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# A Compact and Broadband Microstrip Patch Antenna with Circular Polarization for L-S-C BAND: A Review

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*Abstract: -* **The thesis covers three aspects of Micro strip array antenna designs. The first is the analysis and design of single element rectangular Microstrip antenna which operates at the central frequency of 5 GHz and the second aspect is the design of Compact Broad band rectangular Microstrip antenna which is operates as Compact Broadband. Both antennas have been modeled, designed and simulated. Basically, transmission line is going to use to model both antennas. First, the design parameters for single element of rectangular patch antenna have been calculated from the transmission line model equation and extend the antenna design to Broad Band rectangular Microstrip patch antenna using the appropriate slots and shorting pin at radiating edge. The simulation process has been done through IE3D electromagnetic software which is based on method of movement (MOM).For rectangular Microstrip antenna design used FR-4 material and the result compared between different optimization scheme and theoretical results.**

*Keywords*: **IE3D; FR-4 substrate,**

## I. INTRODUCTION

Satellite communication and Wireless communication has been developed rapidly in the past decades and it has already a dramatic impact on human life. In the last few years, the development of wireless local area networks (WLAN) represented one of the principal interests in the information and communication field. Thus, the current trend in commercial and government communication systems has been to develop low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a large spectrum of frequencies. This technological trend has focused much effort into the design of Microstrip antennas [1]. With a simple geometry, patch antennas offer many advantages not commonly exhibited in other antenna configurations. For example, they are extremely low profile, lightweight, simple and inexpensive to fabricate using modern day printed circuit board technology, compatible with microwave and millimeter-wave integrated circuits (MMIC), and have the ability to conform to planar and non-planar surfaces. In addition, once the shape and operating mode of the patch are selected, designs become very versatile in terms of operating frequency, polarization, pattern, and impedance.

## II. HISTORY

A microstrip antenna was firstly introduced in 1950's but it became popular and took place in various applications in 1970's. Recently, microstrip antennas are widely used in several applications where small size, low weight and cost, high performance and easily fabricated and installed antennas are required such as air borne, space borne commercial and military applications and mobile and wireless technologies. Some other advantages of microstrip antennas are that they are conformable to planar and non-planar surfaces, easily fabricated using printed circuit technology, and they are mechanically robust. Microstrip patches are resonant type antennas.

## III. LITERATURE SURVEY

**1. Multilayer Parasitic Microstrip Antenna Array For WiAX Application Rina Abdullah ,M.T Ali ;N.Ismail,N.N.S.N.Dzuikefli ; IEEE Asia-Pacific Conference on Applied Electromagnetics Publication Year: 2012 , Page(s):128 - 131.**

A multilayer parasitic microstrip patch antenna array concerned on enhancement of gain for WiMAX application .in this paper proposed structure is microstrip patch antenna array which is compose of three layers using different material,substrate .The substrate for the first layer consists of Flame Retardant 4 that has thickness 1.6mm While the second layer and third layer are 3mm thickness using foam substrate .so that multilayer microstrip patch Antenna is designed . In this paper gain increased 62.3 % and performance of the designed antenna is to test for return loss , Voltage Standing wave ratio (VSWR),bandwidth, directivity radiation pattern and gain.

**2. Design and Analysis of a Low Profile and Broadband Microstrip Monopolar Patch Antenna Juhua Liu, QuanXue, HangWong, HauWah Lai, Yunliang Long**

A new Microstrip monopole patch antenna is presented and analyzed in this paper. The antenna has a wide bandwidth and a monopole like radiation pattern. Such antenna is constructed on a circular patch antenna that is shorted concentrically with a set of conductive vias.The antenna is analyzed using a cavity model. The cavity model analysis not only distinguishes each resonating mode and gives a physical insight into each mode of the antenna, but also provides a guide line to design a broadband monopolar patch antenna that utilizes two modes (TM01 and TM02 modes). Both modes provide a monopole like radiation pattern. The antenna has a simple structure with a low profile of 0.024wavelengths, and yields a wide impedance bandwidth of 18% and a maximum gain of 6 dBi.

