ECE 600 Seminar
Monday, October 17, 2011
1610 Engineering Hall
3:30PM - 5:00PM

At the boundaries of high-frequency analog & RF ICs: Speed, energy and uncertainty

Abstract: In integrated circuits, the analog domain represents the interface between the physical world and the modern digital age. Because of this, many of the boundaries of performance, such as speed, energy, efficiency, linearity, etc., are a direct result of physical limitations, such as noise, power, size and fundamental device operation. In this talk I will discuss our approach to address several of the important limitations in modern analog and RF ICs through the development of novel circuits and new passive and active devices. I will illustrate our work through two specific research projects. The first aims to significantly increase the speed, power output and efficiency of RF power amplifiers (PA). Current state-of-the-art Si PAs above 20 GHz suffer from low power-added-efficiency (PAE) and output power, typically < 20% and < 0.5W. I will present our work on developing high PAE (30% - 50%), high power PAs (> 1W) above 45 GHz using SiGe and 45 nm CMOS, optimized topologies, active cascodes and novel power combiners. The second project aims to realize high effective number of bits (ENOB) ADCs. At very high sampling rates (40 GS/s) and high resolutions (> 10 bits), clock degradation and jitter represents some of the fundamental roadblocks to achieving high ENOB for frequencies close to Nyquist. In this research I am examining clock skew, clock slope and distribution, and clock jitter and their impact on high-speed, interleaved ADCs. I will discuss our efforts to understand these fundamental limitations and some ideas on how to overcome them to achieve ADCs with ENOB > 5 bits at speeds of 40 GS/s and ENOB > 10 bits at 1GS/s. In addition to our work on high-speed analog and RF, I will briefly discuss some of the other research we are pursuing at the interface of physical world and circuits: microrobotics, nanoelectronic devices, and magnetoquasistatic wireless power and position tracking.

Bio: David S. Ricketts received the PhD from Harvard University and is an Assistant Professor of ECE and MSE (courtesy) at Carnegie Mellon University. Before joining academia, Prof. Ricketts spent 8 years in industry developing over 40 integrated circuits in mixed-signal, RF and power management applications. Prof. Ricketts' research crosses the fields of device physics, material science and circuit design. His work has appeared in *Nature, Proc. IEEE* and in numerous other IEEE conferences and journals and he has authored two books: Electrical Solitons: Theory, Design and Applications and The Designer's Guide to Jitter in Ring Oscillators. He is the recipient of the NSF CAREER award, the DARPA Young Faculty Award and the George Tallman Ladd research award at Carnegie Mellon. In addition to his technical research, Prof. Ricketts investigates the role of the scientist and engineer in creating breakthrough innovations and has co-developed several courses on innovation and creativity at Harvard and Carnegie Mellon. He is currently a Harvard Innovation Fellow in the School of Engineering and Applied Science at Harvard University and was a 2009 Wimmer Teaching Fellow at Carnegie Mellon.