Design of A Dual-Band Verre de Champagne Fractal CPW Antenna for LTE and Aircraft Altimeter Application

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***Abstract* – The work scheme of this paper represents the new design of a dual-band coplanar waveguide feed (CPW) antenna with a concept of fractal and coplanar to provide dual-band and Omni-directional radiation. Each Verre de Champagne fractal geometry response an individual frequency by the larger shape operates at lower frequency whereas the smaller shape operates at RF altimeter frequency band. This type of antenna can response the demand in aviation industry which is easy to integrate with system device, expedient fabrication and required operating frequency at 4.3GHz with bandwidth more than 100MHz for aircraft radio altimeter. Matching step-impedance between antenna patch and waveguide feed is applied in this fractal CPW antenna which has been achieved the improved return loss (S_{11}) below -10dB on both operating frequencies. The return loss of the antenna also can correct by using blending ground plane technique which makes the suitable capacitance and inductance on ground plane. The commercial software "CST Microwave Simulation" is use to optimize and simulate this antenna research.**

***Index Terms* — Verre de Champagne, Coplanar, Dual-Band, Fractal, RF Altimeter and Long term Evolution.**

1. Introduction

Nowadays, a multi-band antenna is widespread in many applications of high frequency communication system. Coplanar feed is the one of the structures of feed-line which is recently well-known because via-hole is unnecessary, a patch resonator is on same side with ground planes and compact size [1-4]. Such as, the rhombus and butterfly shape which are the slot antennas operated in WLAN (Wireless Local Area Network) [1-2], which their pattern are nearly Omni-directional and bi-directional, respectively. For special applications in high frequency, the patch resonator with CPW is still been presented [3], but pattern control difficultly. Besides, the circular patch is also published, but asymmetrical pattern produced [4].

Communications on aircraft system also uses in radio frequency range. So this letter proposes the dual-band antenna which is supported not only telecommunication but also airborne system. Its patch looks like a champagne glass. The frequency responses are 1.8 GHz of 4G system and 4.3 GHz of the altimeter system.

2. Antenna design process

Verre de Champagne geometry antenna is designed on an epoxy resin (FR-4) which has thickness is 1.6 mm. And using the Conventional Coplanar Waveguide (CPW) to make 50 Ω of transmission line by W=1.9 mm, G=0.2 mm, P=18.2 mm, L=24.85 mm. Geometry of Antenna is shown in Fig 1. The patches of antenna have inspiration from champagne glass shape. At first starts from largest of patch that resonant at 1.8 GHz then uses the same patch which reduces size to operate at 4.3 GHz. Design of matching step-impedance between the top of feed line and antenna patch is based on the optimization to get the parameters as L_{f1}, L_{f2}, W_{f1} and W_{f2} which are also shown on Table. 1.

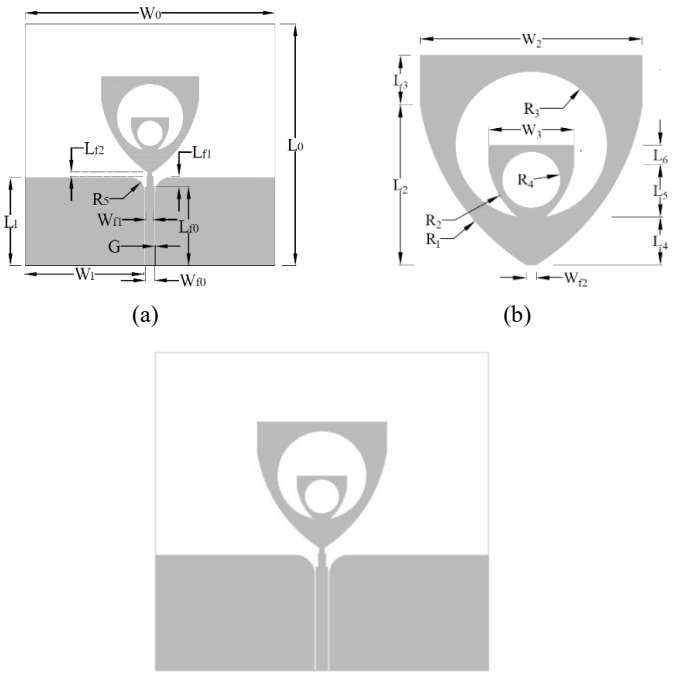


Fig. 1.Verre de Champagne geometry.
(a) Dimension of waveguide feed and parameters
(b) Dimension of antenna patch and parameters
(c) Geometry structure and waveguide feed

