An Implementation of Conjugately Characteristic-Impedance Transmission Lines Using Periodically Loaded Structures and Multi-Section Reciprocal Transmission Lines

Suthasinee Lamultree[1,2 *], Danai Torrungrueng[1], and
Chuwong Phongcharoenpanich[2]

[1]Asian University, Banglamung, Chon Buri, Thailand, 20260
[2]Faculty of Engineering & ReCCIT, King Mongkut's Institute of Technology
Ladkrabang, Bangkok, Thailand, 10520
Email: suthasineel@asianust.ac.th, dtg@asianust.ac.th, kpchuwon@kmitl.ac.th

This paper presents an implementation of conjugately characteristic-impedance transmission lines (CCITLs) using periodically loaded structures and multi-section reciprocal transmission lines. Note that CCITLs are lossless, and possess *conjugate* characteristic impedances of waves propagating in *opposite* directions. Typical examples of CCITLs are reciprocal lossless uniform transmission lines, nonreciprocal lossless uniform transmission lines, and exponentially tapered lossless nonuniform transmission lines.

In this study, finite lossless periodically loaded transmission lines with *unsymmetrical* unit cells are firstly considered. Periodic structures possess passband and stopband characteristics similar to those of filters. Theoretically, it has been found that the equation of the input impedance of terminated finite lossless periodically loaded structures at the terminal of each unit cell is in the same form as that of terminated CCITLs. Thus, periodically loaded structures can be employed to implement CCITLs. Several realizable canonical unit cells associated with periodic structures (e.g., L-type, T-type and π-type unit cells) for both *passive* ($\mathrm{Re}\{Z_0^{\pm}\} \geq 0$) and *active* ($\mathrm{Re}\{Z_0^{\pm}\} < 0$) cases are analyzed and designed using a microwave CAD software. In addition, practical structures are also implemented using coplanar waveguides and surface-mount technology (SMT) chip components. Only periodic structures operating in passbands are considered in this study. It is found that measured and simulated results are in good agreement.

To avoid using lumped elements as in periodically loaded structures, multi-section reciprocal transmission lines can also be used as another way of implementing CCITLs. This is due to the fact that a whole of multi-section transmission lines can be viewed as a unit cell of periodic structures. Thus, the theory of periodic structures can be applied for multi-section transmission lines in the implementation of CCITLs. It is found that both periodically loaded structures and multi-section transmission lines yield characteristic impedances of CCITLs that depend on the operating frequency in a complicated fashion. Comparisons of characteristic parameters of CCITLs implemented using both approaches are discussed.