## UCLA Electrical Engineering ARR 2011

## Session 10. High-Performance Oscillators and PLLs
## Grand Horizon Room

### *1:15-1:40*
"Analysis of Phase Noise in Phase/Frequency Detectors"
*Ali Homayoun and Behzad Razavi*

Abstract: The mechanisms giving rise to the phase noise for a PFD in a phase-locked loop are described. The phase noise is calculated based on the accumulation of phase noise in successive transitions around the PFD circuit. Each transition is similar to the transition in an inverter, whose phase noise due to both white and flicker noise is modeled and computed. The proposed phase noise calculations are validated by spectre simulations of static and dynamic PFDs realized in 65-nm CMOS technology.

### *1:40-2:05*
"A V-band Voltage Controlled Oscillator with Greater than 18GHz of Continuous Tuning-Range Based on Orthogonal E mode and H mode Control"
*Alborz Jooyaie and Mau-Chung Frank Chang*

Abstract:
A technique to achieve an extended continuous tuning range for Voltage Controlled Oscillators (VCO) is presented. The technique is scalable and the theory could be applied to achieve wide tuning range VCOs operating at arbitrary center frequency; however, it is more desirable at mm-wave regime (V-Band in this case) as it alleviates the need for switches and big varactor banks. The technique incorporated here relies on separate E and H mode excitation of the resonator, while avoiding the Q-degrading switches. The standing-wave V-band VCO reported here is implemented in 65-nm CMOS technology and achieves a continuous tuning range from 58 GHz to 76.2 GHz, with an average phase noise of -89.5 dBc/Hz at 1 MHz offset across the entire band, consumes an average of 5.8 mW (excluding the output buffers), and thus achieves a record FoM.

## *2:05-2:30*

"A 2.8 to 3.2 GHz fractional-N digital PLL with ADC-assisted TDC and inductively coupled fine-tuning DCO"

*Chih-Wei Yao and Alan Willson*

Abstract:
A 2.8 to 3.2 GHz fractional-N digital PLL implemented in 0.18-um CMOS is presented. An ADC is employed to boost TDC resolution by five times to achieve 2 ps effective resolution. A dither-less DCO with an inductively coupled fine-tune varactor bank improves tuning step-size to
20 kHz. A divider with two-stage retiming improves linearity to reduce fractional spurs without increasing the in-band noise floor. The prototype is expected to achieve better in-band phase noise, better FOM, and smaller area than the state-of-art fractional-N charge-pump PLLs.

## *2:30-2:55*

"A 25-Gb/s 5-mW CMOS CDR Circuit"

*Jun Won Jung and Behzad Razavi*

Abstract:
Low-power solutions for high-speed wireline circuits have seen a resurgence in demand. This presentation introduces a charge-steering circuit technique that considerably reduces the power consumption of circuits such as latches and flipflops. A half-rate CDR circuit employing this technique and including a 2:4 DMUX consumes less than 5 mW from a 1-V supply in 65-nm CMOS technology.

## Session 11. Innovative Analog and RF Design
## North Ridge Room

### *3:15-3:40*

"V-band Self-Healing Power Amplifier with Adaptive Feedback Bias Control in 65nm CMOS"

*Jenny Yi-Chun Liu, Adrian Tang, Ning-Yi Wang, Qun Jane Gu, Roc Berenguer, and Frank Chang*

Abstract:
A self-healing two-stage 60 GHz power amplifier (PA) with amplitude/phase compensation is realized in 65 nm CMOS. An adaptive feedback bias scheme with three control knobs is proposed to extend the linear operating region and enhance chip-to-chip performance yield; allowing a 5.5 dB improvement of the output 1-dB compression point (P1dB) and a less than 2% chip-to-chip gain variation. At a 1 V supply, the fully differential PA achieves a saturation output power (Psat) of 14.85 dBm with a peak power-added-efficiency (PAE) of 16.2%. With the on-chip amplitude compensation, the P1dB is extended to 13.7dBm. With the on-chip phase compensation, the output phase variation is minimized to less than 0.5 degree. The PA delivers a linear gain of 9.7 dB and has a 7 GHz bandwidth from 55.5 to 62.5 GHz with a very compact area of 0.042 mm2.

