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Tetra Band Floral Patterned Patch Antenna with CSRR in its Ground Plane

Dr. R. Gayathri Rajaraman
Assistant Professor, Department of Electronics & Communication Engineering,
Annamalai University, Chidambaram, India
E-mail: Gayathri_rajaraman@yahoo.co.in

Abstract
A compact floral patterned antenna using a novel metamaterial structure (CSRR) in its ground plane is presented. These metamaterial structures miniaturize the antenna, inducing tetra resonances. The antenna resonates at 4.735, 5.185, 6.08, 6.71 GHz with adequate gains of 2.87, 3.05, 3.76, 4.30 dB's and a bandwidth of 56, 75, 50, 110 MHz in its resonances. The proposed antenna is targeted to create resonances in Radar and public Bands of frequency spectras. Key Antenna parameters obtained from the simulator are presented along with detailed discussions in this paper.

Keywords: *Microstrip patch antenna, linear polarization, wireless applications, radar, cable TV relay applications*

INTRODUCTION

The concept of Metamaterials started with the prediction of backward waves and negative permeability, permittivity by Vessalago [1]. These artificial synthesized materials play a key role in antenna design, addressing multiresonances, gain enhancement, bandwidth enhancement requirements of wireless antennas. Two Phi shaped SRR placed back-back miniaturizing the MPA effectively is suggested by S. Vipul *et al*. This may find utility in space applications [2].

H. M. Lee suggested a modified planar antenna by designing a single unit cell of MTM using CRLH technique. Metal insulator metal (MIM) capacitor and microstrip stub inductors are used in this design as elements of CRLH. The design equations for design of micro strip stub inductor and capacitor are also explained in [3]. J. D. Baena *et al.* studied the equivalents of SRR and CSRR [4]. They also extracted the parameters of these structures both analytically as well as experimentally, particularly for microstrip technologies. X. Cheng *et al.* used CSRR in a flexible substrate to miniaturize the size of antenna down to 74%. This finds application in medical implantable antennas but the gain is found to be negative, which is a pre-requisite for such applications [5].

C. Wenquan *et al.* proposed the use of CSRR on the ground of MPA specially for beam steering while no metamaterial loading is seen on patch [6]. Many research articles using metamaterials for antenna design are seen in [8–13]. In this paper a floral patch design with CSRR in its ground plane resulting in a tetra band resonances is discussed.

DESIGN OF PROPOSED ANTENNA

The antenna is designed with RT Duroid substrate with relative permittivity of 2.2 and a thickness of 62 mils. Coaxial feeding is carried out [7]. Four turns of CSRR which exhibit negative permittivity features supporting backward waves are etched on ground planes besides etching a total of 24 triangles on patch surface yielding a floral pattern patch resonating at four different wireless spectras.

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The resonant frequency of the CSRR structure is determined from the equation which is given below.

$$\omega_o = \frac{1}{\sqrt{L_c C_c}} \qquad (1)\ [8]$$

The top view and its ground plane view are shown in Figures 1–2, while the dimensions are seen tabulated in Table 1.

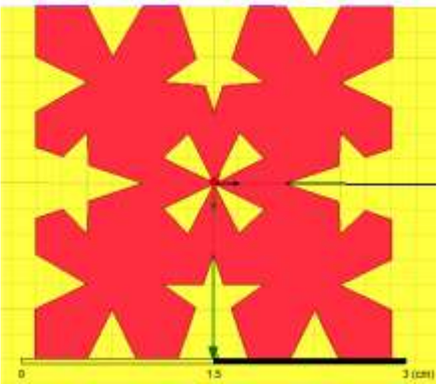

***Fig. 1:** Top View of the Proposed Antenna.*

ANALYSIS OF THE PROPOSED ANTENNA

The Coaxial fed floral antenna is designed by optimizing the dimensions using commercial EM simulator to create tetra band resonances at 4.735, 5.185, 6.08, 6.71 GHz with a return loss of -17.4, -18.1, -11.8, -13.8 dB's respectively and are shown in Figure 3.

The impedance plot of the antenna with its polar, radiation plots are clearly depicted in Figures 4–12 while directivity and VSWR are seen in the last two Figures 13-14.

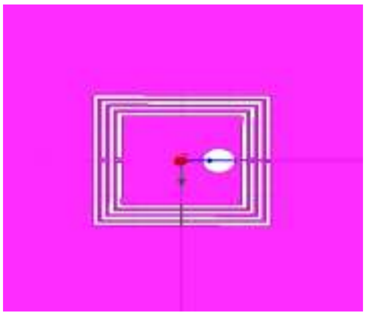

***Fig. 2:** Ground View of the Proposed Antenna.*

***Table 1:** Dimension of the Proposed Antenna.*

Parameters	Size
Substrate	62 mils
Ground	45 X 35
CSSR turns	4
Space	0.3
Length of outer ring	15
Width	0.5

