ISSN: 2455-1848
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & GROWTH
VOLUME-II ISSUE-VI APRIL-2016
WWW.IJIRG.COM

# A Comparative Study On Effective Improvement In Bandwidth Of Modified Geometry Square Patch Antenna Using Band Gap Structure Formation

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***Abstract***
*The purpose of this paper is to design a compact size high bandwidth microstrip patch antenna with promising efficiency for various wire-less applications. A modified antenna design is proposed to enhance the bandwidth of 30x30 mm rectangular patch antenna via conversion of rectangular patch into U- shape. It is found that bandwidth is improved significantly where as the addition of square PBG structure on ground plane and a parasitic rectangular patch on top surface provide a very good improvement in bandwidth keeping other parameters satisfied. The MOM (method of moment) based technique is used to analyze proposed antenna. The proposed antenna design is able to improve bandwidth about* 39.51% *in the band of frequency* 1.5-2.3 GHz *with centre frequency 2.029 GHz.*
***Keywords:*** *microstrip antenna, photonic bandgap structure, bandwidth, probe feed antenna, MOM.*

## Introduction

It has become very important to microstrip patch antennas family to focus on its bandwidth enhancement rapid growth in its importance in the field of wireless communication due to ease of fabrication and versatility of possible geometries. It is still being the part of development, to design a suitable antenna of high bandwidth with compact geometry for commercial applications. 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 [1,2].

The use of Photonic Band Gap (PBG)[3] structure is becoming attractive for many researchers in electromagnetic and antenna field. PBG 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[3,4,].

Electromagnetic Band Gap (EBG) or Photonic Band Gap (PBG) materials are periodic dielectrics, which can stop the propagation of electromagnetic waves in certain directions, within certain frequency bands [4,5]. Several types of EBG or PBG substrates have been investigated [5]. It has been reported that EBG or PBG 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 PBG [6].

**Method of moment (MOM)**

Microstrip antenna models that account for the dielectric substrate in a rigorous manner are referred to as full-wave solutions. These models usually assume that the substrate is infinite in extent in the lateral dimensions, and enforce the proper boundary conditions at the air-dielectric interface. This is most commonly done by using the exact Green's function for the dielectric substrate, which allows space wave radiation, surface wave modes, dielectric loss, and coupling to external elements to be included in the model.Using the Green's function in a moment method solution.Green's function moment method solutions for printed antennas generally employ the electric field integral equation to solve for the unknown currents on antenna elements and feeds. This is done by expanding the unknown electric and/or magnetic currents in a set of expansion modes, then using a set of weighting modes to discretize the integral equation. The key step in this process is the evaluation of impedance matrix elements that involve the integration of the fields due to an expansion mode multiplied by a weighting mode[1,2].

Finally a U-shape micro strip patch antenna & its parasitic patch [7] with PBG structure give 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.

**Antenna design & specifications**

The rectangular patch antenna of size 30x30 mm on ground plane of size 45x45 mm [fig.1] is being converted into a new dimension of U-shape along with additional parasitic patch [fig.2] on same layer. The conversion helps in reduction of overall patch area while formation of PBG structure on ground plane[fig.3] causes to improve overall antenna performance. The proposed antenna [fig.2] consists of a commercial available FR-4 dielectric substrate glass epoxy with dielectric constant 4.2 and height of 1.6 mm. As compare to conventional rectangular patch antenna of similar size, the proposed antenna could be able to make significant change in bandwidth under satisfactory values of other parameter. The new design of proposed antenna consists of following design specifications:

