Volume 8, No. 3, March – April 2017

ISSN No. 0976-5697

International Journal of Advanced Research in Computer Science

RSEARCH PAPER

Available Online at www.ijarcs.info

# A Fractal Dual Band Microstrip Patch Antenna using CSRR in its Ground Plane

Dr. R. Gayathri Rajaraman
Assistant Professor, Department of Electronics & Communication Engineering,
Annamalai University, Chidambaram, India

***Abstract:*** Complementary split ring resonators (CSRR) (planar structures hence easily realizable nature) exhibit negative permittivity. The Design of a Novel Dual band Patch Antenna using CSRR and fractal concept is presented in this paper. The Kotch fractals are effectively implemented; circular, triangular slots are also further etched on the patch. The antennas radiating feature is improved by loading its ground plane with an innovative material named Metamaterial (Complementary Split Ring Resonator) Confirming an Omnidirectional pattern with radiating efficiency greater than 99, 86% respectively in the bands of its resonances. The model yields adequate Gain, Directivity at its resonances. The Key antenna parameter analysis (with the aid of commercial E.M simulator) carried out is also presented.

***Keywords:*** Microstrip Patch Antenna, Linear Polarization, Wireless Applications, Fractal, Koch, CSRR.

## INTRODUCTION

To design a Multi Band, Multi functioning antennas are always a challenging task for antenna designers while growing Wireless world (mobile) always places, the demand for a low-cost, compact antenna. Use of slots, DGS, EBG, Reactive loading using co-planar line elements or chip components were done in the past. Metamaterials; synthesize media of constitutive properties; not otherwise found in nature; are todays alternative for such requirements and they are artificial materials exhibiting negative permeability and permittivity over a certain range of frequencies. The end result of their usage is miniaturization, Wide band, Multiresonant, Omnidirectional antennas. Vessalago introduced the term first [1]. Pendry *et. al.* proved the existence of negative permeability and permittivity of Metamaterials [2]. MTM, Fractal utility in antenna design are seen in [3-12]. Spectrum Details are seen in [13]

### Physics Of CSRR

A Split Ring Resonator has negative permeability but the Complementary Split Ring Resonators have negative permittivity; and are analyzed using Babinet's principle; Electric and magnetic properties are exactly the reverse of SRR. They are resonators and they show negative permittivity when excited by axial electrical field like electrical dipole. This structure resonates and couples the field to the patch by means of capacitive and magnetic coupling.

### Design of the Proposed Antenna

NELTEC NY9220 substrate with a thickness of 62 mils is used in the design with Coaxial feeding. The dimensions of the antenna is optimised using the EM simulator. The convential patch is found to resonate at 2.75 GHz. The Modification includes; introduction of Kotch fractal along with circular and triangular etch on the patch as well as four CSRR (with four turns) are etched on the ground plane improving the radiatingfeatures. The CSRR, antenna dimensions used to design the proposed antenna are noted in Table 1. Top, Ground View of the antenna are presented in Figures 1,2.

**Table 1 Optimized Dimensions.**

| Dimensions | Value (mm) |
|---|---|
| Ground | 60 X60 |
| Substrate | 45 X 38 |
| Width | 0.5 |
| Length | 9.1 |
| Gap | 0.5 |
| Space | 0.3 |

## ANALYSIS OF THE PROPOSED ANTENNA

The coaxial fed antenna is found to resonate at two frequencies they are 5.69, 6.88 GHz and its Return Loss characteristics values of -17.08, -21 dB's and are shown in Figure 3. Various Wireless Applications and its spectra are available in [11, 12]; IEEE 802.11a (5.8 GHz), DCS (1710-1880 MHz), PCS (1850-1990 MHz), UMTS (1920-2170 MHz), BLUETOOTH (2400-2483.5 MHz) and Wi-Fi (2400-2480 MHz), Ultra wide band (3.1- to 10.6-GHz).