## IV. PROBLEM IDENTIFICATION

With bandwidths as low as a few percent, broadband applications using conventional Microstrip patch designs are limited. Other drawbacks of patch antennas include low efficiency, limited power capacity, spurious feed radiation,

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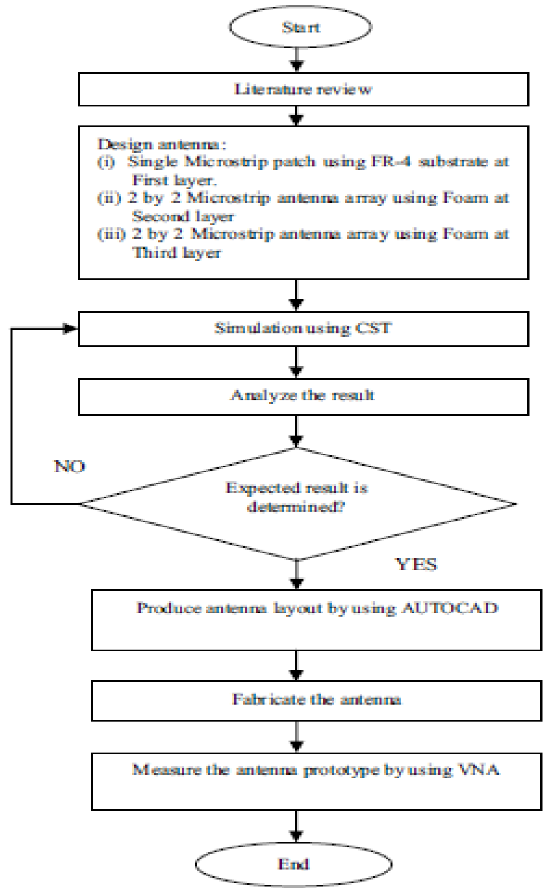
poor polarization purity, narrow bandwidth, and manufacturing tolerance problems. For over two decades, research scientists have developed several methods to increase the bandwidth and low frequency ratio of a patch antenna. Many of these techniques involve adjusting the placement and/or type of element used to feed (or excite) the antenna. Broadband frequency operations of antennas has become a necessity for many applications in recent wireless communication systems, such as GPS, GSM services operating at two different frequency bands. In satellite communication, antennas with low frequency ratio are very much essential. It is also less sensitive to feed position, which allows the use of an inset planar feed.

## V. PROPOSED ANTENNA DESIGN

Figure 1 shows the flowchart for the proposed antenna. In this part, the procedure of analyzing and designing multilayer parasitic microstrip antenna array is explained. Analysis of design criteria will be analyzed and need to be achieved and this required a major evaluation. The antenna will be fabricated then measured using a calibrated vector network analyzer only if the result meets the requirement. Finally, the outcome result from fabrication and measurement is compared and analyzed. In this paper, I design one by using single layered and second by fractal geometries implemented on multilayer. **[2]**




**1 Design Consideration for geometry-I**

The proposed design analyses with and without ground plan, analyses done by considering the effect of ground plan for enhancing the bandwidth , antenna efficiency, Gain, Return loss, VSWR.

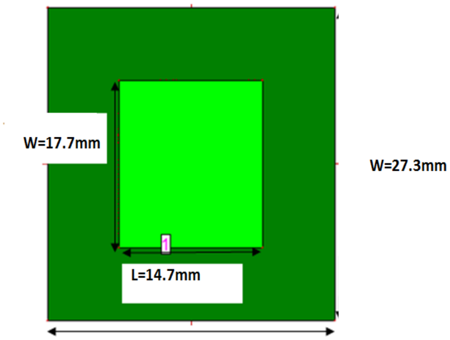
***Antenna Design with Ground plane***

The configuration of the proposed antenna is shown in Fig.4.1. The antenna is analyzed and optimized by IE3Dsoftware. The proposed antenna is composed of a FR-4 and foam dielectric material, two square slots, 2 by 2 parasitic L-Slot. The radiating arms are designed as two square slots and two L- slot to obtain compact size.

