# A New Design of Dual-Band Microstrip Patch Antenna for Wireless Communication

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**Abstract** - *The future development of personal communication devices will aim to provide image, speech and data anywhere around the world at any time. This shows that the upcoming communication terminal antennas must meet the requirements of wideband to effectively cover all the possible operating bands. The aim of this paper is to improve the bandwidth and return loss of a Rectangular Microstrip Patch antenna using EBG structure on ground plane. EBG structures are 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 enhance the efficiency of the antenna, the propagation through the substrate must be restricted so the antenna can radiate more power towards the main beam direction and hence enhance its efficiency. For designing this, we uses CST software tool. The designed antenna offers much improved bandwidth of 51.2 MHz and return loss of -15.15 dB at 2.446 GHz & bandwidth of 77.4 MHz and return loss of -39.02 dB at 3.8875 GHz as compared to conventional rectangular microstrip patch antenna which having bandwidth of 26 MHz and return loss of -19.16 dB at 1.806 GHz & bandwidth of 28 MHz and return loss of -14.24 dB at 2.2677 GHz respectively.*

***Key Words***: CST-Computer Simulation Technology, EBG-Electromagnetic Band Gap structure, ISMB-Industrial Scientific and Medical band, Microstrip Patch Antenna, Bandwidth, Return Loss, Wireless Communication.

## 1. INTRODUCTION

Antennas are one of the basic components required for wireless Communication. An antenna is defined by Webster's Dictionary as "a usually metallic device for radiating or receiving radio waves'' [1]. In the recent years, there has been a rapid and continuous growth in wireless communication.

A large number of users is increasing daily but limited bandwidth is available to use. Hence engineers are trying hard to optimize their devices for larger capacity and improved quality coverage. Microstrip antennas have a major disadvantage of narrow bandwidth but wireless communication applications require broad bandwidth and relatively high gain [2].

Microstrip antennas are planar resonant cavities that leak from their edges and radiate. Printed circuit techniques are used to etch antennas on soft substrates to produce a low-cost and repeatable antennas in low profile [3]. 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 [4].

### 1.1 EBG

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, 6, 7]. EBG can be realized in 1-D, 2-D and 3-D forms. The unique electromagnetic properties of EBG structures have led to a wide range of applications in antenna engineering [8, 9].

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 EBG slot is 5mm x 5mm. This will increase the return loss value of the antenna and hence bandwidth of antenna.

### 1.2 Bandwidth

The bandwidth of an antenna is defined as "the range of frequencies within which the performance of the antenna, with respect to some characteristic, conforms to a specified standard [1]."

The bandwidth can be considered to be the range of frequencies on either side of a center frequency (usually the resonance frequency for a dipole) or where the antenna characteristics (such as input impedance, pattern, beamwidth, side lobe level, gain, beam direction, radiation efficiency) are within an acceptable value of those at the center frequency. For broadband antennas, the bandwidth is usually expressed as the ratio of the upper-to-lower frequencies of acceptable operation.

### 1.3 Return Loss

It is a parameter which indicates the amount of power that is "lost" to the load and does not return as a reflection. Hence the RL is a parameter to indicate how well the matching between the transmitter and antenna has taken place. Simply, it is the S11 of an antenna. A graph of S11 of an antenna vs. frequency is called its return loss curve. For optimum working of antenna such a graph must show a peak dip at the operating frequency and have a minimum dB value at this frequency. This parameter was found to be crucial importance factor for our paper [1].

## 2. ANTENNA DESIGN

We considered a single layer conventional rectangular microstrip patch antenna. Dimensions for this conventional patch antenna 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 2012 version. The geometry of the conventional rectangular microstrip patch antenna is shown in Fig.1.

**Table -1:** Dimensions of Conventional antenna

| NAME | VALUE | DESCRIPTION |
|---|---|---|
| $f_o$ | 2.4GHz | Operating Frequency |
| h | 1.6 mm | Height of Substrate |
| $\epsilon_r$ | 4.3 | Dielectric Constant |
| Lg | 50 mm | Length of ground |
| Wg | 70 mm | Width of ground |
| L | 29.778626 mm | Length of patch |
| W | 38.393444 mm | Width of patch |
| t | 0.038 mm | Thickness of patch |
| F | (5mm,6mm) | Feed Points |

Fig.1 shows design of conventional microstrip patch antenna where as Fig.2 shows design of proposed microstrip patch antenna with EBG structure introduced at ground.

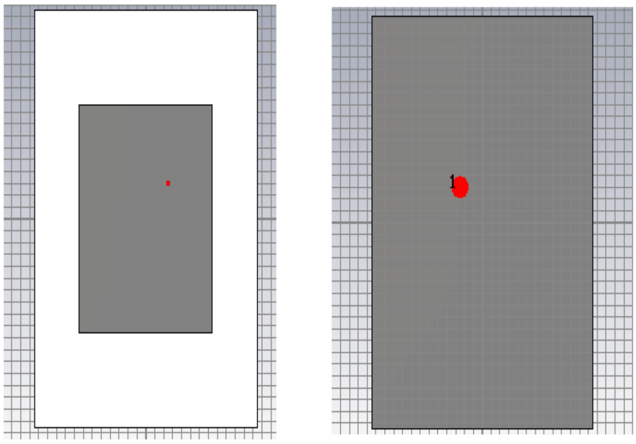

**Fig -1:** Conventional Microstrip Patch Antenna showing front and back view

In proposed antenna, we introduced 4 holes each of size 5mm x 5mm on ground plane and a slot of 2mm x 10mm on patch as shown in Fig.2.

