Electromagnetic-Wave Propagation in Chiral H-Guides

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Chiral media are known to exhibit optical activity, while keeping reciprocity. Therefore, unlike magnetically biased ferrites, these media can be useful in the design of some reciprocal devices such as mode converters, polarizers and phase shifters. The application of chiral media to closed metallic waveguides, known as chirowaveguides, and to open slab waveguides and circular rods has been exhaustively analyzed. However, to the authors' best knowledge, no work has been published yet on their application to NRD and H-guides. The major reason for this may be the unfeasibility of an exact rigorous analysis for any rectangular geometry waveguide, due to the coupled differential equations that govern the transverse variation of the filed components. In fact, as metallic rectangular cross-section waveguides are filled with chiral slabs, TE or TM modes can no longer be supported. Some numerical analyses, based on the finite-element method, have been presented in the literature for the metallic rectangular waveguide (J.A.M. Svedin, *IEEE Trans. Microwave Theory Tech*. 38, 1488-1496, 1990). Exact analytical analyses are only available for the parallel-plate waveguide and for the metallic circular waveguide.

This paper addresses the guided-wave propagation in an H-guide when the common isotropic slab is replaced by a chiral slab. Other examples have been already published in the literature, especially the cases when the isotropic slab is replaced by a uniaxial crystal, a transversely magnetized ferrite or an omega medium (A.L. Topa, C.R. Paiva, and A.M. Barbosa, *IEEE Trans. Microwave Theory Tech.* 46, 1263-1269, 1998). However no analysis has been published so far for the chiral H-guide. This can be an interesting problem as chirality may provide an important degree of freedom and suggest potential applications.

The procedure applied in this analysis is based on the transverse resonance method together with a mode matching technique. A building-block approach is then used. In a first stage, a chiral parallel-plate waveguide is studied using a frequency dispersion model for the optically active medium. A constitutive chiral parameter based on the gyrotropic parameter is assumed (E.U. Condon, *Rev. Mod. Phys.* 9, 432-457, 1937). This study provides the elementary modes propagating in the inner region, which are then used for the complete full-wave analysis. Numerical results for the operation and dispersion diagrams of the chiral H-guide are presented. The existence of leaky modes is also investigated, using an approach similar to that used in the analysis of open dielectric planar waveguides (S.-T. Peng and A.A. Oliner, *IEEE Trans. Microwave Theory Tech*. MTT-29, 843-855, 1981).