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Rectangular Patch Antenna With EBG Enabled DGS For UWB Applications

[1]Manoj Kr. Sain, [2]Subhi Jain, [3]Pankaj Kr. Goswami &[4]Garima Goswami
[1]M.Tech Scholar SKIT, Jaipur, Rajasthan, India
[2]Asst. Prof. SKIT, Jaipur, Rajasthan, India
[3,4]Associate Professor, JNU, Jaipur, Rajasthan, India
Email- sain439@gmail.com

Abstract
The versatility is only in the inclusion of multiple band of operation in wireless technology, while the patch antennas are the most crucial key factors of this mode of communication. Patch antennas have a rapid growth of its importance in the field of wireless communication due to ease of fabrication and versatility of possible geometries. It is area of concern to design a suitable antenna of high bandwidth with compact geometry for commercial applications. The purpose of this paper is to design a compact size high bandwidth microstrip patch antenna with promising efficiency for wire-less applications. A Rectangular shape microstrip patch antenna, has become always an area of interest for wideband operations, operating in dual band, with EBG structure is proposed. A Rectangular shape strip feed antenna with Electronic band gap structure on ground plane could be able to improve bandwidth about 8.3 GHz in the band of frequency 3.7-12 GHz. *The results are simulated & depicted with the help of full wave simulator HFSS.*
Keywords: *microstrip antenna;Electronicbandgap structure; bandwidth; probe feed antenna.*

1- INTRODUCTION

The basic configuration of a microstrip antenna is a metallic patch printed on a thin, grounded dielectric substrate [1]. Originally, the element was fed with either a coaxial line through the bottom of the substrate, or by a coplanar micro strip line. allows feed networks and other circuitry to be fabricated on the same substrate as the antenna element, as in the corporate- fed micro strip array shown in The micro strip antenna radiates a relatively broad beam broadside to the plane of the substrate. Thus the micro strip antenna has a very low profile, and can be fabricated using printed circuit (photolithographic) techniques. This implies that the antenna can be made conformable, and potentially at low cost. Other advantages include easy fabrication into linear or planar arrays, and easy integration with microwave integrated circuits. Disadvantages of the original microstrip antenna con- figurations include narrow bandwidth, spurious feed radiation, poor polarization purity, limited power capacity, and tolerance problems. Much of the development work in microstrip antennas has thus gone into trying to overcome these problems, in order to satisfy increasingly stringent systems requirements. This effort has involved the development of novel microstrip antenna configurations, and the development of accurate and versatile analytical models for the understanding of the inherent limitations of microstrip antennas, as well as for their design and optimization [1].

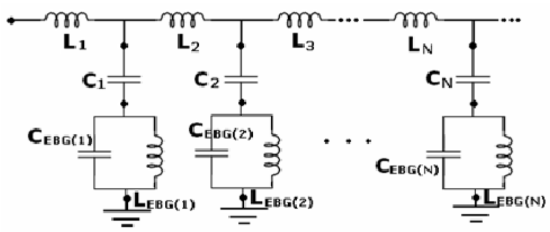


Fig.1 EBG equivalent diagram

The use of Electronic Band Gap (EBG) structure is becoming attractive for many researchers in electromagnetic and antenna field. EBG had been used to improve the performance of various antennas such as patch antenna and resonant antenna. Microstrip patch antenna is promising to be a good candidate for wireless technologies. Microstrip patch antenna consists of a dielectric substrate, with a ground plane on the other side. Due to its advantages such as low weight , low profile planar configuration, low fabrication costs and capability to integrate with microwave integrated circuits technology, the microstrip patch antenna is very well suited for applications such as wireless communications system, cellular phones, pagers, Radar systems and satellite communications systems [1, 2, 3].

Electromagnetic Band Gap (EBG) or Electronic Band Gap (EBG) materials are periodic dielectrics, which can stop the propagation of electromagnetic waves in certain directions, within certain frequency bands [4]. Several types of EBG or EBG substrates have been investigated [5]. It has been reported that EBG or EBG materials used with microstrip patch antennas can improve their radiation patterns, increase their gain, and reduce the side lobe and back lobe levels. Also, some research has been reported on improving the antenna bandwidth by using EBG [6]. EBG has been used in the ground plane to improve the bandwidth as shown in figure 1.