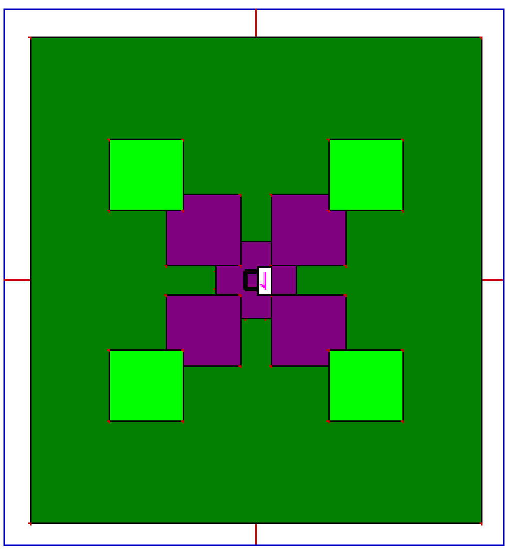
The dimensions of design at 5 GHz are:

Hence, the essential parameters for the design are:

- f0 = 5 GHz
- Ɛr1 = 4.4
- Ɛr2 = 1.05
- Ɛr3 = 1.05
- h1 = 1.6 mm
- h2= 3 mm
- h3= 3 mm
- Total height of substrate = h1+ h2+ ag =1.6+3+3=7.6 mm




Bottom layer consists with and without ground plan, in first geometry analyses proposed design with effect of ground plan of dimension Lg =24.3 mm, Wg =27.3mm. In second design analysis proposed antenna without consideration of effect of ground plan. Radom is used for protection of radiation of antenna from atmospheric obstacle and radiation of other object in fig 4.1 depicts Proposed Design Antenna with Ground Plan, in fig 4.2 depicts middle layer with slots. Microstrip antenna mathematical theory used for calculation of dimensions and designing.

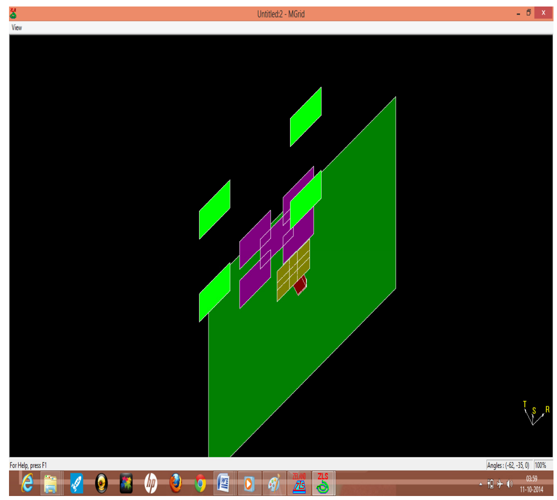


Top layer dimension is
L=14.7mm, W=17.7mm
Middle layer dimension is
L=14.7mm, W=17.7mm with two L slot and two square slot

