



Development of 1.8 M Diameter Dish Reflector using Fiberglass Materials at Ku-Band Applications

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ABSTRACT

This paper describes the design, simulation and development of parabolic reflector using fiber glass. The antenna is 1.8m in diameter, for operation at Ku-band (10.95 – 12GHz). An f/d ratio of 0.43 was chosen and other parameters were computed. The S parameters for the antenna were obtained using Design-Expert 6.0.8 Software Version and Advance Design System (ADS). The properties of the antenna such as bandwidth, beam width, gain, directivity, return loss and VSWR were obtained. The antenna offers high efficiency and high gain. The fiberglass has good surface accuracy with a light weight of 20 kg.

Keywords: radiation pattern, fiberglass, parabolic reflector, VSWR, moulding

1.0 INTRODUCTION

An antenna is a metallic conductor that is cut into size and shape which radiates and receives electromagnetic waves effectively. The major function of an antenna is to couple radio waves in free space to an electrical current used by a radio receiver or transmitter. In reception, the antenna intercepts some of the power of electromagnetic waves in order to produce a tiny voltage that the radio receiver can amplify. Antennas are of different types based on their frequency of operation, application and characteristics [1]. Currently, parabolic reflector is used to receive the ku-band signals. The dish provides the best compromise of high gain, which is about 37dB at 12.5GHz for 0.6m diameter, 38.5dB for 0.75m and 40.3dB for 0.9m [2]. A parabolic dish antenna has a reflector which is a section of a parabolic reflector. Parabolic dish reflector antenna

contains characteristics of high directivity, extremely low side lobes, pencil beam radiation pattern and high gain [3]. As a result, they are widely used in the fields of point to point and satellite communication at microwave regions.

A dish antenna has a reflector, which is a section of a normal parabolic reflector. If the section does not include at the center of the reflector, then none of the radiated beam is received by Low Noise Block (LNB) the in feed antenna and support structure. For small dishes, feed blockage in an axial feed dish causes a significant loss in efficiency. In this paper, using a fiberglass material to for the parabolic reflector instead of metal is considered.

2.0 DESIGN

The value of f/d employed is 0.43 for efficient performance. The higher the ratio of f/d the shallower the dish, with higher directivity and gain [4].

f/d = focal length to diameter ratio

$$f = 0.77\text{m}$$

The depth of the dish, D is given as

$$D = d^2/16f \quad (1)$$

$$D = 0.26\text{ m}$$

The dish aperture A_p is given as

$$A_p = \pi(d/2)^2 \quad (2)$$

$$A_p = 0.785\text{ m}^2$$

The wavelength (λ) is

$$\lambda = c/f \tag{3}$$

$$\lambda = 0.027 \text{ m}$$

The E-field and H-field are given by [5]

$$E_{\theta} = \frac{jke^{-jkr}}{4\pi r} (1 + \cos \theta)(f_x \cos \theta + f_y \sin \theta) \tag{4}$$

$$E_{\phi} = \frac{-jke^{-jkr}}{4\pi r} (1 + \cos \theta)(f_x \sin \theta - f_y \cos \theta) \tag{5}$$

The parabolic reflector gain, G is given by [6]

$$G = (4\pi \epsilon G_p A_p) / \lambda^2 \tag{6}$$

$$G = 40.6 \text{ dB}$$

The reflection coefficient ρ is given as

$$\rho = \frac{Z_A - Z_0}{Z_A + Z_0} \tag{7}$$

Z_A = Antenna Impedance

Z_0 = Characteristics Impedance

$$\rho = 0.04961$$

The voltage standing wave ratio is given as

$$VSWR = \frac{1 + |\rho|}{1 - |\rho|} \tag{8}$$

$$VSWR = 1.30$$

The return loss is given as

$$\text{Return loss} = -20 \log |\rho| \tag{9}$$

$$R_L = -20 \text{ dB}$$

3.0 MATERIALS

Table 1: Formulation of a standard fiber glass moulding [7]

Composition	Percentage Content
Polyester resin	30
Fiber mat	18
Filler	48
Pigment	3
Grease	0.6
Catalyst	0.3

4.0 RESULTS AND DISCUSSION

The simulation of the parameters for the antenna was done using Design Expert software (6.8.0) design System, Fig. 1 Shows the radiation pattern side lobes in polar form; Fig.2 and Fig.3 Shows the E- and H-Gain and Directivity, and Fig. 4 Shows the Return loss of fiberglass parabolic antenna. The antenna resonates at 10 GHz at a return loss of -20 dB with directivity and gain of 25 dB.

