

## An Extended T-Chart for Solving General Problems Associated with Conjugately Characteristic-Impedance Transmission Lines

Danai Torrungrueng\* and Po-Yen Chou

Asian University, Banglamung, Chon Buri, Thailand, 20260

<http://www.asianust.ac.th/>

Email: dtg@asianust.ac.th, chouman\_b@hotmail.com

Conjugately characteristic-impedance transmission lines (CCITLs) have found various applications in microwave technology; e.g., periodically loaded lossless transmission lines. In general, 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. Recently, the T-chart, which is a generalized Smith chart, has been developed to perform the analysis and design of CCITLs effectively. However, only CCITLs with *passive* characteristic impedances ( $\text{Re}\{Z_0^\pm\} \geq 0$ ) terminated with passive loads are considered, where the magnitude of associated reflection coefficients is always less than or equal to one.

For some cases, CCITLs can exhibit *active* characteristic impedances ( $\text{Re}\{Z_0^\pm\} < 0$ ) if associated parameters are chosen appropriately. It is found that the magnitude of associated reflection coefficients for these cases is always greater than one. Interestingly, the power conservation for these CCITLs is still satisfied, which implies that CCITLs with *active* characteristic impedances are realizable in practice. Thus, it is of interest to develop a graphical tool for these cases; i.e., an extended version of the T-chart.

In the study, the extended T-chart developed for *active* CCITLs terminated with passive loads will be demonstrated for several cases. By comparing graphical solutions obtained from the extended T-chart with analytical solutions in the computation of input impedances of terminated *active* CCITLs with passive loads, they are in very good agreement, which implies that the extended T-chart is indeed valid. Like the standard T-chart, it is found that the extended T-chart depends on the argument of characteristic impedances in a complicated fashion. Unlike the standard T-chart and the standard Smith chart for passive loads, only the region outside the unit circle in the reflection coefficient plane is considered for the extended T-chart for passive loads. Several other properties of the extended T-chart will be discussed during the presentation.