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Editorial

CMOS RF Circuits for Wireless Applications

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Advanced concepts for wireless communications present a vision of technology that is embedded in our surroundings and practically invisible, but present whenever required. From established radio techniques like GSM, 802.11, or Bluetooth to more emerging like ultra-wideband (UWB) or smart dust moats, a common denominator for future progress is the underlying CMOS technology. Although the use of deep-submicron CMOS processes allows for an unprecedented degree of scaling in digital circuitry, it complicates implementation and the integration of traditional RF circuits. The explosive growth of standard cellular radios and radically different new wireless applications makes it imperative to find architectural and circuit solutions to these design problems.

This special EURASIP issue contains carefully selected 12 papers that represent state-of-the-art CMOS designs for wireless applications. The first group of three papers from University of California at Berkeley, Philips Research, and the University of Alberta discusses various system aspects in the context of CMOS implementation. Cabric et al. propose novel radio architectures that might be used at 60 GHz and for cognitive radios. Leenaerts presents one of the first CMOS circuit implementations of the ultra-wideband (UWB) technology. Howard et al. delineate conditions under which error control coding (ECC) is efficient from an energy point of view in wireless sensor networks (WSNs).

While it is true that heterogeneous circuits and architectures originally developed for their native technologies cannot be effectively integrated "as is" into highly scaled CMOS processes, one might ask the question whether those functions can be ported into more CMOS-friendly architectures to reap all the benefits of the digital design and flow. It is not predestined that RF wireless frequency synthesizers be always charge-pump-based PLLs with VCOs, RF transmit up-converters be I/Q modulators, receivers use only Gilbert cell or passive continuous-time mixers. Performance of modern CMOS transistors is nowadays good enough for multi-GHz RF applications.

The following four papers from Texas Instruments, Carleton University, and Silicon Labs describe the RF CMOS circuit design challenges. Ho et al. present a key component of RF direct processing—the RF sampling mixer. The circuit is used in Bluetooth and GSM applications. Koh et al. propose a novel sigma-delta ADC with embedded decimation and gain control. The remaining two papers in that group address challenges of phase-locked loop (PLL) design for RF applications. Rogers et al. provide a tutorial on phase noise modeling for fractional PLLs, while Maxim presents solutions for effective power supply filtering and their effects on PLL performance.

Low power has been always important for wireless communications. With new developments in wireless sensor networks and wireless systems for medical applications, the power dissipation is becoming the number one issue. Traditional wireless markets like cellular telephony or wireless LANs demand low power as well. This calls for innovative design methodologies at the circuit and component levels to address this rigorous requirement.

The third group of papers from the University of British Columbia (UBC), Carleton University, and the University of Calgary addresses some of the circuit problems at the component and technology levels. Chamseddine et al. propose a new structure for an RF switch implemented in a system-on-sapphire (SoS) technology. Danson et al. show how a MEMS technology can be used to improve RF performance, using an LNA and a power amplifier as examples. Sameni et al. introduce a new model for VCO modeling, while Chan et al. present a novel application for parameter conversion using a MOS varactor as a key device.

Effective CMOS RF design would not be possible without proper electronic design automation (EDA) tools. The last paper of the special issue by Zhu et al. from Lakehead University reviews some circuit simulation techniques used for RF simulations.

The special issue would not be possible without the dedicated efforts of many reviewers for which the editors are very grateful. We hope that the collected research papers can help in fulfilling a gap between the two communities of CMOS circuit designers and experts in wireless communication theories.

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Kris Iniewski is an Associate Professor at the Electrical Engineering and Computer Engineering Department, University of Alberta. He is also a President of CMOS Emerging Technologies, Inc., a consulting company in Vancouver. His research interests are in advanced CMOS devices and circuits for ultra-low-power wireless systems, medical imaging, and optical networks. From 1995 to 2003, he was with PMC-Sierra and held various technical and management positions in Research & Development and Strategic Marketing. Prior to joining PMC-Sierra, from 1990 to 1994, he was an Assistant Professor at the University of Toronto's Electrical Engineering and Computer Engineering Department. He has published over 80 research papers in international journals and conferences. He holds 18 international patents granted in USA, Canada, France, Germany, and Japan. He is a frequent invited speaker and consults for multiple organizations internationally. He received his Ph.D. degree in electronics (with honors) from the Warsaw University of Technology (Warsaw, Poland) in 1988. Together with Carl McCrosky and Dan Minoli he is an author of *Data Networks-VLSI and Optical Fibre* (Wiley, 2006). He is also an editor of *Emerging Wireless Technologies* (CRC Press, 2006).

Mourad El-Gamal is an Associate Professor of electrical engineering at McGill University, Montreal, Canada, where he holds the William Dawson Scholar Chair. He is also the President of InfiniteChips, Inc., a company that provides integrated circuit solutions for a variety of markets. In 2002 he was the Director then VP Engineering at MEMSCAP in France—a 165-employee public company. He oversaw the business and technical aspects in different sites around the world related to RF-MEMS devices, RFICs, and millimeter-wave passive circuits. He published over 60 technical papers, and one book chapter on low-voltage 5-GHz RFIC front ends. Dr. El-Gamal served as a Guest Editor for the IEEE Journal of Solid-State Circuits, and is currently an Associate Editor of the IEEE Transactions on Circuits and Systems. He is on the Executive Committee of the IEEE Bipolar/BiCMOS Circuits and Technology Meeting (BCTM), a Member of the Emerging Technologies Committee of the IEEE Custom Integrated Circuits Conference (CICC), and a Member of the Analog Signal Processing Committee of the IEEE Circuits and Systems (CAS) Society. Earlier, he worked for the French telecommunications company ALCATEL, and for IBM. He regularly serves as consultant for microelectronics companies. He holds one patent and has three patents pending.

Robert Bogdan Staszewski received the B.S.E.E. (summa cum laude), M.S.E.E., and Ph.D. degrees from the University of Texas at Dallas in 1991, 1992, and 2002, respectively. From 1991 to 1995, he was with Alcatel Network Systems in Richardson, Tex, working on Sonnet cross-connect systems for fiber optics communications. He joined Texas Instruments in Dallas, Tex, in 1995 where he is currently a Distinguished Member of Technical Staff. Between 1995 and 1999, he has been engaged in advanced CMOS read channel development for hard disk drives. In 1999 he costarted a Digital RF Processor (DRP^{TM}) Group within Texas Instruments with a mission to invent new digitally intensive approaches to traditional RF functions for integrated radios in deep-submicron CMOS processes. He currently leads the DRP system and design development for transmitters and frequency synthesizers. He has authored and coauthored 60 journal and conference publications and holds 25 issued and 35 pending US patents. His research interests include deep-submicron CMOS architectures and circuits for frequency synthesizers, transmitters, and receivers.