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Bandwidth and Return Loss Improvement of H-shaped Patch Microstrip Antenna using EBG structure

Govind Bhai*, Mrinal Dubey**, Lalit Kishor Tyagi***
*(M.Tech Scholar, Department of Electronics & Communication, SRCEM, Banmore, Morena, MP, India)
**(M.Tech Scholar, Department of Electronics & Communication, SRCEM, Banmore, Morena, MP, India)
******* (Assistant Professor, Department of Electronics & Communication, DBIT College, Dehradun, UK, India)

ABSTRACT
The future development of personal communication devices will aim to provide image, speech and data anywhere around the world at any time. This indicates that the future communication terminal antennas must meet the requirements of wideband to sufficiently cover the possible operating bands. The aim of this paper is to improve the bandwidth and return loss of H-shaped patch microstrip antenna using EBG structure on ground plane. EBG structure is a periodic arrangement of dielectric materials and metallic conductors on ground plane of antennas. Microstrip antennas mounted can radiate only a small amount of its power into free space as more power leakage through the dielectric substrate. To improve the efficiency of the antenna, the propagation through the substrate must be prohibited so the antenna can radiate more power towards the main beam direction and hence improve its efficiency. As the proposed antenna has resonant frequency at 2.496 GHz so suitable for ISM-band applications. For designing this, we uses CST software tool. The designed antenna offers much improved bandwidth of 59.9 MHz and return loss is -30.02 dB as compared to conventional H-shaped patch microstrip antenna which having bandwidth of 33 MHz and return loss is -12.43 dB.

Keywords – CST-Computer Simulation Technology, EBG- Electromagnetic Band Gap structure, ISMB-Industrial Scientific and Medical band.

I. INTRODUCTION

Antennas are one of the basic components required for wireless communications. An antenna is defined by Webster's Dictionary as "a usually metallic device for radiating or receiving radio waves'' [3]. In the recent years, there has been rapid growth in wireless communication. Large number of users is increasing daily but limited bandwidth is available and engineers are trying hard to optimize their devices for larger capacity and improved quality coverage. Microstrip antennas have a major drawback of narrow bandwidth but wireless communication applications require broad bandwidth and relatively high gain [4]. Microstrip antenna is planar resonant cavities that leak from their edges and radiate. Printed circuit techniques can be used to etch antennas on soft substrates to produce low-cost and repeatable antennas in low profile. For a good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since it's provides better efficiency. Many techniques have been used to improve the bandwidth by interpolating ground modification in antenna configuration [11].

EBG structures originate from the solid-state physics and optic domain where photonic crystals with forbidden band-gap for light emissions were proposed and then widely investigated [5]. EBG can be realized in one, two and three dimensional forms. The unique electromagnetic properties of EBG structures have led to a wide range of applications in antenna engineering.

In this paper, to improve the bandwidth of the proposed microstrip patch antenna, a square EBG structures has been introduced on the ground plane of the antenna. Size of each square slot is 5mm x 5mm.This also increases the return loss value of the antenna.

II. ANTENNA DESIGN

We considered a single layer conventional H-shaped patch microstrip antenna. Dimensions for this conventional patch were taken as Length L=30 mm and Width W=30 mm. FR4 is used as a substrate to design the antenna. The dielectric constant of FR4 is 4.3, loss tangent is 0.025 and the thickness is 1.6 mm. The Coaxial probe feed technique was used to excite the patch. Design and simulation process were carried out using CST MWS software 2010 version. The geometry of the conventional H-shaped patch microstrip antenna is shown in Fig. 1.

Table 1: Dimensions of Conventional antenna

S.No	Parameters	Dimensions
1.	Substrate	L_S=57.50 mm W_S=46.50 mm H_S=1.6 mm
2.	H-shaped patch	L_P=30 mm W_P=30 mm
3.	Hole in patch	8mm x 8mm
4.	Feed points	(15 mm, 15 mm) from origin

Fig.1 shows design of conventional H-shaped patch microstrip antenna where as Fig.2 shows design of proposed antenna with EBG structure.

