A DUAL OFFSET SHAPED REFLECTOR WITH A TILTED ELLIPTICAL MAIN REFLECTOR

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INTRODUCTION

Spacecraft antennas with elliptical beams, low cross polarization and low side lobes can be designed systematically using Geometrical Optics (Viskum et al, 1992). By controlling the amplitude taper of the aperture distribution through the shaping, low side lobes can be enforced, and a good choice of geometrical parameters in the offset system can minimize the cross polarization.

It is customary to design dual offset shaped reflectors with elliptical apertures in such a fashion that the minor axis of the ellipse is in the plane of offset for the antenna, since this will tend to minimize the overall size of the system. Such configuration is shown in a front view in Figure 1 (a). The elliptical beam radiated from the aperture has its minor axis orthogonal to the plane of offset. If the coverage requirements are such that the beam axes shall be tilted at some angle from the spacecraft axes, then the antenna must be mounted accordingly.

This places constraints on the spacecraft layout: the earth deck must be able to accommodate the antenna geometry at the required angle, and the waveguide runs to the feed are predetermined also from the geometry.

It would be advantageous to be able to design the antenna in such a way that the above constraints could be removed. It would provide greater flexibility in the layout of the earth deck, and it could be possible to minimize the waveguide runs. Therefore the systematic shaping procedure has been enhanced to handle cases in which the minor axis of the main reflector aperture is not necessarily in the plane of offset, but rotated some angle. An example of a 45° rotation is shown in Figure 1 (b). This example is further described in the following.

SYNTHESIS PROCEDURE

The synthesis starts with a regular Gregorian system, for which the main reflector surface is expanded in Zernike modes. It is possible to describe the sub reflector implicitly in terms of the main reflector expansion, from the requirement that the aperture

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phase must be constant. The GO aperture field is then calculated and compared to a prescribed distribution. By changing the coefficients of the Zernike expansion using a least squares optimization program, it is possible to change the design to meet the requirements. An elliptic shape of the aperture is imposed during the synthesis, at the angle required from the spacecraft layout constraints.

DESIGN EXAMPLE

A design has been made for a 45° rotation of the main reflector aperture, and compared to a conventional design without rotation. The results are analyzed using the GRASP7-program (Pontoppidan, 1989) with a feed model that takes near field effects into account. Physical Optics (PO) is used both on the sub and the main reflector. The main reflector aperture is 1.0 m x 0.58 m.

Radiation patterns are shown in Figure 2 for the regular and the titled design. Both exhibit extremely low side lobes and excellent cross polarization characteristics. The peak co- and cross polar components at 10.95 GHz are:

	Copolar (dBi)	Cross polar (dBi)
Regular design	36.4	-2.7
Tilted design	36.6	-0.1

It is seen that there is very little difference between the two designs, which is also confirmed by the contour plots shown in Figures 3 and 4. The structure of the cross polarization is different because the linear polarization in one case is orthogonal to the plane of offset whereas it is rotated 45° in the other.

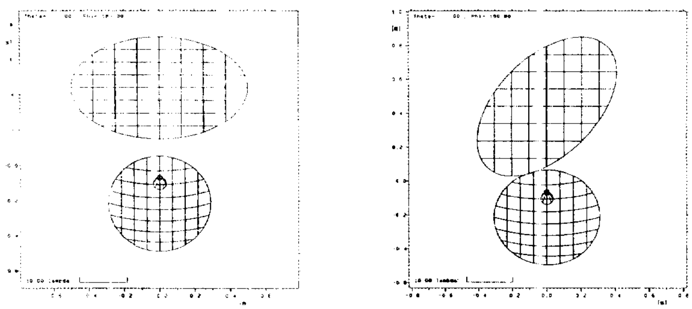
CONCLUSION

A systematic procedure has been derived in which it is possible to shape a dual offset system with elliptical aperture, to provide uniform phase and prescribed amplitude taper over the aperture, which can be rotated with respect to the plane of offset. The approach is demonstrated through an example, which confirms the validity of the technique

REFERENCES

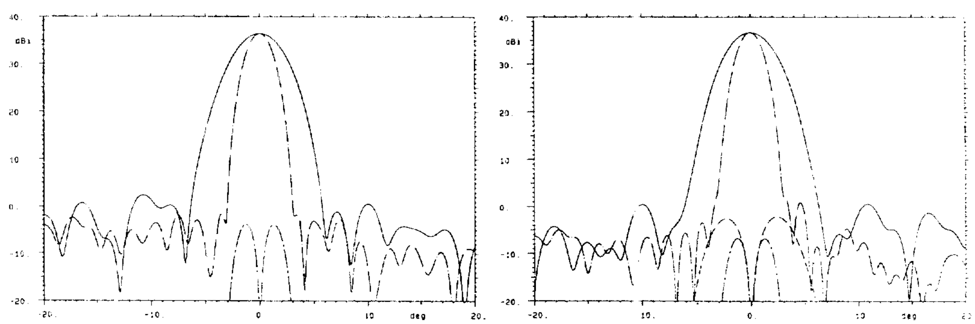
Pontoppidan, K., "Technical Description of GRASP7 and GRASPC", TICRA Report S-359-03, 1989.

Viskum, H.-H., Wolf, H. and Lindley, A., "A Dual Band Dual Polarized Shaped Dual Offset Reflector...", AIAA Int. Comm. Satellite Systems Conf., 1542-1551, 1992.



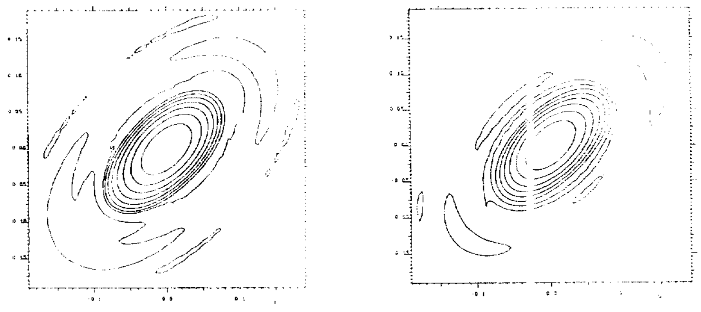
(a) (b)

Figure 1. Examples of dual offset shaped reflector systems with regular orientation (a) and 45°-rotation (b) of main reflector aperture



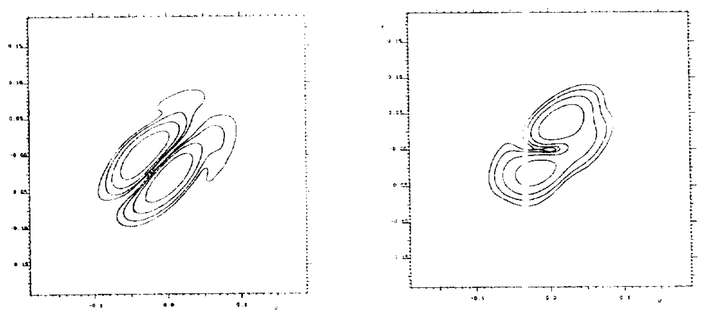
(a) (b)

Figure 2. Pattern cuts in narrow and broad plane at 10.95 GHz for regular (a) and 45°-rotated (b) designs



(a) (b)

Figure 3. Copolar contour plots for regular (a) and 45°-rotated (b) designs



(a) (b)

Figure 4. Cross polar contour plots for regular (a) and 45°-rotated (b) designs