### Proposed Antenna Design with Ground plan

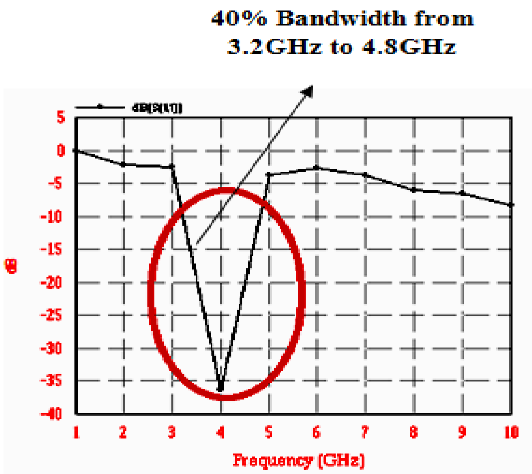
depicts Return loss of proposed design with respect to frequency. Firstly designed conventional design on IE3D Simulator, after simulation we found that reflection at 4GHz is very high and VSWR is 5.212, this is a theoretical design with respect to centre frequency but with respect to standard system results cannot be useable. for effective using at 4GHz we required good impedance matching, for providing good impedance matching we used stub matching technique of transmission line and found position of stub and length of stub, using resonance theory found width of stub, After finding stub dimension, substitute stub on the edges of middle layer patch, optimization completed by using appropriate dimension of ground plan. From this optimization, we found return loss up to -36dB, and VSWR at 4GHz is 1.023
The essential parameter specifications for the design slotted 2 BY 2 antenna array of the conventional rectangular microstrip Patch antenna are as in fig.

Side view (3-D)

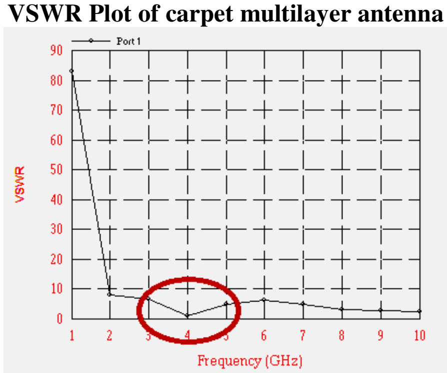


**Simulation Setup** The software used to model and simulate the Microstrip patch antenna is ZelandInc's IE3D. IE3D is a full-wave electromagnetic simulator based on the method of moments. It analyzes 3D and multilayer structures of general shapes. It has been widely used in the design of MICs, RFICs, patch antennas, wire antennas, and other RF/wireless antennas. It can be used to calculate and Return loss plot, VSWR, current distributions, radiation patterns etc. For design simplicity of the conventional MSA, the patch's length and width are shows in the table 5.2. Here two different geometry fractal antenna simulated and observe all antenna parameters like Return loss plot, VSWR, radiation patterns, Directivity, Gain and efficiency. Then compare both result and investigated advantages of applying Sierpinski carpet.
The Inset feed used at point (8, 0) to design the rectangular patch antenna. The center frequency is selected as the one at which the return loss is minimum. The bandwidth can be calculated from the return loss (RL) plot. The bandwidth of the antenna is said to be those range of frequencies over which the return loss is below than -7.5 dB. The Implemented Sierpinski carpet antenna simulated return loss data and its operating frequency are as shown figure.

