



Enhanced Bandwidth of Rectangular Microstrip Antenna using Uniplanar EBG Cells

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ABSTRACT: In this paper, bandwidth enhancement of a conventional rectangular microstrip antenna using new kind of technique, so called Electromagnetic Band Gap (EBG) cells, is being discussed. This new technique, called Uniplanar Electromagnetic Band Gap (UC-EBG) cells is used to replace the commonly used ground plane of the conventional microstrip antenna (MSA). The conventional MSA showed a percentage bandwidth of 4.18%. After the replacement of the ground plane of the conventional MSA by the UC-EBG the bandwidth is increased greatly to 60.64 %.

KEYWORDS: rectangular Microstrip antenna, uniplanar Electromagnetic Band Gap (EBG), bandwidth.

I. INTRODUCTION

With the rapid development of wireless field, microstrip antennas became more appealing in antenna community. These antennas are low-profile, light weight, low price compactness. A narrow impedance bandwidth is another limitation of microstrip patch antennas. However, surface waves are, a major drawback for this type of antenna as they lower the antenna efficiency [1-2]. Over the past few years the new techniques have been applied to suppress surface wave propagation, namely periodic structures called the Electromagnetic Band Gap (EBG) structures [3]. EBG structures have attracted a great attention due to their unique characteristics in controlling the propagation of electromagnetic waves in specified frequency bands. This property enables the EBG structures to block the propagation of waves and guide them in a desired direction by forbidding the propagation of EM waves in certain frequency band [4]. Therefore, if the EBG structure is applied to the mobile phone, the undesired electromagnetic waves can be prevented. The features of EBG structures are suppressing unwanted substrate modes and acting as an artificial magnetic ground plane [5]. The EBG structures are also used to improve the antenna performance as radiation patterns and to minimize the side and back lobe levels. An EBG structure is a periodic structure that forbids the propagation of all electromagnetic waves within a particular frequency band called the band gap. These structures provide a simple and effective solution to the problems of surface and leaky waves [6]. Several types of microstrip based EBG structures have been analyzed for variety of applications.

In this paper uniplanar EBG cells are loaded on the ground plane of the microstrip antenna to study the performance of the antenna enhance the bandwidth of the conventional Microstrip antenna.

II. ANTENNA AND EBG STRUCTURE

In this paper a conventional microstrip antenna has been designed for 6GHz. The antenna is designed on FR4 with dielectric constant $\epsilon_r = 4.4$ and with the height of $h=1.6\text{mm}$ with the width of $W=1.133\text{mm}$ and the length $L=15.24\text{mm}$ respectively. The antenna is feed by stripline fed $L_{f50}=6.18\text{mm}$ & $W_{f50}=3.06\text{mm}$ to match the impedance and quarter wave transformer $L_t=4.92\text{mm}$ & $W_t=0.5\text{mm}$ is used and ground plane $L_g=40\text{mm}$ and $W_g=40\text{mm}$ is considered for the design. The geometry is as shown in Fig.1 (a) and the photographic view of the conventional MSA antenna is shown in the Fig.1 (b).

Further the study is carried out by replacing the conducting ground plane of the MSA with high impedance surface UC-EBG cells for bandwidth enhancement by keeping all the parameter of the radiating patch and feeding technique constant. The fig.2 (a) shows the antenna with EBG on the ground plane. The geometry of the single enlarged UC-EBG1 cell is shown in the Fig. 2(b). There are 4x4 UC-EBG cells with dimension of 9mmx9mm and a gap between UC-EBG $G=0.75\text{mm}$, the other parameters $s=3\text{mm}$, $t=2\text{mm}$ and the slot $t_s=1\text{mm}$ at the center of the t. The gap

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between s and t is $g=0.5\text{mm}$ and a single enlarged unit of UC-EBG cell is as shown in Fig. 2(b). The photographic view of top and bottom of antenna MSAUC-EBG1 is as shown in Fig. 3(a).

In MSAUC-EBG2 the parameter there are 4×4 UC-EBG cells with dimension of $9\text{mm} \times 9\text{mm}$ and gap $G=0.75\text{mm}$ and $s=3\text{mm}$ are kept constant as that in MSAUC-EBG1. The parameter ' g ' is varied from 1mm to 0.5mm and ' t ' is varied by removing slot ' t '. The geometry of the single enlarged unit of UC-EBG2 is as shown in the Fig.2 (b.) Also the photographic view of the antenna with MSAUC-EBG2 cells is shown in Fig. 3(b).

