Enhancement of Bandwidth in Triangular Microstrip Patch Antenna using EBG Structure in Ground Plane: A Review
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Abstract— This paper presents a review article on the design of an equilateral triangular microstrip patch antenna (ETMPA) with EBG structure in ground plane [1, 2] for bandwidth improvement. There are many methods to enhance the bandwidth of microstrip antenna such as by increasing the substrate thickness or by using lower dielectric constant of substrate or by using EBG structure on ground plane or on substrate or in the localization of patch. Key words: Equilateral Triangular Microstrip patch Antenna (ETMPA), Bandwidth, EBG Structure, Return loss & Computer Simulation Technology (CST) Software

I. INTRODUCTION

Microstrip antennas are widely used due to their low profile, light weight, and easy fabrication while they are usually designed for linear polarization; circularly polarized antennas have attracted much attention in recent years. In some applications such as satellite communication systems, a microstrip antenna with circular polarization (CP) is more suitable because of its insensitivity to transmitter and receiver orientation. But the disadvantages of microstrip antenna have its narrow bandwidth [8]. 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.

II. EBG STRUCTURES

Electromagnetic bandgap substrates (EBGs) [1, 2, 3, 4, and 6] have produced a wide variety of design alternatives for researchers working in the area of microwaves and photonics. Electromagnetic band their applications in antennas have become a new research direction in the 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. The gain of patch antennas can be increased by using multiple patches connected to an array or by reducing the surface wave which can create ripples in radiation pattern. Several methods have been proposed to reduce the effects of surface wave. One approach suggested is the synthesized substrate that lowers the effective dielectric constant on the substrate either under or around the patch. Other approaches are to use parasitic elements or to use a reduced surface-wave antenna. 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.

Fig. 1: EBG structure (circular holes)

Fig. 2: Periodic structure of the square hole (EBG structure)

Above two figure shows the EBG structure on ground plane. First one is the periodic structure of the circular holes and second one is the periodic structure of the square holes. From these two structures we conclude the first one is better because it provides better band gap to suppress the surface wave [3] and hence by using this EBG structure we can enhance the bandwidth of the microstrip patch antenna.
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(IJSRD/Vol. 4/Issue 0/2016/043)

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Fig. 3: Suppression of surface waves using EBG Structure

Based on the cavity model, the resonant frequency of the rectangular patch antenna, of length $L$, can be calculated using the following formula:

$$f_{1,0} = \frac{c}{2L\sqrt{\varepsilon_r}}$$

Where $c$ is the speed of light in free space, and $\varepsilon_r$ is the dielectric constant of the substrate.

![Fig. 3](Image)

Fig. 4: Geometry of both rectangular and equilateral triangular patch antennas

It is worth to mention that, the rectangular patch width $W$ has a minor effect on the resonant frequency and radiation pattern of the rectangular patch antenna. Regarding the equilateral triangular patch antenna (ETPA), of side length $a$, the resonant frequency can be calculated using the following formula.

$$f_{1,0} = \frac{2c}{3a\sqrt{\varepsilon_r}}$$

Triangular patch is selected because it takes minimum patch area as compared to the rectangular patch & Using triangular patch antenna, we could obtain better suppression for side lobe level than that obtained using rectangular patch antenna.

III. CONCLUSION

The paper presents an analysis of EBG structures used in microstrip patch antenna. Several structures of both rectangular and circular EBG were analyzed and observed that EBG structures provide enhancement in bandwidth. In this paper, we also observed the advantage of triangular patch antenna on rectangular patch antenna. Using triangular patch antenna, we could obtain better suppression for side lobe level than that obtained using rectangular patch antenna. So for better results we can design a triangular microstrip patch antenna with EBG structures on ground plane (periodic structure of the circular holes) [5].

REFERENCES


