ELECTRICAL DESIGN OF THE INTELSAT VIII S1 KU-BAND SPOT BEAM ANTENNA

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INTRODUCTION

The INTELSAT VIII spacecraft will carry two steerable spot beam antennas for operation in the Ku-band (10.95 - 12.75 GHz Tx; 14.0 - 14.5 GHz Rx), thereby continuing the success INTELSAT has had since the INTELSAT V spacecraft generation in providing this flexible service. Both antennas are linearly polarized, with the possibility of switching between horizontal and vertical orientation at both transmit and receive. This places stringent requirements on the reflector and feed chain, since the design must operate with extreme good polarization characteristics over both bands.

The S1 antenna shall provide a circular spot beam whereas the S2 antenna shall provide an elliptical beam. In order to increase the flexibility over previous spacecraft generations, the antennas are subject to strict requirements on the side lobes, such that the two steerable beams can be moved closely together without interfering each other. This paper describes the design of the S1 antenna which shall generate a circular beam with an inner coverage of 2.39° in diameter and an outer coverage of 3.15°, including an allocation for pointing error.

DESIGN METHOD

In principle, the S1 antenna could be designed as a regular dual offset Gregorian system (Gregorian for compactness) consisting of a paraboloidal main reflector and an ellipsoidal sub reflector. However, it is chosen to use a systematic shaping technique in which the amplitude taper of the aperture field can be controlled while the phase is kept fixed. The method is based upon Geometrical Optics and has been applied previously to designs in which the main reflector was elliptical (Viskum et al, 1992, 1993). There are several advantages in also applying the method in the case of a circular main reflector:

The aperture taper can be selected to fulfil the side

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lobe requirements, independently of the feed radiation pattern.

The feed can be selected from other considerations, i.e low cross polarization, good return loss, existing, space qualified design. For the present antenna a slightly modified version of a corrugated horn build by DASA for the DFS-KOPERNIKUS program is used.

The overall antenna geometry can be selected to fit the spacecraft in an easier fashion than if the design was of the regular type.

PREDICTED PERFORMANCE

An illustration of the antenna geometry is shown in Figure 1. Due to the stringent performance requirements set by INTELSAT it is important to analyze the design with extreme care prior to hardware manufacturing. First the corrugated horn is analyzed using a mode-matching program for the propagation through the inner of the horn, followed by a moment-method solution accounting for the outer structure to obtain the far field pattern (CHAMP, 1990). This is expanded in spherical modes which are used as input to the analysis program GRASP7 (1989). The GRASP7 analysis consist of a Physical Optics (PO) integration of the sub reflector field to find the induced currents on the main reflector, which are then also integrated to obtain the far field. Also the rear radiation from the sub reflector must be added to the field, since the diffraction from the subreflector will peak in the near-in side lobes of the main reflector and cause an increase of the side lobes.

Radiation patterns are presented in Figures 2 and 3 where also the envelope curve as specified by INTELSAT is shown. The frequency is 10.95 GHz where the side lobes are the highest. A design margin of 1.7 dB is required, which is achieved over both bands. The minimum directivities in dBi are:

	Tx	Rx
Inner	34.8	31.8
Outer	34.6	31.7

The worst-case cross polarization is 37.5 dB below peak, which is well within the specification of 35 dB.

CONCLUSIONS

The GO shaping method for dual offset reflectors has proven to be a flexible tool in the design of antenna systems with strict side lobe and cross polarization requirements. It has been applied to the design of the INTELSAT VIII S1 antenna, for which the expected performance is significantly better than the design requirements. Based on previous experience with shaped reflector designs it is expected that the final performance of the manufactured antenna will be in close agreement with the predictions.

REFERENCES

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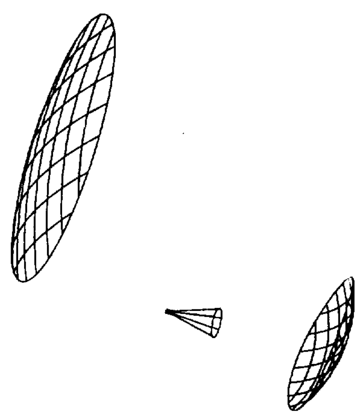

Figure 1. Geometry of shaped dual offset reflector antenna design

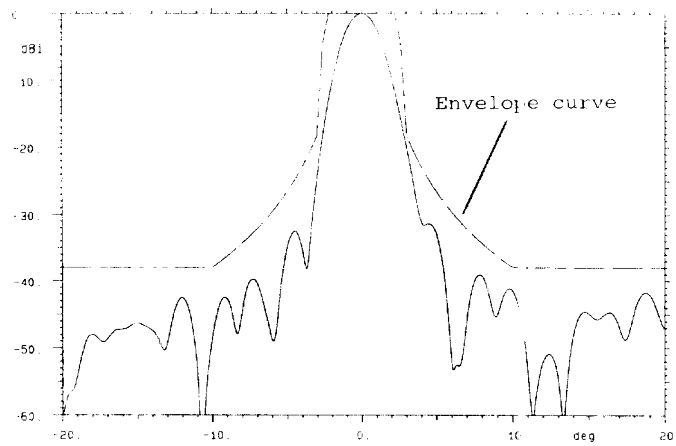

Figure 2. E-plane radiation pattern at 10.95 GHz with INTELSAT side lobe envelope curve superimposed

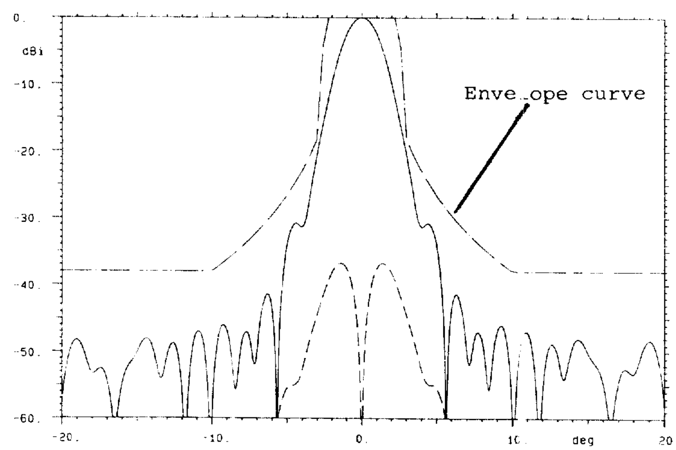

Figure 3. H-plane radiation pattern at 10 95 GHz with INTELSAT side lobe envelope curve superimposed