WORKSHOPS AND SHORT COURSES

9:10 - 09:40 Advances in SiGe BiCMOS Technology for mm-Wave Applications in the DOTSEVEN Project

Klaus Aufinger, Infineon, Germany

Abstract:

Recent advances in SiGe BiCMOS technology in the FP7-DOTSEVEN project are presented. The optimized traditional double-polysilicon self-aligned HBT with selectively epitaxially grown base of the predecessor project DOTFIVE is integrated into a 130nm CMOS platform with nearly no negative impact on performance. In a further step towards future BiCMOS technologies a new transistor concept that evolved from DOTFIVE by the partner IHP to overcome base resistance limitations of the traditional concept is integrated into the same platform providing significant speed improvements. These technology developments offer substantial improvement potential for existing applications, e.g. in terms of power consumption, and provide a cost-effective base for newly emerging mm-Wave applications.

9:40 - 10:10 55nm SiGe BiCMOS for Optical, Wireless and High-Performance Analog Applications

Pascal Chevalier, STMicroelectronics, France

Abstract:

STMicroelectronics 55nm SiGe BiCMOS platform will be presented. The technology is based on a triple gate oxide CMOS technology featuring General Purpose (1.0 V), Low Power (1.2 V) and I/O (2.5 V) transistors. SRAM are also available with a 0.45 µm² 6T-SRAM as smallest bit cell. High-speed, medium-voltage and high-voltage SiGe HBTs with Ft ranging from 320 GHz to 65 GHz associated to BVceo between 1.5 V and 3.2 V are offered. Corresponding Fmax values of 380 GHz and 270 GHz are demonstrated. A full suite of millimeter-wave passives has been developed too, taking advantage of a specific 9 metal layers back-end of line.

10:10 - 10:40 Optimization of vertical doping profiles for high-speed SiGe HBTs

Holger Rücker, IHP, Germany

Abstract:

Device simulations suggest a significant potential for improving maximum transit frequencies fT of SiGe HBTs. While highest experimentally demonstrated fT values are about 400 GHz device simulations predicted fT values of up to 1 THz for optimized vertical doping profiles. The experimental investigation reported here addresses (i) the feasibility of fabricating the theoretically assumed profiles and (ii) the estimation of the accuracy of theoretical predictions by comparison of measured and simulated data. Vertical doping profiles for maximizing fT require concentration changes of several orders of magnitude within very few nm not only after deposition but also at the end of the process. A dedicated fabrication process with minimum thermal budget was established for the realization of doping profiles approximating the theoretical assumptions. HBTs with systematically varied boron and germanium profiles in the base as well as with extremely narrow base emitter and base collector junction widths are characterized experimentally. Measured DC and RF characteristics are compared to results of hydrodynamic device simulations.

11:20 - 12:05 Impact of physical effects and compact modeling on mm-wave circuit performance

Andreas Pawlak, Dresden University of Technology, Germany

Abstract:

As the performance of Silicon-Germanium HBTs increases, linear and large signal non-linear compact modeling at very high frequencies becomes crucial to minimize circuit design iterations. The influence of specific compact model equations and elements, including non-quasi-static effects, on the device characteristics is shown with reference to linear and non-linear measurement. Due to measurement equipment related limitations at very high frequencies numerical device simulations based on BTE and calibrated DD and HD transport models are employed to significantly increase the investigated frequency range, particularly for high harmonics. Excellent modeling capabilities of HICUM/L2 are demonstrated based on experimental and simulation results for single transistors and simple benchmark circuits.

12:05 - 12:50 Challenges in Modeling, Design, and Characterization of Terahertz Circuits in Silicon

Ullrich Pfeiffer, University of Wuppertal, Germany

Abstract:

The push towards terahertz frequencies presents both challenges and opportunities for emerging applications and circuit. This talk presents recent attempts to operate SiGe HBTs close to and beyond their transistor cut-off frequencies. Silicon process technologies have recently reached fmax as high as 0.5 THz, which enables circuits to operate fundamentally up to about 160-220 GHz with reasonable RF circuit performance. Beyond fmax, where transistors do not provide power gain, circuits may be operated sub-harmonically to extend further the operation region. Despite their increased receiver NF, such circuits prove to be useful for emerging applications. At terahertz frequencies, on-chip antennas may be implemented with reasonably high efficiencies and very small area, thus eliminating the need for additional external components such as expensive waveguides or horn antennas. Topics covered during the talk include:

