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Design of Ultra Wideband Antenna with EBG to Improve the Gain

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ABSTRACT- A novel shape of microstrip UWB planar monopole with enhanced gain using EBG structure is presented. The popularity of microstrip antennas are increasing day by day because of easy analysis and fabrication, and their attractive radiation characteristics microstrip antenna using simple electromagnetic band gap (EBG) substrate has higher gain than conventional microstrip antenna. In this paper we propose to mushroom like Electromagnetic Band Gap (EBG) structure with different diameter of vias was designed to analyze the behavior of the EBG structure. Mushroom-like electromagnetic band-gap (EBG) structures exhibit unique electromagnetic properties that have led to a wide range of electromagnetic device applications and a simple, compact EBG microstrip antenna is proposed

Keywords: Electromagnetic band-gap (EBG) structure, microstrip antenna, ultra wideband (UWB).

I. INTRODUCTION

The frequency band 3.1-10.6 GHz, was approved by the Federal Communications Commission (FCC) of USA in 2002 for unlicensed usage [1]. Since then, the interest in designing UWB antennas that operate over wide frequency range and that can be used for multiple channels or systems, has excelled. It enables high data transmission rates, low power consumption and simple hardware configuration in communication systems for different applications. Whereas, compact size and non-dispersion property are crucial issues that face these types of antennas.

Electromagnetic band gap structures are defined as artificial periodic (or sometimes non-periodic) objects that prevent/assist the propagation of electromagnetic waves in a specified band of frequency for all incident angles and all polarization states [2]. EBG structures are usually realized by periodic arrangement of dielectric materials and metallic conductors. In general, they can be categorized into three groups according to their geometric configuration: (1) three-dimensional volumetric structures, (2) two-dimensional planar surfaces, and (3) one-dimensional transmission lines.

Then, designing and simulation is done using CST (Computer Simulation Technology) commercial software. In the earlier stage, circular UWB antenna is design. The FR4-Epoxy substrate is used for this design. The value of permittivity of the substrate is get from the IEEE paper. The process is continued by altering the shape of the patch.

To achieve the best performance of the antenna, the simulation result is optimized. The following Fig 1 shows Design Methodology Flow Chart for MSA.

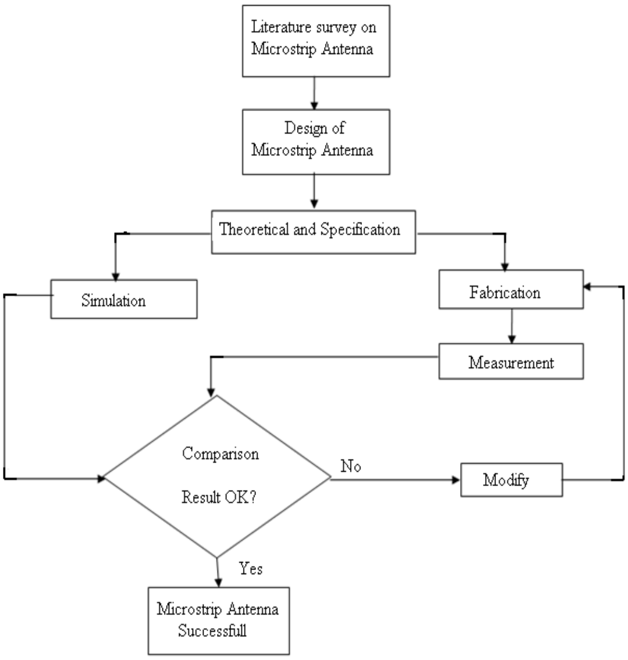

Figure 1: Design Methodology Flow Chart

II. ANTENNA DESIGN

The Fig. 1 shows the structure of the antenna. The radius of the circular patch is 10 mm. The fabricated antenna is printed on a 55 ×77 mm FR-4 board with εr =4.2 and thickness of 0.8 mm and is fed by a 50 ohm microstrip line that is tapered at the end part. To improve the radiation pattern stability, a metallic staircase plane with optimized dimensions is proposed. In the UWB planar monopole antennas, currents are distributed on the antenna surface and ground plane. When the antenna is placed in the plane, surface currents are distributed in vertical xy plane and horizontal (x) directions.

