

A High-Gain Planar Dual Reflector Antenna

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Abstract - A high-gain planar antenna model is proposed in this article. The dual reflector function is attained by using metalized via-holes as the reflector with the shape of hyperbola and parabola. The antenna is fed with the *H*-horn of SIW. Simulation in CST shows good impedance matching realized from 32.7 to 37.6 GHz with the maximum gain over 16 dBi throughout the entire band. This antenna can be widely used in millimeter radar or communication system.

Index Terms — Substrate Integrated Waveguide, planar antenna, high gain, dual reflector.

1. Introduction

With the development of communication and electronic techniques, the range of frequency tends to be higher and higher up to millimeter band. Millimeter wave antenna which has received extensive attention [1,2] can be designed very small because of its short wavelength, so large amount of antenna elements can form an array in a smaller area. Previous researches show that the utilization coefficient of aperture field of dispersed antenna array is low [3], while the size of the continuous antenna array is too large to be integrated, so as not possible to be used in millimeter integrated circuit.

Substrate Integrated Waveguide (SIW) [4] is a technique to make antenna planarization, which has been widely used in millimeter field. Previous works have proposed some planar horn antennas based on SIW [5-7], but the gain is low because of its small aperture, so it usually forms an array to enhance gain [8]. A method of improving gains by the metalized via-holes with the shape of hyperbola and parabola, separately, to constitute a dual reflector structure is proposed in this paper, which has drawn lessons from Cassegrain antenna. The high-gain principle is explained by simulating the aperture field and the result is presented in detail.

2. Antenna Configuration

The structure of the proposed antenna is displayed in Fig. 1. The antenna is integrated on one printed substrate circuit board. Thin metal layers are distributed on the both sides of the dielectric substrate with the size of 122 mm×78 mm×3 mm and the relative permittivity of 4.4, gray area for the metal and blue for the dielectric. A series of metalized via-holes are set in the dielectric slab. The boundaries of the via-holes are described by $y = x^2 / 240$ and $y = (0.672x^2 + 160.78)^{1/2} + 40$, the origin lies the parabolic vertex, and the coordinate of horn antenna aperture center is (0,20,1.5). The antenna is fed by microstrip line.

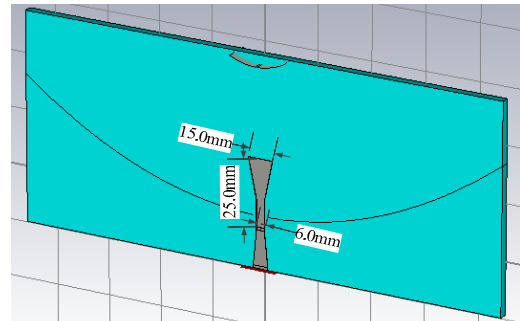


Fig. 1. Structure diagram of the proposed antenna.

3. Simulated Results

Simulations of the proposed antenna are performed by CST-Microwave Studio. The simulation results of antenna reflection coefficient and radiation pattern at 35.5GHz are shown in Fig. 2 and Fig. 3. Simulation results show the center frequency of antenna is at 35.5 GHz (32.7-37.6GHz, 14%) with the bandwidth gain of 16.4 dBi and the directional property of the pattern is very strong. In the center (typical) frequency point of *E*-plane, the main lobe width is 60 deg. The side-lobe level of the measured result is -10.7 dB. The high sidelobe level should be caused by the aperture efficiency which is closed to 1, so the antenna gain is higher.

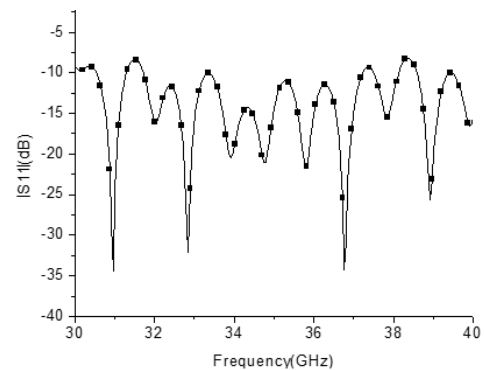
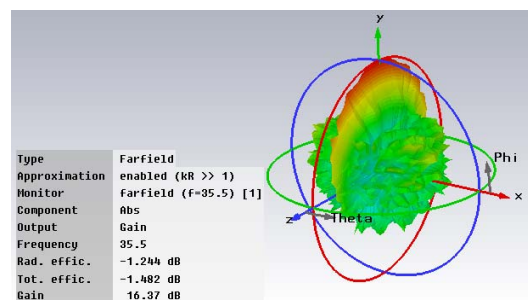
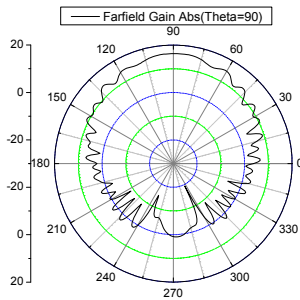


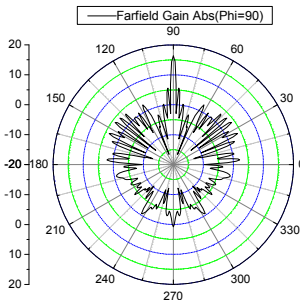
Fig. 2. Simulated reflection coefficient of the antenna.



(a) 3D radiation pattern.



(b) E-plane radiation pattern



(c) H-plane radiation pattern

Fig. 3. Simulated patterns of the antenna at 35.5 GHz.

4. Simulation Analysis

This antenna can be regarded as the planarization structure of Cassegrain antenna. After two reflections from the hyperbolic cylindrical surface and parabolic cylindrical surface, when the electromagnetic wave emitted from the H -plane horn arrives at the aperture (e.g. $-61\text{mm} \leq x \leq 61\text{mm}$, $y=60\text{mm}$, $-1.5\text{mm} \leq z \leq 1.5\text{mm}$), it will form an aperture field with the approximately uniformly distributed phase. This aperture field distribution area is far bigger than the aperture of H -plane as feed; therefore, the gain is significantly improved.

5. Conclusion

In this paper, A high-gain planar dual reflector antenna based on SIW H -plane horn antenna is presented for the first time. The antenna can achieve a maximum gain of 16.4 dBi within the operating frequency range of 32.7-37.6GHz. It puts forward a new design method of parabolic and hyperbolic cylinders borrowing from Cassegrain antenna, which wins the high gain and aperture utilization coefficient as well as the low profile. The proposed antenna is of printed circuit board structure, which is easy to be integrated in communication and electronic system.

References

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