**Table -2:** Dimensions of Proposed antenna

| S.No | Parameters | Dimensions |
|---|---|---|
| 1. | Substrate | $L_S$=57.50 mm<br>$W_S$=46.50 mm<br>$H_S$=1.6 mm |
| 2. | Holes in patch | 4 square holes of each 5mm x 5mm at corner |
| 3. | Holes in ground plane | 4 square holes of each 5mm x 5mm at corner |
| 4. | Feed points | (6 mm, 6 mm) from origin |
| 5. | Slot in Patch | 2mm x 10mm |

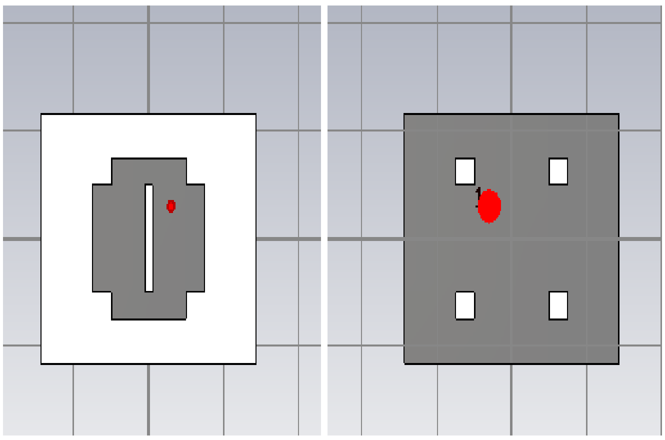

**Fig -2:** Design of Proposed Microstrip Patch antenna with EBG structure showing front and back view

## 3. RESULTS AND DISCUSSIONS

The conventional microstrip patch antenna is simulated first using CST software. This simulated antenna shows having a bandwidth of 26 MHz and return loss of -19.16 dB at 1.806 GHz & bandwidth of 28 MHz and return loss of -14.24 dB at 2.2677 GHz as shown in Fig 3. The total value of bandwidth for this antenna is 54 MHz so the conventional antenna has low bandwidth. Hence further modifications are required to improve the bandwidth as well as return loss.

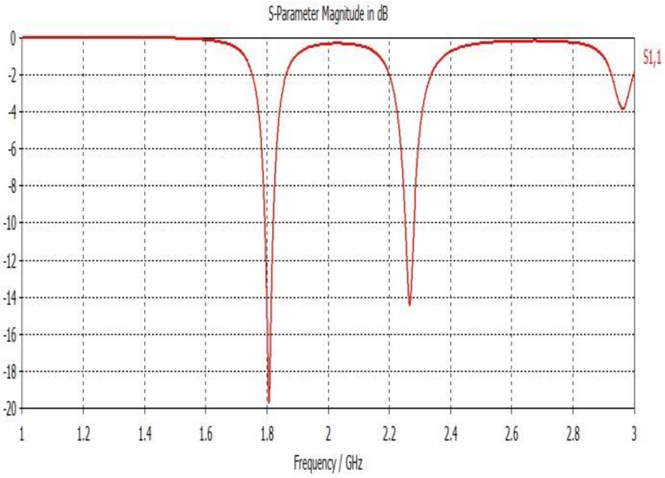


**Fig -3:** Variation of Return Loss(dB) vs Frquency (GHz) of Conventional antenna

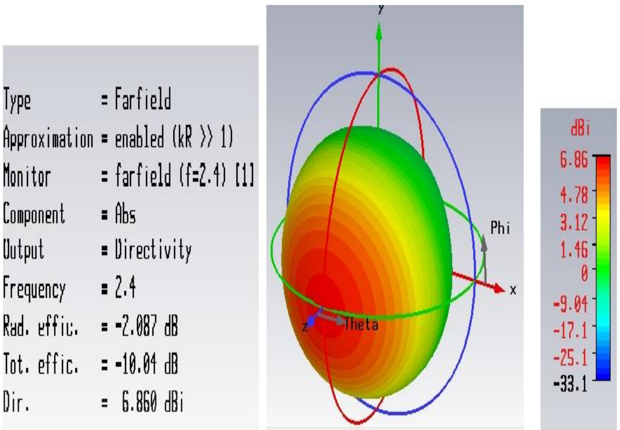


**Fig –4:** Radiation pattern of Conventional antenna

The Fig.5 shows the variation of Return Loss (dB) vs Frequency (GHz) for proposed antenna. It shows that it has a bandwidth of 51.2 MHz and return loss of -15.15 dB at 2.446 GHz & bandwidth of 77.4 MHz and return loss of -39.02 dB at 3.8875 GHz respectively. The total value of bandwidth for proposed antenna is 128.6 MHz which is much better than conventional microstrip patch antenna. This proves that introduction of EBG in ground plane improve the antenna performance.