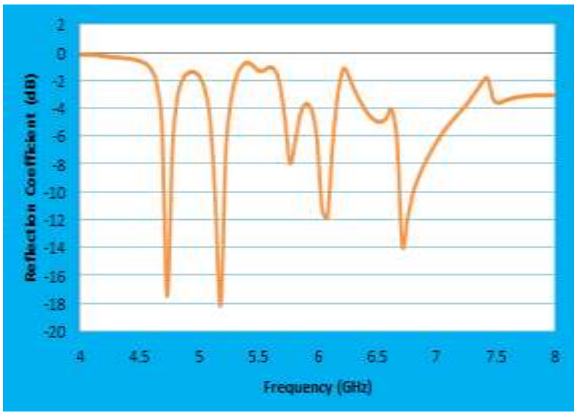

***Fig. 3:** Reflection Coefficient of Proposed Antenna.*

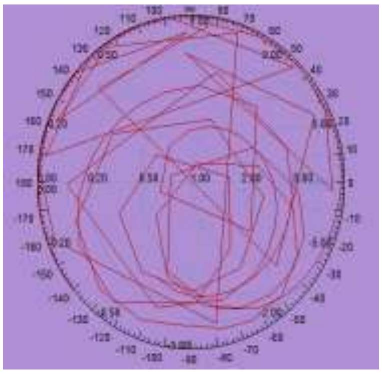

***Fig. 4:** Impedance Plot of the Proposed Antenna.*

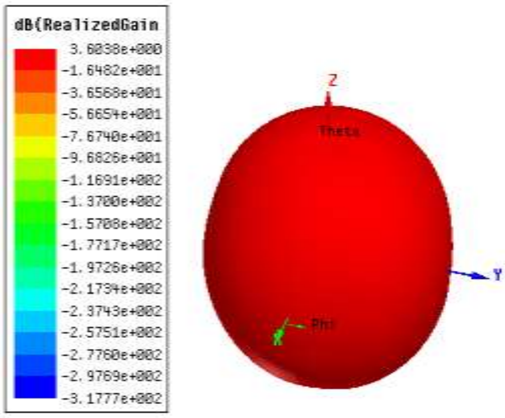

***Fig. 5:** Polar Plot (Gain) of the Proposed Antenna.*

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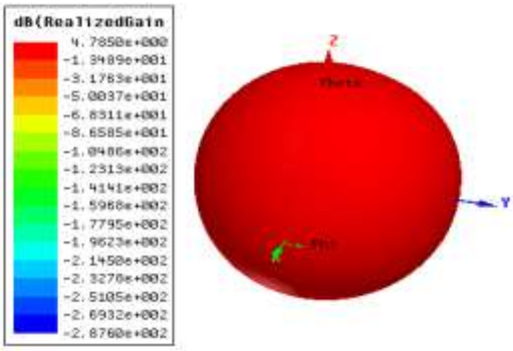

Fig. 6: *Polar Plot (Gain) of the Proposed Antenna.*

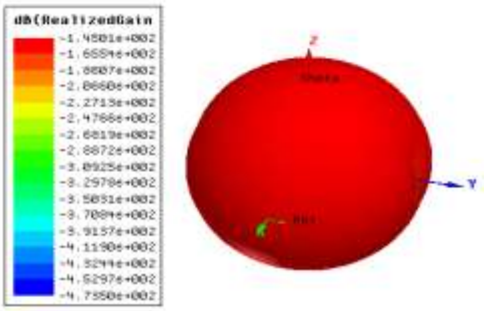

Fig. 7: *Polar Plot (Gain) of the Proposed Antenna.*

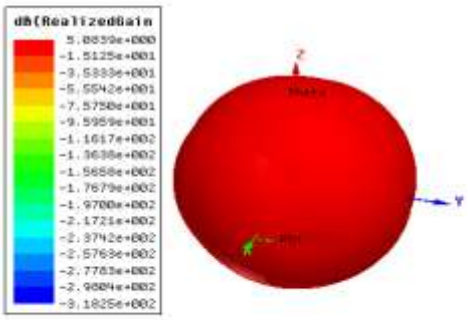

Fig. 8: *Polar Plot (Gain) of the Proposed Antenna.*

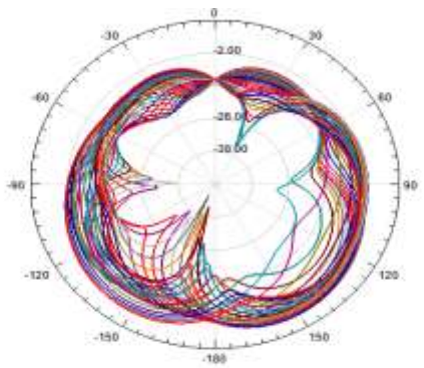

Fig. 9: *Radiation Pattern of the Proposed Antenna.*

The Simulated antenna parameters at the four resonant frequencies are seen in Tables 2–5.

