

Electromagnetic Lens Design
and
Generalized TEM, E, and H Modes

A. P. Stone and C. E. Baum

Among several possible approaches to the design of lens waveguide transitions is a differential-geometric method. In general one starts with Maxwell's equations together with boundary conditions and general theorems such as conservation of energy and reciprocity and looks for various mathematical concepts for representing the solution of an EM problem. One may start with inhomogeneous TEM plane waves which propagate on ideal transmission lines with two or more independent perfectly conducting boundaries. These types of inhomogeneous media can be used to define lenses for TEM waves without reflection or distortion between conical and cylindrical transmission lines. While there may be practical limitations (i.e., the properties of materials used to obtain the desired permittivity and permeability of the inhomogeneous medium) perfect characteristics are not really necessary. This approach to EM lens design was initiated by C. E. Baum and has been applied successfully in many applications. Specifically the scaling method creates a class of equivalent electromagnetic problems each having a complicated geometry and medium from an electromagnetic problem having a simple (Cartesian) geometry and medium. Thus the scaling method transforms an EM problem by a change of coordinates, and is a method that is well known in fluid dynamics and mechanics. In earlier work transient lens for propagating TEM modes with dispersion have been considered. We may also consider the properties of E and H modes in such lenses. The presence of longitudinal field components brings in additional constraints on the coordinate systems that are allowable. As a consequence the cases of transient lenses supporting E and H modes is limited to a subset of those supporting TEM modes.