

# **2014 IEEE Radio Frequency Integrated Circuits Symposium**

**(RFIC 2014)**

**Tampa, Florida, USA  
1-3 June 2014**



**IEEE Catalog Number: CFP14MMW-POD  
ISBN: 978-1-4799-3874-2**

---

## SESSION LIST

❖ RFIC Plenary

### Monday Sessions

[RMO1A](#) Energy-Efficient Wireless Transceivers  
[RMO1B](#) Blocker-Tolerant and Low-Noise Front-Ends  
[RMO2A](#) Mixed Signal Circuits at Gigahertz Frequencies  
[RMO2B](#) K-Band Front-End ICs  
[RMO2C](#) Advanced PLL Techniques  
[RMO2D](#) Advancements in Distributive, Thermal, and Non-Linear Device Modeling  
[RMO3A](#) Advances in Wireless Mobile ICs  
[RMO3B](#) mm-Wave PAs: 60GHz and Beyond  
[RMO3C](#) mm-Wave & Terahertz Frequency Generation Techniques  
[RMO3D](#) Advances in Nano-Scale Devices and Novel Measurement Techniques for RFIC Designs

[RMO4A](#) Wireless Connectivity Transceivers and Multi-Standard Digital Transmitters  
[RMO4B](#) Highly-Efficient Power Amplifiers  
[RMO4C](#) Quadrature and Multi-Mode VCOs  
[RMO4D](#) High-Speed Data Transceivers

### Tuesday Sessions

[RTU1C](#) mm-Wave Integration Technologies  
[RTU2A](#) Software-Defined and Cognitive Radio Techniques  
[RTU2B](#) Multiband PAs and Power Mixers  
[RTU2C](#) Sub-mm-Wave Transceivers  
[RTUIF](#) Interactive Forum

# Table of Contents

**Sunday Evening, 1 June 2014**  
**Marriott Waterside Hotel and Marina**

**17:30**

**Marriott Grand Ballroom**

**RFIC Plenary**

Chair: Lawrence Kushner, BAE Systems

Co-Chair: Bertan Bakkaloglu, Arizona State University

Co-Chair: Albert Wang, University of California at Riverside

<b>17:30</b>	Welcome Message from General and TPC Chairs, Student Paper Awards	<b>4</b>
<b>18:00</b>	How to Differentiate with RF Silicon Technologies in High Volume Applications? <b>Pieter Hooijmans</b> , NXP Semiconductors	<b>6</b>
<b>18:30</b>	The Next Era of Wireless Communications – Enabling Revolutions in Health Care, Transportation, Energy, and the Environment <b>Lawrence Larson</b> , Brown University.	<b>7</b>
<b>19:00</b>	“Hot Chips and Cold Drinks” Industry Showcase and Reception Part 1 (Marriott Grand Ballroom Foyer)	<b>8</b>
<b>20:00</b>	The Inaugural RFIC Plenary Round Table (Marriott Grand Ballroom)	<b>10</b>
<b>21:00</b>	Reception Part 2 (Marriott Grand Ballroom Foyer)	

**Monday, 2 June 2014**

**08:00–09:40**

**Room TCC 10–11**

**Session RMO1A: Energy-Efficient Wireless Transceivers**

Chair: David Wentzloff, University of Michigan

Co-Chair: Gernot Hueber, NXP Semiconductors

**RMO1A-1 08:00**

**13**

**A 2.3pJ/Bit Frequency-Stable Impulse OOK Transmitter Powered Directly by an RF Energy Harvesting Circuit with -19.5dBm Sensitivity**

Hiroyuki Ito<sup>1</sup>, Shoichi Masui<sup>2</sup>, Youichi Momiyama<sup>2</sup>, Atsushi Shirane<sup>1</sup>, Motohiro Takayasu<sup>1</sup>, Yoshihiro Yoneda<sup>1</sup>, Taiki Ibe<sup>1</sup>, Taisuke Hamada<sup>1</sup>, Sho Ikeda<sup>1</sup>, Daisuke Yamane<sup>1</sup>, Noboru Ishihara<sup>1</sup>, Kazuya Masu<sup>1</sup>

<sup>1</sup>Tokyo Institute of Technology, Japan, <sup>2</sup>Fujitsu Laboratories, Japan

**RMO1A-2 08:20**

**17**

**A 2.5nJ/Bit Multiband (MBAN & ISM) Transmitter for IEEE 802.15.6 Based on a Hybrid Polyphase-MUX/ILO Based Modulator**

Mustafijur Rahman, Mohammad Elbadry, Ramesh Harjani

University of Minnesota, USA

**RMO1A-3 08:40**

**21**

**A Low-Power Digitally Controlled Wideband FM Transceiver**

N. Saputra<sup>1</sup>, John R. Long<sup>1</sup>, John J. Pekarik<sup>2</sup>

<sup>1</sup>Technische Universiteit Delft, The Netherlands, <sup>2</sup>IBM, USA

**RMO1A-4 09:00**

**25**

**A 700pJ/Bit, 2.4GHz, Narrowband, PLL-Free Burst Mode Transmitter Based on an FBAR with 5 $\mu$ s Startup Time for Highly Duty-Cycled Systems**

Raghavasimhan Thirunarayanan<sup>1</sup>, David Ruffieux<sup>2</sup>, Franz Pengg<sup>2</sup>, Nicola Scolari<sup>2</sup>, Pascal Persechini<sup>2</sup>, Christian Enz<sup>1</sup>

<sup>1</sup>EPFL, Switzerland, <sup>2</sup>CSEM, Switzerland

**RMO1A-5 09:20**

**29**

**A 0.5-V 5.8-GHz Ultra-Low-Power RF Transceiver for Wireless Sensor Network in 65nm CMOS**

Sho Ikeda, Sang-yeop Lee, Shin Yonezawa, Yiming Fang, Motohiro Takayasu, Taisuke Hamada, Yosuke Ishikawa, Hiroyuki Ito, Noboru Ishihara, Kazuya Masu

