

WSF (RFIC) Sunday 08:00 – 17:00 BCEC Room 157AB
Devices and Design Techniques for Advanced Handset/Mobile PAs
Full-day workshop reviewed by RFIC.

Organizer(s):

Nick Cheng, Skyworks Solutions; RFIC TPC.

David Ngo, RF Micro Devices; RFIC TPC Co-Chair.

During the past decade, cellular handsets have moved from single-band, single-mode platforms to very complex multiband, multimode architectures that optimize carrier capacity flexibility, support numerous geographic air-interface standards and enable more multimedia features. The ever-increasing complexity in cellular handsets has been imposing more and more stringent requirements on power amplifiers. Advancements in both device technology and design techniques have been escalating in addressing critical issues such as efficiency, linearity, noise, harmonics, switching transient, to name a few. Several presentations in this workshop will cover future handset trends, requirements on advanced power amplifiers and choice of device technology. Furthermore, design techniques of linearization, efficiency enhancement, power detection and controls will be covered with design examples demonstrated on various technologies such as GaAs HBT, CMOS, Silicon-on-Insulator and Silicon Germanium.

Speakers:

1. Ville Vintola, Nokia

“Handset Trends and Advanced PA Requirements”

3GPP list now 17 (subject to change) bands for HSPA and LTE FDD and some eight more for TDD system. Expanding number operating bands is directly visible on requirements for operating frequency and noise output from PA's. The terminal size is decreasing which affect directly to the size of the battery and antennas than can be used. This means less power capacity and worse environment to RF meaning VSWR etc. Also continuous push for integration is setting new targets for components used in the radios. In the meanwhile, operators are becoming more aware of the RF performance of the terminals. This will end up more stringent Total Radiated Power requirements which can be addressed in PA many ways. Also terminals are becoming smaller and thinner which together with SAR requirements set new challenges for antenna and Front-End co-operation.

2. Peter Zampardi, Skyworks Solutions

“Device Technology for Handset Power Amplifiers”

Cellular handsets are one of the few everyday high-tech devices that uses of a wide variety of semiconductor technologies (i.e. it's not just silicon CMOS). In particular, front-end modules (FEMs) that consist of a transceiver, switches, and power amplifier, make extensive use of III-V semiconductors, in addition to more traditional silicon technologies. Currently, the FEM is undergoing an evolution from single-mode to multi-mode, multi-band (including higher frequency bands). As this migration to higher

frequency, higher integration occurs; it presents an opportunity to reconsider how the functions are partitioned across various technologies at a module level. With a focus on the FEM, we compare and contrast the semiconductor technologies currently being used for switching and power amplification and, hopefully, provide some insight into which technologies will “win” for next generation applications.

3. R. Magoon, Axiom Microdevices,
“Fully Integrated CMOS PAs for the Handsets”

Fully integrated watt-level CMOS power amplifiers offer an exciting opportunity for complete radio integration on silicon. They make it possible to optimize the transceiver architecture at a more global level. We will discuss techniques and methods for watt level CMOS power amplifier used for constant and non-constant envelope modulation schemes in next generation mobile handsets. In particular we will discuss innovative approaches such as distributed active transformer (DAT) for high-efficiency power generation and show some practical examples of this.

4. Ali Tombak, RFMD
“Highly Integrated Wireless Handset Front-End Modules Based on Bulk Silicon and Silicon-on-Insulator (SOI) Technologies”

This talk describes a bulk Silicon and Silicon-On-Insulator (SOI) technology that provides a platform for monolithic integration of several RF TX functions for cellular/WLAN RF system applications. The technology includes the integration of an RF power LDMOS transistor capable of nearly comparable linear and saturated RF power characteristics to GaAs solutions at cellular frequency bands. Measurement results for integrated PA and power management circuitry based on DC-DC buck converters will be presented. Various PA / TX Module architectures utilizing bulk Si, SOI, and GaAs technologies will be presented.

5. Youngwoo Kwon, Seoul National University
“Low-Power PAE Enhancement for 3G Handset Power Amplifiers”

As the cellular network infrastructure matures, the transmit power requirement is shifting to a lower power range. For example, CDMA usage probability density function shows its peak around 0dBm. Power amplifier design thus requires new metrics that emphasize overall efficiencies across the entire usage power range rather than just PAE (power-added-efficiency) at the maximum output power. In this presentation, different circuit techniques to enhance the efficiencies in the low power region are presented together with their impact on overall talk time of 3-G handsets.

6. Donald Lie, Texas Tech University

“SiGe PA for WLAN/WiMax and Handset Applications”

The favorable thermal properties, the higher breakdown voltage of SiGe vs. CMOS devices, the high integration capabilities of SiGe PAs and the lower cost of wafer processing are attracting many researchers and vendors to come up with commercially available low-cost and robust SiGe PA products. Recently, there has been a sizable commercial success for stand-alone and fully-integrated medium-power SiGe PAs (under 1W) for WLAN applications. I will discuss the technical accomplishments that enabled this recent success of SiGe PAs products, and also discuss if this success can be duplicated for WiMAX/WiBro and even handsets applications.

7. Leo de Vreede, Delft University of Technology

“Out-Of-Band Linearization of Semiconductor Devices”

Out-of-band linearity optimization is a powerful technique to improve on the classical trade-off between linearity and efficiency as present in RF power amplifiers. In support of this technique, novel dedicated active harmonic Load Pull setups have been developed. These setups provide full control of the impedances in baseband, fundamental and 2nd harmonic frequency bands at both input & output of the device under test, while facilitating linearity characterization / optimization with wideband complex modulated signals. IM3 linearization techniques will be presented in detail. The achievable improvements using these strategies are presented for HBTs as well as LDMOS devices. Furthermore, we will show that specific varactor topologies that make use of out-of-band tuning can yield distortion free operation while providing continuous RF tuning. The resulting devices are compatible with the most demanding requirements of wireless applications.

8. David Ripley, Skyworks Solutions

“Power Detection and Control for Handset Power Amplifiers”

Integral with the modern mobile handset power amplifier is the means of detecting and controlling the transmitted power. This presentation explores the various power detection techniques used in modern handsets as well as multiple methods of power control for amplifiers operating in saturated and linear modes. Detection methods such as current, voltage, diode, power and log detection are considered along with performance characteristics such as RF bandwidth, video bandwidth, dynamic range, temperature compensation and VSWR insensitivity. Techniques for power control of cellular handset solutions supporting the major standards of GSM, EDGE and WCDMA vary significantly and these differences compound as we move towards converged multi-mode solutions which must support several standards. This discussion is placed into context considering modern customer expectations balanced against product size and cost constraints.