

# The Design of CMOS Radio-Frequency Integrated Circuits



Thomas H. Lee

# Design Of Cmos Radio Frequency Integrated Circuits

**Kathleen Armour**



## **Design Of Cmos Radio Frequency Integrated Circuits:**

*The Design of CMOS Radio-Frequency Integrated Circuits* Thomas H. Lee, 2003-12-22 This book first published in 2004 is an expanded and thoroughly revised edition of Tom Lee's acclaimed guide to the design of gigahertz RF integrated circuits. A new chapter on the principles of wireless systems provides a bridge between system and circuit issues. The chapters on low noise amplifiers, oscillators, and phase noise have been significantly expanded. The chapter on architectures now contains several examples of complete chip designs including a GPS receiver and a wireless LAN transceiver that bring together the theoretical and practical elements involved in producing a prototype chip. Every section has been revised and updated with findings in the field, and the book is packed with physical insights and design tips and includes a historical overview that sets the whole field in context. With hundreds of circuit diagrams and homework problems, this is an ideal textbook for students taking courses on RF design and a valuable reference for practising engineers.

**The Design of CMOS Radio-Frequency Integrated Circuits International Student Edition** Professor Thomas H. Lee, 2004-07-15 An expanded and revised new edition of Tom Lee's acclaimed guide to the design of gigahertz RF integrated circuits.

*The Design Of Cmos Radio Frequency Integrated Circuits* LEE, Thomas H. Lee, 2006-08-30 Presenting an expanded and thoroughly revised new edition of Tom Lee's acclaimed guide to the design of gigahertz RF integrated circuits. A new chapter on the principles of wireless systems provides a bridge between system and circuit issues. The chapters on low noise amplifiers, oscillators, and phase noise have been significantly expanded. The chapter on architectures now contains several examples of complete chip designs including a GPS receiver and a wireless LAN transceiver that bring together the theoretical and practical elements involved in producing a prototype chip. Every section has been revised and updated with the latest findings in the field, and the book is packed with physical insights and design tips and includes a historical overview that sets the whole field in context. With hundreds of circuit diagrams and homework problems, this is an ideal textbook for students taking courses on RF design and a valuable reference for practising engineers.

**Radio Frequency Integrated Circuit Design** John W. M. Rogers, Calvin Plett, 2010 This newly revised and expanded edition of the 2003 Artech House classic *Radio Frequency Integrated Circuit Design* serves as an up-to-date practical reference for complete RFIC know-how. The second edition includes numerous updates including greater coverage of CMOS PA design, RFIC design with on-chip components, and more worked examples with simulation results. By emphasizing working designs, this book practically transports you into the authors' own RFIC lab so you can fully understand the function of each design detailed in this book. Among the RFIC designs examined are RF integrated LC-based filters, VCO automatic amplitude control loops, and fully integrated transformer-based circuits, as well as image reject mixers and power amplifiers. If you are new to RFIC design, you can benefit from the introduction to basic theory so you can quickly come up to speed on how RFICs perform and work together in a communications device. A thorough examination of RFIC technology guides you in knowing when RFICs are the right choice for designing a communication

device This leading edge resource is packed with over 1 000 equations and more than 435 illustrations that support key topics

*The Design of CMOS Radio-Frequency Integrated Circuits* Thomas H. Lee, 2004 This book first published in 2004 is an expanded and revised edition of Tom Lee's acclaimed RFIC text

*Design Of Cmos Rf Integrated Circuits And Systems* Kiat Seng Yeo, Manh Anh Do, Chirn Chye Boon, 2010-03-24 This book provides the most comprehensive and in depth coverage of the latest circuit design developments in RF CMOS technology It is a practical and cutting edge guide packed with proven circuit techniques and innovative design methodologies for solving challenging problems associated with RF integrated circuits and systems This invaluable resource features a collection of the finest design practices that may soon drive the system on chip revolution Using this book's state of the art design techniques one can apply existing technologies in novel ways and to create new circuit designs for the future

