Time & Location: March 18, 2011 at 12:30 PM in HEC 450
Title: CMOS RF CIRCUITS VARIABILITY AND RELIABILITY RESILIENT DESIGN, MODELING, AND SIMULATION

The work presents a novel voltage biasing design that helps the CMOS RF circuits resilient to variability and reliability. The biasing scheme provides resilience through the threshold voltage (VT) adjustment, and at the mean time it does not degrade the PA performance. Analytical equations are established for sensitivity of the resilient biasing under various scenarios. Power Amplifier (PA) and Low Noise Amplifier (LNA) are investigated case by case through modeling and experiment. PTM 65nm technology is adopted in modeling the transistors within these RF blocks. A traditional class-AB PA with resilient design is compared the same PA without such design in PTM 65nm technology. Analytical equations are established for sensitivity of the resilient biasing under various scenarios. A traditional class-AB PA with resilient design is compared the same PA without such design in PTM 65nm technology. The results show that the biasing design helps improve the robustness of the PA in terms of linear gain, P1dB, Psat, and power added efficiency (PAE). Except for post-fabrication calibration capability, the design reduces the majority performance sensitivity of PA by 50% when subjected to threshold voltage (VT) shift and 25% to electron mobility (µn) degradation. The impact of degradation mismatches is also investigated. It is observed that the accelerated aging of MOS transistor in the biasing circuit will further reduce the sensitivity of PA.

In the study of LNA, a 24 GHz narrow band cascade LNA with adaptive biasing scheme under various aging rate is compared to LNA without such biasing scheme. The modeling and simulation results show that the adaptive substrate biasing reduces the sensitivity of noise figure and minimum noise figure subject to process variation and device aging such as threshold voltage shift and electron mobility degradation. Simulation of different aging rate also shows that the sensitivity of LNA is further reduced with the accelerated aging of the biasing circuit.

Thus, for majority RF transceiver circuits, the adaptive body biasing scheme provides overall performance resilience to the device reliability induced degradation. Also the tuning ability designed in PA provides the circuit post-process calibration capability.

Major: Electrical Engineering

Educational Career:
Bachelor's of Electrical Engineering, BS, 2003, Shanghai Jiaotong University
Master's of Microelectronics, MS, 2006, Chinese Academy of Sciences

Committee in Charge:
Dr. Jiann-Shiun Yuan, Chair, Electrical Engineering
Dr. Kalpathy B. Sundaram, Electrical Engineering
Dr. Thomas Xinzhang Wu, Electrical Engineering
Dr. Lee Chow, Physics

Approved for distribution by Dr. Jiann-Shiun Yuan, Committee Chair, on February 17, 2011.

The public is welcome to attend.