Finally a Rectangular micro strip patch antenna [7] with EBG structure gives a new dimension to antenna performance. The simulation results depiction makes this very clear as the various parameters like bandwidth, VSWR, efficiency, radiation pattern are affected significantly.

2- ANTENNA DESIGN

The proposed antenna consists of a dielectric substrate glass epoxy with dielectric constant 4.2. As compare to conventional rectangular patch antenna of similar size, insertion of four square cut EBG structure on ground plate make its performance batter, while creation of Rectangular on patch layer put a very effective results in its all parameter along with enhancement in its band width. A simple rectangular patch with given design specification is shown in fig.2.The positive side of proposed antenna is shown in fig.2, while negative side which is deformed ground structure is shown in fig.3.The final modified structure is enabled with Rectangular Patch with deformed and EBG enabled geometry in figure 4. The simulation results will be shown in figure.

The new design of proposed antenna consists of following design specifications

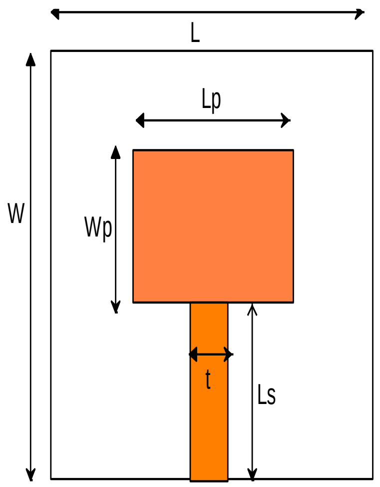


Fig.2 Simple Rectangular patch MSA

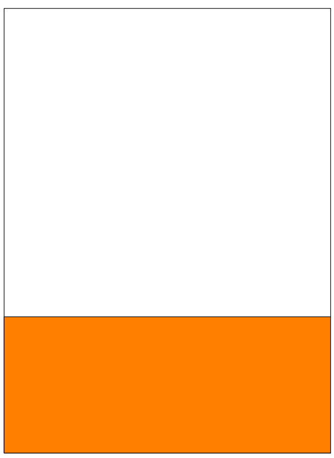


Fig.3 Deformed ground structure

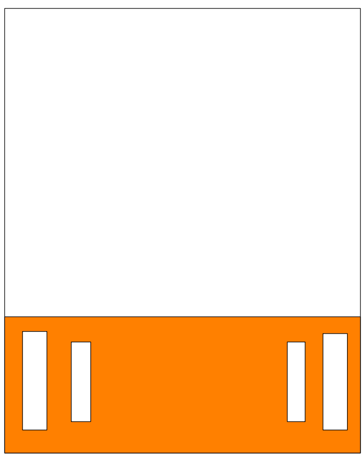


Fig.4 Deformed Ground with EBG

3- ANTENNA DESIGN

The effective length of the patch Leff now become

$L_{eff} = L + 2\Delta L$

$$\Delta L = 0.412h \frac{\varepsilon_{reff}+0.3}{\varepsilon_{reff}-0.258}\left(\frac{W/_h+0.264}{W/_h+0.813}\right)$$

For a given resonant frequency fo, the effective length is

$$L_{eff} = \frac{C}{2f_0\sqrt{\varepsilon_{reff}}}$$

For a rectangular microstrip patch antenna, the resonance frequency for any TM mn mode is given by James and Hall as:

$$f_0 = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right]^{0.5}$$

Where m and n are modes along L and W respectively.

