



Performance Analysis of Dielectric Radiation with Sporadic Metallic Sheet

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Abstract: This paper presents performance analysis of dielectric radiation with sporadic metallic sheet. Different antenna prototypes have been modeled and simulated. Firstly, antenna is designed with plane metallic sheet and further sheet has been modified to observe the effect on antenna behavior. Antenna 1 has plane metallic sheet and antenna 2 and 3 has sporadic metallic sheet. Antenna 2 and 3 has metallic sheet having two rectangular holes and two circular holes respectively, so as to get dielectric radiation from sporadic metallic sheets. Behavior of antennas in terms of return loss, gain, radiation pattern, directivity and power has been presented and compared. Excitation technique used is co-axial probe fed. Theoretical performance of the antenna is verified by full-wave simulations and experimental data obtained from prototype antennas.

Index Terms: Dielectric Radiation, Radiation Pattern, Gain, Return Loss, Co-axial Feed, Multiple frequency Operation

I. INTRODUCTION

In the last two decades, microstrip antenna and dielectric resonator antennas (DRAs) [1] have been investigated as suitable antennas for wireless applications. The DRA can be used as millimeter frequency bands and is compatible with existing excitation method such as the coaxial probe, microstrip transmission line, co-planer waveguide feed or aperture coupling. DRAs are available in basic shapes such as rectangular, cylindrical, spherical and hemispherical geometries. Rectangular DRAs offer more design flexibility since two of the three of its dimensions can be varied independently for a fixed resonant frequency and known dielectric constant of the material [2-4]. In this research work geometry of dielectric material of size in mm range will be proposed, which will be mounted on a metallic substrate. A metallic strip of suitable dimension will be used to cover some surface area of the dielectric resonator. Antenna has been excited using coaxial probe feed technique. Coaxial probe feed; it is a feeding method in which the inner conductor of the coaxial is attached to the radiating element of the antenna while the outer conductor is connected to the ground plane. The radiation produced by this system will be studied.

III. ANTENNA STRUCTURE

The proposed design uses a substrate of material Rogers RT/Duroid 5880 (tm) having relative permittivity of 2.2 and dimension 10 cm X 9 cm X .32 cm. It is placed on a plane having infinite E-field, which acts as ground plane. This has been done to minimize the back lobe radiation phenomenon. "Antenna 1" has rectangular metallic sheet of dimension of 6.54 cm X 5.44 cm. "Antenna 2" is having sporadic metallic sheet with two rectangular holes, having dimensions of 1.5 cm x 1 cm. "Antenna 3" is having sporadic metallic sheet with two circular holes, having radius of 0.7 cm. Antennas has been excited using coaxial feed method. These antennas have been simulated on High Frequency Structure Simulator (HFSS).

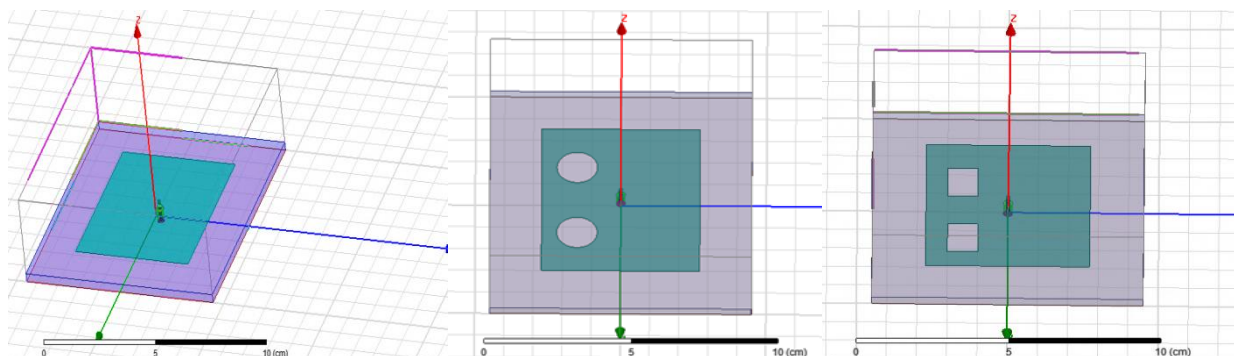


Figure 1 3D View of (a) Antenna 1, (b) Antenna 2 and (c) Antenna 3

III. SIMULATION

A. Antenna 1

The S_{11} Vs Frequency plot of Antenna 1 is shown in Fig. 2 (a). It can be seen that antenna is well matched at different frequency, f_1 is 2.9GHz and f_2 is 3.38GHz having maximum return loss of -17.31dB and -24.42 dB respectively. Gain of the antenna in terms of radiation pattern has been presented in Fig. 2 (b), which is found to be 5.68.

