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2020



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PLEASE NOTE: This program book is meant to be commemorative and reflects what would have taken place should IMS2020 and Microwave Week remained an in person event, 21-26 June 2020 in Los Angeles, CA. A new virtual event program book will be available in Mid July 2020. For the latest information please visit www.ims-ieee.org.

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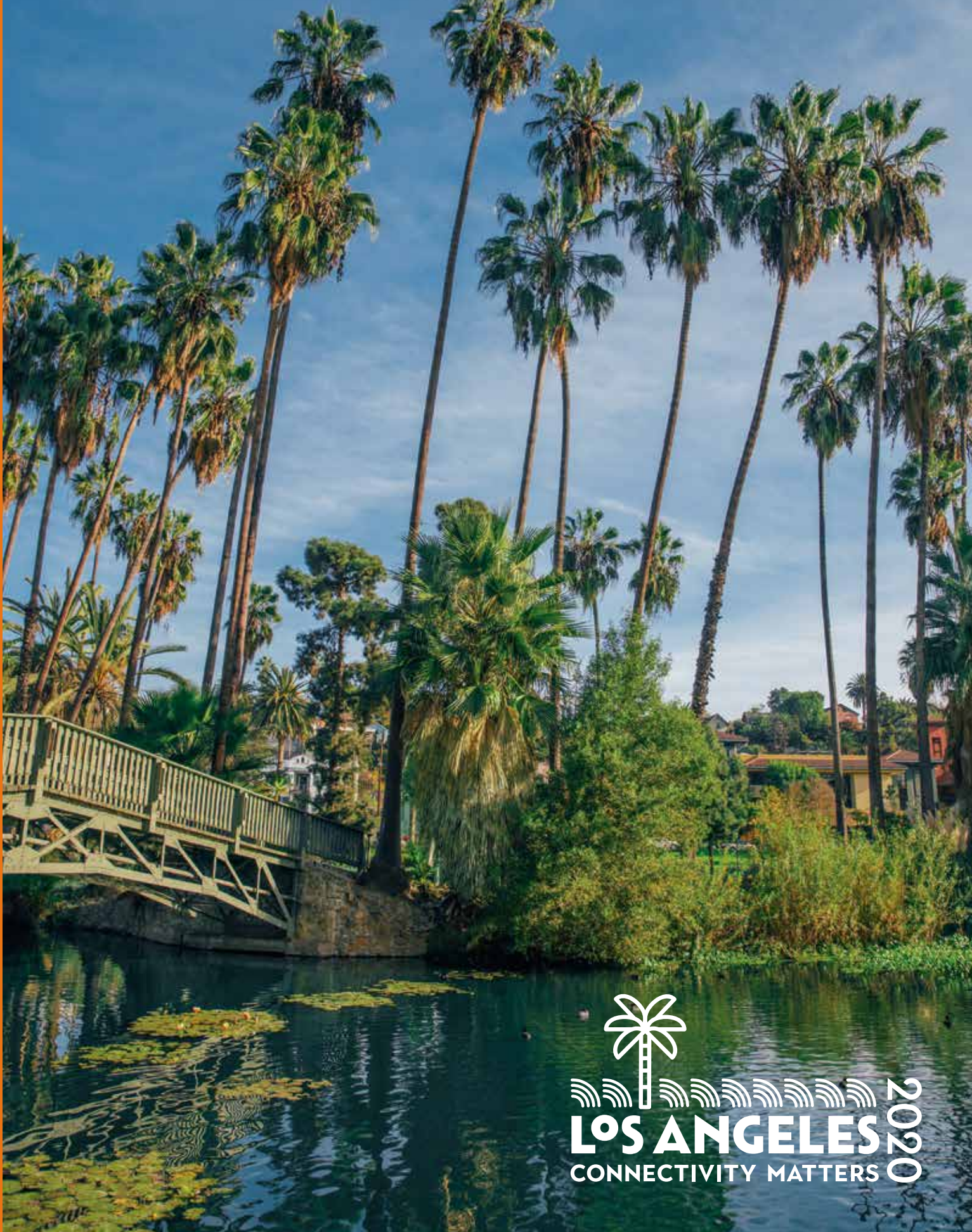
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Sunday

Workshop Title	Workshop Abstract
<p>WSA</p> <p>Machine Learning and AI Techniques with Intelligent RF/mm-Wave Systems for Wireless Communication, Sensing, and Computation Sponsor: IMS; RFIC Organizer: A. Arbabian, Stanford University, V. Giannini, Uhnder, V. Giannini, Uhnder 08:00 – 17:15</p>	<p>Recent development of machine learning and AI techniques have extended the capability of conventional RF and mm-wave systems beyond their classical limits to solve unconventional problems. This workshop will showcase intelligent mixed-signal, RF/mm-wave, and microwave photonics systems, which exploit machine learning and AI techniques in three focused application areas – advanced wireless communication, sensing, and computation. With a focused theme on wireless communication, the workshop will explore machine learning and AI techniques exploited for RF signal conditioning, dynamic wireless spectrum collaboration, wireless power amplifier linearization, and massive MIMO mm-wave phased array beamforming. With a focus on sensing and imaging applications, the workshop will present machine learning based radar signal processing techniques for autonomous navigation and their implementations with integrated frequency modulated continuous wave (FMCW) radar systems. The unique advantages in using neural networks in super-resolution radar signal processing will also be discussed in comparison to classical approaches such as maximum likelihood estimation. With a focus on computation, the workshop will culminate mixed-signal, RF/mm-wave, and microwave photonics circuit techniques to accelerate energy-efficient multi-dimensional signal processing for machine learning and AI algorithms. In addition, this workshop will discuss several applications of photonic deep learning hardware accelerators in wireless communication such as RF fingerprinting. The emphasis of the workshop will be given to the design considerations and the interaction between underlying hardware system architectures and signal processing algorithms for advancing the capability of classical systems by leveraging machine learning and AI techniques.</p>
<p>WSB</p> <p>CMOS mm-Wave Imaging Radars: State-of-the-Art and a Peek into the Future! Sponsor: IMS; RFIC Organizer: B. Jalali Farahani, Acacia Communications, R. Aroca, Acacia Communications 08:00 – 17:15</p>	<p>Advances in mm-wave CMOS technology have resulted in fully integrated mm-wave radar sensors that offer a cost-effective and robust solution to automotive safety, provide accurate industrial sensing and enable gesture recognition. This workshop will feature technical experts from both academia and industry to present the state-of-the-art in mm-wave CMOS technology such as all-digital architectures, higher carrier frequencies, advanced signal processing and machine learning. These technologies promise to improve the achievable accuracy and push performance levels further. Speakers will also share their view of the next steps in this space and the possibilities for the future.</p>
<p>WSC</p> <p>Coherent Optical Communications for Cloud Data Centers, Metro, and Submarine Networks Sponsor: IMS; RFIC Organizer: F. Sebastiano, Technische Universiteit Delft, J. Bardin, UMass Amherst 08:00 – 17:15</p>	<p>The introduction of IoT (Internet of things) and cloud computing has accelerated the demand for higher bandwidth and higher capacity networks. Coherent detection, where the phase information of the optical carrier provides higher signal-to-noise ratios, has gained an ever-increasing momentum. Today coherent communication dominates long-haul networks operating with data rates beyond 400 Gbps per wavelength. Thanks to advancements in digital signal processing that leverage ultra-low power implementations in deep submicron technologies (i.e. 7nm), the cost and power of coherent transponders are becoming competitive for short reach networks as well (inter and intra-data centers). Reducing the cost and enhancing the overall performance of such networks are only achievable through highly integrated solutions that encompass complex digital signal processing algorithms, state-of-the-art transimpedance amplifiers and modulator drivers, and integrated silicon photonics. The co-design and co-optimization become the key factor in further power and performance scaling of coherent transponders. Different parts of optical communication systems have been subject of prior workshops at RFIC. This workshop, however, brings together a multidisciplinary team of experts to inform the audience of various technology advancements in all key components that make up an integrated optical communication system. Co-design, co-optimization, and hybrid integration will be the theme and focus of this workshop and are addressed by several speakers from different backgrounds. The following talks are planned for this workshop: (1) Introduction to the Workshop: (Co-organizers) 15-minutes Brief overview of coherent and direct detection in optical communication systems. Market Forces and Network Evolution: (Martin Zirngibl Chief Technologist at II-VI-Confirmed) 40-minutes · Coherent scaling trends from long-haul to data centers · Direct or coherent detection for short reach 800G and beyond · How to use technologies that have been used for long-haul for short-reach applications · Co-packaging optics and processors · Q&A 5-minutes (2) Integrated Optics: (Chris Doerr, VP of Engineering Advanced Development, Acacia- Confirmed) 40-minutes · State-of-the-art SiPh transceivers for 100Gbaud and beyond: Performance, Hybrid Integration, and Packaging · Laser requirements and integration challenges · Q&A 5-minutes (3) mm-Wave ASICs: (Prof. Jim. Buckwalter- University of Santa Barbara-Confirmed) 40-minutes · Energy-efficient Coherent Optical Transceivers using Silicon Photonic and Si CMOS/SiGe BiCMOS RFICs · Q&A 5-minutes (4) ADCs and DACs for coherent transmission beyond 400G (Ian Dedic - Acacia-Confirmed) 40-minutes · architecture and challenges · performance scaling · opto-electronic co-design · Q&A 5-minutes (5) Digital Signal Processing: (Prof. Joseph M. Kahn- Stanford-Confirmed) 40-minutes · How coherent detection and digital signal processing (DSP) revolutionized long-haul systems · DSP-based compensation of dispersion, polarization effects, component limitations, and laser phase noise · Digital vs. analog signal processing for emerging coherent intra- and inter-data center systems · Q&A 5-minutes (6) Panel Discussion 40-minutes. Address more debatable topics. Allow all the speakers and audience to participate in the discussion and tackle the problem from different angles. Panel is moderated by co-organizers.</p>

Workshop Abstract	Workshop Title	
<p>Quantum computing has recently spurred intense research activity towards the development of the cryogenic electronics to control quantum devices operating at cryogenic temperatures. Furthermore, several applications beyond quantum computing require cryogenic electronics either to be compatible with very low ambient temperatures or to outperform the performance of their room-temperature counterparts. This workshop will present an overview of cryogenic electronics from applications down to device operation, focusing on integrated circuits. First, typical applications requiring operation at cryogenic temperatures, such as quantum computing (first talk) and particle physics (second talk), will be presented to highlight requirements, current limitations, and future perspectives. Next, the operation of SiGe (third talk) and CMOS (fourth talk) at cryogenic temperatures will be discussed. Finally, four design examples of integrated circuits employing SiGe, bulk CMOS and FD-SOI CMOS and targeting low-noise amplification or quantum computing will be shown, thus practically demonstrating techniques to exploit (or circumvent) cryogenic operation.</p>	<p>Cryogenic Electronics for Quantum Computing and Beyond: Applications, Devices, and Circuits Sponsor: RFIC Organizer: D. Chowdhury, Broadcom, D.Y.C. Lie, Texas Tech University, P. Reynaert, Katholieke Universiteit Leuven 08:00 – 17:15</p>	<p>WSD</p>
<p>LNA, PA, SW, phase shifter can all be integrated into 1 silicon RF Front-End (RFFE) IC for mm-wave 5G, and even multichannel integration are likely; however, the advantages in costs, robustness, manufacturability for the all-silicon RFFE IC approach not yet clear vs. hybrid III-V/silicon solutions for 5G. The power efficiency of mm-wave 5G broadband PA is considerably lower than their 4G counterparts, and GaN/GaAs III-V based PAs have high output power and good efficiency vs. those of silicon-based PAs, but hybrid integration approaches increase rapidly in cost as complexity increases, as will be covered in this workshop. mm-Wave PA linearity vs. PAE (power-added-efficiency) at power backoff is always a design trade-off, and novel RF linearization techniques are required to improve these 5G mm-wave PAs. All-silicon solutions with superstrates for antennas are currently being investigated, and we will discuss the PA-Antenna and PA-Package co-design for 5G MIMO PAs as well.</p>	<p>Fully Integrated Silicon vs. Hybrid RFFE Systems for 5G mm-Wave Highly Efficient PA Design Trade-Offs Sponsor: RFIC Organizer: B. Sadhu, IBM T.J. Watson Research Center, T. LaRocca, Northrop Grumman 08:00 – 17:15</p>	<p>WSE</p>
<p>The tutorial-style workshop by top phased array experts in academia and industry will provide an in-depth learning experience for the attendees and walk them through the different aspects of mm-wave phased-array transceiver design. The workshop will feature leading experts from academia and industry and cover the following topics on mm-wave phased arrays: (1) silicon-based mm-wave phased array basics, (2) phase and gain control circuits, (3) package, antenna and module co-design and calibration, (5) phased array measurements: on-chip and over-the-air, (5) applications of phased arrays in commercial and defense systems, and (6) current 5G NR phased array systems, limitations, and an outlook towards 6G.</p>	<p>mm-Wave Phased-Array Transceiver Design: From Basics to Advancements Sponsor: RFIC Organizer: A. Frappé, IEMN (UMR 8520), J. Kitchen, Arizona State University, R. Pulella, MaxLinear 08:00 – 17:15</p>	<p>WSF</p>
<p>5G communications in the sub-6GHz frequencies offer enhanced data rates, capacity, and flexibility but face challenges such as energy efficiency, linearity, integration, and scalability. To increase battery life, optimization of the efficiency of the power amplifier is of utmost importance. This workshop investigates digitally intensive transmit architectures and pre-distortion techniques that enhance efficiency of transmitters and power amplifiers used in these next-generation wireless systems. Experts from industry and academia will share their latest research on linearization techniques to build highly efficient linear PAs in various technologies employing topologies such as Doherty, out-phasing or polar. Circuit topologies and digital signal processing algorithms for pre-distortion of these power amplifiers will also be covered in this workshop.</p>	<p>Sub-6GHz Advanced Transmitter Architectures and PA Linearization Techniques Sponsor: RFIC Organizer: E. Klumperink, University of Twente, K. Entesari, Texas A&M University 08:00 – 17:15</p>	<p>WSG</p>
<p>To meet an order-of-magnitude increase in data traffic demand on mobile networks, 5G networks will be key to support this growth. 5G massive multiple-input, multiple-output (MIMO) technology will deliver high data rates to many users, helping to increase capacity. It will support real-time multimedia services and reduce energy consumption by targeting signals to individual users utilizing digital beamforming. Also, element-level digital beamforming that supports emerging multi-beam communications and directional sensing at mm-wave frequency range, will expand the use of mm-wave phased-arrays and make them broadly applicable across Department of Defense (DoD) systems. The focus of this workshop is to present state-of-the-art radio circuits and systems exploiting MIMO and digital beamforming at sub-6GHz and mm-wave bands for both civilian 5G NR and defense applications.</p>	<p>5G Radio Circuits and Systems Exploiting MIMO and Digital Beamforming Sponsor: RFIC Organizer: G. Hueber, Silicon Austria Labs, Y.-H. Liu, IMEC 08:00 – 17:15</p>	<p>WSH</p>

Workshop Title	Workshop Abstract
<p>WSI</p> <p>Wireless Technologies for Indoor Positioning and Localisation Systems Sponsor: RFIC; IMS Organizer: M. Mikhemar, Broadcom, S.E. Turner, BAE Systems, T. LaRocca, Northrop Grumman 08:00 – 17:15</p>	<p>Indoor positioning and localization will be the big wave in next generation IoT. It is a process of obtaining the location of a device or a user in an indoor environment, which is a key technology enabling various IoT applications, e.g., smart building, distance-bounded security, smart industrial, etc. In this workshop, several popular smartphone based wireless technologies that are used for localizing people or objects will be discussed. Currently Bluetooth Low Energy (BLE), Ultra-WideBand (UWB) and WiFi are three popular standard compliant localization approaches. BLE is the most widely adopted smartphone based wireless protocol, so BLE-based localization has the advantage in densely deployed infrastructure. UWB is an emerging wireless localization technology, and it is now also used in future smartphones (e.g., iphone 11). The new UWB protocol IEEE802.15.4z can provide cm-level accuracy thanks to its wide spectrum. Finally, WiFi, as a wireless technology deployed in most of the buildings, will also play an important role in accurate positioning with the upcoming IEEE 802.11az protocol. Finally, the anchor-less indoor localization using radar will also be covered in this workshop.</p>
<p>WSJ</p> <p>Satellite Communication Systems: An End-to-End Review From LEO-GEO-CubeSat System Requirements to Radiation Hardened Devices Sponsor: RFIC Organizer: J. Walling, Qualcomm, O. Eliezer, Apogee Semiconductor 08:00 – 17:15</p>	<p>Want to understand the “Go” in GoGo Wireless In-flight Satellite Internet? Interested in learning about satellite orbits, CubeSats and its demands on RF electronics? Need to design on CMOS using a high-reliability PDK or next generation rad-hard process? This vertically oriented workshop provides technical know-how from the satellite to the device by bringing together commercial and defense leaders in space hardware. A review of satellite orbits and the demands on the antenna system as well as a detailed overview of CubeSats and the drive for small-form factor, high reliability electronics is covered. This is followed by a comprehensive review of the market and challenges for SatCom terminals and the need for high reliability electronics. The workshop will then cover RFICs for space in both CMOS and III-V technology including a special overview of advanced very low power CMOS for deep space sensors. Finally, a technical review of radiation types, effects on CMOS, and the techniques to successfully design in space using a radiation hard library or a next generation radiation hard process on advanced bulk CMOS is offered. This is a great place for new and experienced engineers to learn about the adventure of space.</p>
<p>WSK</p> <p>Highly Linear and Linearized Power Amplifiers for Broadband and mm-Wave Communications Sponsor: RFIC Organizer: R. Han, MIT, W. Wu, Samsung 08:00 – 11:50</p>	<p>Presently, power amplifiers do not fulfill all of the requirements of linearity, energy efficiency, and bandwidth that are required for new radio and mm-wave operation for 5G and future communications, particularly for the user equipment. New techniques are required in the design of ultra-high linearity power amplifiers, or through improved linearization, efficiency enhancement and bandwidth extension techniques to dramatically improve the performance to open the full potential of future communications systems. It is noted that all aspects of new radio and mm-wave PA design become more challenging when placed into arrays with non-negligible element-to-element coupling. This workshop will explore power amplifier designs in the mm-wave spectrum, as well as linearization techniques (digital pre-distortion (DPD), outphasing, envelope tracking, etc.) and efficiency enhancement (load-modulation, supply modulation, etc.), in both user equipment and base stations.</p>
<p>WSL</p> <p>Recent Advances in Frequency Generation Techniques for sub-6GHz, mm-Wave, and Beyond Sponsor: RFIC Organizer: J. Gu, University of California, Davis, M. Rodwell, University of California, Santa Barbara, T. LaRocca, Northrop Grumman 13:30 – 17:15</p>	<p>In emerging 5G cellular communication and other mm-wave systems, the generation, distribution, and synchronization of the local oscillator (LO) signals remain a challenge. This workshop covers the latest design techniques of frequency synthesis circuit components and systems to generate LO signals with low phase noise, low spurious tones, wide modulation bandwidth, and long term stability across a wide operation frequency range. The first talk address LO frequency synthesis and voltage-controlled oscillator (VCO) coupling mitigation in the advanced 5G cellular transceiver. The second talk focuses on ultra-wide-tuning-range VCO design for mm-wave and sub-THz frequencies. The third talk explores state-of-the-art phase locked loops (PLLs) for frequency-modulated continuous wave (FMCW) generation. And the last talk introduces a new low cost reference clock generation method, molecular clock, for wireless network synchronization and navigation.</p>
<p>WSM</p> <p>100–300GHz mm-Wave Wireless for 0.1–1Tb/s Networks Sponsor: RFIC Organizer: U. Rueddenklau, Infineon Technologies, V. Issakov, OvG Universität Magdeburg 08:00 – 17:15</p>	<p>Wireless systems using higher (100–300GHz) mm-wave carrier frequencies will benefit from large available bandwidths and, given the very short wavelengths, massive spectral re-use via massive spatial multiplexing. Simple radio link budget analysis suggests that ~1Tb/s capacities are feasible in both point-multipoint network hub and point-point backhaul links. But, range is limited by high Friis path loss and high foul-weather attenuation, and beams are readily blocked. We will examine the design, the technical challenges, and the potential design of such systems, including link architecture, link budgets, radio propagation characteristics, array tile module and antenna design, MIMO channel estimation, massive MIMO beamformer dynamic range analysis, digital beamformer design, design of mesh networks to accommodate beam blockage, RF front-end design in CMOS, SiGe and III-V technologies, and estimates of system DC power consumption as a function of architecture.</p>

Workshop Abstract	Workshop Title
<p>The rationale for the 5th generation of mobile communications (5G) development is to expand the broadband capability of mobile networks, and to provide capabilities not only for consumers but also for other sectors of the economy in particular vertical industries at large such as manufacturing. 5G is built to address three essential types of communication: extreme mobile broadband (eMBB), massive machine type communication (mMTC), and ultra-reliable low-latency communications (URLLC). The first type, enhanced mobile broadband (eMBB) is meant to provide both extreme high data-rate (several Gbps) and low latency communications (several ms) also to offer enhanced coverage, well beyond that provided by 4G. mMTC is designed to provide wide area coverage and deep penetration for hundreds of thousands of sensor devices per square kilometer of coverage. mMTC is also designed to provide ubiquitous connectivity with low software and hardware complexity for a device and battery-saving low-energy operation. The third category URLLC, which is also called Critical MTC, wherein monitoring and control occur in real time, E2E latency requirements are very low (at millisecond levels), and the need for reliability is high, e.g., down to 10^{-5} and lower. The objective of URLLC is, among others, to provide communication to industrial process control and sensor networking that have stringent requirements in terms of reliability and low latency at the application layer. In this half-day workshop we focus on URLLC, particularly Latency and Reliability for URLLC. 5G will ensure that URLLC will have the capability to achieve a latency over the 5G radio interface of e.g. 1 ms with a reliability of $1-10^{-5}$ meaning that a small packet can be transferred over the radio interface, where the successful transmission can be guaranteed with a failure probability of 10^{-5} within a specified time bound e.g. 1ms. Low latency communication is enabled by introducing short transmission slots, allowing faster uplink and downlink transmission. By reducing the transmission duration and interval, both the time over the air and the delay introduced at the transmitter while waiting for the next transmission opportunity are reduced. Reliability can be achieved by e.g. using robust modulation and coding schemes (MCS), and diversity/redundancy techniques. Known channel coding schemes are used (such as Turbo codes or low-density-parity-check (LDPC) codes for data channels; and tail-biting convolutional or Reed-Müller codes or Polar codes for control channels, respectively). Redundancy can be provided by various means among e.g. multi-antenna, frequency or time diversity. Multi-connectivity via multi-carrier or multiple transmission points comes as a further diversity technique extending, where the device is connected via multiple frequency carriers to the radio network. Several flavors of multi-connectivity have been defined in 3GPP. While these features previously focused on improving the user throughput, by aggregating resources of the different used carriers, the focus has shifted recently to improve the transmission reliability. We describe use cases, frequency spectrum situation, technologies including measurement challenges for the 5G area of Industry 4.0 for IIoT, factory automation and smart manufacturing. Distinguished speakers from leading companies and 5G standardization discuss several aspects of 5G wireless infrastructure.</p>	<p>Wireless Technologies for Ultra-Reliable Low-Latency Communication (URLLC) Applications Sponsor: IMS Organizer: U. Rueddenklau, Infineon Technologies, V. Issakov, OvG Universität Magdeburg 13:30 – 17:15</p>

WSN

SUNDAY

THREE MINUTE THESIS

LACC

15:00 – 17:00

SUNDAY, 21 JUNE 2020

IMS2020

(3MT®) COMPETITION

Now in its fourth year, the Microwave Week 3MT® competition is designed to stimulate interest in the wide range of applications of microwave technology. Eligible student and young professional competitors will make a presentation of three minutes or less, supported only by one static slide, in a language appropriate to a non-specialist audience.

New for 2020: our finalists represent IMS, RFIC and ARFTG.

The winners of the 3MT® competition will receive their prizes at the IMS2020 Closing Ceremony on Thursday, 25 June 2020.

We encourage all Microwave Week attendees to come to our Pre-Competition Presentation Skills Session, our briefing session, and our coaching session, all in the same venue as the competition.



ORGANIZERS/CO-CHAIRS: John Bandler, *McMaster University*; Erin Kiley, *MCLA*

MASTER OF CEREMONIES: Sherry Hess, VP Marketing, *AWR Group at National Instruments*

JUDGES: TBA

Pre-Competition Presentation Skills Session 10:00 – 12:00
Hosted by John Bandler and Erin Kiley

Three Minute Thesis Briefing Session 13:00-14:00

Three Minute Thesis Coaching Session 14:00-15:00

Three Minute Thesis Competition 15:00-17:00

THIS YEAR'S FINALISTS ARE:

Making 5G Devices Multilingual

Tu3C Eduardo Vilela Pinto dos Anjos, KU Leuven

Shaping and Steering Electromagnetic Beams for Pennies on the Dollar

Th2G Fatemeh Akbar, California Institute of Technology (Caltech)

Magical Antenna Array without the Rainbow Effect

Tu4A Minning Zhu, Rutgers University

Smart Textiles for Recycling Radio Waste

Th1E Mahmoud Wagih, University of Southampton

Improving 5G Cell Towers' Power Efficiency Using Signal Processing

We1F AhmedBen Ayed, University of Waterloo

Journey towards Energy-Saving Electronic Ecosystems

Th2D Aditya Dave, University of Minnesota, Twin Cities

Thriving Beyond Copper for 5G

Tu4A Renuka Bowrothu, University of Florida

Silent, But We Can Hear You!

We3D Li Wen, Shanghai Jiao Tong University

Finding the Musical Notes of Material Properties

Tu4D Nikita Mahjabeen, University of Texas at Dallas

Beating the Enemy in Communication

We3G Xiaoyu Wang, University College Dublin

No Ambiguity at All!

We2B Wei Xu, Shanghai Jiao Tong University

Redefining Electronics through Printing

Tu1G Shuai Yang, King Abdullah University of Science and Technology

Be Gone, Diabetes! Microwave is in the House!

Th2E Dieff Vital, Florida International University

Improving and Enabling Future Generations of Wireless Communications: the Grandparent Factor

WEIF1 Abdessamad Boulmirat, Université Grenoble Alpes - CEA, LETI

A Pocket-Sized Microwave Detector

Tu3D Elif Kaya, Texas A&M University

A Truly Connected World

We1F Ifrah Jaffri, University of Waterloo

IoT: Interacting with Low-Power Devices

Tu2A Chung-Ching Lin, Washington State University

Adaptable Wireless Sensor Networks: The Backbone of Future Smart Cities

Mo2C Jay Sheth, University of Virginia

Enhancing Weather Predictions and Downloads with Microwave Electronics

Tu1A Sunil Rao, Georgia Institute of Technology

Make Low-Voltage RF Systems Possible

Tu1D Bowen Wang, Tsinghua University

Interference-Canceling 5G Devices

Mo3A Arun Paidimarri, IBM T.J. Watson Research Center

5G Signals Can See the World While Delivering Your Data

Mo3A Bodhisatwa Sadhu, IBM T. J. Watson Research Center

The Human Body: A Wire for Wireless Communications

Mo2A Baibhab Chatterjee, Purdue University

Silicon of Stars

Tu2B Yun Wang, Tokyo Institute of Technology

Are We Ready for 6G?