**The Design of CMOS Radio-Frequency Integrated Circuits, Second Edition** Thomas Lee, 2003 Presenting an expanded and thoroughly revised edition of Tom Lee's acclaimed guide to the design of gigahertz RF integrated circuits A new chapter on the principles of wireless systems provides a bridge between system and circuit issues The chapters on low noise amplifiers oscillators and phase noise have been significantly expanded The chapter on architectures now contains several examples of complete chip designs including a GPS receiver and a wireless LAN transceiver that bring together the theoretical and practical elements involved in producing a prototype chip Every section has been revised and updated with findings in the field and the book is packed with physical insights and design tips and includes a historical overview that sets the whole field in context With hundreds of circuit diagrams and homework problems this is an ideal textbook for students taking courses on RF design and a valuable reference for practising engineers

*Radio Frequency Integrated Circuits and Technologies* Frank Ellinger, 2008-09-11 In the last decade wireless communications engineering has seen outstanding progress making merged enhanced and novel applications in the area of mobile phones wireless networks sensors and television feasible Technologies have developed from hybrid systems to highly integrated solutions in silicon SiGe GaAs and InP By aggressive scaling of device dimensions below 0.1  $\mu\text{m}$  and employing advanced technologies such as SOI strained silicon and low  $k$  circuits with operation frequencies and bandwidths up to approximately 100 GHz can now be fabricated However especially in silicon the restrictions inherent in scaling make circuit engineering a demanding task Examples of these drawbacks are the limited high frequency signal power leakage effects and significant parasitics in passive devices Enhanced circuit topologies and design techniques have to be applied to achieve maximum performance In this context designers must have profound skills in the following areas circuit theory IC technologies communications standards system design measurement techniques etc The aim of this book is to address all these multidisciplinary issues in a compact and comprehensive form and in a single volume Suitable for students engineers and scientists the manuscript provides the necessary theoretical background together with cookbook like optimisation strategies and state of the art design examples Each chapter is accompanied by tutorial questions repeating the key issues of

the treated subjects The manuscript is organised as follows Chapter 1 preludes with an introduction concerned with the exciting history of integrated circuits technologies and wireless communications *Radio-Frequency Integrated-Circuit Engineering* Cam Nguyen,2015-03-04 Radio Frequency Integrated Circuit Engineering addresses the theory analysis and design of passive and active RFIC s using Si based CMOS and Bi CMOS technologies and other non silicon based technologies The materials covered are self contained and presented in such detail that allows readers with only undergraduate electrical engineering knowledge in EM RF and circuits to understand and design RFICs Organized into sixteen chapters blending analog and microwave engineering Radio Frequency Integrated Circuit Engineering emphasizes the microwave engineering approach for RFICs Provides essential knowledge in EM and microwave engineering passive and active RFICs RFIC analysis and design techniques and RF systems vital for RFIC students and engineers Blends analog and microwave engineering approaches for RFIC design at high frequencies Includes problems at the end of each chapter

*High-Linearity CMOS RF Front-End Circuits* Yongwang Ding,Ramesh Harjani,2006-02-08 This book focuses on high performance radio frequency integrated circuits RF IC design in CMOS 1 Development of radio frequency ICs Wireless communications has been advancing rapidly in the past two decades Many high performance systems have been developed such as cellular systems AMPS GSM TDMA CDMA W CDMA etc GPS system global positioning system and WLAN wireless local area network systems The rapid growth of VLSI technology in both digital circuits and analog circuits provides benefits for wireless communication systems Twenty years ago not many people could imagine millions of transistors in a single chip or a complete radio for size of a penny Now not only complete radios have been put in a single chip but also more and more functions have been realized by a single chip and at a much lower price A radio transmits and receives electro magnetic signals through the air The signals are usually transmitted on high frequency carriers For example a typical voice signal requires only 30 Kilohertz bandwidth When it is transmitted by a FM radio station it is often carried by a frequency in the range of tens of megahertz to hundreds of megahertz Usually a radio is categorized by its carrier frequency such as 900 MHz radio or 5 GHz radio In general the higher the carrier frequency the better the directivity but the more difficult the radio design

**Radio Frequency Integrated Circuit Design** John W. M. Rogers,Calvin Plett,2003 Focuses mainly on bipolar technology to demonstrate circuits but CMOS is included as well

