

## **Exact Analysis of a 3D Cavity-backed Aperture With an Isorefractive Lens**

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The exact solution to an electromagnetic boundary-value problem involving a semi-oblate spheroidal cavity with metallic walls flush-mounted under a metallic ground plane and coupled to the half-space above the plane via a circular hole is considered. The material filling the cavity is separated from the free-space above the ground plane by a lens that occupies the circular hole and separates the cavity interior from the half-space above the cavity; both lens surfaces are coordinate surfaces in the oblate spheroidal coordinate system. The material inside the cavity and the lens material are both isorefractive to free space. The exact solution is in terms of series expansions involving oblate spheroidal wave functions. The expansion coefficients may be evaluated exactly, thereby leading to a canonical solution of the problem.

The primary source is an antenna located on the axis of symmetry of the structure and axially oriented. An exact formula is given for the electric and magnetic fields at any location inside or outside the cavity, or inside the lens. By invoking the reciprocity theorem, the fields on the axis of symmetry due to a primary radiator located elsewhere are given exactly.

The series representing the exact solutions are evaluated numerically, and the results are compared to those obtained by applying general frequency-domain computer codes to the problem at hand, thereby providing an independent validation of such codes. In particular, issues such as the evaluation of fields and surface currents near the edge of the coupling hole, and the effects of ground-plane truncation in the application of general computer codes, are analyzed in detail.