Tu1C Awani Khodkumbhe, BITS Pilani

Empowering 5G Antenna Measurements

ARFTG Mohammadreza Ranjbar Naeini, University of Wisconsin

PLENARY SPEAKER 1

Is the Third Wave Coming in CMOS RF?

Dr. Thomas Byunghak Cho, EVP Samsung Semiconductor



ABSTRACT:

In the late 90's, academia's active research on CMOS RF, combined with the industry's increasing need for compact and low-cost mobile devices, had triggered a succession of waves in CMOS RF, making the rapid deployment and widespread commercialization of CMOS RFICs. Of course, there were many technical challenges and concerns in using CMOS for RF for the first time, such as substrate noise, lack of good RF models, etc. However, they weren't big enough to stop those waves. In fact, CMOS scaling for digital and increasing digital signal processing capabilities added extra momentum to the waves. As a result, CMOS RF has played a key role in enabling many generations of modern solutions for a variety of wireless applications such as Cellular, WiFi, BT, GPS, IoT, etc.

Now, we are in 2020. The market is still hot. It demands even more mobile performance than before. New applications such as 5G, Automotive, AR/VR, etc. are on the rise. However, for RFIC designers, the situation is even more challenging than before. RF performance gain from scaling has slowed down. Sub-6GHz spectrum is quite busy and crowded, pushing new standards to higher frequency. Low power consumption is ever important. In this complex situation, several questions arise. Is the third wave coming in CMOS RF? If so, what are the winds that will create the new wave? Is the wave big enough to enable new applications? In this talk, we will briefly go over the past two decades of CMOS RF history and examine these questions to gain insights into the future.

PLENARY SPEAKER 2

The Flexible Future of RF

Prof. Ali Hajimiri, Bren Prof. of Elect. Eng. and Medical Eng., *Caltech*



ABSTRACT:

Over the last quarter of a century, RF and mm-wave CMOS integrated circuits have gone from the realm of exotic research to becoming the only realistic way to implement almost all commercial communication and sensing systems. The ability to reliably integrate a large number of active and passive components operating at RF and mm-wave frequencies continues to enable an unlimited number of new applications and design approaches previously not practical or economical. Wireless power transfer at a distance is an example of an emerging third prong of novel use cases for RF and mm-waves integrated circuits.

Despite these major advances, such RF and microwave systems remain relatively small, static, and rigid, thereby limiting their ability to be used in many novel applications ranging from wearable fabric, to easily deployable large-scale arrays in various environments. Such systems can provide significant additional utilization of the unprecedented IC fabrication capacity of the silicon foundries and enable yet another wave of new domains of use.

Flexible lightweight collapsible active electromagnetic surfaces enabled by an array of CMOS RFICs with the dynamic ability to compensate and correct for mechanical changes in the real time can open the door to a breadth of new applications from RF active fabric for clothing to communication and wireless power transfer systems that can be rapidly deployed on the ground and in space to enable a truly wireless ecosystem of the future.

RECEPTION FEATURING INDUSTRY SHOWCASE AND STUDENT PAPER AWARD FINALISTS

THE INDUSTRY SHOWCASE

The RFIC Industry Showcase Session, held concurrently with the plenary reception, will highlight a total of 10 outstanding paper finalists listed below, submitted by authors from the industry. In this interactive session, authors will present their innovative work in poster format. These 10 paper finalists were nominated this year by the RFIC Technical Program Committee to enter the final contest. A committee of eleven TPC judges have selected the top three Industry Papers after rigorous reviews and discussions. The top three will be announced during the RFIC Plenary Session on 21 June 2020 in Los Angeles, and each winner will receive a plaque. This year's Industry Paper Award finalists are:

3D Imaging Using mmWave 5G Signals | RMo3A-1 | 13:40

Junfeng Guan, Arun Paidimarri, Alberto Valdes-Garcia,
Bodhisatwa Sadhu
IBM T.J. Watson Research Center, USA

Spatio-Temporal Filtering: Precise Beam Control Using Fast Beam Switching | RMo4A-2 | 16:10

Arun Paidimarri, Bodhisatwa Sadhu
IBM T.J. Watson Research Center, USA

A 77GHz 8RX3TX Transceiver for 250m Long Range Automotive Radar in 40nm CMOS Technology | RMo1B-2 | 08:20

Tatsunori Usugi, Tomotoshi Murakami, Yoshiyuki Utagawa,
Shuya Kishimoto, Masato Kohtani, Ikuma Ando,
Kazuhiro Matsunaga, Chihiro Arai, Tomoyuki Arai, Shinji Yamaura
DENSO, Japan

A 1.2V, 5.5GHz Low-Noise Amplifier with 60dB On-Chip Selectivity for Uplink Carrier Aggregation and 1.3dB NF | RTu2C-2 | 10:30

Daniel Schrögenderfer, Thomas Leitner
Infineon Technologies, Austria

A D-Band Radio-on-Glass Module for Spectrally-Efficient and Low-Cost Wireless Backhaul | RMo2B-3 | 10:50

Amit Singh, Mustafa Sayginer, Michael J. Holyoak, Joseph Weiner,
John Kimionis, Mohamed Elkhoully, Yves Baeyens,
Shahriar Shahramian
Nokia Bell Labs, USA

Fully Autonomous System-on-Board with Complex Permittivity Sensors and 60GHz Transmitter for Biomedical Implant Applications | RMo3A-4 | 14:40

Issakov¹, C. Heine¹, V. Lammert¹, J. Stoegmueller¹, M. Meindl²,
U. Stubenrauch¹, C. Geissler¹
¹*Infineon Technologies, Germany*, ²*eesy-IC, Germany*

High Resolution CMOS IR-UWB Radar for Non-Contact Human Vital Signs Detection | RMo1B-3 | 08:40

Sang Gyun Kim, In Chang Ko, Seung Hwan Jung
GRIT Custom-IC, Korea

Parasitic Model to Describe Breakdown in Stacked-FET SOI Switches | RMo2D-3 | 10:50

Kathleen Muhonen¹, Scott Parker¹, Kaushik Annam²
1Qorvo, USA, 2University of Dayton, USA

77GHz CMOS Built-In Self-Test with 72dB C/N and Less Than 1ppm Frequency Tolerance for a Multi-Channel Radar Application RMo1B-5 | 09:20

Masato Kohtani, Tomotoshi Murakami, Yoshiyuki Utagawa,
Tomoyuki Arai, Shinji Yamaura
DENSO, Japan

A Reconfigurable SOI CMOS Doherty Power Amplifier Module for Broadband LTE High-Power User Equipment Applications | RMo2A-2 | 10:30

A. Serhan¹, D. Parat¹, P. Reynier¹, M. Pezzin¹, R. Mourot¹, F. Chaix¹,
R. Berro¹, P. Indirayanti², C. De Ranter², K. Han², M. Borremans²,
E. Mercier¹, A. Giry¹
¹*CEA-Leti, France*, ²*Huawei Technologies, Belgium*

Industry Paper Contest Eligibility: The first author must have an affiliation from industry. The first author must also be the lead author of the paper and must present the paper at the Symposium.

STUDENT PAPER AWARD FINALISTS

The RFIC Symposium's Student Paper Award is devised to both encourage student paper submissions to the conference as well as give the authors of the finalists' papers a chance to promote their research work with the conference attendees after the plenary session during reception time. A total of thirteen outstanding student paper finalists were nominated this year by the RFIC Technical Program Committee to enter the final contest. A committee of ten TPC judges have selected the top-three papers after rigorous reviews and discussions. All finalists benefit from a complimentary RFIC registration. The top-three Student Papers will be announced during the RFIC Plenary Session on 21 June 2020 in Los Angeles. Each winner will receive an honorarium and a plaque. This year's Student Paper Award finalists are:

Ultra Compact, Ultra Wideband, DC-1GHz CMOS Circulator Based on Quasi-Electrostatic Wave Propagation in Commutated Switched Capacitor Networks | RMo1C-5 | 09:20

Aravind Nagulu¹, Mykhailo Tymchenko², Andrea Alù², Harish Krishnaswamy¹

¹Columbia University, USA, ²University of Texas at Austin, USA

A 66.97pJ/Bit, 0.0413mm² Self-Aligned PLL-Calibrated Harmonic-Injection-Locked TX with >62dBc Spur Suppression for IoT Applications

RTu2A-1 | 10:10

Chung-Ching Lin, Huan Hu, Subhanshu Gupta, Washington State University, USA

A Scalable 60GHz 4-Element MIMO Transmitter with a Frequency-Domain-Multiplexing Single-Wire Interface and Harmonic-Rejection-Based De-Multiplexing | RMo3B-3 | 14:20

Ali Binaie¹, Sohail Ahasan¹, Armagan Dascurcu¹, Mahmood Baraani Dastjerdi¹, Robin Garg², Manoj Johnson², Arman Galioglu¹, Arun Natarajan², Harish Krishnaswamy¹

¹Columbia University, USA, ²Oregon State University, USA

A SiGe Millimeter-Wave Front-End for Remote Sensing and Imaging | RMo4B-3 | 16:30

Milad Frounchi, John D. Cressler, Georgia Tech, USA

A 1.5-3GHz Quadrature Balanced Switched-Capacitor CMOS Transmitter for Full Duplex and Half Duplex Wireless Systems | RMo2C-1 | 10:10

Nimrod Ginzberg¹, Dror Regev², Emanuel Cohen¹

¹Technion, Israel, ²Toga Networks, Israel

A Dual-Mode V-Band 2/4-Way Non-Uniform Power-Combining PA with +17.9-dBm Psat and 26.5% PAE in 16-nm FinFET CMOS | RMo3C-1 | 13:40

Kun-Da Chu¹, Steven Callender², Yanjie Wang³, Jacques C. Rudell¹, Stefano Pellerano², Christopher Hull²

¹University of Washington, USA, ²Intel, USA, ³USA

A DC to 43-GHz SPST Switch with Minimum 50-dB Isolation and +19.6-dBm Large-Signal Power Handling in 45-nm SOI-CMOS | RMo1D-2 | 08:20

Ayman Eltaliawy¹, John R. Long¹, Ned Cahoon²

¹University of Waterloo, Canada, ²GLOBALFOUNDRIES, USA

A Wideband True-Time-Delay Phase Shifter with 100% Fractional Bandwidth Using 28nm CMOS | RMo1D-1 | 08:00

Minjae Jung, Hong-Jib Yoon, Byung-Wook Min, Yonsei University, Korea

A 16-Element Fully Integrated 28GHz Digital Beamformer with In-Package 4x4 Patch Antenna Array and 64 Continuous-Time Band-Pass Delta-Sigma Sub-ADCs | RTu2B-1 | 10:10

Rundao Lu, Christine Weston, Daniel Weyer, Fred Buhler, Michael P. Flynn,

University of Michigan, USA

A Dual-Core 8-17GHz LC VCO with Enhanced Tuning Switch-Less Tertiary Winding and 208.8dBc/Hz Peak FoMT in 22nm FDSOI | RMo4C-4 | 16:50

Omar El-Aassar, Gabriel M. Rebeiz, University of California, San Diego, USA

A 7.4dBm EIRP, 20.2% DC-EIRP Efficiency 148GHz Coupled Loop Oscillator with Multi-Feed Antenna in 22nm FD-SOI | RTu1A-5 | 09:20

Muhammad Waleed Mansha, Mona Hella, Rensselaer Polytechnic Institute, USA

Characterization of Partially Overlapped Inductors for Compact Layout Design in 130nm RFCMOS and 22nm FinFET Processes | RMo2D-2 | 10:30

Xuanyi Dong, Andreas Weisshaar, Oregon State University, USA

A Hybrid-Integrated Artificial Mechanoreceptor in 180nm CMOS | RMo3A-3 | 14:20

Han Hao, Lin Du, Andrew G. Richardson, Timothy H. Lucas, Mark G. Allen, Jan Van der Spiegel, Firooz Aflatouni, University of Pennsylvania, USA

Student Paper Contest Eligibility: The student must have been a full-time student (9 hours/term graduate, 12 hours/term undergraduate) during the time the work was performed. The student must also be the lead author of the paper and must present the paper at the Symposium.



MONDAY



LAX




LOS ANGELES
CONNECTIVITY MATTERS **2020**

MONDAY, 22 JUNE 2020

IMS2020

Monday

MONDAY

402AB

Mo1A: High Spectral Purity Phase-Locked Loops

Chair: Fa Foster Dai, Auburn University
Co-Chair: Joseph D. Cali, BAE Systems

Mo1A-1: A 23.6–38.3GHz Low-Noise PLL with Digital Ring Oscillator and Multi-Ratio Injection-Locked Dividers for Millimeter-Wave Sensing

Y. Zhang; Univ. of California, Los Angeles; Y. Zhao; Univ. of California, Los Angeles; R. Huang; Univ. of California, Los Angeles; C.-J. Liang; National Chiao Tung Univ. ; C.-W. Chiang; National Chiao Tung Univ. ; Y.-C. Kuan; National Chiao Tung Univ. ; M.-C.F. Chang; Univ. of California, Los Angeles

Mo1A-2: A 1Mb/s 2.86% EVM GFSK Modulator Based on BB-DPLL Without Background Digital Calibration

Y. Liu; Tsinghua Univ.; W. Rhee; Tsinghua Univ.; Z. Wang; Tsinghua Univ.

Mo1A-3: A 2.0–2.9GHz Digital Ring-Based Injection-Locked Clock Multiplier Using a Self-Alignment Frequency Tracking Loop for Reference Spur Reduction

R. Xu; Fudan Univ.; D. Ye; Fudan Univ.; L. Lyu; Fudan Univ.; C.-J.R. Shi; Univ. of Washington

Mo1A-4: A 10-to-12GHz 5mW Charge-Sampling PLL Achieving 50fsec RMS Jitter, -258.9dB FOM and -65dBc Reference Spur

J. Gong; Technische Universiteit Delft; F. Sebastiano; Technische Universiteit Delft; E. Charbon; EPFL; M. Babaie; Technische Universiteit Delft

403A

Mo1B: Microwave and mmWave Radar Systems

Chair: Ed Balboni, Analog Devices
Co-Chair: Duane Howard, Jet Propulsion Laboratory

Mo1B-1: Low Power Low Phase Noise 60GHz Multichannel Transceiver in 28nm CMOS for Radar Applications

J. Rimmelspacher; Infineon Technologies; R. Ciocoveanu; Infineon Technologies; G. Steffan; Infineon Technologies; M. Bassi; Infineon Technologies; V. Issakov; Infineon Technologies

Mo1B-2: A 77GHz 8RX3TX Transceiver for 250m Long Range Automotive Radar in 40nm CMOS Technology

T. Usugi; DENSO; T. Murakami; DENSO; Y. Utagawa; DENSO; S. Kishimoto; DENSO; M. Kohtani; DENSO; I. Ando; DENSO; K. Matsunaga; DENSO; C. Arai; DENSO; T. Arai; DENSO; S. Yamaura; DENSO

Mo1B-3: High Resolution CMOS IR-UWB Radar for Non-Contact Human Vital Signs Detection

S.G. Kim; GRIT Custom-IC; I.C. Ko; GRIT Custom-IC; S.H. Jung; GRIT Custom-IC

Mo1B-4: A 62mW 60GHz FMCW Radar in 28nm CMOS

S. Park; IMEC; A. Kankuppe; IMEC; P. Renukaswamy; IMEC; D. Guermandi; IMEC; A. Visweswaran; IMEC; J.C. Garcia; IMEC; S. Sinha; IMEC; P. Wambacq; IMEC; J. Craninckx; IMEC

Mo1B-5: 77GHz CMOS Built-In Self-Test with 72dB C/N and Less Than 1ppm Frequency Tolerance for a Multi-Channel Radar Application

M. Kohtani; DENSO; T. Murakami; DENSO; Y. Utagawa; DENSO; T. Arai; DENSO; S. Yamaura; DENSO

403B

Mo1C: Circulators and Full-Duplex Transceivers

Chair: François Rivet, IMS (UMR 5218)
Co-Chair: Magnus Wiklund, Qualcomm

Mo1C-1: RFIC Inductorless, Widely-Tunable N-Path Shekel Circulators Based on Harmonic Engineering

N. Reiskarimian; Columbia Univ.; M. Khorshidian; Columbia Univ.; H. Krishnaswamy; Columbia Univ.

Mo1C-2: A Full-Duplex Receiver Leveraging Multiphase Switched-Capacitor-Delay Based Multi-Domain FIR Filter Cancelers

A. Nagulu; Columbia Univ.; A. Gaonkar; Columbia Univ.; S. Ahasan; Columbia Univ.; T. Chen; Columbia Univ.; G. Zussman; Columbia Univ.; H. Krishnaswamy; Columbia Univ.

Mo1C-3: A 3.4–4.6GHz In-Band Full-Duplex Front-End in CMOS Using a Bi-Directional Frequency Converter

X. Yi; MIT; J. Wang; MIT; C. Wang; MIT; K.E. Kolodziej; MIT Lincoln Laboratory; R. Han; MIT

Mo1C-4: A Self-Interference-Tolerant, Multipath Rake Receiver with More Than 40-dB Rejection and 9-dB SNR Multipath Gain in a Fading Channel

A. Hamza; Univ. of California, Santa Barbara; C. Hill; Univ. of California, Santa Barbara; H. AlShammery; Univ. of California, Santa Barbara; J. Buckwalter; Univ. of California, Santa Barbara

Mo1C-5: Ultra Compact, Ultra Wideband, DC-1GHz CMOS Circulator Based on Quasi-Electrostatic Wave Propagation in Commutated Switched Capacitor Networks

A. Nagulu; Columbia Univ.; M. Tymchenko; Univ. of Texas at Austin; A. Alü; Univ. of Texas at Austin; H. Krishnaswamy; Columbia Univ.

404AB

Mo1D: Switches and Delay Elements for Receiver Front-Ends

Chair: Domine M.W. Leenaerts, NXP Semiconductors
Co-Chair: Danilo Manstretta, Università di Pavia

Mo1D-1: A Wideband True-Time-Delay Phase Shifter with 100% Fractional Bandwidth Using 28nm CMOS

M. Jung; Yonsei Univ.; H.-J. Yoon; Yonsei Univ.; B.-W. Min; Yonsei Univ.

Mo1D-2: A DC to 43-GHz SPST Switch with Minimum 50-dB Isolation and +19.6-dBm Large-Signal Power Handling in 45-nm SOI-CMOS

A. Eltaliawy; Univ. of Waterloo; J.R. Long; Univ. of Waterloo; N. Cahoon; GLOBALFOUNDRIES

Mo1D-3: DC-40GHz SPDTs in 22nm FD-SOI and Back-Gate Impact Study

M. Rack; Université catholique de Louvain; L. Nyssens; Université catholique de Louvain; S. Wane; eV-Technologies; D. Bajon; eV-Technologies; J.-P. Raskin; Université catholique de Louvain

Mo1D-4: A 100W, UHF to S-Band RF Switch in the Super-Lattice Castellated Field Effect Transistor (SLCFET) 3S Process

J.J. Hug; Northrop Grumman; J. Parke; Northrop Grumman; V. Kapoor; Northrop Grumman

08:00

08:20

08:40

09:00

09:20

9:40

402AB

Mo2A: Reconfigurable RF Front-End Blocks

Chair: Magnus Wiklund, Qualcomm
Co-Chair: François Rivet, IMS (UMR 5218)

Mo2A-1: A Context-Aware Reconfigurable Transmitter with 2.24pJ/Bit, 802.15.6 NB-HBC and 4.93pJ/Bit, 400.9MHz MedRadio Modes with 33.6% Transmit Efficiency

B. Chatterjee; Purdue Univ.; A. Srivastava; Purdue Univ.; D.-H. Seo; Purdue Univ.; D. Yang; Purdue Univ.; S. Sen; Purdue Univ.

Mo2A-2: A Reconfigurable SOI CMOS Doherty Power Amplifier Module for Broadband LTE High-Power User Equipment Applications

A. Serhan; CEA-LETI; D. Parat; CEA-LETI; P. Reynier; CEA-LETI; M. Pezzini; CEA-LETI; R. Mouro; CEA-LETI; F. Chaix; CEA-LETI; R. Berro; CEA-LETI; P. Indirayanti; Huawei Technologies; C. De Ranter; Huawei Technologies; K. Han; Huawei Technologies; M. Borremans; Huawei Technologies; E. Mercier; CEA-LETI; A. Giry; CEA-LETI

Mo2A-3: A 4-Element 7.5–9GHz Phased Array Receiver with 8 Simultaneously Reconfigurable Beams in 65nm CMOS Technology

N. Li; Zhejiang Univ.; M. Li; Zhejiang Univ.; S. Wang; Zhejiang Univ.; Z. Zhang; Zhejiang Univ.; H. Gao; Zhejiang Univ.; Y.-C. Kuan; National Chiao Tung Univ.; X. Yu; Zhejiang Univ.; Z. Xu; Zhejiang Univ.

Mo2A-4: A 29-mW 26.88-GHz Non-Uniform Sub-Sampling Receiver Front-End Enabling Spectral Alias Spreading

C. Yang; Univ. of Southern California; M. Ayesh; Univ. of Southern California; A. Zhang; Univ. of Southern California; T.-F. Wu; Univ. of Southern California; M.S.-Y. Chen; Univ. of Southern California

403A

Mo2B: Millimeter-Wave Circuits in D and E Band for High Data-Rate Wireless Links

Chair: Kenichi Okada, Tokyo Institute of Technology
Co-Chair: Pierre Busson, STMicroelectronics

Mo2B-1: D-Band Phased-Array TX and RX Front Ends Utilizing Radio-on-Glass Technology

M. Elkhoully; Nokia Bell Labs; M.J. Holyoak; Nokia Bell Labs; D. Hendry; Nokia Bell Labs; M. Zierdt; Nokia Bell Labs; A. Singh; Nokia Bell Labs; M. Sayginer; Nokia Bell Labs; S. Shahramian; Nokia Bell Labs; Y. Baeyens; Nokia Bell Labs

Mo2B-2: A 71–76/81–86GHz, E-Band, 16-Element Phased-Array Transceiver Module with Image Selection Architecture for Low EVM Variation

N. Ebrahimi; Univ. of Michigan; K. Sarabandi; Univ. of Michigan; J. Buckwalter; Univ. of California, Santa Barbara

Mo2B-3: A D-Band Radio-on-Glass Module for Spectrally-Efficient and Low-Cost Wireless Backhaul

A. Singh; Nokia Bell Labs; M. Sayginer; Nokia Bell Labs; M.J. Holyoak; Nokia Bell Labs; J. Weiner; Nokia Bell Labs; J. Kimionis; Nokia Bell Labs; M. Elkhoully; Nokia Bell Labs; Y. Baeyens; Nokia Bell Labs; S. Shahramian; Nokia Bell Labs

Mo2B-4: A 134–149GHz IF Beamforming Phased-Array Receiver Channel with 6.4–7.5dB NF Using CMOS 45nm RFSOI

S. Li; Univ. of California, San Diego; G.M. Rebeiz; Univ. of California, San Diego

Mo2B-5: A Fully Integrated 32Gbps 2×2 LoS MIMO Wireless Link with UWB Analog Processing for Point-to-Point Backhaul Applications

M. Sawaby; Stanford Univ.; B. Grave; Stanford Univ.; C. Jany; Stanford Univ.; C. Chen; Stanford Univ.; S. Kananian; Stanford Univ.; P. Calascibetta; STMicroelectronics; F. Gianesello; STMicroelectronics; A. Arbabian; Stanford Univ.

403B

Mo2C: Digital Power Amplifiers

Chair: Jeffrey Walling, Qualcomm
Co-Chair: Justin (ChiaHsin) Wu, AmLogic

Mo2C-1: A 1.5–3GHz Quadrature Balanced Switched-Capacitor CMOS Transmitter for Full Duplex and Half Duplex Wireless Systems

N. Ginzberg; Technion; D. Regev; Toga Networks; E. Cohen; Technion

Mo2C-2: A 65nm CMOS Switched-Capacitor Carrier Aggregation Transmitter

Q.H. Le; Fraunhofer IPMS; D.K. Huynh; Fraunhofer IPMS; D. Wang; Fraunhofer IPMS; Z. Zhao; GLOBALFOUNDRIES; S. Lehmann; GLOBALFOUNDRIES; T. Kämpfe; Fraunhofer IPMS; M. Rudolph; Brandenburgische Technische Universität

Mo2C-3: A Differential Digital 4-Way Doherty Power Amplifier with 48% Peak Drain Efficiency for Low Power Applications

J. Sheth; Univ. of Virginia; S.M. Bowers; Univ. of Virginia

Mo2C-4: 1.2–3.6GHz 32.67dBm 4096-QAM Digital PA Using Reconfigurable Power Combining Transformer for Wireless Communication

B. Yang; UESTC; H.J. Qian; UESTC; T. Wang; UESTC; X. Luo; UESTC

Mo2C-5: A Quadrature Digital Power Amplifier with Hybrid Doherty and Impedance Boosting for Efficiency Enhancement in Complex Domain

H.J. Qian; UESTC; B. Yang; UESTC; J. Zhou; UESTC; H. Xu; Fudan Univ.; X. Luo; UESTC

404AB

Mo2D: Novel RF Devices and Modeling Approaches

Chair: Edward Preisler, Tower Semiconductor
Co-Chair: Hsieh-Hung Hsieh, TSMC

Mo2D-1: W-Band Noise Characterization with Back-Gate Effects for Advanced 22nm FDSOI mm-Wave MOSFETs

Q.H. Le; Fraunhofer IPMS; D.K. Huynh; Fraunhofer IPMS; D. Wang; Fraunhofer IPMS; Z. Zhao; GLOBALFOUNDRIES; S. Lehmann; GLOBALFOUNDRIES; T. Kämpfe; Fraunhofer IPMS; M. Rudolph; Brandenburgische Technische Universität

Mo2D-2: Characterization of Partially Overlapped Inductors for Compact Layout Design in 130nm RFCMOS and 22nm FinFET Processes

X. Dong; Oregon State Univ.; A. Weisshaar; Oregon State Univ.

Mo2D-3: Parasitic Model to Describe Breakdown in Stacked-FET SOI Switches

K. Muhonen; Qorvo; S. Parker; Qorvo; K. Annam; Univ. of Dayton

Mo2D-4: Residual Network Based Direct Synthesis of EM Structures: A Study on One-to-One Transformers

D. Munzer; Georgia Tech; S. Er; Georgia Tech; M. Chen; Georgia Tech; Y. Li; Georgia Tech; N.S. Mannem; Georgia Tech; T. Zhao; Georgia Tech; H. Wang; Georgia Tech

10:10

10:30

10:50

11:10

11:30

11:50

402AB

Mo3A: RFIC Systems and Applications I: Biomedical and Radar Systems

Chair: Oren Eliezer, Apogee Semiconductor
Co-Chair: Yao-Hong Liu, IMEC

Mo3A-1: 3D Imaging Using mmWave 5G Signals

J. Guan; IBM T.J. Watson Research Center; A. Paidimarri; IBM T.J. Watson Research Center; A. Valdes-Garcia; IBM T.J. Watson Research Center; B. Sadhu; IBM T.J. Watson Research Center

Mo3A-2: Digitally Assisted mm-Wave FMCW Radar for High Performance

K. Subburaj; Texas Instruments; A. Mani; Texas Instruments; K. Dandu; Texas Instruments; K. Bhatia; Texas Instruments; K. Ramasubramanian; Texas Instruments; S. Murali; Texas Instruments; R. Sachdev; Texas Instruments; P. Gupta; Texas Instruments;

S. Samala; Texas Instruments; D. Shetty; Texas Instruments; Z. Parkar; Texas Instruments; S. Ram; Texas Instruments; V. Dudhia; Texas Instruments; D.