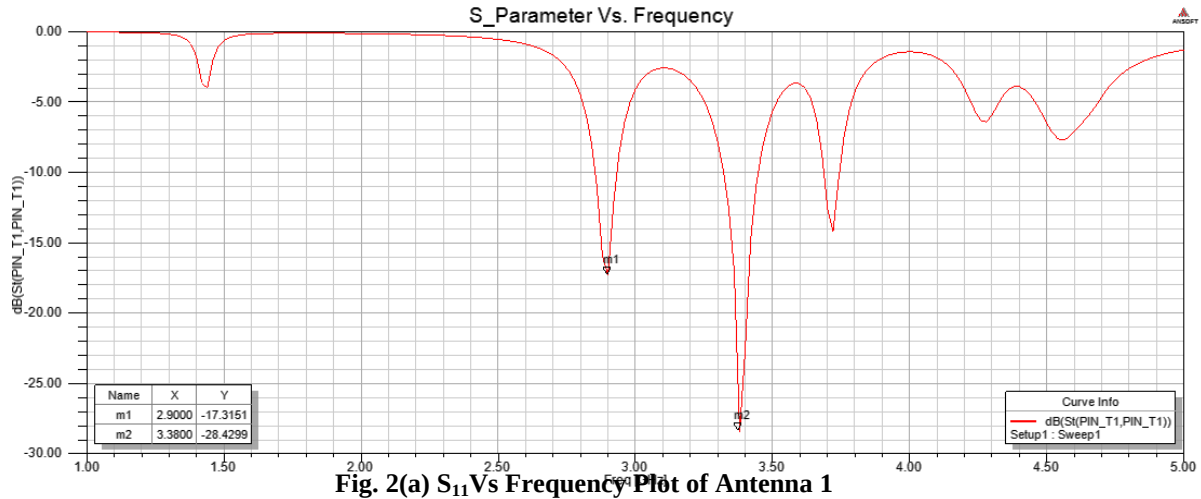


Fig. 2(a) S_{11} Vs Frequency Plot of Antenna 1

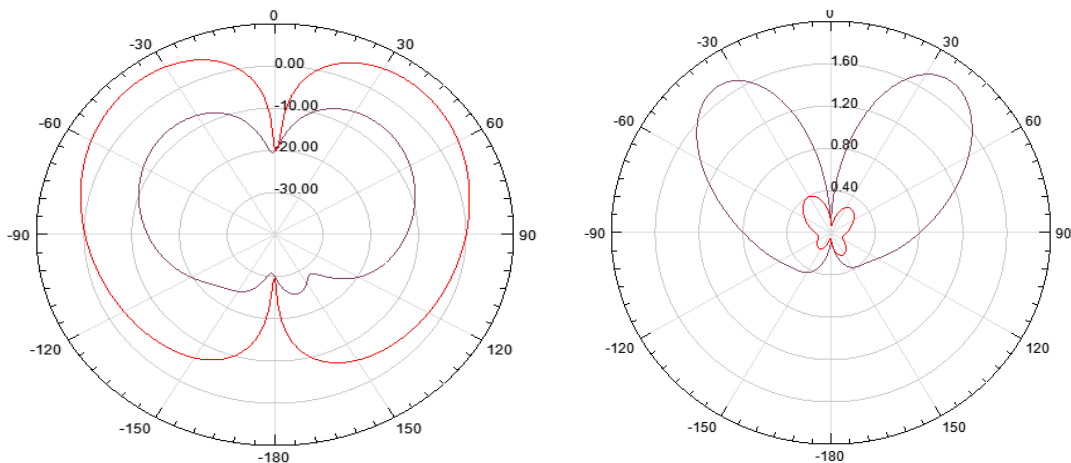


Fig. 2(b) Gain of Antenna 1 in terms of radiation Pattern

B. Antenna 2

The S_{11} Vs Frequency plot of Antenna 2 is shown in Fig. 3 (a). It can be seen that antenna is well matched at different frequency, f_1 is 2.76GHz, f_2 is 3.14 GHz and f_3 is 3.46GHz having maximum return loss of -16.44dB, -11.44dB and -14.63 dB respectively. Gain of the antenna in terms of radiation pattern has been presented in Fig. 3 (b), which is found to be 3.66.