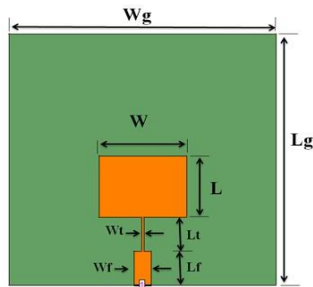


Fig.1 (a) Geometry of MSA

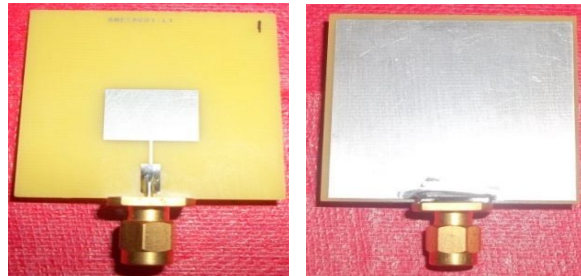


Fig.1 (b) Photographic view of top and bottom MSA

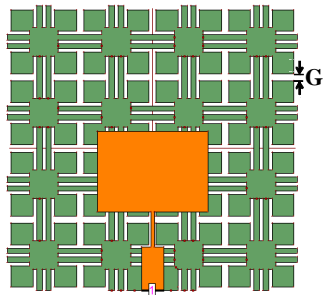


Fig.2 (a) Geometry of MSAUC-EBG1

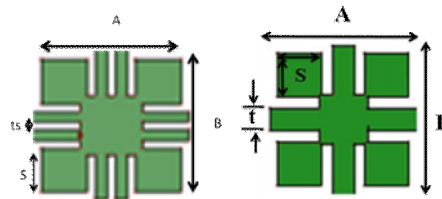


Fig.2 (b) Single enlarged UC-EBG1 cell & UC-EBG2 cell



Fig.3 (a) Photographic view MSAUC-EBG1



Fig.3 (b) Photographic view MSAUC-EBG2

III. EXPERIMENTAL RESULTS

The characteristics of proposed antennas have been experimentally measured with Vector Network Analyzer (Rohde & Schwarz, Germany make ZVK model 1127.28651). The variation of return loss versus frequency characteristics of proposed antennas, MSA, MSAUC-EBG1 & MSAUC-EBG2 are shown in Fig.4, 5 & 6. From the Fig.4, it is found that, the antenna MSA resonates at $f=5.99\text{GHz}$ and gives a bandwidth of 4.81%. From this Fig.5, it is clear that by loading & UC-EBG cells on the ground plane there is enhancement of bandwidth of the rectangular Microstrip antenna i.e., MSAUC-EBG1 is giving multifrequency with increase in bandwidth. It is found that, the antenna MSAUC-EBG1 gives a three bands with $f_1 = 6.99\text{GHz}$, $f_2 = 8.86\text{GHz}$, $f_3 = 10.87\text{GHz}$ and the overall bandwidth of MSAUC-EBG1 is 57.11%. Similarly MSAUC-EBG2 operates between 5GHz to 14GHz gives six bands

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with $f_1=5.19$ GHz, $f_2=5.90$ GHz, $f_3=7.43$ GHz, $f_4=9.22$ GHz, $f_5=11.10$ GHz, $f_6=13.41$ GHz, so the overall bandwidth measured for MSAUC-EBG2 is 60.64%.The proposed antennas are compared with conventional MSA. All the results are reported in table1.