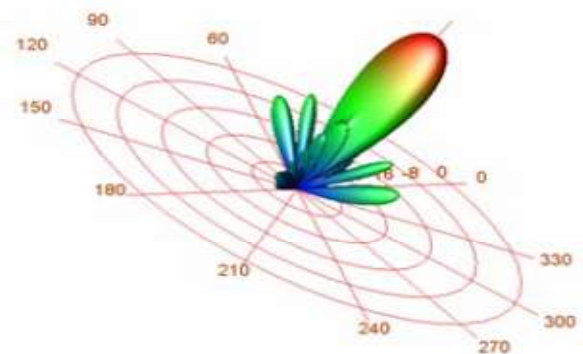


Fig. 1 Shows the 3-D radiation pattern with side lobes in polar form

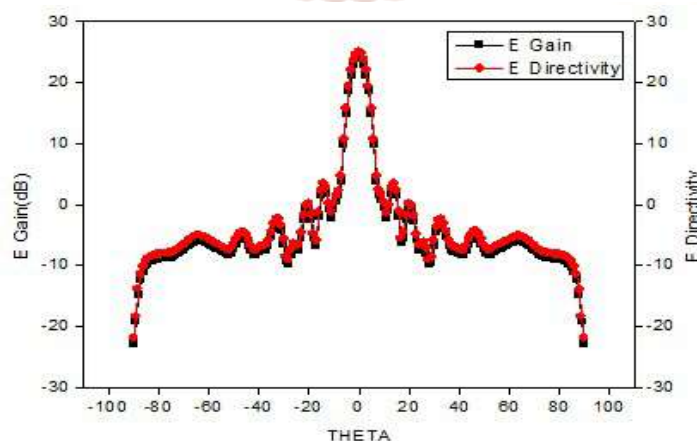


Fig. 2 Shows the E- Gain and Directivity

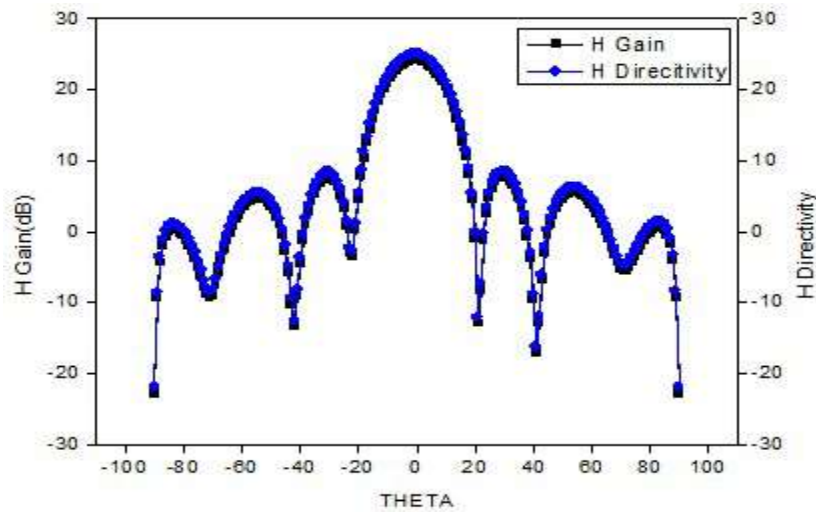


Fig 3 Shows the H-Gain and Directivity

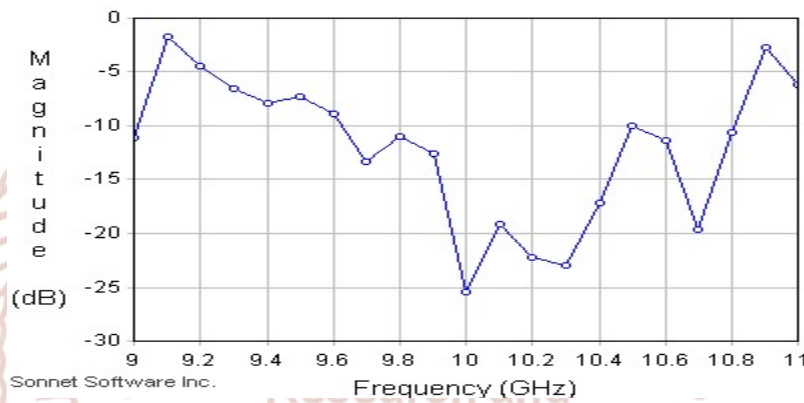


Fig 4. Shows the Return loss

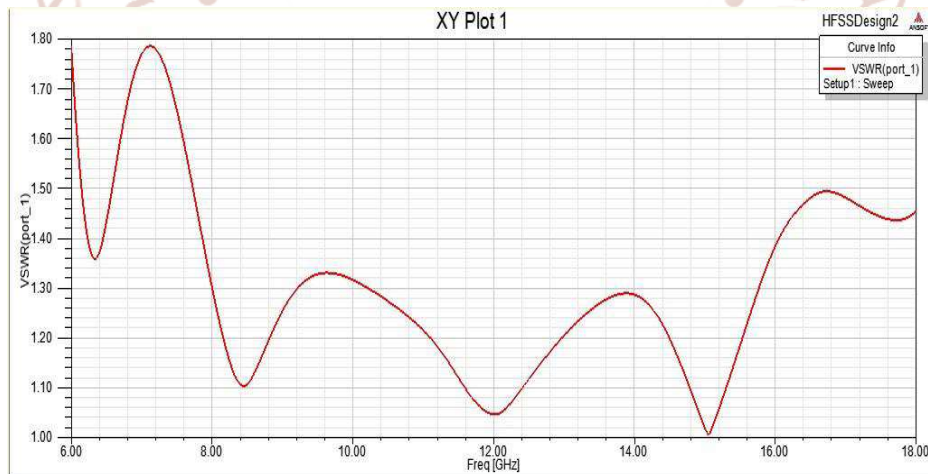


Fig 5. Shows the VSWR

5.0 CONCLUSION

In this paper, a fiberglass parabolic reflector antenna has been presented. The antenna has been designed to operate at (10.95 – 12GHz) in the Ku-band. The antenna has good pattern and proper. The design has been accomplished using commercially available

Design-Expert 6.0.8 Software Version and Advance Design System (ADS) with multiple interface. The design antenna has shown good performance in terms of return loss, VSWR and radiation patterns. The percentage compositions of materials required for

moulding of the antenna have also been presented. Good performance has been obtained for the envisaged applications.

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