A Novel Bow-Tie Shaped Sierpenski Gasket Antenna for Multi-Band Applications

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Abstract- The designs of Sierpinski Gasket in a Bow-tie antenna using a coaxial probe feed are presented in this paper. The antenna is composed of equilateral triangular patches and FR-4 epoxy substrate which has a dielectric constant of 4.4 and thickness of 1.6 mm. The antenna design has 2 iterations and with this shape, antenna behaviours are investigated. The antenna operates over 3 different frequencies. The antenna design have resonant frequency band at 0.9, 2.1and 2.4 GHz. It has been designed and simulated through Ansoft's HFSS electromagnetic software which is based on finite element method.

Keywords-Sierpenski gasket, Bow-Tie, Fractal, VSWR, Radiation Pattern

I. INTRODUCTION

Since the time of wireless telegraphy, radio communication has been used extensively.Our society has been looking for acquiring mobility in communication since then.Initially the mobile communication was limited between one pair of users on singlechannel pair. The range of mobility was defined by the transmitter power, type of antenna used and the frequency of operation. With the increase in the number ofusers, accommodating them within the limited available frequency spectrum becamea major problem. To resolve this problem, the concept of cellular communicationwas evolved. To accommodate multiple users, Time Division multiple Access (TDMA), Code Division Multiple Access (CDMA), Frequency Division Multiple Access (FDMA)and their hybrids are used. Numerous mobile radio standards have been deployed at various places such as AMPS, PACS, GSM, NTT, PHS and IS-95, each utilizing different set of frequencies and allocating different number of users and channels[4].

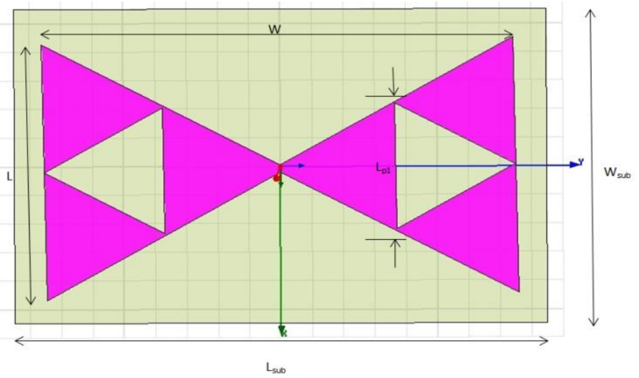
In mobile communication, commonly used antennas are helical antenna, monopole antenna and micro strip antenna. They are easy to use but drawback of this type of antenna is they operate on single frequency or application. Mobile communication require a specially designed antenna in order to avoid use of separate antennas for different applications. Here multiband antenna system comes into picture.There are different types of multiband antenna which can be categories as: printed dipole, loop antenna, slot antenna & printed inverted f antenna (PIFA).in past few year remarkable work has done on above mentioned antenna[7].

In this paper we discuss a design of multiband fractal antenna. A typical Sierpenski gasket antenna is selected for GSM, UMTS mobile services. The antenna structure cover volume of(340x 220x 1.59) mm, the antenna is fed by coaxial probe feed with input impendence of 50Ω. The antenna discussed in this paper is a Bow-Tie shaped Sierpenski gasket fractal antenna which is simple to design & offers effective control of three bands in its second iteration[6]. The antenna theory & geometry are discussed in following section. The current distribution, radiation pattern , VSWR are also disused in following sections.

II. DESIGN AND CONFIGURATION OF ANTENNA

A. Design for 1st iteration:

The discussed antenna is designed using FR4 epoxy substrate with dielectric constant of 4.4 & height of 1.59mm. The volume of antenna is given as (340 x 220x 1.59) mm. At first, a simple bow tie antenna with symmetrical equilateral triangles is designed. We considered it as 0th iteration At the 1st iteration, a single equilateral triangular patch is applied at both sides.



(a)

(b)

Antenna Parameters in mm	
L	308
W	178
Lp1	89
Wsub	220
Lsub	340

Fig.1.Geometry and Dimensions of 1st iteration of the antenna.

