Preface

RF (radio frequency) tunable devices, such as barium strontium titanate (BST) varactors, digitally tunable capacitors (DTC) consisting of SOI/SOS switches and metal-isolator-meta (MIM) fixed capacitors, and micro-electro-mechanical system (MEMS) tunable capacitors, will play a central role in tunable RF front-ends of mobile phones and wireless transceivers since the frequency bands for cellular mobile communications have increased to more than 40 bands. These RF tunable devices and the corresponding subsystems, such as tunable matching networks, and tunable filters are relatively new in the applications of mobile phone RF front-ends. To properly use these new tunable devices and subsystems, they must be well characterized and accurately modeled. Most of modern simulation software tools are potentially able to do these tasks, but right methods are still needed to properly execute them. This book discusses the methods of characterizing, modeling, analyzing, and applying RF tunable devices and subsystems. It should be emphasized that this book elaborates on the necessary methods of utilizing these tunable devices and subsystems instead of discussing the RF tunable devices themselves.

Modern simulation software tools are usually very powerful, but they still have certain limitation. The resulting errors of using certain software tools for the MEMS tunable capacitor design and/or simulations, for an example, may go up to 15–20 % sometimes. In addition, it will be very hard to directly and accurately model complicated tunable capacitor arrays by using any software tool. This book introduces accurate approaches for characterizing and modeling RF tunable devices and subsystems and thus accurate characteristics and models of these devices and subsystems can be achieved.

In recent years, people seem to only rely on utilizing software simulation tools and having forgotten how to use analytic analysis methods in their research studies and design tasks since there are many powerful software simulation tools available. However, it is hard to judge the accuracy of the results obtained from simulations if having no pre-knowledge since tool users may not really understand the physical meaning of the simulation process. On the other hand, a simulation procedure, such as optimization, is generally quite time-consuming, and the result cannot be employed in real-time systems. Many of the methods in this book are analytic analysis based. The analytic analysis on a device or a system can only be done when we have a clear physical picture of the device or the system. The analytic methods usually result in closed-form formulas/solutions, and the resulting calculations can be definitely carried out correctly. In addition, a calculation or simulation based on a closed-form formulation is fast enough to be adopted in real-time systems, such as matching network adaptive controls and filter frequency automatic tuning loops. Another advantage is that the calculation of closed-form formulas/solutions resulting from analytic methods may only need to use popular Excel spread sheet instead of expensive and sophistic software tools.

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