Mo3A-3: A Hybrid-Integrated Artificial Mechanoreceptor in 180nm CMOS**Mo3A-4: Fully Autonomous System-on-Board with Complex Permittivity Sensors and 60GHz Transmitter for Biomedical Implant Applications**

Breen; Texas Instruments; S. Bharadwaj; Texas Instruments; S. Bhatara; Texas Instruments

403A

Mo3B: Millimeter-Wave Transceivers and Building Blocks

Chair: Shahriar Shahramian, Nokia Bell Labs
Co-Chair: Hongtao Xu, Fudan University

Mo3B-1: 60GHz Variable Gain & Linearity Enhancement LNA in 65nm CMOS

D. Bierbuesse; RWTH Aachen Univ.; R. Negra; RWTH Aachen Univ.

Mo3B-2: A 64-QAM 45-GHz SiGe Transceiver for IEEE 802.11aj

P. Zhou; Southeast Univ.; J. Chen; Southeast Univ.; P. Yan; Southeast Univ.; H. Gao; Technische Universiteit Eindhoven; D. Hou; Southeast Univ.; J. Yu; Southeast Univ.; J. Hu; Southeast Univ.; C. Wang; Southeast Univ.; H. Dong; Southeast Univ.; L. Wang; Southeast Univ.; Z. Jiang; Southeast Univ.

Mo3B-3: A Scalable 60GHz 4-Element MIMO Transmitter with a Frequency-Domain-Multiplexing Single-Wire Interface and Harmonic-Rejection-Based De-Multiplexing

A. Binaie; Columbia Univ.; S. Ahasan; Columbia Univ.; A. Dascurcu; Columbia Univ.; M. Baraani Dastjerdi; Columbia Univ.; R. Garg; Oregon State Univ.; M. Johnson; Oregon State Univ.; A. Galioglu; Columbia Univ.; A. Natarajan; Oregon State Univ.; H. Krishnaswamy; Columbia Univ.

Mo3B-4: A Bidirectional 56–72GHz to 10.56GHz Transceiver Front-End with Integrated T/R Switches in 28-nm CMOS Technology

W. Zhu; Tsinghua Univ.; D. Li; Tsinghua Univ.; J. Wang; Tsinghua Univ.; X. Zhang; Rice Univ.; Y. Wang; Tsinghua Univ.

Mo3B-5: A 10.56Gbit/s, -27.8dB EVM Polar Transmitter at 60GHz in 28nm CMOS

J. Nguyen; IMEC; K. Khalaf; Pharrowtech; S. Brebels; IMEC; M. Shrivastava; IMEC; K. Vaesen; IMEC; P. Wambacq; IMEC

403B

Mo3C: mmWave Power Amplifiers

Chair: Patrick Reynaert, Katholieke Universiteit Leuven
Co-Chair: Oleh Krutko, Xilinx

Mo3C-1: A Dual-Mode V-Band 2/4-Way Non-Uniform Power-Combining PA with +17.9-dBm Psat and 26.5% PAE in 16-nm FinFET CMOS

K.-D. Chu; Univ. of Washington; S. Callender; Intel; Y. Wang; J.C. Rudell; Univ. of Washington; S. Pellerano; Intel; C. Hull; Intel

Mo3C-2: A 28-GHz Highly Efficient CMOS Power Amplifier Using a Compact Symmetrical 8-Way Parallel-Parallel Power Combiner with IMD3 Cancellation Method

H. Ahn; Pusan National Univ.; I. Nam; Pusan National Univ.; O. Lee; Pusan National Univ.

Mo3C-3: An Embedded 200GHz Power Amplifier with 9.4dBm Saturated Power and 19.5dB Gain in 65nm CMOS

H. Bameri; Univ. of California, Davis; O. Momeni; Univ. of California, Davis

Mo3C-4: A 130-GHz Power Amplifier in a 250-nm InP Process with 32% PAE

K. Ning; Univ. of California, Santa Barbara; Y. Fang; Univ. of California, Santa Barbara; M. Rodwell; Univ. of California, Santa Barbara; J. Buckwalter; Univ. of California, Santa Barbara; J. Buckwalter; Univ. of California, Santa Barbara

Mo3C-5: A 160GHz High Output Power and High Efficiency Power Amplifier in a 130-nm SiGe BiCMOS Technology

X. Li; Tsinghua Univ.; W. Chen; Tsinghua Univ.; Y. Wang; Tsinghua Univ.; Z. Feng; Tsinghua Univ.

13:40

14:00

14:20

14:40

15:00

15:20

402AB

Mo4A: RFIC System and Applications II: Wideband Wireless Communication and Quantum Computing

Chair: Renyuan Wang, BAE Systems
Co-Chair: Rocco Tam, NXP Semiconductors

Mo4A-1: A Flexible Control and Calibration Architecture Using RISC-V MCU for 5G Millimeter-Wave Mobile RF Transceivers

J. Kim; Samsung; J.M. Kim; Samsung; S. Han; Samsung; P.Vora; Samsung; P. Dayal; Samsung; H. Kim; Samsung; J. Lee; Samsung; D. Yoon; Samsung; J. Lee; Samsung; T. Chang; Samsung; I.S.-C. Lu; Samsung; K.-B. Song; Samsung; S.W. Son; Samsung; J. Lee; Samsung

Mo4A-2: Spatio-Temporal Filtering: Precise Beam Control Using Fast Beam Switching

A. Paidimarri; IBM T.J. Watson Research Center; B. Sadhu; IBM T.J. Watson Research Center

Mo4A-3: An Integrated True Zero-Wait-Time Dynamic Frequency Selection (DFS) Look-Ahead Scheme for WiFi-Radar System Co-Existence

Y. Chen; MediaTek; B. Xu; MediaTek; E. Lu; MediaTek; O. Shana'a; MediaTek

Mo4A-4: RF Clock Distribution System for a Scalable Quantum Processor in 22-nm FDSOI Operating at 3.8K Cryogenic Temperature

I. Bashir; Equal1 Labs; D. Leipold; Equal1 Labs; M. Asker; Equal1 Labs; A. Esmailiyan; Univ. College Dublin; H. Wang; Univ. College Dublin; T. Siriburanon; Univ. College Dublin; P. Giounanlis; Univ. College Dublin; A. Koziol; Univ. College Dublin; D.A. Miceli; Univ. College Dublin; E. Blokhina; Univ. College Dublin; R.B. Staszewski; Univ. College Dublin

403A

Mo4B: Millimeter-Wave and Terahertz Circuits and Systems for Sensing and Communications

Chair: Omeed Momeni, University of California, Davis
Co-Chair: Ruonan Han, MIT

Mo4B-1: An Integrated 132–147GHz Power Source with +27dBm EIRP

A. Visweswaran; IMEC; A. Haag; KIT; C. de Martino; Technische Universiteit Delft; K. Schneider; KIT; T. Maiwald; FAU Erlangen-Nürnberg; B. Vignon; IMEC; K. Aufinger; Infineon Technologies; M. Spirito; Technische Universiteit Delft; T. Zwick; KIT; P. Wambacq; IMEC

Mo4B-2: A High-Speed 390GHz BP00K Transmitter in 28nm CMOS

C. D'heer; Katholieke Univ. Leuven; P. Reynaert; Katholieke Univ. Leuven

Mo4B-3: A SiGe Millimeter-Wave Front-End for Remote Sensing and Imaging

M. Frounchi; Georgia Tech; J.D. Cressler; Georgia Tech

Mo4B-4: A Fully Integrated Coherent 50–500-GHz Frequency Comb Receiver for Broadband Sensing and Imaging Applications

S. Razavian; Univ. of California, Los Angeles; A. Babakhani; Univ. of California, Los Angeles

403B

Mo4C: High-Performance Frequency-Generation Components

Chair: Mohyee Mikhemar, Broadcom
Co-Chair: Wanghua Wu, Samsung

Mo4C-1: A 0.082mm² 24.5-to-28.3GHz Multi-LC-Tank Fully-Differential VCO Using Two Separate Single-Turn Inductors and a 1D-Tuning Capacitor Achieving 189.4dBc/Hz FOM and 200±50kHz 1/f³ PN Corner

H. Guo; University of Macau; Y. Chen; University of Macau; P.-I. Mak; University of Macau; R.P. Martins; University of Macau

Mo4C-2: A 22.4-to-40.6-GHz Multi-Ratio Injection-Locked Frequency Multiplier with 57.7-dBc Harmonic Rejection

J. Zhang; UESTC; Y. Peng; UESTC; H. Liu; UESTC; C. Zhao; UESTC; Y. Wu; UESTC; K. Kang; UESTC

Mo4C-3: A 0.35mW 70GHz Divide-by-4 TSPC Frequency Divider on 22nm FD-SOI CMOS Technology

Z. Tibenszky; Technische Universität Dresden; C. Carta; Technische Universität Dresden; F. Ellinger; Technische Universität Dresden

Mo4C-4: A Dual-Core 8–17GHz LC VCO with Enhanced Tuning Switch-Less Tertiary Winding and 208.8dBc/Hz Peak FoMT in 22nm FDSOI

O. El-Aassar; Univ. of California, San Diego; G.M. Rebeiz; Univ. of California, San Diego

15:50

16:10

16:30

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17:30

Workshop Title	Workshop Abstract
<p>WMA</p> <p>Enabling Technologies for Efficient Ultra-High Speed Wireless Communication Systems Towards 100Gb/s Sponsor: IMS Organizer: C. Carlowitz, <i>FAU Erlangen-Nürnberg</i>; N. Kaneda, <i>Nokia Bell Labs</i> 08:00 – 17:15</p>	<p>Recently, major advances in analog front-ends for ultra-high speed wireless communication systems targeting data rates towards 100Gbps have been demonstrated at high frequencies between 100 and 300GHz. In order to deliver this performance in a complete system to the end-user, they need to be integrated with very high bandwidth baseband components, analog-to-digital converters and high-speed digital signal processors. Substantial challenges need to be addressed, most notably high relative and absolute bandwidth, high frequencies at technological limits as well as low efficiency in terms of power consumption and system size. Consequently, reconsidering central system architecture decisions from a holistic perspective can be beneficial to achieve efficient implementations. Enabling technologies will be covered, including front-end designs in different frequency ranges (75–300GHz), technologies (SiGe, InP, CMOS), with antenna to baseband integration, phased array / MIMO, synchronous sampling receivers / ADCs as well as efficient real-time basebands.</p>
<p>WMB</p> <p>Recent Advances in mm-Wave Circuits and Systems for Emerging Radar Sensing Applications Sponsor: IMS; RFC Organizer: A. Hagelauer, <i>Universität Bayreuth</i>; I. Nasr, <i>Infineon Technologies</i>; V. Issakov, <i>OvG Universität Magdeburg</i> 08:00 – 17:15</p>	<p>The amount of new radar based 3D sensing applications at mm-wave frequencies is continuously growing. The radar sensors are used extensively almost everywhere to make the daily life more comfortable and safe. Driven by the demand for module size reduction, the operating frequencies of the radar modules keep on increasing, as one can integrate antennas in package or on chip and reduce the module size. The achievable compact module size, low DC power consumption and affordable price open up numerous opportunities for radar sensors to be employed in a whole new range of applications. Thus, there is a growing interest in using radar sensors beyond the classical applications, e.g. automotive radar or door openers. Recent advances in modulation techniques and radar signal processing techniques in combination with MIMO radar arrays, enable achieving very high spatial resolution for three-dimensional (3D) radar imaging. Hence, radar has become also a viable option for such emerging applications as wearable devices, robot-assisted surgery and many others. In this full-day workshop distinguished speakers from leading companies and academia will present the latest advances on a wide range of topics spanning from chip design, advanced system architectures and modulation techniques for emerging (non-automotive) radar applications, such as industrial, healthcare, UaV detection, smart presence detection and indoor people monitoring. The novel system architectures addressed in this workshop include e.g. reconfigurable transmitters towards software-defined radar, reconfigurable system on chip with power duty cycling using a finite state machine, radar interference detection and mitigation techniques, achieving high spatial resolution using a single radar sensor using delay lines and another using MIMO radar in combination with chirp modulation and frequency-division multiplexing. Additionally, physical implementation aspects are addressed by comparison of SOI CMOS versus SiGe technology for mm-wave radar realizations. Finally, design aspects of integrated antennas on-chip for radar applications is discussed. A brief concluding discussion will round-off the workshop to summarize the key learnings on the wide range of aspects presented during the day.</p>
<p>WMC</p> <p>Platforms, Trials, and Applications – The Next Step for 5G and Future Wireless Networks Sponsor: IMS Organizer: A. Valdes-Garcia, <i>IBM T.J. Watson Research Center</i>; C. Fager, <i>Chalmers University of Technology</i>; Z. Chen, <i>Dalhousie University</i> 08:00 – 17:15</p>	<p>Emerging RF technologies for 5G, such as MIMO, scaled phased arrays, and mm-wave transceivers, have reached a significant level of maturity enabling initial product deployments and standards completion. While RF-specific challenges remain, significant wireless R&D efforts around the world are now integrating the new RF capabilities into end-to-end wireless networking platforms and application demonstrations. Such testbeds and application proofs-of-concept (PoC) are key to accelerate the commercial deployment of 5G, augment its impact and value, and ultimately ignite the vision for what 6G may become. This workshop will present a comprehensive overview of multi-disciplinary efforts in the areas of advanced end-to-end platforms for wireless research, emerging 5G trials, and testbeds for new radio concepts. Common themes in the workshop are (1) the enablement and execution of real-world wireless experimentation and (2) projects where emerging RF hardware capabilities (such those provided by multi-antenna mm-wave systems) are a main differentiator. The expert speakers will present diverse perspectives on these topics including: university-led research, industry-lead research, government-academia collaborations, and deployments led by telecommunication equipment providers. The audience will gain a broad understanding of the challenges associated with incorporating RF hardware into these testbeds and performance results from platform-scale experimentation. Last, but not least, a common thread of discussion throughout the workshop, and particularly at the concluding panel, will be an initial set of requirements, concepts, and implementation challenges for 6G networks.</p>
<p>WME</p> <p>Wireless Power Transmission – Myths and Reality Sponsor: IMS Organizer: N.B. Carvalho, <i>Universidade de Aveiro</i>; Z. Popovic, <i>University of Colorado Boulder</i> 08:00 – 17:15</p>	<p>Wireless Power Transmission (WPT) has gained a lot of attention over the past decade, and various applications have been proposed, from low-power IoT device non-directive powering to beaming mm-waves for propulsion. The goal of this workshop is to present a critical review of WPT applications, from very low-power to high-power ones, using kHz to GHz frequencies. Near-field inductive and capacitive power transfer in the kHz and low MHz ISM bands will be first overviewed and then compared in the context of kW-level power for both stationary and in-motion electric vehicles. Power transfer for implants will be discussed, and near-field compared to mid-field. Directive beaming for Space Solar Satellites will be overviewed in the context of existing demonstrations, and roadblocks to real systems presented. Finally, non-directive far-field low-power Simultaneous Wireless Information and Power Transfer (SWIPT) will be addressed as a way to make 5G – Massive IoT a reality. The 5G – Massive Internet-of-Things (MIoT) vision calls for thousands of interconnected devices using a multitude of sensors to provide useful information. As a result, mechanical and electrical properties become important, such as conformal profile, compact size, flexibility, stretchability, or even biodegradable properties. The combination of wireless power transmission and information can be the solution to address the needs of Massive IoT, due to the simplicity of the circuit and the ability to minimize the usage of batteries or even completely eliminate them.</p>

Workshop Abstract	Workshop Title
<p>With the deployment of sub-6GHz 5G, a strong interest for power-efficient broadband amplifiers has emerged. Multiple-input PAs such as (1) outphasing power amplifiers (OPA) operating in the Doherty-Chireix continuum, and (2) load-modulated balanced amplifiers (LMBA) appear to provide promising opportunities. This workshop will focus on the new types of calibrated testbeds, test equipment and associated control and measurement techniques which have been developed for their characterization, optimization and linearization. The characterization of multi-input power amplifiers introduces new challenges. The different RF sources need to be phase locked if they do not share the same local oscillator (LO). The modulation needs to be time synchronized. The testbed itself needs to be calibrated at its test ports for (1) power, (2) LO phase and (3) group delay. The measurements also need to consider reflections since multi-input PAs are exhibiting dynamically varying input impedances. New types of test solutions are emerging to facilitate the characterization and linearization of multi-input PAs including: the use of multipoint VNAs operated as multi-channel VSAs, the synchronization of modular instruments or the use of BIST (built-in self-test) combined with machine learning. In support of the workshop theme, two talks will also feature a review of the theory of multiple-input PAs such as OPA and LMBA to establish the drive requirements, and one talk will address the linearization of multi-input PAs. Emphasis throughout the workshop will be placed on describing the various testbeds developed, their calibration, and their use for the characterization, optimization and linearization of multi-input power amplifiers.</p>	<p>Calibrated Testbeds for the Characterization, Optimization and Linearization of Multi-Input Power Amplifiers Sponsor: ARFTG IMS Organizer: J.A. Reynoso-Hernández, CICESE; K. Rawat, IIT Roorkee 08:00 – 17:15</p> <p style="text-align: right;">WMF</p>
<p>Innovations in material science are crucial for the ongoing development of faster, high-throughput wireless communications at microwave and mm-wave frequencies. As communications systems advance into the mm-wave regime, low-loss materials are needed for fast, efficient, on-chip signal transmission. High-mobility materials are required for energy-efficient transducers that enable small-cell-based platforms. New measurement methods and material testbeds are needed to understand nonlinearity and intermodulation. Tunable materials are required for beam-forming applications and other reconfigurable systems. Materials-by-design approaches to advanced materials offer the enticing possibility of engineering optimal property-performance material relationships to meet these needs. Materials-by-design approaches can be applied across a wide variety of relevant systems, including ferrite ceramics, tunable oxides, perovskites, and novel nanomaterials. In the context of developing devices for wireless communications, materials-by-design can serve as the foundation of a multifaceted approach that includes materials engineering, materials and device modeling, measurements, and ultimate incorporation of material building blocks into microwave and mm-wave systems. This workshop will bring together researchers in all facets of this approach in the context of microwave and mm-wave communications, serving as a bridge between what are sometimes disparate communities. Researchers in materials synthesis will contribute insight about materials design and optimization. Specifically, they will show how current state-of-the-art, first-principles calculations can now be used to accurately predict yet-to-be-synthesized compounds with superior, application-specific functionalities. From there, experts in microwave and mm-wave modeling will show how devices based on new materials can be designed and validated with computational and analytical approaches. For example, tunable metal oxides provide a rich testbed that illustrates how ab initio, multi-physics modeling can enable design and validation with novel material systems by quantifying fundamental, frequency-dependent properties such as conductivity, permittivity, and permeability. Transitioning from numerical and analytical modeling to practical measurements, microwave and mm-wave metrologists will describe methods for characterization of materials, both as free-standing systems and as integrated building blocks within devices. In one case, nonlinear, on-chip measurements of thin films will serve to illustrate how measurements can enable optimized performance in communications devices. In another case, microwave microscopy will be introduced as a tool for local microwave characterization of materials with nanoscale spatial resolution. Finally, device and systems engineers will bring these aspects together to illustrate the ultimate incorporation of novel materials into practical wireless communications devices. Practical applications that will be covered in this workshop include reconfigurable mm-wave antennas, non-reciprocal devices based on magnetic heterostructures, and bulk acoustic wave (BAW) filters.</p>	<p>Materials by Design for Microwave and mm-Wave Communications Sponsor: IMS Organizer: N. Orloff, NIST; T.M. Wallis, NIST 08:00 – 17:15</p> <p style="text-align: right;">WMG</p>
<p>The workshop will discuss the advanced microwave and mm-wave techniques and technologies for 5G wireless communication applications. These include system and transceiver architectures including software-defined phased array radio, recent advances and different techniques and technologies in designing power amplifiers, switches, low-noise amplifiers and filters in both sub-6GHz and mm-wave 5G frequency bandwidths. This workshop brings together the experts of both bulk CMOS, SOI CMOS, GaN HEMT and other technologies to explain the advantages and proper choice of certain technology to design different active and passive components of 5G front-ends and transceivers. Specifically, efficient transmitter design using advanced Doherty techniques for base station and sub-6GHz front-end modules using envelope-tracking techniques for handset applications will be discussed.</p>	<p>Advanced Microwave and mm-Wave Techniques and Technologies for 5G Applications Sponsor: IMS; RFIC Organizer: A. Grebennikov, Sumitomo Electric Europe; F. Balteanu, Skyworks Solutions 08:00 – 17:15</p> <p style="text-align: right;">WMH</p>

	Lecture Title	Course Syllabus
TMA1	Understanding Oscillator Phase Noise and Locking Speaker: Ali Hajimiri, Caltech 12:00 – 13:30	In this lecture, we will discuss the nature and properties of oscillators and the general behavior of the phase noise. We then investigate methods to model the phase noise in oscillators and the resultant design insights. In particular, we develop a time-varying model of noise in oscillators based on the impulse sensitivity function (ISF). We will use this model to describe some important phenomena such as up-conversion of $1/f$ noise, the effect of cyclostationary noise source, and the impact of correlated noise and their associated design implications. We will look at the newly developed generalization of the approach to model oscillator injection locking and pulling and finally we will look at several design examples of oscillators.
TMB2	Intuitive Microwave Filter Design with EM Simulation Speaker: Daniel Swanson, DGS Associates, LLC 13:30 – 17:00	Microwave filters are one of the basic building blocks in RF systems along with amplifiers, mixers and oscillators. At some point, you may be called on to design or specify a filter, even though you are not a filter design expert. Luckily, there is simple design method for narrow band filters that is easy to learn and quite universal. It can be applied to any lumped element or distributed topology and any manufacturing technology except SAW-BAW, and, the method is valid for bandwidths from a fraction of a percent up to 20 percent or more. This technical lecture is a “no math” approach to filter design that requires only simple algebra and no knowledge of complex filter synthesis techniques. The root of the design flow is based on Dishal’s method with the addition of EM simulation for accuracy and port tuning for updates to the filter geometry. The basic design method can also be expanded to include cross-coupled filters and multiplexers. Two design flow examples have been prepared for this technical lecture. The first is a high Q cavity combine bandpass filter and the second is a microstrip combine bandpass filter. Example project files will be made available to attendees.

RF BOOTCAMP

This one day course is ideal for newcomers to the microwave world, such as technicians, new engineers, college students, engineers changing their career path, as well as marketing and sales professionals looking to become more comfortable in customer interactions involving RF & Microwave circuit and system concepts and terminology.

The format of the RF Boot Camp is similar to that of a workshop or short course, with multiple presenters from industry and academia presenting on a variety of topics including:

- The RF/Microwave Signal Chain**
- Network Characteristics, Analysis and Measurement**
- Fundamentals of RF Simulation**
- Impedance Matching Basics**
- Spectral Analysis and Receiver Technology**
- Signal Generation**
- Modulation and Vector Signal Analysis**
- Microwave Antenna Basics**
- RFMW Application Focus**

LACC

08:00 – 16:45 MONDAY, 22 JUNE 2020

This full day course will cover real-world, practical, modern design and engineering fundamentals needed by technicians, new engineers, engineers wanting a refresh, college students, as well marketing and sales professionals. Experts within industry and academia will share their knowledge of: RF/Microwave systems basics, simulation and network design, network and spectrum analysis, microwave antenna and radar basics. Attendees completing the course will earn 2 CEUs.



HW Startups – No Longer an Oxymoron?

PANEL ORGANIZERS AND MODERATORS:

Oren Eliezer, *Apogee Semiconductors, USA*; **Joseph Cali**, *BAE Systems, USA*;

Francois Rivet, *Bordeaux University, France*; **Chris Rudell**, *Washington University, USA*

PANELISTS:

Amitava Das, *Founder & CEO, Tagore Technology, USA*; **Joy Laskar**, *Co-Founder & CEO, Maja Systems, USA*; **Wouter Steyaert**, *Co-Founder & CEO, Tusk IC, Belgium*; **Tomi-Pekka Takalo**, *Co-Founder & CEO, CoreHW, Finland*

ABSTRACT:

Many successful software startup companies of recent years were able to launch their product via the internet relatively quickly and appeared to have effortlessly reached a high number of users without ever delivering a physical hardware product. Many of these have even exceeded a valuation of \$1B, thereby qualifying as a “unicorn”.

In contrast, RFIC companies experience long and costly development and productization cycles, due to the high costs of the personnel, CAD tools, IC fabrication, measurement equipment and marketing and delivery logistics.

RFIC entrepreneurs nowadays seem to be challenged with competing over the attention and funds of potential investors, and it is apparently also becoming more difficult to attract young talent into this field.

In this lunchtime panel several entrepreneurs, at different levels of the maturity of their companies, will share their experiences: how they were able to bootstrap the activity from a funding point of view, what led them to believe that they can compete in a given market, what business and exit strategies they had, and what challenges they have been facing.

The panel will try to answer questions such as whether the development of RFICs will soon be done only in the existing large companies and what the chances of success are for an RFIC startup.

Come and share your own experiences, opinion and questions!

PLENARY SPEAKER 1

Can Digital Technologies Really Change the World?

Doreen Bogdan-Martin, Director, Telecommunication Development,
International Telecommunication Union



ABSTRACT:

Half the planet is now online. Great news – at least for those who can connect. But what of the rest? 3.6 billion people remain totally cut-off from a world the rest of us take for granted. Like no other technology before, digital devices, platforms and apps have unprecedented power to overcome traditional development barriers. They can bring education where there are no teachers, health advice where there are no doctors, financial services where there are no banks, libraries where there are no books.

The Internet has changed our world. But its transformational potential will be magnified 1,000 times in the hands of people held back for generations through lack of access to the power of information. Digital is the transformational force that will enable us to meet the 17 UN Sustainable Development Goals by the target date of 2030. In short, the UN pledge

to ‘Leave No-one Behind’ will mean getting everyone online.

How do we make that happen in markets where incomes are low, infrastructure is lacking, and literacy and digital skills are in short supply? In Africa alone, connecting the continent will mean bringing 220 million new people online and an estimated US\$9 billion in investment. The situation can look bleak, but sometimes a simple paradigm shift can dramatically change the picture. The interrelatedness of the SDGs provides a great opportunity for common approaches and integration within and across institutions. Coupled with policy approaches that prioritize digital skills and promote access and affordability, the power of digital could just turn out to be the power to change the world.

PLENARY SPEAKER 2



Mark Dankberg, Chairman of the Board and Chief Executive Officer, Viasat, Inc.

Tuesday

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406AB

Tu1E: Novel Components, Waveguides, and Methods for Radiating Structures

Chair: Dan Jiao, Purdue University
Co-Chair: Werner Thiel, ANSYS, Inc.