1) Fundamental and sub-harmonic RF circuit design methodologies
2) RF power generation techniques and their limitations at terahertz frequencies (>300GHz)
3) Circuit modeling and characterization methodologies up to 1 THz
4) Summary of SiGe, CMOS, and Schottky diode terahertz benchmarking circuits
5) Examples of highly integrated 160, 220 GHz TX/RX chip-sets, RF sources up to 825 GHz, fully integrated heterodyne and direct detection receivers up to 1 THz.
6) Emerging terahertz applications for silicon circuits

14:20 - 15:05 From Adaptive Modulation Schemes towards Software Defined Radar (SDR)

Andreas Stelzer, Johannes Kepler University Linz, Austria

Abstract:

Nowadays, the FMCW principle is widely used in automotive radar sensors with an ongoing acceptance of fast-chirp systems and incorporating range-Doppler processing. Although these systems require faster sampling due to a higher IF-bandwidth the sampling frequency is still moderate. A further alternative is using digitally enhanced RF by combining FM ramps with an additional digital modulation part. PRN as another fully digital broadband modulation principle can be combined with analog or digital correlation in the receiver. The future goal would be a software defined radar, where the transmit signal used as well as the signal processing applied are fully digitally controlled and thus in a situation aware manner. The workshop contribution will show different approaches, either in the RF hardware as well as in terms of modulation schemes and evaluation procedures.

15:05 - 16:00 Concepts for Highly Integrated Automotive Radar Circuits

Rainer Stuhlberger, Infineon - DICE GmbH & Co KG, Austria

Abstract:

In the last few years the automotive safety market gets more and more important especially radar based systems like adaptive cruise control, blind spot detection or emergency brake systems. To be able to handle the higher demand of automotive radar systems and to reduce the system costs at the same time, it is necessary to increase the level of integration, especially on the high frequency (HF) front end side. Traditionally the radar market was dominated by HF bipolar semiconductor based transceivers. For a higher level of integration and to fulfill the high demands of HF performance different technologies like bipolar complementary Metal-oxide-semiconductor (BiCMOS) are necessary. This shift in technology favored a more “digital” centric transceiver partitioning, although the traditional analog HF-architectures (e.g. HF VCO, power amplifier, HF mixers)

remained in bipolar technology. It also offers the possibilities of new transmit modulation concepts, and especially in digital front end (DFE) enhanced receiver architectures. Another important aspect for higher integration is the growing demand on monitoring functionality with high coverage to fulfill the requirements for an ISO26262 compliant design. This and more conceptional aspects including an outlook will be part of this presentation during the workshop.

16:30 - 17:15 Beyond 10 Gbit/s mm-wave wireless communication using SiGe BiCMOS transceivers

Erik Öjefors, SiversIMA, Sweden

Abstract:

Abstract: Wireless mm-wave data communication with data rates of 10 Gbit and above using radio front-ends and transceivers implemented in state-of-the-art SiGe BiCMOS technologies is presented. The design and implementation of low-noise and power amplifiers for multi-Gbit/s E-band back-haul links using >500 GHz fmax SiGe HBTs is detailed. Module integration and base-band signal-conditioning techniques for short-haul links aiming towards 100 Gbit/s wireless communication at 220 GHz are also discussed.

17:15 - 18:00 Application challenges and potential solutions for robust radar sensors

Dirk Steinbuch, Bosch, Germany

Abstract:

The application of today's high frequency MMICs in high volume Radar sensors imposes a variety of challenges. In order to meet AEC-Q100 qualification, the assembly and interconnection technology has to be developed to comply with the OEM's temperature cycle requirements. The heat dissipation has to be looked at from a system perspective taking into account housing, PCB, modulation scheme and customer requirements, the latter moving slowly from 85° to 95° ambient. Furthermore, the realization of a sensor power supply capable of dealing with currently challenging requirements is essential. Those comprise demanding on-board battery supply disturbances as well as unavoidable power supply spurs degrading the MMIC's performance. During this presentation, those major application challenges will be discussed and potential solutions to develop a robust Radar sensor meeting the future needs will be highlighted.