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ENHANCEMENT OF BANDWIDTH IN TRIANGULAR MICROSTRIP PATCH ANTENNA USING EBG STRUCTURE IN GROUND PLANE

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ABSTRACT

This paper presents the bandwidth enhancement of a triangular microstrip patch antenna using EBG structure in ground plane [1, 2] for 6.42 GHz resonant frequency. The surface waves must be suppressed to increase the bandwidth by using EBG. By using EBG the stop band characteristics is created over certain frequency and that has been adapted to suppress the surface wave and to enhance the bandwidth of the antenna at the resonating frequency. The main goal of using EBG structures in this microstrip antenna is to achieve better bandwidth and efficiency by suppressing the surface wave.

Keywords- *Equilateral Triangular Microstrip patch Antenna (ETMPA), Bandwidth, EBG Structure, Return loss & Computer Simulation Technology Microwave Studio (CSTMS).*

I. INTRODUCTION

Microstrip patch antennas are used in many applications due to their small size, low cost, ease of fabrication, dual frequency operation and support of linear and circular polarization. However, their gain and bandwidth are very low. The techniques used to enhance bandwidth are to choose a thick substrate with low dielectric constant or by using different EBG structures. Microstrip antennas are also called the patch antennas. The Microstrip antenna consists of three layers. The substrate is sandwiched between a ground plane and metallic patch. The radiating element and the feed line are made by process of photo etching on the dielectric substrate. The patch configuration may be square, rectangular, dipole, circular, elliptical, triangular or any other shape. Due to their advantages, they become suitable for various applications like, vehicle based satellite link antennas, global positioning systems (GPS), radar for missiles and telemetry and mobile handheld radios or communication devices. Basically there are four feeding techniques. The feed that is used in the proposed work is Microstrip line feed. The side of the equilateral triangle is calculated by using the values of resonant frequency, dielectric constant and velocity of light. Among the popular geometries like rectangular, circular and triangular, triangular geometry is selected because it takes minimum patch area as compared to other two geometry.

II. DESIGN SPECIFICATION

	Dimension	Material	Thickness
Ground	16.5mm×19.25mm	PEC	0.02mm
Substrate	16.5mm×19.25mm	FR4(lossy)	1.6mm
Patch	Equilateral triangle Of side a=14mm	Copper(annealed)	0.02mm

The lowest order resonant frequency is given by –

$$f_r = \frac{2c}{3a\sqrt{\varepsilon_r}} \quad \text{(in GHz)} \quad \ldots\ldots (1)$$

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Where, c is the velocity of light & c= 3×10^8 m/sec, a is the side length of equilateral triangle & a=14mm, $\mathcal{E}_r$ is dielectric constant of the substrate. & $\mathcal{E}_r$ =4.3 for FR4 (lossy).The side of the equilateral triangle for resonant frequency f_r=6.42 GHz is calculated from the above equation (1).

The effective side length of the equilateral triangle is given by

$$a_{eff} = a + \frac{h}{\mathcal{E}_r} \quad \text{(in mm)} \quad \ldots\ldots.. (2)$$

and relative permittivity of the substrate is given by

$$\mathcal{E}_{eff} = \frac{1}{2}(\mathcal{E}_r + 1) + \frac{1}{4}\frac{\varepsilon_r - 1}{\sqrt{1+\frac{12h}{a}}} \quad \ldots\ldots.. (3)$$

Where,
$\mathcal{E}_r$ = Substrate relative permittivity (4.3); a =Side length of the equilateral triangle (14mm) and
h = Height of dielectric substrate (1.6mm)

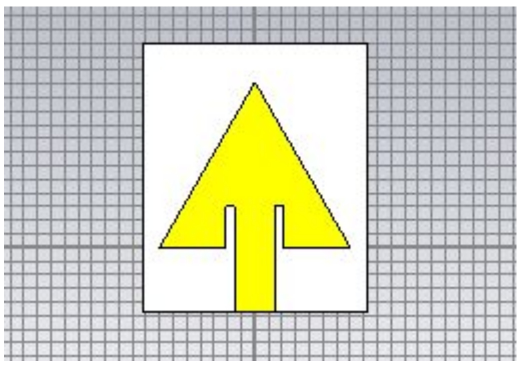
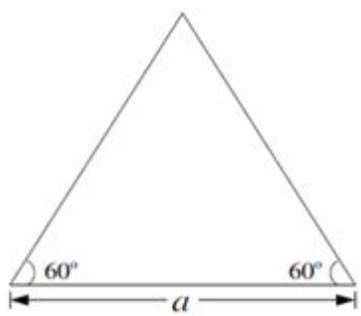


