

# Operating bandwidth enhancement of fractal defected ground structure Microstrip antenna

M.Poovarasi<sup>#1</sup>, K.Sivadhani<sup>#2</sup>, S.vinothini<sup>#3</sup> and J.Venkatachalapathi<sup>\*4</sup>

<sup>#</sup> B.Tech, Electronics and communication engineering, Shri krishnaa college of engineering and technology, Puducherry, India

<sup>\*</sup> B.E, M.E, Assistant Professor of ECE department, Shri krishnaa college of engineering and technology, Puducherry, India

**Abstract**— A new technique to design single-feed circularly polarized (CP) microstrip antenna is proposed. The CP radiation is obtained by adjusting the dimension of the etched fractal defected ground structure (FDGS) in the ground plane. Parameter studies of the FDGS are given to illustrate the way to achieve CP radiation. The CP microstrip antennas with the second and third iterative FDGS are fabricated and measured. The measured 10-dB return-loss bandwidth of the CP microstrip antenna is about 50 MHz (4.6 to 4.75 GHz).

**Index Terms**— Defected ground structure, micro strip antenna, circular polarization, fractal structure.

## I. INTRODUCTION

### A. HISTORY OF ANTENNAS

An antenna is any structure or device used to collect or radiate electromagnetic waves. In some sense the first antenna dates from 1887, when Heinrich Hertz designed a brilliant set of wireless experiments to test James Clerk Maxwell's hypothesis. Hertz used a flat dipole for a transmitting antenna and a single turn loop for a receiving antenna. For the next fifty years antenna technology was based on radiating elements configured out of wires and generally supported by wooden poles. These "wire" antennas were the mainstay of the radio pioneers, including: Guglielmo Marconi, Edwin Howard Armstrong, and Lee deForest. Each of these "engineers" has been called the Father of the Radio [Lewis, 1991]. Dr. deForest conducted his first

Long-distance wireless broadcasts, one hundred years ago, from the Illinois Institute of Technology (then it was The Armour Institute) [Fayant, 1907], where he was on the faculty [IIT Technews, 1999]. The first generation antennas were narrowband (small range of the order of a few percent around the designed operating frequency) and were often arrayed to increase directivity. Development of the array eliminated in the work of Hidetsu Yagi and Shintaro Uda (1926) [Kraus, 1988]. During this period broadband antennas were also developed. The Yagi-Uda antenna remained king until after the war. Then during the 1950s and 1960s research at the University of Illinois culminated in the development of a class of antennas that became known as frequency independent.

These have a performance that is periodic in a logarithmic fashion, and have come to be known as "log-periodic" antennas. In recent years, new work (fractal antennas) is coming out of a number of research centers.

### B. FEEDING TECHNIQUES

Microstrip patch antennas can be fed by a variety of methods. These methods can be classified into two categories—contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch.

#### 1) Coaxial Feed

- The Coaxial feed or probe feed is a very common technique used for feeding Micro strip patch antennas.
- As seen from Fig. 1.6, the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane.
- The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation
- However, its major disadvantage is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates ( $h > 0.02\lambda_0$ ).
- Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems. It is seen above that for a thick dielectric substrate, which provides broad bandwidth, the micro strip line feed and the coaxial feed suffer from numerous disadvantages. The non-contacting feed techniques discussed below, solve these problems.

[1] Mutual Coupling Reduction by Novel Fractal Defected Ground Structure Band-Gap Filter

Micro strip antenna, as a main antenna category, is widely used in military and civil application because of its small size, low cost, easy to be manufactured and convenient to expand into array. The isolation between coplanar micro strip antenna elements is important in applications, which includes systems relying on array antennas such as multiple inputs and multiple output (MIMO) wireless communication. High level mutual coupling will result in low antenna efficiency, loss of bandwidth and further degradation in the performance of either diversity gain or considerations indicate that the corresponding capacity of the systems may be reduced when the received signal in different antenna element are correlated MIMO system design considers the antenna diversity technique that increases spectrum efficiency. which will be degraded when mutual coupling exists. So reducing mutual coupling is significantly important in MIMO systems.

