Preface

One of the creative device innovations in recent decades is the mobile phone, which provides users with a simple anytime and anywhere communication tool. Originally designed for interpersonal communication, today mobile phones are capable of connecting their users to a wide variety of Internet-enabled services and applications, which can vary from a simplified web browser to a GPS-enabled navigation system.

So far, current research has focused mostly on applications designed for 2G, 3G and 4G (i.e., for the communications sector).

Now, with emerging new wireless devices, understanding the development techniques of the integrated circuit devices has become very important. The future impact of these integrated circuit devices include green technologies, healthcare and safety/security technologies.

Monolithic Microwave Integrated Circuits (MMIC) are one of the integrated circuit devices which support the development of the mobile phone and corresponding infrastructure. They are also widely used in all high frequency wireless systems. In developing MMIC as a product, understanding the process, analysis techniques, design techniques, modeling, measurement methodology and awareness of current product invention are therefore essential.

Example of MMIC devices are low noise amplifier, mixer, power amplifier, oscillator and T/R switch. The integration of these devices into a single monolithic (transceiver) is a norm for radio frequency range (up to GHz).

The design of these MMIC devices depend on the process/device technology. State of the art silicon technology is normally employed for low frequency and therefore a transceiver design is doable. For higher frequency (multi GHz), compound technology is normally employed. In the future, there will be more integration of these devices using this technology.

Electronic Design Automation (EDA) is available for digital integrated circuit design, but for MMIC design, it only confines around computer aided design (CAD). Hopefully, in the future will be more work on EDA as a tool for MMICs.

Undoubtedly, three segments of knowledge are important in developing these MMICs devices. They are theory, design and practical approaches.

This book is a collective effort of many researchers and practitioners from industry and academia. It offers a variety of perspectives on MMIC and RFIC and provides several experience reports with experiments and surveys.

The book opens with the a section on theory, which consists of five chapters. Chapter 1, Multi-Standard Multi-Band Reconfigurable LNA by Mohd Tafir Mustaffa describes a new low noise amplifier (LNA) for a multi-standard mobile receiver based on reconfigurability concept. The LNA design is based on the inductively-degenerated common-source (IDCS) topology as it has been proven to be a good choice
in designing multi-standard multi-band LNA. The design is using 0.18 \textmu m CMOS technology. Chapter 2, LNA Inventions by Norlaili Mohd. Noh surveys five LNA topologies. They were studied, analyzed and compared in this chapter. The topologies are the Simultaneous Noise and Input Matching (SNIM), Power-Constrained Simultaneous Noise and Input Matching (PCSNIM), Current-Reuse (CR) and Folded-Cascode (FC) LNAs. The last topology is the PCSNIM with buffer. Chapter 3, Multiband Multi-Standard LNA with CPW Transmission Line Inductor by M. Ben Amor, M. Loulou, S. Quintanel and D. Pasquet, presents a wide band LNA design for IEEE802.16 standard with the CMOS 0.35 \textmu m technology. In this LNA, a CPW transmission line is used to design the inductive degeneration inductor of 0.38 nH. The circuit has a $S_{21}$ of 12 dB, a noise figure less than 3 dB and an input/output reflection coefficient less than -10 dB between 2 and 6GHz. Chapter 4, Design of Low Noise Amplifiers through Flow-Graphs and their Optimization by the Simulated Annealing Technique by M. Fakhfakh, M. Boughariou, A. Sallem, and M. Loulou presents the optimal design of Low Noise Amplifiers (LNAs). The basic idea consists of optimizing performances of LNAs by a direct action on the scattering parameters. A symbolic approach, namely the Coates Flow-Graph technique, is used to automatically generate symbolic expressions of the impedance parameters and, thus, those of the scattering parameters. The Simulated Annealing optimization technique is applied to determine the optimal sizing of the LNA. Chapter 5, Optimization of CMOS Quadrature VCO Using a Graphical Method by Hassene Mnif, Dorra Mellouli and Mourad Loulou describes the design and the optimization of Quadrature Voltage Controlled Oscillators (QVCOs) based on the coupling of two LC-tank VCO. This work covers the phase noise analysis, a graphical optimization approach, already used to optimize LC oscillator phase noise, to optimize QVCO phase noise while satisfying design constraints such as power dissipation, tank amplitude, tuning range and start up condition.

Designs are discussed in the second part of the book. Chapter 6, The Design and Modeling of 2.4 and 3.5 GHz MMIC PA by Chin Guek Ang discusses the design of MMIC power amplifiers for wireless application by using 0.15 \textmu m GaAs Power Pseudomorphic High Electron Mobility Transistor (PHEMT) technology with a gate width of 100 \textmu m and 10 fingers at 2.4 GHz and 3.5 GHz. The design methodology for power amplifier design can be broken down into three main sections: architecture design, small-signal design, and large-signal optimization.

Chapter 7, The Design and Modeling of 2.4 GHz and 3.5 GHz MMIC LNA, by Ching Wen Yip describes the LNA that was designed using cascode topology with feedback techniques which produces better matching and unconditionally stable over the entire desired frequencies. Chapter 8, Design of Medium Power Amplifier Using GaAs PHEMT Technology for Wireless Applications by Amiza Rasmi presents the design of single-stage and two-stage medium power amplifiers (MPAs) using GaAs PHEMT technology for the wireless applications. The single-stage MPA was designed using 0.15 \textmu m GaAs PHEMT technology to be operated at 3.5 GHz whereas the two-stage MPA was designed using 0.5 \textmu m GaAs PHEMT technology to be operated at 5.8 GHz. The MPAs employ a simple RC feedback in order to linearize the stages as well as to improve the circuit stability and to control the gain. Chapter 9, The Design and Modeling of 30 GHz Microwave Front-End by Wan Yeen Ng and Xhiang Rhung Ng discusses a millimeter wave integrated circuit (MMWIC) in frequency of 30 GHz especially switch (SPDT), medium power amplifier (MPA) and low noise amplifier (LNA). The switch is developed using a commercial 0.15 \textmu m GaAs pHEMT technology. It achieves low loss and high isolation for millimeter wave applications. The circuit and layout drawing of SPDT switch are done by using Advanced Design System (ADS) software.
Practical approaches are discussed in the last section of the book, which consists of two chapters. Chapter 10, Inventions of Monolithic Microwave Integrated Circuits by Arjuna Marzuki introduces the inventions of Voltage Controlled Oscillator (VCO), Mixer, Low Noise Amplifiers (LNA), Power Amplifiers (PA) and Transmit-Receive Switch (T/R). A first time right IC concept is also discussed in the chapter. Last chapter, RF and Microwave Test of MMICs: from Qualification to Mass Production by Mohamed MABROUK describes some basic characteristic responses that must be known for each Monolithic Microwave Integrated Circuits. The main parameters such Return Loss, Insertion Losses or Gain, Power at 1dB compression, InterModulation Products or Noise Figure are very important and have to be measured before using the device in final applications.

With an in-depth coverage of a variety of advances in Monolithic Microwave Integrated Circuits for Wireless Systems, this book aims to provide a central source of reference on MMIC development which covers knowledge in analysis, design, modeling, measurement and inventions. Today, there is a growing trend of multistandard and multiband, which will lead to an increased interest in publications covering different aspects of circuit techniques and methodology to make multimode SOC.

This book will be of interest to researchers in industry and academia working in the areas of circuit design, integrated circuit, and RF and microwave, to graduate and undergraduate students, and anyone with an interest in monolithic wireless devices development.

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