**Design Of High-speed Communication Circuits** Ramesh Harjani,2006-01-17 MOS technology has rapidly become the de facto standard for mixed signal integrated circuit design due to the high levels of integration possible as device geometries shrink to nanometer scales The reduction in feature size means that the number of transistor and clock speeds have increased significantly In fact current day microprocessors contain hundreds of millions of transistors operating at multiple gigahertz Furthermore this reduction in feature size also has a significant impact on mixed signal circuits Due to the higher levels of integration the majority of ASICs possesses some analog components It has now become nearly mandatory to integrate both analog and digital circuits on the same substrate

due to cost and power constraints This book presents some of the newer problems and opportunities offered by the small device geometries and the high levels of integration that is now possible The aim of this book is to summarize some of the most critical aspects of high speed analog RF communications circuits Attention is focused on the impact of scaling substrate noise data converters RF and wireless communication circuits and wireline communication circuits including high speed I O

*High-Frequency Integrated Circuits* Sorin Voinigescu, 2013-02-28 A transistor level design intensive overview of high speed and high frequency monolithic integrated circuits for wireless and broadband systems from 2 GHz to 200 GHz this comprehensive text covers high speed RF mm wave and optical fibre circuits using nanoscale CMOS SiGe BiCMOS and III V technologies Step by step design methodologies end of chapter problems and practical simulation and design projects are provided making this an ideal resource for senior undergraduate and graduate courses in circuit design With an emphasis on device circuit topology interaction and optimization it gives circuit designers and students alike an in depth understanding of device structures and process limitations affecting circuit performance

**Schaltungstechnik - Analog und gemischt analog/digital** Johann Siegl, Edgar Zocher, 2014-10-16 Dieses bew hrte Lehrbuch vermittelt das erfolgreiche Entwickeln von Schaltungen Es bietet eine gr ndliche und systematische Einf hrung in die Entwicklungs und Analysemethodik analoger und gemischt analog digitaler Schaltungen Wesentlich ist die funktionsorientierte Vorgehensweise bei der Schaltungsentwicklung und Aufteilung von komplexeren Schaltungen in bekannte Funktionsprimitive Unterst tzt wird die Systematik durch eine Einf hrung in die Absch tzanalyse und in rechnergest tzte Entwurfsverfahren zur Designbeschreibung und zur Designverifikation mit Orcad Lite PSpice sowie durch eine Einf hrung in die Hardwarebeschreibungssprache VHDL AMS Mit SystemVision lassen sich die Beispiele leicht nachvollziehen Neu in der 5 Auflage ist ein Kapitel zur Schaltungsintegration in dem in die Vorgehensweise in die physikalischen Grundlagen und in die Besonderheiten des Entwurfs integrierter Schaltungen Full Custom IC Design eingef hrt wird Zahlreiche Beispiele zeigen die Praxis des IC Designs mit Hilfe des Entwurfstools MICROWIND Der Leser lernt das Schaltungsverhalten anhand von praktischen Aufgabenstellungen durch eigenes Absch tzen zu ermitteln und durch Simulation zu kontrollieren Er kann dies in zahlreichen Beispielen und ca 70 bungsaufgaben mit ausf hrlichen L sungen nachvollziehen Die wichtigsten Funktionsprimitive und Funktionsschaltungen lassen sich in den ber 300 vorbereiteten Experimenten verifizieren ber 300 Experimente stehen auf der Springer homepage unter <http://extras.springer.com> 2013 978 3 642 29559 1 zur Verf gung

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durch Simulation mit Orcad Lite PSpice zu kontrollieren Die wichtigsten Funktionsprimitive und Funktionsschaltungen lassen sich in den 250 vorbereiteten Experimenten verifizieren Diese stehen neben VHDL AMS Beispielen auf der Springer Homepage zur Verfügung Neu ist ein Kapitel zur Schaltungsintegration in dem in die Vorgehensweise in die physikalischen Grundlagen und in die Besonderheiten des Entwurfs integrierter Schaltungen Full Custom IC Design eingeführt wird Zahlreiche Beispiele zeigen die Praxis des IC Designs mit Hilfe des Entwurfstools MICROWIND Die Zielgruppen Das Buch wendet sich an Studierende der Elektrotechnik Elektronik Informationstechnik und verwandter Fachgebiete

