

Design and Analysis of Dual Split Rings Metamaterial based Antenna for Wireless Communication

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Abstract- In wireless communication systems such as satellite and radar communication, their systems are mostly antenna for transmission and reception. Microstrip antennas play very important roles in wireless or mobile communication systems. The presented paper is a dual split ring metamaterial based antenna with modified ground plane microstrip structure, used for wireless communication applications from 1GHz to 10GHz. We present two microstrip antenna out of which one having single split ring patch on the other hand second design having dual split ring patch but with same ground plane. On the basis of proposed design we investigate the effect of dual split ring antenna on return loss, VSWR bandwidth and gain. The proposed design with properties of dual split ring, increase the operating band of antenna with better bandwidth.

Keywords— Multiband Microstrip Antenna (MBMA), Split Ring Resonator (SRR), Strip Line.

I. INTRODUCTION

As the technology changes rapidly, there is a great demand of compact size, high selectivity, low cost, and high-performance components in any modern wireless communication system. Antenna is an essential component in modern communication system. In response to this plea, in recent times many planar antennas with better performances parameters have received extensive attention. Many more techniques and methodologies have been investigated in designing such antennas. As microstrip patch antenna (MPA) emerge as one of the key components in modern communication system. It plays a major role of signal transmission at different frequencies and receiving the desired signal [1]. Active devices such as mixer and oscillator are often followed by MPA for signal transmission and reception at desired frequency. MPA can be used for WIFI and Bluetooth application and in many low earth orbit satellites, military satellites, and terrestrial wireless connections like GSM mobile phones [2].

The contents of the paper are organized in following manner. Section II, describe the basic concepts of EBG specially SRR technique. Section III presents two SSR

designs proposed for microstrip patch antenna with different patch Shapes. Section IV demonstrates the simulation results and performance parameters using HFSS software for the proposed design, and finally, a conclusion is reached in section V.

II. CHARACTERISTIC OF EBG

Diverse types of metamaterial structures area plaited in collected works to upgrade the implementation of a microstrip patch antenna. The objective of the metamaterial-based patch is to realize contraction of shape, low VSWR, low reflection loss and larger bandwidth. As the EBG is introduced in the ground plane of the patch antenna, the resultant of final capacitance and inductance introduce amendment and these as a result will change the resonant frequency of the microstrip antenna. For keeping this theory in mind, we introduce SRR technique for single and dual split ring, the basic of SRR is presented in fig 1. Due to the amalgamation of SRR, there will be deviation in inductance and capacitance. The quality factor will also transform due to variation in inductance and capacitance. The quality factor can be transcribed as: $Q = \frac{f_0}{BW}$ Here, f_0 is the resonating frequency, BW is the bandwidth of operating devices, and Q is the quality factor. If the quality factor decreases, bandwidth will increase but circuit performance is degraded because of increased losses. Therefore, there is a tradeoff between the value of L and C in such a manner that the performance of the antenna s is not reduced. The inductance and capacitance depend on the lattice dimensions and slot gap of the SRR.

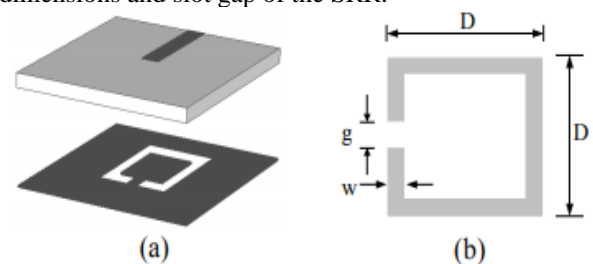


Figure 1: EBG resonator configuration

Fig. 1 demonstrates a SRR setup. The resonator resembles a folded half wavelength resonator.

III. PROPOSED MICROSTRIP ANTENNA

This section we are presenting two different designs of microstrip patch antenna the proposed design is a split ring resonator based microstrip antenna with different SSR patch and modified ground plane, the substrate thickness of all two designs are keeping fixed as 1.6 mm. the detailed proposed designs are shown below.

A. G-Shape SRR antenna Design

First proposed design is a Split Ring Patch based Microstrip antenna, made-up of Split Ring PEC removal from metallic patch which is grown on a FR-4 dielectric substrate of thickness 1.6 mm. The total area of ground plane and substrate is 32 mm × 26 mm. which is shown in the Figure 2.