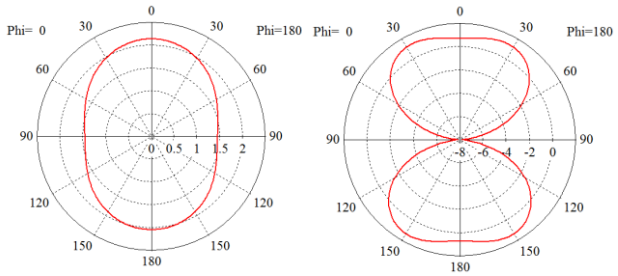
Table.1. Antenna geometry parameters

PAR.	mm	PAR.	mm	PAR	mm	PAR	mm
W_0	52	L_0	50	L_2	15.16	W_3	7.8
W_1	24.85	L_1	18.2	L_3	4.63	R_1	22.16
W_{f0}	1.9	L_{f0}	16.3	L_4	4.53	R_2	8.53
W_{f1}	1.3	L_{f1}	2.2	L_5	4.98	R_3	6.93
W_{f2}	0.9	L_{f2}	0.83	L_6	1.78	R_4	2.66
G	0.2	R_5	3	W_2	20.28		

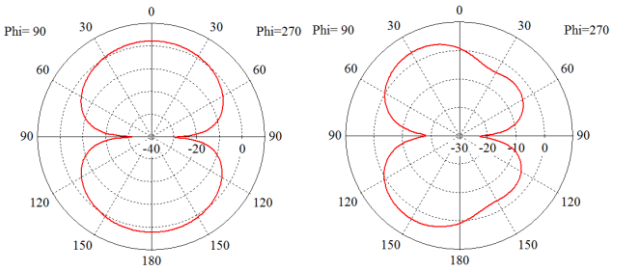
3. Simulation Result & Discussion

Radiation Pattern of 1st band (1.8 GHz) is an Omni-directional radiation and the 2nd band (4.3 GHz) is a bi - directional. Radiation pattern of both 1.8 and 4.3 GHz are shown in Fig.2.

Reducing the overall size of small patch is direct proportional to the higher frequency and its frequency responses as shown in Fig. 3 when its size compare to the main patch. It can be noticed that the 1st band is matching at 1.8 GHz with bandwidth 317 MHz (1.667 - 1.985 GHz) and the 2nd band at 4.3 GHz with bandwidth 143 MHz (4.23 – 4.37 GHz).



(a) H-field plane



(b) E-field plane

Fig 2. Radiation pattern of 1.8 (left hand side) and 4.3 GHz (right hand side)

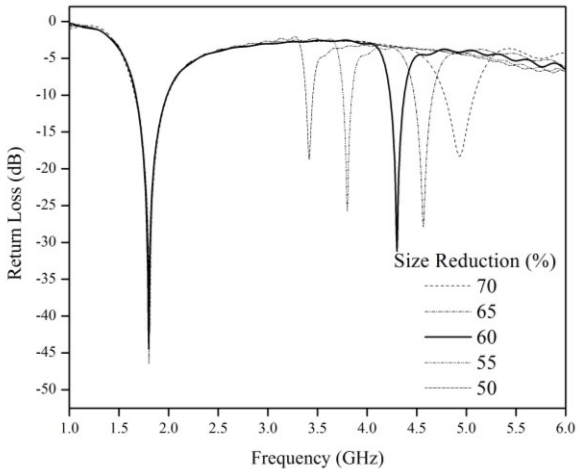


Fig. 3. The simulated frequency response

4. Conclusion

The dual-band Verre de Champagne shape is designed with the Fractal concept to achieve the compact size. The main patch is supporting the first frequency and the small patch can control the harmonic response by its size. The proposed Verre de Champagne dual band antenna can work properly with LTE and RF Altimeter with the total dimension of 50 mm. x 52 mm.

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