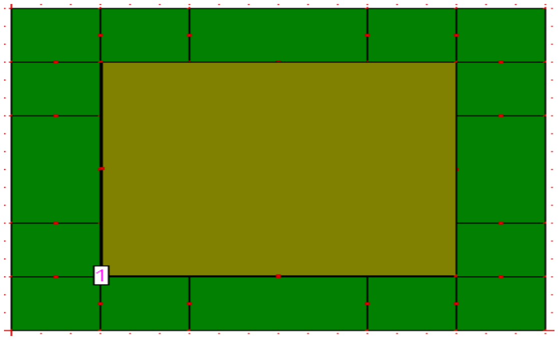

Figure-1 Simple Square patch MSA

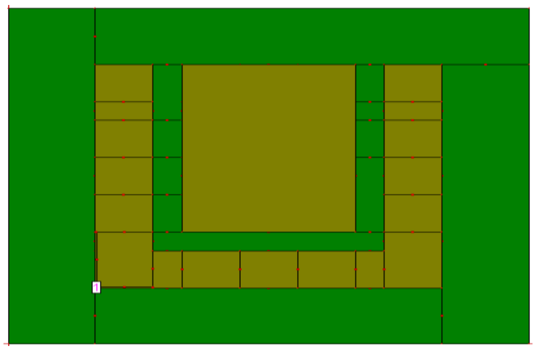

Figure-2 U-shape MSA with PBG

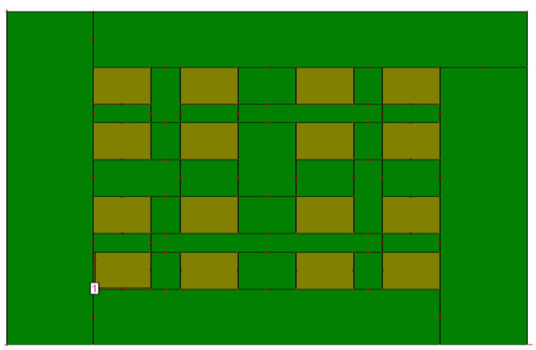

Figure-3 U-shape MSA with PBG

**Antenna Dimensions**

**Table 1**

| **Dimensions** | **mm** |
|---|---|
| **Length of ground plane** | 45 |
| **Width of ground plane** | 45 |
| **Length of square patch** | 30 |
| **Width of square patch** | 30 |
| **Length of U-shape patch** | 30 |
| **Width of U-shape patch** | 5 |
| **Length of parasitic patch** | 22.5 |
| **Width of parasitic patch** | 15 |
| **Size of square PBG structure** | 5x5 |

**Simulation Results**

The results are simulated and verified on IE3D V9.0.The simulation results show a very fine improvement of bandwidth for selected frequency band of 2-3 GHz.

