



Study of Uniplanar EBG Cells with Rectangular Microstrip Antenna

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ABSTRACT: Wideband antenna is highly demandable due to the dynamic development in the wireless technology. In this paper, we propose a new design of rectangular microstrip antenna based on the EBG Cell loading technique. By incorporating the Uniplanar Electromagnetic Band Gap (EBG) Cells on the ground plane of the rectangular microstrip Antenna, the enhanced performance of the antenna can be enhanced. Here we have studied and compared Conventional Rectangular Microstrip Antenna (CRMA) antenna performance with and without EBG cells. Comparison result shows that the bandwidth of CRMA is enhanced by loading EBG cells and the bandwidth increases to 62.45%. Also with EBG cells there is reduction in the back lobe radiations.

KEYWORDS: Rectangular Microstrip Antenna, Uniplanar Electromagnetic Band Gap (EBG), parameters, Bandwidth.

I. INTRODUCTION

Recent advances in wireless communications, radar, satellite and space programs have introduced tremendous demands in the antenna technology. Among the various types of antenna, Microstrip antennas are of special interest because of their light weight, low profile, compactness and compatibility with integrated circuits, though they suffer from some drawbacks e.g., narrow bandwidth, low gain and excitation of surface waves [1]. To overcome these limitations, new methods are still being explored and the interesting features of Electromagnetic Band Gap (EBG) structure have attracted the antenna researchers. Usually, the Electromagnetic Band Gap (EBG) cells are periodical structures composed of metallic or dielectric elements [2, 3]. Addition of defects into the periodical structure, exhibits the ability to reject the propagation of the electromagnetic waves whose frequency is included within their frequency band gap and to open localized electromagnetic modes inside the forbidden frequency band (Yablonovitch, 1987) [4]. EBG always referred as high impedance surface that increase antenna surface efficiency by suppressing the unwanted surface wave current. Suppression of surface waves excitation helps to improve antenna's performance such as, it reduces backward radiation [5,6]. In this study, CRMA with uniplanar EBG cells in the ground plane is considered and the parameter such as width of the slot of uniplanar EBG cell is varied & the performance is observed.

II. ANTENNA DESIGN

The CRMA is designed and fabricated on low cost glass epoxy substrate of relative permittivity with $\epsilon_r=4.4$, $h=1.6\text{mm}$ with length of the patch $L=11.33\text{mm}$ & width of the patch $W=15.24\text{mm}$. The radiating patch is fed by microstrip feed line $L_{f50}=6.187\text{mm}$ & $W_{f50}=3.06\text{mm}$ to match the impedance and quarter wave transformer $L_t=4.922\text{mm}$ & $W_t=0.5\text{mm}$ is used and ground plane of $(40\text{m}\times 40\text{m})$ is considered for the design. The geometry of the CRMA is as shown in Fig1 (a). The photographic top and bottom view of the CRMA is as shown in Fig.1 (b).

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 3, March 2014

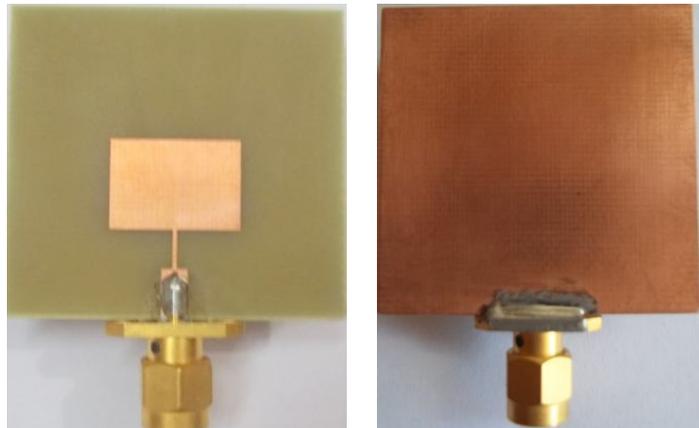
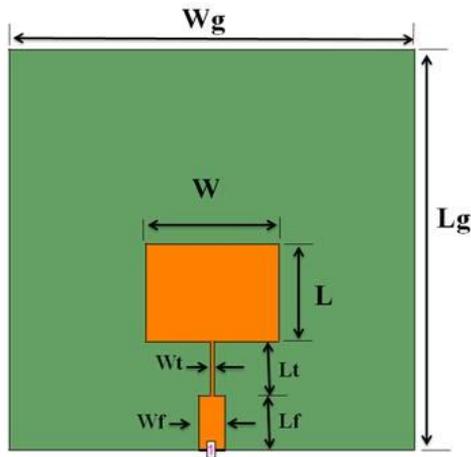