Fig: Triangular Patch with Microstripline Feed



Equilateral triangle, a=14mm W= 3 mm where ''w'' is width of the microstripline feed

III. ELECTROMAGNETIC BAND GAP(EBG)

Electromagnetic band gap (EBG) [1, 2, 3, 4, 6] and their applications in antennas have become a new research in the direction of antenna community. It was first proposed to respond to some antenna challenges in wireless communications. In recent years, electromagnetic band gap structures have attracted increasing interests because of their desirable electromagnetic properties that cannot be observed in natural materials. Electromagnetic band gap structures, also known as photonic crystals, are also used to improve the antenna performance. These structures have the ability to open a band gap, which is a frequency range for which the propagation of electromagnetic wave is forbidden. Reduction of mutual coupling and co-site interference are other benefits of these EBG antennas. The electromagnetic band gap structure (EBGs) in the ground plane has been determined. It has been observed that the band gap location is shifted from the case of EBGs in the substrate. In EBGs , band are designed by etching circular cylindrical holes in the ground plane .The maximum band gap is observed for r/x = 0.45mm according to the reference paper [1] but I observed after several calculation the maximum bandwidth is improved for r/x = 0.46mm. Where x is the centre to centre distance of the two consecutive circular holes in ground plane and r is the radius of the circular holes. (r=1.5mm & x=3.25mm).

