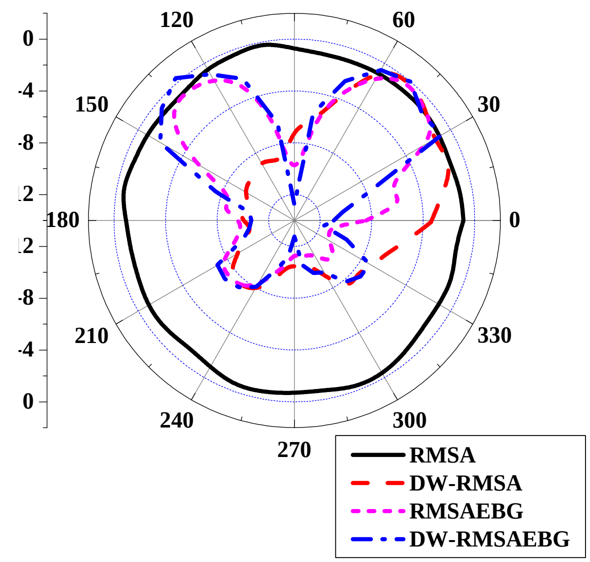

Fig.-9(a): E-plane Radiation pattern of RMSA, DW-RMSA, RMSAEBG, DW-RMSAEBG

Table-2: Results of proposed antenna

Antenna	Resonant Freq. (GHz)	Return loss (dB)	Bandwidth in MHz	Bandwidth in (%)age	Overall Bandwidth in (%)age
RMSA	5.99	-37.21	250	4.18	4.18
RMSA-EBG	4.14 5.67 7.07 8.23 9.05 11.00	-18.98 -15.99 -18.06 -15.27 -12.65 -14.90	22 50 75 68 126 439	5.31 8.81 10.60 8.26 13.92 40.0	86.99
DW-RMSA	5.96 10.71 11.94	-13.50 -15.45 -15.45	22 70 192	3.69 6.53 16.08	26.30
DWRMSA-EBG	4.07 5.52 7.97 11.11 11.92	-15.88 -25.33 -14.46 -12.76 -18.65	57 229 211 46 337	14.0 41.48 26.47 4.14 28.27	114.36

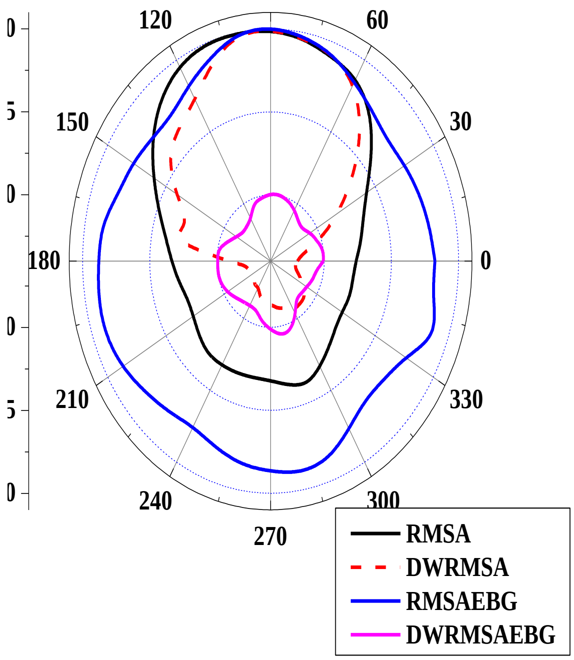

Fig.-9(b): H-plane Radiation pattern of RMSA, DW-RMSA, RMSAEBG, DW-RMSAEBG

4. CONCLUSIONS

A design technique for a high impedance EBG structure with microstrip antenna is described. In this design technique, the shape of the rectangular microstrip antenna is modified with dual slit and then the ground plane is replaced by the spiral EBG structure in order to enhance the bandwidth of the microstrip. In addition, the design technique is simple and easily realized with rectangular microstrip antenna fabrication, making it suitable to various wireless communications applications.

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REFERENCES

[1]. Balanis C.A. (1997) Antenna Theory, 2nd ed., New York: John Wiley & Sons, Inc.
[2]. Dalia M.N. Elsheakh, Hala A. Elsadek and Esmat A. Abdallah Antenna Designs with Electromagnetic Band Gap Structures.
[3]. Mrs. Priti N.Bhagat, Prof. V. B. Baru" Rectangular Slotted Patch Antennas with EBG Structure" International Journal of System, Algorithms & ApplicationsVolume 2, Issue ICRAET12, May 2012,pp 134-136.
[4]. Thakur O.P, Dwari S AND Kushwaha A.K" EnhancemenT of bandwidth by using photonic bandgap structure in microstrip antenna" International Journal of Computational Intelligence Techniques, Volume 3, Issue 2, 2012, pp 112-113.
[5]. Fan Yang And Yahya Rahmat-Samii "Electromagnetic Bandgap Structures In Antenna Engineering", Cambridge University Press, 2009.
[6]. Gaurav Kumar Sharma Narinder Sharma "Analysis of a Rectangular Microstrip Patch Antenna with EBG Structures" International Journal of Computer Applications (0975 – 8887) Volume 84 – No 13, December 2013 pp 39-42.
[7]. Shrikant Verma Monika Chauhan" Performance Enhancement of Butterfly Shape Microstrip Patch Antenna by Using Modified Ground Plane" International Journal of Engineering Technology & Management Research Volume 1, Issue 1 February 2013, pp267-269

BIOGRAPHIES

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