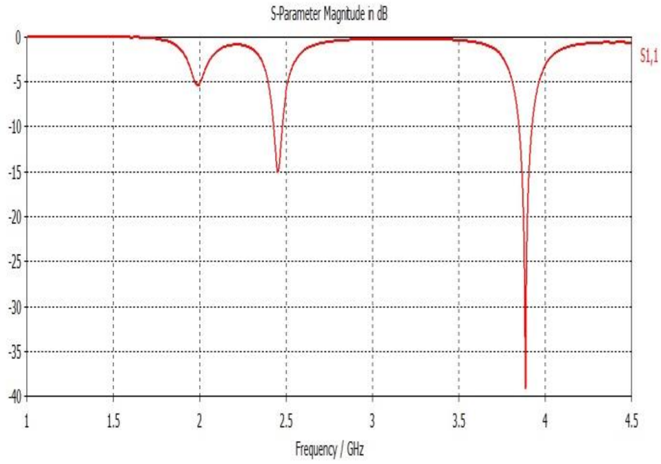


**Fig -5:** Variation of Return Loss(dB) vs Frquency (GHz) of Proposed antenna

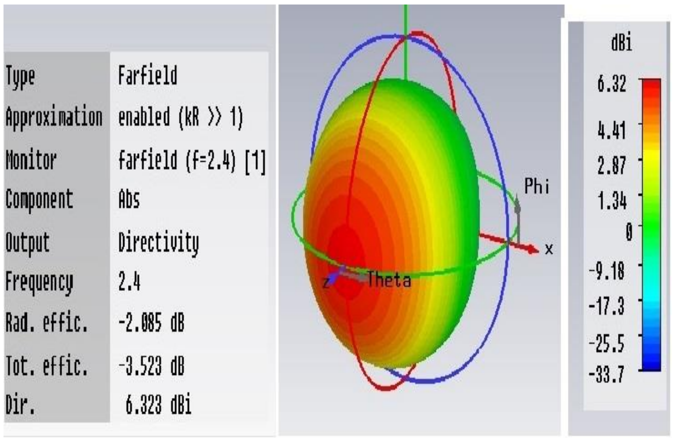


**Fig -6:** Radiation pattern of Proposed antenna

**Table -3:** Comparison between both antennas

| TYPE | RETURN LOSS | BW | VSWR |
|---|---|---|---|
| Conv. Rect. Micro. Patch Antenna | (a) -19.66 dB at 1.806 GHz<br>(b) -14.24 dB at 2.2677 GHz | (a)26 MHz<br>(b)28 MHz | (a)1.230<br>(b)1.483 |
| Proposed Micro. Patch Antenna | (a)-15.15 dB at 2.446 GHz<br>(b) -39.02 dB at 3.8875 GHz | (a)51.2 MHz<br>(b)77.4 MHz | (a)1.333<br>(b)1.022 |

## 4. CONCLUSIONS

From the above results and discussion, it can be concluded that Microstrip patch antenna with EBG structure provides better performance in terms of bandwidth and return loss when compared to conventional microstrip patch 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 and other Wireless applications, Bluetooth devices, many Medical and Defense applications. It can also be designed in future for different mode of applications having different frequencies by reducing patch dimensions and much more improved bandwidth and return loss.

## ACKNOWLEDGEMENT

The authors would like to express their gratitude towards Dr. P.K. Singhal, Professor, EC Department, MITS College, Gwalior for this kind cooperation in this research work.

## REFERENCES

[1] C.A. Balanis, "Antenna Theory: Analysis and Design", 3rd Edition, Willey 2005.

[2] Pozar, M. David, "Microstrip Antenna", IEEE Invited Paper.

[3] R. Garg, P. Bhartia, I. Bahl, A. Ittipiboon, "Microstrip Antenna Design Handbook", Arteck House, 2001.

[4] William H. Hayt, Jr. John A. Buck, "Engineering Electromagnetic", 6th Edition, McGraw-Hill, 2001.

[5] "IEEE Standard Test Procedures for Antennas", IEEE Std. 149-1979, Institute of Electrical and Electronics Engineers, New York, 1979.

[6] CST Tutorial, "Microwave Studio Computer Simulation Technology", 2006.

[7] Alka Verma, "EBG structures and its recent advances in Microwave Antenna" publication in "International Journal of Scientific Research Engineering & Technology (IJSRET)", Vol-1 Issue-5, pp. 084-090, Aug 2012.

[8] Sandeep Kumar, Subodh Kumar Tripathi, Nitin Kumar, Rachit Aggarwal, "Design of Microstrip square-patch antenna for improved Bandwidth And Directive gain" in "International Journal of Engineering Research and Applications (IJERA)", Vol-2, Issue-5, pp. 441-444, Mar-April 2012.

[9] R.J. James and P.S. Hall, "Handbook of Microstrip Antennas'', IEEE Electromagnetic waves series 28, 1989.