Tu1E-1: Linear-to-Circular Polarization Converter Based on Stacked Metasurfaces with Aperture Coupling Interlayer

C. Tao; Univ. of California, Los Angeles; A. Papathanasopoulos; Univ. of California, Los Angeles; T. Itoh; Univ. of California, Los Angeles

Tu1E-2: A Coupled Pair of Anti-Symmetrically Nonreciprocal Composite Right/Left-Handed Metamaterial Lines

T. Ueda; Kyoto Institute of Technology; K. Yamagami; Kyoto Institute of Technology; T. Itoh; Univ. of California, Los Angeles

Tu1E-3: Partially-Air-Filled Slow-Wave Substrate Integrated Waveguide in Metallic Nanowire Membrane Technology

J. Corsi; RFIC-Lab (EA 7520); G.P. Rehder; Universidade de São Paulo; L.G. Gomes; Universidade de São Paulo; M. Bertrand; L2E; A.L.C. Serrano; Universidade de São Paulo; E. Pistono; RFIC-Lab (EA 7520); P. Ferrari; RFIC-Lab (EA 7520)

Tu1E-4: The Transition Between Radiative and Reactive Region for Leaky Waves in Planar Waveguiding Structures

W. Fuscaldo; Università di Roma "La Sapienza"; P. Burghignoli; Università di Roma "La Sapienza"; A. Galli; Università di Roma "La Sapienza"

Tu1E-5: Small-Scale Beam Scanning with an Ultrathin High Impedance Surface-Based Leaky Wave Antenna with Multiple Feeds

M.M.R.H. Tanmoy; Univ. of South Alabama; S.I. Latif; Univ. of South Alabama; A.T. Almutawa; Univ. of California, Irvine; F. Capolino; Univ. of California, Irvine

408A

Tu1F: High Power Amplifiers for HF Through S Band

Chair: Marc Franco, QORVO, Inc.
Co-Chair: Robert Caverly, Villanova University

Tu1F-1: Series-Combined Coaxial Dielectric Resonator Class-F Power Amplifier System

R.A. Beltran; Ophir RF; F. Wang; Ophir RF; G. Villagrana; Ophir RF

Tu1F-2: An Over 230W, 0.5–2.1GHz Wideband GaN Power Amplifier Using Transmission-Line-Transformer-Based Combining Technique

Y. Niida; Fujitsu Laboratories; M. Sato; Fujitsu Laboratories; M. Nishimori; Fujitsu Laboratories; T. Ohki; Fujitsu Laboratories; N. Nakamura; Fujitsu Laboratories

Tu1F-3: Compact and Highly Efficient Lumped Push-Pull Power Amplifier at Kilowatt Level with Quasi-Static Drain Supply Modulation

R. Tong; Uppsala Univ.; D. Dancila; Uppsala Univ.

Tu1F-4: A 2.3kW 80% Efficiency Single GaN Transistor Amplifier for 400.8MHz Particle Accelerators and UHF Radar Systems

G. Formicone; Integra Technologies; J. Custer; Integra Technologies

Tu1F-5: An Enhanced Large-Power S-Band Injection-Locked Magnetron with Anode Voltage Ripple Inhibition

X. Chen; Sichuan Univ.; B. Yang; Kyoto Univ.; X. Zhao; Sichuan Univ.; N. Shinohara; Kyoto Univ.; C. Liu; Sichuan Univ.

408B

Tu1G: Innovative RF Switches and Applications

Chair: Guoan Wang, University of South Carolina
Co-Chair: John Ebel, US Air Force Research Laboratory

Tu1G-1: RF-MEMS Switched Capacitor Using Ta/Ta2O5 Electrodes

J.-C. Orianges; XLIM (UMR 7252); M. Laouini; XLIM (UMR 7252); C. Hallepee; XLIM (UMR 7252); P. Blondy; XLIM (UMR 7252)

Tu1G-2: A 25THz FCO (6.3 fs RON*C_OFF) Phase-Change Material RF Switch Fabricated in a High Volume Manufacturing Environment with Demonstrated Cycling > 1 Billion Times

N. El-Hinnawy; Tower Semiconductor; G. Slovin; Tower Semiconductor; J. Rose; Tower Semiconductor; D. Howard; Tower Semiconductor

Tu1G-3: Fully Printed V02 Switch Based Flexible and Reconfigurable Filter

S. Yang; KAUST; W. Li; KAUST; M. Vaseem; KAUST; A. Shamim; KAUST

Tu1G-4: Miniaturized Reconfigurable 28GHz PCM-Based 4-Bit Latching Variable Attenuator for 5G mmWave Applications

T. Singh; Univ. of Waterloo; R.R. Mansour; Univ. of Waterloo

Tu1G-5: Monolithic Integration of Phase-Change RF Switches in a Production SiGe BiCMOS Process with RF Circuit Demonstrations

G. Slovin; Tower Semiconductor; N. El-Hinnawy; Tower Semiconductor; C. Masse; Tower Semiconductor; J. Rose; Tower Semiconductor; D. Howard; Tower Semiconductor

409AB

Tu1H: Advances in RF and Microwave CAD Techniques

Chair: Erin Kiley, Massachusetts College of Liberal Arts
Co-Chair: Jose Rayas-Sanchez, ITESO - The Jesuit University of Guadalajara

Tu1H-1: High-Dimensional Variability Analysis via Parameters Space Partitioning

Y. Tao; Carleton Univ.; F. Ferranti; IMT Atlantique; M. Nakhla; Carleton Univ.

Tu1H-2: Adaptively Weighted Training of Space-Mapping Surrogates for Accurate Yield Estimation of Microwave Components

J. Zhang; Tianjin Univ.; F. Feng; Carleton Univ.; W. Na; Beijing Univ. of Technology; J. Jin; Tianjin Univ.; Q.J. Zhang; Carleton Univ.

Tu1H-3: Computationally Efficient Performance-Driven Surrogate Modeling of Microwave Components Using Principal Component Analysis

S. Koziel; Reykjavik University; A. Pietrenko-Dabrowska; Gdansk University of Technology; J.W. Bandler; McMaster Univ.

Tu1H-4: Design of SIW Filters in D-Band Using Invertible Neural Nets

H. Yu; Georgia Tech; H.M. Torun; Georgia Tech; M.U. Rehman; Georgia Tech; M. Swaminathan; Georgia Tech

Tu1H-5: Automated Spiral Inductor Design by a Calibrated PI Network with Manifold Mapping Technique

X. Fan; Univ. of Regina; S. Li; Univ. of Regina; P.D. Laforge; Univ. of Regina; Q.S. Cheng; SUSTech

Tu1H-6: An Objective Function Formulation for Circuit Parameter Extraction Based on the Kullback-Leibler Distance

R. Loera-Díaz; ITESO; J.E. Rayas-Sánchez; ITESO

402AB

Tu1A: mmWave Signal Generation

Chair: Ehsan Afshari, University of Michigan
Co-Chair: Andreia Cathelin, STMicroelectronics

Tu1A-1: Frequency Multiplier-by-4 (Quadrupler) with 52dB Spurious-Free Dynamic Range for 152GHz to 220GHz (G-Band) in 130nm SiGe

P. Stärke; Technische Universität Dresden; V. Rieß; Technische Universität Dresden; C. Carta; Technische Universität Dresden; F. Ellinger; Technische Universität Dresden

Tu1A-2: A D-Band SiGe Frequency Doubler with a Harmonic Reflector Embedded in a Triaxial Balun

S.G. Rao; Georgia Tech; M. Frounchi; Georgia Tech; J.D. Cressler; Georgia Tech

Tu1A-3: A Multichannel Programmable High Order Frequency Multiplier for Channel Bonding and Full Duplex Transceivers at 60GHz Band

A. Siligaris; CEA-LETI; J.L. Gonzalez-Jimenez; CEA-LETI; C. Jany; CEA-LETI; B. Blampey; CEA-LETI; A. Boulmirat; CEA-LETI; A. Hamani; CEA-LETI; C. Dehos; CEA-LETI

Tu1A-4: A 126GHz, 22.5% Tuning, 191dBc/Hz FOMt 3rd Harmonic Extracted Class-F Oscillator for D-Band Applications in 16nm FinFET

B. Philippe; Katholieke Univ. Leuven; P. Reynaert; Katholieke Univ. Leuven

Tu1A-5: A 7.4dBm EIRP, 20.2% DC-EIRP Efficiency 148GHz Coupled Loop Oscillator with Multi-Feed Antenna in 22nm FD-SOI

M.W. Mansha; Rensselaer Polytechnic Institute; M. Hella; Rensselaer Polytechnic Institute

403A

Tu1B: 5G Focus Session on Advances in Mixer-First Receivers

Chair: Ramesh Harjani, University of Minnesota
Co-Chair: Harish Krishnaswamy, Columbia University

Tu1B-1: mm-Wave Mixer-First Receiver with Passive Elliptic Low-Pass Filter

P. Song; Univ. of Southern California; H. Hashemi; Univ. of Southern California

Tu1B-2: 10–35GHz Passive Mixer-First Receiver Achieving +14dBm In-Band IIP3 for Digital Beam-Forming Arrays

S. Krishnamurthy; Univ. of California, Berkeley; A.M. Niknejad; Univ. of California, Berkeley

Tu1B-3: A 9–31GHz 65nm CMOS Down-Converter with >4dBm OOB B1dB

Z.G. Boynton; Cornell Univ.; A. Molnar; Cornell Univ.

Tu1B-4: A 2.5-to-4.5-GHz Switched-LC-Mixer-First Acoustic-Filtering RF Front-End Achieving <6dB NF, +30dBm IIP3 at 1×Bandwidth Offset

H. Seo; Univ. of Illinois at Urbana-Champaign; J. Zhou; Univ. of Illinois at Urbana-Champaign

403B

Tu1C: Linearization and Efficiency Enhancement Techniques

Chair: Margaret Szymanowski, NXP Semiconductors
Co-Chair: Sungwon Chung, Neuralink

Tu1C-1: A 1–3GHz I/Q Interleaved Direct-Digital RF Modulator as a Driver for a Common-Gate PA in 40nm CMOS

Y. Shen; Technische Universiteit Delft; R. Bootsman; Technische Universiteit Delft; M.S. Alavi; Technische Universiteit Delft; L.C.N. de Vreede; Technische Universiteit Delft

Tu1C-2: A 1.3V Wideband RF-PWM Cartesian Transmitter Employing Analog Outphasing and a Switched-Capacitor Class-D Output Stage

H. Kang; Univ. of Texas at Austin; V. S. Rayudu; Univ. of Texas at Austin; K.Y. Kim; Univ. of Texas at Austin; R. Gharpurey; Univ. of Texas at Austin

Tu1C-3: Preserving Polar Modulated Class-E Power Amplifier Linearity Under Load Mismatch

A. Khodkumbhe; BITS Pilani; M. Huiskamp; Univ. of Twente; A. Ghahremani; Univ. of Twente; B. Nauta; Univ. of Twente; A.-J. Annema; Univ. of Twente

Tu1C-4: A 28GHz Voltage-Combined Doherty Power Amplifier with a Compact Transformer-Based Output Combiner in 22nm FD-SOI

Z. Zong; IMEC; X. Tang; IMEC; K. Khalaf; Pharrowtech; D. Yan; IMEC; G. Mangraviti; IMEC; J. Nguyen; IMEC; Y. Liu; IMEC; P. Wambacq; IMEC

Tu1C-5: A 6GHz 160MHz Bandwidth MU-MIMO Eight-Element Direct Digital Beamforming TX Utilizing FIR H-Bridge DAC

B. Zheng; Univ. of Michigan; L. Jie; Univ. of Michigan; R. Wang; Univ. of Michigan; M.P. Flynn; Univ. of Michigan

404AB

Tu1D: Mixed-Signal and Power Management Techniques for RF Transceivers

Chair: Antoine Frappé, IEMN (UMR 8520)
Co-Chair: Bahar Jalali Farahani, Cisco Systems

Tu1D-1: Fourier-Domain DAC-Based Transmitter: New Concepts Towards the Realisation of Multigigabit Wireless Transmitters

O. Hanay; RWTH Aachen Univ.; E. Bayram; RWTH Aachen Univ.; S. Müller; RWTH Aachen Univ.; M. Elsayed; RWTH Aachen Univ.; R. Negra; RWTH Aachen Univ.

Tu1D-2: A 10MHz 40V VIN Slope-Reconfigurable Gaussian Gate Driven GaN DC-DC Converter with 49.1dB Conducted EMI Noise Reduction at 100MHz

C. Yang; Southern Methodist Univ.; W. Chen; Southern Methodist Univ.; W. Da; Texas Instruments; Y. Fan; Texas Instruments; P. Gui; Southern Methodist Univ.

Tu1D-3: A Sub-10fs FOM, 5000× Load Driving Capacity and 5mV Output Ripple Digital LDO with Dual-Mode Nonlinear Voltage Detector and Dead-Zone Charge Pump Loop

B. Wang; Tsinghua Univ.; W. Rhee; Tsinghua Univ.; Z. Wang; Tsinghua Univ.

Tu1D-4: A 32–40GHz 7-Bit CMOS Phase Shifter with 0.38dB/1.6° RMS Magnitude/Phase Errors for Phased Array Systems

Y. Li; USTC; Z. Duan; ECRIE; W. Lv; ECRIE; D. Pan; USTC; Z. Xie; USTC; Y. Dai; ECRIE; L. Sun; USTC

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406AB

Tu2E: Advances in Microwave to Terahertz Photonics and Nanotechnology

Chair: Mona Jarrahi, University of California, Los Angeles

Co-Chair: Luca Pierantoni, Università Politecnica delle Marche

Tu2E-1: High-Sensitivity Plasmonic Photoconductive Terahertz Detector Driven by a Femtosecond Ytterbium-Doped Fiber Laser

D. Turan; Univ. of California, Los Angeles; N.T. Yardimci; Univ. of California, Los Angeles; M. Jarrahi; Univ. of California, Los Angeles

Tu2E-2: Terahertz Generation Through Bias-Free Telecommunication Compatible Photoconductive Nanoantennas Over a 5THz Radiation Bandwidth

D. Turan; Univ. of California, Los Angeles; N.T. Yardimci; Univ. of California, Los Angeles; P.K. Lu; Univ. of California, Los Angeles; M. Jarrahi; Univ. of California, Los Angeles

Tu2E-3: A 63-Pixel Plasmonic Photoconductive Terahertz Focal-Plane Array

X. Li; Univ. of California, Los Angeles; M. Jarrahi; Univ. of California, Los Angeles

Tu2E-4: Operation of Near-Field Scanning Millimeter-Wave Microscopy up to 67GHz Under Scanning Electron Microscopy Vision

P. Polovodov; IEMN (UMR 8520); D. Théron; S. Eliet; V. Avramovic; C. Boyaval; D. Deresmes; G. Dambriane; K. Haddadi; IEMN (UMR 8520)

Tu2E-5: Covert Photonics-Enabled Millimeter-Wave Transmitter

E. Siman-Tov; Johns Hopkins Univ.; J.H. Kalkavage; Johns Hopkins Univ.; J.C. Juarez; General Dynamics; D.M. Coleman; Johns Hopkins Univ.

Tu2E-6: Microwave Photonic Self-Adaptive Bandpass Filter and its Application to a Frequency Set-On Oscillator

G. Charalambous; Univ. of Cyprus; S. Iezekiel; Univ. of Cyprus

408A

Tu2F: Power Amplifiers for S and C Band

Chair: Vittorio Camarchia, Politecnico di Torino

Co-Chair: Damon Holmes, NXP Semiconductors

Tu2F-1: Optimal Supply Voltage for PA Output Power Correction Under Load Varying Scenarios

C.F. Gonçalves; Instituto de Telecomunicações; F.M. Barradas; Instituto de Telecomunicações; L.C. Nunes; Instituto de Telecomunicações; P.M. Cabral; Instituto de Telecomunicações; J.C. Pedro; Instituto de Telecomunicações

Tu2F-2: A 3.9-GHz-Band Outphasing Power Amplifier with Compact Combiner Based on Dual-Power-Level Design for Wide-Dynamic-Range Operation

R. Ogasawara; Univ. of Electro-Communications; Y. Takayama; Univ. of Electro-Communications; R. Ishikawa; Univ. of Electro-Communications; K. Honjo; Univ. of Electro-Communications

Tu2F-3: Co-Designed High-Efficiency GaN Filter Power Amplifier

J.A. Estrada; University of Colorado Boulder; P. de Paco; Univ. Autònoma de Barcelona; S. Johannes; University of Colorado Boulder; D. Psychogiou; University of Colorado Boulder; Z. Popovic; University of Colorado Boulder

Tu2F-4: Integrated Filtering Class-F Power Amplifier Based on Microstrip Multimode Resonator

L.-H. Zhou; CityU; X.Y. Zhou; CityU; W.S. Chan; CityU; J. Pang; Univ. College Dublin; D. Ho; CityU

408B

Tu2G: Filters Based on Micro-machined Acoustic or Electromagnetic Structures

Chair: Amelie Hagelauer, University of Bayreuth

Co-Chair: Songbin Gong, University of Illinois at Urbana-Champaign

Tu2G-1: High-Q Bandpass-to-Bandstop Reconfigurable Filter Based on SAW Resonators

R. Chen; USTC; Q. Sheng; USTC; L. Zhou; USTC; C. Chen; USTC; H. Zhang; UMass Lowell

Tu2G-2: Microfabrication of a Miniaturized Monolithic Folded Half-Mode Integrated Waveguide Cavity for W-Band Applications

T.R. Jones; Univ. of Alberta; M. Daneshmand; Univ. of Alberta

Tu2G-3: An Intrinsically Switchable Balanced Ferroelectric FBAR Filter at 2GHz

M. Zolfagharloo Koochi; Univ. of Michigan; W. Peng; Univ. of Michigan; A. Mortazawi; Univ. of Michigan

Tu2G-4: W-Band Micro-Fabricated Waveguide Band-Pass Filters

N. Jguirim; XLIM (UMR 7252); C. Dalmay; XLIM (UMR 7252); D. Passerieux; XLIM (UMR 7252); P. Blondy; XLIM (UMR 7252)

Tu2G-5: Suppression of Acoustic Resonances in All-Oxide Varactors

D. Walk; Technische Univ. Darmstadt; D. Kienemund; Technische Univ. Darmstadt; P. Agrawal; Technische Univ. Darmstadt; P. Salg; Technische Univ. Darmstadt; L. Zeinar; Technische Univ. Darmstadt; P. Komissinskiy; Technische Univ. Darmstadt; L. Alff; Technische Univ. Darmstadt; R. Jakoby; Technische Univ. Darmstadt; H. Maune; Technische Univ. Darmstadt

409AB

Tu2H: Advances in Electromagnetic Modeling Techniques

Chair: Zhizhang David Chen, Dalhousie University

Co-Chair: Marco Pirola, Politecnico di Torino

Tu2H-1: Surface-Volume-Surface EFIE for Analysis of 3-D Microwave Circuits in Multilayered Substrates with Finite Dielectric Inclusions

S. Zheng; Univ. of Manitoba; R. Gholami; Univ. of Manitoba; V. Okhmatovski; Univ. of Manitoba

Tu2H-2: A Volume Current Based Method of Moments Analysis of Shielded Planar 3-D Circuits in Layered Media

J.C. Rautio; Sonnet Software; M. Thelen; Sonnet Software

Tu2H-3: Multiphysics Sensitivity Analysis in FDTD Based Electromagnetic-Thermal Simulations

K.-A. Liu; Intel; C.D. Sarris; Univ. of Toronto

Tu2H-4: Application of Conformal Mapping to Rigorous Validation of 2D Coupled EM-CFD Modelling

K. Wilczynski; Warsaw Univ. of Technology; M. Olszewska-Plachta; QWED; M. Celuch; QWED

Tu2H-5: The Entropy Technique for the Time-Reversal Source Reconstruction

X.-Y. Feng; Dalhousie University; Z. Chen; Dalhousie University; J.-C. Liang; Southeast Univ.

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TUESDAY

402AB

Tu2A: Ultra-Low Power Transceivers

Chair: Chun Huat Heng, NUS

Co-Chair: Gernot Hueber, Silicon Austria Labs

Tu2A-1: A 66.97pJ/Bit, 0.0413mm² Self-Aligned PLL-Calibrated Harmonic-Injection-Locked TX with >62dBc Spur Suppression for IoT Applications

C.-C. Lin; Washington State Univ.; H. Hu; Washington State Univ.; S. Gupta; Washington State Univ.

Tu2A-2: A 67- μ W Ultra-Low Power PVT-Robust MedRadio Transmitter

S. Mondal; Univ. of California, San Diego; D.A. Hall; Univ. of California, San Diego

Tu2A-3: A 400MHz/900MHz Dual-Band Ultra-Low-Power Digital Transmitter for Biomedical Applications

Z. Weng; Tsinghua Univ.; H. Jiang; Tsinghua Univ.; Y. Guo; Tsinghua Univ.; Z. Wang; RITS

Tu2A-4: A mm-Scale Sensor Node with a 2.7GHz 1.3 μ W Transceiver Using Full-Duplex Self-Coherent Backscattering Achieving 3.5m Range

Z. Feng; Univ. of Michigan; L.-X. Chuo; Univ. of Michigan; Y. Shi; Univ. of Michigan; Y. Kim; Univ. of Michigan; H. Kim; Univ. of Michigan; D. Blaauw; Univ. of Michigan

Tu2A-5: A Fully Integrated 0.2V 802.11ba Wake-Up Receiver with -91.5dBm Sensitivity

J. Im; Univ. of Michigan; J. Breiholz; Univ. of Virginia; S. Li; Univ. of Virginia; B. Calhoun; Univ. of Virginia; D.D. Wentzloff; Univ. of Michigan

403A

Tu2B: 5G Focus Session on Millimeter-Wave Components and Systems

Chair: Tim Larocca, Northrop Grumman

Co-Chair: Jane Gu, University of California, Davis

Tu2B-1: A 16-Element Fully Integrated 28GHz Digital Beamformer with In-Package 4 \times 4 Patch Antenna Array and 64 Continuous-Time Band-Pass Delta-Sigma Sub-ADCs

R. Lu; Univ. of Michigan; C. Weston; Univ. of Michigan; D. Weyer; Univ. of Michigan; F. Buhler; Univ. of Michigan; M.P. Flynn; Univ. of Michigan

Tu2B-2: A 28GHz Front-End Module with T/R Switch Achieving 17.2dBm Psat, 21.5% PAEmax and 3.2dB NF in 22nm FD-SOI for 5G Communication

Y. Liu; IMEC; X. Tang; IMEC; G. Mangraviti; IMEC; K. Khalaf; Pharowtech; Y. Zhang; IMEC; W.-M. Wu; IMEC; S.-H. Chen; IMEC; B. Debaillie; IMEC; P. Wambacq; IMEC

Tu2B-3: A 24–28GHz Power and Area Efficient 4-Element Phased-Array Transceiver Front-End with 21.1%/16.6% Transmitter Peak/OP1dB PAE Supporting 2.4Gb/s in 256-QAM for 5-G Communications

W. Zhu; Tsinghua Univ.; J. Wang; Tsinghua Univ.; W. Lv; ECRIIE; X. Zhang; Rice Univ.; B. Liao; ECRIIE; Y. Zhu; ECRIIE; Y. Wang; Tsinghua Univ.

Tu2B-4: A CMOS Ka-Band SATCOM Transceiver with ACI-Cancellation Enhanced Dual-Channel Low-NF Wide-Dynamic-Range RX and High-Linearity TX

Y. Wang; Tokyo Institute of Technology; D. You; Tokyo Institute of Technology; X. Fu; Tokyo Institute of Technology; T. Nakamura; Tokyo Institute of Technology; A.A. Fadila; Tokyo Institute of Technology; T. Someya; Tokyo Institute of Technology; A. Kawaguchi; Tokyo Institute of Technology; J. Pang; Tokyo Institute of Technology; K. Yanagisawa; Tokyo Institute of Technology; B. Liu; Tokyo Institute of Technology; Y. Zhang; Tokyo Institute of Technology; H. Zhang; Tokyo Institute of T

Tu2B-5: Inter-Stream Loopback Calibration for 5G Phased-Array Systems

Y. Aoki; Samsung; Y. Kim; Samsung; Y. Hwang; Samsung; S. Kim; Samsung; M.T. Dao; Samsung; D. Kang; Samsung; D. Minn; Samsung; H. Kang; Samsung; H.-C. Park; Samsung; A.-S. Ryu; Samsung; S. Jeon; Samsung; S.-G. Yang; Samsung

403B

Tu2C: Sub-6 GHz Receiver Front-End Circuits

Chair: Kamran Entesari, Texas A&M University

Co-Chair: Gary Hau, Qualcomm

Tu2C-1: A Wide-Band RF Front-End Module for 5G mMIMO Applications

M. Fraser; NXP Semiconductors; V.N.K. Malladi; NXP Semiconductors; J. Staudinger; NXP Semiconductors; C.-W. Chang; NXP Semiconductors

Tu2C-2: A 1.2V, 5.5GHz Low-Noise Amplifier with 60dB On-Chip Selectivity for Uplink Carrier Aggregation and 1.3dB NF

D. Schrögendorfer; Infineon Technologies; T. Leitner; Infineon Technologies

Tu2C-3: A 5–6GHz Low-Noise Amplifier with >65-dB Variable-Gain Control in 22nm FinFET CMOS Technology

Y.-S. Yeh; Intel; H.-J. Lee; Intel

Tu2C-4: A Wideband Variable-Gain Amplifier with a Negative Exponential Generation in 40-nm CMOS Technology

Y. Dong; NTU; L. Kong; NTU; C.C. Boon; NTU; Z. Liu; NTU; C. Li; NTU; K. Yang; NTU; A. Zhou; NTU

Tu2C-5: A 0.08mm² 1–6.2GHz Receiver Front-End with Inverter-Based Shunt-Feedback Balun-LNA

B. Guo; Chengdu University; D. Prevedelli; Università di Pavia; R. Castello; Università di Pavia; D. Manstretta; Università di Pavia

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TUESDAY

COMPETITIONS

All attendees are invited to the 16th annual IMS Student Design Competitions. Students have been busy over the past several months designing and building solutions to the challenging engineering problems presented in the 12 student design competitions listed below. Judges will measure the students' designs at this event to determine the winners of the various competitions. With 130+ students registered across 50+ teams, this lively event is bound to be filled with teamwork and friendly competition. Come to this event to cheer on the students, celebrate their hard work, and learn about their innovative designs.

#	Title	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
1	Switched Acoustic Filter Modules								
2	5G Wideband 3.4-3.8 GHz Receiver								
3	13.56 MHz High Efficiency Power Amplifier								
4	Exploring 5G: Design of a 26 GHz filter								
5	Spectrum Sensing radio Receiver								
6	High Efficiency Power Amplifiers								
7	Linear HPA Design with Behavioral Model								
8	Wide Frequency Coverage Tunable Bandstop Filter								
9	Digital Predistortion								
10	Microwave Energy Harvesting								
11	High Sensitivity Motion Radar								
12	Microwave Photonic Link Receiver								

TUESDAY TECHNICAL LECTURES

	Lecture Title	Course Syllabus
TTA1	<p>Quantum Computing: an RF Control Perspective Speaker: Evan Jeffrey, Google, Inc. 12:00 – 13:30</p>	<p>Quantum computing is moving from a long running research interest in the physics community to a field promising significant impact to society. The process of transitioning from a research prototype to scalable, fault tolerant computing systems will provide numerous opportunities for engagement from the RF and microwave design community. This talk will provide an introduction to quantum computing with a focus on superconducting transmon qubit architectures that is accessible to microwave engineers. This will include a description of the basic principles of quantum computing and the most important commercial applications. Then we will cover the transmon qubit and how the basic operational requirements are all achieved via analog RF circuits. Finally, we will cover the basics of how fault tolerance is achieved in a fundamentally analog system and what challenges are needed to build such a system along with a picture of what a fault tolerant computer might look like.</p>
TTA1	<p>Trends in Automotive Radars: Waveform, System Implementation, and IC Technologies Speaker: Cicero Vaucher, NXP Semiconductors 12:00 – 13:30</p>	<p>This technical lecture will introduce fundamental automotive radar performance parameters, review latest market trends and functional requirements, and discuss the latest signaling waveforms and practical system implementation aspects. It will also introduce IC technology options for next-generation car-radar products, discuss key circuits and present measurement results of a fully-integrated radar front-end in 40nm CMOS silicon technology and review experiments using the CMOS chip in several prototype radars. Finally, it will discuss typical antenna implementations, radar link budget considerations, and multiple cascaded chips usage for high angular resolution imaging radars.</p>

TUESDAY

MICROAPPS SCHEDULE

09:40 – 16:50

TUESDAY, 23 JUNE 2020

MicroApps offers a lot of information in 15 minutes! These presentations of application notes target the working engineer or technician and are color coded by general topic area below.