Microwave and RF Engineering Roberto Sorrentino, Giovanni Bianchi, 2010-07-26 An essential text for both students and professionals combining detailed theory with clear practical guidance This outstanding book explores a large spectrum of topics within microwave and radio frequency RF engineering encompassing electromagnetic theory microwave circuits and components It provides thorough descriptions of the most common microwave test instruments and advises on semiconductor device modelling With examples taken from the authors own experience this book also covers network and signal theory electronic technology with guided electromagnetic propagation microwave circuits such as linear and non linear circuits resonant circuits and cavities monolithic microwave circuits MMICs wireless architectures and integrated circuits passive microwave components control components microwave filters and matching networks Simulation files are included in a CD Rom found inside the book Microwave and RF Engineering presents up to date research and applications at different levels of difficulty creating a useful tool for a first approach to the subject as well as for subsequent in depth study It is therefore indispensable reading for advanced professionals and designers who operate at high frequencies as well as senior students who are first approaching the subject Radio Frequency Integrated Circuits and Systems Hooman Darabi, 2020-03-12 Equips students with essential industry relevant knowledge through in depth explanations practical applications examples and exercises *Adaptive Multi-Standard RF Front-Ends* Vojkan Vidojkovic, J. van der Tang, Arjan Leeuwenburgh, Arthur H.M. van Roermund, 2008-02-07 In this information era people are living in a society in which processing and exchange of information are vital for their existence Two major issues in such society which are related to processing and exchange of information are connectivity and mobility On one hand computers and Internet provide connectivity and allow communication as well as fast access to large amounts of information On the other hand wireless technologies bring mobility People can move and still be able to communicate and have access to various kind of information Therefore the functioning of an information society is unthinkable without the use of computers Internet and wireless technologies The expectations are that in the future they will merge into a unique system for communication access to information as well as their exchange and processing The era of wireless communications started in 1901 when Guglielmo Marconi successfully transmitted radio signals across the Atlantic Ocean From that moment up to now wireless communications experienced explosive growth and became the fastest growing field in the engineering world Pushed by customer requirements new

wireless technologies have been emerging very fast Each new generation of wireless technologies have brought new features and more complexity Pushed by market forces to reduce costs the semiconductor industry has provided new technologies for solid state circuits implementation Fortunately at the same time with the cost reduction performance of new technologies has been improving

**Hochfrequenztechnik** Holger Heuermann, 2018-08-07 Dieses Lehr und Fachbuch vermittelt anschaulich die Grundlagen der HF Technik und gibt konkrete Beschreibungen für den Entwurf von Leitungen und linearer Komponenten in High Speed und HF Schaltungen Dem Leser wird vermittelt wie diese Schaltungen synthetisiert optimiert und modelliert werden Mit Hilfe frei verfügbarer Simulationssoftware können GHz Schaltungen selbst entwickelt werden Viele Beispiele ermöglichen die Eigenkontrolle des Wissensstandes Neben einer detaillierten Darstellung der wichtigsten HF Grundlagen werden komplexe Komponenten wie Hochfrequenzmischer Oszillatoren und Synthesegeneratoren in ihrer Funktionalität dargestellt Die neue Mixed Mode Streuparameter sowie deren Leitungs und Schaltungstechnik für Anwendungen der schnellen Digital und der modernen HF Technik sind ausführlich beschrieben Es wird auf HF Messsystemen und auf Funksysteme einschließlich des echtzeitfähigen Dual Mode Funks eingegangen Dem Leser wird somit ermöglicht GHz Schaltungen insbesondere mit Halbleiter SMD und LTCC Schaltungen zu entwickeln

**On-Chip Electro-Static Discharge (ESD) Protection for Radio-Frequency Integrated Circuits** Qiang Cui, Jun J. Liou, Jean-Jacques Hajjar, Javier Salcedo, Yuanzhong Zhou, Parthasarathy Srivatsan, 2015-03-10 This book enables readers to design effective ESD protection solutions for all mainstream RF fabrication processes GaAs pHEMT SiGe HBT CMOS The new techniques introduced by the authors have much higher protection levels and much lower parasitic effects than those of existing ESD protection devices The authors describe in detail the ESD phenomenon as well as ESD protection fundamentals standards test equipment and basic design strategies Readers will benefit from realistic case studies of ESD protection for RFICs and will learn to increase significantly modern RFICs ESD safety level while maximizing RF performance



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