International Journal of Electrical, Electronic and Communication Sciences
ISSN: 2517-9438
Vol:9, No:1, 2015

Design of a Novel CPW Fed Fractal Antenna for UWB

A. El Hamdouni, J. Zbitou, A. Tajmouati, L. El Abdellaoui, A. Errkik, A. Tribak, M. Latrach

***Abstract*—**This paper presents a novel fractal antenna structure proposed for UWB (Ultra – Wideband) applications. The frequency band 3.1-10.6GHz released by FCC (Federal Communication Commission) as the commercial operation of UWB has been chosen as frequency range for this antenna based on coplanar waveguide (CPW) feed and circular shapes fulfilled according to fractal geometry. The proposed antenna is validated and designed by using an FR4 substrate with overall area of 34x43 mm^2. The simulated results performed by CST-Microwave Studio and compared by ADS (Advanced Design System) show good matching input impedance with return loss less than -10dB between 2.9 GHz and 11 GHz.

***Keywords*—**Fractal antenna, Fractal Geometry, CPW Feed, UWB, FCC.

I. Introduction

THE fractal geometry become more involved in the printed antenna conception, especially in Ultra Wideband (UWB) applications, due to the opportunities offered by this geometry such as smaller size, improvement of performances and gain optimization. Fractal means fragmented geometric shape subdivided in parts and each part is an imitate image with reduced size of the main form. Fractals are often self-similar and independent of scale [1], [2].

With the growth of wireless communication systems and applications, the demand of low profile and wideband antennas increased, in order to satisfy this progress, the fractal antenna with coplanar waveguide (CPW) Fed supposed to be the appreciated candidate [3].

Another advantage of CPW is that the characteristic impedance can be calculated by the ratio of the feed line width and the width of the gap between the ground plane and feed line [4].

This paper presents a new circular fractal antenna for UWB applications. The proposed fractal antenna has advantages of compact size, low manufacturing cost, easy fabrication, low profile, and very small ground plane that can be appreciated for antenna to be integrated in compact UWB systems [5]-[14].

A complete study of antenna has been done by studying the Return Loss, VSWR and radiation pattern in order to identify the performances and features of the proposed antenna.

A. El Hamdouni and A. Tajmouati are with LITEN Laboratory, FSTof Settat University Hassan 1st, Settat, Morocco (e-mail: akram.elhamdouni@ yahoo.fr, tajmoua@gmail.com).
J. Zbitou is with FPK/FSTS LITEN Laboratory, Polydisciplinary Faculty of Khouribga, University Hassan 1st, Morocco (e-mail: jazbitou@gmail.com).
A. Tribak is with National Institute of Posts AND Telecommunications, Rabat, Morocco.
M.Latrach is with Microwave group in ESEO ANGERS in France.

II. Antenna Design

The proposed antenna is shown in Fig. 1, the substrate used to implement this antenna is an FR4 with a relative dielectric permittivity ε_r=4.4, thickness of h=1.6 mm and dimensions of 34x43mm^2.

The designed antenna is based on CPW fed, where the width ground plane is W_G = 15 mm and the length is L_G = 16 mm. the gap between the ground and the transmission line, where the width is 3 mm, is S = 0.5 mm. The complete dimensions are shown in Table I.

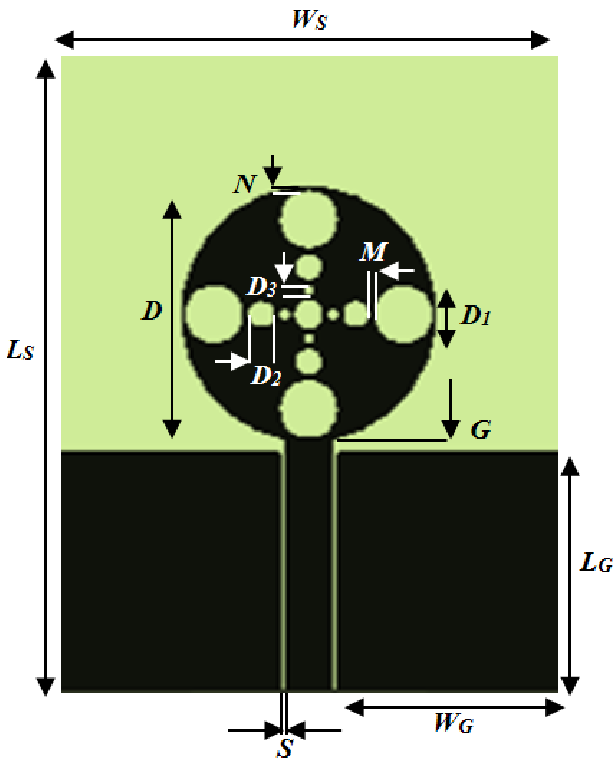

Fig. 1 The Geometry and configuration of the proposed CPW UWB antenna

TABLE I
The Optimized Dimensions of the Proposed Antenna

Parameter	Value(mm)	Parameter	Value(mm)
WS	43	M	0.2
LS	43	N	0.1
WG	15	D	17
LG	16	D1	4.05
S	0.5	D2	1.925
G	1	D3	0.8625