Tokyo Institute of Technology, Japan

**Monday, 2 June 2014**

**08:00–09:40**

**Room TCC 13–14**

**Session RMO1B: Blocker-Tolerant and Low-Noise Front-Ends**

Chair: Domine Leenaerts, NXP Semiconductors

Co-Chair: Frank Henkel, IMST

- RMO1B-1 08:00** **35**  
A Noise Cancelling 0.7–3.8GHz Resistive Feedback Receiver Front-End in 65nm CMOS  
Anders Nejdell, Markus Törmänen, Henrik Sjöland  
Lund University, Sweden
- RMO1B-2 08:20** **39**  
A Blocker-Tolerant RF Front End with Harmonic-Rejecting N-Path Filtering  
Yang Xu, Jianxun Zhu, Peter R. Kinget  
Columbia University, USA
- RMO1B-3 08:40** **43**  
An Integrated CMOS Passive Transmitter Leakage Suppression Technique for FDD Radios  
Tong Zhang, Apsara Ravish Suvarna, V. Bhagavatula, Jacques C. Rudell  
University of Washington, USA
- RMO1B-4 09:00** **47**  
A 2-Stage Recursive Receiver Optimized for Low Flicker Noise Corner  
Rangakrishnan Srinivasan, Wei-Gi Ho, Travis Forbes, Ranjit Gharpurey  
University of Texas at Austin, USA
- RMO1B-5 09:20** **51**  
In-situ Noise Characterization of a 20–35GHz 32nm SOI CMOS Reconfigurable LNA Using a Broadband On-Chip Noise Source  
Mohammad Ghadiri-Sadrabadi, Ajay Subramanian, Ahmet H. Coskun, Joseph C. Bardin  
University of Massachusetts at Amherst, USA

**Monday, 2 June 2014**

**10:10–11:50**

**Room TCC 10–11**

**Session RMO2A: Mixed Signal Circuits at Gigahertz Frequencies**

Chair: Jennifer Kitchen, Arizona State University

Co-Chair: Renaldi Winoto, Marvell Semiconductors

**RMO2A-1 10:10**

**57**

**A 5<sup>th</sup> Order 0.8/2.4GHz Programmable Active Band Pass Filter for Power DAC Applications**

Zhiwei Xu, Deborah Winklea, Thomas C. Oh, Samuel Kim, Steven T.W. Chen, Yakov Royter, Maggy Lau, Irma Valles, Donald A. Hitko, James C. Li  
HRL Laboratories, USA

**RMO2A-2 10:30**

**61**

**A 6-b UWB Subsampling Track & Hold with 5.5-GHz ERBW in 40nm CMOS**

Maarten Strackx<sup>1</sup>, Emiliano D'Agostino<sup>2</sup>, Paul Leroux<sup>1</sup>, Patrick Reynaert<sup>1</sup>  
<sup>1</sup>Katholieke Universiteit Leuven, Belgium, <sup>2</sup>SCK•CEN, Belgium

**RMO2A-3 10:50**

**65**

**An 8-Bit 100-GS/s Distributed DAC in 28-nm CMOS**

Hao Huang, Johannes Heilmeyer, Markus Grözing, Manfred Berroth  
Universität Stuttgart, Germany

**Monday, 2 June 2014**

**10:10–11:50**

**Room TCC 13–14**

**Session RMO2B: K-Band Front-End ICs**

Chair: Danilo Manstretta, University of Pavia

Co-Chair: Li Lin, Marvell Technology Group

- RMO2B-1 10:10** **71**  
A Compact 24–54GHz CMOS Band-Pass Distributed Amplifier for High Fractional Bandwidth Signal Amplification  
V. Bhagavatula<sup>1</sup>, M. Taghivand<sup>2</sup>, Jacques C. Rudell<sup>1</sup>  
<sup>1</sup>University of Washington, USA, <sup>2</sup>Qualcomm, USA
- RMO2B-2 10:30** **75**  
A K-Band 5-Bit Digital Linear Phase Rotator with Folded Transformer Based Ultra-Compact Quadrature Generation  
Jong Seok Park, Hua Wang  
Georgia Institute of Technology, USA
- RMO2B-3 10:50** **79**  
K-Band FMCW Radar CMOS Front-End ICs with 13.3dBm Output Power  
Gitae Pyo<sup>1</sup>, Jaemo Yang<sup>1</sup>, Hyunji Ku<sup>1</sup>, Choul-Young Kim<sup>2</sup>, Songcheol Hong<sup>1</sup>  
<sup>1</sup>KAIST, Korea, <sup>2</sup>Chungnam National University, Korea
- RMO2B-4 11:10** **83**  
A 10–50GHz True-Time-Delay Phase Shifter with Max 3.9% Delay Variation  
Qian Ma, Domine M.W. Leenaerts, R. Mahmoudi  
Technische Universiteit Eindhoven, The Netherlands

**Monday, 2 June 2014**

**10:10–11:50**

**Room TCC 15–16**

**Session RMO2C: Advanced PLL Techniques**

Chair: Danielle Griffith, Texas Instruments

Co-Chair: Salvatore Levantino, Politecnico di Milano

- RMO2C-1 10:10** **89**  
A 9.2–12.7GHz Wideband Fractional-N Subsampling PLL in 28nm CMOS with 280fs RMS Jitter  
Kuba Raczkowski, Nereo Markulic, Benjamin Hershberg, Joris Van Driessche, Jan Craninckx  
imec, Belgium
- RMO2C-2 10:30** **93**  
A 0.6/1.2-V 14.1-mW 96.8GHz-to-108.5GHz Transformer-Based PLL with Embedded Phase Shifter in 65-nm CMOS  
Yue Chao<sup>1</sup>, Howard C. Luong<sup>1</sup>, Zhiliang Hong<sup>2</sup>  
<sup>1</sup>HKUST, China, <sup>2</sup>Fudan University, China
- RMO2C-3 10:50** **97**  
A Fractional-N DPLL with Adaptive Spur Cancellation and Calibration-Free Injection-Locked TDC in 65nm CMOS  
Cheng-Ru Ho, Mike Shuo-Wei Chen  
University of Southern California, USA
- RMO2C-4 11:10** **101**  
A 12GHz 67% Tuning Range 0.37pS  $RJ_{\text{rms}}$  PLL with LC-VCO Temperature Compensation Scheme in 0.13 $\mu\text{m}$  CMOS  
Yang You<sup>1</sup>, Deping Huang<sup>1</sup>, Jinghong Chen<sup>1</sup>, Sudipto Chakraborty<sup>2</sup>  
<sup>1</sup>Southern Methodist University, USA, <sup>2</sup>Texas Instruments, USA
- RMO2C-5 11:30** **105**  
A 60-GHz Sub-Sampling Frequency Synthesizer Using Sub-Harmonic Injection-Locked Quadrature Oscillators  
Teerachot Siriburanon, Tomohiro Ueno, Kento Kimura, Satoshi Kondo, Wei Deng, Kenichi Okada, Akira Matsuzawa  
Tokyo Institute of Technology, Japan