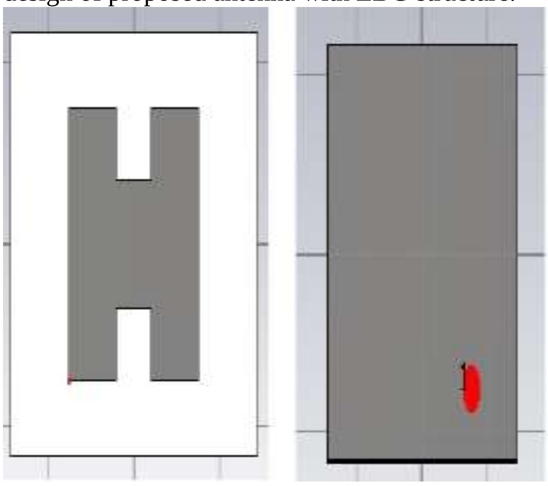

Figure 1: Design of H-shaped patch MSA without EBG structure showing front and back view

In proposed antenna, we make 4 holes each of size 5mm x 5mm on ground plane as shown in figure 2 .

Table 2: Dimensions of Proposed antenna

S.No	Parameters	Dimensions
1.	Substrate	L_S=57.50 mm W_S=46.50 mm H_S=1.6 mm
2.	H-shaped patch	L_P=30 mm W_P=30 mm
3.	Hole in patch	8mm x 8mm
4.	Hole in ground plane	4 square holes of each 5mm x 5mm
5.	Feed points	(6 mm, 6 mm) from origin

Table 1 and 2 shows the dimensions of various parameters of antennas.

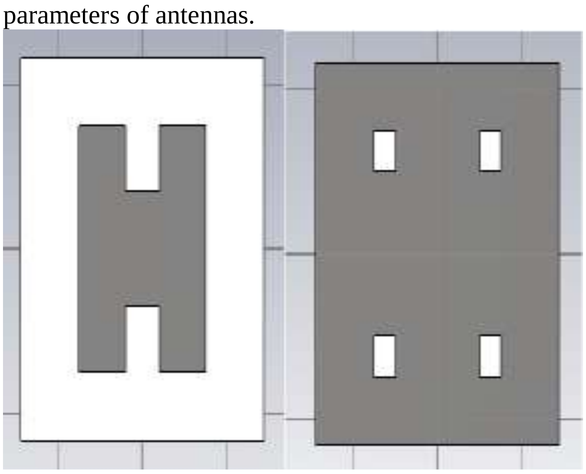

Figure 2: Design of H-shaped patch MSA with EBG structure showing front and back view

III. RESULTS AND DISCUSSIONS

The conventional H-shaped patch microstrip antenna is simulated first using CST software. This simulated antenna shows a return loss of -12.43 dB at 2.493 GHz which is its resonating frequency as shown in fig 3. The value of bandwidth of this antenna is 33 MHz so the conventional antenna has low bandwidth, hence further modifications are required to improve the bandwidth as well as return loss.

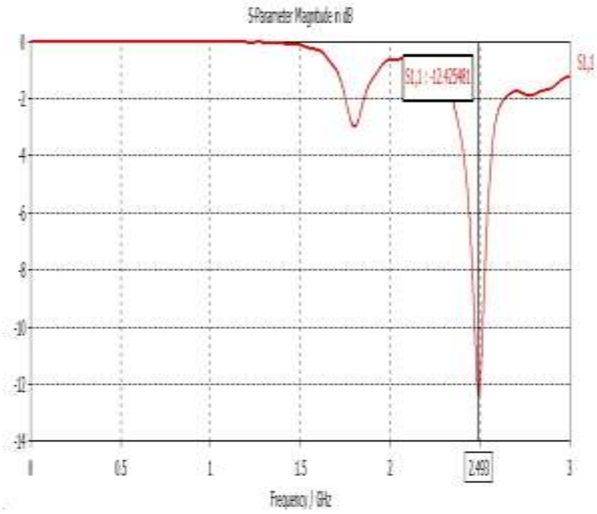

Figure 3: Variation of Return Loss(dB) vs Frquency (GHz) of conventional antenna

VSWR value of conventional antenna are shown in Fig.4. The conventional H-shaped patch MSA have a VSWR value of 1.63 at its resonant frequency.