### *3:40-4:05*

"Wide-bandwidth open loop phase modulator"

*Nitin Nidhi and Sudhakar Pamarti*

Abstract:
Emerging wireless communication standards require the transmitter to be wide-bandwidth and power efficient. Polar and out-phasing are two promising candidates for such applications. Both of these architectures require a wide-bandwidth phase modulator. Open loop phase modulation presents a viable solution for achieving wide-bandwidth operation. An on-chip calibration technique, which can attain high precision in the measurement of digital-to-phase characteristics of a phase interpolator, is proposed. The technique makes use of the time-to-digital converter (TDC) in a digital PLL, while avoiding the impact of its non-idealities.

### *4:05-4:30*

"Gain-Enhanced Distributed Amplifier-Based CRLH-Leaky Wave Antenna for Quasi-Resonant Power Recycling Scheme"
*Chung-Tse Michael Wu and Tatsuo Itoh*

Abstract:
A distributed amplifier combined with CRLH-leaky wave antennas (LWAs) for a new resonant type power recycling scheme is proposed. By connecting a closed loop to the LWA on the drain side of the distributed amplifier, we can obtain gain enhancement compared to the one directly terminated without the loop. Such enhancement fluctuates with respect to the frequency. At some specific frequencies, the enhancement reaches a maximum. The phenomenon will be explained theoretically and validated through the measurement and simulation.

### *4:30-4:55*

"Signal-processing techniques for wideband data converters"
*Abhishek Ghosh and Sudhakar Pamarti*

Abstract:
This talk will focus on signal conditioning techniques for voltage-controlled oscillator (VCO) ring A/D converters. VCOs promise an inexpensive, power-efficient way to implement A/D converters of moderate to high bandwidths. The frequency of the ring oscillator output is changed proportional to the input signal that needs to be quantized; quantization is achieved by simply counting the number of rising/falling edges of the ring oscillator output(s) in a given period of time. However, the non-linear VCO tuning curve poses severe limitations on the ADC dynamic range. To allay this problem, novel dithered signal-conditioning techniques to scramble the VCO-tuning errors are proposed. The oversampled nature of the system enables pushing out the error power out of the signal band, thereby attaining a robust SNDR at a minimal power expense. The scheme is able to achieve a resolution >12 bits at a nominal power-consumption of 5mW for signals having bandwidths in the 20MHz range.

## Session 12. Next-Generation Communications
## West Coast Room

### *3:15-3:40*

"Detecting Stumbles Using Accelerometers"
*Nabil Hajj Chehade and Gregory Pottie*

Abstract:
Falls are a major health problem for the elderly, and stumbles are good indicators for a fall. In this talk, we describe an approach for the detection of stumbles with a new personal activity monitoring system. Our system consists of low cost triaxial accelerometers that may be worn by patients and are convenient for a wide range of subjects. We use machine learning and data mining techniques to detect and count the stumbles in the acceleration data. We also validate our system with data collected from 10 subjects.

## *3:40-4:05*

"Cyclostationary Feature Detection from Sub-Nyquist Samples"
*Eric Rebeiz, Danijela Cabric*

Abstract:
Wideband spectrum sensing which requires detecting the presence or absence of signals in a wideband channel faces multiple practical issues. Current bandwidth limitations of state-of-the-art analog to digital converters require alternative approaches to be considered for wideband sensing. Cyclostationary feature detection is a promising sensing tool which is robust to noise, and takes advantage of the noise stationarity. In this talk, we propose a cyclostationary feature detector that operates on sub-Nyquist samples obtained via either multicoset sampling or the modulated wideband converter analog front-end, and present the receiver.