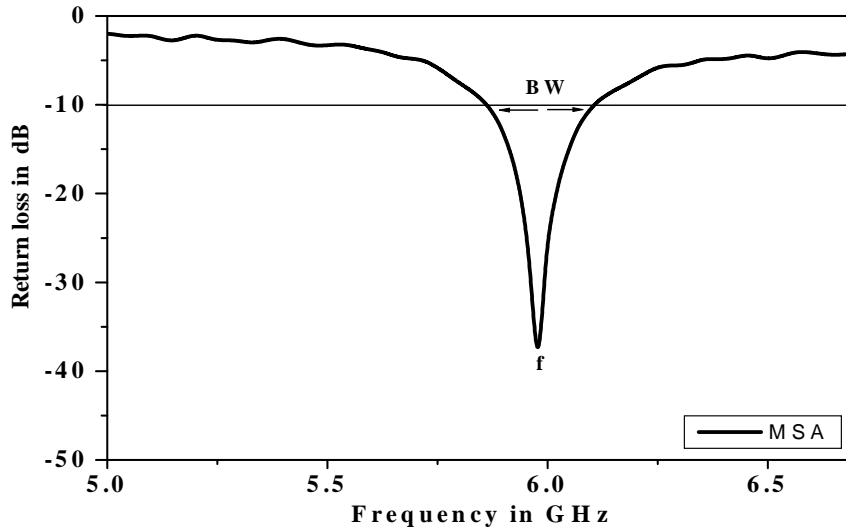


Fig.4 Variation of return loss versus frequency of MSA

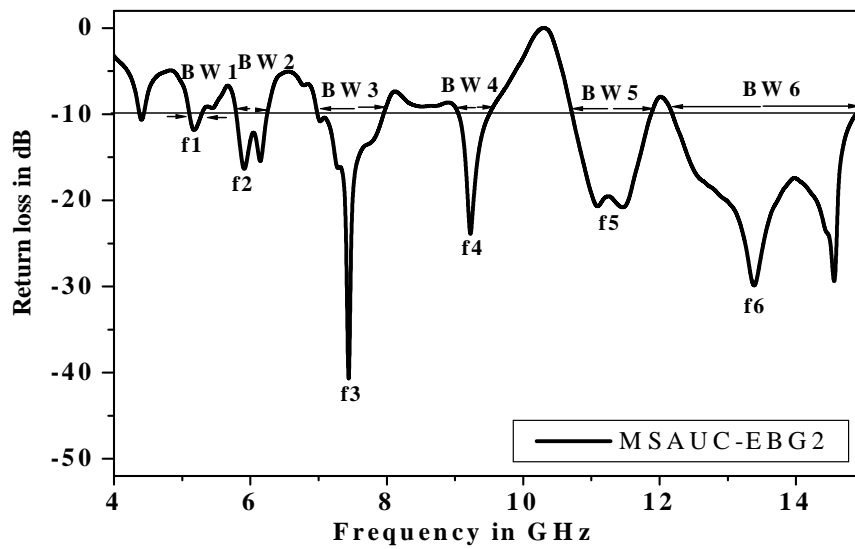


Fig.5 Variation of return loss versus frequency of MSAUC-EBG1

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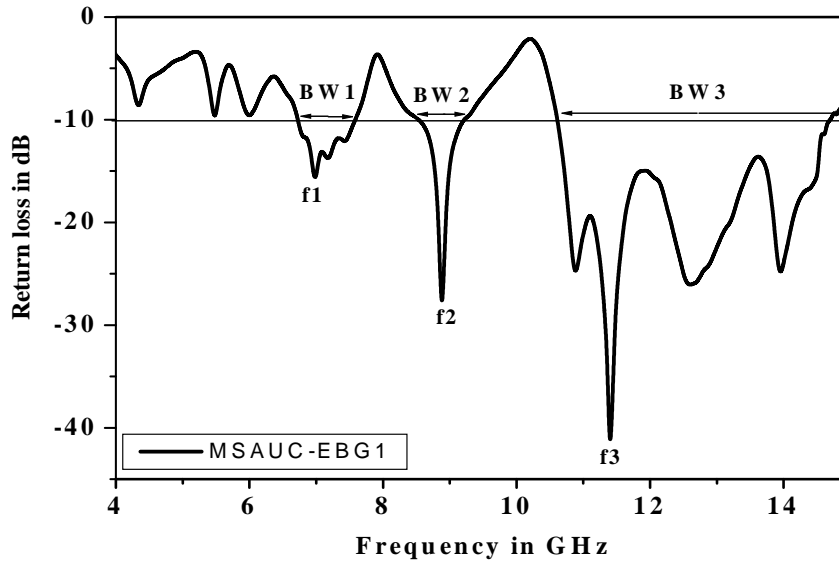


Fig.6 Variation of return loss versus frequency of MSAUC-EBG2

Antenna	Resonant Frequency (GHz)	Return loss (dB)	Bandwidth in MHz	Bandwidth in (%)age	Overall Bandwidth in (%)age
MSA	5.99	-37.21	250	4.18	4.18
MSAUC-EBG1	6.99	-15.45	82	11.73	57.11
	8.86	-27.65	68	7.67	
	10.87	-24.19	41	37.71	
MSAUC-EBG2	5.19	-11.51	19	3.6	60.64
	5.90	-16.13	46	7.79	
	7.43	-40.18	93	12.51	
	9.22	-23.83	43	4.6	
	11.10	-20.62	11	9.90	
	13.41	-29.76	276	22.24	

Table1: Results of all the proposed antennas

For the measurement of radiation pattern, the antenna under test (AUT) i.e., the proposed antennas and standard pyramidal horn antenna are kept in far field region. The AUT, which is the receiving antenna, is kept in phase with respective transmitting pyramidal horn antenna. The power received by AUT is measured from -0^0 to $+360^0$ with the steps of 10^0 . The E-plane radiation patterns of conventional MSA, MSAUC-EBG1 & MSAUC-EBG2 are measured and are shown respectively in Fig.7. Fig.8 gives H-plane patterns of proposed antennas. From these figures it is clear that, there is reduction in back lobes of the MSAUC-EBG1 and MSAUC-EBG2.