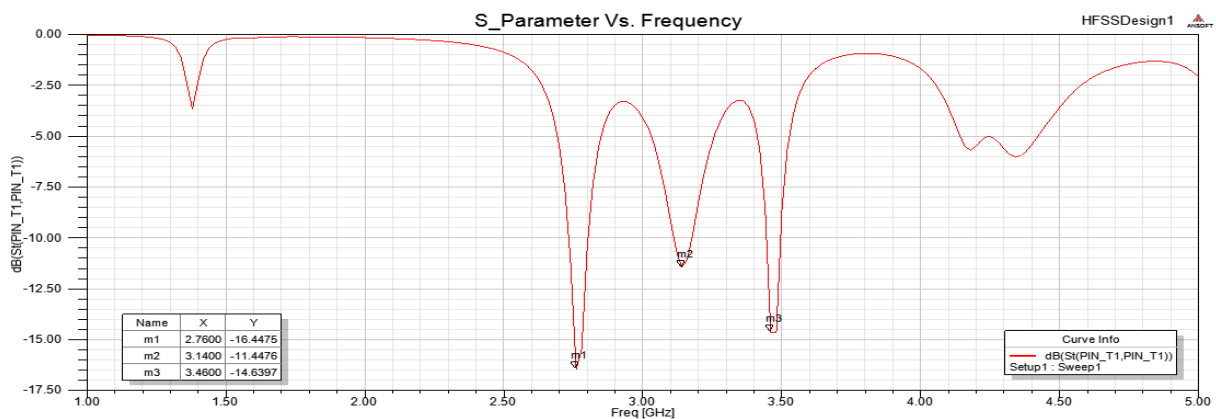


Fig. 3(a) S_{11} Vs Frequency Plot of Antenna 2

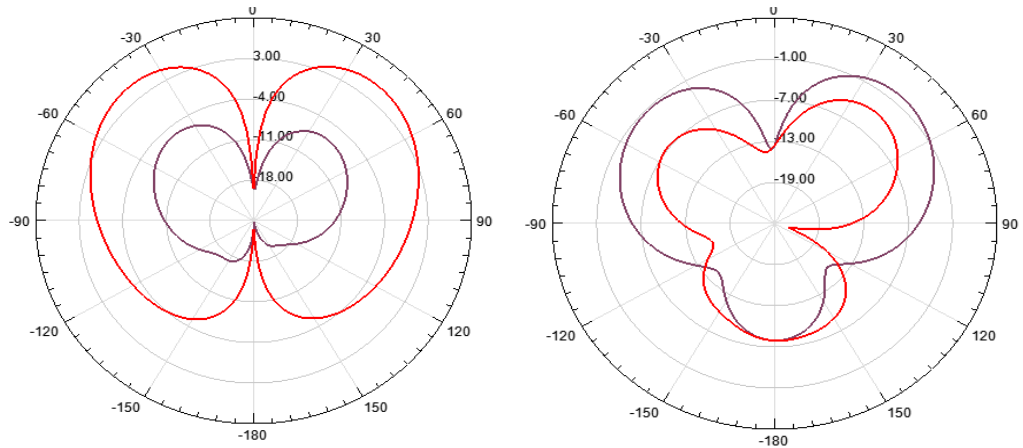


Fig. 3(b) Gain of Antenna 2 in terms of radiation Pattern

C. Antenna 3

The S_{11} Vs Frequency plot of Antenna 3 is shown in Fig. 4 (a). It can be seen that antenna is well matched at different frequency, f_1 is 2.9GHz and f_2 is 3.38GHz having maximum return loss of -17.31dB and -24.42 dB respectively. Gain of the antenna in terms of radiation pattern has been presented in Fig. 4 (b), which is found to be 5.13.

