Abstracts

Waveguide and Cavity Oscillations in the Presence of Nonlinear Media

D. Censor. "Waveguide and Cavity Oscillations in the Presence of Nonlinear Media." 1985 Transactions on Microwave Theory and Techniques 33.4 (Apr. 1985 [T-MTT]): 296-301.

This paper deals with the problem of waves in metallic structures containing nonlinear media. Problems of this kind are encountered in the analysis of microwave devices operated at high power levels, or when the constitutive parameters of nonlinear materials are investigated by means of microwave measurements. The Volterra series are the functional analog of the well-known Taylor series for functions. This mathematical tool is adequate for a description of constitutive relations in dispersive nonlinear media. For practical purposes, we deal with weak nonlinearity, such that the series can be truncated. Weak nonlinearity also denotes the absence of shock waves, such that all spectral components of a wave are phase matched (i.e., propagate with the same phase velocity). The main effect of nonlinearity are the production of harmonics, and the dependence of the dispersion equation on the field amplitudes. These are incorporated into the present model. The development of the present model involves some heuristic assumptions which facilitate the derivation of an algebraic dispersion equation. Therefore, the range of validity of the present model will have to be determined by experimental results, when these are available. In waveguides, and cavities in particular, the question of the effect of the geometry and boundary conditions arises, too. It is shown here that nonlinearity induces harmonic modes in rectangular structures. In cylindrical and spherical structures, the geometry affects the budget of harmonics and produces mode coupling.

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