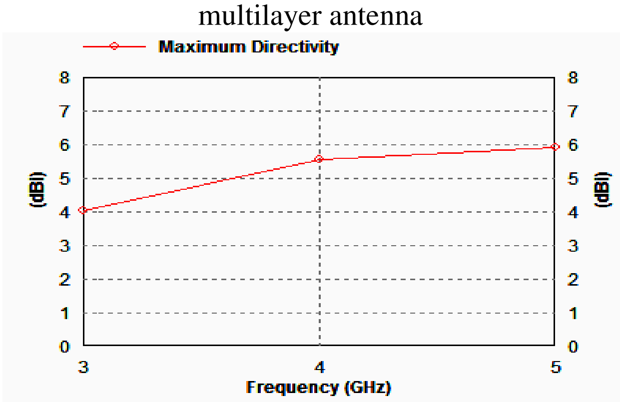
## a. Return Loss Plot



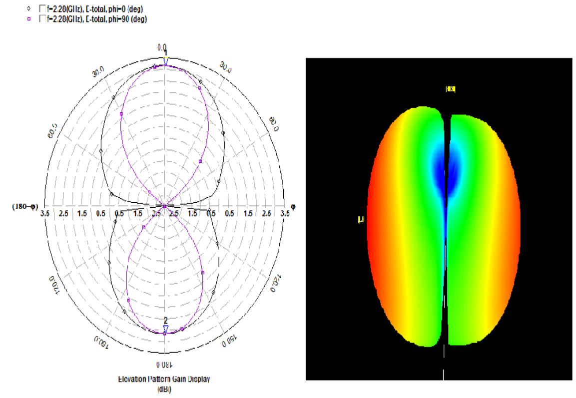

**VSWR Plot of carpet multilayer antenna**



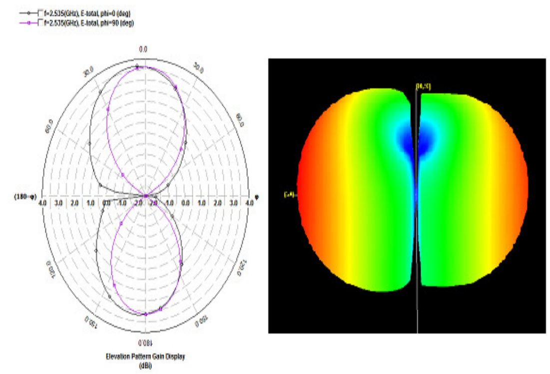

**Directivity vs. Frequency** Plot of carpet multilayer antenna




The gain of an antenna is essentially a measure of the antenna's overall efficiency. If an antenna is 100% efficient, it would have a gain equal to its directivity. Shown in figure Radiation pattern for 5 GHz



For 5 GHz frequency. See the figure represents 2D radiation pattern and 3D radiation pattern respectively.



## VI. Conclusion

This Paper work presents new concept of implementation of Fractal geometry on multilayer Sieperinski Carpet fractal geometry and designed multiband antenna.The aim of this paper work is to find how implementation on multilayer gives better result in achieving antenna parameters like return loss (RL),VSWR, antenna efficiency ,Gain, directivity and bandwidth. In this paper work I first design multiband Carpet fractal microstripe patch antenna and simulate its results with IE3D software. of bands. Hence fractal geometry is a used to obtain multiband application antennas

## References

[1] HomayoonOraizi ,Senior Member, IEEE and ShahramHedayati," Miniaturized UWB Monopole Microstrip Antenna Design by the Combination of Giuseppe Peano and Sierpinski Carpet Fractals" IEEE Antenna andWireless Propagation Letter, vol.-10,no.-,pp.67-70.2011.

[2] Homayoon Oraizi, Senior Member, IEEE and ShahramHedayati," Miniaturization of Microstrip Antennas by the Novel Application of the Giuseppe Peano Fractal Geometries" IEEE Transaction on Antenna and Propagation, vol.- 60, NO. 8, pp.3559-3567 August 2012.

[3] Kin-Lu Wong, Senior Member, IEEE, Gwo-Yun Lee, and Tzung-WernChiou, "Low-Profile Planar Monopole Antenna for Multiband Operation of Mobile Handsets",IEEE Transaction on antenna and propagation, vol.- 51. No.- 1, pp. 121-125.January 2003.

[4] EkoTjiptoRahardjo, FitriYuliZulkifli and DesiMarlena,"Multiband MicrostripAntenna Array for WiMAX Application", Microwave Conference, 2008, APMC2008; Asia-Pacific, Year: 2008, PP:1– 4. ISBN 978-1-4244-2642-3.

[5] Douglas H. Werner', Randy L. Haupt ,and Pingjuan L. Werner "Fractal Antenna Engineering: The Theory and Design of Fractal Antenna Arrays" IEEE Antennas and Propagation Magazine, vol.- 41, No. 5 PP. 37-58., October I999,

[6] AbolfazlAzari, "A New Super Wideband Fractal Microstrip Antenna" IEEE Transaction on Antenna and propagation, vol.- 59, no. 5, 1724-1727 MAY 2011. ISSN 0018-926X.