**Monday, 2 June 2014**

**10:10–11:50**

**Room TCC 18**

**Session RMO2D: Advancements in Distributive, Thermal, and Non-Linear Device Modeling**

Chair: Francis M. Rotella, Peregrine Semiconductor

Co-Chair: Francois Rivet, University of Bordeaux

- RMO2D-1 10:10** **111**  
**Variable Delay Transmission Lines in Advanced CMOS SOI Technology**  
Shlomo Shlafman<sup>1</sup>, Benny Sheinman<sup>1</sup>, Danny Elad<sup>1</sup>, Alberto Valdes-Garcia<sup>2</sup>, Mihai A.T. Sanduleanu<sup>2</sup>  
<sup>1</sup>IBM, Israel, <sup>2</sup>IBM, USA
- RMO2D-2 10:30** **115**  
**Analysis of Tunable Marchand Baluns**  
Luciano Boglione, Joel Goodman  
Naval Research Laboratory, USA
- RMO2D-3 10:50** **119**  
**Self-Heat Modeling of Multi-Finger n-MOSFETs for RF-CMOS Applications**  
Hitoshi Aoki, Haruo Kobayashi  
Gunma University, Japan
- RMO2D-4 11:10** **123**  
**The Thermal Scaling: From Transistor to Array**  
Tianbing Chen, Tzung-Yin Lee, Justin Allum, Mike McPartlin  
Skyworks Solutions, USA
- RMO2D-5 11:30** **127**  
**A Circuit-Level Model for Accurately Modeling 3rd Order Nonlinearity in CMOS Passive Mixers**  
Hazal Yüksel, Dong Yang, Alyosha C. Molnar  
Cornell University, USA

**Monday, 2 June 2014**

**13:30–15:10**

**Room TCC 10–11**

**Session RMO3A: Advances in Wireless Mobile ICs**

Chair: Andre Hanke, Intel

Co-Chair: Magnus Wiklund, Qualcomm Atheros

**RMO3A-1 13:30**

**133**

**A HSPA+/WCDMA/EDGE 40nm Modem SoC with Embedded RF Transceiver Supporting RX Diversity**

Jon Strange<sup>1</sup>, Hsiang-Hui Chang<sup>2</sup>, Paul Muller<sup>1</sup>, Walid Ali-Ahmad<sup>3</sup>, Christophe Beghein<sup>1</sup>, Fahd Ben Abdeljelil<sup>1</sup>, Wen-Chang Lee<sup>2</sup>, Charles Chiu<sup>2</sup>, Tze Yee Sin<sup>3</sup>, Ta-Hsin Lin<sup>2</sup>, David Ivory<sup>1</sup>, Hao-Tang Shih<sup>2</sup>, Chris Beale<sup>1</sup>, Dimitris Nalbantis<sup>1</sup>, Ivan S.C. Lu<sup>4</sup>, Chi-Wei Fan<sup>2</sup>, Shao-Hung Lin<sup>2</sup>, Hsin-Hua Chen<sup>2</sup>, Chih-Hao Sun<sup>2</sup>, Li-Shin Lai<sup>2</sup>, Jhy-Rong Chen<sup>2</sup>, Sheng-Jui Huang<sup>2</sup>

<sup>1</sup>MediaTek, UK, <sup>2</sup>MediaTek, Taiwan, <sup>3</sup>MediaTek, Singapore, <sup>4</sup>MediaTek, USA

**RMO3A-2 13:50**

**137**

**A 65nm 3G Femtocell Multiband Transceiver**

Sofoklis Plevridis<sup>1</sup>, Kostis Vavelidis<sup>1</sup>, Nikos Haralabidis<sup>1</sup>, Theodore Georgantas<sup>1</sup>, Stamatis Bouras<sup>1</sup>, Charalampos Kapnistis<sup>1</sup>, Eleni Kytonaki<sup>1</sup>, Yiannis Kokolakis<sup>1</sup>, Theodoros Chalvatzis<sup>1</sup>, Spyros Kavadias<sup>1</sup>, Hamed Peyravi<sup>1</sup>, Nikos Kanakaris<sup>1</sup>, Christos Kokozidis<sup>1</sup>, Spyridon Liolis<sup>1</sup>, Kosmas Tsilipanos<sup>1</sup>, Aris Kyranas<sup>1</sup>, Chrysostomos Xesternos<sup>1</sup>, Panagiotis Betzios<sup>1</sup>, Ilias Bouras<sup>1</sup>, Maryam Rofougaran<sup>2</sup>

<sup>1</sup>Broadcom, Greece, <sup>2</sup>Broadcom, USA

**RMO3A-3 14:10**

**141**

**A Multiband Power Amplifier Using Combination of CMOS and GaAs Technologies for WCDMA Handsets**

T. Shimura, S. Maki, S. Fujiwara, K. Fujii, Y. Takahashi, S. Suzuki, M. Miyashita, K. Yamamoto, H. Seki, M. Hieda, Y. Hirano

Mitsubishi Electric Corporation, Japan

**RMO3A-4 14:30**

**145**

**Broadband CMOS Stacked Power Amplifier Using Reconfigurable Interstage Network for Envelope Tracking Application**

Sunghwan Park, Jung-Lin Woo, Moon-Suk Jeon, Unha Kim, Youngwoo Kwon

Seoul National University, Korea

**Monday, 2 June 2014**  
**13:30–15:10**  
**Room TCC 13–14**  
**Session RMO3B: mm-Wave PAs: 60GHz and Beyond**  
Chair: Eddie Spears, RFMD  
Co-Chair: Kevin Kobayashi, RFMD