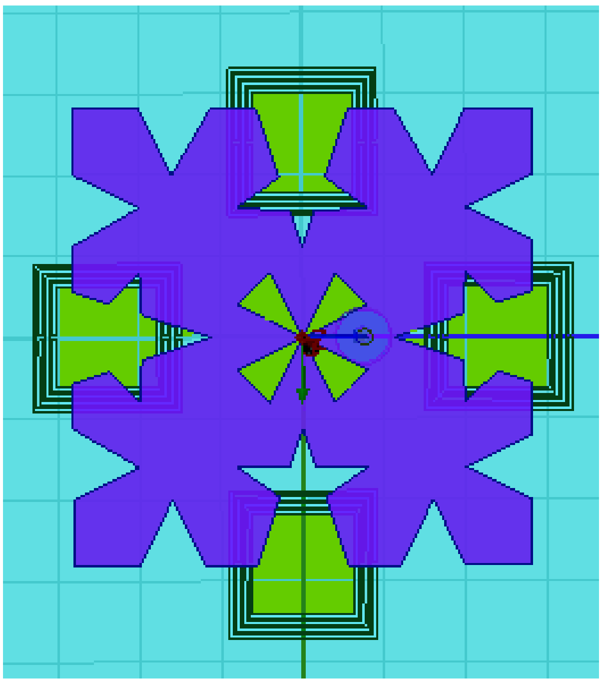

**Fig. 1 Top View of the Proposed Antenna.**

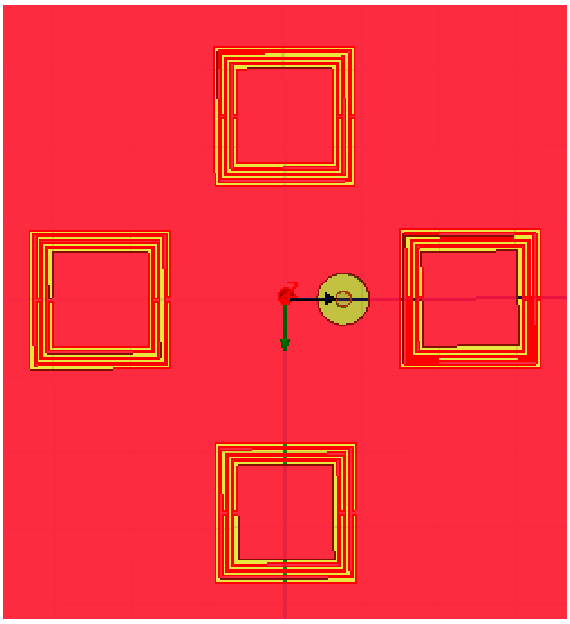

**Fig. 2 Ground Plane of the Proposed Antenna.**

The Ludwig Gain Radiation Pattern, Polar Plot is presented in Figures 4-7. The summative antenna parameters are given in Tables 2-3. To understand the reason for multi resonance surface current distribution (Longest Vector) is near the slots creating extra path) are shown in Figures 8, 9. VSWR are shown in Figure. 10. Directivity, rE field is shown in Figures 11-14.