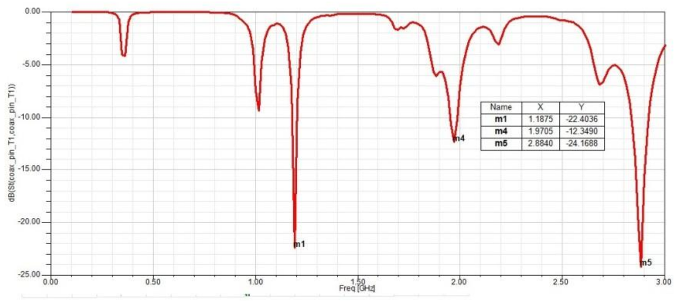


Fig. 2. Return Loss at 1st iteration

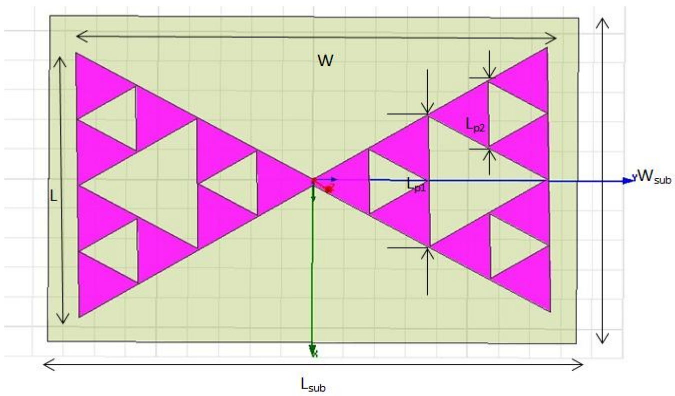
Fig. 2. shows the simulated return loss for the 1st iteration of the proposed Siesrpinski gasket antenna. The simulation shows that the resonating frequencies are around 1.18 GHz, 1.97 GHz and 2.8 GHz and has return loss of -22dB, -12.34 dB and -24dB respectively.

Fig. 3: VSWR of the 1st iteration

Fig. 3. shows the VSWR of the 1st iteration of the proposed antenna. At 1.18 GHz, the VSWR is 1.16, at 1.97 GHz its 1.63 while at 2.8 Ghz the VSWR is 1.13.

B. Design for 2nd iteration:

At the second iteration, 3 equilateral triangular patches are added on both sides of the given dimensions.



(a)

Antenna Parameters in mm	
L	308
W	178
L_{p1}	89
L_{p2}	45
W_{sub}	220
L_{sub}	340

(b)

Fig. 4. Geometry and Dimensions of 2nd iteration of the antenna.

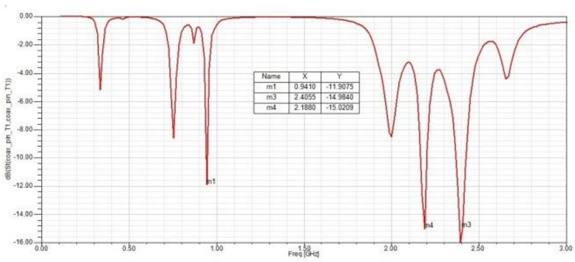


Fig.5. Return Loss of the 2nd iteration of antenna.

Fig. 5 shows the simulated return loss for the 2nd iteration of the discussed antenna. The simulation shows that the resonating frequencies are around 900 MHz, 2.18 GHz and 2.4 GHz and has return loss of -11dB, 14dB and --15dB respectively. This clearly shows that the frequency bands are shifted to the left.

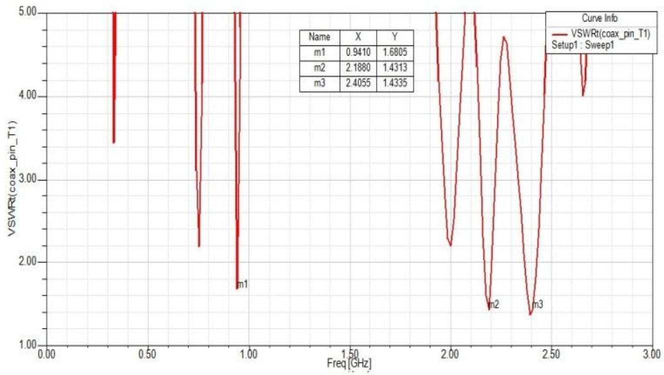


Fig. 6. VSWR after 2nd iteration.

Fig. 6 shows the VSWR after the 2nd iteration of the proposed antenna. We find the VSWR at 900 MHz is 1.68, and at 2.18 MHz and 2.4 GHz it is 1.43.

III. RADIATION PATTERN AND CURRENT DISTRIBUTION

The Radiation pattern after 2nd iteration is as shown in the Fig.7. The gain is found out to be 4.6 at 30° angle of arrival.