- RMO3B-1 13:30** **151**  
**Spatially Power-Combined W-Band Power Amplifier Using Stacked CMOS**  
Jefy Jayamon, Ozan Gurbuz, Bassel Hanafi, Amir Agah, James Buckwalter, Gabriel M. Rebeiz, Peter Asbeck  
University of California at San Diego, USA
- RMO3B-2 13:50** **155**  
**A Dual-Mode Highly Efficient 60GHz Power Amplifier in 65nm CMOS**  
Payam M. Farahabadi, Kambiz Moez  
University of Alberta, Canada
- RMO3B-3 14:10** **159**  
**A Digitally Modulated 60GHz Polar Transmitter in 40nm CMOS**  
K. Khalaf<sup>1</sup>, V. Vidojkovic<sup>1</sup>, K. Vaesen<sup>1</sup>, John R. Long<sup>2</sup>, W. Van Thillo<sup>1</sup>, Piet Wambacq<sup>1</sup>  
<sup>1</sup>imec, Belgium, <sup>2</sup>Technische Universiteit Delft, The Netherlands
- RMO3B-4 14:30** **163**  
**A 112–134GHz SiGe Amplifier with Peak Output Power of 120mW**  
Hsin-Chang Lin, Gabriel M. Rebeiz  
University of California at San Diego, USA
- RMO3B-5 14:50** **167**  
**E-Band Transformer-Based Doherty Power Amplifier in 40nm CMOS**  
Ercan Kaymaksut, Dixian Zhao, Patrick Reynaert  
Katholieke Universiteit Leuven, Belgium

**Monday, 2 June 2014**

**13:30–15:10**

**Room TCC 15–16**

**Session RMO3C: mm-Wave & Terahertz Frequency Generation Techniques**

Chair: Kamran Entesari, Texas A&M University

Co-Chair: Brian Floyd, NC State University

- RMO3C-1 13:30** **173**  
A 46.4–58.1GHz Frequency Synthesizer Featuring a 2nd Harmonic Extraction Technique That Preserves VCO Performance  
Bodhisatwa Sadhu, Mark Ferriss, Alberto Valdes-Garcia  
IBM, USA
- RMO3C-2 13:50** **177**  
An 8<sup>th</sup> Sub-Harmonic Injection Locked V-Band VCO for Low Power LO Routing in mm-Wave Beamformers  
Suman P. Sah, Deukhyoun Heo  
Washington State University, USA
- RMO3C-3 14:10** **181**  
235–275GHz ( $\times 16$ ) Frequency Multiplier Chains with up to 0dBm Peak Output Power and Low DC Power Consumption  
Neelanjan Sarmah<sup>1</sup>, Bernd Heinemann<sup>2</sup>, Ullrich R. Pfeiffer<sup>1</sup>  
<sup>1</sup>Bergische Universität Wuppertal, Germany, <sup>2</sup>IHP, Germany
- RMO3C-4 14:30** **185**  
A 5<sup>th</sup> Subharmonic, Inverter-Based Injection Locked Oscillator with 72–83GHz Locking Range  
Qixian Shi<sup>1</sup>, Davide Guermandi<sup>2</sup>, Vito Giannini<sup>2</sup>, Piet Wambacq<sup>1</sup>  
<sup>1</sup>Vrije Universiteit Brussel, Belgium, <sup>2</sup>imec, Belgium

**Monday, 2 June 2014**

**13:30–15:10**

**Room TCC 18**

**Session RMO3D: Advances in Nano-Scale Devices and Novel Measurement Techniques for RFIC Designs**

Chair: Aditya Gupta, Northrop Grumman

Co-Chair: Fujiang Lin, USTC

- RMO3D-1 13:30** **191**  
**mm-Wave Noise Characterization of 40nm CMOS Transistor for up to 67GHz**  
Xi Sung Loo<sup>1</sup>, Hoang V. Nguyen<sup>2</sup>, Zhihong Liu<sup>1</sup>, Johnny Kok Wai Chew<sup>1</sup>, Neven Misljenovic<sup>2</sup>, Bryan Hosein<sup>2</sup>, Christos Tsironis<sup>2</sup>, Jen Shuang Wong<sup>1</sup>, Wai Heng Chow<sup>1</sup>  
<sup>1</sup>GLOBALFOUNDRIES, Singapore, <sup>2</sup>Focus Microwaves, Canada
- RMO3D-2 13:50** **195**  
**A High-Power, Low-Loss W-Band SPDT Switch Using SiGe PIN Diodes**  
Peter Song, Robert L. Schmid, Ahmet Çağrı Ulusoy, John D. Cressler  
Georgia Institute of Technology, USA
- RMO3D-3 14:10** **199**  
**High-Q 3D RF Solenoid Inductors in Glass**  
Jitae Kim, Ravi Shenoy, Kwan-yu Lai, Jonghae Kim  
Qualcomm, USA
- RMO3D-4 14:30** **201**  
**A Cascade RF Power Sensor Based on GaAs MMIC for Improved Dynamic Range Application**  
Zhenxiang Yi, Xiaoping Liao, Zhiqiang Zhang  
Southeast University, China
- RMO3D-5 14:50** **205**  
**RF Power Transistor Characterization and Testing with Hybrid Harmonic Injection Source and Load Tuners**  
Hoang V. Nguyen, Neven Misljenovic, Bryan Hosein  
Focus Microwaves, Canada

