Prime Feed Reflector Antenna for Applications of Site Survey

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1. Introduction

Due to DBS antenna have high directivity characteristic, so it is often used for use in radio astronomy, satellite tracking, microwave communication, and radar detection system applications, the blocking of the co-phase aperture of a reflector antenna by its feed, feed supports, subreflector generally cause significant RF deterioration of a microwave pencil beam: gain is degraded, beam efficiency is reduced, sidelobes and cross-polarization levels are raised [1]-[3]. Consequently, many high performance, microwave telecommunication and remote sensing system have employed offset-fed configurations to eliminate the effects of blocking. Reflectors are widely used to modify the radiation pattern of a radiating element. For example, the backward radiation from an antenna may be eliminated with a plane sheet reflector of large enough dimensions. This paper propose a low cost antenna for the applications of site survey, this design uses 35cm diameter offset reflector, in order to reduce the cost, the feed use dipole antenna, and using square corner reflector to increase the antenna efficiency.

1. Theoretical Analysis

The 35cm existing DBS reflector antenna is used. The operating frequency is from 4.5GHz to 5GHz. The ratio of focus to diameter is 0.6. The feed of dipole antenna is with square corner reflector to increase the gain of the feed. The theory of both dipole antenna and square corner reflector design will be described separately.

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A. Design of dipole antenna

In order to reduce cost and easy manufacture, the feed with dipole antenna is used as shown in Fig. 1. Since the impedance of coaxial line feed dipole antenna is designed for 50 ohm, the balum is not used. In order to have the symmetry antenna pattern, the dipole antenna is not the same at half wavelength length.

B. Theory of corner reflector antenna

Since the dipole antenna pattern is an omni-directional antenna, it is low gain antenna. In order to increase the antenna gain, a square 90 degrees corner reflector is used. The corner reflector antenna is shown in Fig. 2. In the analysis of the square corner reflector there are 3 image elements as shown in fig.3. The driven antenna 1 and the 3 images have currents of equal magnitude. The phase of the currents in 1 and 3 is the same. The phase of the currents in 2 and 4 is the same but 180 degrees out of phase with respect to the currents in 1 and 3.The total field of the system can be derived by summing the contributions from the feed and its images [4]. Thus

$$E(r,\theta,\phi) = E_1(r_{1,\theta,\phi}) + E_2(r_2,\theta,\phi) + E_3(r_3,\theta,\phi) + E_4(r_4,\theta,\phi) \tag{1}$$

In the far-zone, the normalized scalar field can be written as

$$E(r,\theta,\phi) = f(\theta,\phi)\frac{e^{-jkr_1}}{r_1} - f(\theta,\phi)\frac{e^{-jkr_2}}{r_2} + f(\theta,\phi)\frac{e^{-jkr_3}}{r_3} - f(\theta,\phi)\frac{e^{-jkr_4}}{r_4} \tag{2}$$

$$E(r,\theta,\phi) = \frac{e^{-jk(r-\frac{\lambda}{2})}}{r-\frac{\lambda}{2}} - 2\frac{e^{-jkr}}{r} + \frac{e^{-jk(r+\frac{\lambda}{2})}}{r+\frac{\lambda}{2}}$$

$$= -4\frac{e^{-jkr}}{r} \tag{3}$$

$$\Rightarrow 20\log|-4| = 12\ dB$$

It increases gain about 12dB. The gain of ideal dipole antenna is 2.15dBi. So the gain of square corner reflector with half-wavelength dipole antenna is 14.15dBi.

3. Results of Simulations and Measurements

The simulation of feed is by using the Ansoft HFSS. Figs. 4 and 5 show the results of E-, H-plane pattern of dipole with square corner reflector by HFSS

and measurement. The E-plane pattern of HPBW is about 55degrees, the H-plane pattern of HPBW is about 40degrees, the results of pattern by simulation and measurement are almost the same, Fig. 6 shows the final antenna system measured by compact range. Fig. 7 shows the measurement result of H-plane pattern. The antenna HPBW is about 12 degrees, and the gain is about 21dBi.

4. Conclusion

A 35cm offset reflector antenna is developed. The gain of feed, dipole with square corner reflector is about 12dBi. The gain of the design feed and offset reflector antenna is about 21 dBi. The HPBW is about 12degrees. The results with simulation and measurement are quite agreed.

5. References

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Fig. 1 The size of dipole antenna

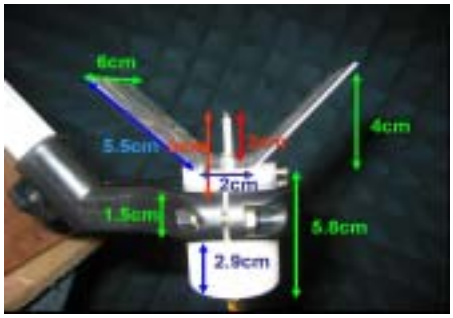

Fig. 2 Side view of corner reflector antenna

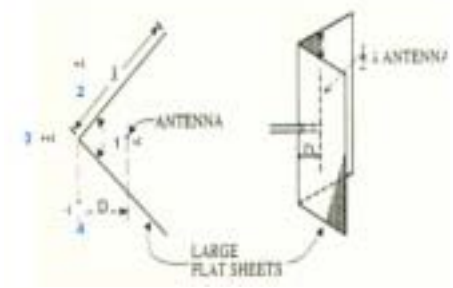

Fig.3 Square corner reflector with images used in analysis

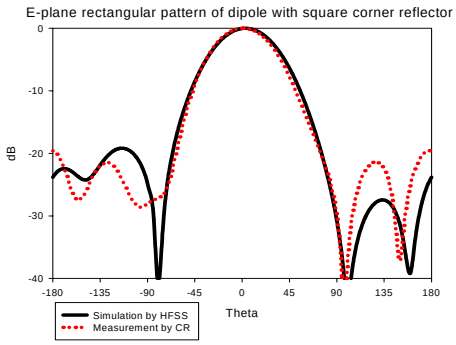

Fig. 4 E-plane pattern of dipole with square corner reflector by simulation and measurement

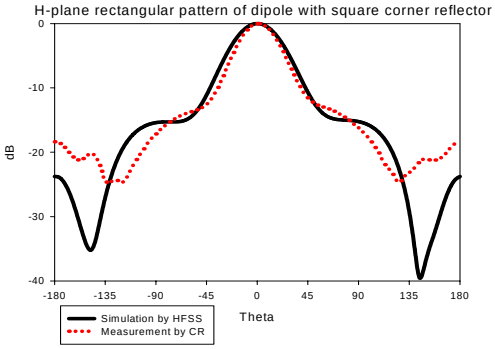

Fig. 5 H-plane pattern of dipole with square corner reflector by simulation and measurement

Fig. 6 Antenna system measured by compact range

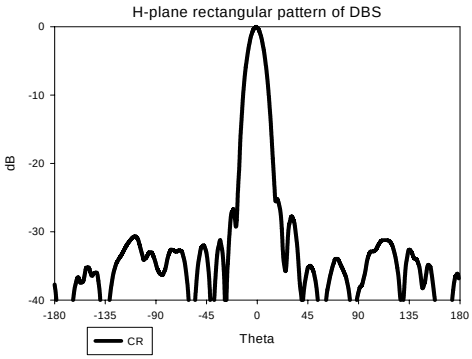

Fig. 7 Measured H-plane pattern