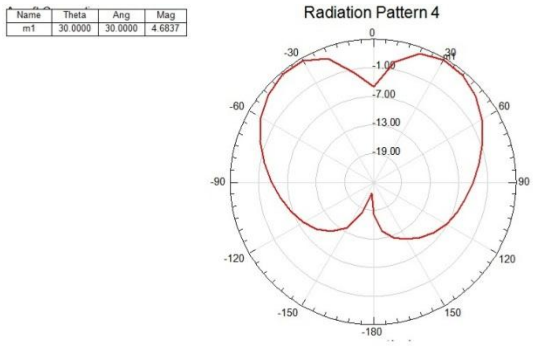


Fig. 7. Radiation Pattern

Fig. 8. Directivity

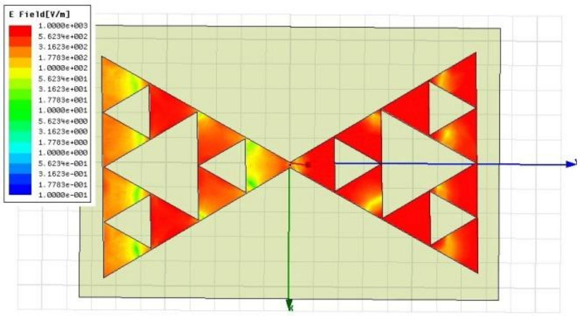


Fig.9. Current Distribution of the proposed antenna.

IV. COMPARISION TABLE OF SIMULATED RESULTS

Sr. No	Type of antenna	Freq(GHz)	VSWR	Bandwidth (MHz)	Directivity (dB)
1.	1st iteration of the antenna	F1=1.18 F2=1.9 F3=2.88	1.16 1.63 1.13	25 34 140	8.10
2.	2nd iteration of the antenna	F1=0.94 F2=2.18 F3=2.40	1.68 1.43 1.42	10 36 60	4.68

V. CONCLUSIONS

There are 2 geometries of Sierpenski Gasket Antenna in a Bow-Tie shape are studied here and the simulated results are compared and the one with best results is fabricated. The Sierpenski Gasket Antenna designed here with coaxial probe feed is suitable for GSM, UMTS, ISM applications. The gain is increased with increase in dimensions. This antenna can be reduced in dimensions along with better results in future.

REFERENCES

[1] Junho Yeo, Raj Mittra IEEE, A "Modified Sierpenski Gasket Antenna for Multi-Band Applications", *IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 61, NO. 4, APRIL 2013*

[2] C. Puente, J. Romeu, R Bartolome, and R. Pous, "On *the* behavior of the Sierpinski Multiband Antenna," *IEEE Transactions on Antennas and Propagation, Vol. 46, NO. 4,pp. 517-524, April 1998*

[3] Carles Puente Baliarda, Member, IEEE, Carmen Borja Borau, Mònica Navarro Rodero, and Jordi Romeu Robert, Member, IEEE, "An Iterative Model for Fractal Antennas:Application to the Sierpinski Gasket Antenna",*IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 48, NO. 5, MAY 2000*

[4] Dr. Abhijit Mitra, Department of Electronics and Communication Engineering ,Indian Institute of Technology Guwahati, "A Curriculum Development Cell Project Under QIP", *IIT Guwahati.*

[5] C. Boja and J. Romeu, "Multiband Sierpinski Fractal Patch Antenna" *Proceedings of the IEEE Antennas and Propagation Sociery International Symposium, Vol. 3, pp. 1708-1711, Salt Lake City, Utah, July 2000.*

[6] D.Anagnortou, Majid Khodier, J.C. Lyke and *C.G.*Christadaulou,"Fractal Antenna with RF MEMS Switches for Multiple Frequency Applications",University of New Mexico, USA,Air Force Research Laboratory VSSE Kinland AFB

[7] S. Hong, W. Kim, S. Kahng, and J. Choi, "Design of an internal multiresonant monopole antenna for GSM900/DCS1800/USPCS/S-DMB operation", *IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION*, vol. 56, pp. 1437–1443,May 2008

[8] K. D. Prasad, Deepak Handa, "Antenna and wave propagation," Satyaprakashan, 1996

[9] Sumit Rakibe, Aniket Jangam, Prof. S. V. Khobragade, "Reconfigurable Fractal Tree Antenna for multi-frequency Applications using PIN Diode" *International Journal of Engineering Research & Technology (IJERT), Vol. 3 Issue 4, April – 2014*

[10] R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon, "Microstrip Antenna Design Handbook", Artech House, 2000