**Monday, 2 June 2014**

**15:40–17:20**

**Room TCC 10–11**

**Session RMO4A: Wireless Connectivity Transceivers and Multi-Standard Digital Transmitters**

Chair: Julian Tham, Broadcom  
Co-Chair: Yanjie (Jay) Wang, Intel

- RMO4A-1 15:40** **209**  
**A 55nm CMOS 4-in-1 (11b/g/n, BT, FM, and GPS) Radio-in-a-Package with IPD Front-End Components Directly Connected to Antenna**  
Jing-Hong Conan Zhan<sup>1</sup>, Yuli Hsueh<sup>1</sup>, Min Chen<sup>1</sup>, Meng-Hsiung Hung<sup>1</sup>, Yi-An Li<sup>1</sup>, Lan-Chou Cho<sup>1</sup>, Hui-Hsien Liu<sup>1</sup>, Ming-Da Tsai<sup>1</sup>, Ping-Yu Chen<sup>1</sup>, Jui-Lin Syu<sup>1</sup>, Yi-Chien Tsai<sup>1</sup>, Tao-Yao Chang<sup>1</sup>, Jen-Che Tsai<sup>1</sup>, Sheng-Hao Chen<sup>1</sup>, Ping-Hsuan Tsu<sup>1</sup>, Kuo-Hao Chen<sup>1</sup>, Chun-Yi Wu<sup>1</sup>, Sheng Jau Wong<sup>2</sup>, Chun Geik Tan<sup>2</sup>, George Chien<sup>3</sup>  
<sup>1</sup>MediaTek, Taiwan, <sup>2</sup>MediaTek, Singapore, <sup>3</sup>MediaTek, USA
- RMO4A-2 16:00** **213**  
**A 0.9dB NF 9mW 28nm Triple-Band GNSS Radio Receiver**  
Matteo Conta<sup>1</sup>, Eric Rodal<sup>2</sup>, Seema Anand<sup>1</sup>, Henrik Jensen<sup>1</sup>, Hu Huang<sup>1</sup>, Yu-Wei Lin<sup>1</sup>, Zhenhua Liu<sup>1</sup>, Franco De Flaviis<sup>1</sup>, Kamel Benboudjema<sup>1</sup>  
<sup>1</sup>Broadcom, USA, <sup>2</sup>R2 Semiconductor, USA
- RMO4A-3 16:20** **217**  
**A 23dBm Fully Digital Transmitter Using  $\Sigma\Delta$  and Pulse-Width Modulation for LTE and WLAN Applications in 45nm CMOS**  
Rahmi Hezar, Lei Ding, Joonhoi Hur, Baher Haroun  
Texas Instruments, USA
- RMO4A-4 16:40** **221**  
**A Digital Centric CMOS RF Transmitter for Multistandard Multiband Applications**  
Bastian Mohr, Jan Henning Mueller, Ye Zhang, Bjoern Thiel, Renato Negra, Stefan Heinen  
RWTH Aachen University, Germany
- RMO4A-5 17:00** **225**  
**A 2×2 MIMO 802.11abgn/ac WLAN SoC with Integrated T/R Switch and On-Chip PA Delivering VHT80 256QAM 17.5dBm in 55nm CMOS**  
Tsung-Ming Chen<sup>1</sup>, Wei-Chia Chan<sup>1</sup>, Chien-Cheng Lin<sup>1</sup>, Jui-Lin Hsu<sup>1</sup>, Wen-Kai Li<sup>1</sup>, Pi-An Wu<sup>1</sup>, Yen-Lin Huang<sup>1</sup>, Yen-Chuan Huang<sup>1</sup>, TzungChuen Tsai<sup>1</sup>, Po-Yu Chang<sup>1</sup>, Chih-Lung Chen<sup>1</sup>, Chih-Hou Tsai<sup>1</sup>, Tao-Yao Chang<sup>1</sup>, I-Ching Huang<sup>1</sup>, Wen-Hsien Chiu<sup>1</sup>, Chun-Hao Liao<sup>1</sup>, Chia-Hsin Wu<sup>1</sup>, George Chien<sup>2</sup>  
<sup>1</sup>MediaTek, Taiwan, <sup>2</sup>MediaTek, USA

**Monday, 2 June 2014**

**15:40–17:20**

**Room TCC 13–14**

**Session RMO4B: Highly-Efficient Power Amplifiers**

Chair: Jeff Walling, University of Utah

Co-Chair: Nick Cheng, Skyworks Solutions

- RMO4B-1 15:40** **231**  
**A 25dBm Outphasing Power Amplifier with Novel Non-Isolated Combining Network**  
Lei Ding, Joonhoi Hur, Rahmi Hezar, Baher Haroun  
Texas Instruments, USA
- RMO4B-2 16:00** **235**  
**A +27.3dBm Transformer-Based Digital Doherty Polar Power Amplifier Fully Integrated in Bulk CMOS**  
Song Hu<sup>1</sup>, Shouhei Kousai<sup>2</sup>, Jong Seok Park<sup>1</sup>, Outmane Lemtiri Chlieh<sup>1</sup>, Hua Wang<sup>1</sup>  
<sup>1</sup>Georgia Institute of Technology, USA, <sup>2</sup>Toshiba Corporation, Japan
- RMO4B-3 16:20** **239**  
**A 2.4GHz Class-D Power Amplifier with Conduction Angle Calibration for -50dBc Harmonic Emissions**  
Ao Ba<sup>1</sup>, Vamshi Krishna Chillara<sup>1</sup>, Yao-Hong Liu<sup>1</sup>, Hiromu Kato<sup>2</sup>, Kathleen Philips<sup>1</sup>, Robert Bogdan Staszewski<sup>3</sup>  
<sup>1</sup>imec, The Netherlands, <sup>2</sup>Renesas Electronics Corporation, Japan, <sup>3</sup>Technische Universiteit Delft, The Netherlands
- RMO4B-4 16:40** **243**  
**Wideband and Efficient Watt-Level SiGe BiCMOS Switching Mode Power Amplifier Using Continuous Class-E Modes Theory**  
Mustafa Özen<sup>1</sup>, Mustafa Acar<sup>2</sup>, Mark P. van der Heijden<sup>2</sup>, Melina Apostolidou<sup>2</sup>, Domine M.W. Leenaerts<sup>2</sup>, Rik Jos<sup>2</sup>, Christian Fager<sup>1</sup>  
<sup>1</sup>Chalmers University of Technology, Sweden, <sup>2</sup>NXP Semiconductors, The Netherlands
- RMO4B-5 17:00** **247**  
**A Fully-Integrated 18GHz Class-E Power Amplifier in a 45nm CMOS SOI Technology**  
Jing-Hwa Chen, Sultan R. Helmi, Alice Yi-Szu Jou, Saeed Mohammadi  
Purdue University, USA

**Monday, 2 June 2014**

**15:40–17:20**

**Room TCC 15–16**

**Session RMO4C: Quadrature and Multi-Mode VCOs**

Chair: Jane Gu, University of California at Davis

Co-Chair: Fred Lee, Fairchild Semiconductor

- RMO4C-1 15:40** **253**  
A 26-GHz Low-Phase-Error In-Phase-Coupled QVCO Using Modified Bi-Directional Diodes  
Jun-Chau Chien, Nai-Chung Kuo, Ali M. Niknejad  
University of California at Berkeley, USA
- RMO4C-2 16:00** **257**  
Low-Phase-Noise 54GHz Quadrature VCO and 76GHz/90GHz VCOs in 65nm CMOS Process  
Tianzuo Xi<sup>1</sup>, Shita Guo<sup>1</sup>, Ping Gui<sup>1</sup>, Jing Zhang<sup>2</sup>, Kenneth K. O<sup>2</sup>, Yanli Fan<sup>3</sup>, Daquan Huang<sup>3</sup>, Richard Gu<sup>3</sup>, Mark Morgan<sup>3</sup>  
<sup>1</sup>Southern Methodist University, USA, <sup>2</sup>University of Texas at Dallas, USA, <sup>3</sup>Texas Instruments, USA
- RMO4C-3 16:20** **261**  
A 57-to-75GHz Dual-Mode Wide-Band Reconfigurable Oscillator in 65nm CMOS  
Cheng-Hsien Hung, Ranjit Gharpurey  
University of Texas at Austin, USA
- RMO4C-4 16:40** **265**  
A 2.75–6.25GHz Low-Phase-Noise Quadrature VCO Based on a Dual-Mode Ring Resonator in 65nm CMOS  
Masoud Moslehi Bajestan, Vahid Dabbagh Rezaei, Kamran Entesari  
Texas A&M University, USA