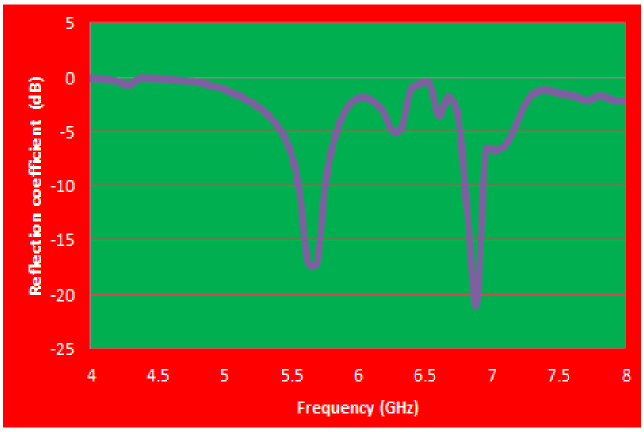


**Fig. 3 Reflection Coefficient of the Proposed Antenna.**

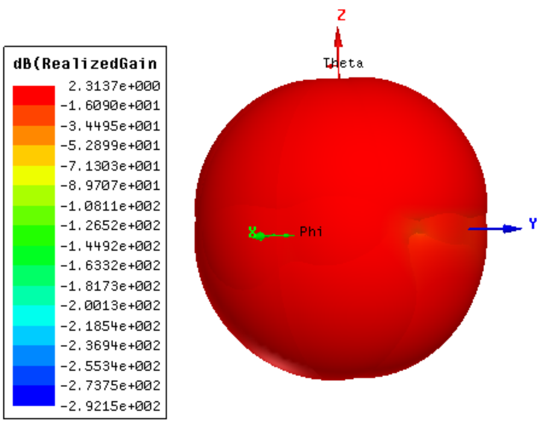


**Fig. 4 Polar Plot (Gain) of the Proposed Antenna.**

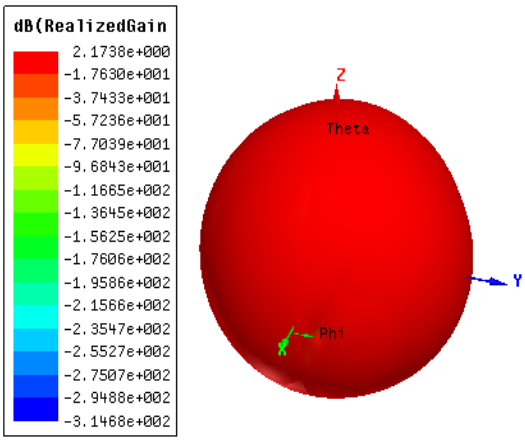


**Fig. 5 Polar Plot of the Proposed Antenna.**

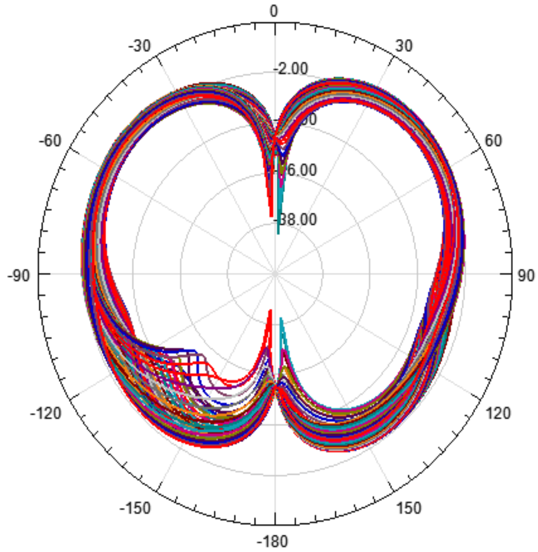


**Fig. 6 Gain pattern of the Proposed Antenna.**

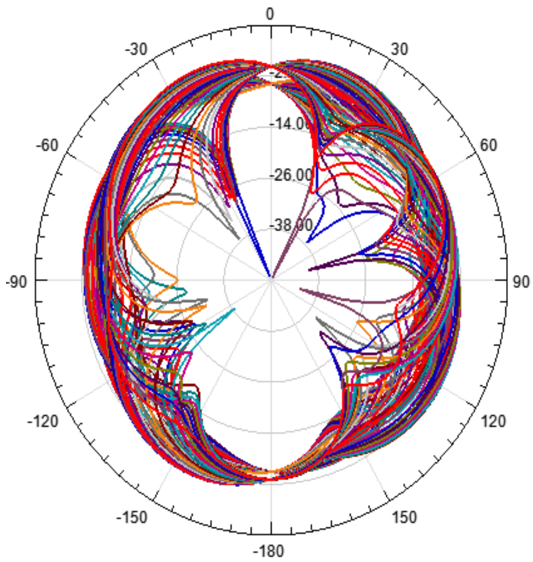


**Fig. 7 Gain pattern of the Proposed Antenna.**

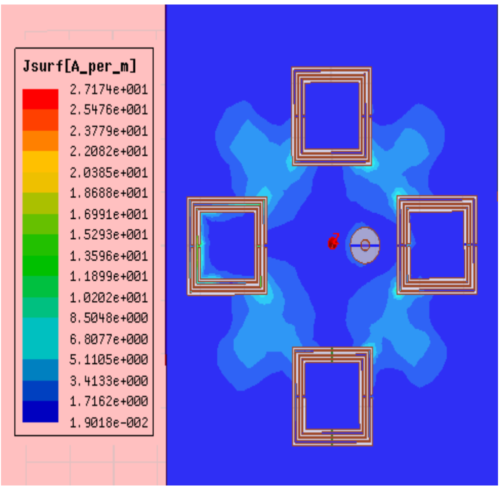


**Fig. 8 Current (Surf Density) of the Proposed Antenna.**

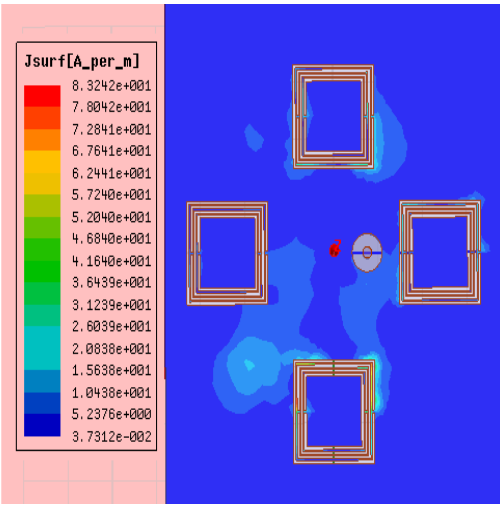


**Fig. 9 Current (Surf Density) of the Proposed Antenna.**

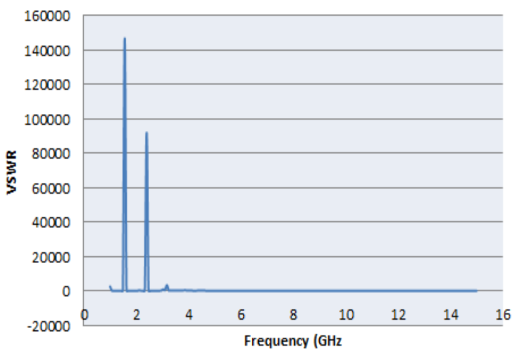


**Fig. 10 VSWR Characteristics of the Proposed Antenna.**

**Table 2: Antenna Parameters at 5.69 GHz**

| Quantity | Value |
|---|---|
| Directivity | 2.7919 |
| Gain (dB) | 2.7353 |
| Efficiency | 99.2 |
| VSWR | <2 |

