# Multigrid Preconditioning for Time-Harmonic Maxwell's Equations

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We consider three-dimensional electromagnetic problems in parameter regimes where the quasi-static approximation applies, the permeability is constant, the conductivity may vary significantly, and the range of frequencies is moderate. The difficulties encountered include handling solution discontinuities across interfaces and accelerating convergence of traditional iterative methods for the solution of the linear systems of algebraic equations that arise when discretizing Maxwell's equations in the frequency domain.

A finite volume discretization on a staggered grid derived from a potential-current formulation leads to a large, sparse, complex linear system of equations with a block structure that is diagonally dominant. We compare various strategies based on block-ILU, SSOR, and multigrid preconditioners used within a Krylov space iteration. A Fourier analysis suggests a block preconditioner that leads to mesh independent rates of convergence. Numerical experiments support theoretical predictions and demonstrate the efficacy of this approach.