[2] Microstrip Open-Slot Antenna with Broadband Circular Polarization and Impedance Bandwidth

In the maximal polarization efficiency for antennas, devices of circular polarization (CP) and related publication has been attracting attention in recent years. It is known that the faraday rotation effect results in the rotation of the linearly polarized fields and thus the fields interact along the direction of propagation to compare with the linearly polarized wave, the circularly polarized electromagnetic wave is generated by two orthogonal resonant modes of equal amplitude and in-phase quadrature, and it can decrease the impact of the faraday rotation effect in satellite communication. Because of its low cost, low profile, light weight, wide bandwidth and easy matching, the microstrip slot antenna is widely used for wireless communication, the slot antenna, which has a patterned slot in the conducting ground plane, can excite desired resonances and radiate power into free space. As open-slot antenna with broadband circular polarization and wide impedance bandwidth has been presented. By locating the open slot optimally on the edge of the ground plane.

[3] Coupling-Feed Circularly Polarized RFID Tag Antenna Mountable on Metallic Surface

A radio frequency identification (RFID) operating in the Ultra-high frequency (UHF) bands (860-960 MHz) are expanding exponentially, due to the advantages such as long reading distance, high data transfer rate and small size. For practical applications in a commercial RFID system, a reader antenna with circular polarization (CP) is usually employed in the RFID reader in order to increase orientation diversity, and the majority of the RFID tags in the UHF band are designed as dipole or microstrip type antennas with linear polarization (LP) in this situation, although the reading range will not be affected by the orientation of the tag attached on the, however, the polarization mismatch will result in the fact that only half of the transmitted power is received by the tag. Therefore, if

the tag antenna is circularly polarized, the power received by the CP tag antenna can be improved by 41%.

[4] Nature of Cross Polarized from Probe Fed Circular Microstrip Antennas and Geometries of Defected Ground Structure (DGS)

Circular microstrip patch excited with dominant TM mode radiates linearly polarized fields along the broadside and the plane of polarization is determined by an imaginary vertical plane (xz-plane) of electric field (E-field) is supposed to be present. But orthogonally polarized E-fields have been evident since the early experiments and are designed as the cross-polarized (XP) radiations. It is typically about 25dB down relative to the co-polarized (Cop) gain in E-plane, but increase considerably in H-plane, particularly showing peaks around on either side of bore sight. The source of XP fields was theoretically analyzed in first higher order mode was attributed to this phenomenon. The theory considered infinite ground plane (GP) and showed absolutely no XP component in E-plane. This does not agree with a practical antenna.

[5] Dual-Band Dual Circularly Polarized Microstrip Antenna with Two Eccentric Rings and an Arc-Shaped Conducting Strip

Circularly polarized (CP) antennas are extensively used in modern wireless communication systems with their features of reducing polarization mismatch and improving system sensitivity. These have been several types of methods design CP antennas, which involve exciting two orthogonal modes of equal amplitude and  $90^\circ$  phase difference. In the external feeding networks were adopted for CP operation with wide bandwidth. However, these antennas may not meet the requirements of circuit miniaturization and cost reduction. CP operation can also be achieved by loading with proper asymmetry, such as inserting slits at the patch boundary and using an unequal lateral cross slot ground plane with the rapid development of wireless systems, various design of dual-band CP antennas have been reported. In Compared to a circular patch, a circular ring patch has smaller dimensions for a fixed operating frequency, the measured results show that proposed antenna works at 2.1 and 3.6 GHz, with the characteristics of low profile, indirection radiation and dual-CP radiated.

## II. HELPEFUL HINTS

### A. EXISTING SYSTEM:

- There are several types of antennas proposed for CP microstrip antennas are commonly used in the wireless communication system, because they are able to reduce the loss caused by the polarization misalignment between the transmitting antenna and receiving antennas.
- A single feed CP U-slot microstrip antenna is asymmetrical U-slot structure is able to generate

two orthogonal modes for CP operation.

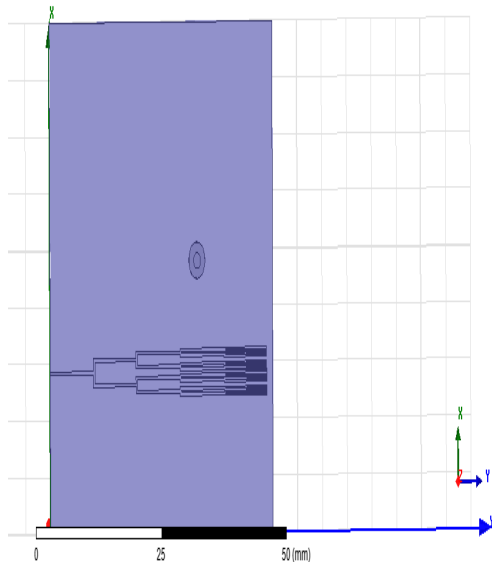
**B. PROPOSED SYSTEM:**

In the proposed system, the DGS in the ground plane below (not under) the antenna patch often increases the XP of the linearly polarized microstrip antenna. When the magnitude of the increased XP resonant mode is the same as that of the original resonant mode, the fundamental factor for generating CP radiation is achieved. But the conventional DGSs, like the classic double'