START TIME	TITLE	SPEAKERS
9:40	SMD Characterization Using Progressive De-embedding Methods with a VNA	Rebecca Wilson – Copper Mountain Technologies
9:55	Stingray - X-Ku Band Phased Array Prototyping System	Eamon Nash, Weston Sapia – Analog Devices
10:10	60 GHz Phased Array Antenna Design Using XFDTD for WiGig Application	Naveen Kumar, T J – Remcom
10:25	A 24GHz Radar Evaluation and Development Platform	Alex Andrews – Analog Devices
10:40	16TX-16RX S-Band Phased Array Radar Prototyping Platform	Chas Frick, Michael Jones, Peter Delos – Analog Devices
10:55	A 2.6GHz Compact 40W Fully Integrated 3-Way Doherty for m-MIMO 5G Applications	Marc Vigneau – Ampleon
11:10	Gaining Insight to Doherty Amplifiers	Markus Loerner – Rohde & Schwarz
11:25	Fully Integrated IC-Package Co-Simulation Flow for RF IC Designs	Feng Ling, Changhua Wan, Joshua – Xpedic Technology
11:40	Power Handling in Passive Surface Mount RF Devices	Hassan Dani – Knowls DLI
12:00	What is the Best Semiconductor Technology for 5G mmWave Applications? - PANEL Session	Pat Hindle – Microwave Journal
13:05	Surface Mount Quadrature Hybrid Couplers for Microwave Designs	Dave Thibado – Knowles Corporation
13:20	Alternative Architectures for Extending Ground Coverage of Mobile Networks Using Satellites	Paul Moakes – CommAgility - Wireless Telecom
13:35	Device Miniaturization with High K Materials	Jared Burdick – Knowles Capacitors
13:50	Network Synthesis and Vendor Component Models Support Impedance Matching Circuit Development	David Vye, Chris Bean – AWR Group, NI
14:05	Automated Rigorous Filter Synthesis using Mician Filter Workbench	Ralf Ihmels – Mician GmbH
14:20	Highly Accurate Calculation of EM Shielding Effectiveness in WIPL-D Software Package	Branko Mrdakovic – WIPL-D
14:35	Power Amplifier Modeling for System-Level Simulation	Joel Kirshman – AWR Group, NI
14:50	The Advantages of FET Based Limiters	Chris Gregoire – Custom MMIC
15:05	RF Amplifier Bias Networks: What could go wrong?	Ray Barker – Analog Devices
15:20	TFLE-Thin Film Lumped Elements Filters and Transition Time Converters (TTC) Solutions.	Rafi Hershtig – K&L Microwave
15:35	Component Phase Noise Measurement Practices	Jacob Trevithick – Marki Microwave
15:50	AXIEM EM Simulation for Complex ICs and PCBs	John Dunn – AWR Group, NI
16:05	Easy Semiconductor Workflows with the new Sonnet Technology File (.STF)	Brian Rautio – Sonnet Software
16:20	Parallel and Remote Schematic Simulation and Optimization in AWR	Dustin Hoekstra – AWR Group, NI
16:35	A New Wave of Simulation for Electromagnetism and Design Optimization	Katsuhiko Kosenda – Murata Software

5G Cell Phone ≤ 6GHz, FR1

5G Millimeterwave, FR2

Antenna and Antenna Components

Components & Materials

CAD and Modeling Products and Techniques

High Power Devices, including GaN Devices

Instrumentation and Measurement Techniques

Systems

MicroApps Sponsor:



MicroApps Media Sponsor:



COMPETITION

The Technical Paper Review Committee has identified the following students as Finalists in this year's Student Paper Competition. Finalists will be presenting their papers at the Student Paper Competition's Interactive Forum (SPC-IF) in addition to their regular presentation. All attendees are encouraged to stop by the SPC-IF and interact with these promising students, in addition to seeing them in their regular speaking sessions.

THIS YEAR'S SPC FINALISTS ARE:

High Output Power Ultra-Wideband Distributed Amplifier using Diamond Heat Spreader in InP DHBT Technology | Tu4F

Student Finalists: Md Tanjil Shivan, Maruf Hossain, Ralf Doerner, Ksenia Nosaeva, Hady Yacoub, Ferdinand-Braun-Institut; Tom K Johansen, Technical Univ. of Denmark; Wolfgang Heinrich, Ferdinand-Braun-Institut; Viktor Krozer, Ferdinand-Braun-Institut
Advisor: Professor Viktor Krozer, Ferdinand-Braun-Institut / Johann Wolfgang Goethe-Universität Frankfurt am Main,

High-Sensitivity Plasmonic Photoconductive Terahertz Detector Driven by a Femtosecond Ytterbium-Doped Fiber Laser | Tu2E

Student Finalists: Deniz Turan, Nezhil Tolga Yardimci, Mona Jarrahi, Univ. of California, Los Angeles
Advisor: Mona Jarrahi, University of California, Los Angeles

Negative Group Delay Enabled Artificial Transmission Line Exhibiting Squint-Free, Dominant Mode, Backward Leaky-Wave Radiation | Tu4A

Student Finalists: Minning Zhu, Chung-Tse (Michael) Wu, Rutgers Univ.
Advisor: Chung-Tse Michael Wu, Rutgers University

A 1 mW Cryogenic LNA Exploiting Optimized SiGe HBTs to Achieve an Average Noise Temperature of 3.2 K from 4–8 GHz | Tu3B

Student Finalists: Wei-Ting Wong, Mohsen Hosseini, Univ. of Massachusetts, Amherst, Holger Rücker, IHP GmbH, Joseph Bardin, Univ. of Massachusetts, Amherst
Advisor: Joseph Bardin, Univ. of Massachusetts, Amherst

Load Modulated Balanced mm-Wave CMOS PA with Integrated Linearity Enhancement for 5G applications | Th1G

Student Finalists: Chandrakanth R. Chappidi, Princeton Univ., Tushar Sharma, NXP Semiconductors, Zheng Liu, Kaushik Sengupta, Princeton Univ.
Advisor: Kaushik Sengupta, Princeton Univ.

Miniaturized 28 GHz PCM-Based 4-bit Latching Variable Attenuator | Tu1G

Student Finalists: Tejinder Singh, Raafat Mansour, Univ. of Waterloo
Advisor: Raafat R. Mansour, Centre for Integrated RF Engineering, Univ. of Waterloo

Transmit-Receive Cross-Modulation Distortion Correction in a 5-GHz Full Duplex Quadrature Balanced CMOS RF Front-End | Th2F

Student Finalists: Nimrod Ginzberg, Technion - Israel Institute of Technology, Tomer Gidoni, Tel-Aviv University, Dror Regev, Huawei Technologies Co., Ltd., Emauel Cohen, Technion - Israel Institute of Technology
Advisor: Professor Emanuel Cohen, Technion - Israel Institute of Technology

Gate Bias Incorporation into Cardiff Behavioural Modelling Formulation | Tu4H

Student Finalists: Ehsan M. Azad, James J. Bell, Roberto Quaglia, Jorge J. Moreno Rubio, Paul J. Tasker, Cardiff University
Advisor: Roberto Quaglia, Cardiff University

A Compact Reconfigurable N-Path Low-Pass Filter Based on Negative Trans-Resistance with <1dB Loss and >21dB Out-of-Band Rejection | We3E

Student Finalists: Mohammad Khorshidian, Columbia Univ., Negar Reiskarimian, Massachusetts Institute of Technology, Harish Krishnaswamy, Columbia Univ.
Advisor: Prof. Harish Krishnaswamy, Columbia University

A Compact Bandpass Filter with Wide Stopband and Low Radiation Loss Using Substrate Integrated Defected Ground Structure | We2E

Student Finalists: Deshan Tang, Changxuan Han, Zhixian Deng, Huizhen J. Qian, Xun Luo, Univ. of Electronic Science and Technology of China
Advisor: Xun Luo, University of Electronic Science and Technology of China

Dual-Octave-Bandwidth RF-Input Pseudo-Doherty Load Modulated Balanced Amplifier with ≥ 10 -dB Power Back-off Range | We2G

Student Finalists: Yuchen Cao, Kenle Chen, Univ. of Central Florida
Advisor: Kenle Chen, Univ. of Central Florida

An Enhanced Large-Power S-band Injection-Locked Magnetron with Anode Voltage Ripple Inhibition | Tu1F

Student Finalists: Xiaojie Chen, Xiang Zhao, Sichuan Univ., Bo Yang, Naoki Shinohara, Kyoto Univ., Changjun Liu, Sichuan Univ.
Advisor: Changjun Liu, School of Electronics and Information Engineering, Sichuan University, China

A 19 GHz Lithium Niobate Acoustic Filter with FBW of 2.4% | Tu3E

Student Finalists: Liuqing Gao, Yansong Yang, Songbin Gong, Univ. of Illinois at Urbana, Champaign
Advisor: Songbin Gong, University of Illinois at Urbana, Champaign,

A High-Sensitivity Low-Power Vital Sign Radar Sensor Based on Super-Regenerative Oscillator Architecture | We2D

Student Finalists: Yichao Yuan, Rutgers Univ., Austin Ying, Kuang Chen, California State Univ., Northridge, Chung-Tse (Michael) Wu, Rutgers Univ.
Advisor: Chung-Tse (Michael) Wu, Rutgers University

Polyolithic Integration for RF/MM-Wave Chiplets using Stitch-Chips: Modeling, Fabrication, and Characterization | Th1D

Student Finalists: Ting Zheng, Paul K. Jo, Sreejith Kochupurackal Rajan, Muhannad S. Bakir, Georgia Institute of Technology
Advisor: Muhannad S. Bakir, Georgia Institute of Technology

Impact of Input Nonlinearity on Efficiency, Power, and Linearity Performance of GaN RF Power Amplifiers | Tu3H

Student Finalists: Sagar Dahr and Fadhel M. Ghannouchi, University of Calgary
Advisor: Prof. Fadhel M. Ghannouchi, University of Calgary

Noncontact High-Linear Motion Sensing Based on A Modified Differentiate and Cross-Multiply Algorithm | We2B

Student Finalists: Wei Xu, Changzhan Gu, Shanghai Jiao Tong Univ.
Advisor: Prof. Changzhan Gu, Shanghai Jiao Tong University, Shanghai

A 162 GHz Ring Resonator based High Resolution Dielectric Sensor | Tu3D

Student Finalists: Hai Yu, Bo Yu, Skyworks Solutions, Inc., Xuan Ding, Sebastian Gomez-Diaz, Jane Gu, Univ. of California, Davis,
Advisor: Qun Jane Gu, University of California, Davis

A Feasibility Study on the Use of Microwave Imaging for In-Vivo Screening of Knee Prostheses | We2D

Student Finalists: Konstantin Root, Martin Vossiek, Friedrich-Alexander-Universität Erlangen-Nürnberg
Advisor: Martin Vossiek, Friedrich-Alexander-Universität Erlangen-Nürnberg,

Localization and Tracking Bees Using a Battery-less Transmitter and an Autonomous Unmanned Aerial Vehicle | Th3C

Student Finalists: Jake Shearwood, Sam Williams, Nawaf Aldabashi, Paul Cross, Bangor Univ., Breno M. Freitas, Federal University of Ceará, Chaochun Zhang, China Agricultural University, Cristiano Palego, Bangor Univ.
Advisor: Cristiano Palego, Bangor University

Closed-Loop Sign Algorithms for Low-Complexity Digital Predistortion | We3G

Student Finalists: Pablo Pascual Campo, Vesa Lampu, Tampere University, Lauri Anttila, Alberto Brihuega, Tampere Univ. of Technology, Markus Allén, Mikko Valkama, Tampere University
Advisor: Mikko Valkama, Tampere University

InP HBT Oscillators Operating up to 682 GHz with Coupled-Line Load for Improved Efficiency and Output Power | We3C

Student Finalists: Jungsoo Kim, Heekang Son, Doyoon Kim, Kiryong Song, Junghwan Yoo, Jae Sung Rieh, Korea Univ.
Advisor: Jae-Sung Rieh, Korea University, jsrieh@korea.ac.kr

A Low Power 60 GHz 6 V CMOS Peak Detector | Th3G

Student Finalists: Zoltán Tibenszky, Corrado Carta, Frank Ellinger, Technische Univ. Dresden
Advisor: Dr. Frank Ellinger, Technische Univ. Dresden

Concurrent Dual-Band Microstrip Line Hilbert Transformer for Spectrum Aggregation Real-Time Analog Signal Processing | WE1F1

Student Finalists: Rakibul Islam, Md Hedayatullah Maktoomi, Washington State Univ., Yixin Gu, Univ. of Texas at Arlington, Bayaner Arigong, Washington State Univ.
Advisor: Bayaner Arigong, Washington State University

Phase Recovery in Sensor Networks based on incoherent Repeater Elements | Th2C

Student Finalists: David Werbnat, Benedikt Meinecke, Maximilian Steiner, Christian Waldschmidt, Ulm Univ.
Advisor: Christian Waldschmidt, Ulm University

SPC FINALISTS CONTINUED:

In-Situ Self-Test and Self-Calibration of Dual-Polarized 5G TRX, Phased Arrays Leveraging Orthogonal-Polarization Antenna Couplings | Th1F

Student Finalists: Ahmed Nafe, Abdurrahman H. Aljuhani, Univ. of California, San Diego, Kerim Kibaroglu, Movandi, Mustafa Sayginer, Nokia Bell Labs, Gabriel Rebeiz, Univ. of California, San Diego

Advisor: Prof. Gabriel M. Rebeiz, University of California San Diego

A Scalable Switchable Dual-Polarized 256-Element Ka-Band SATCOM Transmit Phased-Array with Embedded RF Driver and $\pm 70^\circ$ Beam Scanning | We3F

Student Finalists: Kevin Kai Wei Low, Univ. of California, San Diego, Samet Zahir, Integrated Device Technology, Inc., Tumay Kanar, Integrated Device Technology, Inc., Gabriel Rebeiz, Univ. of California, San Diego

Advisor: Gabriel M. Rebeiz, University of California, San Diego

A Silicon-Based Closed-Loop 256-Pixel Near-Field Capacitive Sensing Array with 3-ppm Sensitivity and Selectable Frequency Shift Gain | We1B

Student Finalists: Jia Zhou, Univ. of California, Los Angeles, Chia-Jen Liang, National Chiao Tung Univ., Christopher E. Chen, Jieqiong Du, Rulin Huang, Univ. of California, Los Angeles, Richard Al Hadi, Alcatel-Lucent, James C.M. Hwang, Cornell Univ., Mau-Chung, Frank Chang, Univ. of California, Los Angeles

Advisor: Professor Frank Chang, Univ. of California, Los Angeles

Octave Frequency Range Triple-band Low Phase Noise K/Ka-Band VCO with a New Dual-path Inductor, , | Tu4C

Student Finalists: Md Aminul Hoque, Mohammad Chahardori, Washington State Univ., Pawan Agarwal, MaxLinear, Inc., Mohammed Ali Mokri, Deukhyoun Heo, Washington State Univ.

Advisor: Deukhyoun Heo, Washington State University

Liquid Crystal Based Parallel-Polarized Dielectric Image Guide Phase Shifter at W-Band | Tu4A

Student Finalists: Henning Tesmer, Roland Reese, Ersin Polat, Rolf Jakoby, Holger Maune, Technische Univ. Darmstadt

Advisor: Prof. Rolf Jakoby, Technische Universität Darmstadt

LACC

INDUSTRY WORKSHOPS 08:00 – 17:30 TUESDAY, 23 JUNE 2020

Industry workshops cover contemporary topics spanning the state of the art in RF, microwave, and mm-wave areas. These two-hour workshops include in-depth technical presentations from and discussions with experts in the industry. Don't miss this opportunity to expand your knowledge and interact with colleagues in these very relevant fields!

SESSION TIME	SESSION TITLE	EVENT COMPANY	SPEAKERS
8:00 – 9:40	COTS Phased Array Radar System Design and Measurement Using Model-Based Engineering	Keysight Technologies	Ian Rippke, Keysight Technologies; Eamon Nash, Analog Devices; John Richardson, X-Microwave; Wilfredo Rivas-Torres, Keysight Technologies
	Automotive Radar IQ Data Simulation for Performance Analysis	MathWorks, Inc.	Rick Gentile, MathWorks, Inc.; Honglei Chen, MathWorks, Inc.
	Analytical vs. numerical techniques for beamforming optimization in phased arrays	Optenni Ltd	Joni Lappalainen, Optenni Ltd; Jussi Rahola, Optenni Ltd
10:10 – 11:50	Multi-Channel mmWave EW Receiver Workshop	Keysight Technologies	Neil Hoffman, Keysight Technologies; Rich Hoft, Keysight Technologies; Joanne Mistler, Keysight Technologies
	Hybrid Beamforming for 5G Systems	MathWorks, Inc.	Rick Gentile, MathWorks, Inc.; Tim Reeves, MathWorks, Inc.; Honglei Chen, MathWorks, Inc.
	Understanding 5G System-Level Evaluation	Cadence Design Systems, Inc.	Gent Paparisto, Cadence Design Systems, Inc.; Takao Inoue, Cadence Design Systems, Inc.
13:40 – 15:20	Achieving Electromagnetic Compatibility (EMC) for 5G Devices	ETS-Lindgren	Ross Carlton, ETS-Lindgren
	RF and mmWave Frontends: efficient RF power amplifiers and affiliates	Rohde & Schwarz GmbH & Co KG	
	Optimizing System Performance for Emerging Wideband mmWave Applications	Keysight Technologies	Jaakko Juntunen
15:50 – 17:30	Phase-Noise Theory and Measurement Workshop	Keysight Technologies	Brooks Hanley, Keysight Technologies; Rich Hoft, Keysight Technologies; Joanne Mistler, Keysight Technologies
	Integrated Passive Devices (IPD) for 5G RF Front-end Designs	Xpedic Technology, Inc.	Feng Ling, Xpedic Technology, Inc.; Lijun Chen, Xpedic Technology Co. Ltd.
	Enabling Technologies for Silicon Beamformers for 5G and Satcom Systems	Integrated Device Technology, Inc.	

402AB

Tu3A: Integrated Millimeter-Wave Transmission Lines

Chair: Jun Choi, University at Buffalo
Co-Chair: Maurizio Bozzi, University of Pavia

Tu3A-1: Dual Image Dielectric Guide (DIDG) for Polarization Diversity Applications at Millimeter Wave Frequency

M. Noferesti; INRS-EMT; T. Djerafi; INRS-EMT

Tu3A-2: A Cost-Efficient Air-Filled Substrate Integrated Ridge Waveguide for mmWave Application

C.-W. Ting; National Taiwan Univ.; S. Chen; National Taiwan Univ.; T.-L. Wu; National Taiwan Univ.

Tu3A-3: Travelling-Wave SIW Transmission Line Using TE20 Mode for Millimeter-Wave Antenna Application

Z. Wang; UESTC; Y. Dong; UESTC

Tu3A-4: AFSIW-to-Microstrip Directional Coupler for High-Performance Systems on Substrate

A. Ghiotto; IMS (UMR 5218); J.-C. Henrion; IMS (UMR 5218); T. Martin; IMS (UMR 5218); J.-M. Pham; IMS (UMR 5218); V. Armengaud; CNES

Tu3A-5: Design and Analysis of 3D Printed Slotted Waveguides for D-Band Using Stereolithography and Electroless Silver Plating

K. Lomakin; FAU Erlangen-Nürnberg; M. Sippel; FAU Erlangen-Nürnberg; K. Helmreich; FAU Erlangen-Nürnberg; G. Gold; FAU Erlangen-Nürnberg

403A

Tu3B: Advances in Low Noise Circuits for Quantum Computing, Scientific Sensing, and Broadband Communications

Chair: Pekka Kangaslahti, Jet Propulsion Laboratory
Co-Chair: George Duh, BAE Systems

Tu3B-1: A 1mW Cryogenic LNA Exploiting Optimized SiGe HBTs to Achieve an Average Noise Temperature of 3.2K from 4–8GHz

W.-T. Wong; UMass Amherst; M. Hosseini; UMass Amherst; H. Rücker; IHP; J.C. Bardin; Google

Tu3B-2: Cryogenic W-Band SiGe BiCMOS Low-Noise Amplifier

M. Varonen; VTT Technical Research Centre of Finland; N. Sheikhipoor; VTT Technical Research Centre of Finland; B. Gabritchidze; Caltech; K. Cleary; Caltech; H. Forstén; VTT Technical Research Centre of Finland; H. Rücker; IHP; M. Kaynak; IHP

Tu3B-3: X- to Ka-Band Cryogenic LNA Module for Very Long Baseline Interferometry

A. Fung; L. Samoska; J. Bowen; S. Montanez; J. Kooi; M. Soriano; C. Jacobs; R. Manthena; D. Hoppe; Jet Propulsion Lab; A. Akgiray; Özyegin University; R. Lai; Northrop Grumman; X. Mei; Northrop Grumman; M. Barsky; Northrop Grumman

Tu3B-4: A Fully-Integrated W-Band I/Q-Down-Conversion MMIC for Use in Radio Astronomical Multi-Pixel Receivers

F. Thome; Fraunhofer IAF; E. Türe; Fraunhofer IAF; A. Leuther; Fraunhofer IAF; F. Schäfer; MPI for Radio Astronomy; A. Navarrini; INAF; P. Serres; IRAM; O. Ambacher; Fraunhofer IAF

Tu3B-5: A 125.5–157GHz 8dB NF and 16dB of Gain D-Band Low Noise Amplifier in CMOS SOI 45nm

A. Hamani; CEA-LETI; A. Siligaris; CEA-LETI; B. Blampey; CEA-LETI; C. Dehos; CEA-LETI; J.L. Gonzalez Jimenez; CEA-LETI

403B

Tu3C: Advanced Mixed-Signal Transmitter and Optical Driver ICs towards 100Gbit/s

Chair: Christian Carlowitz, Friedrich-Alexander-Universität Erlangen-Nürnberg
Co-Chair: Hermann Boss, Rohde & Schwarz GmbH & Co KG

Tu3C-1: A 3-Bit DAC with Gray Coding for 100-Gbit/s PAM Signal Generation

V. Rieß; Technische Universität Dresden; P. Stärke; Bosch Sensortec; M.M. Khafaji; Technische Universität Dresden; C. Carta; Technische Universität Dresden; F. Ellinger; Technische Universität Dresden

Tu3C-2: A 50-Gb/s Optical Transmitter Based on Co-Design of a 45-nm CMOS SOI Distributed Driver and 90-nm Silicon Photonic Mach-Zehnder Modulator

N. Hosseinzadeh; Univ. of California, Santa Barbara; K. Fang; Univ. of California, San Diego; L.A. Valenzuela; C.L. Schow; J.F. Buckwalter; Univ. of California, Santa Barbara

Tu3C-3: A 2.85pJ/Bit, 52-Gbps NRZ VCSEL Driver with Two-Tap Feedforward Equalization

L.A. Valenzuela; Univ. of California, Santa Barbara; H. Andrade; Univ. of California, Santa Barbara; N. Hosseinzadeh; Univ. of California, Santa Barbara; A. Maharry; Univ. of California, Santa Barbara; C.L. Schow; Univ. of California, Santa Barbara; J.F. Buckwalter; Univ. of California, Santa Barbara

Tu3C-4: A 6.5–7.5-GHz CMOS Wideband FMCW Radar Transmitter Based on Synthetic Bandwidth Technique

H. Su; NUS; S.D. Balon; NUS; K.Y. Cheong; NUS; C.-H. Heng; NUS

Tu3C-5: A 24–30GHz Ultra-Compact Phase Shifter Using All-Pass Networks for 5G User Equipment

E.V.P. Anjos; Katholieke Univ. Leuven; D.M.M.-P. Schreurs; Katholieke Univ. Leuven; G.A.E. Vandenbosch; Katholieke Univ. Leuven; M. Geurts; NXP Semiconductors

404AB

Tu3D: Microwave Characterization of Liquid and Biological Materials

Chair: Malgorzata Celuch, QWED Sp. z o.o.
Co-Chair: Arnaud Pothier, Xlim - CNRS-Universite De Liroges

Tu3D-1: An SIW Oscillator for Microfluidic Lossy Medium Characterization

M. Abdolrazzagh; Univ. of Alberta; N. Kazemi; Univ. of Alberta; M. Daneshmand; Univ. of Alberta

Tu3D-3: A CMOS Microwave Broadband Adaptive Dual-Comb Dielectric Spectroscopy System for Liquid Chemical Detection

E. Kaya; Texas A&M Univ.; K. Entesari; Texas A&M Univ.

Tu3D-4: A 162GHz Ring Resonator Based High Resolution Dielectric Sensor

H. Yu; Univ. of California, Davis; B. Yu; Skyworks Solutions; X. Ding; Univ. of California, Davis; J.S. Gómez-Díaz; Univ. of California, Davis; Q.J. Gu; Univ. of California, Davis

Tu3D-5: Electrical Properties of Jurkat Cells: An Inverted Scanning Microwave Microscope Study

G. Fabi; Università Politecnica delle Marche; C.H. Joseph; Università Politecnica delle Marche; X. Jin; Lehigh University; X. Wang; Cornell Univ.; T. Pietrangelo; Università "G. D'Annunzio" Chieti-Pescara; X. Cheng; Lehigh University; J.C.M. Hwang; Cornell Univ.; M. Farina; Università Politecnica delle Marche

13:40

13:50

14:00

14:10

14:20

14:30

14:40

14:50

15:00

15:10

15:20

406AB

Tu3E: Acoustic Devices for Ultra-high Frequency Applications and RF Filter Synthesis

Chair: Brice Ivira, Broadcom Corporation
Co-Chair: Amir Mortzawi, University of Michigan

Tu3E-1: A 19GHz Lithium Niobate Acoustic Filter with FBW of 2.4%

L. Gao; Univ. of Illinois at Urbana-Champaign; Y. Yang; Univ. of Illinois at Urbana-Champaign; S. Gong; Univ. of Illinois at Urbana-Champaign

Tu3E-2: 5.4GHz Acoustic Delay Lines in Lithium Niobate Thin Film with 3dB Insertion Loss

R. Lu; Univ. of Illinois at Urbana-Champaign; Y. Yang; Univ. of Illinois at Urbana-Champaign; S. Link; Univ. of Illinois at Urbana-Champaign; S. Gong; Univ. of Illinois at Urbana-Champaign

Tu3E-3: An X-Band Lithium Niobate Acoustic RFFE Filter with FBW of 3.45% and IL of 2.7dB

Y. Yang; Univ. of Illinois at Urbana-Champaign; L. Gao; Univ. of Illinois at Urbana-Champaign; S. Gong; Univ. of Illinois at Urbana-Champaign

Tu3E-4: Surface Acoustic Wave Resonators Using Lithium Niobate on Silicon Carbide Platform

S. Zhang; Chinese Academy of Sciences; R. Lu; Univ. of Illinois at Urbana-Champaign; H. Zhou; Chinese Academy of Sciences; S. Link; Univ. of Illinois at Urbana-Champaign; Y. Yang; Univ. of Illinois at Urbana-Champaign; Z. Li; Chinese Academy of Sciences; K. Huang; Chinese Academy of Sciences; X. Ou; Chinese Academy of Sciences; S. Gong; Univ. of Illinois at Urbana-Champaign

Tu3E-5: Synthesis and Realization of Chebyshev Filters Based on Constant Electromechanical Coupling Coefficient Acoustic Wave Resonators

S.-Y. Tseng; National Taiwan Univ.; C.-C. Hsiao; Tai-Saw Technology; R.-B. Wu; National Taiwan Univ.