## *4:05-4:30*

"A practical approach to interference suppression using multiple antennas"
*Gaelen Pereira and Babak Daneshrad*

Abstract:
Interference suppression has been the subject of extensive research in multi-user communication, with several strategies having emerged to address this issue. However, most multi-antenna based approaches assume knowledge of channel estimates, which are hard to obtain in practice. We propose a practical two step solution that consists of a spatial

filter applied directly to the incoming signal, followed by an MMSE decoder, and thus does not require channel estimates or changes to the existing receiver in order to suppress interference. The talk will also cover implementation challenges such as AGC control in a MIMO OFDM radio prototype, and we show through experimental results robust performance at a SIR of -10dB.

## Session 13. Novel Photonic and High-Energy Techniques
## South Bay Room

### *3:15-3:40*
"Lensfree Optical Tomographic Microscopy"
*Serhan O. Isikman, Waheb Bishara, Sam Mavandadi, Steve Feng,Frank Yu, and Aydogan Ozcan*

Abstract:
Tomographic imaging of biological specimen provides detailed volumetric information regarding their internal structure. Nevertheless, existing three-dimensional microscopy (3D) modalities are relatively costly and bulky, and they can probe limited imaging volumes. To provide an alternative microscopy tool that enables depth-resolved imaging of orders of magnitude larger samples in a compact and simple architecture, we have recently developed lensfree optical tomography. In this platform, holographic shadow images of micro-objects are recorded for different illumination angles to compute slice images (tomograms) with micrometer-scale 3D resolution. Lensfree optical tomography can be a particularly useful sectional-imaging tool for lab-on-a-chip applications and telemedicine microscopy.

### *3:40-4:05*
"Developing a Compact Source of High Energy Protons for Cancer Therapy"
*Dan Haberberger, Sergei Tochitsky, Chao Gong, Chan Joshi, Warren Mori,Frederico Fiuza*

Abstract:
Over the past decade, laser driven ion acceleration (LDIA) has drawn great

interest from the scientific community due to the promise of a cheap and compact source of high quality ion beams for a myriad of applications including hadron cancer therapy. Towards this end, at the UCLA Neptune Laboratory we have investigated LDIA using a high-power CO2 laser pulse in a H2 gas jet. This unique interaction produces a shock wave which accelerates protons to energies up to 22MeV contained within an energy spread of E/EFWHM~1%.With a modest extrapolation of state-of-the-art laser technology, it may be possible to reach 100-200 MeV proton beams that are needed for the treatment of many types of cancerous tumors.

### *4:05-4:30*

"Lensfree Fluorescence Microscopy"

*Ahmet F. Coskun, Ting- Wei Su, Ikbal Sencan, Aydogan Ozcan*

Abstract:
We review a recently introduced wide-field on-chip fluorescence microscopy platform that can *simultaneously* monitor fluorescent micro-objects or labeled cells/model animals over >0.6-8 cm2 imaging field-of-view without the use of any lenses, thin-film interference filters or mechanical scanners. In this platform, the fluorescence emission from the objects is collected by a fiber-optic faceplate and is delivered to an opto-electronic sensor-array (e.g., a CCD chip). These recorded lensfree fluorescence images are then rapidly decoded using a compressive sampling algorithm to achieve ~4µm spatial resolution over entire chip area (e.g., >0.6-8cm2). Such an on-chip lensfree imaging platform could be very useful for high-throughput cytometry, rare-cell analysis, and microarray research.

### *4:30-4:55*

"Active terahertz quantum-cascade leaky-wave antenna"

*Amir A. Tavallaee, Benjamin S. Williams, Philip W. C. Hon, Tatsuo Itoh, and Qi-Sheng Chen*

Abstract:
We present an active leaky-wave metamaterial antenna realized in terahertz quantum-cascade (QC) structures that exhibits frequency-dependent direction of radiation. The metamaterial antenna is fed by a master oscillator QC-laser with a mode that propagates with an effective phase index smaller than unity such that it radiates in the surface direction due to a leaky-wave mechanism. The direction of emission of main beam

is governed by the antenna dispersion characteristic. 25 degrees of beam steering is observed as the lasing frequency of the QC-laser is varied from 2.65-2.81 THz.