The width W is

$$W = \frac{C}{2f_0}\left(\frac{\varepsilon_r+1}{2}\right)^{-0.5}$$

Where fo = Resonant frequency

C =speed of light in free-space

4- DESIGN SPECIFICATIONS

Parameters	Dimension (mm)
Length of ground plate:	18 mm
Width of ground plate	21 mm
Length of patch:	12 mm
Width of patch	9 mm
Height of dielectric substrate:	1.5 mm
Length of EBG structure:	6 mm
Width of EBG structure:	2 mm
No. of EBG square cut on ground plate	04

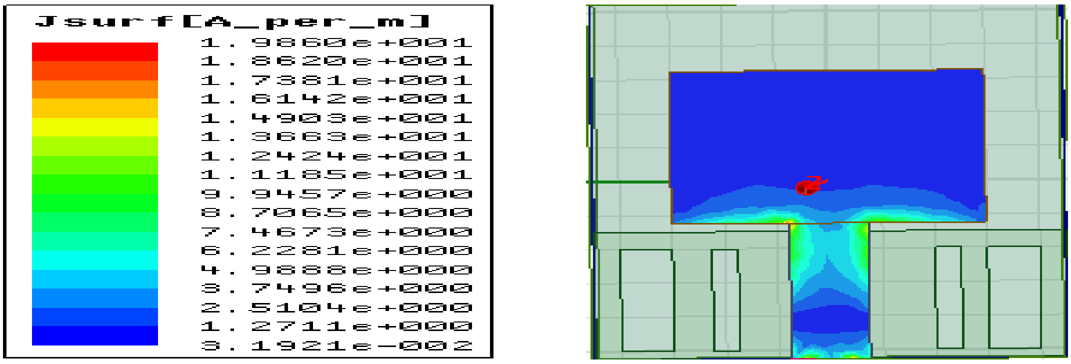


Fig. 5 Current distribution

Fig. 5 shows current distribution in rectangular patch with EBG enabled ground structure that simply shows the radiating characteristics of patch.

5- DESIGN SPECIFICATIONS

A- S11 parameter:

The simulated graph shows the variation of return loss parameter with frequency for both microstrip patch antenna with and without PBG. The graph of not PBG microstrip patch antenna shows a bandwidth of 2.4 GHz and return loss of -27dB. The graph of microstrip patch antenna for PBG shows the bandwidth of 8.3 GHz and return loss of-32dB.As from the comparision it is clear that the having PBG provide a good results.

