Fei Yuan

# CMOS Active Inductors and Transformers

Principle, Implementation, and Applications



Egidio Ragonese, Angelo Scuderi, Tonio Biondi, Giuseppe Palmisano

CMOS Active Inductors and Transformers Fei Yuan, 2008-06-17 Many new topologies and circuit design techniques have emerged recently to improve the performance of active inductors but a comprehensive treatment of the theory topology characteristics and design constraint of CMOS active inductors and transformers and a detailed examination of their emerging applications in high speed analog signal processing and data communications over wire and wireless channels is not available This book is an attempt to provide an in depth examination and a systematic presentation of the operation principles and implementation details of CMOS active inductors and transformers and a detailed examination of their emerging applications in high speed analog signal processing and data communications over wire and wireless channels The content of the book is drawn from recently published research papers and are not available in a single cohesive book Equal emphasis is given to the theory of CMOS active inductors and transformers and their emerging applications Major subjects to be covered in the book include inductive characteristics in high speed analog signal processing and data communications spiral inductors and transformers modeling and limitations a historical perspective of device synthesis the topology characterization and implementation of CMOS active inductors and transformers and the application of CMOS active inductors and transformers in high speed analog and digital signal processing and data communications Simulation and Applications of Inductors and Transformers for Si RF ICs Ali M. Niknejad, Robert G. Meyer, 2000-10-31 Wireless RF and microwave ICs depend critically on passive devices such as inductors capacitors and transformers Passive devices allow the optimization of key RF circuit building blocks by minimizing noise maximizing gain and frequency of operation and minimizing power The integration of passive devices on the Si IC substrate requires a critical understanding of substrate coupling and loss including electrically induced conductive and displacement current flowing in the substrate as well as magnetically induced eddy currents Design Simulation and Applications of Inductors and Transformers for Si RF ICs provides a deep understanding of the physics involved in the operation of these devices at microwave frequencies Additionally the book tackles two critical blocks that depend critically on the passive devices the voltage controlled oscillator and a distributed amplifier Design Simulation and Applications of Inductors and Transformers for Si RF ICs will be of interest to RF and microwave integrated circuit engineers computer aided designers device physicists and electromagnetic researchers as well as power electronics engineers Integrated Inductors and Transformers Egidio Ragonese, Angelo Scuderi, Tonio Biondi, Giuseppe Palmisano, 2010-11-15 With the ability to improve performance reduce fabrication costs and increase integration levels of both RX and TX sections of the RF mm wave front end passive inductive components have experienced extraordinary growth in ICs Therefore a fundamental understanding of monolithic inductors and transformers has become essential for all process eng Improved Control System for Process, Voltage, and Temperature Compensation of CMOS Active Inductors Reinhold Frederick William Hollender (III.), 2011 Wireless communications play an increasingly

large role in today s society Today many wireless functions are necessarily integrated into chips and other small packages to support miniaturized wireless devices such as cell phones laptops netbooks etc These Radio Frequency Integrated Circuits RFICs often require inductances to perform their function Most RFICs utilize spiral inductors Spiral inductors have their properties defined by their physical dimensions often taking up large areas of IC real estate There has been research into replacing these spiral inductors with active elements to reduce their size However these active inductors are based on parasitic elements that can vary significantly over temperature supply voltage and processing variations of the wafers themselves This professional paper documents an improved control scheme to maintain correct active inductor behavior over process voltage and temperature variations in applications where the active inductor is used in a Wilkinson power divider