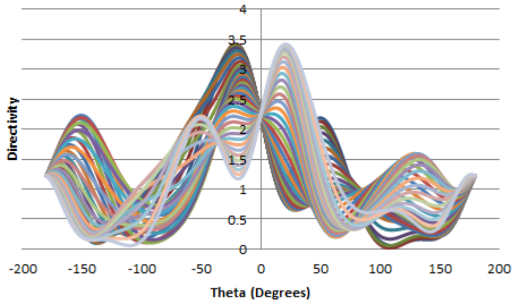


**Fig. 11 Directivity of the Proposed Antenna.**

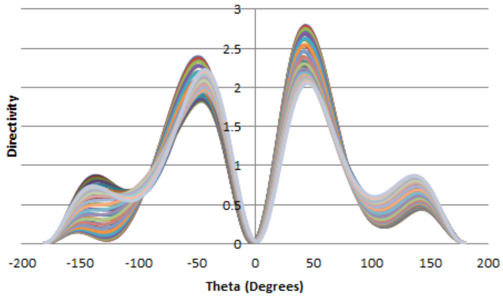


**Fig. 12 Directivity of the Proposed Antenna.**

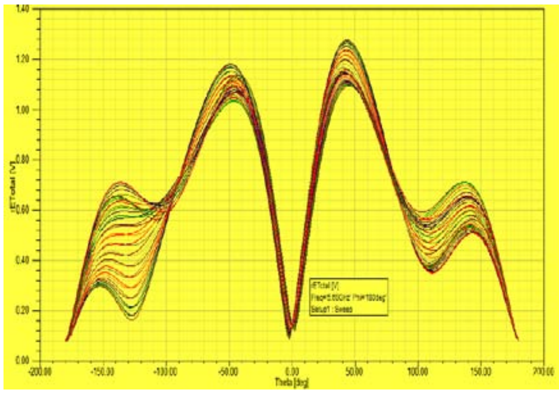

**Fig. 13 rE of the Proposed Antenna.**

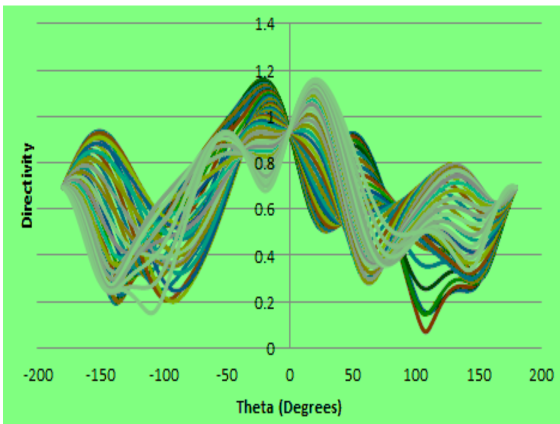


**Fig. 14 rE of the Proposed Antenna.**

**Table 3 Antenna Parameters at 6.88 GHz**

| Quantity | Value |
|---|---|
| Directivity | 3.419 |
| Gain (dB) | 2.26 |
| Efficiency | 86.3 |
| VSWR | <2 |

## CONCLUSION

CSRR (An Innovative material) is effectively used in this design along with Koch fractal concept leading to dual resonances. One band is intented for IEEE 802.11a application, ISM spectra; while the other falls in 3.1- to 10.6-GHz range that is intended for Ultra wide band applications. The antenna is cheap and can be realized using any known PCB techniques. Both the spectra supports linear polarization. They are spaced far apart with adequate band width.

## ACKNOWLEDGEMENTS

The author wishes to thank the authorities of Annamalai university. With Deep sense of gratitude the author thanks her Guru, Dr. Khagindra Kumar Sood, Group Head, Satcom Systems and Technology Group (SSTG) & Satcom and Navigation Applications Area (SNAA), Space Applications Centre, Indian Space Research Organization, Ahmedabad, India. The current paper is an improved version of the one presented in National Conference on March 24, 2017, SRDBME, Alpha College of Engineering.

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