Fig.1 (a) The Geometry of the CRMA

Fig.1 (b) Photographic view of Top & Bottom of CRMA

Now we replace the conducting ground plane with the uniplanar EBG cells and the study is made for bandwidth enhancement. The geometry of the antenna with uniplanar EBG cells is shown in the Fig. 2(a). The enlarged view of the EBG cell is shown in the Fig. 2(b). There are 4x4 EBG cells with dimension of 9mmx9mm and a spacing $g=0.75\text{mm}$, the other parameters $s=3\text{mm}$ and t are shown in Fig. 2(b). The parameter t is varied from 1.5mm to 0.5mm and the performance of the antenna has been studied. The antenna with uniplanar EBG in which $t=1.5\text{mm}$ is treated as RMA1. The antenna with EBG in which $t=0.5\text{mm}$ is treated as RMA2. The characteristics of these antennas are studied & compared with CRMA. Also the photographic view of the antenna with Uniplanar EBG cells is shown in Fig. 3(a) & 3(b).

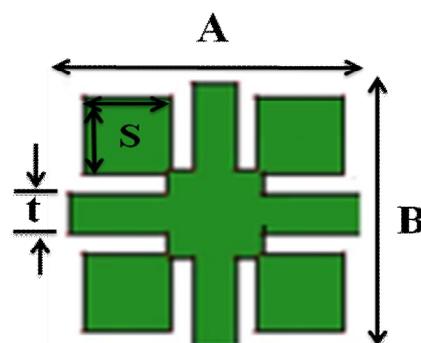
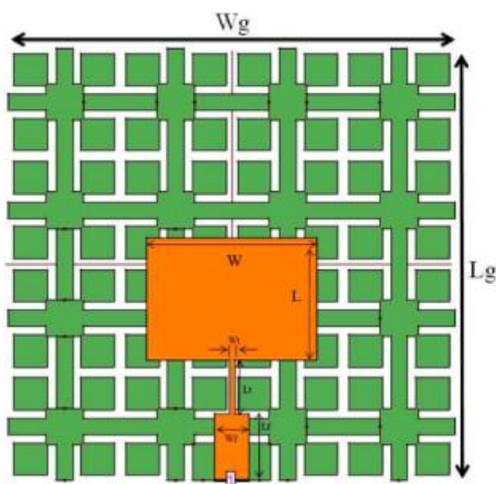


Fig.2 (a) Geometry of RMA1

Fig.2 (b) Single enlarged Uniplanar EBG cell

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Vol. 3, Issue 3, March 2014

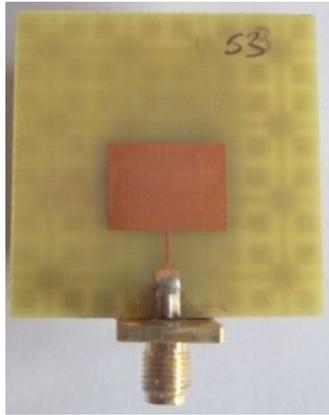


Fig.3 (a) Top view of RMA1

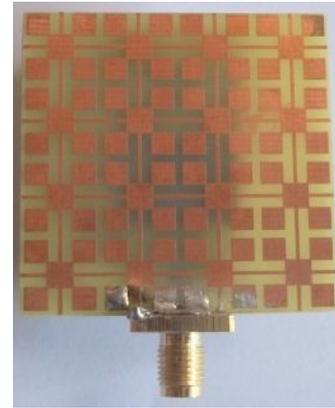


Fig.3 (b) Bottom Photographic view of RMA1& RMA2

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, CRMA, RMA1 & RMA2 are shown in Fig.4 (a) & 4(b). The antenna with EBG i.e., RMA1 & RMA2 are giving multifrequency with increase in bandwidth.

