Coplanar Waveguide Periodically Loaded Discontinuities for Realizing Negative Propagation Characteristics

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Since the late 60's there has been considerable interest in the media that exhibits simultaneously negative values of electric permittivity as well as the magnetic permeability. In this type of media, the electric field, the magnetic field, and the wave vector do not satisfy the conventional right hand rule but rather form a left hand rule. Hence these materials are aptly termed left handed materials (LHM). It has already been shown that the periodically loaded transmission lines can also exhibit negative group velocity as well as negative refractive index. These negative dispersion characteristics can be put to use in several circuit applications.

Among the planar microwave transmission lines, the coplanar waveguide (CPW) has very good characteristics at high frequencies, offers scalability, and has the flexibility for assembling the shunt as well as the series components on a single plane, thus making truly uni-planar circuits a reality. Hence MMIC systems can be easily designed using the CPW transmission line. It is widely known that the discontinuities in the central conductor of the CPW add reactance to the transmission line. It has recently been reported that slots cut in the shape of spirals on to the ground trace of the CPW can also introduce reactances. These reactances can lead to interesting resonant characteristics at the high frequencies. Thus the negative characteristics can be obtained by suitably loading a CPW transmission line with such discontinuities at periodic intervals. The period of the discontinuities is so adjusted as to give the desired characteristics at the frequency of interest.

Along with the above said discontinuities, the device can be made tunable. This tunability is achieved by the use of electric field dependent ferroelectric material, which in our case is barium strontium titanate (BST). The thin film of BST, under the discontinuity makes the capacitance of that discontinuity dependent on the applied filed, thus making the device properties voltage-dependent. Therefore the frequency characteristics of the device can be made tunable.