Design & Simulation of Circular Rectangular Patch Antenna for Wireless Application

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***Abstract* --** A rectangular patch antenna is design and simulated in this paper. The overall antenna is simulated in microwave tool High Frequency Structure Simulator. The proposed antenna is used for wireless communication system. Gain, Return loss and bandwidth are the performance parameter of rectangular antenna. The electromagnetic substrate used in the patch antenna. But virtually RT- Duroid substrate is used with ε_r = 2.33. The proposed antenna is analyzed at two frequency 16.6 GHz & 18.3 GHz. Gain and return loss of circular rectangular patch antenna is -35.7673 db & -29.2070 and gain of patch is 5.097 db & 12.44 db respectively.

Keywords-- Microstrip, Antenna, Gain, Bandwidth

I. Introduction

In the present time, the enhanced technology of wireless communication is increase day by day as per the requirements. In prospective to security point of view, wireless sensor network are used in automatic organization and company. Wireless communication systems are used to transmit images and videos with higher data rates [1]. Electromagnetic band gaps which work for both transverse electric field and transverse magnetic field can eliminate the surface waves along the same frequency band. Electromagnetic band gaps are the regular manner structures which aroused to transmit electromagnetic waves in the space. Electromagnetic band gap structures can be designed in different dimensions and shapes according to the operating frequencies. Popular EBG structures are, rectangular, circular, fractal and mushroom shapes. EBG structures are formed on either substrate or ground, depending on the application of antenna. According to our survey, if we uses mushroom like structure of the electromagnetic band gaps, it will have half wavelength. This half wavelength structure can be used in microwave applications [2].There are two important properties of electromagnetic band gap, one is reflection phase property and second one is surface wave suspension. First property is used for the applications having phase -180* to 180* and other one is used to improve the gain, minimization of backward radiation and reduction of mutual coupling [4]. Electromagnetic band gaps acts as a artificial magnetic ground plane. EBG design on the substrates so that it can create band gap around the operating frequencies. Due to this property it can avoid the radiations from radiated in the substrate surface. In this paper, we are reviewingthe designing and operations of EBGs Structure. The effect of these shapes is much higher in the substrates as compared to the patches.

The rest of paper is design as follows. The related work of proposed antenna is described in section II. Frame work of overall paper is described in section III. Simulation results & analysis is described section IV. The overall conclusion of review describe in section VI

II. Literature Survey

Xiyao Liu et.al [1] designed a circular arc with optimized gain. The proposed antenna operates at 2.40–2.44 GHz and at5.1–6.0 GHz with broadside radiation patterns and average gain of about 5.7 dBi. The antenna can be applied to WLAN IEEE802.11a. The experimental results are in good agreement with the analyses and the simulations. The impedance bandwidths of the antenna are about 40 MHz and 900 MHz with consistent broadside radiation patterns at 2.4 GHz and 5.5 GHz band. Additionally, their measured average gains are about 5.1dBi and 6.3 dBi, respectively.

Lin Peng et.al [2] designed a notch shaped electromagnetic band gap antenna. The antenna was operating for WLAN & X -Band operation. The design methodology can also be utilized to design rectangular notched-band for other interference bands efficiently. The method utilizes two EBG structures with close resonances in the feeding line. Then, the rectangular notched band can be controlled by the EBGs. Therefore, the method can be easily adjusted to different interference bands. Three prototypes with rectangular notched-band were design and measured.

Tahsin Ferdous et.al [3] proposed simple rectangular patch antenna. The proposed antenna is work for X band frequency. The patch antenna was operating at 10 GHz resonant frequency. The proposed antenna was used for ultra -wide range frequency operations. Gain was improved up to 7.25 db. Vertical standing wave ratio is improved up to 1.27.

Viorel Ionescn et.al [4] designed different structures of EBGs .Basically Mushroom type structure is used . Finite element method is used in antenna. The proposed antenna was given a 2.45 GHz band stop frequency.

Kamariah [5] designed a improved fractural antenna with electromagnetic substrates. The overall antenna had resonant frequency 5.8 GHz. In this antenna, Rogger RT Duroid was used. The substrate had 0.38 mm thick. The return loss was improved up to -44.27 db. Gain and bandwidth was improved up to 8.55 db & 25.05 % respectively.

Wriddhi Bhowmik [6] proposed an mesh operated planed electromagnetic structure substrates. The antenna was operated at 14.5 GHz .The proposed antenna is design for stop band filtering. The range of stopping the frequency was started from 2.15 GHz. The antenna had meshing in 3×1 & 4×4 manner. The overall gain is simulated & measured at 14.5 GHz frequency. The coaxial feed is used in this paper.

