Preface

Extremely and super high radio frequencies (RF) correspond to the ranges of 3–30 and 30–300 GHz, respectively. In these frequency ranges, applications like point-to-point communications and radars have emerged in recent years. RF microelectromechanical systems (RF MEMS) is one available technology to implement circuits in such high frequencies, and is nowadays an interesting research topic. Other more conventional technologies include bipolar junction transistors (BJT), in particular, the heterojunction bipolar transistors (HBT).

Regardless of the used technology, passive components are always necessary for the functionality of the implemented circuit. This book handles the design, modeling, and optimization of these components. Active components like MEMS switches are not investigated. The elements handled involve inductors, coplanar lines, and MIM-capacitors.

In order to study the issue as closely as possible to practice, the components were studied using a definite fabrication technology. The so-called ISiT technology, provided by the Fraunhofer Institute for Silicon Technology (Itzehoe, Germany) is investigated. In addition to the electromagnetic (EM) simulations, some structures were fabricated and measured using the ISiT fabrication process. The research project accomplished here was part of a larger one, mainly corresponding to the application of MEMS structures to frequencies between 24 and 77 GHz. It was called the RF Platform project.

In Chap. 1, the ISiT technology is explained briefly. It is also explained how introducing a polycrystalline silicon layer suppresses the substrate losses, which are usually caused by the inversion channels created under the oxide layer. It is shown how this means that *Agilent ADS* (Advanced Design System, an RF design environment including an EM simulation software called “Momentum”) is able to predict the losses of the passive elements, and therefore making loss models for the passive components based on the EM simulations possible.

In Chap. 2 several inductors are designed for operation at frequencies of 24 and 35 GHz. The importance of these two frequencies is due to the specific application in the investigated RF Platform project, which includes these operating frequencies.

The figure of merit for optimizing these inductors was the quality factor. In the design process, it is assumed that the influence of the under-oxide inversion channels is eradicated. Therefore, the substrate was considered as lossless in the EM simulations.

In Chap. 3 a new coplanar line model for the ISiT technology is developed. As this technology has a passivation oxide layer on the substrate, the common coplanar line model available in the literature is no longer applicable. It is shown that the model is able to predict all the necessary parameters of coplanar lines (loss coefficient, characteristic impedance, and effective dielectric constant) on ISiT substrate.

In Chap. 4 a new model for DC-block (MIM-capacitor) was developed. The model is based on basic electromagnetic theory and in part on the line model already presented in Chap. 3. It predicts the simulations (*Sonnet* EM simulations) very accurately.

In Chap. 5 the development of a design-kit for the *Agilent ADS* software is explored. Several pictures are included to show the functionality and different parts of the design-kit. In addition to the DC-block, coplanar line, and the inductors the design-kit includes MEMS switches designed with ISiT. In this design-kit, all the components have an automatic layout generator associated with them and all, except the coplanar lines, can be used for S-parameter simulation. The codes generating the design-kit are presented in the Appendix.

I would like to thank very warmly Prof. Dr.-Ing. Hermann Schumacher and Dr.-Ing. Tatyana Purtova for their great help in accomplishing the current research. Dr. Purtova was always full of innovative ideas and has donated a lot to this work. I also want to thank a lot Mr. Till Feger, especially for his great help in the design-kit development. Finally, I thank my sister Nasim Pour Aryan for motivating me to write this book.

Ulm, July 2014 Naser Pour Aryan

http://www.springer.com/978-3-319-10186-6

Design and Modeling of Inductors, Capacitors and
Coplanar Waveguides at Tens of GHz Frequencies
Pour Aryan, N.
2015, XI, 81 p. 70 illus., 38 illus. in color., Softcover
ISBN: 978-3-319-10186-6