The physical dimension of the proposed microstrip antennas are designed through ansys-HFSS software. The analysis of design is performed of frequency range of 1 to 10 GHz. With one input/output port as lumped port and their dimensions are 4mm × 4 mm. dimension of substrate is 32 mm × 26 mm × 1.6 mm. and dielectric constant of 4.4.

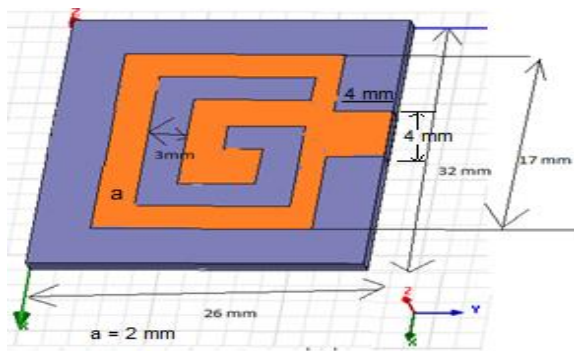


Figure.2 Top view of 1st Design model.

On the other hand we can classify the shape and dimension ground plane for the first design in fig 3. here we can see that the overall dimension of the ground plane is same as that of the substrate structure i.e 32 mm × 26 mm. The H-Shape is symmetrical in design and having an opening of 3 mm.

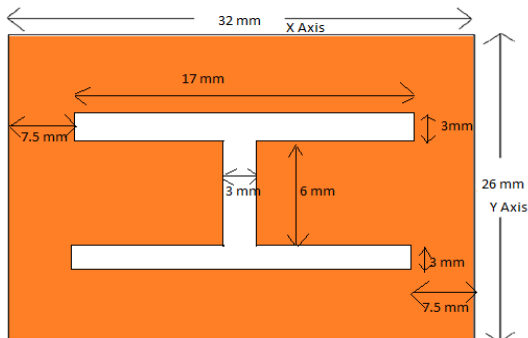


Figure.3 Bottom view of 1st Design ground plane.

B. Dual Split Ring Antenna Design

The proposed second design is a dual split ring structure on the same dimension of substrate as used in first design i.e. 32 x 26 mm² and thickness of 1.6 mm. the dimension of dual SRR is shown in fig 4. The feed line of this design is having dimension of 3mm × 4 mm. The ground plane of the proposed design has same area of dimension 32 mm × 26 mm as that of 1st design.

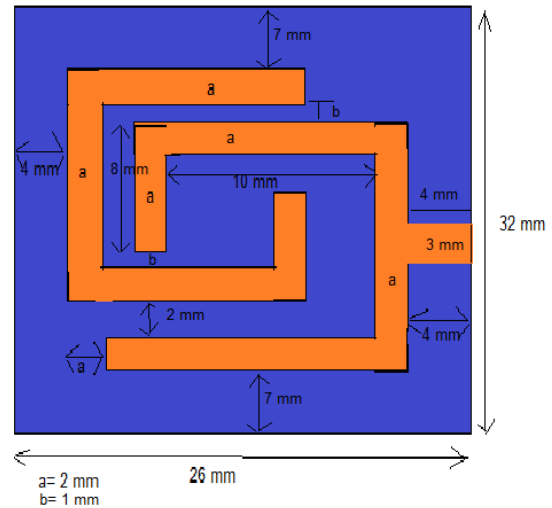


Figure.4 Top view of 2nd Design.

IV. RESULTS

The foremost performance parameter of proposed antenna design presented here are Return Loss, Bandwidth, VSWR, radiating band and peak Gain. For first design we achieve two operating band, we also get two very small band but due to its narrow bandwidth we ignore them and hence calculated the numerous performance parameter for only two band of operation with center frequency 8.49 and 9.21 GHz. On the other hand for second design we attain five multiple band of radiation, the inclusive results achieved by all two designs are shown in table 1.

Table I: Result analysis of Patch antenna.

