Realization of Minkowski Fractal Antenna for Multiband Wireless Communication

N.Koteswaramma, P.A.Harsha Vardhini, K.Murali Chandra Babu

Abstract—A F-Planar radio wire for the band of low (698-960 MHz) and centre (1710-2690 MHz) band LTE Frequency is presented in this paper. Receiving wire goes about as a circle radio wire in high recurrence. The Antenna ground plane is set with the element of 150mm *200mm proportional to a cell phone tablet PC. Proposed wire design in the mentioned bands has desirable Omni-directional radiation pattern and gain characteristics for wireless systems.

Keywords—Antenna, Fractal, Radiation, Multiband

I. INTRODUCTION

High degree of mobility and enhanced data transmission is the major demand to be provided by the new standards of ever growing wireless broadband services. Smart antenna technologies like beamforming, advanced antenna systems and MIMO antenna technology improves the throughput of the system and capacity of the radio communication. Many attempts to design small and compact antennas in the past have been endeavoured through slots, shorting and folded geometries, but it was not until the introduction of fractals in antenna engineering that this could be done in a most efficient and sophisticated [1]. With fractal antenna physical geometry, it facilitates miniaturization. Fractal geometry are self-resonant radiators and electrically small. Minkowski fractal geometry being the size of the conventional loop antenna leading to compactness and miniaturization. With the same bandwidth, tight packing of Minkowski Island loop antenna elements in the array and reduced mutual coupling was achieved.

A. Antenna Design

Based on the existing antenna structure, in order to operate at several frequency bands, the existing structure should be reconfigured by slot antenna comprises of a metal surface more often than not a level plate with a gap or space cut out. When the plate is driven as degree reception apparatus by a driving recurrence the opening transmits attraction waves all through the methodology somewhat like flying. The structure and size of the opening moreover in light of the fact that the driving recurrence check the radiation dissemination design. Generally, the radio waves territory unit given by the wave manage and thusly the receiving wire comprises of spaces inside the wave control.

Space receiving wire territory unit normally utilized at radio recurrence and microwave recurrence, instead of line reception apparatus once bigger administration of radiation graph is required. Opening reception apparatus region unit wide utilized in radio recognition and going receiving wire for the part the world the territory unit receiving wire utilized for the radiophone base station and are typically found in ordinary work area microwave supply utilized for examination capacities.

B. Dielectric Resonator Antenna

Dielectric Resonator Antenna (DRA) stays away from certain constraints of the fix receiving wire just as the high conduit misfortunes at metric straight unit wave frequencies, affectability to resistance and slim data measure. the elliptical structure is route simpler to manufacture and one or a ton of dimensional parameters zone unit out there.

C. Substrate

FR4, Thickness: 0.8mm, Permittivity: 2.4, Loss digression: 0.24, FR4 substrate is utilized on the grounds that the material as substrate on account of its property in flammability and in this way the application cell phone radio wire because of in cell phones it's empowered with FR4 in light of the fact that the PCB board substrate. Ground plane/dissimilar segment is copper plate that is because of its property of a ton of conduction.

II. DESIGN EQUATIONS AND DESIGN FLOW

Table.I. Design parameters and relating values

Parameter	Values
Ground plane size (L*W)	100mm*100mm
Loop Slot Dimension (L0*W0)	25mm*25mm
Stub length (L_s)	3mm
Slot width (Sw)	0.4mm
second space factor (i2)	0.5 mm
Dielectric Slab Dimensions (A*B*H)	33mm*30mm*5mm

Table II. Frequency ranges

Technology	Frequency Range
WCDMA	824-894 MHz
GSM	880-960MHz
FDD-LTE/GSM	1.7-1.8GHz
WCDMA/GSM	1.8-1.9GHz
TD-LTE/TD-SCDMA	1.9-2.1GHz
TD-SCDMA	2.0-2.02GHz
TD-LTE	2.3-2.4 GHz
FDD-LTE	2.5-2.6 GHz
WLAN (Wi-Fi, Bluetooth)	3.4-3.6 GHz
WiMAX (Overall MW frequency)	4.6-5.9GHz
WiMAX (mobile equipment)	6.1-7GHz

