Scattering by a Sheet Impedance Strip in a Metal Plane

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The geometry considered in this work consists of a thin gap in a perfect electrical conductor (PEC) plate of negligible thickness. This gap is then covered by a sheet with finite sheet impedance and illuminated by an E-polarized and obliquely incident plane wave, meaning that the magnetic field parallel to the edges of the strip is zero. Analysis is conducted in elliptic cylindrical coordinates (ξ,η,z) with a time dependence factor exp(+jωt) omitted throughout.

The scattered field is expressed as an infinite sum of products of radial and angular Mathieu functions with unknown expansion coefficients for each of the modes. The expansion coefficients are obtained by first truncating the series to a finite number of terms and applying the continuity conditions for the electric and magnetic fields across the gap. The continuity conditions are then multiplied by appropriate weighting functions and integrated to create a set of equations which is solved through matrix inversion. Particular attention is paid to two cases, one in which the sheet impedance is constant and the second in which the sheet impedance is inversely proportional to $(1-\eta^2)^{1/2}$. The first case is of interest for practical applications while the second case is shown to allow for analytic closed form expressions for the expansion coefficients.

The fields far from the gap are obtained using the asymptotic expressions for the radial Mathieu functions and this pattern is then related to the far field radiation pattern. The dependence of the shape and intensity of the radiated field is discussed in terms of both the sheet impedance and the incidence angle. The end of this work then looks at the case of an electrically small gap in which simple models for the radiation pattern and intensity are obtained in terms of sheet conductivity and incidence angle. Lastly, future applications for this simple model are proposed such as use in methods requiring rapid computations of far field radiation patterns, e.g. conformal array design through heuristic methods.