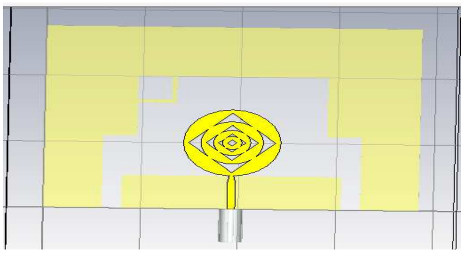

Figure 2: : Designed Snap of Top View of Antenna without EBG

III. ELECTROMAGNETIC BAND-GAP (EBG)

A unit cell of EBG structure is shown in Fig. 2. It consists of a square patch on top of the substrate that is connected to the staircase plane by a metallised via. Periodicity of the structure is 4mm.

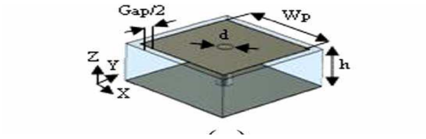

Figure 3 : Perspective view of the embedded EBG structure. Wp = 3 mm, Gap =1 mm, d= 0.8 mm, and h=0.8 mm.

Because of the unique electromagnetic properties, EBG structures have been widely considered in antennas and microwave circuits to improve their performance. EBG structures are used for further improve the antenna performance. It is shown that by embedding metallo-EBG structure (MEBG) such as circular and square patches.

IV. ANTENNA WITH EBG

Fig. 4 shows front view of antenna with EBG. 3x3 mushroom like EBG structure connected to ground plane using via. Using EBG structures in substrate of antenna is a very useful method to suppress the surface waves into substrate of Microstrip antenna, because EBG materials prevent the spreading of surface waves in gap band area and improve the operation of Microstrip antennas. EBG structures basically are periodic made of dielectrics or metals. These structures are periodic in one, two or three dimensions. The main characteristic of these structures is existence of frequency band that there is no propagation electromagnetic waves into the structure. This frequency band is known as Electromagnetic Band Gap.

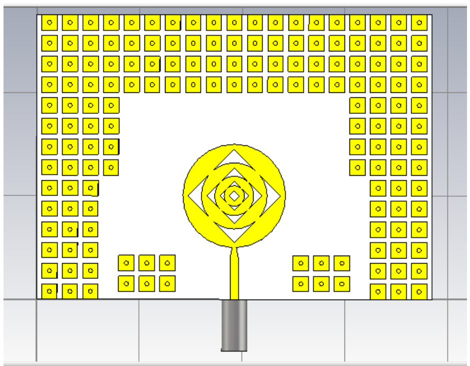

Figure 4: Designed Snap of Front View of Antenna with EBG

V. RESULT

Simulations were done using CST MMS. CST MICROWAVE STUDIO® (CST MWS) is a specialist tool for the 3D EM simulation of high frequency components. The unparalleled performance of CST MWS makes it the first choice in technology leading R&D departments. CST MWS enables the fast and accurate analysis of high frequency (HF) devices such as antennas, filters, couplers, planar and multi-layer structures and SI and EMC effects. Exceptionally user friendly, CST MWS quickly gives you an insight into the EM behavior of your high frequency designs.

A. RETURN LOSS

Fig. 5 shows the simulated s11 of the antenna with and without the EBG. As can be seen, both antennas have good matching in the 3.1–17GHz frequency band. Green line shows s11 of antenna without EBG and Red line shows s11 of antenna with EBG. Comparison shows using EBG bandwidth of antenna increases.