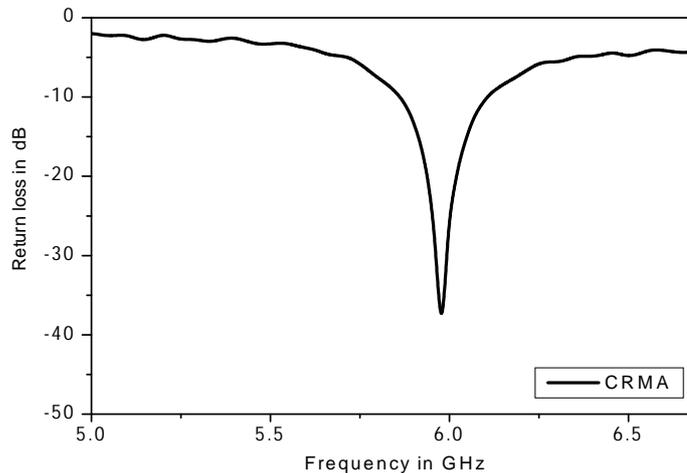


Fig.4 (a) Variation of return loss versus frequency of CRMA

From the figure 4(a), it is found that, the antenna CRMA resonates at $f=5.99\text{GHz}$. From this figure 4(b), it is found that, the antenna RMA1 operates between 5 to 13 GHz and gives a four bands with $f_1 = 5.73\text{GHz}$, $f_2 = 8.34\text{GHz}$, $f_3 = 10.37\text{GHz}$ and $f_4 = 12.37\text{GHz}$. Similarly RMA2 operates between 4GHz to 13GHz and gives six bands with $f_1 = 4.8\text{GHz}$, $f_2 = 6.04\text{GHz}$, $f_3 = 6.8\text{GHz}$, $f_4 = 8.0\text{GHz}$, $f_5 = 10.1\text{GHz}$ and $f_6 = 12.4\text{GHz}$. So the overall bandwidth measured for RMA1 is 56.33% & for RMA2 is 62.45%. All the results are reported in table1.

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 3, March 2014

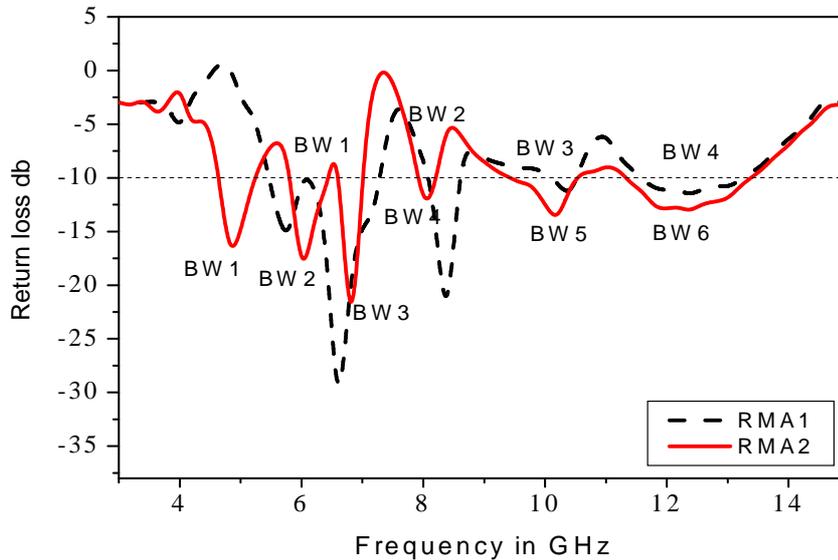


Fig.4 (b) Variation of return loss versus frequency of RMA1 & RMA2

Antenna	Resonant Freq.(GHz)	Return loss (dB)	Band width in MHz	Bandwidth in (%)age	Overall Bandwidth in (%)age
CRMA	5.99	-15.25	176	2.93	2.05
RMA1 t = 0.5mm	5.73 8.34 10.37 12.37	-14.83 -20.84 -11.13 -11.31	BW1=182 BW2=55 BW3 =37 BW4=177	BW1=31.88 BW2=6.59 BW3=3.56 BW4=14.30	56.33
RMA2 t=1.5mm	4.87 6.04 6.85 8.06 10.18 12.45	-16.43 -17.42 -21.54 -11.92 -13.43 -12.98	BW1=61 BW2=61 BW3=46 BW4=36 BW5=112 BW6=206	BW1=12.57 BW2=10.14 BW3=6.82 BW4=4.55 BW5=10.81 BW6=16.55	62.45

