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Introduction

The shaped dual offset reflector antenna configuration is considered to yield the best radiation pattern performance for FSS ground stations operating in a small angle satellite spacing environment, where the present trend is a continuo tightening of offaxis radiation levels specifications. When properly designed and fitted with a low crosspolarization primary feed, the shaped dual offset reflector antenna radiation pattern can easily meet the present ITU-R recommendation (29-25log(θ)), achieving simultaneously high aperture efficiencies, above 90%, and low levels for the crosspolarization peaks in the azimuth radiation pattern plane. However, widespread utilization of this configuration is still curbed by the higher manufacture costs when these are compared, for instance, with the cost required for the manufacture of symmetrical dual reflector antennas.

In this paper, the possibility of reducing the manufacture costs for the dual offset configuration is explored by utilizing the parabolic offset reflector as the main reflector, and shaping only the subreflector. This solution can be very cost reduction effective, particularly for manufacturers that already have a highly diversified production of single offset antennas. Selected reflectors could then be easily utilized as the main reflector in a dual offset design fit with a suitably shaped subreflector. This configuration when compared with the classical one has the advantage of furnishing the higher efficiency considered compatible with the double offset configuration.

Dual Reflector Antenna Design

A Gregorian configuration is chosen for the dual reflector antenna that has to operate at the Receive and Transmit Ku-Band. The offset parabolic reflector to be employed in the design has a projected circular aperture with a 3.6 m diameter (D), f/D=0.64 (focal to diameter ratio) and the offset distance 1.95 m, as indicated in the Figure 1. The subreflector diameter (D_S) is 0.50 m and the feed dimensions have to be designed to avoid blockage of the fields scattered by the subreflector. To operate over wide frequency band, the varying characteristics of feed

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radiation with the frequency affect the antenna performance. To minimize these effects, TELEBRAS has designed a corrugated feed horn with an almost uniform radiation pattern over the entire band, as shown in Figure 2. It provides -15 dB taper of the field toward the subreflector rim ($\theta=16^0$), it is linearly polarized in the plane of tilt and the feed crosspolarization is bellow -35 dB at the 45^0 plane.

Classical offset Gregorian configurations are a natural option and they can be designed by following the procedure described in [1], where the feed offset angle is adjusted to minimize crosspolarization. However, gain is limited by the feed radiation pattern and the aperture phase error produced by displacement of the feed phase center with the frequency[2]. Maximum efficiency of 74 % has been predicted at 11.7 GHz by placing the phase center at the focus of the ellipsoid. Alternatively, Geometrical Optics Synthesis [3] can be used to shape the subreflector to achieve uniform illumination of the main reflector. When compared to the previous case, the subreflector surface suffers a more intense shaping at the edge in order to compensate the taper mismatching between feed and aperture power distribution. However, the subreflector shaping produces a non uniform phase at the main reflector aperture. By using simple numerical procedures, the position of the paraboloid focus can be adjusted to minimized aperture phase error at single frequency (11.7 GHz) and a efficiency high as 84 % has been predicted. However, variation of 15% in the efficiency is observed over the band.

To make the antenna performance uniform over the receive and the transmit band, the subreflector is shaped by employing the diffraction synthesis technique for dual reflector antenna described in [4]. In this optimization synthesis procedure, the main reflector surface is kept constant and the coefficients used to describe the subreflector surface are adjusted to maximize the antenna efficiency and to reduce farfield crosspolarization. To alleviate the reflector shaping, the synthesis procedure also optimises the feed position and the offset angle. Thus, the subreflector shaping compromises the aperture illumination and aperture phase error produced by the displacement of the feed phase center position with frequency. The choice of an adequate initial solution for the iteration is essential to control the subreflector dimension, the clearance between the top of subreflector and the bottom of reflector, and subreflector edge illumination, and, also, to reduce computing time. As it is close to the optimum solution, the GO-shaped subreflector mentioned before is employed as starting point. The synthesized dual reflector antenna shows an efficiency above 84% and farfield crosspolarization is below -45 dB over the receive and transmit band. For the synthesized dual reflector antenna, Figure 3 shows the copolar and the crosspolar farfield radiation patterns at 11.7 and 14.3 GHz in asymmetry plane. The subreflector and reflector spillover effects on the sidelobe region require special design considerations. Further reduction in the costs of the antenna production can be obtained by employing in the dual reflector antenna design the same feed used in the single reflector configuration.