408A

Tu3F: Broadband, High-Performance GaN and GaAs Power Amplifiers

Chair: Charles Campbell, QORVO, Inc.
Co-Chair: Gayle Collins, Obsidian Microwave, LLC.

Tu3F-1: A Compact 10W 2-20GHz GaN MMIC Power Amplifier Using a Decade Bandwidth Output Impedance Transformer

M. Roberg; Qorvo; M. Pilla; Qorvo; S. Schafer; Qorvo; T.R. Mya Kywe; Qorvo; R. Flynt; Qorvo; N. Chu; Qorvo

Tu3F-2: 2.5 to 10.0GHz Band-Pass Non-Uniform Distributed GaN MMIC HPA

J. Kamioka; Mitsubishi Electric; M. Hangai; Mitsubishi Electric; S. Miwa; Mitsubishi Electric; Y. Kamo; Mitsubishi Electric; S. Shinjo; Mitsubishi Electric

Tu3F-3: Two-Stage Concurrent X/Ku Dual-Band GaAs MMIC Power Amplifier

P. Zurek; University of Colorado Boulder; Z. Popovic; University of Colorado Boulder

Tu3F-4: Broadband Driver Amplifier with Voltage Offset for GaN-Based Switching PAs

T. Hoffmann; FBH; F. Hühn; FBH; S. Shevchenko; FBH; W. Heinrich; FBH; A. Wentzel; FBH

Tu3F-5: A Dual-Mode Bias Circuit Enabled GaN Doherty Amplifier Operating in 0.85-2.05GHz and 2.4-4.2GHz

Y. Komatsuzaki; Mitsubishi Electric; R. Ma; MERL; S. Sakata; Mitsubishi Electric; K. Nakatani; Mitsubishi Electric; S. Shinjo; Mitsubishi Electric

409AB

Tu3H: Advances in Microwave Semiconductor Devices

Chair: Patrick Fay, University of Notre Dame
Co-Chair: Tony Ivanov, US Army CERDEC

Tu3H-1: Impact of Input Nonlinearity on Efficiency, Power, and Linearity Performance of GaN RF Power Amplifiers

S.K. Dhar; Univ. of Calgary; T. Sharma; NXP Semiconductors; R. Darraji; Ericsson; D.G. Holmes; J. Staudinger; NXP Semiconductors; X.Y. Zhou; City U; V. Mallette; Focus Microwaves; FM. Ghannouchi; Univ. of Calgary

Tu3H-2: High Power AlN/GaN HEMTs with Record Power-Added-Efficiency >70% at 40GHz

K. Harrouche; IEMN (UMR 8520); R. Kabouche; IEMN (UMR 8520); E. Okada; IEMN (UMR 8520); F. Medjdoub; IEMN (UMR 8520)

Tu3H-3: InAlN/GaN-on-Si HEMT with 4.5W/mm in a 200-mm CMOS-Compatible MMIC Process for 3D Integration

S. Warnock; C.-L. Chen; J. Knecht; R. Molnar; D.-R. Yost; M. Cook; C. Stull; R. Johnson; C. Galbraith; J. Daulton; W. Hu; G. Pinelli; MIT Lincoln Laboratory; J. Perozek; MIT; T. Palacios; MIT; B. Zhang; MIT Lincoln Laboratory

Tu3H-4: Noise Performance of Sub-100-nm Metamorphic HEMT Technologies

F. Heinz; Fraunhofer IAF; F. Thome; Fraunhofer IAF; A. Leuther; Fraunhofer IAF; O. Ambacher; Fraunhofer IAF

Tu3H-5: High-Power RF Characterization of Diamond Schottky Barrier Diodes at X-Band

X. Konstantinou; Michigan State Univ.; C.J. Herrera-Rodriguez; Michigan State Univ.; A. Hardy; Fraunhofer USA CCD; J.D. Albrecht; Michigan State Univ.; T. Grotjohn; Michigan State Univ.; J. Papapolymerou; Michigan State Univ.

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TUESDAY

Automotive Radars and AI: Is My Car Really Safe?

PANEL ORGANIZERS AND MODERATORS:

Francois Rivet, *University of Bordeaux, France*

Magnus Wiklund, *Qualcomm, USA*

PANELISTS:

Margaret Huang, *Sr. Administrative Assistant, Intel, USA;*

Karam Noujeim, *Technology Fellow, Anritsu, USA;* **Juergen Hasch**, *Senior Expert, Bosch, Germany*

Manju Hegde, *CEO, Uhnder, USA;* **Mohammad Emadi**, *CTO, Zadar Labs, USA*

ABSTRACT:

Are we ready to take our hands off the car steering wheel? In any case, our cars are ready to steal control from us and to do without the major responsible for road accidents: man. This panel will ask the question of how much confidence we have in the electronics of our cars and whether we can trust it. Automotive radar is the vision and artificial intelligence is the decision making. We will discuss the reliability of this vision and this decision making of our cars to decide if it is wise enough to stop driving or if we should our hands on the steering wheel?

The technologies and systems for 5G are now pushing for commercial deployment with focus on Stand Alone (SA) networks, mass market for 5G devices, and global adoption of mmWave in premium devices and for small cell enhancement and fixed wireless access (FWA). Furthermore and looking beyond 5G, technology research and development needs to focus on MIMO enhancement, V2X and IoT evolution, integration of 5G with Non-Terrestrial Network, and new FR3 & FR4 spectrum development. To bring all this into focus, the IEEE Microwave Theory and Techniques Society (MTT-S) is organizing a 5G Summit at the 2020 MTT-S International Microwave Symposium (IMS2020), 23 June 2020, with speakers at the leadership level from different companies and industries to discuss 5G related topics, including foundries, standards, mobile networks, MIMO and millimeter-wave systems, RFIC, and RFFE. As part of the IEEE Comsoc 5G Summit series (details at www.5GSummit.org), this summit will provide a platform for leaders, innovators, and researchers from both industrial and academic communities to collaborate and exchange ideas regarding 5G and beyond 5G technologies.

SPEAKERS LIST:

Dr. Bami Bastani, Senior Vice President, RF Business Unit, GLOBALFOUNDRIES

Differentiated end to end silicon solutions for the new 5G reality

Dr. Lawrence Loh, Corporate Senior Vice President and CSO, MediaTek

5G – Evolution or Revolution

Dr. Chih-Lin I, China Mobile Chief Scientist, Wireless Technology, China Mobile

TBD

Mr. Joel King, Senior Vice President and General Manager, Skyworks

RF Front-End Evolution from 4G to 5G

Dr. Naveen Yanduru, Vice President and General Manager, Renesas Electronics

Sub-6GHz and mmWave RFICs for 5G Wireless Infrastructure RF Front Ends”

Dr. Curtis Ling, Co-Founder and Chief Technology Officer, MaxLinear

A fabless perspective on 5G phased arrays, from devices to network capacity

Dr. Shahriar Shahramian, Director, Bell Labs

The 5G Quest: System, Deployment & Application Challenges

Dr. Ir. Michael Peeters, Program Director Connectivity, IMEC

FR 1,2,3,4,... PA and FEM technology approaches for 5G and beyond

The 5G Summit will be open to all IMS and RFIC attendees for a nominal cost, and attendees will be able to register for the 5G Summit using the IMS2020 registration site; the summit will be complemented by a reception for all registered attendees, followed by a rump session to drive a live discussion between the speakers and the audience on the summit presented topics. IMS2020 will be an incredible week that focuses on 5G connectivity and brings together the best engineering minds from systems to hardware.

5G Summit Co-Sponsor:



5G Summit Co-Sponsor:



402AB

Tu4A: Innovative Wave Transmission, Manipulation and Generation

Chair: Christian Damm, Ulm University
Co-Chair: Jason Soric, Raytheon Company

Tu4A-1: A Fine Picosecond Pulse Generator Based on Novel SRD Topology and Tapered NLTL

M. Rahman; Polytechnique Montréal;
 K. Wu; Polytechnique Montréal

Tu4A-2: Liquid Crystal Based Parallel-Artificial Dielectric Image Guide Phase Shifter at W-Band

H. Tesmer; Technische Univ. Darmstadt;
 R. Reese; Technische Univ. Darmstadt;
 E. Polat; Technische Univ. Darmstadt;
 R. Jakoby; Technische Univ. Darmstadt;
 H. Maune; Technische Univ. Darmstadt

Tu4A-3: Negative Group Delay Enabled Artificial Transmission Line Exhibiting Squint-Free, Dominant Mode, Backward Leaky-Wave Radiation

M. Zhu; Rutgers Univ.; C.-T.M. Wu; Rutgers Univ.

Tu4A-4: Demonstration of Low Loss RF Conductor in Ka and V Bands Using Cu/Fe Multilayers for 5G and Millimeter Wave Applications

R. Bowrothu; Univ. of Florida; Y.-K. Yoon; Univ. of Florida

Tu4A-5: Equivalent Circuit Models for Full-Tensor Anisotropic Composite Right/Left-Handed Metamaterials

T. Nagayama; Kagoshima Univ.

403A

Tu4B: High-Performance Low-Noise Amplifiers

Chair: Chinchun Meng, National Chiao Tung University
Co-Chair: Luciano Boglione, Naval Research Laboratory

Tu4B-1: A 6.5–12GHz Balanced Variable Gain Low-Noise Amplifier with Frequency-Selective Non-Foster Gain Equalization Technique

H. Gao; Zhejiang Univ.; N. Li; Zhejiang Univ.; M. Li; Zhejiang Univ.; S. Wang; Zhejiang Univ.; Z. Zhang; Zhejiang Univ.; Y.-C. Kuan; National Chiao Tung Univ.; X. Yu; Zhejiang Univ.; Q.J. Gu; Univ. of California, Davis; Z. Xu; Zhejiang Univ.

Tu4B-2: A Compact Frequency-Tunable VGA for Multi-Standard 5G Transceivers

R. Ben Yishay; ON Semiconductor;
 D. Elad; ON Semiconductor

Tu4B-3: A CMOS Band-Pass Low Noise Amplifier with Excellent Gain Flatness for mm-Wave 5G Communications

H.-W. Choi; Chungnam National University; S. Choi; Chungnam National University; C.-Y. Kim; Chungnam National University

Tu4B-4: A Tri (K/Ka/V)-Band Monolithic CMOS Low Noise Amplifier with Shared Signal Path and Variable Gains

C.-J. Liang; National Chiao Tung Univ.; C.-W. Chiang; National Chiao Tung Univ.; J. Zhou; Univ. of California, Los Angeles; R. Huang; Univ. of California, Los Angeles; K.-A. Wen; National Chiao Tung Univ.; M.-C.F. Chang; National Chiao Tung Univ.; Y.-C. Kuan; National Chiao Tung Univ.

Tu4B-5: A 64.5–88GHz Coupling-Concerned CMOS LNA with >10dB Gain and 5dB Minimum NF

K. Zhang; East China Normal Univ.; C. Shi; East China Normal Univ.; G. Chen; Shanghai Eastsoft Microelectronics; J. Chen; Univ. of Houston; R. Zhang; East China Normal Univ.

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Tu4C: Advanced Design Techniques for Voltage Controlled Oscillators

Chair: Nils Pohl, Ruhr University Bochum
Co-Chair: Hiroshi Okazaki, NTT DoCoMo, Inc.

Tu4C-1: Octave Frequency Range Triple-Band Low Phase Noise K/Ka-Band VCO with a New Dual-Path Inductor

Md.A. Hoque; Washington State Univ.; M. Chahardori; Washington State Univ.; P. Agarwal; MaxLinear; M.A. Mokri; Washington State Univ.; D. Heo; Washington State Univ.

Tu4C-2: A Superharmonic Injection Based G-Band Quadrature VCO in CMOS

X. Ding; Univ. of California, Davis; H. Yu; Univ. of California, Davis; B. Yu; Skyworks Solutions; Z. Xu; Zhejiang Univ.; Q.J. Gu; Univ. of California, Davis

Tu4C-3: A Power Efficient 60-GHz Super-Regenerative Oscillator with 10-GHz Switching Rate in 22-nm FD-SOI CMOS

A. Ferschischi; Technische Universität Dresden; H. Ghaleb; Technische Universität Dresden; Z. Tibenszky; Technische Universität Dresden; C. Carta; Technische Universität Dresden; F. Ellinger; Technische Universität Dresden

Tu4C-4: A 0.011-mm² 27.5-GHz VCO with Transformer-Coupled Bandpass Filter Achieving -191dBc/Hz FoM in 16-nm FinFET CMOS

C.-H. Lin; TSMC; Y.-T. Lu; TSMC; H.-Y. Liao; TSMC; S. Chen; TSMC; A.L.S. Loke; TSMC; T.-J. Yeh; TSMC

Tu4C-5: An X-Band LC VCO Using a New Boosted Active Capacitor with 53% Tuning Range and -202.4dBc/Hz FoMT

. Agarwal; Washington State Univ.; M. Chahardori; Washington State Univ.; D. Heo; Washington State Univ.

404AB

Tu4D: Microwave Systems and Methods for Permittivity Measurements

Chair: Pawel Kopyt, Warsaw University of Technology
Co-Chair: Rashaunda Henderson, University of Texas at Dallas

Tu4D-1: Broadband Measurement of Dielectric Properties of Substrates up to 67GHz Using a Coaxial Air Line

N. Mahjabeen; Univ. of Texas at Dallas; A.P. Zanders; Univ. of Texas at Dallas; R. Henderson; Univ. of Texas at Dallas

Tu4D-2: High-Resolution Millimeter-Wave Tomography System for Characterization of Low-Permittivity Materials

A. Och; P.A. Hözl; Infineon Technologies; S. Schuster; voestalpine; J.O. Schrottenecker; Intel; P.F. Freidl; Infineon Technologies; S. Scheiblhofer; D. Zankl; voestalpine; V. Pathuri-Bhuvana; Silicon Austria Labs; R. Weigel; FAU Erlangen-Nürnberg

Tu4D-3: Non-Destructive Testing of Non-Metallic Concentric Pipes Using Microwave Measurements

H. Wu; NYIT; M. Ravan; NYIT; R. Sharma; NYIT; J. Patel; NYIT; R.K. Amineh; NYIT

Tu4D-4: Portable Low-Cost Measurement Setup for 2D Imaging of Organic Semiconductors

M. Celuch; QWED; O. Douheret; Materia Nova; P. Korpas; Warsaw Univ. of Technology; R. Michnowski; Vigo System; M. Olszewska-Placha; QWED; J. Rudnicki; QWED

Tu4D-5: Clutter Mitigation Based on Adaptive Singular Value Decomposition in Tomographic Radar Images for Material Inspection

D. Meier; Fraunhofer IAF; B. Gashi; Fraunhofer IAF; T. Link; Composite Material Supply; T. Schwarze; GFal; C. Zech; Fraunhofer IAF; B. Baumann; Fraunhofer IAF; M. Schlechtweg; Fraunhofer IAF; J. Kühn; Fraunhofer IAF; M. Rösch; Fraunhofer IAF; L.M. Reindl; Albert-Ludwigs-Universität Freiburg

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TUESDAY

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Tu4E: Nonlinear Circuits & Systems

Chair: Christopher Silva, The Aerospace Corporation

Co-Chair: Subrata Halder, QORVO, Inc.

Tu4E-1: Mutual Injection Locking of Oscillator Circuits Through Inductor Coupling

A. Suárez; Universidad de Cantabria; F. Ramírez; Universidad de Cantabria; R. Melville; Emecon

Tu4E-2: Analysis of the Transient Dynamics of Coupled-Oscillator Systems

S. Sancho; Universidad de Cantabria; A. Suárez; Universidad de Cantabria; F. Ramírez; Universidad de Cantabria

Tu4E-3: Analysis and Design of a Concurrent Dual-Band Self-Oscillating Mixer

M. Pontón; Universidad de Cantabria; A. Herrera; Universidad de Cantabria; A. Suárez; Universidad de Cantabria

Tu4E-4: A Coupling Factor Independent Wireless Power Transfer System Employing Two Nonlinear Circuits

R. Chai; Univ. of Michigan; A. Mortazawi; Univ. of Michigan

Tu4E-5: Over-The-Air Behavioral Modeling of Millimeter Wave Beamforming Transmitters with Concurrent Dynamic Configurations Utilizing Heterogeneous Neural Network

H. Yin; Southeast Univ.; Z. Jiang; Southeast Univ.; X.-W. Zhu; Southeast Univ.; C. Yu; Southeast Univ.

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Tu4F: Innovations in Broadband Millimeter-wave Power Amplifiers

Chair: David Brown, BAE Systems

Co-Chair: Mark van der Heijden, NXP Semiconductors

Tu4F-1: High Output Power Ultra-Wideband Distributed Amplifier in InP DHBT Technology Using Diamond Heat Spreader

T. Shivan; FBH; M. Hossain; FBH; R. Doerner; FBH; T.K. Johansen; Technical Univ. of Denmark; K. Nosaeva; FBH; H. Yacoub; FBH; W. Heinrich; FBH; V. Krozer; FBH

Tu4F-2: Broadband PA Architectures with Asymmetrical Combining and Stacked PA Cells Across 50–70GHz and 64–110GHz in 250nm InP

T. Sharma; Princeton Univ.; Z. Liu; Princeton Univ.; C.R. Chappidi; Princeton Univ.; H. Saeidi; Princeton Univ.; S. Venkatesh; Princeton Univ.; K. Sengupta; Princeton Univ.

Tu4F-3: C to V-Band Cascode Distributed Amplifier Design Leveraging a Double Gate Length Gallium Nitride on Silicon Process

P.E. Longhi; Università di Roma "Tor Vergata"; S. Colangeli; Università di Roma "Tor Vergata"; W. Ciccognani; Università di Roma "Tor Vergata"; L. Pace; Università di Roma "Tor Vergata"; R. Leblanc; OMMIC; E. Limiti; Università di Roma "Tor Vergata"

Tu4F-4: A 20W GaN-on-Si Solid State Power Amplifier for Q-Band Space Communication Systems

R. Giofrè; Università di Roma "Tor Vergata"; F. Costanzo; Università di Roma "Tor Vergata"; A. Massari; Thales Alenia Space; A. Suriani; Thales Alenia Space; F. Vitulli; Thales Alenia Space; E. Limiti; Università di Roma "Tor Vergata"

Tu4F-5: Highly Linear & Efficient Power Spatium Combiner Amplifier with GaN HPA MMIC at Millimeter Wavelength Frequency

S.D. Yoon; Qorvo; J. Kitt; Qorvo; D. Murdock; Qorvo; E. Jackson; Qorvo; M. Roberg; Qorvo; G. Hegazi; Qorvo; P. Courtney; Qorvo

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Tu4H: Advanced Transistor Modeling and Characterization

Chair: Rob Jones, Raytheon Company

Co-Chair: Doug Teeter, QORVO, Inc.406AB

Tu4H-1: Gate Bias Incorporation into Cardiff Behavioural Modelling Formulation

E.M. Azad; Cardiff University; J.J. Bell; Cardiff University; R. Quaglia; Cardiff University; J.J. Moreno Rubio; Cardiff University; P.J. Tasker; Cardiff University

Tu4H-2: GaN and GaAs HEMT Channel Charge Model for Nonlinear Microwave and RF Applications

A.E. Parker; Macquarie Univ.

Tu4H-3: A Transient Two-Tone RF Method for the Characterization of Electron Trapping Capture and Emission Dynamics in GaN HEMTs

P.M. Tomé; FM. Barradas; L.C. Nunes; J.L. Gomes; T.R. Cunha; J.C. Pedro; Instituto de Telecomunicações

Tu4H-4: Explaining the Different Time Constants Extracted from Low Frequency Y22 and IDS-DLTS on GaN HEMTs

J.L. Gomes; Instituto de Telecomunicações; L.C. Nunes; Instituto de Telecomunicações; J.C. Pedro; Instituto de Telecomunicações

Tu4H-5: Extraction of an Extrinsic Parasitic Network for InGaAs/InP DHBTs Scalable Model Using Electromagnetic simulation

Yukun Li; University of Electronic Science and Technology of

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TUESDAY

IEEE youngprofessionals



TUESDAY

AMATEUR (HAM)

19:00 – 21:00

TUESDAY, 23 JUNE 2020

RADIO SOCIAL

IMS2020 will be hosting a ham radio social event in Los Angeles, California on Tuesday June 23 at 19:00. All radio amateurs and other interested IMS attendees are cordially invited. The keynote speaker will be the VP of Engineering of the AMSAT Amateur Radio Satellite Organization, Jerry Buxton (call sign NOJY)!

AMSAT is a worldwide group of hams that was formed in the District of Columbia in 1969 as an educational organization. For over 50 years AMSAT groups in North America and elsewhere have played a key role in significantly advancing the state of the art in space science, space education, and space technology. Jerry will be presenting the current and future technology trends in the exciting area of amateur radio satellite communications.

The Los Angeles, California location for IMS2020 has special significance for amateur radio. Located in the Port of Los Angeles, the RMS Queen Mary with her restored wireless room and fully equipped amateur radio station W6RO is reminiscent of the humble beginnings of amateur radio. Established in 1979, it was the first permanent amateur radio station to be installed aboard a museum ship. The station is staffed daily and guests may earn an operator's certificate from W6RO.

Near the iconic Hollywood sign on Mount Lee holds significance in amateur radio history as being the site of the first fully-automated amateur

repeater. Created in the 1950's by broadcast engineer Art Gentry, W6MEP, the K6MYK repeater operated AM on 2 meters and covered the highly populated area, greatly increasing connectivity between hams in the Los Angeles area and helped spur widespread use of repeaters throughout the country.

Today, hams are using the latest digital modes and SDR software defined radio technology in addition to traditional CW, AM phone, SSB, FM, satellite, moon-bounce, and other radio techniques.

The event will also host the local San Bernardino Microwave Society! SBMS is a non-profit technical organization that is dedicated to the advancement of communications above 1GHz. The club will be demoing some of their amazing microwave equipment and projects that you don't want to miss!

Participate in a fun and exciting Morse Code competition where contestants compete for who can copy the code with the most accuracy! Appetizers and refreshments will also be provided!

We look forward to seeing you at our exciting event in Los Angeles where you will view live radio and project demos, learn about the latest advances in the Ham community, and network and connect with other Hams from across the world!





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Wednesday

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We1A: Non-Planar Filters I

Chair: Simone Bastioli, RS Microwave
Co-Chair: Miguel Laso, Public University of Navarre (UPNA)

We1A-1: Direct Synthesis Technique of Quasi-Canonical Filters Comprising Cascaded Frequency-Variant Blocks

Y. He; Yokohama National Univ.; Z. Ma; Saitama University; N. Yoshikawa; Yokohama National Univ.

We1A-2: Design of Extracted-Pole Filters: An Application-Oriented Synthesis Approach

G. Macchiarella; Politecnico di Milano; S. Tamiazzo; CommScope

We1A-3: A Dispersive Coupling Structure for In-Line Helical Resonator Filters with Transmission Zeros

Y. Zhang; CUHK; K.-L. Wu; CUHK

We1A-4: Synthesis of Extracted Pole Filters Without the Extra Spikes

Y. Yang; CUHK; Y. Zeng; CUHK; M. Yu; CUHK; Q. Wu; Xidian Univ.

We1A-5: A Synthesis-Based Design Procedure for Waveguide Duplexers Using a Stepped E-Plane Bifurcated Junction

G. Macchiarella; Politecnico di Milano; G.G. Gentili; Politecnico di Milano; L. Accatino; ACConsulting; V. Tornielli di Crestvolant; ESA-ESTEC

403A

We1B: Advances in Wireless Sensors

Chair: Jasmin Grosinger, Graz University of Technology
Co-Chair: Etienne Perret, Grenoble Institute of Technology

We1B-1: Highly Sensitive Capacitive Sensor Based on Injection Locked Oscillators with ppm Sensing Resolution

M. Babay; C. Hallepee; C. Dalmay; B. Barelaud; XLIM (UMR 7252); E.C. Durmaz; IHP; C. Baristiran Kaynak; IHP; M. Kaynak; IHP; D. Cordeau; XLIM (UMR 7252); A. Pothier; XLIM (UMR 7252)

We1B-2: An Integrated Battery-Less Wirelessly Powered RFID Tag with Clock Recovery and Data Transmitter for UWB Localization

H. Rahmani; Univ. of California, Los Angeles; A. Babakhani; Univ. of California, Los Angeles

We1B-3: A Silicon-Based Closed-Loop 256-Pixel Near-Field Capacitive Sensing Array with 3-ppm Sensitivity and Selectable Frequency Shift Gain

J. Zhou; C.-J. Liang; C. Chen; J. Du; R. Huang; Univ. of California, Los Angeles; R. Al Hadi; Alcatel; J.C.M. Hwang; Lehigh University; M.-C.F. Chang; Univ. of California, Los Angeles

We1B-4: All-Digital Single Sideband (SSB) Bluetooth Low Energy (BLE) Backscatter with an Inductor-Free, Digitally-Tuned Capacitance Modulator

J. Rosenthal; Univ. of Washington; M.S. Reynolds; Univ. of Washington

We1B-5: Microwave Encoders with Synchronous Reading and Direction Detection for Motion Control Applications

F. Paredes; Univ. Autònoma de Barcelona; C. Herrojo; Univ. Autònoma de Barcelona; F. Martín; Univ. Autònoma de Barcelona

403B

We1C: Millimeter-Wave and Terahertz Transmitter Components

Chair: Theodore Reck, Virginia Diodes Inc.
Co-Chair: Adrian Tang, Jet Propulsion Laboratory

We1C-1: A 99–132GHz Frequency Quadrupler with 8.5dBm Peak Output Power and 8.8% DC-to-RF Efficiency in 130nm BiCMOS

K. Wu; Analog Devices; M.W. Mansha; Rensselaer Polytechnic Institute; M. Hella; Rensselaer Polytechnic Institute

We1C-2: A 135–183GHz Frequency Sixtupler in 250nm InP HBT

M. Bao; Ericsson; T.N.T. Do; Chalmers Univ. of Technology; D. Kuylenstierna; Chalmers Univ. of Technology; H. Zirath; Ericsson

We1C-3: Broadband and High-Gain 400-GHz InGaAs mHEMT Medium-Power Amplifier S-MMIC

B. Gashi; Fraunhofer IAF; L. John; Fraunhofer IAF; D. Meier; Fraunhofer IAF; M. Rösch; Fraunhofer IAF; A. Tessmann; Fraunhofer IAF; A. Leuther; Fraunhofer IAF; H. Maßler; Fraunhofer IAF; M. Schlechtweg; Fraunhofer IAF; O. Ambacher; Fraunhofer IAF

We1C-4: A 160–183GHz 0.24-W (7.5% PAE) PA and 0.14-W (9.5% PAE) PA, High-Gain, G-Band Power Amplifier MMICs in 250-nm InP HBT

Z. Griffith; Teledyne Scientific & Imaging; M. Urteaga; Teledyne Scientific & Imaging; P. Rowell; Teledyne Scientific & Imaging; L. Tran; Teledyne Scientific & Imaging

We1C-5: A 140GHz Power Amplifier with 20.5dBm Output Power and 20.8% PAE in 250-nm InP HBT Technology

A.S.H. Ahmed; Univ. of California, Santa Barbara; M. Seo; Sungkyunkwan Univ.; A.A. Farid; Univ. of California, Santa Barbara; M. Urteaga; Teledyne Scientific & Imaging; J.F. Buckwalter; Univ. of California, Santa Barbara; M.J.W. Rodwell; Univ. of California, Santa Barbara

404AB

We1D: Novel Microwave Technologies for Biomedical Sensing

Chair: Souvik Dubey, Abbott Labs
Co-Chair: Hung-Wei Wu, Kun Shan University

We1D-1: A Quadband Implantable Antenna System for Simultaneous Wireless Powering and Biotelemetry of Deep-Body Implants

A. Basir; Hanyang Univ.; H. Yoo; Hanyang Univ.

We1D-2: The Design of Transmitting Tag for Nasogastric Intubation Sensing

M.-H. Lin; National Chung Cheng Univ.; C.-C. Chang; National Chung Cheng Univ.; S.-F. Chang; National Chung Cheng Univ.