Table1: Results of proposed antennas

The radiation patterns of the designed antennas at the resonant frequencies are also measured and plotted. For the measurement of radiation patterns, the antenna under test (AUT), i.e. the designed antennas and standard pyramidal horn antenna are kept in the far field region. The received power by AUT is measured from 0° to 360° with the rotational motion at steps of 10° each. The H-plane patterns of CRMA, RMA1 & RMA2 are shown in fig. 5(a). The E-plane patterns of CRMA, RMA1 & RMA2 are shown in Fig. 5(b). From the radiation patterns it is observed that the

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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antenna RMA2 has more reduction in backlobe radiations compared to RMA1 & CRMA. This shows the back lobe radiations are reduced with uplanar EBG structure compared to CRMA.

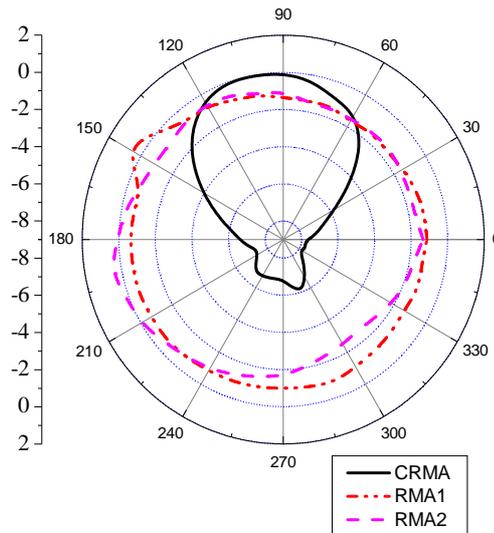


Fig. 5(a) H-plane Radiation pattern of CRMA& RMA1 & RMA2

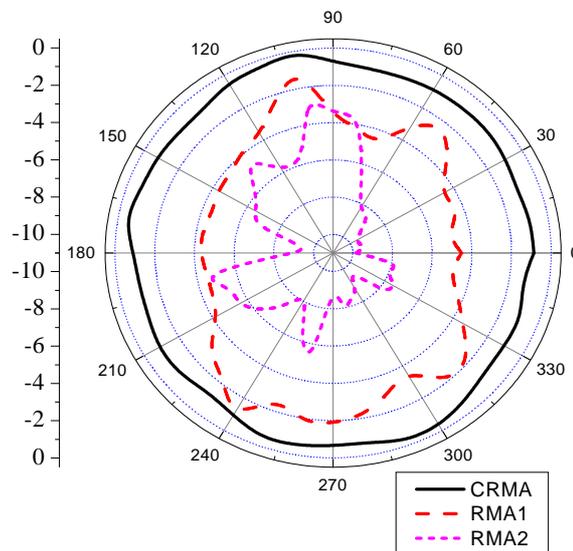


Fig. 5(b) E-plane Radiation pattern of CRMA RMA1 & RMA2



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IV CONCLUSION

The paper investigated the bandwidth improvement of Rectangular microstrip antenna by using Uniplanar EBG cell on the ground plane of the antenna. Also the antenna with EBG operates in multibands with enhancement of bandwidth to 62.45% compared to conventional antenna (CRMA). By observing the radiation patterns, it is clear that there is backlobe reduction with EBG structure. These antennas may find application in wireless communication system.

ACKNOWLEDGMENT

The authors would like to convey thanks to the department of science & technology (DST) government of India, New Delhi, for sanctioning vector Network analyzer to this department under FIST project.

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BIOGRAPHY



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ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 3, March 2014

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