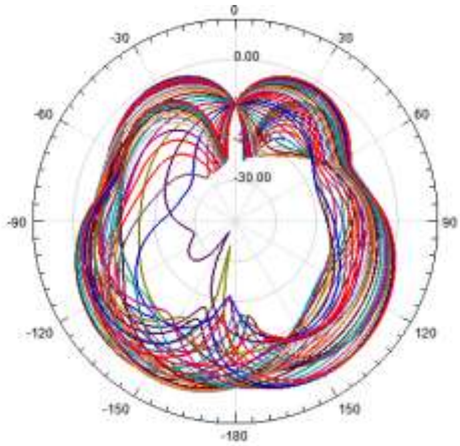

Fig. 10: *Radiation Pattern of the Proposed Antenna.*

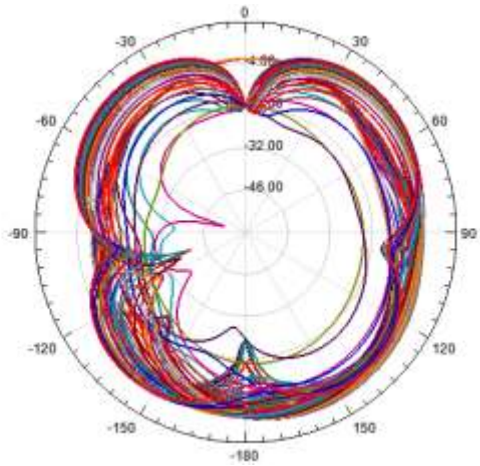

Fig. 11: *Radiation Pattern of the Proposed Antenna.*

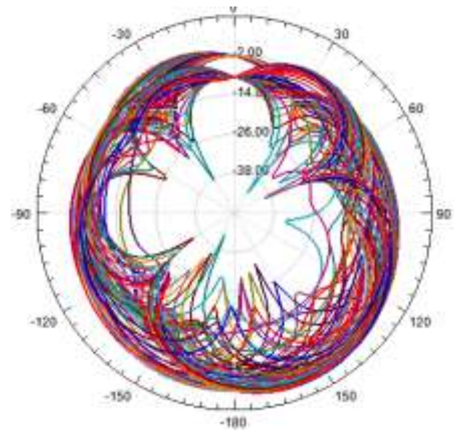

Fig. 12: *Radiation Pattern of the Proposed Antenna.*

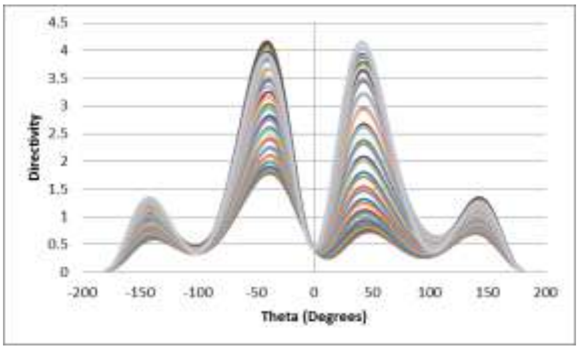

Fig. 13: *Directivity of the Proposed Antenna.*

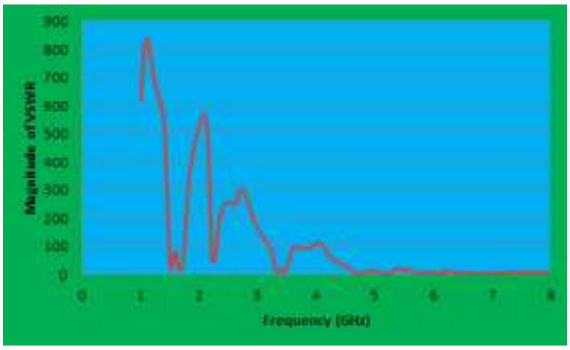

Fig. 14: *VSWR Characteristics of the Proposed Antenna.*

Table 2: *Simulated Antenna Parameters at 4.7375 GHz.*

Quantity	Value
Directivity	3.0
Gain (dB)	2.87
Efficiency	95.75
VSWR	1.38

Table 3: *Simulated Antenna Parameters at 5.185GHz.*

Quantity	Value
Directivity	3.12
Gain (dB)	3.05
Efficiency	97.6
VSWR	1.28

Table 4: *Simulated Antenna Parameters at 6.085 GHz.*

Quantity	Value
Directivity	3.926
Gain (dB)	3.76
Efficiency	95.9
VSWR	1.69

Table 5: *Simulated Antenna Parameters at 6.715GHz.*

Quantity	Value
Directivity	4.362
Gain (dB)	4.3019
Efficiency	98.6
VSWR	1.51

CONCLUSION

A novel, compact floral patterned patch antenna with tetra band resonance is designed. The antenna is designed without the use of stacking of substrate and without the use of Via yielding good gain and adequate bandwidth. Hence, suggested antenna is inexpensive and it finds application in cable relay and RADAR.

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