Lalithendra Kurra et.al [7] proposed a frequency selective layer of different EBG substrates. The substrates were in form of unit cells. These substrates was used as capacitor and inductor which can tuned their frequency according to need. In this paper , 13 × 13 units cell were used. The antenna was operated for 10.8 GHz frequency. The return loss for the FSS layered antenna is -32.5 db . The improvement in bandwidth was achieved up to 26.08 %.

N.M.Jizat et.al [8] designed a branch lined coupler. These couplers were integrated to electromagnetic band gap. The Rogger RT duroid with $\varepsilon_r = 3.38$ was used. The operating frequency is 7 GHz.. There is a suspension property of electromagnetic substrates For use in microwave industry. The coupling value was improved up to 3.12 db. On the other hand, transmission value was improved up to 4.04 db. The EBGs slots were designed in the ground. The bandwidth of the antenna was increase 120% as compared to traditional antenna.

D.Helena Margaret et.al [9] designed a C slotted antenna. The antenna was operated at 5.2 GHz frequency. In this eigen value & eigen vector solver are used to design the proper antenna. The microstrip feed line methodology was used in current paper. The transmission coefficient for the antenna is -23.98 db. The antenna is used for narrow band operation with resonant frequency 5.29 GHz.

III. Frame Work of Paper

The EBG substrates are used in the antenna. Electromagnetic band gap are substrates which show negative permittivity & negative permeabilityThe propose methodology of research work is optimized design of antenna with proper feed. In proposed antenna coaxial feed applied to obtain gain & bandwidth.

Design the substrate

Design Substrate

Design Circular Rectangular Patch Antenna

NO

Iteration of feeding point

Optimized Gain

NO

YES

Compare the Ordinary Antenna

The steps of design of EBG based rectangular antenna are as shown in the fig 1. The firstly we design the substrate having dimension $40 \times 50 \times 0.8\ mm^3$.The substrate having material Rogger with relative permittivity 2.33. After designing the substrates, EBG is design with square shape with small slots all around it.

The main objectives of the work are to design a fractal antenna with metamaterial substrates. The return loss of antenna should be minimum & gain should be maximum. The main aim of the overall work to enhance the bandwidth [13-16] .

The overall design is based on the irregularity of design with iteration form. The antenna is design for circular rectangular antenna. The return loss is obtained from this fractal antenna. The return loss is to be minimum. It is obtained by changing the feed position. The feed position is alternated by set a variable to position. The position is rotate in complete plane.

The best optimized position is set by simulation tool. At this feed position minimum return loss and maximum gain is obtain.

Circular Rectangular Patch Antenna Design

Rectangular patch antenna with EBG structure are designed and simulated in HFSS software. The main objective of the design is to enhance the bandwidth & decrease the return loss.

Fig 1 defines all the dimension of the rectangular patch antenna. The length and width of substrate are define using the formula

Wg =6h+w , Lg = 6h+L

Rogger Substrates was used with ε_r = 2.33. with 0.8 mm thickness. The microstrip feed line is used with 50Ω impedance matching. The rectangular patch are operated at two different frequency 16.6 GHz & 18.3 GHz respectively

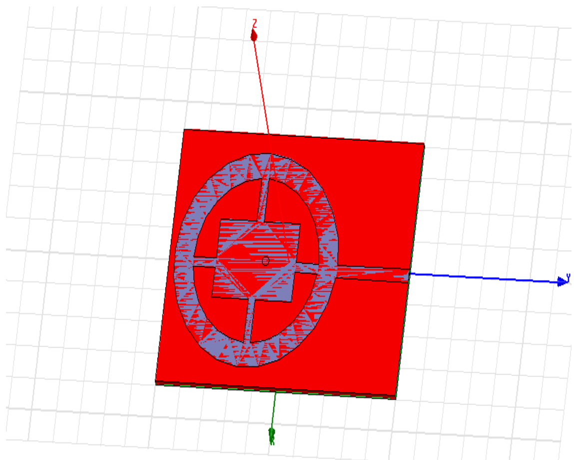

Fig. 1. Top & Side view of Antenna

IV. Simulation result & Analysis

The proposed substrates are of dimension 40 × 50 × 0.8 (mm). A rectangular patch antenna made of copper is employed on it. The dimension of rectangular patch is 12.4 ×16.59 (mm). The radius of circular patch is 17 mm. The design of antenna is based on FDTD method where all the feeding process is assigned to the patch. The feeding point is given (0,-5, 0).After Simulation return loss is obtained -35.7673 db with gain 5.097 db and bandwidth 15.96 % at 16.6 GHz. Frequency Vs Return Loss is shown in fig 2. Antenna is another one operated at 18.3 GHz. After simulation return loss is obtained -29.2070 db with gain 12.44 db and bandwidth 16.26 % at 18.3 GHz. Frequency Vs Return Loss is shown in fig 3