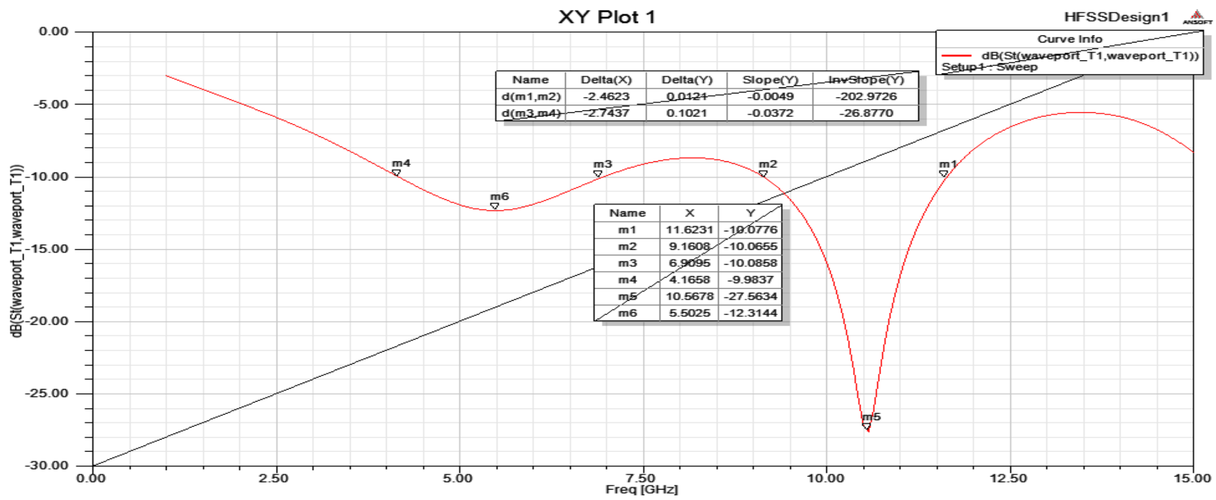


Figure: 6 1 S- parameters of Rectangular Patch

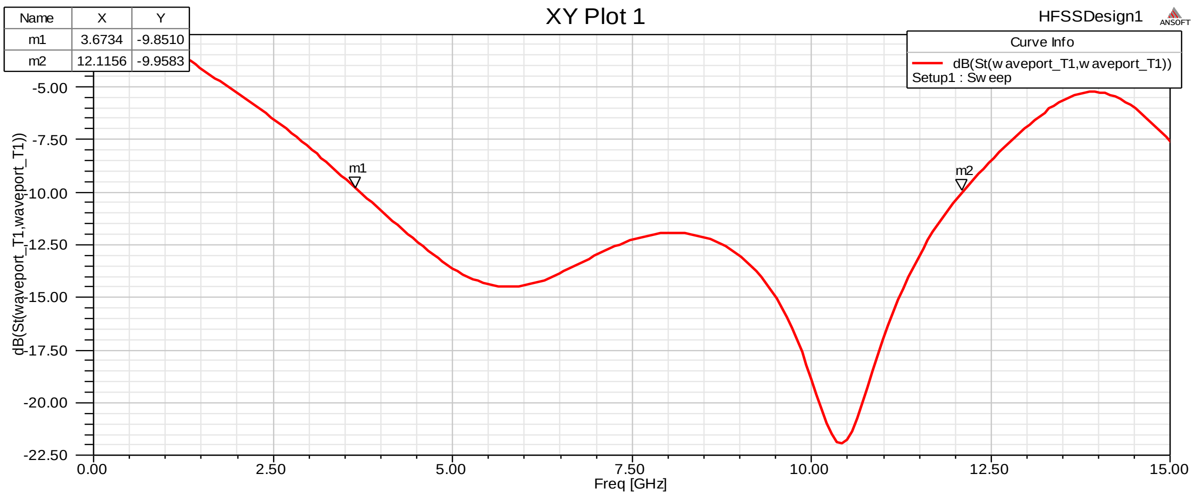
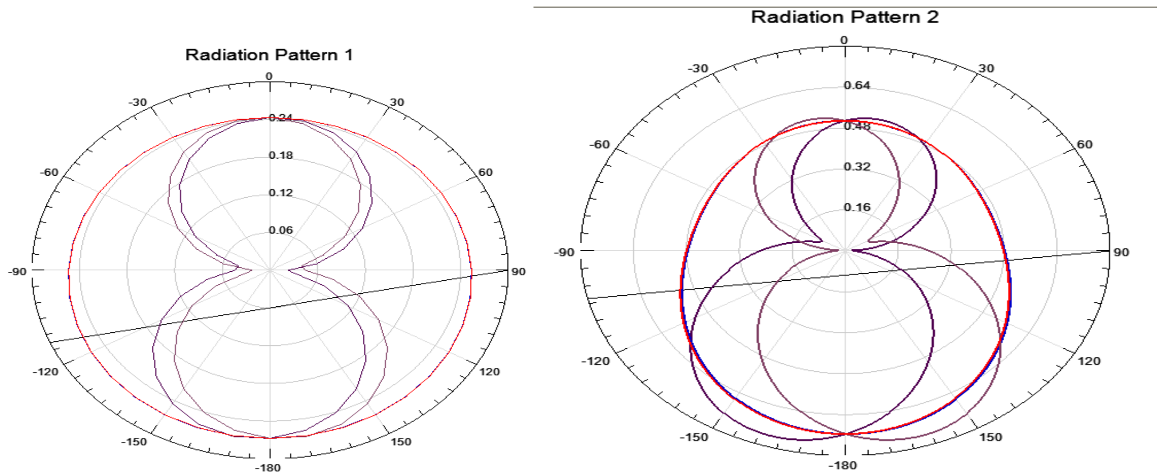