Design	Radiating Frequency (GHz)	BW (-10dB) (MHz)	Gain (dB)	Return Loss	VSWR
A	8.49	181	5.59	-12.50	1.63
	9.21	306	6.33	-19.97	1.21
B	1.11	273	-11.70	-19.47	1.24
	4.50	142	2.45	-13.10	1.59
	4.80	316	3.28	-12.92	1.59
	8.52	197	4.49	-13.07	1.56
	9.23	392	7.50	-17.35	1.30

The figure 5, 6 and 7 represents the mentioned parameter viz. return loss S₁₁, impedance Bandwidth, gain and VSWR respectively for first design.

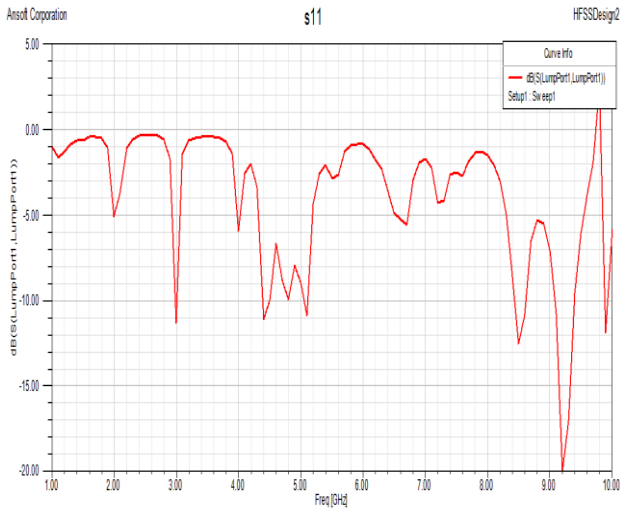


Figure 5. S11 for 1stDesign gain

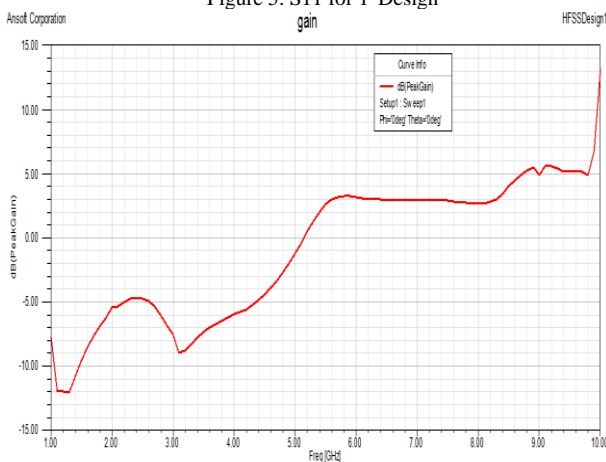


Figure 6. Gain for 1stDesign XY Plot 7

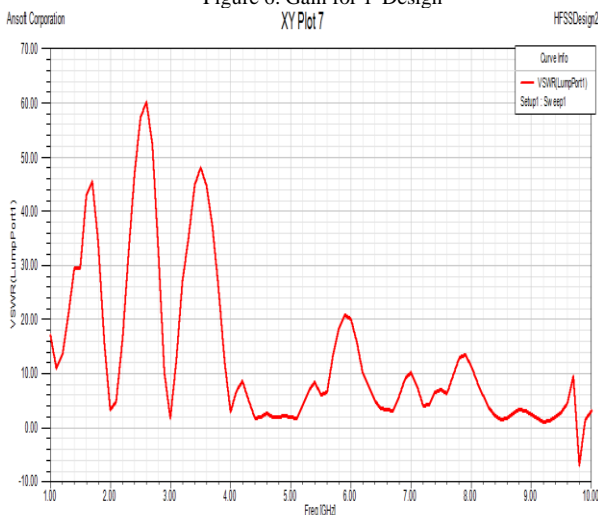


Figure 7. VSWR for 1stDesign

The figure 8, 9 and 10 represents the mentioned parameter viz. return loss S11, impedance Bandwidth, gain and VSWR respectively for second design.. respectively for design C.