The Study of CMOS Based VCO with Active Inductor and Its Design Methodology Sy-Min Chueng, 2012 Active Inductors are useful in reducing the large chip area typically consumed by spiral inductors as well as providing larger inductance values and higher quality factors that otherwise cannot be achieved by spiral inductors Integrated inductors find application in many radio frequency RF front end integrated circuits including impedance matching filtering biasing and in oscillator circuits Nonetheless because of the interdependent relationship of the self resonant frequency and quality factor it is often difficult to meet desired circuit requirements Additionally active devices pose problems of higher power consumption noise figure and potential instability This thesis begins with the study of active inductors the Wu active inductor in particular and considers tuning methods based on the Wu active inductor topology Starting with the small signal model the emulated inductance and quality factor expressions are derived Next the operation of active inductors under large signal is closely examined Comparisons between a passive and an active VCO are made The active inductor based voltage controlled oscillator Active VCO is studied extensively and the methods of improving the performance under large signal behavior are discussed Then a design procedure based on gm ID methodology is proposed A Matlab script that can be applied to gyrator C based active inductors is developed to determine the sizing of the transistors for a desired inductance and resonant frequency Cadence Virtuoso is used for simulations and extraction based on an IBM 8RF technology file Finally a low power active VCO is designed simulated and laid out **Transformers and Inductors for Power Electronics** W.G. Hurley, W.H. Wölfle, 2013-02-21 Based on the fundamentals of electromagnetics this clear and concise text explains basic and applied principles of transformer and inductor design for power electronic applications It details both the theory and practice of inductors and transformers employed to filter currents store electromagnetic energy provide physical isolation between circuits and perform stepping up and down of DC and AC voltages The authors present a broad range of applications from modern power conversion systems They provide rigorous design guidelines based on a robust methodology for inductor and transformer design They offer real design examples informed by proven and working field examples Key features include emphasis on high frequency design including optimisation of the winding layout and treatment of non sinusoidal waveforms a

chapter on planar magnetic with analytical models and descriptions of the processing technologies analysis of the role of variable inductors and their applications for power factor correction and solar power unique coverage on the measurements of inductance and transformer capacitance as well as tests for core losses at high frequency worked examples in MATLAB end of chapter problems and an accompanying website containing solutions a full set of instructors presentations and copies of all the figures Covering the basics of the magnetic components of power electronic converters this book is a comprehensive reference for students and professional engineers dealing with specialised inductor and transformer design It is especially useful for senior undergraduate and graduate students in electrical engineering and electrical energy systems and engineers working with power supplies and energy conversion systems who want to update their knowledge on a field that has progressed considerably in recent years **Design of CMOS Active Inductors and Their Use in Tuned** Narrowband and Wideband-extension Low Noise Amplifier Dhuri Rohan Suresh, 2014 The evolution of CMOS technology has allowed the integration of communication systems on a single chip A Low Noise Amplifier LNA is the first block in an integrated receiver and its design is critical for the system performance On chip spiral inductors are key components in LNA's running at GHz frequency range They are the performance limiting components of LNA's and have the added problems of rigidity and also do not scale well with CMOS i e consume a large amount of area which increases the chip cost Their quality factor Q is limited by the resistive losses in the spiral coil and by substrate losses This project deals with replacing the areaconsuming lossy spiral inductors by gyrator based CMOS active inductors. The project starts with the simulation of some reference spiral inductors to find their main characteristics inductance value quality factor at different frequencies and selfresonant frequency Next several CMOS active inductors are designed with the target to achieve similar or improved performance compared to the reference ones Several topologies are tested and the designed is optimized after predictions of simple models Finally both active and passive inductors are then used in two test amplifiers a tuned narrowband amplifiers and a wideband extension amplifier Their performance is compared in terms of input and output matching gain isolation noise figure and linearity Frequency tuning capability is tested in the active inductors which would provide an interesting flexibility in future communication receivers Linear CMOS RF Power Amplifiers Hector Solar Ruiz, Roc Berenguer Pérez, 2013-09-14 The work establishes the design flow for the optimization of linear CMOS power amplifiers from the first steps of the design to the final IC implementation and tests The authors also focuses on design guidelines of the inductor's geometrical characteristics for power applications and covers their measurement and characterization Additionally a model is proposed which would facilitate designs in terms of transistor sizing required inductor quality factors or minimum supply voltage The model considers limitations that CMOS processes can impose on implementation The book also provides different techniques and architectures that allow for optimization

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