**1) MERITS:**

- Smaller in Size
- High gain and directivity.
- Low fabrication cost
- Light weight
- Mechanically robust

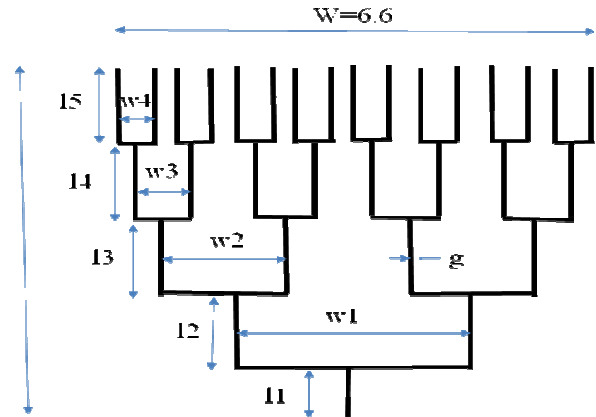
**III. RESULTS AND DISCUSSION**



**A. DESIGN OF FOURTH ITERATION USING FRACTAL SHAPE**

The fourth iteration using fractal shape of CP microstrip antenna with the fourth iterative FDGS is fabricated to verify is the simulation. The measured s11 of this design are compared with the one. The measured data in general meets well with the simulated results. The simulated and measured radiation patterns of the CP microstrip antenna with the third iterative FDGS. The microstrip antenna with the second iterative FDGS has two resonant modes. One of the resonant modes fixed in the lower frequency in x direction. The increased resonant mode in the y direction is determined by the FDGS, which moves to lower frequency when increasing the structure length.

**IV. FOURTH ITERATION FDGS**

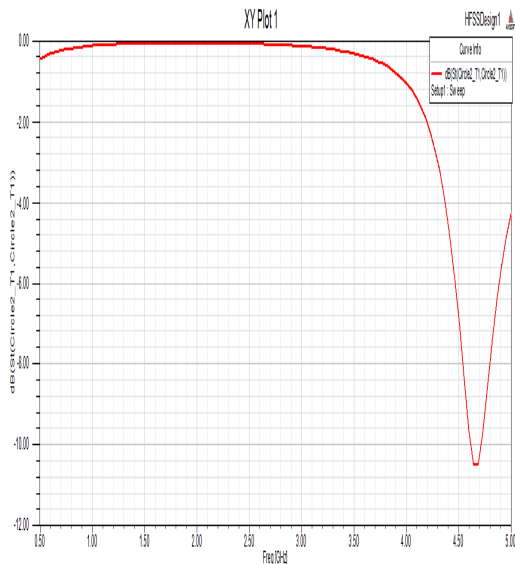


**A. DESIGN SPECIFICATIONS OF FRACTAL SHAPED STRUCTURE**

- 11=2.1m
- 12=2.4mm
- 13=2.4mm
- 14=2.4mm
- 15=2.4mm
- w1=3.6mm
- w2=1.9mm
- w3=0.7mm
- w4=0.4mm
- g=0.3mm

In the fourth iteration, the length of the structure is decreased and the width of the structure is increased. In order to show the CP generation mechanism by the proposed antenna, the FDGS parameter studies are conducted. Key parameters of the FDGS are structure length l and width w. The antenna s11 when tuning FDGS length l2.

## B. PROPOSED SIMULATION OUTPUT



Simulation Output

## V. CONCLUSION

A new technique to design single-feed CP microstrip antenna using FDGS has been presented in this communication. By using this method, the XP level of the linearly polarized micro strip antenna is increased to the required level for CP radiation. The CP microstrip antennas with the second and third iterative FDGS are fabricated and measured. Both the fabricated microstrip antennas have the measured 10-dB return loss bandwidths about 50 MHz (4.6 to 4.75 GHz).

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