Session 28 Overview: *Biomedical Systems*

IMAGERS, MEDICAL, MEMS AND DISPLAYS SUBCOMMITTEE

Session Chair:
Joonsung Bae
Kangwon National University
Chuncheon, Korea

Session Co-Chair:
Jennifer Lloyd
Analog Devices, Santa Clara, CA

Session Moderator:
Chris Van Hoof
IMEC, Leuven, Belgium

Health-monitoring capabilities continue to expand, with increasingly low-power and artifact-tolerant operation for both non-invasive and immersive applications. The first paper describes a high-performance artifact-tolerant ECG/EOG system, followed by papers demonstrating in-ear and on-chest PPG measurement, dry-electrode tolerant ECG recording, bioimpedance measurement, and long-term ECG recording capability. Two neural-recording papers demonstrate very low power and area for immersive design.

7:00 AM

28.1 A Distortion-Free VCO-Based Sensor-to-Digital Front-End Achieving 178.9dB FoM and 128dB SFDR with a Calibration-Free Differential Pulse-Code Modulation Technique

Jiannan Huang, University of California, San Diego, CA

In Paper 28.1, the University of California, San Diego presents a sensor interface front-end for wearable applications with 95dB dynamic range and 128dB linearity in 1.68μW in 65nm CMOS. The front-end is demonstrated through in-vivo recordings of ECG and EOG in the presence of motion and other artifacts.

7:08 AM

28.2 A 400-to-1000nm 24μW Monolithic PPG Sensor with 0.3A/W Spectral Responsivity for Miniature Wearables

Sung-jin Jung, Samsung Electronics, Hwaseong, Korea

In Paper 28.2, Samsung presents a monolithic PPG sensor for in-ear monitoring. An integrated near-IR sensor achieves 4-fold increase in spectral efficiency from 400 to 1000nm over conventional photodiodes. The system provides 90dB dynamic range and consumes 24μW in 5.5mm^2 in 65nm BSI CMOS, enabling in-vivo measurement of heart rate and blood pressure in the presence of motion artifacts.

7:16 AM

28.3 A 28μW 134dB DR 2nd-Order Noise-Shaping Slope Light-to-Digital Converter for Chest PPG Monitoring

Qiuyang Lin, imec, Leuven, Belgium and KU Leuven, Leuven, Belgium

In Paper 28.3, imec introduces a sensor for chest-based PPG monitoring utilizing a 2nd-order noise-shaping slope light-to-digital converter with an on-chip DC compensation loop. The system achieves 134dB dynamic range and consumes 28μW in 0.18μm CMOS, demonstrating both chest PPG and SpO2 in vivo.

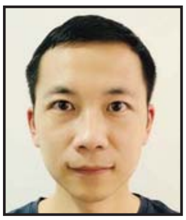
7:24 AM

28.4 A 400mV$_{pp}$ 92.3dB-SNDR 1kHz-BW 2nd-Order VCO-Based ExG-to-Digital Front-End Using a Multiphase Gated-Inverted Ring-Oscillator Quantizer

Corentin Pochet, University of California, San Diego, CA

In Paper 28.4, the University of California, San Diego introduces a VCO-based ΔΣ AFE for biopotential measurement, achieving 92.3dB SNDR in 1kHz, and enabling ECG signal recording in the presence of motion artifacts. The 65nm CMOS design uses an impedance booster to maintain >50MΩ input impedance for dry electrode measurement, while consuming <5.8μW.

7:32 AM



28.5 A 0.6V/0.9V 26.6-to-119.3μW ΔΣ-Based Bio-Impedance Readout IC with 101.9dB SNR and <0.1Hz 1/f Corner

*Tantan Zhang, Institute of Microelectronics, A*STAR, Singapore*

In Paper 28.5, the Institute of Microelectronics, Singapore describes a bioimpedance measurement scheme, leveraging first-order noise-shaped ΔΣ and a technique to modulate flicker noise to high frequencies for improved noise performance. The circuit achieves 101.9dB SNR within a 4Hz bandwidth, and measures bioimpedance from 20Ω to 20kΩ with a maximum of 119.3μW in 0.6mm^2 in 40nm CMOS, and demonstrates respiration and heart-rate measurement in vivo.

7:40 AM

28.6 A 22.6μW Biopotential Amplifier with Adaptive Common-Mode Interference Cancelation Achieving Total-CMRR of 104dB and CMI Tolerance of 15V$_{pp}$ in 0.18μm CMOS

Nahmil Koo, KAIST, Daejeon, Korea

In Paper 28.6, KAIST presents a biopotential amplifier utilizing an adaptive loop to achieve a total CMRR of >100dB. This 180nm CMOS, 22.6μW circuit demonstrates long-term recording of ECG in the presence of electrode mismatch of up to 40% and common-mode interference of up to 15V$_{PP}$.

7:48 AM

28.7 A 0.00378mm^2 Scalable Neural Recording Front-End for Fully Immersible Neural Probes Based on a Two-Step Incremental Delta-Sigma Converter with Extended Counting and Hardware Reuse

Daniel Wendler, University of Freiburg - IMTEK, Freiburg im Breisgau, Germany

In Paper 28.7, the University of Freiburg - IMTEK reveals a neural recording front-end for immersible probe designs based on a continuous-time g_m-C incremental ΔΣ ADC design. The modular system enables a flexible number of recording sites and circuit sharing to achieve very low per-channel area (<0.0005mm^2 total with electrode offset compensation) and power of <15μW per channel in 180nm CMOS.

7:56 AM

28.8 Multi-Modal Peripheral Nerve Active Probe and Microstimulator with On-Chip Dual-Coil Power/Data Transmission and 64 2nd-Order Opamp-Less ΔΣ ADCs

José Sales Filho, University of Toronto, Toronto, Canada

In Paper 28.8, the University of Toronto introduces an SoC for peripheral nerve stimulation and recording. This 64-channel neural-recording system includes cuff imbalance compensation and per-channel ΔΣ ADC consuming 140nW in 130nm CMOS. The system demonstrates nerve stimulation and fascicle selectivity in vivo.