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Complex Analysis of the Lossy-Transmission Line Theory: A Generalized Smith Chart

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**Abstract:** It has been very usual in the specialized literature to skip the detailed study of the lossy transmission line theory by reducing it to the low-loss approximation. Although this is valid in the most common practical cases, the study of the general lossy case becomes very important due to the fact that it makes possible a better and deeper understanding of the physical effects associated to general losses, as well as the low-loss frequency-dependent regime. Besides, the analysis of the general case provides important results that may be extended to the analysis of real waveguiding systems, facilitating the understanding and description of their physical behavior. The present paper deals with the analysis of the most important parameters involved in the general lossy transmission line theory by introducing a general methodology based on their complex analysis. This methodology let us to understand and predict the physical behavior of a lossy transmission line problem by means of very intuitive graphical representations. As a particular result, the concept of a generalized Smith chart will appear. As a consequence, this general analysis covers the usual lossless and low-loss cases, providing a clear methodology that may be properly used for both educational and professional purposes. This methodology has been also implemented into a suitable software tool which serves as a perfect complement to visualize and understand the underlying analysis, thus improving the educational possibilities of this kind of generalized analyses.

**Key Words:** Complex analysis, losses, low-loss approximation, transmission lines, generalized Smith chart

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