Design Of A Rectangular Microstrip Antenna Using EBG Structure

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Abstract

The paper presents a design of circularly polarized microstrip antenna with dual feed and employs Electromagnetic Band Gap (EBG) structure to improve antenna efficiency and bandwidth. A cross slot is introduced with equal arm lengths. The antenna is designed to work on Taconic RF-30 having thickness of 0.76mm and ϵ_r of 2.92.The proposed EBG structure constructed with many vacuum holes. Return loss, VSWR, E & H plane pattern of the antenna are observed with CST Microwave Studio simulator.

1. Introduction

A microstrip patch antenna is a printed type of antenna consists of a substrate sandwiched between a ground plane and a patch [1-2]. Patch antennas exhibit characteristics such as light weight and a low profile which makes this antenna desirable for many applications [3-6]. But surface waves are by products in these antenna designs. Directing electromagnetic wave propagation along the ground plane instead of radiation into free space, the surface waves reduce the antenna efficiency and gain. The diffraction of surface waves increases the back lobe radiation, which may deteriorate signal to noise ratio in wireless communication system [7]. The band gap feature of EBG structure has found useful applications in suppressing the surface waves in various antenna designs [8-9]. Many array antennas also integrate EBG structures to reduce mutual coupling [10].
EBG structures possess unique electromagnetic properties that have led to a wide range of applications. These are realized by periodic dielectric substrates and different metallization patterns [11-12].

A microstrip patch is one of the most widely used radiators for circular polarization. A single patch can be made to radiate circular polarization, if two orthogonal patch modes are simultaneously excited with equal amplitude and $\pm 90^0$ out of phase. The present paper describes novel design of circularly polarized microstrip antenna with dual feed and EBG structure. The simulation of the structure is performed using CST Microwave Studio.

2. Antenna and EBG design

The EBG structure is mainly a periodic structure defined by

$$k = \pi / d \quad \ldots\ldots\ (1)$$

Where k is wave number at a stop band frequency and‘d’ is period or cell spacing. If EBG is realized with periodically spaced round holes, ripples and suppression of harmonics depend on cell spacing (d) and filling factor(r/d), which is defined as ratio of the radius of circular hole and the cell spacing in order to get optimum performance in the rejection band(r/d) must be in the range of 0.24 to 0.3[13]. The geometry of the proposed antenna without EBG structure is shown in fig.1.Dual feed arrangement is used to obtained circular polarisation. The dimension of the proposed antenna is tabulated in table 1 using the design procedure [14].Several vaccum holes are embedded in this substrate for realizing EBG and is shown in fig.2. The patch antenna with EBG structure is shown in fig.3.

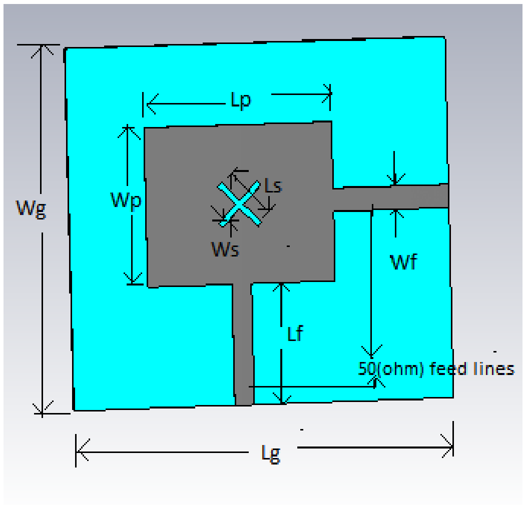

Fig.1 The geometry of the proposed antenna without EBG structure.

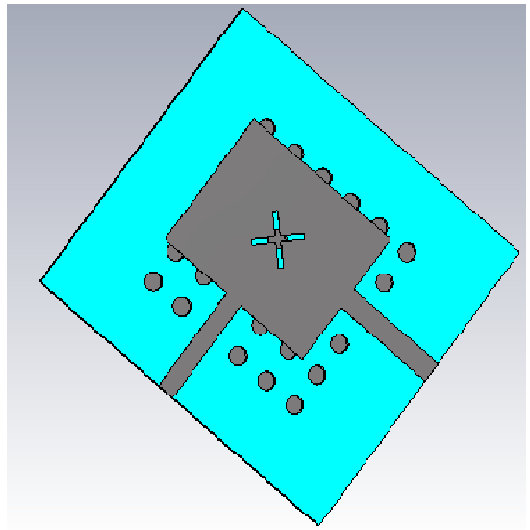

Fig.3 The geometry of the proposed antenna with EBG structure.

