# A Generalized Theory of Small Reflections for Conjugately Characteristic-Impedance Transmission Lines

Danai Torrungrueng* and Chananya Thimaporn
Asian University, Banglamung, Chon Buri, Thailand, 20260
http://www.asianust.ac.th/
Email: dtg@asianust.ac.th, dokcae@hotmail.com

The theory of small reflections for standard reciprocal transmission lines has been available in well-known microwave textbooks. For small reflections, the theory states that the resultant reflection coefficient, caused by partial reflections from several small discontinuities, is obtained by taking only first-order reflections into account. It is useful in the development of a first-order theory for multi-section quarter-wave transformers to obtain more bandwidth for impedance matching, compared to a single quarter-wave section.

Conjugately characteristic-impedance transmission lines (CCITLs) are *lossless* and possess different characteristic impedances $Z_0^+$ and $Z_0^-$, which are *complex conjugate* of each other, for waves propagating in opposite directions. Due to their potential applications in impedance matching, it is of interest to extend the original theory of small reflections to the case of multi-section CCITL transformers with small discontinuities. Only CCITLs with *passive* characteristic impedances ($\mathrm{Re}\{Z_0^{\pm}\} \geq 0$) terminated with passive loads are considered in this paper.

In the presentation, the original theory of small reflections is reviewed. Then, a single-section CCITL transformer, connected between a CCITL feedline and a passive load, is considered. It is found that the exact form of the total reflection coefficient at the end of the feedline can be expressed in terms of associated partial reflection coefficients. Using the assumption of small reflections, the total reflection coefficient can be approximated, resulting in the theory of small reflections for the single-section CCITL transformer. Finally, the single-section theory is generalized for multi-section CCITL transformers with small discontinuities. Like the original theory of small reflections, it is found that the generalized theory still takes only first-order reflections into account. Physical interpretations and potential applications of results will be discussed during the presentation.