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## Design and Analysis of Sierpinski Fractal WB Antenna with Double DGS for Wireless Applications

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**ABSTRACT:** A low profile sierpinski fractal antenna for ultra wide band applications. The proposed antenna is designed by incorporating sierpinski fractals inside a circular ring of width 1mm which improves the impedance band width and radiation efficiency of the antenna. The proposed antenna of dimensions 29x28x1.6 covering the frequency range of 3.7 to 14.3 GHz with radiation efficiency of 92% is fed by micro-strip feed line. The radiation pattern is stable over the operating WB range. Sierpinski fractal WB antenna is designed and simulated using High Frequency Structure Simulator (HFSS).

KEYWORDS: sierpinsk, Antenna, Gain, Simulation, Frequencies, Return Losses.

#### I. INTRODUCTION

WB technology is a radio transmission technology used to deliver a vast amount of digital data over a wide band width of 7.5 GHz ranging from 3.1 GHz to 10.6 GHz consuming very low power for short distance. It satisfies the demands set by the wireless applications such as short range radars, high speed data transmission etc. It is essential for a WB antenna[1] to possess broad operating band width for a better impedance matching which results in high gain radiation in desired direction. Fractal antenna[4] is a self similar and provides multi resonance. Fractal WB antennas exhibits properties like wide band phenomenon, Omni directional radiation pattern and low resonance.

Due to its attractive features fractal WB antennas are widely used for ultra wide band applications. Initially a circular ring of width 1mm is designed which gives the narrow band width operation. Introducing fractals in antenna allows distinct current distributions to exist, which gives rise to radiation. As a result fractal introduced antenna will have very high band width. sierpinski fractals are used inside the circular ring for obtaining ultra wide band. Introducing sierpinski fractals inside the ring also gives better radiation characteristics[2]. Fractals are etched in central portion of the patch which can have less effect on radiation characteristics. Incorporating more fractals leads to wide band width[1] and good radiation characteristics. The radiation efficiency of the proposed antenna is more compared to other structures reported.

#### **II. ANTENNA DESIGN**

The proposed WB antenna is designed using FR4 substrate with relative permittivity of 4.4 and thickness of 1.6mm (h). Due to its attractive radiation characteristics[2] a circular patch antenna which operates at resonant frequency of 6 GHz is designed for WB

$$f_r = \frac{1.8412 c}{2\pi r_{\text{eff}} \sqrt{\varepsilon_{\text{reff}}}} \tag{1}$$



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Applications. The radius of the circular path is calculated using (1). Where,

$$r_{eff} = r \left[ 1 + \frac{2h}{\pi^{r} e_{eff} \left\{ \ln(\frac{r}{2h}) + (1.41\varepsilon_{r} + 1.77) + \frac{h}{r} (0.268\varepsilon_{eff} + 1.65) \right\}} \right]^{\frac{1}{2}}$$

fris the resonant frequency, c is the speed of light, and r is the radius of patch. From (1) the radius of circular patch is obtained as 8.5mm. The circular patch antenna is fed by micro-strip feed line of impedance 50 ohms. The width of the micro-strip feed line is calculated using (2).

 $\frac{w}{h} = \frac{8e^{A}}{e^{2A} - 2}$ where  $A = \frac{z_{0}}{60} \sqrt{\frac{\varepsilon_{r} + 1}{2}} + \frac{\varepsilon_{r} - 1}{\varepsilon_{r} + 1} \left( 0.23 + \frac{0.11}{\varepsilon_{r}} \right)$ 

(2) the width (w) of the micro-strip feed line is obtained as 3mm. Hence a circular ring of width 1mm is formed by etching circular patch of radius 7.5mm from circular patch of radius 8.5mm. Three order sierpinski fractals are introduced in the circular ring for improved band width and better radiation characteristics (Figure 1). The dimensions of 1st order, 2nd order, and 3rd order sierpinski fractals are 10.6mm,7.6mm, 4.5mm respectively. A partial ground plane[4] of length and width (Lg x Wg) 10 x 28 mm2 is placed below the substrate of length and width (Ls x Ws) 29 x 28mm2 which is fed through micro-strip feed line of length and width (Lf x Wf) 11.1 x 3mm2. The performance characteristics of proposed WB antenna[1] are validated using High Frequency Structure Simulator (HFSS) v 13.0.



Fig 2.1 Proposed WB antenna design

#### **III. SIMULATION USING HFSS**

#### **Introduction to software:**

HFSS is a commercial finite element method solver for electromagnetic structures from Ansys. The acronym originally stood for High Frequency Structural Simulator. It is one of several commercial tools used for antenna design[6], and the design of complex RF electronic circuit elements including filters, transmission lines, and packaging. It was originally developed by Professor Zoltan Cendes and his students at Carnegie Mellon University. Prof. Cendes



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and his brother Nicholas Cendes founded Ansoft and sold HFSS stand-alone under a 1989 marketing relationship with Hewlett- Packard, and bundled into Ansoftproducts.