**Monday, 2 June 2014**

**15:40–17:20**

**Room TCC 18**

**Session RMO4D: High-Speed Data Transceivers**

Chair: Mozghan Mansuri, Intel

Co-Chair: Steven Turner, BAE Systems

- RM04D-1 15:40** **271**  
**A 25Gbps, 2×-Oversampling CDR Using a Zero-Crossing Linearizing Phase Detector**  
Zhongkai Wang<sup>1</sup>, Rui Bai<sup>2</sup>, Juncheng Wang<sup>1</sup>, Xing Jing<sup>1</sup>, Qi Nan<sup>2</sup>, Li Sun<sup>3</sup>, C. Patrick Yue<sup>4</sup>, Zhiliang Hong<sup>1</sup>, Patrick Yin Chiang<sup>1</sup>  
<sup>1</sup>Fudan University, China, <sup>2</sup>Oregon State University, USA, <sup>3</sup>University of California at Santa Barbara, USA, <sup>4</sup>HKUST, China
- RM04D-2 16:00** **275**  
**A 3-mW 25-Gb/s CMOS Transimpedance Amplifier with Fully Integrated Low-Dropout Regulator for 100GbE Systems**  
Yipeng Wang, Yan Lu, Quan Pan, Zhengxiong Hou, Liang Wu, Wing-Hung Ki, C. Patrick Yue  
HKUST, China
- RM04D-3 16:20** **279**  
**A 23-mW 30-Gb/s Digitally Programmable Limiting Amplifier for 100GbE Optical Receivers**  
Zhengxiong Hou, Quan Pan, Yipeng Wang, Liang Wu, C. Patrick Yue  
HKUST, China
- RM04D-4 16:40** **283**  
**A 25Gb/s 170μW/Gb/s Optical Receiver in 28nm CMOS for Chip-to-Chip Optical Communication**  
Saman Saeedi, Azita Emami  
California Institute of Technology, USA
- RM04D-5 17:00** **287**  
**A Compact Antenna-in-Package 60-GHz SiGe BiCMOS Radio**  
Eric Juntunen, Alex Tomkins, Alan Poon, Jennifer Pham, Ahmed El-Gabaly, Mohammad Fakharzadeh, Hatem Tawfik, Yat-Loong To, Mihai Tazlauanu, Brad Lynch, Ron Glibbery  
Peraso Technologies, Canada

**Tuesday, 3 June 2014**

**08:00–09:40**

**Room TCC 15–16**

**Session RTU1C: mm-Wave Integration Technologies**

Chair: Luciano Boglione, Naval Research Lab

Co-Chair: Georg Boeck, Berlin University of Technology

- RTU1C-1 08:00 291**  
**Dynamic Polarization Control of Integrated Radiators**  
Steven M. Bowers, Amirreza Safaripour, Ali Hajimiri  
California Institute of Technology, USA
- RTU1C-2 08:20 295**  
**A 64QAM 94GHz CMOS Transmitter SoC with Digitally-Assisted Power Amplifiers and Thru-Silicon Waveguide Power Combiners**  
Tim LaRocca<sup>1</sup>, Yi-Cheng Wu<sup>1</sup>, Khanh Thai<sup>1</sup>, Rob Snyder<sup>1</sup>, Naveen Daftari<sup>1</sup>, Owen Fordham<sup>1</sup>, Paul Rodgers<sup>2</sup>, Monte Watanabe<sup>1</sup>, Yeat Yang<sup>1</sup>, Mohammad Ardakani<sup>1</sup>, Waleed Namoo<sup>1</sup>, Sumiko Poust<sup>1</sup>, Mau-Chung Frank Chang<sup>3</sup>  
<sup>1</sup>Northrop Grumman Aerospace Systems, USA, <sup>2</sup>Space Micro, USA, <sup>3</sup>University of California at Los Angeles, USA
- RTU1C-3 08:40 299**  
**An F-Band 20.6Gbp/s QPSK Transmitter in 65nm CMOS**  
Eli Bloch<sup>1</sup>, Eran Socher<sup>2</sup>  
<sup>1</sup>Technion, Israel, <sup>2</sup>Tel-Aviv University, Israel
- RTU1C-4 09:00 303**  
**A 79-GHz Bidirectional Pulse Radar System with Injection-Regenerative Receiver in 65nm CMOS**  
Pen-Jui Peng, Chiro Kao, Chin-Yang Wu, Jri Lee  
National Taiwan University, Taiwan
- RTU1C-5 09:20 307**  
**A 9-psec Differential Lens-Less Digital-to-Impulse Radiator with a Programmable Delay Line in Silicon**  
M. Mahdi Assefzadeh, Aydin Babakhani  
Rice University, USA