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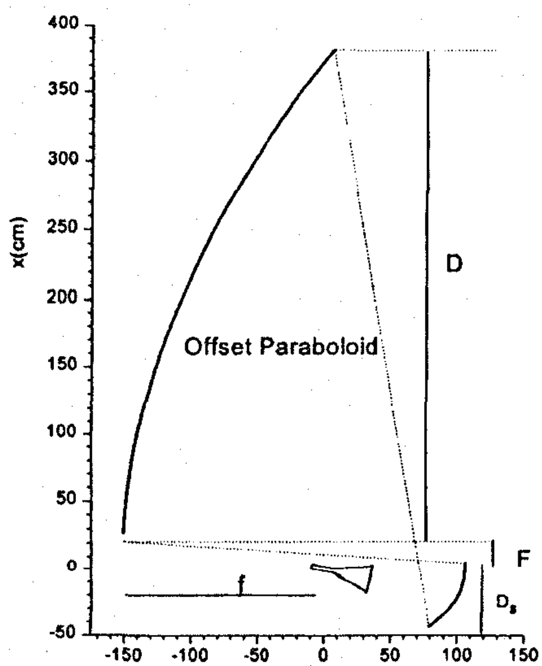

Figure 1. Dual reflector configuration

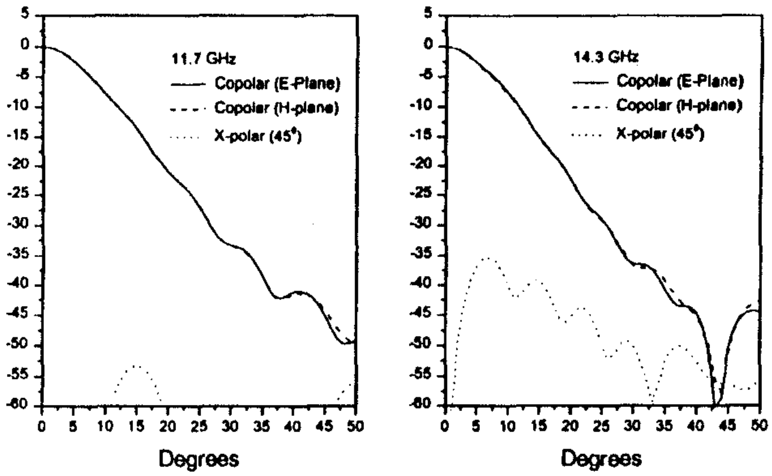

Figure 2 . Feed Radiation Pattern

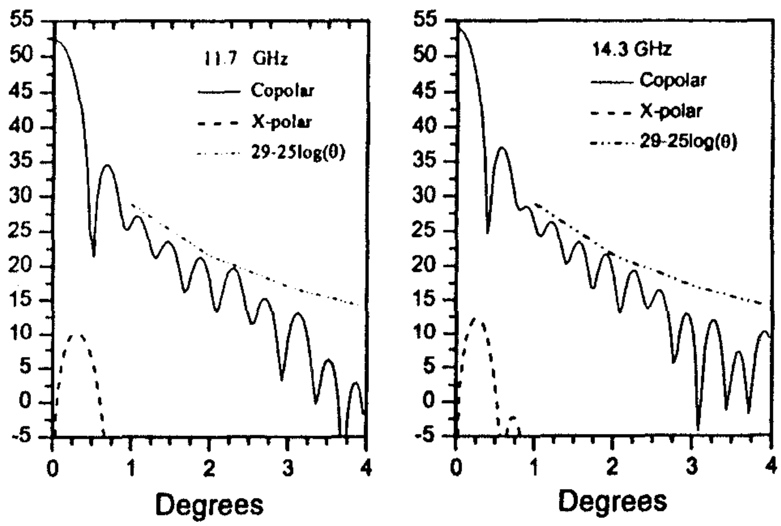

Figura 3 - Antenna radiation patterns in the asymmetry plane