WSJ (RFIC) Sunday 08:00 – 12:00 BCEC Room 51
Active Radio Circuits for Bio & Medical Applications
Half-day workshop reviewed by RFIC.

Organizer(s):
Jacques Rudell, University of Washington, Seattle, WA USA
Donhee Ham, Harvard University, Cambridge, MA USA
Brian Otis, University of Washington, Seattle, WA USA

Scientist and engineers have spent the better part of the last century developing more efficient radio circuits, systems and software for wireless communication. Recently, the scientific community has begun exploring the use of radio-frequency circuits for bio-medical applications. These bio-able radio circuits can be categorized into two sub-topics. The first is the use of radios to communicate sensed information from the human body to the outside world. The second is the use of traditional radio circuits for medical analysis. Two speakers in this workshop will explore using radio circuits for biomedical sensing and diagnosis, such as early-cancer detection and Protein and DNA analysis. Two additional speakers will describe current work on communication with radios links for body area networks (BAN) and implantable devices.

Speakers:
1. Arjang Hassibi, University of Texas, Austin, TX
”Challenges in CMOS Integrated Biosensors”

In this talk, we will discuss integrated biosensors, i.e., molecular detection systems which include the biochemical assay, transducers, and interface circuitry. These systems, if fully developed, can become an enabling and mass-deployable platform in many research and industrial applications ranging from medical diagnostics to environmental testing. In particular, we will examine the usage of CMOS VLSI fabrication processes as the ‘backbone’ for integrated biosensors and show that CMOS can not only enable smaller and more cost efficient systems, but also can improve the overall detection performance.

2. Brian P. Otis, University of Washington, Seattle, WA
“BANning Low Power Radio Design”

Emerging applications of wireless sensors require new levels of system integration, functionality, and lifetime. Body area networks, implantable devices, and small animal tracking research are a few examples that will be discussed. These applications place increasingly severe demands on RFIC designers. Miniaturization and power concerns, already important considerations in portable radio design, are amplified in these emerging wireless sensor applications. Additionally, there are several needs on the horizon that will demand completely thin-film integration of RF transceivers, prohibiting surface-mount components of any kind. This talk will discuss various RF transceiver design techniques, including miniaturized BAW-based radio components, frequency-multiplying transceiver architectures, and wirelessly-powered sensor data links. Test chip architectures will be presented and measured results described.

3. Joel L. Dawson, Massachusetts Institute of Technology, Cambridge, MA
"A New Architecture for Implantable Transceivers"

This presentation addresses the design of radio frequency (RF) transceivers for medical implants. The FCC has dedicated frequency band specifically for medical telemetry, allowing for RF communications between a medical implant and a base-station. Although this standard has existed for almost a decade, current solutions could do more to exploit the unique features of the implant environment to lower the cost and power dissipation, as well as the size, of implantable transceivers. Here we present an overall system concept for an implantable that takes advantage of the body's extraordinary temperature regulation capabilities. Measured results from a prototype IC are also presented.

4. Donhee Ham, Harvard University, Cambridge, MA
"NMR-Based CMOS RF Biomolecular Sensor"

I will present our recent work that showcases how silicon RF chips can be used not only for wireless RF applications, but also for biosensing aimed at early disease detection and low-cost medicine. The main function of our RF chip is to manipulate and monitor RF dynamics of protons in water via nuclear magnetic resonance (NMR). Target biological objects such as cancer marker proteins alter the proton dynamics, which is the basis for our biosensing. The RF chip has a receiver noise figure of only 0.6 dB. This high sensitivity made possible our construction of an entire NMR system around the RF chip in a 2-kg platform, which is 60 times lighter, yet 60 times more mass sensitive than a state-of-the-art commercial benchtop NMR system. Our system is a circuit designer's approach to pursue early disease detection in a low-cost, hand-help platform.