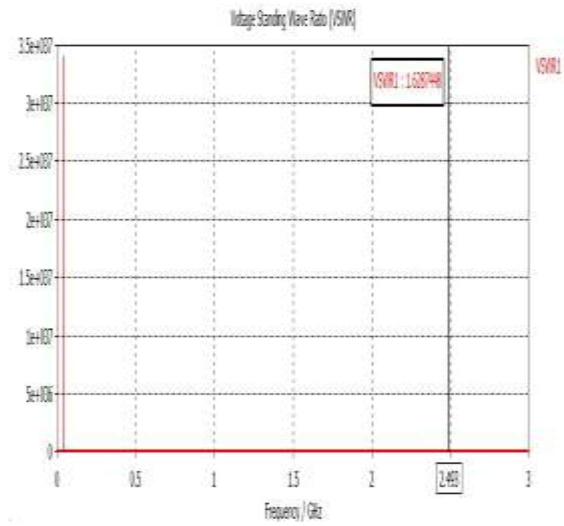

Figure 4: VSWR plot for H-shaped patch MSA

The Fig.5 shows the variation of Return Loss (dB) vs Frequency (GHz) of proposed antenna. It shows that it has a return loss of -30.02 dB at 2.496 GHz which is its resonating frequency.The value of bandwidth of proposed antenna is 59.9 MHz which is higher than conventional H-shaped patch microstrip antenna. This shows that introduction of EBG in ground plane can improve the antenna parameters.

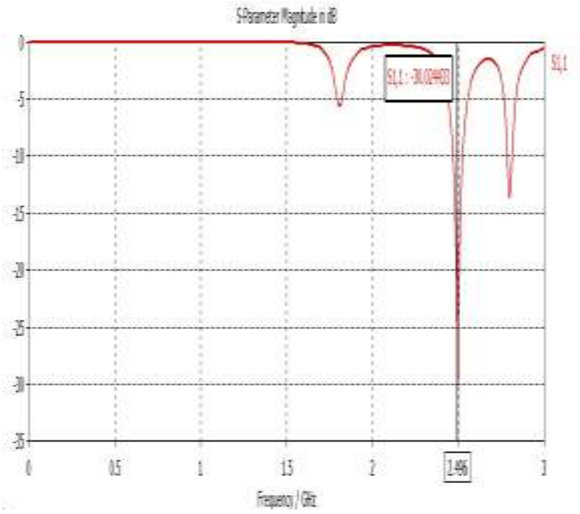

Figure 5: Variation of Return Loss(dB) vs Frquency (GHz) of proposed antenna

VSWR value of proposed antenna are shown in Fig.6. The proposed H-shaped patch MSA with EBG structure have a VSWR value of 1.065 at its resonant frequency which is also improved.

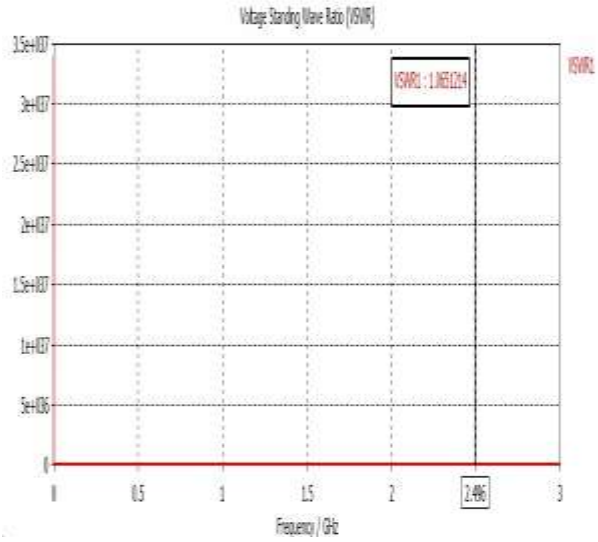

Figure 6: VSWR plot for proposed antenna

From the above Fig.3 and Fig.5, it is clear that bandwidth and return Loss is increased from 33 MHZ to 59.9 MHz and -12.43 dB to -30.02 dB respectively.So the optimum bandwidth and return loss is achieved by using EBG structure on ground plane of antenna.

IV. CONCLUSIONS

From the above results and discussion, it can be concluded that Microstrip antenna with EBG structure provides better performance in terms of bandwidth and return loss when compared to conventional microstrip antenna. The desired level of optimization was achieved. The proposed antenna can be used for a variety of ISM-band applications like Wi-Fi devices, Bluetooth devices, many medical and defence applications. It can also be designed in future for different applications having different frequencies by reducing patch size and much more improved bandwidth and return loss.

V. ACKNOWLEDGEMENTS

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