[7] B. R. Franciscatto ,T. P. Vuong and G. Fontgalland, " High gain Sierpinski Gasket fractal shape antenna designed for RFID", Microwave & Optoelectronics Conference (IMOC), SBMO/IEEE MTT-S International.PP.239-243,2011. ISBN978-1-4577-1662-1.

[8] Leonardo Lizzi,Andrea Massa," Dual-Band Printed Fractal Monopole Antenna for LTE Applications", IEEE Antennas and wireless propagation letter, vol.- 10, PP. 760-763. 2011.

[9] AsitK.Panda, ManojK.Panda and SudhansuS.Patra "A Compact Multiband Gasket Enable Rectangular Fractal Antenna" International Conference on Computational Intelligence and Communication Systems.PP.11-14. 2011 ISBN 978-1-4577-2033-8.

[10] HomayoonOraizi, Senior Member, IEEE and ShahramHedayati, "Circularly Polarized Multiband Microstrip Antenna Using the Square and Giuseppe Peano Fractals" IEEE Transactions on antenna and propagation, vol. - 60, NO. 7, PP.3466 -3470. July 2012.

[11] Ashish A. Lale, Bhagwan V. Khiste and Sanjay Khobragade"Study of Sierpinski triangle gasket" Microwave & Optoelectronics Conference (IMOC),SBMO/IEEE MTT-S International.vol.- 3,PP 386-390,2011 ISBN 978-1-4244-8679-3.

[12] L. S. Araújo, C. P. does Nascimento Silva, L. C. Barbosa, A. J. Belfort de Oliveira, "A novel Sierpinski carpet fractal dipole," Microwave & Optoelectronics Conference (IMOC), SBMO/IEEE MTT-S International.PP960—967, 2011.ISBN 978-1-4577-1662-1.

[13] Muhammad Waqas, Zubair Ahmed, Mojeeb Bin Ihsan"Multiband Sierpinski Fractal Antenna" Multi topic Conference. INMIC 2009. IEEE 13th International.PP.1-6, 2009 Print ISBN 978-1-4244-4873-9.

[14] Keng-Chih Lin, Chih-Hao Lin, and Yi-Cheng Lin "Simple Printed Multiband Antenna with Novel Parasitic-element Design for Multistandard Mobile Phone Applications" IEEE Transaction on Antenna vol.- 61,Isuee 1,2012 PP.488-491.

[15] Steven R. Best, "A Multiband Conical Monopole Antenna Derived From a Modified Sierpinski Gasket", IEEE Antennas and Wireless Propagation Letters, vol.- 2,PP. 205-207.2003

[16] Duixian Liu and Brian Gaucher **"**A New Multiband Antenna for WLAN/Cellular Applications", IEEE Antennas and Propagation Magazine, vol.-1, no.4, August2011.PP 243-246,ISSN 1090-3038

[17] David Pozar "Microstrip Antennas" Published in Antennas and propagation IEEE Transactions on vol.45 issue 2, pp. 287-296. 1997, ISSN 0018-926X.

[18] TianTiehong, Zhou Zheng, "A Novel Multiband Antenna: Fractal Antenna", International conference , Proceedings of ICCT vol.-2 issue 1pp. 1907-1910.2010

[19] Qi Luo, J.R.Pereira and H.M.Salgado, "Tunable Multiband Antenna with an Active Artificial Magnetic Conductor Ground Plane", Microwave Conference (EuMC), 2010 European, Year: 2010, PP: 461 – 464, Print ISSN 978-1-4244-7232-1.

[20] Philip Tang and ParveenWahid, "Hexagonal Fractal Multiband Antenna "The IEEE Transaction on Antenna, vol.-4, pp.554-5571997.ISBN 0-7803-7330-8.