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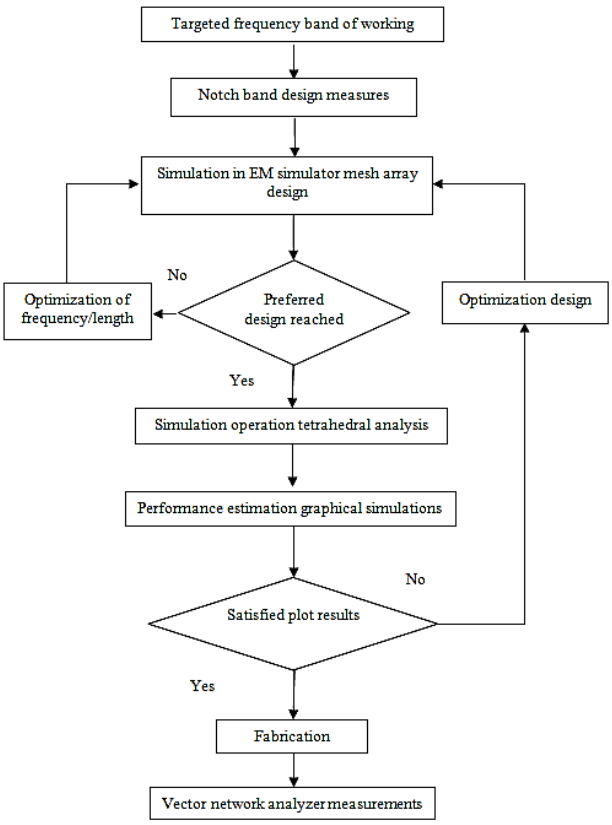

A. Design Equation: Calculation of Resonant Frequency

$$f_0 = \frac{c}{2\Pi\sqrt{\varepsilon_r}} \sqrt{k_x^2 + k_y^2 + k_z^2}$$

Where,

$$k_x = \frac{m\Pi}{a}, \; k_y = \frac{n\Pi}{b}, k_z = \frac{l\Pi}{2d}$$

and

$$k_x^2 + k_y^2 + k_z^2 = \varepsilon_r k_0^2$$

Equation for full recurrence specifically band is

$$f_0 = \frac{c}{q*\delta*\{2(L_0+W_0)\}}$$

The qualities accomplished from the space factor is

$$= 1+\delta = 1+\sum_{k=1}^{n}\left\{\left(\frac{2^k}{3}\right)\prod_{j=1}^{k} i_j\right\}$$

Ratio between the essential recurrence and the nth cycle recurrence is,

$$\frac{f_n}{f_0} = 0.6\,(\eta)^{1.2} + 1.2$$

B. Design Flow

Minkowski shape planned reception apparatus have delivered 11 groups and MIMO design for subjective radio applications. The increase got in this task is 3.5dBi. The structure of radio wire in the primary cycle and the relating yield is appeared in the Fig. 1. In first iteration fractal wire is designed , the frequency plot is as shown in fig. 3.

