Introduction

This work is intended in its broadest sense, for designers of integrated circuits, high frequency hybrid technology or even microwaves. Circuit design is carried out from elaborate models in research and development, models which try to include a maximum number of functional elements or interference affecting the circuit. When frequency increases, models become more complicated as it is no longer possible to ignore propagation effects in circuits, which implies that a model using Maxwell equations must be used in most cases.

Naturally, it is unthinkable for designers to analyze or synthesize circuits by manipulating these equations directly. It is thus important to develop equivalent electrical circuits that take into account all these effects where possible.

As shown, modeling is essential. Supplied models must be reliable within a given validity range. Their preparation stems from numerical analysis including, if necessary, electromagnetic phenomena. Then it is imperative they are validated by measurements either in the frequency or time domain.

Six authors, each an expert in the field addressed within this book, describe all these analysis aspects: modeling, characterization and measurement.

Chapter 1 is dedicated to the most widely used numerical analysis methods in the field: the method of moments, finite element method and finite difference method. The first two operate in the frequency domain while the third works in the time domain.

A fourth method, the TLM (transmission line matrix) method, which also works in the time domain, is described in detail in the Chapter 2 and is applied to coplanar filters.

Chapter 3 deals with multi-scale circuits. It is difficult to use traditional methods when we must analyze circuits whose dimensions are on the one hand in microns or submicrons, but on the other hand in millimeters or even centimeters when they are implanted on a printed circuit. An original and effective solution using the method of auxiliary sources is described in this chapter. Its use in planar circuits is presented.

It is well known that when frequency becomes high, one of the major problems is the placement of chips into their package. Chapter 4 deals with this problem and clarifies the models of distributed and localized packages. Examples of modeling and the extraction of (resistance, inductance, capacitance, and conductance) parameters within the meaning of Maxwell or electric cells under Kirchoff are presented as well as experimental validation results. The comparison of the performance of some plastic packages brings this chapter to a close.

As mentioned above, the characterization of circuits and the experimental validation of models are both essential.

Chapter 5 deals in a very thorough manner with the characterization in the frequency domain at high frequency. The measurement of scattering parameters using a network analyzer is detailed by highlighting the different types of errors that we can encounter and their corrections. In particular, the characterization of passive elements is studied.

The final chapter addresses measurement in the time domain. Complementary to measurements in frequency domain, time domain reflectometry is a powerful tool for modeling impedance and for the localization and characterization of defects in integrated circuits by a simple observation of the response time at the input of the test circuit. On the other hand, measurement in the time domain is essential for the study of digital circuits and in particular, the study of crosstalk in interconnections. The determination of scattering parameters using a time domain method enables the results obtained in Chapter 5 in the time domain to be completed.

Thus, a large number of concepts essential to the study of circuits in the field of high frequency are described within this book and we hope that the overview presented will be of valuable assistance to designers.