Abstracts

Velocity Modulation of Electromagnetic Waves

This paper deals with electromagnetic wave propagation through dielectric media whose propagation constants vary as a function of time. If the parameters of the medium cannot respond to changes in the electric and magnetic fields of the propagating wave, the fields within such media will be linear. Maxwell's equations are solved for cases in which the scalar permittivity and permeability vary independently with time. When the impedance is constant, an exact solution is obtained. When the impedance varies, a closed form approximation is found since an exact solution is not always possible. The field energy and electromagnetic momentum are derived for a velocity transient and it is seen that, in general, the energy changes and the momentum remains constant. The frequency deviation that results when a monochromatic wave is passed through a section of dielectric with nonconstant velocity of propagation is discussed in detail. An approximate solution is obtained for the case in which the electrical length of such a section is small; it is found that essentially linear phase modulation occurs. The general solution is found for the case in wtilch the electrical length of section is long and the permittivity of the medium sinusoidally modulated. The optimum length found to give the greatest frequency deviation is shown to be generally impracticable. It appears that ferroelectric or ferrimagnetic velocity-modulated dielectrics are feasible, at least for low-power modulators.