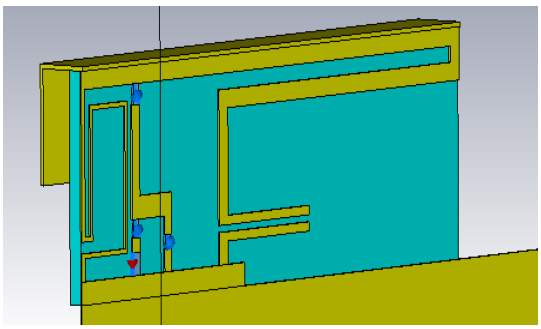

Fig.1. Middle Band Frequency Antenna

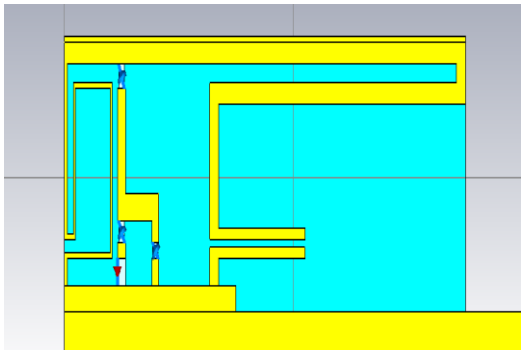

Fig.2. Lower Band Frequency Antenna

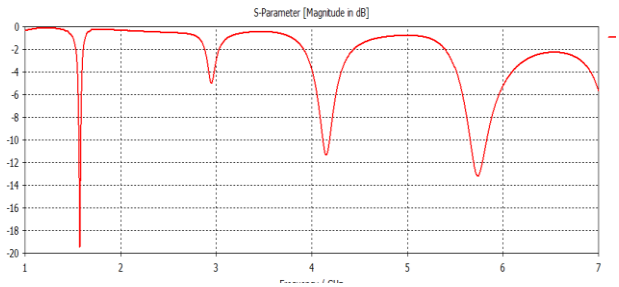

Fig 3 Frequency Plot of 1st Iteration

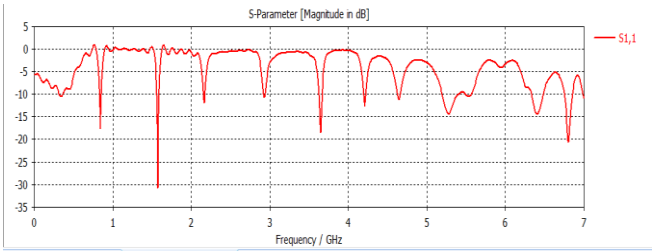

Fig 4 Minkowski Fractal Antenna Dielectric Loaded

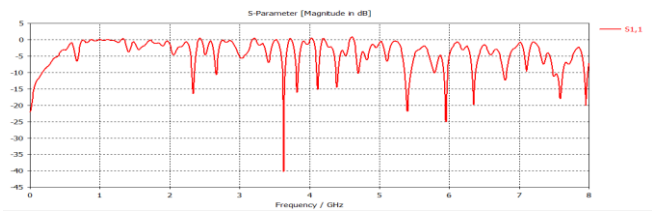

Fig 5 Final Minkowski Fractal Antenna MIMO Frequency Plot Output S11

The final output of S11 for proposed wire as shown in fig.5 is -25dBi. The radiation pattern for different frequencies is as shown in fig. 6