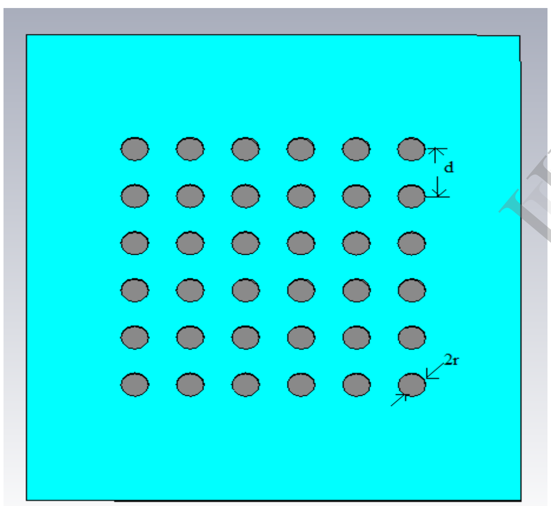

Fig 2. The geometry of the proposed antenna EBG substrate with several vaccum holes

Table 1
Dimensions of the proposed antenna

parameter	Value(mm)
Lp	19.48
Wp	15.73
L_f	12
W_f	2
L_s	5.8
W_s	0.58
Lg	39.48
Wg	35.73
d	4
r	1

3. Simulation and Results

The designed antenna is simulated using CST Microwave Studio.Version 12. Fig.4 shows the return loss plot of antenna without EBG structure. Resonant frequency is at 5.5GHz with -16.9dB return loss.The bandwidth is 410MHz. Return loss with EBG structure is shown Fig.5. Resonant frequency is at 5.5GHz with -17.47dB return loss and Bandwidth is 460MHz taking -10dB as criterion. Fig. 6 shows the 3D-Radiation pattern. Directivity is 8dBi for without EBG structure. Radiation pattern with EBG structure is shown in fig. 7 and it is 8.2dBi.

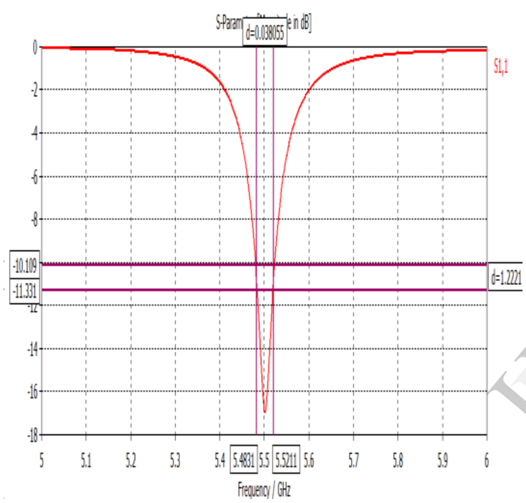

Fig.4 Return loss without EBG structure.

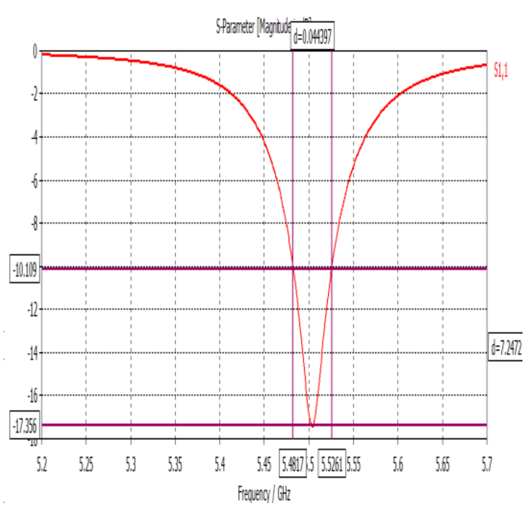

Fig.5 Return loss of antenna with EBG

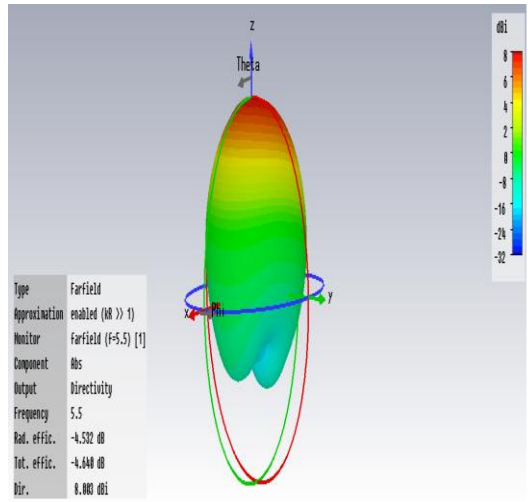

Fig.6 3D-Radiation pattern of antenna without EBG

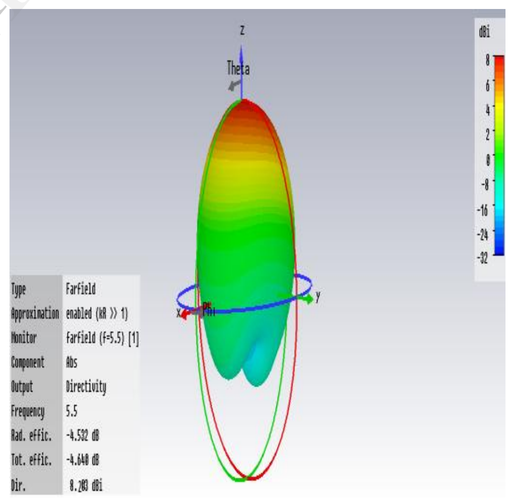

Fig.7 3D-Radiation pattern of antenna with EBG

4. Conclusion

It is obvious from the results that bandwidth can be enhanced with EBG structure. The designed antenna exhibits 500MHz improvement in bandwidth. Directivity also improved from 8.0dBi to 8.2dBi

5. References

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