

Transient Signals on Transmission Lines

*An Introduction to Non-Ideal Effects and
Signal Integrity Issues in Electrical Systems*

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Transient Signals on Transmission Lines: An Introduction to Non-Ideal Effects and Signal Integrity Issues in Electrical Systems

Andrew F. Peterson and Gregory D. Durgin

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ABSTRACT

This lecture provides an introduction to transmission line effects in the time domain. Fundamentals including time of flight, impedance discontinuities, proper termination schemes, nonlinear and reactive loads, and crosstalk are considered. Required prerequisite knowledge is limited to conventional circuit theory. The material is intended to supplement standard textbooks for use with undergraduate students in electrical engineering or computer engineering. The contents should also be of value to practicing engineers with interests in signal integrity and high-speed digital design.

KEYWORDS

crosstalk, digital design, impedance matching, reflection, signal integrity, telegrapher's equations

Preface

The material that follows consists of lectures on the topic of transient signals on transmission lines. Emphasis has been placed on aspects of the subject that have application to signal integrity and high-speed digital circuit design issues, including proper termination schemes to avoid impedance discontinuities, reactive and nonlinear loads, and an introduction to crosstalk. This material has formed the first part of the core undergraduate electromagnetic fields course at the Georgia Institute of Technology since 1999. Since transmission line transients have been de-emphasized in most current textbooks, including those that have been used at Georgia Tech during this time, this material was prepared to supplement traditional texts. With the exception of the material on crosstalk, the authors typically cover each chapter that follows in one 50-minute class period.

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Over the years, the authors have assimilated ideas and perspectives from many of our teachers and colleagues. During the years that this material was being used at Georgia Tech, homework problems and other suggestions originating from others who taught ECE 3025 have been incorporated. We would especially like to acknowledge the contributions, direct and indirect, of I. M. Besieris, P. W. Klock, P. E. Mast, N. N. Rao, W. T. Rhodes, P. G. Steffes, and M. Swaminathan. The first author also acknowledges the influence of S. Rosenstark's 1994 book *Transmission Lines in Computer Engineering*, from which the crosstalk development in Chapter 10 is adapted.

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