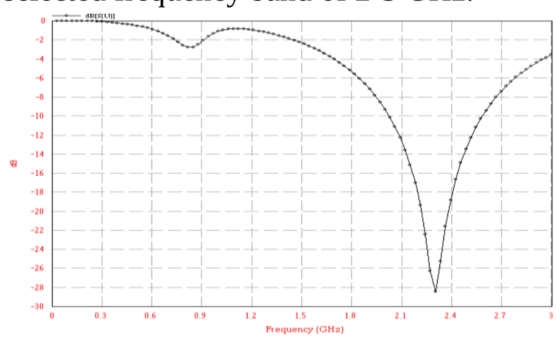


Figure-4 $S_{11}$parameter for square patch without PBG

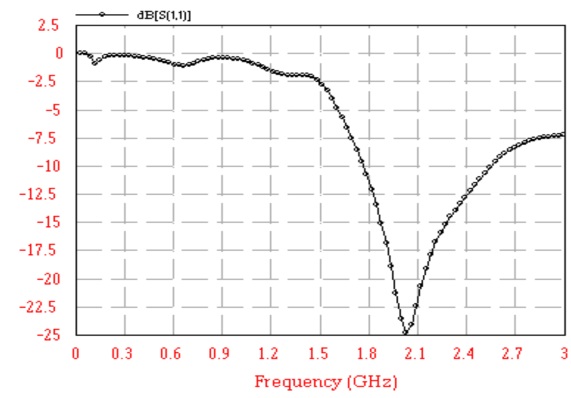


Figure-5 $S_{11}$ parameter for U-shape patch with PBG structure

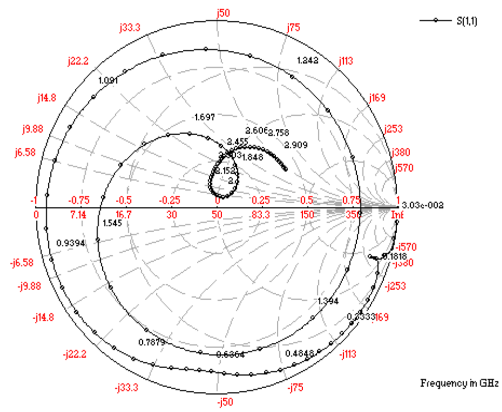


Figure-6 Smithchart

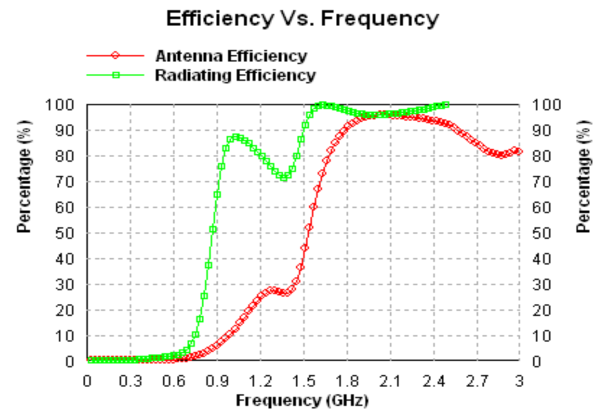


Figure-9 Efficiency

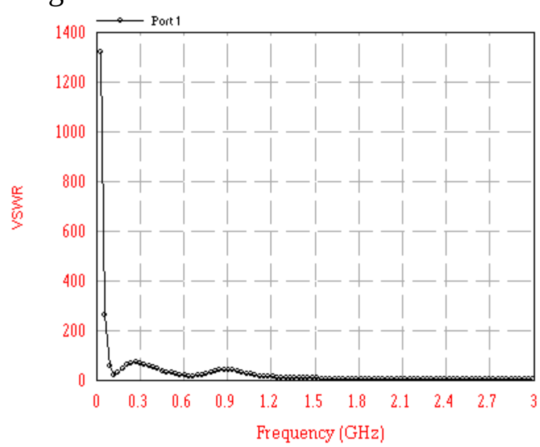


Figure-7 VSWR plot for proposed antenna

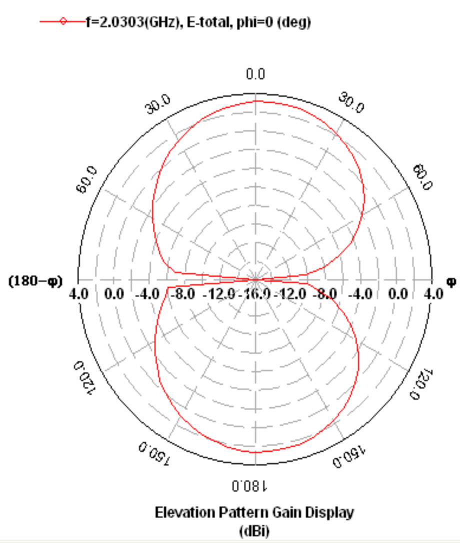


Fig. 8 2-D Radiation pattern

**Comparison table**

**Table 2**

| **Parameters** / **Antenna type** | **Bandwidth (MHz)** (Frequency band) | **Return loss (dB)** At Centre frequency |
|---|---|---|
| **Square patch MSA without PBG** | 550 (2-3 GHz) | -28.5 With centre frequency 2.3GHz |
| **U-shape radiating parasitic MSA with PBG (freq. band)** | 780 (1.77-2.55) GHz | -25 with centre frequency 2.03 GHz |

**Conclusion**

The simulation results of proposed antenna have shown an enhancement of bandwidth to 39.51 % at center frequency of 2.03 GHz. The modifications with the help of insertion of PBG structure and conversion of square patch into radiating parasitic U-shape gives a good result as the bandwidth enhancement with promising efficiency as well as dual band operation. Hence the proposed antenna deserves perfectly for various wireless applications due to its compact size and improved performance.

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