Metamaterial Microwave Components Based on Dual Modes

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Abstract - This paper presents several examples of how mode concepts can be exploited in development of unique microwave components based on Composite Right/Left-Handed transmission line metamaterials.

Orthogonal modes in transmission lines and resonant structures have been extensively used in the past for development of microwave components. As a form of realization, we have introduced the Composite Right/Left-Handed (CRLH) transmission line[1] which has been proven to be low loss and broadband so that the use of orthogonal modes can be introduced as well. However, due to the special properties of CRLH lines, the components developed based on the dual or multiple modes also present unique opportunities.

The directional coupler based on coupled CRLH lines has been built and tested. Due to coupling, both even and odd modes become unbalanced so that the stop-band appears between the left and right handed branches so that within this stop-band, no wave propagation takes place, resulting in a 0 dB coupler[1].

A small antenna made of mushroom type structures can be found to support resonances under the n = 0 (infinite wavelength) and n = -1 modes. The former provides a monopole type radiation pattern while the latter generates a patch like pattern[2].

Depending on even mode or odd mode excitation, backward propagation or forward propagation is selected in a dual-mode CRLH line. By means of excitation, the effective circuit topologies are changed so that the equivalent circuits for either the right handed transmission or the left handed transmission can be accomplished at the same frequency[3].

Finally, a leaky wave antenna made of conductor backed coplanar strip format has a dual mode property[4]. Under even mode (common mode) excitation, no radiation takes place because no transmission structure is formed. On the other hand, under odd mode (differential mode) excitation, the leaky mode is radiated because a virtual ground is attained so that a CRLH line is realized.

REFERENCES

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