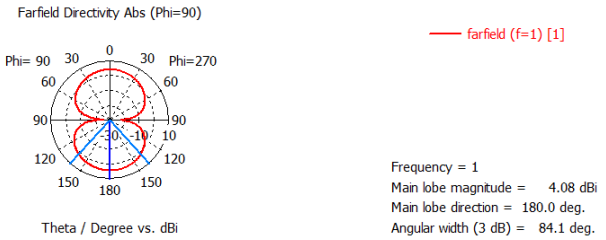

Fig 6 Radiation Pattern for frequency 1GHZ

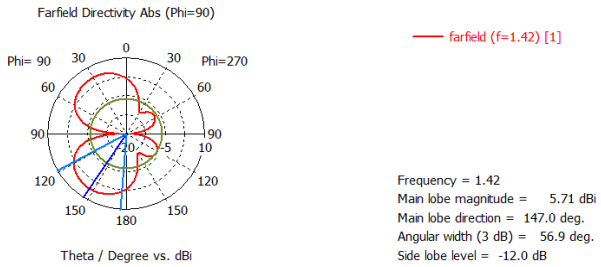

Fig 7 Radiation Pattern for frequency 1.4GHZ

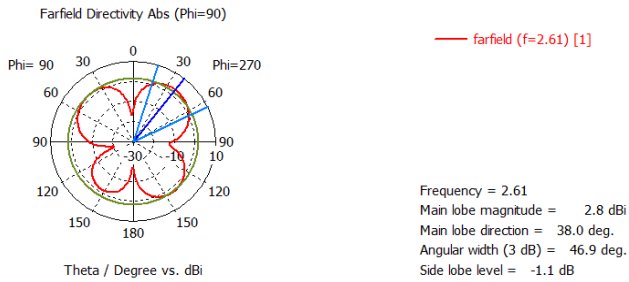

Fig 8 Radiation Pattern for frequency 2.61GHZ

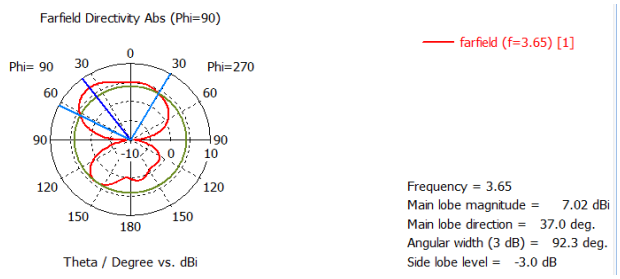

Fig 9 Radiation Pattern For Frequency 3.65GHZ

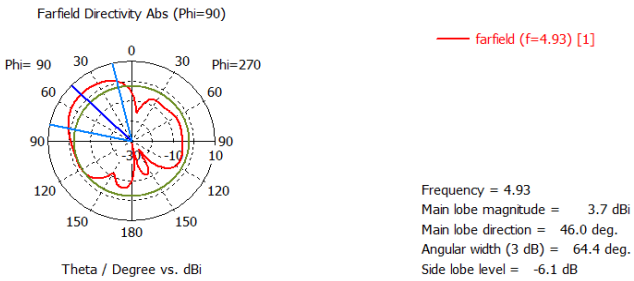

Fig 10 Radiation Pattern for frequency 4.93GHZ

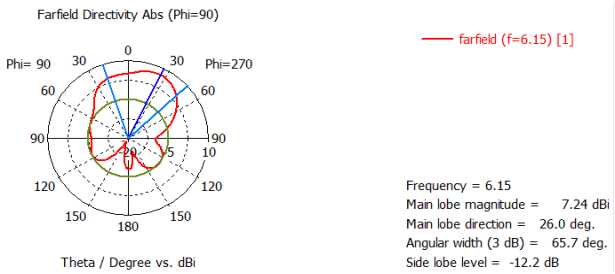

Fig 11 Radiation Pattern for frequency 6 GHZ

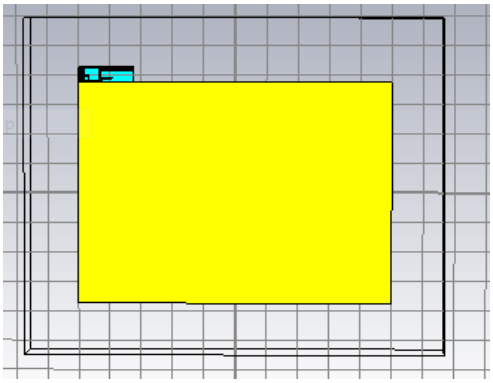

Fig.12. Fractal LTE Tablet1

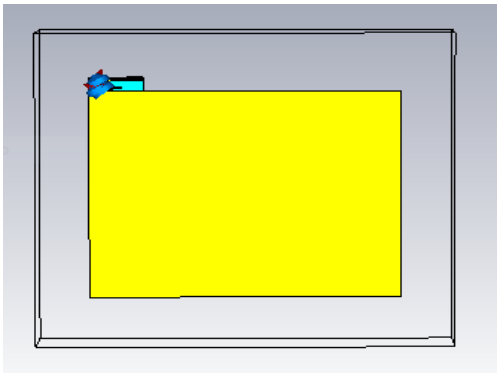

Fig.13. Fractal LTE Tablet2

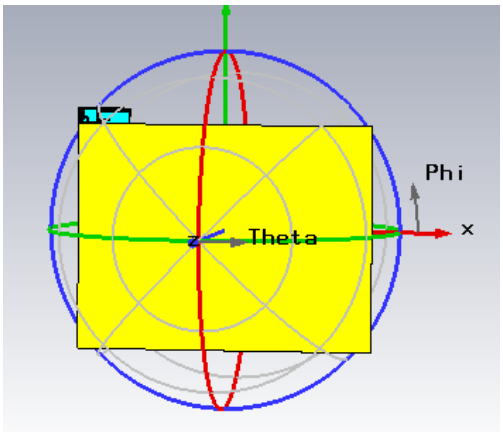

Fig.14. Far Field of First Tablet

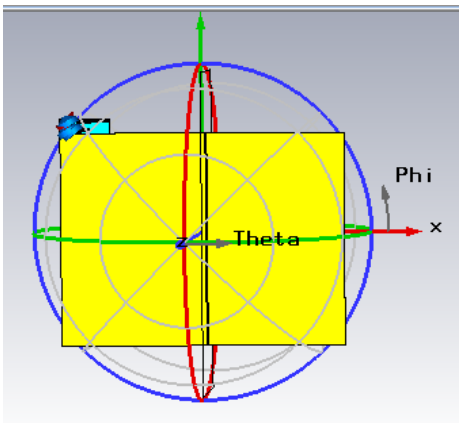

Fig.15. Far Field of Second Tablet

The radiation pattern of proposed wire is omnidirectional.

III. CONCLUSION

This undertaking anticipated a multiband recurrence fluctuate exploitation Minkowski shape planned reception apparatus that gives eleven groups exploitation MIMO example and stuff resonator stacking. The anticipated antenna shows a multiband act with most addition of three. 5dbi. An examination on the use of stuff stacked shape space circle reception apparatus for multi-band execution is performed amid this work. Minkowski limit space cut on partner FR4 substrate encouraged by CPW is anticipated and portrayed. Steady amount examines are allocated to upgrade the receiving wire style parameters. Consistent circuit demonstrate is appeared to supply partner understanding into the working of the radio wire. The whole circuit comprises of lumped resonators for the DRA, dispersed resonator parts for the opening line and resistivity transformers to point the coupling between isolated circuit parts. The imaginary model yields a band exhibition for a 10 db