Radiation characteristics of a parabolic reflector with dielectrics on the aperture

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I. Introduction

Radiation characteristics of a parabolic reflector antenna, illuminated by a conventional TE-11 mode circular waveguide horn and loaded on the aperture by dielectric plates, are described experimentally. The purpose of this experiment is a reduction of cross polarization in the far-field of a front-fed parabolic reflector antenna. It is well known that a front-fed reflector has relatively high cross polarization in the 45°-planes if the antenna is fed by the feed with asymmetrical E-H patterns. Some reports(1)-(2) on the reduction of cross polarization from a front-fed reflector antenna have been made so far. In this paper is presented the result of experiment conducted by loading dielectric plates on the reflector aperture.

II. Measurements

The test reflector is a 500㎜-diameter precision-surface paraboloid reflector fed by an open-ended circular waveguide feed horn at the testing frequency of 12.15 GHz. The reflector is loaded with a parallel-plate radome on the aperture, on which the dielectrics are to be installed. As is well known, half-wavelength dielectric plate rotates the polarization of the incident wave, and this technique is used here in this experiment so as to cancel partially the cross polarization components of the aperture field. Then, if the partial control of the aperture field is properly done, it is expected that the cross polarization of the secondary field would be reduced.

Fig. 1 shows the measured far-field patterns(E- and H-planes) of the feed(0.7 λ -aperture diameter). It is seen in this figure that the E-plane pattern becomes broader than the corresponding H-plane pattern for wider angles due to the edge currents on the feed aperture. The polarization-rotation dielectric plates are then loaded on the peripheral regions of the reflector aperture so as to cancel partially the cross polarization fields and so as to reduce the loading effects of the dielectrics as seen in Fig. 2. The position and the dimension(width and length) of the dielectrics are experimentally decided.

Fig. 3 shows the principal- and the cross-polarized patterns of the test reflector(F/D=0.25), where the dotted lines show the patterns without the dielectrics and the solid lines show

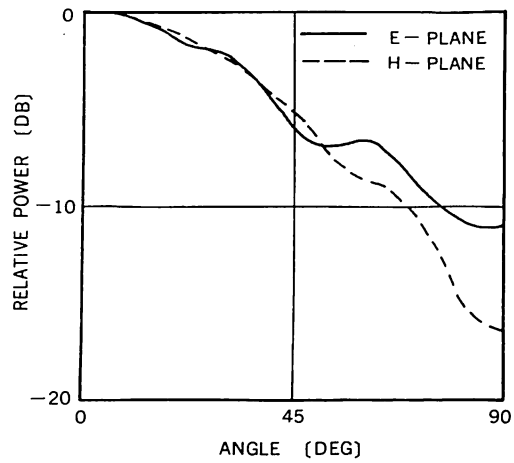

Fig. 1 Measured E- and H-plane patterns of a 0.7 λ-aperture open-ended circular waveguide horn at f=12.15 GHz.

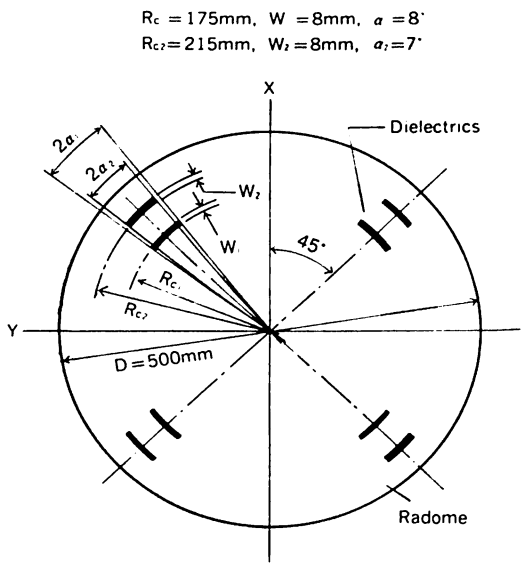

Fig. 2 Configuration of polarization-rotation dielectrics on the experimental reflector aperture.

those with the polarization-rotation dielectrics. It is well observed in this figure that the cross polarization in the 45°-plane is well suppressed below −40 dB within the maximum −10dB-angle of the principal beam; as an example, cross polarization within the −10dB-angle is considered in this paper. The −10dB-angle for the secondary principal beam without the dielectric is 3.58°(E-plane), while that for the secondary beam with the dielectric is 3.83° (E-plane). Since the cross polarization within the −10dB-angle with no dielectrics on the aperture is −27.2 dB, the amount of the reduction of cross polarization with the aperture distribution control is found to be more than 10 dB. The relative gain with and without the dielectrics is 0.31 dB. However, the level of the first sidelobe in the principal polarization appears to increase. As for the cross polarization, it is observed that the level of the cross polarization at the angles wider than the −10dB-angle is also increased when the aperture control is conducted.

III. Conclusion

An experimental study for cross polarization reduction in center-fed parabolic reflector antennas has been described very briefly. Control of the aperture distribution was conducted by loading dielectric plates on the radome of the parabolic reflector. It is shown that the cross polarization radiation within the −10dB-angle of the principal beam could be suppressed below −40 dB at a slight gainloss.

On the other hand, however, the increase of the sidelobe levels in the principal polarization and the increase of the cross polarization radiation at wider angles are simultaneously obseved. These are the problems to be solved for practical application.

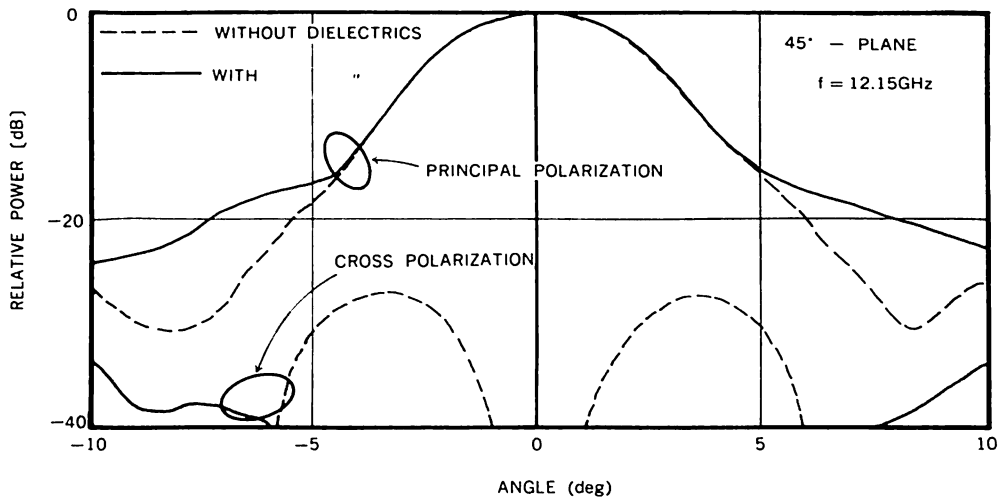

Fig. 3 Measured principal- and cross-polarized patterns.

References

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(2) K.Miyata, "Near-axis cross polarization characteristics of a parabolic antenna by partial shaping of the aperture distribution, "in Summaries of papers of IECE(Japan) National Convention, No. 685, March, 1982.