Fig.7 S11 of Modified Patch with deformed ground PBG

B- Radiation Pattern:



(a) (b)

Fig.8 Radiation Pattern (a) Without PBG (b) With PBG

C- VSWR:

The Voltage Standing Wave Ratio (VSWR) is an indication of the amount of mismatch between an antenna and the feed line connecting to it. The range of values for VSWR is from 1 to ∞. A VSWR value under 2 is considered suitable for most antenna applications. The antenna can be described as having a good match. So when someone says that the antenna is poorly matched, very often it means that the VSWR value exceeds 2 for a frequency of interest. For a good antenna the value of VSWR Should be less than 2 As from the simulation graph it is clear that the antenna is simulated at three frequencies 10.56 GHz. The values of VSWR are 1.08 and 1.17 which is less than 2.

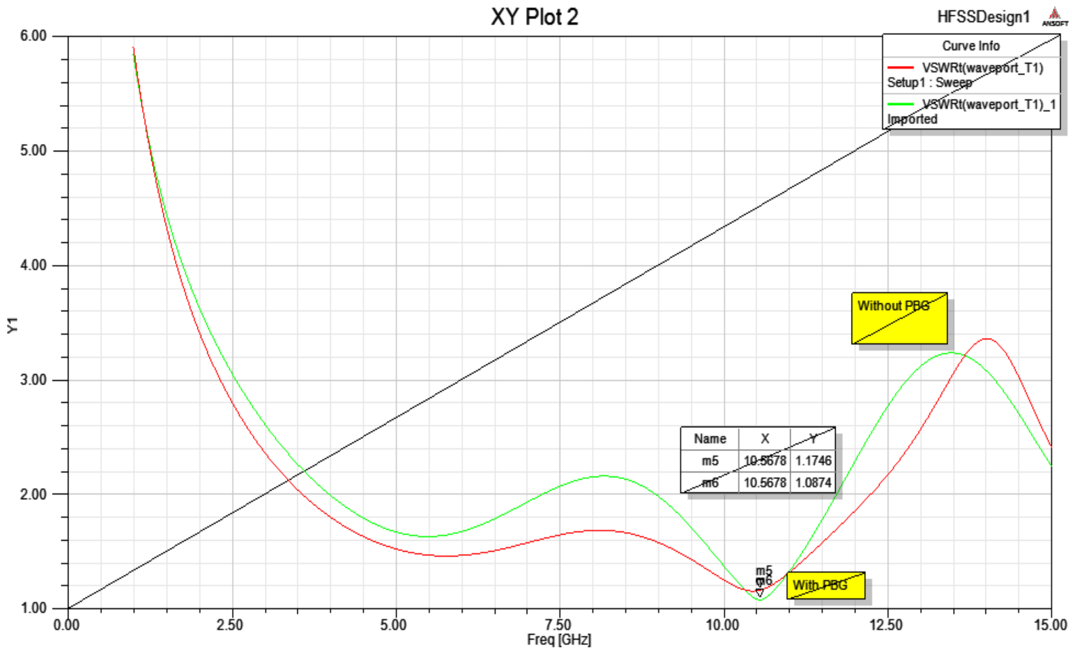


Fig.9 VSWR

Table 1. The comparison between simple Rectangular patch antenna & proposed Rectangular shape antenna with PBG structure

Parameters / Antenna type	Bandwidth	Return loss (dB)
Rectangular Patch MSA without EBG	2.4 GHz	-27
Rectangular MSA with EBG	8.3 GHz	-32

6- CONCLUSION

The simulation results of proposed antenna have shown an enhancement of bandwidth from 2.4 GHz. to 8.3 GHz. In the respective band of frequency 9.1 to 11.62 GHz to 3.7 to 12 GHz band. The modifications with the help of insertion of EBG structure and conversion of square patch into Rectangular shape gives a good result as the bandwidth enhancement with promising efficiency as well as compatible Ultra band operation. Hence the proposed antenna deserves perfectly for various wireless UWB applications due to its compact size and improved performance.

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