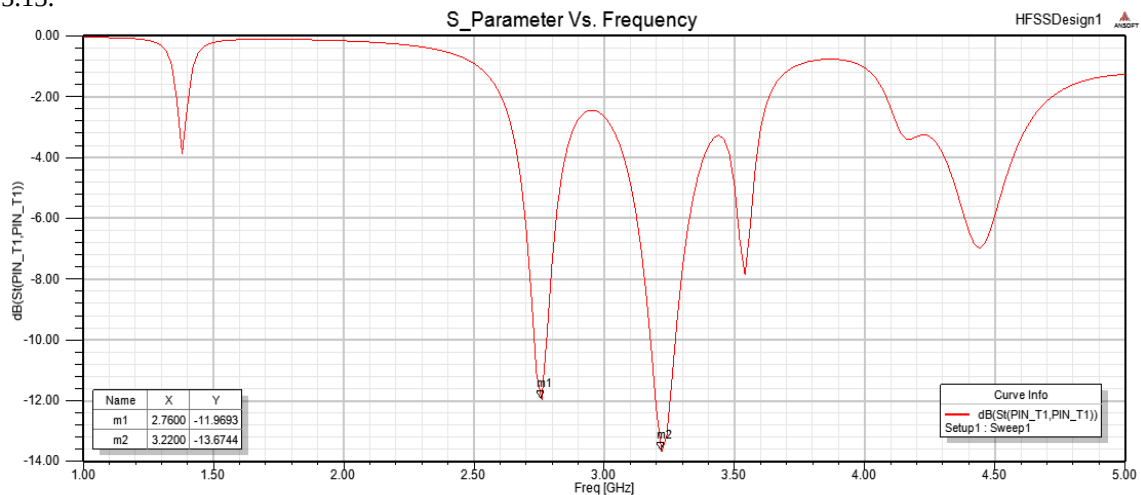


Fig. 4(a) S_{11} Vs Frequency Plot of Antenna 3

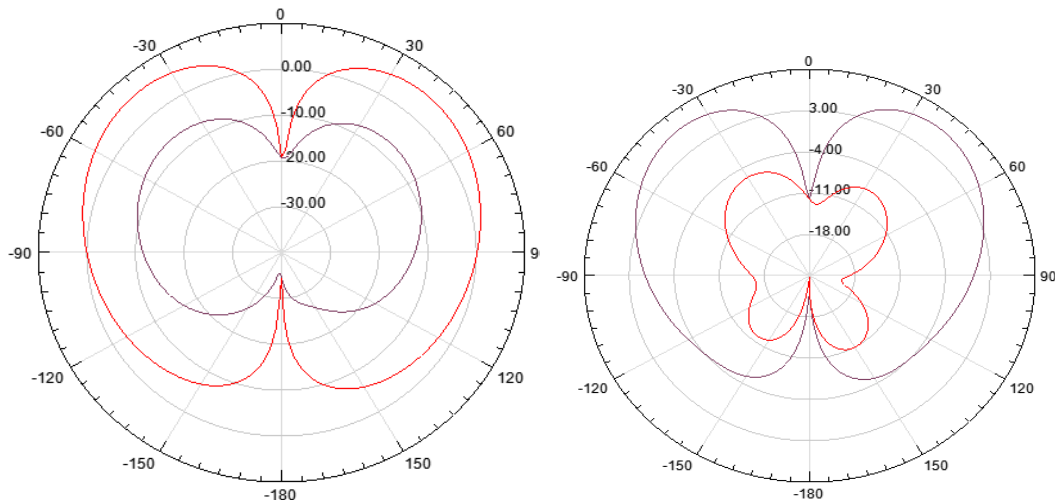


Fig. 4(b) Gain of Antenna 3 in terms of radiation Pattern

IV. DISCUSSION

Antenna Characteristics Parameter	Antenna 1		Antenna 2		Antenna 3	
	Frequency 1 (2.9 GHz)	Frequency 2 (3.38 GHz)	Frequency 1 (2.76 GHz)	Frequency 2 (3.46 GHz)	Frequency 1 (2.76 GHz)	Frequency 2 (3.22 GHz)
Directivity	4.30477	5.68486	3.78242	1.1369	3.81143	5.29974
Gain	4.23146	5.68683	3.66582	1.04381	3.72729	5.13078
Realized Gain	4.15916	5.67682	3.58393	1.00647	3.49862	4.91371
Radiated Power	12.655mW	9.513mW	9.847mW	6.966mW	13.633mW	9.934mW
Accepted Power	12.874mW	9.509mW	10.161mW	7.587mW	13.941mW	10.261mW
Incident Power	13.098mW	9.525mW	10.393mW	7.868mW	14.852mW	10.715mW
Radiation Efficiency	98.29%	100%	96.91%	91.18%	97.79%	96.81%

V. CONCLUSION

This paper investigates the change in the behavior of dielectric resonator antenna when sporadic metallic sheet has been used as a radiating structure. It is observed that antenna characteristics changes significantly. It is found that antenna 3 having radiating structure with rectangular holes in it presents good behavior in terms of directivity, gain, radiation power and efficiency as compared to that with antenna 2, which have radiating structure with circular holes.

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