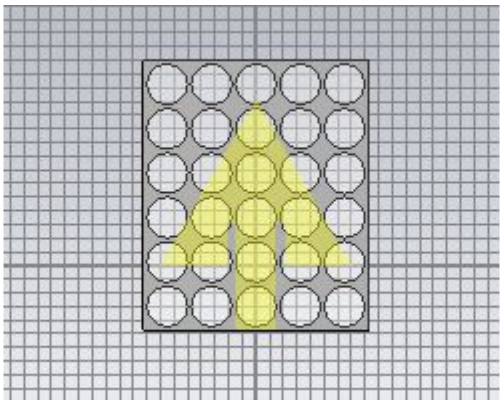


Fig: Ground plane with EBG structure

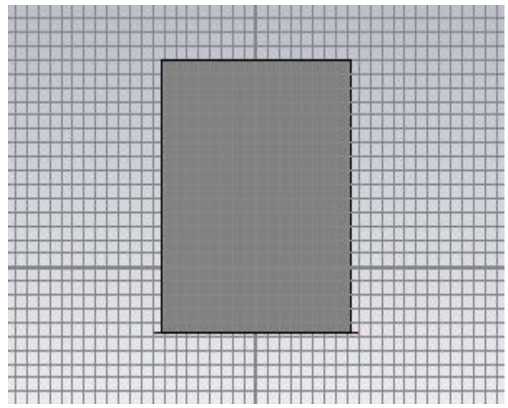


Fig: Ground plane without EBG structure

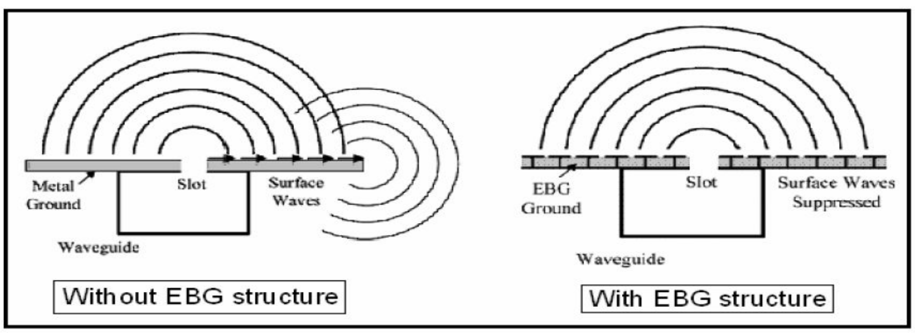
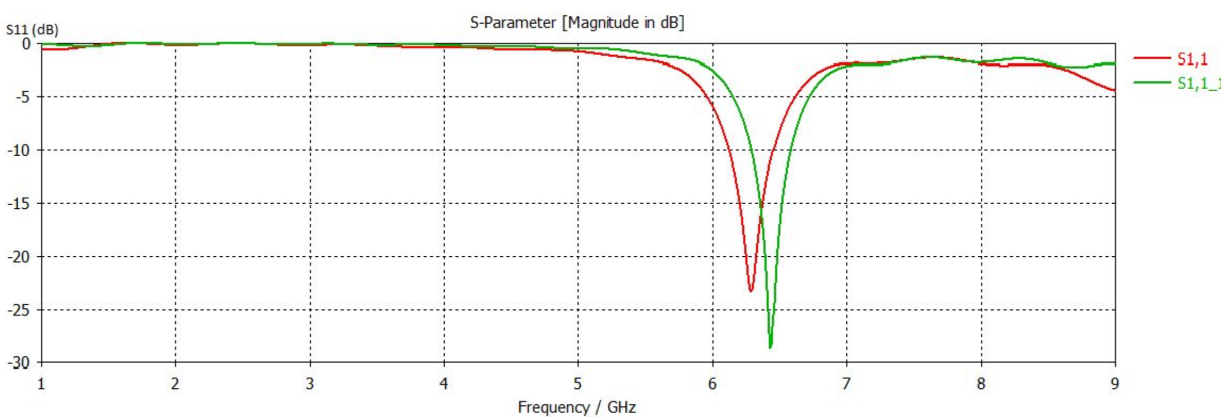


Fig: Suppression of surface waves using EBG Structure

IV. BAND WIDTH CALCULATIONS WITH AND WITHOUT EBG



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Impedance bandwidth = -With EBG (B.W = 334.83 MHz)

Percentage bandwidth = Without EBG (B.W =281.02 MHz)

V. CONCLUSION

From Simulations of both the designs i.e. ETMPA without EBG and ETMPA with EBGs in ground plane for same dielectric constant substrate and same operating frequency, it has been observed that using EBG structure there is an increment in impedance bandwidth of the ETMPA with EBG gives an impedance bandwidth of 53.81 MHz Bandwidth of ETMPA is 281.02MHz where as Band width of ETMPA with EBG structure used in ground plane is 334.83MHz i.e. an improvement of bandwidth by 53.81MHz which provides better results in satellite communication.

REFERENCES

[1] *Rakhesh Singh Kshetrimayum, Sholampettai Subramanian Karthikeyan, DiptoDey "Bandgap determination of triangular lattice EBGs in the ground plane" SienceDirect 2008.*

[2] Nabilah Ripin, Robi'atun Adayiah Awang, Ahmad Asari Sulaiman, Noor Hasimah Baba, Suhaila Subahir "Rectangular Microstrip Patch Antenna with EBG Structure" 978-1-4673-5160-7/12 © 2012. IEEE

[3] Neeraj Rao Dinesh Kumar V. Performance Enhancement of a Microstrip Antenna by Suppression of surface waves using EBG Structure in Multiple Layer Substrate 978-1-4577-0048-4/11 ©2011 IEEE

[4] Harish Kumar, Member IEEE, Manish Kumar, Student Member, Mohit Kumar, Abhijeet Kumar, Rajeev Kanth "Study on Band Gap Behaviour of Electromagnetic Band Gap(EBG) Structure With Microstrip Antenna" ISBN 978-89-5519-163-9 Feb.
19~22, 2012 ICACT2012

[5] Yahya S. H. Khraisat1, Melad M. Olaimat & Sharief N. Abdel-Razeq Comparison between Rectangular and Triangular Patch Antennas Arrays www.ccsenet.org/apr Applied Physics Research Vol. 4, No. 2; 201

[6] Neha Tyagi, Shivani Singh, Niti Sinha " Enhancement of Bandwidth in Microstrip Patch Antenna using EBG" International Journal of Computer Applications (0975 – 8887) Volume 92 – No.15, April 2014

[7] CST Microwave Studio Ver. 2014, CST, Framingham, MA, USA, 2014.

[8] C.A.Balanis, "Antenna Theory Analysis and Design", third edition, Wiley, New Jersey, 2005.