We1D-3: A Wearable Throat Vibration Microwave Sensor Based on Split-Ring Resonator for Harmonics Detection

Y.-R. Ho; National Cheng Kung Univ.; C.-L. Yang; National Cheng Kung Univ.

We1D-4: Experimental Dosimetry Study of a Miniature RF Applicator Dedicated to the Evaluation of Severe RF Exposure Impact on a 3D Biological Model

S. Augé; LAAS; A. Tamra; LAAS; L. Rigal; ITAV (USR 3505); V. Lobjois; ITAV (USR 3505); B. Ducommun; ITAV (USR 3505); D. Dubuc; LAAS; K. Grenier; LAAS

We1D-5: Chest-Worn Self-Injection-Locked Oscillator Tag for Monitoring Heart Rate Variability

R.E. Arif; National Sun Yat-sen Univ.; W.-C. Su; National Sun Yat-sen Univ.; M.-C. Tang; National Sun Yat-sen Univ.; T.-S. Horng; National Sun Yat-sen Univ.; F.-K. Wang; National Sun Yat-sen Univ.

406AB	408A	408B	
<p>We1E: High Frequency Non-Reciprocal Techniques using Novel Material, Device and Circuit Approaches</p> <p>Chair: Dimitris Pavlidis, Florida International University</p> <p>Co-Chair: Yuanxun Ethan Wang, University of California, Los Angeles</p>	<p>We1F: Advances in 5G Millimeter-wave Systems and Architectures</p> <p>Chair: Gent Paparisto, Cadence Design Systems, Inc.</p> <p>Co-Chair: Christian Fager, Chalmers University of Technology</p>	<p>We1G: Emerging Next Generation GaN RF Technologies for 5G and MMW Applications</p> <p>Chair: Jeong-Sun Moon, HRL Laboratories</p> <p>Co-Chair: Kenneth Mays, Boeing</p>	08:00
<p>We1E-1: Lamb Wave Resonator Loaded Non-Reciprocal RF Devices</p> <p>T. Lu; J.D. Schneider; X. Zou; S. Tiwari; Univ. of California, Los Angeles; Z. Yao; Berkeley Lab; G. Carman; Univ. of California, Los Angeles; R.N. Candler; Univ. of California, Los Angeles; Y.E. Wang; Univ. of California, Los Angeles</p>	<p>We1F-1: Demonstrating 139Gbps and 55.6bps/Hz Spectrum Efficiency Using 8×8 MIMO Over a 1.5-km Link at 73.5GHz</p> <p>C.B. Czegledi; Ericsson; M. Hörberg; Ericsson; M. Sjödin; Ericsson; P. Ligander; Ericsson; J. Hansryd; Ericsson; J. Sandberg; Ericsson; J. Gustavsson; Ericsson; D. Sjöberg; Ericsson; D. Polydorou; OTE; D. Siomos; OTE</p>	<p>We1G-1: Emerging High Power mm-Wave RF Transistors</p> <p>Y.-K. Chen; DARPA; A. Sivananthan; Booz Allen Hamilton; T.-H. Chang; HetnTec</p>	08:10
<p>We1E-2: Microwave Applications of Zirconium-Doped Hafnium Oxide Ferroelectrics: From Nanoscale Calculations up to Experimental Results</p> <p>M. Aldrigo; M. Dragoman; IMT Bucharest; E. Laudadio; Università Politecnica delle Marche; S. Iordanescu; IMT Bucharest; M. Modreanu; I.M. Povey; Univ. College Cork; F. Nastase; S. Vulpe; IMT Bucharest; P. Stipa; A. Di Donato; L. Pierantoni; D. Mencarelli; Università Politecnica delle Marche</p>	<p>We1F-2: Digital Predistortion of Millimeter-Wave Phased Array Transmitter with Over-The-Air Calibrated Simplified Conductive Feedback Architecture</p> <p>N. Tervo; Univ. of Oulu; B. Khan; Univ. of Oulu; O. Kursu; Univ. of Oulu; J.P. Aikio; Univ. of Oulu; M. Jokinen; Univ. of Oulu; M.E. Leinonen; Univ. of Oulu; M. Juntti; Univ. of Oulu; T. Rahkonen; Univ. of Oulu; A. Pärssinen; Univ. of Oulu</p>	<p>We1G-2: Advanced GaN HEMT Modeling Techniques and Power Amplifiers for Millimeter-Wave Applications</p> <p>S. Shinjo; Mitsubishi Electric; M. Hangai; Mitsubishi Electric; Y. Yamaguchi; Mitsubishi Electric; M. Miyazaki; Mitsubishi Electric</p>	08:20
<p>We1E-3: Novel Non-Reciprocal Microwave Spin Wave and Magneto-Elastic Wave Devices for On-Chip Signal Processing</p> <p>I.N. Krivorotov; Univ. of California, Irvine; E.A. Montoya; Univ. of California, Irvine; A. Khan; Univ. of California, Irvine; A.N. Slavin; Oakland Univ.; M. Wu; Colorado State Univ.</p>	<p>We1F-3: On the Effectiveness of Near-Field Feedback for Digital Pre-Distortion of Millimeter-Wave RF Beamforming Arrays</p> <p>A. Ben Ayed; Univ. of Waterloo; G. Scarlato; Univ. of Waterloo; P. Mitran; Univ. of Waterloo; S. Boumaiza; Univ. of Waterloo</p>	<p>We1G-3: Qorvo's Emerging GaN Technologies for mmWave Applications</p> <p>Y. Cao; Qorvo; V. Kumar; Qorvo; S. Chen; Qorvo; Y. Cui; Qorvo; S.D. Yoon; Qorvo; E. Beam; Qorvo; A. Xie; Qorvo; J. Jimenez; Qorvo; A. Ketterson; Qorvo; C. Lee; Qorvo; D. Linkhart; Metamagnetics; A. Geiler; Metamagnetics</p>	08:30
<p>We1E-4: Organic Ferrimagnetic Material Vanadium Tetracyanoethylene for Non-Reciprocal Microwave Applications</p> <p>N. Zhu; Yale Univ.; A. Franson; S. Kurfman; M. Chilcote; The Ohio State University; D.R. Candido; Univ. of Iowa; K.E. Nygren; Colorado State Univ.; M.E. Flatté; Univ. of Iowa; K.S. Buchanan; Colorado State Univ.; E. Johnston-Halperin; The Ohio State University; H.X. Tang; Yale Univ.</p>	<p>We1F-4: High-Frequency Vector-Modulated Signal Generation Using Frequency-Multiplier-Based RF Beamforming Architecture</p> <p>I. Jaffri; Univ. of Waterloo; A. Ben Ayed; Univ. of Waterloo; A.M. Darwish; U.S. Army Research Laboratory; S. Boumaiza; Univ. of Waterloo</p>	<p>We1G-4: High-Speed Graded-Channel GaN HEMTs with Linearity and Efficiency</p> <p>J.-S. Moon; HRL Laboratories; B. Grabar; HRL Laboratories; M. Antcliffe; HRL Laboratories; J. Wong; HRL Laboratories; C. Dao; HRL Laboratories; P. Chen; HRL Laboratories; E. Arkun; HRL Laboratories; I. Khalaf; HRL Laboratories; A. Corrion; HRL Laboratories; J. Chappell; HRL Laboratories; N. Venkatesan; Univ. of Notre Dame; P. Fay; Univ. of Notre Dame</p>	08:40
<p>We1E-5: Non-Reciprocal Lithium Niobate-on-Silicon Acoustoelectric Delay Lines</p> <p>H. Mansoorzare; Univ. of Central Florida; R. Abdolvand; Univ. of Central Florida</p>	<p>We1F-5: Aperture-Array & Lens+FPA Multi-Beam Digital Receivers at 28GHz on Xilinx ZCU 1275 RF SoC</p> <p>S. Pulipati; V. Ariyaratna; Md.R. Khan; S. Bhardwaj; A. Madanayake; Florida International Univ.</p>	<p>We1G-5: Advances in the Super-Lattice Castellated Field Effect Transistor (SLCFET) for High Power Density, Energy Efficient RF Amplification</p> <p>J. Chang; Northrop Grumman; S. Afroz; Northrop Grumman; B. Novak; Northrop Grumman; J. Merkel; Northrop Grumman; K. Nagamatsu; Northrop Grumman; R. Howell; Northrop Grumman</p>	08:50
<p>We1E-6: A Highly Linear Non-Magnetic GaN Circulator Based on Spatio-Temporal Modulation with an IIP3 of 56dBm</p> <p>J.A. Bahaonde; Columbia Univ.; I. Kymissis; Columbia Univ.; H. Krishnaswamy; Columbia Univ.</p>	<p>We1F-6: A 3D Detect-Array for Low-Complexity W-Band Beam Sensing and Direction-of-Arrival Estimation</p> <p>J. Kimionis; M.J. Holyoak; A. Singh; S. Shahramian; Y. Baeyens; Nokia Bell Labs</p>		09:00
			09:10
			09:20
			09:30
			09:40

MICROAPPS SCHEDULE 09:40 – 17:00 WEDNESDAY, 24 JUNE 2020

MicroApps offers a lot of information in 15 minutes! These presentations of application notes target the working engineer or technician and are color coded by general topic area below.

START TIME	TITLE	SPEAKERS
9:40	Power Amplifier Measurements using Spectre RF Option and Virtuoso ADE Explorer and Assembler	Sruba Seshadri – Cadence Design Systems
9:55	WinCal, the Microwave Engineer's Toolkit	Craig Kirkpatrick – FormFactor
10:10	Sonnet's Upcoming Fast Solver: Beowulf	Brian Rautio – Sonnet Software
10:25	Bridging the Transition from LTE to 5G NR through Coexistence in Transceiver Integration	Hunsoo Choo, Hsia Kang – Texas Instruments
10:40	Tunable and Fixed Filtering Solutions enhances Dynamic Range and Flexibility of 4G-5G-LTE Measurements	Rafi Hershtig – K&L Microwave
10:55	Automating Simulation of S-Parameters in Spectre	Tawna Wilsey – Cadence
11:10	Precision Low Phase Noise Oven Controlled Crystal Oscillator as a reference source for modern synthesizers	Aleksandr Kotiukov – Morion
11:25	Pulse Shape Duplication for High Power SSPA's	Paulo Correa – Empowe RF Systems
11:40	S-C Band High Q Low Loss Filters for 5G FR1 and Radar Bands	Dave Thibado – Knowles Corporation
12:00	5G New Radio Transceiver and Antenna Arrays: Today's Modern OTA Test Challenges and Solutions - PANEL SESSION	Janet O'Neil – ETS-Lindgren
13:05	A Panelized Filter Array for Millimeter Wave 5G Applications	David Bates – Knowles
13:20	Lies My Tester Told Me: How Impairments in RF Test Equipment Can Hide a DUT's True EVM	Abram Rose – Naitonal Instruments
13:35	Optimisation of Load and Source pull tuning to 110 GHz on Wafer	Gavin Fisher – IMECHE
13:50	Passive RF Mounting & Integration	Jared Burdick – Knowles Capacitors
14:05	Advanced Rigid Organic Substrates for High Frequency Packaging Applications	Daniel Schulze, Susan Bagan – MST Dyconex AG
14:20	How Material Properties and Fabrication can Impact RF Filter Performance	John Coonrod – Rogers Corp.
14:35	Millimeterwave 5G solutions and 7mm compact sub 6GHz 5G Solution	Christina Huang – JQL Electronics Inc.
14:50	The Design of Integrated RFSOI based mm-wave Beamformers	Arun Natarajan – MixComm
15:05	Enabling High Channel Count Multi-Antenna Array Systems	Vijayendra Siddamsetty – Texas Instuments
15:20	Best Practices for the Installation and Test of Board Level Passive Components for Ka-band and Above Applications	Mo Hasanovic – Smiths Interconnect
15:35	Dual Polarized Antennas	Fang Lu – SAGE Millimeter
15:50	Highly Integrated Ka-Band Frontend Module for SATCOM and 5G	Winfried Simon – IMST GmbH
16:05	Beamforming and Multi Array Measurements	Markus Loerner – Rohde & Schwarz
16:20	Plug 'n Play RF Design - Rapid Prototyping and Production of RF and Microwave Systems	Erik Luther – X-Microwave
16:35	Designing a Practical 100GbE Real-time Recording System for the Xilinx RFSoc	Bob Muro – Pentek
16:50	Use of Butler Matrix in Wi-Fi MIMO Application	Rob Sinno – API Technologies

5G Cell Phone ≤ 6GHz, FR1

5G Millimeterwave, FR2

Antenna and Antenna Components

Components & Materials

CAD and Modeling Products and Techniques

High Power Devices, including GaN Devices

Instrumentation and Measurement Techniques

Systems

MicroApps Sponsor:



MicroApps Media Sponsor:



WEIF1-1: Toroidal Metasurface for High Efficiency Sensing

P. Qin; Zhejiang Univ.; T. Li; Zhejiang Univ.; E.-P. Li; Zhejiang Univ.

WEIF1-10: Gysel Power Divider with Fixed Characteristic Impedance

A. Moulay; INRS-EMT; T. Djerfai; INRS-EMT

WEIF1-11: Concurrent Dual-Band Microstrip Line Hilbert Transformer for Spectrum Aggregation Real-Time Analog Signal Processing

R. Islam; Washington State Univ.; Md.H. Maktoumi; Washington State Univ.; Y. Gu; Univ. of Texas at Arlington; B. Arigong; Washington State Univ.

WEIF1-12: Controlled High Order Mode Generation for Tracking Coupler Bench Test

G. Ceccato; Università di Pavia; J.L. Cano; Universidad de Cantabria; A. Mediavilla; Universidad de Cantabria; L. Perregini; Università di Pavia

WEIF1-13: A Second Harmonic Separation Symmetric Ports 180° Coupler with Arbitrary Coupling Ratio and Transparent Terminations

P. Li; Washington State Univ.; H. Ren; Washington State Univ.; Y. Gu; Univ. of Texas at Arlington; B. Pejcinovic; Portland State Univ.; B. Arigong; Washington State Univ.

WEIF1-14: Distributed-Element Absorptive Bandpass Filter with a Broadband Impedance Matching

J. Lee; Korea Univ.; S. Nam; Korea Univ.; J. Lee; Korea Univ.

WEIF1-15: Compact Substrate-Integrated Waveguide Filtering Crossover by Embedding CPW Quarter-Wavelength Resonators

K. Zhou; Polytechnique Montréal; K. Wu; Polytechnique Montréal

WEIF1-16: Synthesis Considerations for Shunt-Starting Acoustic Wave Ladder Filters and Duplexers

E. Guerrero; Univ. Autònoma de Barcelona; P. Silveira; Univ. Autònoma de Barcelona; A. Triano; Univ. Autònoma de Barcelona; J. Verdú; Univ. Autònoma de Barcelona; P. de Paco; Univ. Autònoma de Barcelona

WEIF1-17: Novel Dual-Band Bandpass-to-Bandstop Filter Using Shunt PIN Switches Loaded on the Transmission Line

Y. Zhu; UESTC; Y. Dong; UESTC

WEIF1-18: High-k and Low-Loss Dielectric Composite Feedstock Filaments, Tailored for Additive Manufacturing of Microwave Devices

V. Kosamiya; Univ. of South Florida; J. Wang; Univ. of South Florida

WEIF1-19: Bi-Layer Kinetic Inductance Detectors for W-Band

B. Aja; Universidad de Cantabria; L. de la Fuente; Universidad de Cantabria; A. Fernandez; Universidad de Cantabria; J.P. Pascual; Universidad de Cantabria; E. Artal; Universidad de Cantabria; M.C. de Ory; IMDEA Nanociencia; M.T. Magaz; Centro de Astrobiología; D. Granados; IMDEA Nanociencia; J. Martin-Pintado; Centro de Astrobiología; A. Gomez; Centro de Astrobiología

WEIF1-2: Efficient Modeling of Wave Propagation Through Rough Slabs with FDTD

S. Bakirtzis; Univ. of Toronto; X. Zhang; Univ. College Dublin; C.D. Sarris; Univ. of Toronto

WEIF1-20: Characterization of a Josephson Junction Comb Generator

A.A. Babenko; NIST; A.S. Boaventura; NIST; N.E. Flowers-Jacobs; NIST; J.A. Brevik; NIST; A.E. Fox; NIST; D.F. Williams; NIST; Z. Popovic; University of Colorado Boulder; P.D. Dresselhaus; NIST; S.P. Benz; NIST

WEIF1-21: Design and Measurement of a Josephson Traveling Wave Parametric Amplifier Fabricated in a Superconducting Qubit Process

D.C. Feng; Rigetti Computing; M. Vahidpour; Rigetti Computing; Y. Mohan; Rigetti Computing; N. Sharac; Rigetti Computing; T. Whyland; Rigetti Computing; S. Stanwyck; Rigetti Computing; G. Ramachandran; Rigetti Computing; M. Selvanayagam; Rigetti Computing

WEIF1-22: Lock Detector Integrated in a High Order Frequency Multiplier Operating at 60-GHz-Band in 45nm CMOS SOI Technology

A. Boulmirat; CEA-LETI; A. Siligaris; CEA-LETI; C. Jany; CEA-LETI; J.L. Gonzalez Jimenez; CEA-LETI

WEIF1-23: A Magnetless Microstrip Filtering Circulator Based on Coupled Static and Time-Modulated Resonators

X. Wu; Univ. of California, Davis; M. Nafe; Univ. of California, Davis; X. Liu; Univ. of California, Davis

WEIF1-24: A Novel 32-Gb/s 5.6-Vpp Digital-to-Analog Converter in 100nm GaN Technology for 5G Signal Generation

M. Weiß; Fraunhofer IAF; C. Friesicke; Fraunhofer IAF; R. Quay; Fraunhofer IAF; O. Ambacher; Fraunhofer IAF

WEIF1-25: A 20-30GHz Compact PHEMT Power Amplifier Using Coupled-Line Based MCCR Matching Technique

J. Zhang; Fudan Univ.; T. Wu; Fudan Univ.; L. Nie; Fudan Univ.; D. Wei; Fudan Univ.; S. Ma; Fudan Univ.; J. Ren; Fudan Univ.

WEIF1-26: Complexity Analysis of Wideband Power Amplifiers Linearization in Multi-Band Signal Transmission for Massive MIMO Systems

S. Wang; Chalmers Univ. of Technology; W. Cao; Chalmers Univ. of Technology; T. Eriksson; Chalmers Univ. of Technology

WEIF1-27: Mechanically Decoupled Transitions from MMIC to Rectangular and Dielectric Waveguides at G-Band

M. Geiger; Universität Ulm; M. Hitzler; Universität Ulm; C. Waldschmidt; Universität Ulm

WEIF1-28: A Phase Analysis Method for Ferromagnetic Resonance Characterization of Magnetic Nanowires

Y. Zhang; Univ. of Minnesota; B. Garcia; Univ. of Minnesota; J. Um; Univ. of Minnesota; B. Stadler; Univ. of Minnesota; R. Franklin; Univ. of Minnesota

WEIF1-29: A Software-Defined mmWave Radio Architecture Comprised of Modular, Controllable Pixels to Attain Near-Infinite Pattern, Polarization, and Beam Steering Angles IMS

J. Park; POSTECH; D. Choi; POSTECH; W. Hong; POSTECH

WEIF1-3: Rapid Microwave Optimization Using a Design Database and Inverse/Forward Metamodels

A. Pietrenko-Dabrowska; Gdansk University of Technology; S. Koziel; Reykjavik University; J.W. Bandler; McMaster Univ.

WEIF1-31: Phase Shifter-Relaxed and Control-Relaxed Continuous Tuning 4×4 Butler Matrix

H. Ren; Washington State Univ.; P. Li; Washington State Univ.; Y. Gu; Univ. of Texas at Arlington; B. Arigong; Washington State Univ.

WEIF1-32: An Automatic Gain and Offset Control Circuit for DC-Coupled Continuous-Wave Radar Systems

F. Michler; FAU Erlangen-Nürnberg; S. Schoenhaerl; FAU Erlangen-Nürnberg; S. Schellenberger; Brandenburgische Technische Universität; K. Shi; FAU Erlangen-Nürnberg; B. Scheiner; FAU Erlangen-Nürnberg; F. Lurz; FAU Erlangen-Nürnberg; R. Weigel; FAU Erlangen-Nürnberg; A. Koelpin; Brandenburgische Technische Universität

WEIF1-33: Snow Depth Measurements from an Octo-Copter Mounted Radar

A.E.-C. Tan; Lincoln Agritech; J. McCulloch; University of Canterbury; W. Rack; University of Canterbury; I. Platt; Lincoln Agritech; I. Woodhead; Lincoln Agritech

WEIF1-34: Ultra-Compact and High-Efficiency Rectenna for Wireless Sensing Applications in Concrete Structure

A. Sidibe; LAAS; A. Takacs; LAAS; G. Loubet; LAAS; D. Dragomirescu; LAAS

WEIF1-35: Power-Combined Rectenna Array for X-Band Wireless Power Transfer

E. Kwiatkowski; University of Colorado Boulder; C.T. Rodenbeck; U.S. Naval Research Laboratory; T.W. Barton; University of Colorado Boulder; Z. Popovic; University of Colorado Boulder

WEIF1-36: Conductivity Measurement in mm-Wave Band with a Fabry-Perot Open Resonator

J. Cuper; Warsaw Univ. of Technology; B. Salski; Warsaw Univ. of Technology; T. Karpisz; Warsaw Univ. of Technology; A. Pacewicz; Warsaw Univ. of Technology; P. Kopyt; Warsaw Univ. of Technology

WEIF1-4: Acceleration and Extension of Radial Point Interpolation Method (RPIM) to Complex Electromagnetic Structures

K. Sabet; EMAG Technologies; A.I. Stefan; EMAG Technologies

WEIF1-5: Progress Towards a Compact and Low-Power Miniaturized Rubidium Oscillator (mRO)

J. Gouloumet; Orolia; B. Leuenberger; Orolia; C. Schori; Orolia; S. Grop; Orolia; P. Rochat; Orolia

WEIF1-6: Broadband Conductivity Measurement Method up to 110GHz Using a Balanced-Type Circular Disk Resonator

Y. Kato; AIST; M. Horibe; AIST

WEIF1-7: Millimeter-Wave Resonator Based on High Quality Factor Inductor and Capacitor Based on Slow-Wave CPS

A.A. Saadi; RFIC-Lab (EA 7520); M. Margalef-Rovira; RFIC-Lab (EA 7520); Y. Amara; RFIC-Lab (EA 7520); P. Ferrari; RFIC-Lab (EA 7520)

WEIF1-8: A Compact PCB Gasket for Waveguide Leakage Suppression at 110-170GHz

Z.S. He; Chalmers Univ. of Technology; A. Hassona; Chalmers Univ. of Technology; Á. Pérez-Ortega; Gotmic; H. Zirath; Chalmers Univ. of Technology

WEIF1-9: 3D-Printed Broadband Impedance Transformers Using Helical-Microstrip Transmission Line Segments

J.M. Lopez-Villegas; Universitat de Barcelona; A. Salas; Universitat de Barcelona; N. Vidal; Universitat de Barcelona

10:10

402AB

We2A: Non-Planar Filters II

Chair: Ming Yu, Chinese University of Hong Kong

Co-Chair: Giuseppe Macchiarella, Politecnico di Milano

We2A-1: 3-D Printed Bandpass Filter Using Conical Posts Interlaced Vertically

E. López-Oliver; Università di Perugia; C. Tomassoni; Università di Perugia; L. Silvestri; Università di Pavia; M. Bozzi; Università di Pavia; L. Pregrgrini; Università di Pavia; S. Marconi; Università di Pavia; G. Alaimo; Università di Pavia; F. Auricchio; Università di Pavia

We2A-2: An All-Metal Capacitive Coupling Structure for Coaxial Cavity Filters

Y. Chen; CUHK; K.-L. Wu; CUHK

We2A-3: Design of a Four Channel C-Band Multiplexer with a Modified Star-Junction Topology

M. Martínez Mendoza; Thales Alenia Space; M. García Tudela; Thales Alenia Space; R. Gómez-Chacón Camuñas; Thales Alenia Space

We2A-4: Compact Harmonic Rejection Filter for C-Band High-Power Satellite Applications

F. Teberio; Universidad Pública de Navarra; P. Martín-Iglesias; Universidad Pública de Navarra; I. Arregui; Universidad Pública de Navarra; I. Arnedo; Universidad Pública de Navarra; T. Lopetegui; Universidad Pública de Navarra; M.A.G. Laso; Universidad Pública de Navarra

We2A-5: Substrate Integrated Waveguide Bandpass Filters Implemented on Silicon Interposer for Terahertz Applications

G. Prigent; LAAS; A.-L. Franc; LAPLACE (UMR 5213); M. Wietstruck; IHP; M. Keynak; IHP

We2A-6: A Compact Diplexer for Circularly Polarized 20/30GHz SIW-Antennas

A. Sieganschin; Technische Universität Hamburg-Harburg; T. Jaschke; Technische Universität Hamburg-Harburg; A.F. Jacob; Technische Universität Hamburg-Harburg

10:20

10:30

10:40

10:50

11:00

11:10

11:20

11:30

11:40

11:50

403A

We2B: Advances in Radar and Backscatter Sensor Systems

Chair: Kazuya Yamamoto, Mitsubishi Electric Corporation

Co-Chair: Changzhan Gu, Shanghai Jiao Tong University

We2B-1: Nonlinear Negative Resistance-Based Harmonic Backscatter

K. Gumber; IMS (UMR 5218); F. Amato; Università di Roma "Tor Vergata"; C. Dejous; IMS (UMR 5218); S. Hemour; IMS (UMR 5218)

We2B-2: A 5.8GHz Fully-Tunnel-Diodes-Based 20 μ W, 88mV, and 48dB-Gain Fully-Passive Backscattering RFID Tag

A. Eid; Georgia Tech; J. Hester; Georgia Tech; M.M. Tentzeris; Georgia Tech

We2B-3: Active Reflector Tag for Millimeter Wave Harmonic Radar at 61/122GHz ISM Band Based on 130nm-BiCMOS SiGe:C Technology

S. Hansen; Fraunhofer FHR; C. Bredendiek; Fraunhofer FHR; N. Pohl; Fraunhofer FHR

We2B-4: Long-Range Zero-Power Multi-Sensing in Industrial Environment Using Polarization Diversity and 3D Radar Imagery

D. Henry; LAAS; T. Marchal; LAAS; J. Philippe; LAAS; H. Aubert; LAAS; P. Pons; LAAS

We2B-5: Noncontact High-Linear Motion Sensing Based on a Modified Differentiate and Cross-Multiply Algorithm

W. Xu; Shanghai Jiao Tong Univ.; C. Gu; Shanghai Jiao Tong Univ.; J.-F. Mao; Shanghai Jiao Tong Univ.

403B

We2C: Millimeter-Wave and Terahertz Transmitter and Receiver Systems

Chair: Samet Zehir, Renesas Electronics Corporation

Co-Chair: Herbert Zirath, Chalmers University of Technology

We2C-1: A 300GHz Wireless Transceiver in 65nm CMOS for IEEE802.15.3d Using Push-Push Subharmonic Mixer

I. Abdo; T. Fujimura; T. Miura; K.K. Tokgoz; Tokyo Institute of Technology; H. Hamada; NTT; H. Nosaka; NTT; A. Shirane; K. Okada; Tokyo Institute of Technology

We2C-2: 100Gbps 0.8-m Wireless Link Based on Fully Integrated 240GHz IQ Transmitter and Receiver

M.H. Eissa; IHP; N. Maletic; IHP; E. Grass; IHP; R. Kraemer; IHP; D. Kissinger; Universität Ulm; A. Malignaggi; IHP

We2C-3: Wireless Communication Using Fermi-Level-Managed Barrier Diode Receiver with J-Band Waveguide-Input Port

T. Nagatsuma; F. Ayano; K. Toichi; L. Yi; Osaka Univ.; M. Fujiwara; NTT; N. Iiyama; NTT; J. Kani; NTT; H. Ito; Kitasato University

We2C-4: A 680GHz Direct Detection Dual-Channel Polarimetric Receiver

C.M. Cooke; K. Leong; K. Nguyen; A. Escorcia; X. Mei; Northrop Grumman; J. Arroyo; Cubic Nuovotronics; T.W. Barton; University of Colorado Boulder; C. Du Toit; G. De Amici; D.L. Wu; NASA Goddard Space Flight Center; W.R. Deal; Northrop Grumman

We2C-5: Flexible Radar Front End with Multimodal Transition at 300GHz

M. Geiger; Universität Ulm; S. Gut; Universität Ulm; P. Hügler; Universität Ulm; C. Waldschmidt; Universität Ulm

404AB

We2D: Advancement of Biomedical Radar and Imaging

Chair: Chai-Chan Chang, National Chung Cheng University

Co-Chair: Changzhi Li, Texas Tech University

We2D-1: Frequency-Offset Self-Injection-Locked (FOSIL) Radar for Noncontact Vital Sign Monitoring

P.-H. Juan; National Sun Yat-sen Univ.; K.-H. Chen; National Sun Yat-sen Univ.; F.-K. Wang; National Sun Yat-sen Univ.

