Design and Simulation of Fresnel Zone Plate Antenna Incorporating Aluminium Rings

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Abstract— *Design and simulation result of Fresnel zone plate antenna is presented in this paper. It is very simple to fabricate and easy to implement, small size, light weight, cheap antenna. The effect of different design parameter (Focal length, Radius, dielectric thickness, number of zone and sub zone), on radiation characteristics are examined. In this paper presented different type of design and its simulation result. . It is observed that with increasing the focal length, the number of subzone increases and hence directivity increases. Hence to achieving high directivity, larger number of zones are required and larger aperture are required. Hence for higher frequencies, this concept can give optimum result even for the small aperture. The Frequency chosen 11.5 GHz.*

Keywords— Aluminium rings, Fresnel Zone Plate, Antenna

I. INTRODUCTION

Now day parabolic reflector are used in most of satellite communication. The proposed Fresnel zone plate antenna (FZPA) can good alternative of parabolic antennas used in existing home receiving system (DBS). FZPA is small volume, low weight and does not need a support system that make whole antenna system bulky to transport. Fresnel zone plate works based on optical principal and consist of a set of radial concentrate strip on any flat surface which alternate between transparent and opaque and can be made from any type of material which allow radio wave propagation.

Antenna Design

Fresnel zone plate antennas are planner structure having circular rings, when a plane wave incident normally to its surface, it will transformed into a spherical wave focused at some axial point. The feed is placed to collect the focused waves. A circular ring between two adjacent circles is Fresnel zone. The Fresnel zone plate consisting number of circular Fresnel zones that their radii are determined by Equation 1, [2]

$$r_i = \sqrt{(F + i\frac{\lambda_0}{P})^2 - F^2} \qquad (i=1,2,3 \ldots N)\ldots\ldots(1.1)$$

Where, is the radius r_n of zone, F is focal length, is free-space wavelengthλ_0 and P represents the number of subzones in each full wave zone. The zones are constructed such that a portion of the field contributes for constructive interference which is reflected by the opaque zones of zone plate. The opaque zones may be constructed by any reflective materials e.g. metal rings (aluminium). Glass are used as substrate material. Also this design can be fabricated from any materials which allow to propagate the electromagnetic waves. The hardware of FZPA structures are shown in Fig.1.1.

Fig. 1.1: Hardware of FZPA

II. SIMULATION PARAMETER

In this paper, Simulation in this work is performed at 11.5 GHz frequency range. The simulation for parameter for each F/D ratio in Table 1. The diameter kept constant, which is means that the radii of zones are increasing with increasing F/D ratio.

F/D	Focal length	Diameter D	Total number of zones
0.5	0.3	0.6	7

Table – 1: The simulation for parameter for each F/D ratio

Focal length, F=0.3m, Total number of zones=7, N = 7 (3 transparent, 4 opaque). Here glass material are used and its size is 60x60. Height of aluminium plate is 0.3 mm and height of glass is 0.6mm.

n^{th} Zone	Radii of n^{th} zone(mm)
1	0.089
2	0.1277
3	0.1581
4	0.1844
5	0.2082
6	0.2303
7	0.2511

Table – 2: Dimension of FZPA

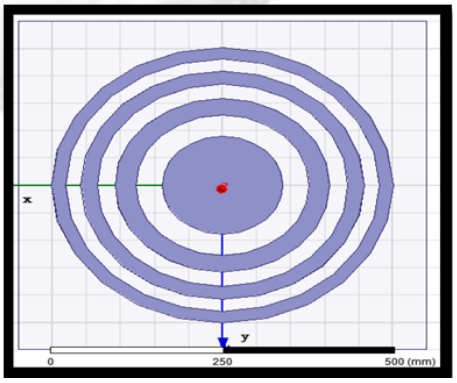

Fig. 2: Design Fresnel zone plate antenna

III. RESULTS DISCUSSION

Here the simulation result of Fresnel zone plate for F/D ratio is 0.5. In this paper included simulation result for F/D=0.5 because of the gain achieving at number of zones are 7 and F/D=0.5.

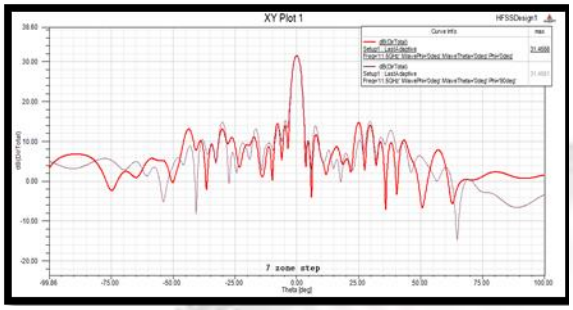

Fig. 3: Directivity of the 7 zone FZPA for F/D= 0.5

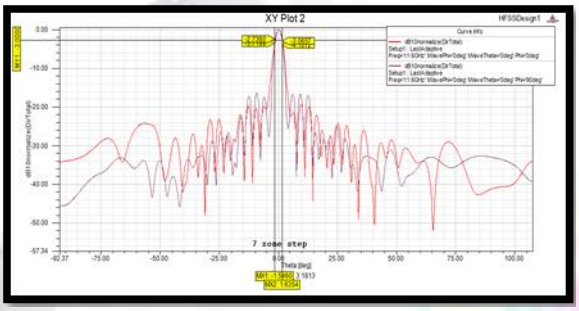

Fig. 4: HPBW and SLL of the 7 zone FZPA for F/D= 0.5

F/D	No. of zone	Peck Direc-tivity (dB)	SLL (dB) /Deg.	HPBW(deg.)
0.5	7	31.08	-7.47	2.80

Table – 3: Directivity, SLL, and HPBW for F/D =0.5 and no of zone is 7 for FZPA.

IV. CONCLUSION

Observed to show simulation result, for F/D=0.5 narrow beam achieved with optimum side lobe level and half power beam width. The directivity obtained for Fresnel zone plate and the is 31.08 dB and side lobe level is -7.47 dB and half power beam width 2.80 degree. The Fresnel zone plate antenna focuses electromagnetic waves and it is used in many application, DBS reception, Microwave power transmission, Remote sensing application, Data collect directly from the satellite, Wearable antenna, Radar application.

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