III. Results and Discussion

The antenna design and simulation is performed by using the Finite Integration Technique included in CST Microwave Studio, in order to optimize the lengths of the ground planes (WG, LG), the gap (S) between the ground planes and feed line and the distance (G) which separates the circular radiator to the ground planes. Once the above parameters have been detected and optimized, the next step was to make the main circular slot in different positions in circular radiator to keep the self-similarity of the fractal antenna geometry.

As shown in Fig. 2, the fractal antenna improves the matching input impedance in the whole FCC frequency band between the frequency 3.1 GHz and 10.6 GHz with return loss less than -10dB.

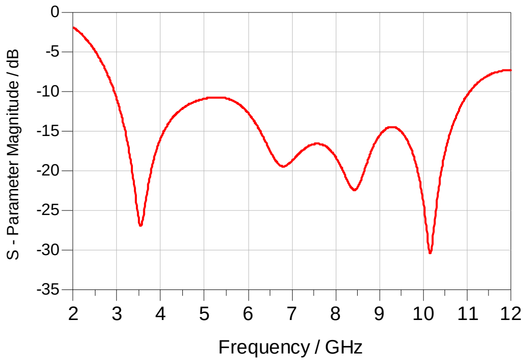

Fig. 2 Return Loss versus frequency by CST

In order to double check the results given by CST Microwave it was necessary to use another electromagnetic software such as ADS (Advanced Design System) from Agilent Technologies using the method of moment integrated in ADS. The result is shown in Fig. 3.

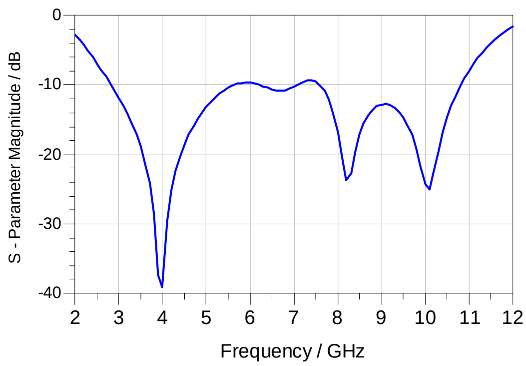

Fig. 3 Return Loss versus frequency in ADS

As shown in the Fig. 4 a good agreement in terms of Return Loss (S_{11}) obtained by CST and ADS.

The radiation pattern is given by Figs. 5-8 in the plane E, which is shown that the antenna is omnidirectional in low frequencies such as 3 GHz and 7 GHz and slightly omnidirectional in high frequencies such as 8 GHz and 10 GHz.

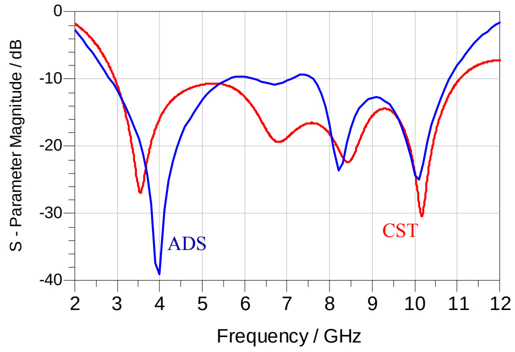

Fig. 4 Return Loss versus frequency in ADS

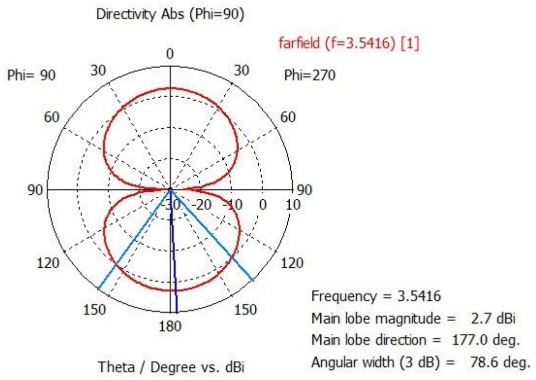

Fig. 5 The Diversity radiation pattern in E-plane of frequency 3.5416 GHz simulated by CST Microwave