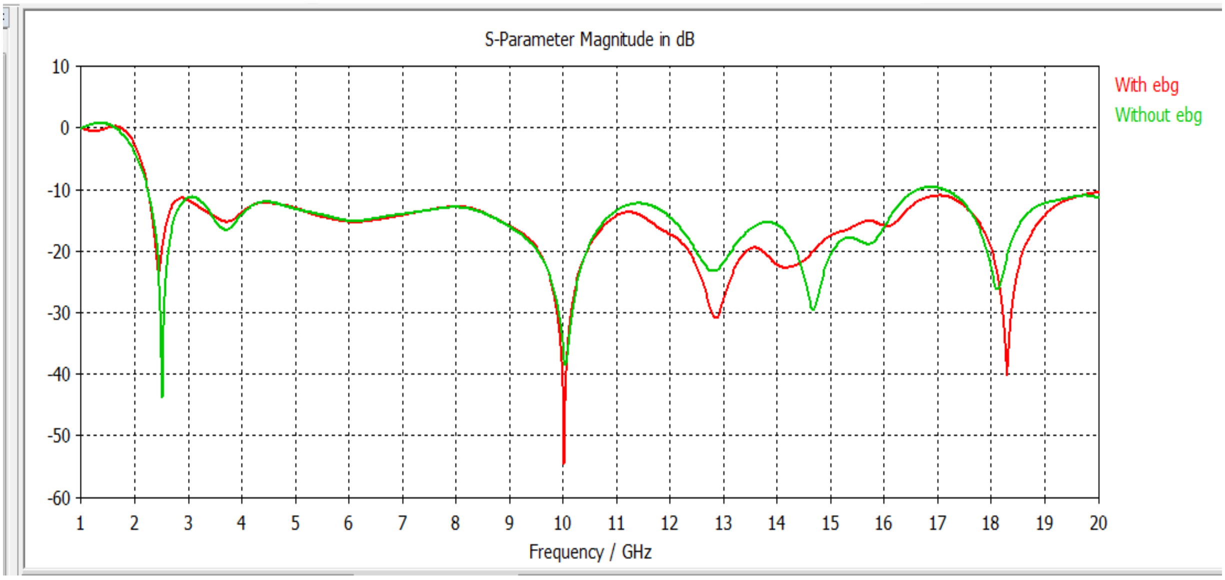

Figure 5: Return loss of the patch antenna with and without EBG

B. GAIN

Fig. 6 shows the simulated gain of the antenna with EBG and without EBG. Peak gain of the antenna is observed to be increased on the lower frequencies. This increase is actually the impact of in phase reflections from EBG structure.

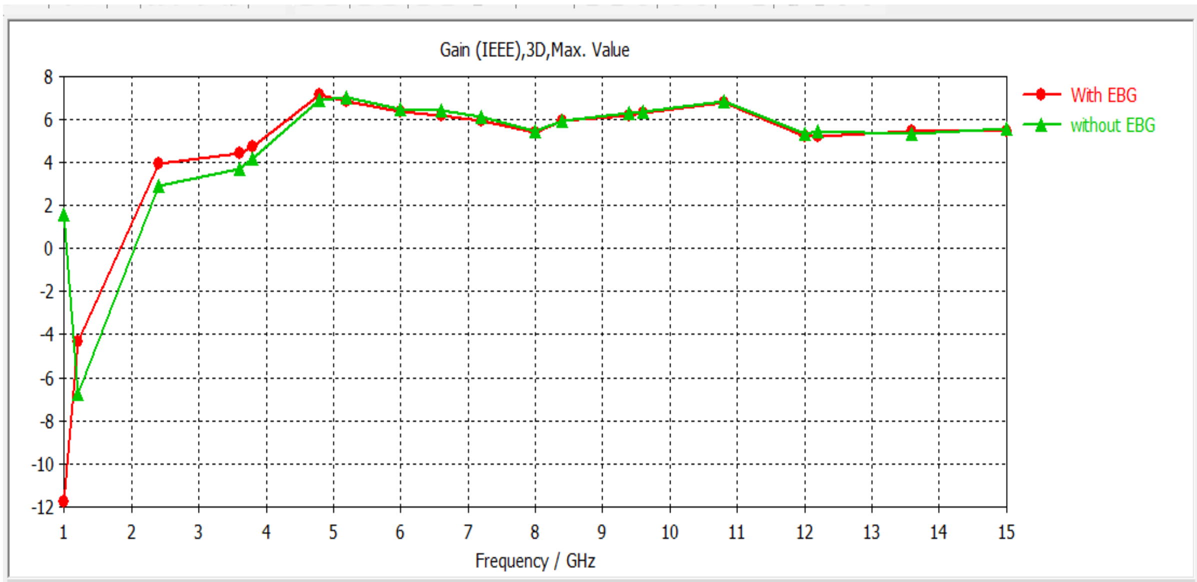

Figure 6: Peak gain of the patch antenna with and without EBG

VI. CONCLUSIONS

In this paper, a metallic staircase plane and a mushroom-like EBG structure were placed in the bottom and top of the substrate of a planar monopole UWB antenna. The proposed structure has a good s11, gain over UWB and low transient distortion. Moreover, the gain of the proposed antenna in broadside increased by 1dB compared to a similar antenna without the EBG and staircase plane. These features make the proposed antenna a good candidate for UWB arrays and positioning applications. In addition, it can be used for multimode and UWB applications simultaneously, which is useful for cognitive radio systems.

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