The industry customary for simulating 3-D, full-wave, EM fields is the ANSYS HFSS software. HFSS stands for High Frequency Structural simulator[10]. Its gold-standard exactness, advanced solvers, and high performance computed technology makes it a critical tool for engineers tasked with executing the accurate and quick design in high-frequency and high-speed electronic devices and platforms. A high-tech solving technology is offered by HFSS based on the finite element, integral equation, asymptotic and complicated mixed methods used to solve a broad range of microwave, high speed digital and RF applications[1]. HFSS follows finite element method technique. This software is developed by ansys

Design and implementation: The Design of Simulation for Sierpinski Fractal WB Antenna is shown in figure 5.2



#### **III. SIMULATION RESULTS AND DISCUSSION**

#### Simulation Results With C Shaped DGS On Both Sides Using HFSS: Return loss:

The return loss for Sierpinski fractal WB antenna[1] with one DGS corresponding to fig 5.2(d) is shown in fig 5.15 From this figure observed that the return loss as -28 at3.3GHz and range between 2.4GHz and 13.34GHz i.e.,10.93GHzband width lies below -10dB



Fig 3.1 Return loss of sierpinksi fractal WB antenna With two DGS's



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#### **VSWR:**

The minimum VSWR which corresponds to a perfect match is unity. The simulation results corresponding to fig 5.2(d) is shown in Fig.5.16.The VSWR of antenna lies between 1 and infinity. For practical applications[3] it should be between 1 and 2. It is observed that the VSWR at 3.3 GHz is 1.08.And corresponding bandwidth[5] observed below -10dB.



Fig 3.2: VSWR of sierpinski fractal WB antenna With two DGS's

#### Gain:

Gain is nothing but the power transmitted per unit solid angle. The 3-D gain of the sierpinski fractal WB antenna designed in HFSS corresponding to fig 5.2(d) is shown inFig.5.17.Gain of any antenna is more than 3dB for any applications[1]. The gain observed for this antenna is 5.14dB.



Fig 3.3:Gain of sierpinski fractal WB antenna With two DGS's

#### **Radiation Pattern:**

A radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. This power variation as a function of arrival angle is observed in antenna's far field. Radiation Pattern of sierpinski fractal WB antenna[1] with one DGS i.e, left side corresponding to fig 5.2(d) is shown in fig 5.18 represents gain vs theta and phi.



`Fig 5.18: Radiation pattern of sierpinski fractal WB antenna With two DGS's



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#### **Current distribution:**

Current Distribution for sierpinski fractal antenna With and without DGS's[5] as shown in the fig 5.19



#### Fig: 3.4 current distribution of sierpinski fractal antenna With two DGS's

SNO	Combination	Gain	VSWR	Bandwidth
1	00	4.56dB	2.2	11.60GHz
2	01	4.59dB	1.03	11.06GHz
3	10	4.52dB	1.15	11.17GHz
`4	11	4dB	)8	10.93GHz

Table 3.1 comparison of design of sierpinski fractal antenna with and without DGS

Fabricated antenna:





Fig 3.5 Fabricated antenna



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Fig 3.6 Experimental setup IV. CONCLUSION

A Novel reconfigurable Sierpinski Fractal Wideband Antenna[1] is proposed. Main advantages of the proposed design are high impedance bandwidth of 10.6 GHz ranging from 3.7 GHz to 14.3 GHz, with a radiation efficiency of 92%. Comparing to other existing fractal antennas the volume occupied by the proposed antenna is small (29 x 28 x 1.6 mm3). By incorporating more sierpinski fractals further band width and radiation efficiency [2] can be improved.

It satisfies all the requirements of an UWB antenna [1] in perspective of Return Loss, VSWR and Gain which is verified from respective simulation results for various WLAN and Wi-MAX applications.

Because of small size and good performance, proposed antenna is most suitable for spectrum sensing in cognitive radio, RF energy harvesting, wireless personal networks, wireless sensor networks, body area networks, GPRS, MIMO and so on. The antenna design and simulation/experimental results using HFSS software are presented.

#### REFERENCES

- Saunders, Simon R., Zavala, A Aragon, "Antennas and wave Propagation for Wireless Communication Systems", John Wiley & Sons, 2<sup>nd</sup> Edition, England (2007), pg. 73.
- Balanis, Constantine A., "Antenna Theory Analysis and Design", John Wiley & Sons, 3rd Edn, USA (2005), pg no. 182
- 3. P Singh, Ankita S, N. U,R. Kala, "Half-Wave Dipole Antenna for GSM Applications", International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970), Vol.-2 Number-4 Issue-6 Dec.-2012
- 4. alanis, Constantine A., "Antenna Theory Analysis and Design", John Wiley & Sons, 2nd Edn, USA (2005), pg. 34-35.
- 5. Saunders, Simon R., Zavala, A Aragon, "Antennas and Propagation for Wireless Communication Systems", John Wiley & Sons, 2nd Edn., England (2007), pg. 77.
- 6. R. M. Black, The History of Electric Wires and Cables, Peter .P, London 1983 .
- 7. BICC Cables Ltd, "Electric Cables Handbook", W.Blackwell; London 3rd Edn 1997.
- 8. M J. Van Der Burgt et al, "HD Cabling and Return Loss", Belden Electronics Division, 2001.
- 9. Yidong Xu, Lili Guo, Wei Xue, Korochentsev Vladimir, and Junwei Qi, "An Optimal Electric Dipole Antenna Model and Its Field Propagation", College of Information and Communication Engg, Harbin Engg University, Harbin, China, 2016.





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