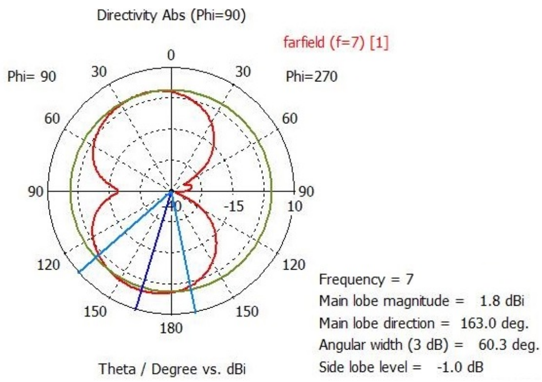

Fig. 6 The diversity radiation pattern E-plane of frequency 7 GHz simulated by CST Microwave

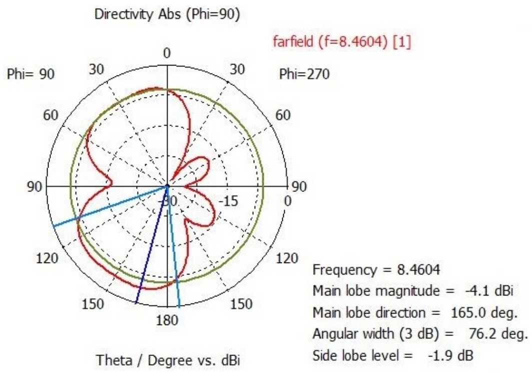

Fig. 7 The diversity radiation pattern E-plane of frequency 8.4604 GHz simulated by CST Microwave.

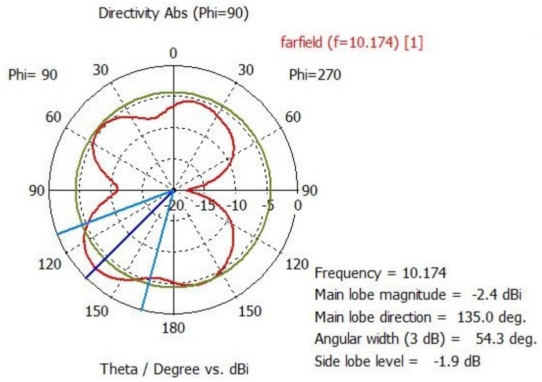

Fig. 8 The diversity radiation pattern E-plane of frequency 10.174 GHz simulated by CST Microwave.

The radiation pattern is given by Figs. 9-12 in the plane H, which is shown that the antenna is also omnidirectional in low frequencies which are 3.5416 GHz and 7 GHz and lose the Omni – directionality in high frequencies which are 8.4604 GHz and 10.174 GHz.

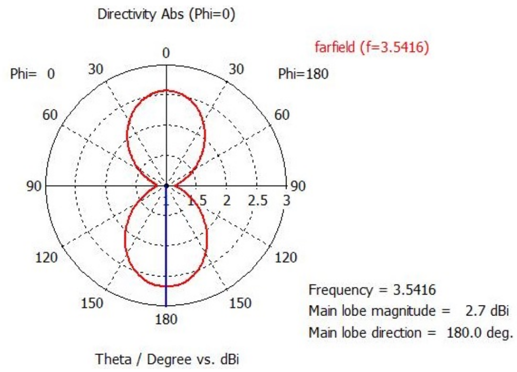

Fig. 9 The Diversity radiation pattern in H-plane of frequency 3.5416 GHz simulated by CST Microwave

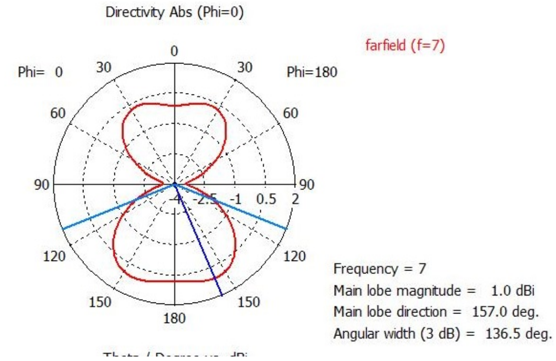

Fig.10 The diversity radiation pattern H-plane of frequency 7 GHz simulated by CST Microwave

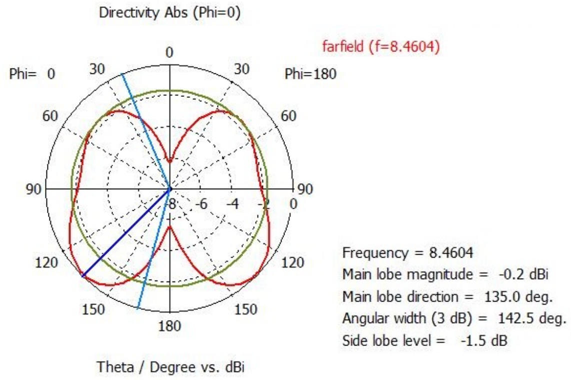

Fig. 11 The diversity radiation pattern H-plane of frequency 8.4604 GHz simulated by CST Microwave.