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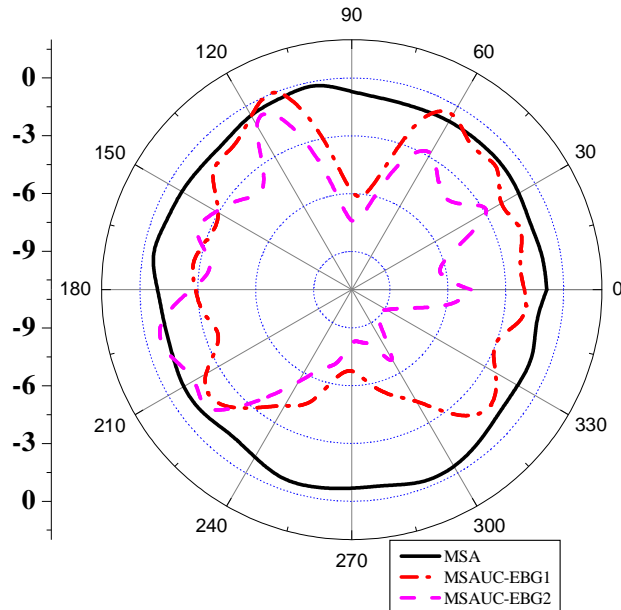


Fig.7. Radiation pattern of E-plane of MSA& MSUC-EBG1 & MSAUC-EBG2

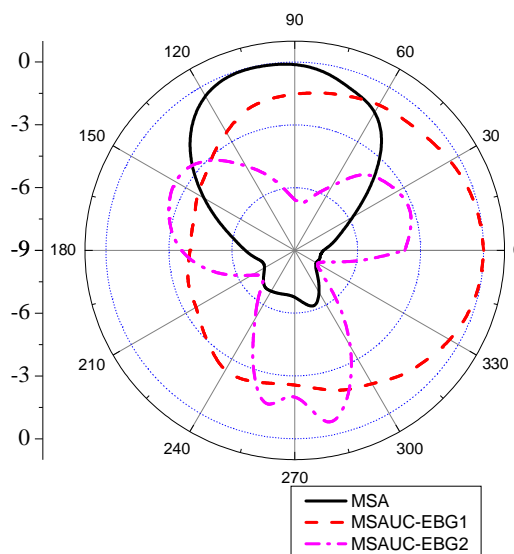


Fig.8. Radiation pattern of H-plane of MSA& MSUC-EBG1 & MSAUC-EBG2



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IV. CONCLUSIONS

A microstrip antenna with enhanced bandwidth using a uniplanar electromagnetic band gap structure design based on EBG technique has been presented. The proposed design helps to achieve multiband and enhancement in the bandwidth of 60.64% after loading UC-EBG cells on the ground plane, which makes the antenna useful for wireless applications.

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REFERENCES

1. M.S. Alam, M.T. Islam and N. Misran "Design Analysis of an Electromagnetic Band Gap Microstrip Antenna", American Journal of Applied Sciences 8 (12): pp 1374-1377, 2011.
2. Anamika Singh, Aadesh Arya & Sanjay Sharma "High Gain of C Shape Slotted Microstrip Patch Antenna for Wireless System", International Journal of Applied Engineering Research, Vol.7, No.11 (2012).
3. Aijaz Ahmed, Yogesh " Electromagnetic Band Gap Coupled Microstrip Antenna for UWB Applications", IOSR Journal of Electronics and Communication Engineering (IOSRJECE) Vol. 2, Issue 6 (Sep-Oct 2012), pp 01-03.
4. O.Rangarao, M. Grace Priscilla, D.N. Bhushan Babu, J. Naveen, T. Vijay Sundeep, E. Raghu "Effect of EBG Presence on Elliptical Patch Antenna", International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 4, April 2013 pp 1892-1895.
5. Gaurav Kumar Sharma, Narinder Sharma " Improving the Performance Parameters of Microstrip Patch antenna by using EBG Substrate" IJRET: International Journal of Research in Engineering and Technology Volume: 02 Issue: 12 Dec-2013, pp 111-115.
6. Chandan Kumar Ghosh, Biswarup Rana, S. K. Parui "Performance Enhancement of Microstrip Patch Antenna Array with EBG Structure", IJEC Vol. 2, Issue 4, Oct. - Dec. 2011, pp 280-283.

BIOGRAPHY

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