

A Comparison of Analytical Methods Used for Beam Waveguide Systems
 ビーム導波管のための解析手法の比較

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1. Calculation Methods

Three different analytical methods to calculate Beam Waveguide(BWG) radiation patterns are compared with the measured data from an experimental BWG system. The three analytical methods are:

1) Beam Mode Expansion[1], in which the electromagnetic waves are represented by a sum of Laguerre-Gauss modes where the cross-sectional amplitude distribution for each beam mode is similar at any cross-section, but its extent and radius of curvature of the wavefront vary along the path of the beam,

2) Near Field Physical Optics(PO) analysis[2], where currents on the reflecting surfaces are calculated by the standard physical optics approximations and a complete near field radiation integral is used for the radiation pattern calculation and

3) BWG Tube analysis [3], where the effect of the metallic tube enclosing the BWG is accounted for by using a PO integration procedure with a Green's function appropriate to the circular waveguide geometry. Therefore Method 3 is expected to better predict the main-beam pattern and cross-pol level than the other two methods when the shroud diameter is small enough to have an appreciable effects.

2. Experiment and Comparison Results

Figure 1 shows the configuration of the experimental setup which is composed of 1) a BWG fed by a corrugated horn and 2) a lineally translating probe.

The measurement frequency was 22GHz. All three methods produced results that agreed well with the main beam experimental results. A typical example measured in the Y-plane at the hypothetical subreflector distance is shown in Figure 2. Cross-pol patterns vary in peak level by 1 or 2 dB according to the measuring plane movement up to 3/8. Method 3 shows good agreement with the measured result which is higher in level than the method 1 or 2 result.

The effectiveness of method 3 is more significant in cases of smaller shroud diameters. Figure 3 shows the experimental results for shroud diameters of 293 and 240mm. Observe the slight main beam broadening and null fill-in caused by the smaller shroud diameter. Figure 4 compares the results in the X-plane of the three methods for the 240mm case. Method 3 correctly predicts the main beam broadening and null fill-in caused by the shroud. Of course, methods one and two do not depend on shroud diameter and predict the same performance for the two cases.

References

- (1) T. Kitsuregawa, Advanced Technology in Satellite Communication Antennas:Electrical and Mechanical Design, Artech House, 1990, Pg45-57.
- (2) W. A. Imbriale and R. Hodges, "Linear Phase Approximation - - -", ACES, Monterey, CA, 1990.
- (3) A. G. Cha and W. A. Imbriale, "New Analysis of Beam waveguide - - -", IEEE AP-S Symp. Dallas Texas, 1990.

