Analysis of large reflector antennas using CSP fringe formulation and higher-order diffraction

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Physical Optics (PO) is one of the most ordinarily used methods to estimate the radiated fields by reflector antennas. It is well known that PO provides results with a good degree of accuracy in the main-beam region; at caustic directions it also overcomes the difficulties in using high-frequency ray methods, such as the Uniform Theory of Diffraction (UTD). However, the PO technique does not produce accurate field predictions in side-lobe directions or in shadow zones (C. Balanis, "Antenna theory: analysis and design." New York, NY, Harper and Row, Publishers, 1982). As workaround for this issue, a significative augmentation of the PO field estimate can be achieved by including along the reflector's edge a line integration of an incremental fringe field. The fringe field acts as a correction term for the field estimate. Several techniques have been published to derive these elementary contributions, leading to PTD, EEW/ILDC and ITD. Recently, we presented an incremental fringe formulation of the field diffracted by edges in perfect electric conductor (PEC) objects when illuminated by a Complex Source Points (CSP) beam expansion (S.M. Canta, D. Erricolo, A. Toccafondi, "Incremental Fringe Formulation for Complex Point Sources Beam Expansion by Edges in Planar Metallic Objects", Proc. AP-S, Charleston, June, 2009). It is found that this formulation yields more accurate predictions of the diffracted field by complex metallic objects in presence of a CSP-expansion illumination.

In this work we discuss an application of the CSP fringe formulation to the analysis of large reflector antennas. The source illuminating the reflector is expanded in terms of an equivalent series of CSP. The incremental fringe correction term at each point on the edge is deduced from tangential canonical problems as the difference between the local incremental diffracted field (A. Polemi, A. Toccafondi, G. Carluccio, M. Albani, and S. Maci, "Incremental theory of diffraction for complex point source illumination," *Radio Science*, vol. 42, no. 6, pp. 1-13, 2007) and the incremental end-point PO field (IEPO) scattered by the half-lit plane tangent to the edge. The total spurious effects due to the presence of the edge of the reflector are corrected by adiabatically distributing and integrating along the line of the edge the local incremental fringe field coefficients. Up to this point, we obtain a first-order augmentation of the PO scattered fields, which however tends to fail in those directions parallel to the apertune plane. To solve this issue, we also provide the correct incremental double-diffraction coefficients for CSP illumination: these coefficients include the effect of the interaction between two points on the edge of the reflector (S.M. Canta, D. Erricolo, A. Toccafondi, "Incremental Double Diffraction Coefficients for Complex Source Points", 2010 National Radio Science Meeting, Boulder, CO, 01/06-09-2010). Numerical results and comparisons with other methods will also be shown.