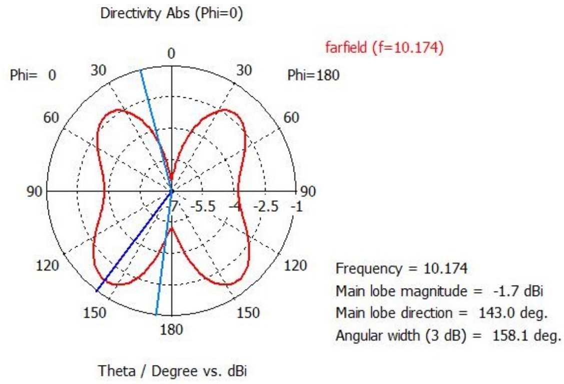

Fig. 12 The diversity radiation pattern H-plane of frequency 10.174 GHz simulated by CST Microwave

IV. Conclusion

The designed fractal UWB antenna with CPW Fed detailed in this paper, considered as original antenna that can be used in the released frequency band 3.1 – 10.6 GHz for FCC as Ultra wideband (UWB), because the Return Loss graph has been matched at 50 Ω and less than -10dB within the above range simulated by both software CST Microwave and ADS. The final circuit is miniature, low cost and presents good performances in term of radiation pattern and matching input impedance in the whole FCC frequency band which validate this fractal antenna for UWB applications.

ACKNOWLEDGMENT

We have to thank Mr. Mohamed Latrach Professor in ESEO, engineering institute in Angers, France, for allowing us to use all the equipment and software available in his laboratory.

REFERENCES

[1] S.Natarajamani, S. Kumar Behera, S. Kumar Patra "Planar UWB Fractal Antenna with Band-NotchedCharacteristics"International Conference on Electronic Systems (ICES-2011), 7-9 Jan 2011, NIT Rourkela, India, p. 290.

[2] P. Felber, "Fractal Antennas" A literature study as aproject for ECE 576 Illinois Institute of Technology December 12, 2000 (Revised: January 16, 2001), p. 5.

[3] R.Kumar, D. Magar, K. Kailas Sawant "On the design of inscribed triangle circular fractal antenna for UWB applications" International Journal of Electronics and Communications (AEÜ) Accepted 10 May 2011, p. 68.

[4] G. M. Yang, R. H. Jin, G. B. Xiao, C. Vittoria, V. G. Harris, andN. X. Sun "Ultrawideband (UWB) Antennas with Multiresonant Split-Ring Loops" IEEE Transactions on Antennas and Propagation, vol. 57, no. 1, January 2009, p. 256

[5] Breed, G., "A summary of FCC rules for ultra-wideband communications," High Frequency Electronics, 42–44, Jan. 2005

[6] Garg, R., P. Bhartia, I. Bahl, and A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, Norwood, MA, 2001

[7] Ren, W., J. Y. Deng, and K. S. Chen, "Compact PCB monopole antenna for UWB applications," Journal of Electromagnetic Waves and Applications, Vol. 21, No. 10, 1411–1420, 2007.

[8] Gopikrishna, M., D. D. Krishna, A. R. Chandran, and C. K. Aanandan, "Square monopole antenna for ultra wide band communication, an applications," Journal of Electromagnetic Waves and Applications, Vol. 21, No. 11, 1525–1537, 2007.

[9] Geran, F., G. Da dashzadeh, M. Fardis, N. Hojjat, and A. Ahmadi, "Rectangular slot with a novel triangle ring microstrip feed for UWB applications," Journal of Electromagnetic Waves and Applications, Vol. 21, No. 3, 387–396, 2007.

[10] Niang, Z. and X. M. Qing, "Research and development of planar UWB antennas," IEEE APMC 2005 Proceedings, 2005.

[11] Schantz, H., "Dispersion and UWB antennas," 2004 International Workshop on Ultra Wideband System. Joint with Conference on Ultra Wideband System and Technologies, 161–165, Kyoto, Japan, 2004.

[12] Yu-Jiun Ren et.al, "An Annual Ring Antenna for UWB Communications" IEEE Antennas and Wireless Propagation Letters, vol. 5, pp 274-276, 2006

[13] Evangelos S. Angelopoulos et.al. ,"Circular and Elliptical CPW-Fed Slot and Microstrip-Fed Antennas for Ultra wideband Applications", IEEE Antennas and Wireless Propagation Letters, vol. 5, pp 294-297, 2006.

[14] Xianimg Qing, Micheal Yan Wah Chia, Xuanhui Wu, "Wide slot antenna for UWB applications", Antennas and Propagation Society International Symposium, 2003. IEEE, vol. 1,2003, pp 834-837.