**Tuesday, 3 June 2014**

**10:10–11:50**

**Room TCC 10–11**

**Session RTU2A: Software-Defined and Cognitive Radio Techniques**

Chair: Glenn Chang, MaxLinear

Co-Chair: Ali Afsahi, Broadcom

- RTU2A-1 10:10 313**  
Dual-Mode 10MHz BW 4.8/6.3mW Reconfigurable Lowpass/Complex Bandpass CT  $\Sigma\Delta$  Modulator with 65.8/74.2dB DR for a Zero/Low-IF SDR Receiver  
Yang Xu, Zehong Zhang, Baoyong Chi, Qiongbing Liu, Xinwang Zhang, Zhihua Wang  
Tsinghua University, China
- RTU2A-2 10:30 317**  
A Dual-Mode, Correlation-Based Spectrum Sensing Receiver for TV White Space Applications Achieving -104dBm Sensitivity  
Xiao Xiao, Borivoje Nikolic  
University of California at Berkeley, USA
- RTU2A-3 10:50 321**  
A Widely Tunable Active Duplexing Transceiver with Same-Channel Concurrent RX/TX and 30dB RX/TX Isolation  
Dong Yang, Alyosha C. Molnar  
Cornell University, USA
- RTU2A-4 11:10 325**  
A 1.8dB NF Blocker-Filtering Noise-Canceling Wideband Receiver with Shared TIA in 40nm CMOS  
Hajir Hedayati<sup>1</sup>, Wing-Fat Andy Lau<sup>2</sup>, Namsoo Kim<sup>2</sup>, Vladimir Aparin<sup>2</sup>, Kamran Entesari<sup>1</sup>  
<sup>1</sup>Texas A&M University, USA, <sup>2</sup>Qualcomm, USA
- RTU2A-5 11:30 329**  
A 50MHz–6GHz, 2×2 MIMO, Reconfigurable Architecture, Software-Defined Radio in 130nm CMOS  
Behnam Analui<sup>1</sup>, Timothy Mercer<sup>2</sup>, Sam Mandegaran<sup>1</sup>, Ankush Goel<sup>1</sup>, Hossein Hashemi<sup>1</sup>  
<sup>1</sup>University of Southern California, USA, <sup>2</sup>Broadcom, USA

**Tuesday, 3 June 2014**

**10:10–11:50**

**Room TCC 13–14**

**Session RTU2B: Multiband PAs and Power Mixers**

Chair: Leon van den Oever, Radio Semiconductor Corporation

Co-Chair: Joseph Staudinger, Freescale

- RTU2B-1 10:10 335**  
A Dual Band CMOS Power Amplifier for an S/X Band High Resolution Radar System  
Junhyuk Choi, Byungjoon Kim, Duksoo Kim, Jaeyong Ko, Sangwook Nam  
Seoul National University, Korea
- RTU2B-2 10:30 339**  
A 9.5–18.5GHz Power Amplifier for Multi-Band Microwave Point-to-Point Backhaul Communication  
Kefeng Han<sup>1</sup>, Xun Luo<sup>2</sup>  
<sup>1</sup>Huawei Technologies, China, <sup>2</sup>Technische Universiteit Delft, The Netherlands
- RTU2B-3 10:50 343**  
A 19.1dBm Segmented Power-Mixer Based Multi-Gbps mm-Wave Transmitter in 32nm SOI CMOS  
Kaushik Dasgupta, Kaushik Sengupta, Alex Pai, Ali Hajimiri  
California Institute of Technology, USA
- RTU2B-4 11:10 347**  
A 200GHz Power Mixer in 130nm-CMOS Employing Nonlinearity Engineering  
Jahnvi Sharma, Tolga Dinc, Harish Krishnaswamy  
Columbia University, USA

**Tuesday, 3 June 2014**  
**10:10–11:50**  
**Room TCC 15–16**  
**Session RTU2C: Sub-mm-Wave Transceivers**  
Chair: Mona Hella, RPI  
Co-Chair: Didier Belot, STMicroelectronics

- RTU2C-1 10:10** **353**  
**A 240GHz Wideband QPSK Transmitter in 65nm CMOS**  
Shinwon Kang, Siva V. Thyagarajan, Ali M. Niknejad  
University of California at Berkeley, USA
- RTU2C-2 10:30** **357**  
**A 240GHz Wideband QPSK Receiver in 65nm CMOS**  
Siva V. Thyagarajan, Shinwon Kang, Ali M. Niknejad  
University of California at Berkeley, USA
- RTU2C-3 10:50** **361**  
**A 314GHz, Fully-Integrated SiGe Transmitter and Receiver with Integrated Antenna**  
Saeed Zeinolabedinzadeh<sup>1</sup>, Mehmet Kaynak<sup>2</sup>, Wasif Khan<sup>1</sup>, Mahmoud Kamarei<sup>3</sup>, Bernd Tillack<sup>2</sup>, John Papapolymerou<sup>1</sup>, John D. Cressler<sup>1</sup>  
<sup>1</sup>Georgia Institute of Technology, USA, <sup>2</sup>IHP, Germany, <sup>3</sup>University of Tehran, Iran
- RTU2C-4 11:10** **365**  
**A 155GHz 20Gbit/s QPSK Transceiver in 45nm CMOS**  
Y. Yang<sup>1</sup>, S. Zehir<sup>1</sup>, Hsin-Chang Lin<sup>1</sup>, O. Inac<sup>2</sup>, W. Shin<sup>3</sup>, Gabriel M. Rebeiz<sup>1</sup>  
<sup>1</sup>University of California at San Diego, USA, <sup>2</sup>Intel, USA, <sup>3</sup>Qualcomm, USA
- RTU2C-5 11:30** **369**  
**An Integrated Traveling-Wave Slot Radiator**  
Steven M. Bowers, Amirreza Safaripour, Ali Hajimiri  
California Institute of Technology, USA

**Tuesday, 3 June 2014**  
**13:30–16:00**  
**Room TCC Ballroom C–D**  
**Session RTUIF: Interactive Forum**  
Chair: Freek Van Straten, NXP Semiconductors  
Co-Chair: Jennifer Kitchen, Arizona State University