reflection co-proficient. Multiband variety is accomplished basically because of the shape style. The extent of the receiving wire is that the primary detriment of this venture accordingly, in future the measurements is additionally decreased beneath 100mm *100mm which can be moveable and might be utilized in portable segments and elective smaller than expected versatile application.

REFERENCES

1. C. C. Chen, C. Y. D. Sim and F. S. Chen, “A Novel Compact Quad-Band Narrow Strip-Loaded Printed Monopole Antenna,” IEEE Antennas Wireless Prop. Letters, vol. 8, pp. 974 – 976, Aug. 2009.
2. S. I. Latif and L. Shafai, “Investigation on the EM-Coupled Stacked Square Ring Antennas With Ultra-Thin Spacing,” IEEE Trans. Antennas Prop, vol. 59, no. 11, pp. 3978 – 3990, Nov. 2011.
3. K. Huang and T. Chiu, “Triband Inverted-F Antenna With Stacked Branched Monopoles and a Parasitic Strip,” IEEE Antennas Wireless Prop. Letters, vol. 10, pp. 1208 – 1211, Nov. 2011.
4. O. P. Falade, M. U. Rehman, Y. Guo, X. Chen and C. G. Parini,“Single Feed Stacked Patch Circular Polarized Antenna for Triple Band GPS Receivers,” IEEE Trans. Antennas Prop,vol. 60, no. 10, pp. 4479 – 4484, Oct. 2012.
5. F. J. H. Martinez, G. Zamora, F. Paredes, F. Martin and J. Bonache, “Multiband Printed Monopole Antennas Loaded With OCSRRs for PANs and WLANs,” IEEE Antennas Wireless Prop. Letters, vol. 10, pp. 1528 – 1531, Dec. 2011.
6. Y.L Ban, S.C. Sun, P.P.Li, J.L.-W.Li and K.Kang, “Compact Eight-Band Frequency Reconfigurable Antenna for LTE/WWAN Tablet Computer Applications,” IEEE Trans.Antennas Propag., Vol.62, no. 1,pp,471-475,Jan.2014.
7. M.Komulainen, M.Brerg, V.K.Palukuru, H.Jantunen and E.Salonen, “Frequency-reconfigurable dual-band monopole antenna for mobile handsets,” in Proc. IEEE Antennas Propag. Soc. Int, Symp., Honolulu

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