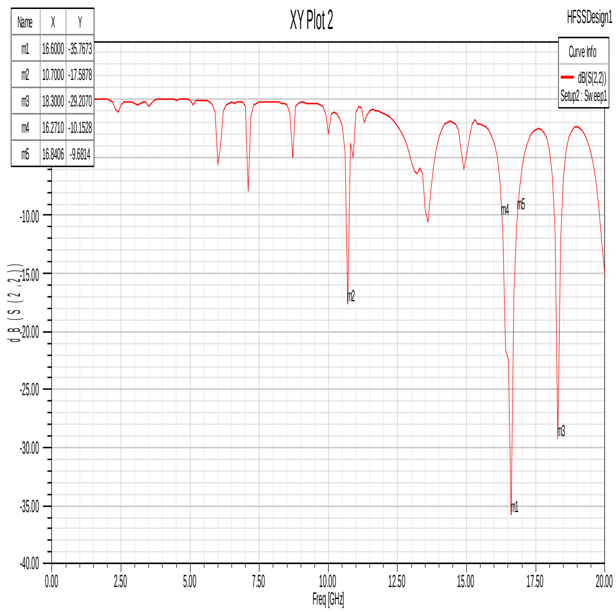

Fig. 2. Scattering parameter of antenna at 16.6 GHz

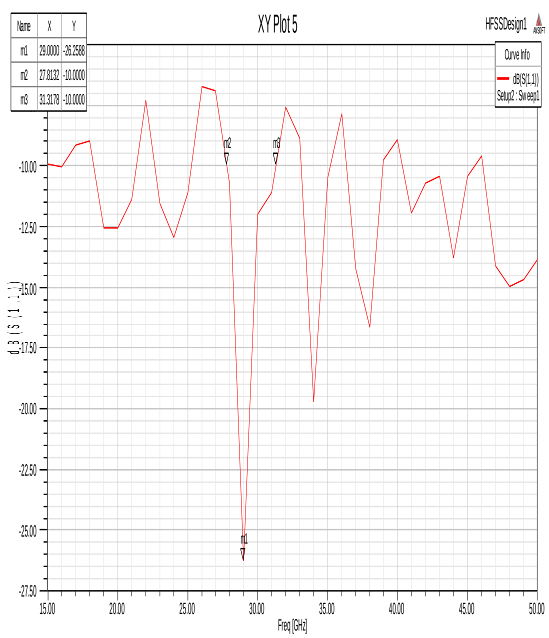

Fig. 3. Fig 3 Scattering parameter of antenna at 18.3 GHz

Gain of antenna at 16.6 GHz and 18.3 GHz is shown in fig 4 and fig 5 respectively.

These figure shows frequency Vs Gain graph. The gain is given on variation of theta & phi. Range of theta & phi.

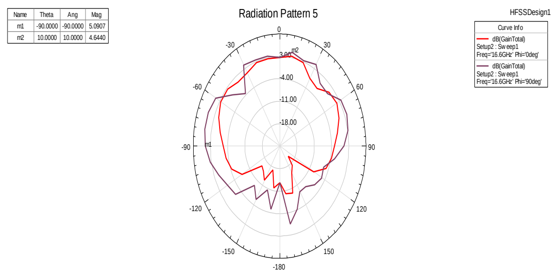

Fig. 4. Fig 4 Gain at 16.6 GHz

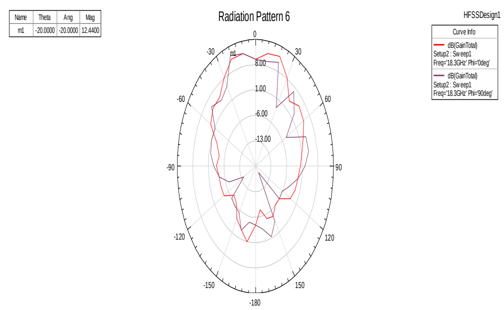

Fig. 5. Gain at 18.3 GHz

TABLE I. COMPARATIVE ANALYSIS OF DIFFERENT CONFIGURATION OF ANTENNA

Sr. No.	Parameter	Base Paper	Proposed Antenna
1.	Return loss	-17.39 db	-35.7576 db
2.	Gain	5.2 db	12.44 db
3.	Bandwidth	1.71	1.2
4	Resonant frequency	16.6	10.7,16.6 ,18.3

The proposed antenna works on 18.3 GHz frequency with 12.44 gain. TE proposed antenna have high percentage b.w 16.26.This antenna design for medical implant. These can be used in human tissues.

V. Conclusion

The proposed antenna works on18.3 GHz frequency with 12.44 gain. TE proposed antenna have high percentage bandwidth 13.94.This antenna design for medical implant. These can be used in human tissues.

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