- RTUIF-1 13:30 377**  
**A Low Power and High Linearity Dual Path Up-Down Converter for Wireless Telecommunication Repeater System**  
Hyo-Bin Jung<sup>1</sup>, Won-Jae Jung<sup>1</sup>, Se-mi Lim<sup>1</sup>, Sung-woo Lim<sup>1</sup>, Ji-hoon Lee<sup>1</sup>, Kyu-Hyun Nam<sup>1</sup>, Nam-Pyo Hong<sup>2</sup>, Jong-Eun Jang<sup>2</sup>, Jun-Seok Park<sup>1</sup>  
<sup>1</sup>Kookmin University, Korea, <sup>2</sup>EPIC Solution, Korea
- RTUIF-2 13:30 381**  
**A 17-mW 5-Gb/s 60-GHz CMOS Transmitter with Efficiency-Enhanced On-Chip Antenna**  
Rui Wu<sup>1</sup>, Wei Deng<sup>1</sup>, Shinji Sato<sup>1</sup>, Takuichi Hirano<sup>1</sup>, Ning Li<sup>1</sup>, Takeshi Inoue<sup>2</sup>, Hitoshi Sakane<sup>2</sup>, Kenichi Okada<sup>1</sup>, Akira Matsuzawa<sup>1</sup>  
<sup>1</sup>Tokyo Institute of Technology, Japan, <sup>2</sup>S.H.I. Examination & Inspection, Japan
- RTUIF-3 13:30 385**  
**A Multi-Mode Software-Defined CMOS BPSK Receiver SoC for the Newly Enhanced WWVB Atomic Clock Broadcast**  
O. Eliezer, T. Jung, R. Lobo, M. Appel, Y. Liang, D. Robbins, P. Nelsen, Z. Islam  
Xtendwave, USA
- RTUIF-4 13:30 389**  
**Design and Implementation of an Analog Front-End Circuit for Semi-Passive HF RFID Tag**  
Xuecheng Zou<sup>1</sup>, Huan Lin<sup>1</sup>, Hui Lin<sup>2</sup>, Dongsheng Liu<sup>1</sup>, Liang Guo<sup>1</sup>, Ke Yao<sup>1</sup>  
<sup>1</sup>HUST, China, <sup>2</sup>WUT, China
- RTUIF-5 13:30 393**  
**A UHF-Band RFID Transmitter with Spur Reduction Technique Using a DLL-Based Spread-Spectrum Clock Generator**  
Seungjin Kim<sup>1</sup>, In-Young Lee<sup>1</sup>, Sang-Sung Lee<sup>1</sup>, Min Su Kil<sup>2</sup>, Jeongki Choi<sup>2</sup>, Jinho Ko<sup>2</sup>, Sang-Gug Lee<sup>1</sup>  
<sup>1</sup>KAIST, Korea, <sup>2</sup>PHYCHIPS, Korea

- RTUIF-6 13:30 397**  
**A Fully Integrated 5.9GHz RF Frontend in 0.25 $\mu$ m GaN-on-SiC for Vehicle-to-Vehicle Applications**  
Pilsoon Choi<sup>1</sup>, Sushmit Goswami<sup>1</sup>, Chirn Chye Boon<sup>2</sup>, Li-Shiuan Peh<sup>1</sup>, Hae-Seung Lee<sup>1</sup>  
<sup>1</sup>MIT, USA, <sup>2</sup>Nanyang Technological University, Singapore
- RTUIF-7 13:30 401**  
**A Low Power 8<sup>th</sup> Sub-Harmonic Injection Locked Receiver for mm-Wave Beamforming Applications**  
Suman P. Sah, Pawan Agarwal, Deukhyoun Heo  
Washington State University, USA
- RTUIF-8 13:30 405**  
**A D-Band Transceiver Front-End for Broadband Applications in a 0.35 $\mu$ m SiGe Bipolar Technology**  
Abhiram Chakraborty<sup>1</sup>, Saverio Trotta<sup>1</sup>, Johann Wuertele<sup>1</sup>, Robert Weigel<sup>2</sup>  
<sup>1</sup>Infineon Technologies, Germany, <sup>2</sup>FAU Erlangen-Nürnberg, Germany
- RTUIF-9 13:30 409**  
**A 0.5–6GHz 25.6dBm Fully Integrated Digital Power Amplifier in 65nm CMOS**  
Hongrui Wang, Hossein Hashemi  
University of Southern California, USA
- RTUIF-10 13:30 413**  
**A Watt-Level 2.4GHz RF I/Q Power DAC Transmitter with Integrated Mixed-Domain FIR Filtering of Quantization Noise in 65nm CMOS**  
Ritesh Bhat, Harish Krishnaswamy  
Columbia University, USA
- RTUIF-11 13:30 417**  
**Design Strategy for High Performance 60GHz CMOS Power Amplifiers**  
Amin Hamidian, Andrea Malignaggi, Georg Boeck  
Technische Universität Berlin, Germany
- RTUIF-12 13:30 421**  
**Voltage Controlled Oscillator Area Reduction in Nano-Scale CMOS**  
Amit Jha<sup>1</sup>, Ken Liao<sup>2</sup>, Geoffrey Yeap<sup>2</sup>, Kenneth K. O<sup>1</sup>  
<sup>1</sup>University of Texas at Dallas, USA, <sup>2</sup>Qualcomm, USA

- RTUIF-13 13:30 425**  
**Impact of Non-Quasi-Static Effects on  $1/f^3$  Phase Noise in a 1.9-to-2.6GHz Oscillator**  
Federico Pepe, Andrea Bonfanti, Salvatore Levantino, Andrea L. Lacaita  
Politecnico di Milano, Italy
- RTUIF-14 13:30 429**  
**A 1.6GHz/4.8GHz Dual-Band CMOS Fractional-N Frequency Synthesizer for S-Band Radio Applications**  
Masoud Moslehi Bajestan, Eugene Foli, Hajir Hedayati, Kamran Entesari  
Texas A&M University, USA
- RTUIF-15 13:30 433**  
**An RF Instantaneous-Hop Frequency Synthesizer Based on a Zero-Initial-Phase-Error Multi-Modulus Divider**  
Tsung-Hao Chuang, Harish Krishnaswamy  
Columbia University, USA
- RTUIF-16 13:30 437**  
**Variation-Aware X-Topology Architecture with Local Ground References for Broadband Characterization of Passives**  
Farooq Mukhtar<sup>1</sup>, Johannes A. Russer<sup>1</sup>, Sidina Wane<sup>2</sup>, Damienne Bajan<sup>3</sup>, An-Yu Kuo<sup>4</sup>, Peter Russer<sup>1</sup>  
<sup>1</sup>Technische Universität München, Germany, <sup>2</sup>NXP Semiconductors, France, <sup>3</sup>ISAE, France, <sup>4</sup>Cadence Design Systems, USA
- RTUIF-17 13:30 441**  
**Analysis of Crosstalk Delay Using Mixed CNT Bundle Based Through Silicon Vias**  
Manoj Kumar Majumder, Archana Kumari, B.K. Kaushik, S.K. Manhas  
IIT Roorkee, India
- RTUIF-18 13:30 445**  
**On the Reliability of SiGe HBT Cascode Driver Amplifiers**  
Michael A. Oakley, Brian Wier, Uppili S. Raghunathan, Partha S. Chakraborty, John D. Cressler  
Georgia Institute of Technology, USA
- RTUIF-19 13:30 449**  
**A 4.7-Gb/s Imaging Receiver with Adaptive Spectrum Re-Balancing Equalizer for Wireless Optical Communications**  
Behrooz Nakhkoob, Mona M. Hella  
Rensselaer Polytechnic Institute, USA