### *4:55-5:20*

"Automated On-Chip Semen Analysis using a Handheld Lensfree Holographic Microscope"

*Ting-Wei Su, Anthony Erlinger, Derek Tseng, and Aydogan Ozcan*

Abstract:
We demonstrate automated semen analysis using a lensfree on-chip microscope. This compact holographic microscope weighs ~46 grams and does not require any lenses, lasers or other bulky optical components to achieve phase and amplitude imaging of sperms over ~24 mm^2 field-of-view with a numerical aperture of ~0.2. Such a compact and light-weight automated semen analysis platform that can investigate both sperm concentration and motility over a large field-of-view is especially important for fertility clinics, personal male fertility tests, as well as for field use in veterinary medicine such as in stud farming and animal breeding applications.

## Session 14. High-Performance Coding Applications
## Grand Horizon Room

### *3:15-3:40*

"Soft Information for LDPC Decoding in Flash: Mutual-Information Optimized Quantization"

*Jiadong Wang, Thomas Courtade, Hari Shankar and Richard Wesel*

Abstract:
High-capacity NAND flash memory can achieve high density storage by using multi-level cells (MLC) to store more than one bit per cell. Although this larger storage capacity is certainly beneficial, the increased density also increases the raw bit-error-rate (BER), making powerful error correction coding necessary. Traditional flash memories employ simple algebraic codes, such as BCH codes, that can correct a fixed, specified number of errors. This talk investigates the application of low-density parity-check (LDPC) codes which are well-known for their ability to

approach capacity in the AWGN channel. We obtain soft information for the LDPC decoder by performing multiple cell reads with distinct word-line voltages. The values of the word-line voltages (also called reference voltages) are optimized by maximizing the mutual information between the input and output of the multiple-read channel. Our results show that using this soft information in the LDPC decoder provides a significant benefit and enables us to outperform BCH codes over a range of block error rates.

### *3:40-4:05*

"Extending the Lifetime of Flash Memory Using Coding Techniques"

*Ryan Gabrys and Lara Dolecek*

Talk:

Flash memories promise faster data access, less power consumption, and greater durability than traditional storage mediums. However, these benefits are accompanied with greater lifetime variability. In this talk, we will demonstrate how a novel coding methodology can be used with great success to mitigate device wear-out and to substantially extend memory lifetime. Coding methods that opportunistically exploit the nature of intracell variability of dense Flash memories will be discussed.

### *4:05-4:30*

"Superposition Coding for Constrained Modulations"

*Thomas Courtade and Richard Wesel*

Abstract:

In this talk, we consider a network of n nodes, each initially possessing a subset of packets. Each node is permitted to broadcast functions of its own packets and the messages it receives to all other nodes via an error-free channel. We provide an algorithm that efficiently solves the Weighted Universal Recovery Problem and the Secrecy Generation Problem for this network.

### *4:30-4:55*

"Protograph-Based Raptor-Like LDPC Codes for Rate Compatibility with Short Blocklengths"

*Tsung-Yi Chen, Dariush Divsalar, Jiadong Wang and Richard Wesel*

Abstract:

In this presentation we will introduce a new class of rate-compatible LDPC codes, protograph-based Raptor-like (PBRL) LDPC codes. The proposed PBRL codes are jointly decodable with an iterative belief propagation decoder. As with Raptor codes, additional parity bits can be easily produced by exclusive-or operations on the precoded bits, providing extensive rate compatibility. We will present a design procedure that optimizes this class of rate-compatible LDPC codes. The new PBRL codes outperform 3GPP rate-compatible turbo codes with the same short blocklength at high SNR and show no sign of an error floor at the FER region of $10^{-7}$.