

WSA (RFIC) Sunday 08:00 – 17:00 BCEC Room 156AB

Advances in CMOS RF Power Amplifiers for Cellular and IEEE 802 Connectivity Radios

Full-day workshop reviewed by RFIC.

Organizer(s):

Malcolm Smith, Amalfi Semiconductor.

Upkar Dhaliwal, Future Wireless Technologies; MTT-20.

Stewart Taylor, Intel.

This workshop will present the latest design and developments in RF Module/RFIC power amplifiers, as well as covering the RF system requirements for Cellular and IEEE 802 connectivity power amplifiers. Until very recently CMOS power amplifiers were not mature enough to compete against other non-silicon technologies and could not be used widely in handheld cell-phones. With some new developments in device technologies, circuit solutions as well as system-level improvements, several companies have announced CMOS power amplifiers products with the ability to be used in mass-market handsets, PC cards, laptops and netbooks. Challenges remain in terms of output power, mismatch handling, thermal and DC performance for the power amplifier so that it may be integrated with the rest of the RF and in future with the baseband. This workshop will present and discuss the advantages, disadvantages and future of CMOS and silicon-based power amplifiers for Cellular (2G – GSM, EDGE, CDMA) (3G UMTS, HSDPA, DO1x) and IEEE 802 (WLAN/WiFi, WiMAX/WiBRO) connectivity power amplifiers.

Speakers:

1. Michael Bailey, Amalfi Semiconductor

“Utilizing Bulk CMOS Transistors for High Frequency Power Amplifiers”

Technology development has placed bulk CMOS squarely in direct competition with traditional InGaP HBTs and InGaAs / AlGaAs / GaAs pHEMTs. Overcoming fundamental device performance limitations requires careful design and an understanding of scalable device parameters. In this workshop session we review basic device figures of merit across the major device technologies and provide a application-oriented forecast for future process nodes.

2. Ali M. Niknejad, Berkeley Wireless Research Center (BWRC)

“Low Voltage Transformer Coupled CMOS PAs”

The Achilles' heel of CMOS is the low breakdown voltage, requiring very aggressive impedance transformation for high output power levels. While in traditional LC matching networks there is a strong trade-off in insertion loss and matching ratio, transformers are much more kind in this respect. Structures such as the distributed active transformer (DAT) and stacked transformers exploit this property to allow much higher output power levels from low-voltage CMOS transistors. This talk will highlight the design of several prototype CMOS PAs which in theory could be adapted to meet the strict linearity requirements of

WiFi and WiMax applications. Distortion generation and techniques to mitigate MOS I-V and C-V non-linearity will also be reviewed.

3. Rahul Magoon, Axiom Microdevices

“The Integration of Cellular CMOS PAs with RF, Mixed Signal, and Digital Circuits on a Single Die Radio: Challenges and Opportunities”

Axiom Microdevices’ award-winning CMOS PA integrates full quad-band GSM/GPRS functionality on a single integrated circuit, using mainstream 0.13um silicon CMOS technology. This patented technology enables integration of the PA output match on die along with the power control function, eliminating the need for complex and expensive multi-chip module technology based on specialty processes. With the implementation in Silicon of the last component of the phone, Axiom has opened up the path to integration of the entire radio function on die. This re-partitioning of the cellular system will result in significant future opportunities in cost reduction due to architecture simplification and hardware reuse as well as allow the implementation of reconfigurable radios that can adapt to their operating modes.

4. Susanne Paul, Black Sand Technologies

“Class P Architectures in Linear 3G CMOS Power Amplifiers”

Commercial power amplifiers have historically been built in non-silicon technologies but CMOS has begun to make entry into this market. CMOS brings the advantages of an improved supply chain, flexibility for new features, and improved reliability. CMOS performance can be improved by use of more advanced architectures and by application of smart supporting circuits. Architectures that were developed for non-silicon power amplifiers are not well suited to a CMOS implementation because they apply excessive voltage stress across the amplifier’s transistors. This presentation will introduce a new class of power amplifier architectures, referred to as Class P, that is well suited to a CMOS implementation and will describe its application to both linear 3G and nonlinear power amplifiers.

5. Bumman Kim, Pohang University of Science and Technology

“CMOS Linear Power Amplifier Design”

We have described the current status of CMOS PA. Then, CMOS power cell design, Transformer design, and CMOS nonlinear characteristics are discussed. Finally, some POSTECH's work in Linear CMOS PA will be reported.

6. Antonino Scuderi, STMicroelectronics, Catania, Italy
“Multimode Digital CMOS PA for Polar Architectures”

Rapidly expanding market for multi-mode and multi-band cellular phones has recently fueled the demand for RF Power Amplifiers (PA) able to operate with 2G, 2.5G, 3G, and above, standards. This trend minimizes component count, radio board size and cost while it increases power added efficiency needs in each operating mode and power level due to the distribution of transmitted power probability. The optimization of a PA for such functionalities has suggested innovative architectures while the desire of the whole radio system, from the base-band digital circuits through the PA, integrated onto a single chip has gained the research on CMOS technology platform. This presentation will discuss the CMOS involvement and limits in the RF PA field moving from analog to digital approach. So, starting from reliability analysis, an analog CMOS PA and then a digital CMOS PA will be introduced together with the adopted digital pre-distortion technique tuned to the exploited polar architecture.

7. Dan Nobbe, Peregrine Semiconductor
“Radio Frequency Front End Integration in UltraCMOS”

CMOS Power Amplifiers have been a hot topic for several years. The PA represents the last big section of the mobile radio that's not implemented in CMOS. However, it is incredibly challenging – high power, tough thermal requirements, demanding efficiency, noise, and a list of other challenges. There have been several recent papers presenting front-end work in SOI technologies. Peregrine Semiconductor is using its UltraCMOS technology toward this pursuit. We believe UltraCMOS is superior to standard SOI in many regards. Peregrine has already established itself as a market leader in handset switches. This presentation will cover recent advances in antenna switches and also cover power amplifiers and front-end integration in UltraCMOS.

8. Peter Gammel, SiGe Semiconductor
”Power Amplifier Design Consideration for WLAN”

The demand for ubiquitous wireless connectivity in battery powered devices is driving a demand for integrated, efficient and cost effective RF front end modules(FEM). The industry roadmap for intelligent connectivity mandates RF front ends which incorporate higher levels of programmability and functionality, all while reducing the footprint for RF solutions at 35% per year. To address these needs for form factor, cost and performance, SiGe BiCMOS offers the most cost effective solution, while giving the benefits of integrated bias and regulation, temperature compensated power detection and improved power density for power amplifiers. In addition, SiGe BiCMOS offers high performance passives for matching and filtering, a high performance LNA and excellent RF switch performance: all the basic building blocks of a complete RF front end module. Integration of a cost effective through silicon via (TSV) into a .35mm SiGe BiCMOS process has paved the way to dual band RF FEMs.

9. Chris D. Hull, Intel Corporation
"Wi-Max CMOS Power Amplifiers"

Wi-Max power amplifiers offer unique challenges. Due to the OFDM modulation, extremely high linearity is required. However, unlike Wi-Fi, Wi-Max is a wide-area network, and requires a large average output power of 23dBm. To date even GaAs PA manufacturers have had difficulty meeting the Wi-Max requirements. This talk discuss design techniques for implementing a Wi-Max PA in conventional CMOS technology, for reduced cost.