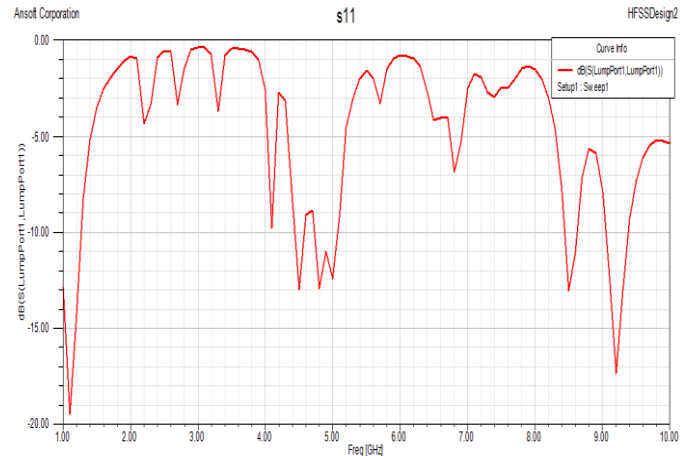


Figure 8. S11 for 2nd design XY Plot 3

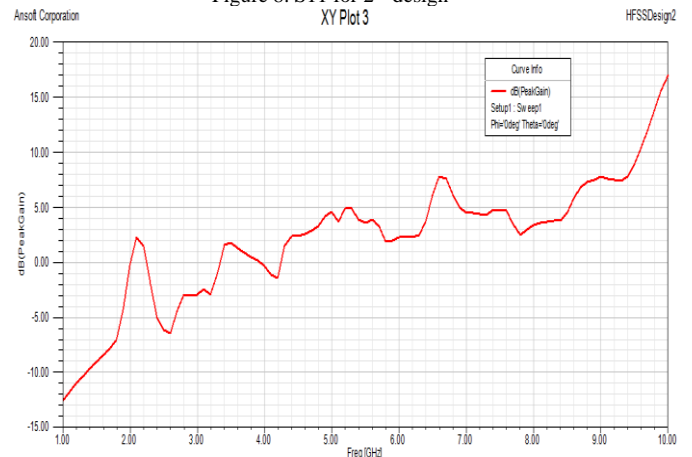


Figure 9. for 2nd design XY Plot 2

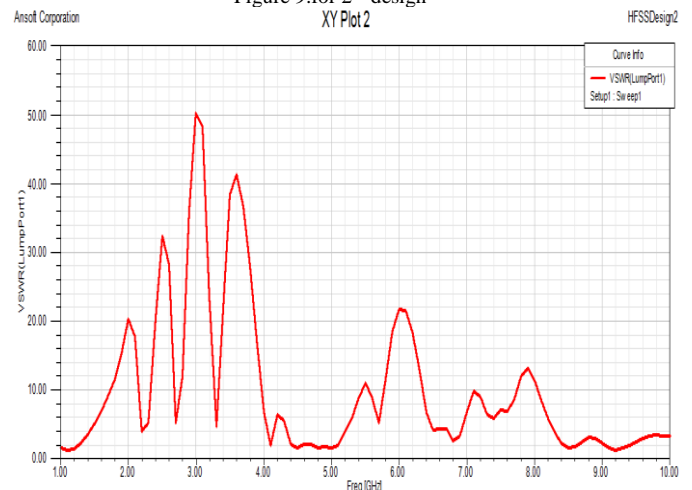


Figure 10. VSWR for 2nd design

IV. CONCLUSION AND FUTURE WORK

In this paper a dual SRR patch antenna is proposed, the final proposed antenna which is design by taking out the idea of first design without changing the dimension of ground plain and substrate. We observed that the 2nd design Produces five-bands of radiation with bandwidth of 273 MHz, 142 MHz, 316 MHz, 197 MHz and finally 392 MHz at center frequency of 1.11 GHz, 4.50 GHz, 4.80 GHz, 8.52 GHz and 9.23 GHz as center frequencies respectively. We also observed that the peek Gain is achieved at 9.23 GHz that is 7.50dB. After analyzing the results in table 1 we can

conclude that the introduction of dual SRR EBG structure improve the multi-band operation of antenna along with the gain improvement as well. Here the antenna gain is improved by around 18.5% as compare of single SRR patch antenna. So far is band of operation is concern again dual SSR gives a far better result as compare of single SRR antenna with five bands of radiation with satisfactory bandwidth and return loss. In future the research can be extended in field of circular SRR and physical realization of the proposed design can also be carried out.

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