We2D-2: Noncontact Wrist Pulse Waveform Detection Using 24-GHz Continuous-Wave Radar Sensor for Blood Pressure Estimation

T.-J. Tseng; Taiwan Tech; C.-H. Tseng; Taiwan Tech

We2D-3: A High-Sensitivity Low-Power Vital Sign Radar Sensor Based on Super-Regenerative Oscillator Architecture

Y. Yuan; Rutgers Univ.; A.Y.-K. Chen; Cal State Northridge; C.-T.M. Wu; Rutgers Univ.

We2D-4: A Feasibility Study on the Use of Microwave Imaging for in-vivo Screening of Knee Prostheses

K. Root; FAU Erlangen-Nürnberg; I. Ullmann; FAU Erlangen-Nürnberg; F. Seehaus; FAU Erlangen-Nürnberg; M. Vossiek; FAU Erlangen-Nürnberg

We2D-5: Human Tracking and Vital Sign Monitoring with a Switched Phased-Array Self-Injection-Locked Radar

W.-C. Su; National Sun Yat-sen Univ.; P.-H. Juan; National Sun Yat-sen Univ.; D.-M. Chian; National Sun Yat-sen Univ.; T.-S. Horng; National Sun Yat-sen Univ.; C.-K. Wen; National Sun Yat-sen Univ.; F.-K. Wang; National Sun Yat-sen Univ.

406AB

We2E: Recent Advances in Compact and High Performance Planar Filter Design and Realization

Chair: Dimitra Psychogiou, University of Colorado

Co-Chair: Christopher Galbraith, Massachusetts Institute of Technology, Lincoln Laboratory

We2E-1: Quasi-Absorptive Substrate-Integrated Bandpass Filters Using Capacitively-Loaded Coaxial Resonators

D. Psychogiou; University of Colorado Boulder; R. Gómez-García; Universidad de Alcalá

We2E-2: UIR-Loaded Dual-Mode SIW Filter with Compact Size and Controllable Transmission Zeros

Y. Zhu; UESTC; Y. Dong; UESTC

We2E-3: Compact Bandpass Filter with Wide Stopband and Low Radiation Loss Using Substrate Integrated Defected Ground Structure

D. Tang; UESTC; C. Han; UESTC; Z. Deng; UESTC; H.J. Qian; UESTC; X. Luo; UESTC

We2E-4: Step Impedance Resonator (SIR) Loaded with Complementary Split Ring Resonator (CSRR): Modeling, Analysis and Applications

P.Vélez; Univ. Autònoma de Barcelona; J. Muñoz-Enano; Univ. Autònoma de Barcelona; A. Ebrahimi; Rmit Univ.; J. Scott; Rmit Univ.; K. Ghorbani; Rmit Univ.; F. Martín; Univ. Autònoma de Barcelona

We2E-5: Quasi-Elliptic Coupled-Line-Based Balanced Bandpass Filters with Ultra-Wide Stopband Characteristics

M. Kong; BUPT; D. Psychogiou; University of Colorado Boulder; Y. Wu; BUPT

408A

We2F: 5G Arrays and Beamformers

Chair: Kwang-Jin Koh, Lockheed Martin Corp.

Co-Chair: Tumay Kanar, Renesas Electronics America

We2F-1: A 28GHz, 2-Way Hybrid Phased-Array Front-End for 5G Mobile Applications

N. Cho; Samsung; H.-S. Lee; Samsung; H. Lee; Samsung; W.-N. Kim; Samsung

We2F-2: A 24–29.5GHz 256-Element 5G Phased-Array with 65.5dBm Peak EIRP and 256-QAM Modulation

Y. Yin; Univ. of California, San Diego; Z. Zhang; Univ. of California, San Diego; T. Kanar; IDT; S. Zahir; IDT; G.M. Rebeiz; Univ. of California, San Diego

We2F-3: Machine Learning for Accelerated IBFD Tuning in 5G Flexible Duplex Networks

K.E. Kolodziej; MIT Lincoln Laboratory; A.U. Cookson; MIT Lincoln Laboratory; B.T. Perry; MIT Lincoln Laboratory

We2F-4: A 38-GHz 32-Element Phased-Array Transmitter Based on Scalable 8-Element Phased-Array Modules for 5G MMW Data Links

C.-N. Chen; L.-C. Hung; Y.-H. Lin; T.-C. Tang; W.-P. Chao; G.-Y. Lin; National Taiwan Univ.; W.-J. Liao; Y.-H. Nien; National Chung Cheng Univ.; W.-C. Huang; T.-Y. Kuo; K.-Y. Lin; T.-W. Huang; Y.-C. Lin; H.-C. Lu; National Taiwan Univ.

We2F-5: OLED Display-Integrated Optically Invisible Phased Arrays for Millimeter-Wave 5G Cellular Devices

J. Park; POSTECH; J. Choi; POSTECH; D. Park; Dongwoo Fine-Chem; M.-S. Kim; Dongwoo Fine-Chem; C. You; LG Electronics; D. Jung; LG Electronics; I. Song; LG Electronics; J. Lee; LG Electronics; Y.N. Whang; SK Telecom; Y. Lee; Y-TECH; B. Kang; Corning Precision Materials; W. Hong; POSTECH

408B

We2G: Load Modulated Power Amplifiers

Chair: Leo de Vreede, Delft University of Technology

Co-Chair: Paul Draxler, MaXentric Technologies, LLC

We2G-1: Dual-Octave-Bandwidth RF-Input Pseudo-Doherty Load Modulated Balanced Amplifier with q10-dB Power Back-Off Range

Y. Cao; Univ. of Central Florida; K. Chen; Univ. of Central Florida

We2G-2: Extend High Efficiency Range of Doherty Power Amplifier by Modifying Characteristic Impedance of Transmission Lines in Load Modulation Network

J. Pang; Univ. College Dublin; Y. Li; Univ. College Dublin; C. Chu; Univ. College Dublin; J. Peng; UESTC; X.Y. Zhou; CityU; A. Zhu; Univ. College Dublin

We2G-3: A Fully-Integrated GaN Doherty Power Amplifier Module with a Compact Frequency-Dependent Compensation Circuit for 5G Massive MIMO Base Stations

S. Sakata; K. Kato; E. Teranishi; T. Sugitani; Mitsubishi Electric; R. Ma; MERL; K. Chuang; NanoSemi; Y.-C. Wu; NanoSemi; K. Fukunaga; Y. Komatsuzaki; K. Horiguchi; K. Yamanaka; S. Shinjo; Mitsubishi Electric

We2G-4: 300W Dual Path GaN Doherty Power Amplifier with 65% Efficiency for Cellular Infrastructure Applications

M. Masood; NXP Semiconductors; S. Embar R.; NXP Semiconductors; P. Rashev; NXP Semiconductors; J. Holt; NXP Semiconductors; J.S. Kenney; Georgia Tech

We2G-5: Digitally Assisted Load Modulated Balanced Amplifier for 200W Cellular Infrastructure Applications

S. Embar R.; NXP Semiconductors; M. Masood; NXP Semiconductors; T. Sharma; NXP Semiconductors; J. Staudinger; NXP Semiconductors; S.K. Dhar; Univ. of Calgary; P. Rashev; NXP Semiconductors; G. Tucker; NXP Semiconductors; F.M. Ghannouchi; Univ. of Calgary

10:10

10:20

10:30

10:40

10:50

11:00

11:10

11:20

11:30

11:40

11:50

INDUSTRY WORKSHOPS 08:00 – 17:30 WEDNESDAY, 24 JUNE 2020

Industry workshops cover contemporary topics spanning the state of the art in RF, microwave, and mm-wave areas. These two-hour workshops include in-depth technical presentations from and discussions with experts in the industry. Don't miss this opportunity to expand your knowledge and interact with colleagues in these very relevant fields!

SESSION TIME	SESSION TITLE	EVENT COMPANY	SPEAKERS
8:00 – 9:40	High Power Solid State Amplifier Advances in Technology	EMPOWER RF Systems, Inc.	Paulo Correa, EMPOWER RF SYSTEMS
	Learn 5G Signals, Demodulation and Conformance Tests with the VSA	Keysight Technologies Inc	Raj Sodhi, Keysight Technologies Inc; Martha Zemedede, Keysight Technologies Inc; Denis Gregoire, Keysight Technologies Inc; Aidin Taeb, Keysight Technologies Inc
	Addressing Calibration and Measurement Challenges of Broadband On-wafer VNA Measurements up to 220 GHz	Anritsu Company	Steve Reyes, Anritsu Company; Jon Martens, Anritsu Company; Andrej Rumiantsev, MPI Corporation
10:10 – 11:50	Design Tutorial for a High-Efficiency GaN Doherty Power Amplifier	Cadence Design Systems, Inc.	David Vye, Cadence Design Systems, Inc.; John Dunn, Cadence Design Systems, Inc.
	Cryogenic Measurement Challenges for Quantum Applications	Keysight Technologies	Suren Singh, Keysight Technologies; Nizar Messaoudi, Keysight Technologies; David Daughton, Lakeshore Cryotronics
	Redefine OTA: Innovative Testing Solution for 5G NR mmWave	TMY Technology, Inc	Ethan Lin, TMY Technology
15:50 – 17:30	Understanding 5G New Radio (NR) Release 15-16 Standards	Keysight Technologies	
	Designing GaN on SiC MMIC Power Amplifiers Using the Cree-Wolfspeed MWO PDK	Wolfspeed, A Cree Company	Yueying Liu, Cree-Wolfspeed
	Module-Level RF-Microwave Design Flows Integrating Circuit-EM and Thermal Analysis	Cadence Design Systems, Inc.	David Choe, Cadence Design Systems, Inc.; Michael Thompson, Cadence Design Systems, Inc.

Who needs RF when we can digitize at the antenna?

PANEL ORGANIZERS AND MODERATORS:

Larry Kushner, Raytheon Technologies

PANELISTS:

Tim Hancock, DARPA Microelectronics Technology Office; Gabriel Rebeiz, University of California San Diego; Craig Hornbuckle, Jariet Technologies; Chris Rudell, University of Washington; Harold Pratt, Raytheon Technologies; Boris Murmann, Stanford University

ABSTRACT:

With the advent of GS-s data converters driven by Moore’s law and advances in converter architectures, it is now possible to digitize directly at RF. The question is, should we? On the one hand, eliminating mixers, filters, amplifiers, and local oscillators reduces RF complexity and allows more flexible, multi-function designs. On the other hand, do we really want to digitize the entire spectrum from DC to daylight and process 10’s of GS-s of data if the information BW we care about is orders of magnitude lower? In the context of phased arrays, element-level digital beamforming allows simultaneous beams with different beamwidths and pointing angles, but may be more susceptible than analog-beam-formed arrays to interferers since spatial filtering occurs after the analog-to-digital conversion. What is the right approach? Our distinguished panel will debate the pros and cons of competing system architectures and the audience will be engaged to judge who is right.

WEDNESDAY TECHNICAL LECTURES

	Lecture Title	Course Syllabus
TWA1	<p>N-Path Mixers and Filters: Concept, Theory and Applications Speaker: Alyosha Molnar, Cornell Univ. 12:00 – 13:30</p>	<p>One of the most important RF circuits to emerge in the past decade is the N-path passive mixer (sometimes called the “N-path filter”). Although known for decades, the advent of deep-submicron CMOS has enabled N-path passive mixers and filters to be scaled to GHz frequencies, providing dramatic enhancements in RF receiver linearity, and enabling various other interesting capabilities. This lecture will introduce the N-path passive mixer and its application to frequency flexible, interference tolerant receivers, as well as a variety of other applications. The lecture will then provide an intuitive frame work for analyzing, designing and optimizing N-path circuits. This framework will also be used to describe ways in which circuit and transistor properties limit N-path mixers’ performance, specifically with regard to frequency of operation, power consumption, noise, and linearity. Second-order phenomena, such as phase noise and LO leakage will also be discussed, as well as techniques for their mitigation. The lecture will also suggest a design methodology for such circuits, with several worked examples, and will finish with several extensions of the core circuit to multi-port applications, such as beamforming, and non-reciprocal circuits.</p>
TWB2	<p>Fundamentals of Phased Arrays Speaker: Marinos Vouvakis, University of Massachusetts Amherst 12:00 – 13:30</p>	<p>Phased arrays have been the linchpin technology behind 5G wireless networks, LEO & MEO broadband high-speed internet connectivity and to some extent autonomous vehicles, in addition to many more conventional defense and security applications. Their main appeal stems from their ability to form directive (high gain) electronically scanned beams with controlled side-lobes, while maintaining smaller form factors than perhaps any other directive antenna e.g. reflectors. This technical lecture offers a top-down introduction into phased arrays, that includes the main operation principles and key analysis and design methodologies. Participants will learn to critically evaluate the system-level performance of phased array systems, and the various antenna elements and array arrangements.</p>

15:50

402AB

We3A: Recent Advances in Passive Components

Chair: Holger Maune, Technische Universität Darmstadt
Co-Chair: Thomas Lingel, TTM

We3A-1: Angular-Momentum Biased Circulator with a Common-Differential Mode Topology for RF and Modulation Isolation

H.M. Kadry; Wayne State Univ.;
 D.L. Sounas; Wayne State Univ.

16:00

We3A-2: Miniature Wideband Rat-Race Coupler in Silicon-Based Integrated Passive Device Technology

Y.-R. Liu; National Central Univ. ;
 C.-H. Chan; National Central Univ. ;
 Y.-S. Lin; National Central Univ.

16:10

We3A-3: A Geometrically Shaped Hemispherical Cavity Resonator with Extended Spurious-Free Region

J. Li; Shenzhen Univ.; T. Yuan; Shenzhen Univ.

16:20

We3A-4: Low-Loss Continuous True Time Delay with Delay Summing

K. Park; Yonsei Univ.; B.-W. Min; Yonsei Univ.

16:30

We3A-5: Miniaturized Couplers Using Multi-Mode Star-Junction

M.H.A. Elsawaf; Ain Shams Univ.;
 A.M.H. Nasr; Ain Shams Univ.; A.M.E. Safwat; Ain Shams Univ.

16:40

16:50

17:00

We3A-6: AFSIW Power Divider with Isolated Outputs Based on Balanced-Delta-Port Magic-Tee Topology

N.-H. Nguyen; IMEP-LAHC (UMR 5130);
 A. Ghiotto; IMS (UMR 5218); T. Martin; IMS (UMR 5218); A. Vilcot; IMEP-LAHC (UMR 5130); T.-P. Vuong; IMEP-LAHC (UMR 5130); K. Wu; Polytechnique Montréal

17:10

17:20

17:30

403A

We3B: Advanced Nonlinear Measurement Techniques and Results

Chair: Marcus Da Silva, National Instruments
Co-Chair: Sherif Ahmed, Entrepreneur

We3B-1: Broadband Error Vector Magnitude Characterization of a GaN Power Amplifier Using a Vector Network Analyzer

A.M. Angelotti; Univ. of Bologna; G.P. Gibiino; Univ. of Bologna; C. Florian; Univ. of Bologna; A. Santarelli; Univ. of Bologna

We3B-2: Precisely Synchronized NVNA Setup for Digital Modulation Signal Measurements at Millimeter-Wave Test Bands

Y. Zhang; NIM; X. Guo; NIM; Z. Zhang; NIM; Z. He; NIM; A. Yang; NIM

We3B-3: Millimeter-Wave Power Amplifier Linearity Characterization Using Unequally Spaced Multi-Tone Stimulus

V. Gillet; XLIM (UMR 7252); J.-P. Teyssier; Keysight Technologies; A. Al Hajjar; OMMIC; A. Gasm; OMMIC; C. Edoua Kacou; OMMIC; M. Prigent; XLIM (UMR 7252); R. Quéré; XLIM (UMR 7252)

We3B-4: Pulse Profiling Active Load Pull Measurements

Y. Alimohammadi; Cardiff University; E. Kuwata; Cardiff University; X. Liu; Cardiff University; T. Hussein; Al-Furat Al-Awsat Technical University; J.J. Bell; Cardiff University; L. Wu; Huawei Technologies; P.J. Tasker; Cardiff University; J. Benedikt; Cardiff University

We3B-5: Enhanced Wideband Active Load-Pull with a Vector Network Analyzer Using Modulated Excitations and Device Output Match Compensation

A.M. Angelotti; Univ. of Bologna; G.P. Gibiino; Univ. of Bologna; T.S. Nielsen; Keysight Technologies; D.M.M.-P. Schreurs; Katholieke Univ. Leuven; A. Santarelli; Univ. of Bologna

403B

We3C: Millimeter-Wave and Submillimeter-Wave Components

Chair: Dietmar Kissinger, Ulm University
Co-Chair: William Deal, Northrop Grumman Corporation

We3C-1: InP HBT Oscillators Operating up to 682GHz with Coupled-Line Load for Improved Efficiency and Output Power

J. Kim; Korea Univ.; H. Son; Korea Univ.; D. Kim; Korea Univ.; K. Song; Korea Univ.; J. Yoo; Korea Univ.; J.-S. Rieh; Korea Univ.

We3C-2: A DC to 194-GHz Distributed Mixer in 250-nm InP DHBT Technology

T. Jyo; NTT; M. Nagatani; NTT; M. Ida; NTT; M. Mutoh; NTT; H. Wakita; NTT; N. Terao; NTT; H. Nosaka; NTT

We3C-3: Broadband 110–170GHz True Time Delay Circuit in a 130-nm SiGe BiCMOS Technology

A. Karakuzulu; IHP; M.H. Eissa; IHP; D. Kissinger; Universität Ulm; A. Malignaggi; IHP

404AB

We3D: Millimeter Wave Radar Vibrometry: Technical Advances and New Phenomenology

Chair: Chris Robenbeck, Naval Research Laboratory
Co-Chair: Chai-Chan Chang, National Chung Cheng University

We3D-1: Silent Speech Recognition Based on Short-Range Millimeter-Wave Sensing

L. Wen; Shanghai Jiao Tong Univ.; C. Gu; Shanghai Jiao Tong Univ.; J.-F. Mao; Shanghai Jiao Tong Univ.

We3D-2: Non-Contact Vital Signs Monitoring for Multiple Subjects Using a Millimeter Wave FMCW Automotive Radar

S.M.M. Islam; University of Hawaii at Manoa; N. Motoyama; ON Semiconductor; S. Pacheco; ON Semiconductor; V.M. Lubecke; University of Hawaii at Manoa

We3D-3: Multi-Spectral THz Micro-Doppler Radar Based on a Silicon-Based Picosecond Pulse Radiator

S. Razavian; Univ. of California, Los Angeles; A. Babakhani; Univ. of California, Los Angeles

We3D-4: Using FMCW Radar for Spatially Resolved Intra-Chirp Vibrometry in the Audio Range

L. Piotrowsky; Ruhr-Universität Bochum; J. Siska; Ruhr-Universität Bochum; C. Schweer; Ruhr-Universität Bochum; N. Pohl; Ruhr-Universität Bochum

We3D-5: AI-Driven Event Recognition with a Real-Time 3D 60-GHz Radar System

A. Tzadok; IBM T.J. Watson Research Center; A. Valdes-Garcia; IBM T.J. Watson Research Center; P. Pepejugoski; IBM T.J. Watson Research Center; J.-O. Plouchart; IBM T.J. Watson Research Center; M. Yeck; IBM T.J. Watson Research Center; H. Liu; IBM T.J. Watson Research Center

406AB	408A	408B	
<p>We3E: Tunable and Active Filters</p> <p>Chair: Sanghoon Shin, Naval Research Laboratory Co-Chair: Julien LINTIGNAT, University of Limoges</p>	<p>We3F: Beamforming for Satellite Communications and Sensors</p> <p>Chair: Byung-Wook Min, Yonsei University Co-Chair: David Ricketts, North Carolina State University</p>	<p>We3G: Digital Predistortion and Supply Modulation</p> <p>Chair: John Wood, Wolfspeed, A Cree Company Co-Chair: Jonmei Yan, MaXentric Technologies, LLC</p>	15:50
<p>We3E-1: A Compact Reconfigurable N-Path Low-Pass Filter Based on Negative Trans-Resistance with <1dB Loss and >21dB Out-of-Band Rejection</p> <p>M. Khorshidian; Columbia Univ.; N. Reiskarimian; Columbia Univ.; H. Krishnaswamy; Columbia Univ.</p>	<p>We3F-1: A Scalable Switchable Dual-Polarized 256-Element Ka-Band SATCOM Transmit Phased-Array with Embedded RF Driver and ±70° Beam Scanning</p> <p>K.K.W. Low; Univ. of California, San Diego; S. Zahir; IDT; T. Kanar; IDT; G.M. Rebeiz; Univ. of California, San Diego</p>	<p>We3G-1: Closed-Loop Sign Algorithms for Low-Complexity Digital Predistortion</p> <p>P. Pascual Campo; Tampere University; V. Lampu; Tampere University; L. Anttila; Tampere University; A. Brihuega; Tampere University; M. Allén; Tampere University; M. Valkama; Tampere University</p>	16:00
<p>We3E-2: BPFs with Parametrically Compensated Passband Insertion Loss and Selectivity</p> <p>L.K. Yeung; Univ. of California, Los Angeles; X. Zou; Univ. of California, Los Angeles; Y.E. Wang; Univ. of California, Los Angeles</p>	<p>We3F-2: A 28-GHz Full Duplex Front-End and Canceller Using Two Cross-Polarized 64-Element Phased Arrays</p> <p>J. Myeong; Yonsei Univ.; K. Park; Yonsei Univ.; A. Nafe; Univ. of California, San Diego; H. Chung; Univ. of California, San Diego; G.M. Rebeiz; Univ. of California, San Diego; B.-W. Min; Yonsei Univ.</p>	<p>We3G-2: OTA-Based Data Acquisition and Signal Separation for Digital Predistortion of Multi-User MIMO Transmitters in 5G</p> <p>X. Wang; Univ. College Dublin; Y. Li; Univ. College Dublin; C. Yu; Southeast Univ.; W. Hong; Southeast Univ.; A. Zhu; Univ. College Dublin</p>	16:10
<p>We3E-3: Fully-Reconfigurable Non-Reciprocal Bandpass Filters</p> <p>D. Simpson; University of Colorado Boulder; D. Psychogiou; University of Colorado Boulder</p>	<p>We3F-3: Affordable, Multi-Function Flight-Worthy Airborne Phased-Array Sensor</p> <p>J. Navarro; Boeing</p>	<p>We3G-3: L-Band Floating-Ground RF Power Amplifier for Reverse-Type Envelope Tracking Systems</p> <p>S. Paul; FBH; W. Heinrich; FBH; O. Bengtsson; FBH</p>	16:20
<p>We3E-4: A Dual-Mode Frequency Reconfigurable Waveguide Filter with a Constant Frequency Spacing Between Transmission Zeros</p> <p>G. B.; Univ. of Waterloo; R.R. Mansour; Univ. of Waterloo</p>	<p>We3F-4: A Scalable 256-Element E-Band Phased-Array Transceiver for Broadband Communications</p> <p>M. Repeta; W. Zhai; T. Ross; K. Ansari; S. Tiller; H.K. Pothula; D. Wessel; X. Li; H. Cai; D. Liang; G. Wang; W. Tong; Huawei Technologies</p>	<p>We3G-4: High Efficiency, High Bandwidth Switch-Mode Envelope Tracking Supply Modulator</p> <p>F. Hühn; FBH; F. Müller; FBH; L. Schellhase; FBH; W. Heinrich; FBH; A. Wentzel; FBH</p>	16:30
<p>We3E-5: Behavior of Lossy Spiral Inductors and Their Applications to the Design of Tunable Band Reject Filters</p> <p>H. Jia; Univ. of Waterloo; R.R. Mansour; Univ. of Waterloo</p>	<p>We3F-5: A Dual-Polarized 1024-Element Ku-Band SATCOM Transmit Phased-Array with ±70° Scan and 43.5dBW EIRP</p> <p>G. Gültepe; Univ. of California, San Diego; S. Zahir; IDT; T. Kanar; IDT; G.M. Rebeiz; Univ. of California, San Diego</p>	<p>We3G-5: Exploiting the Marx Generator as a 100MHz High-Speed Multilevel Supply Modulator</p> <p>P. Gjurovski; RWTH Aachen Univ.; L. Huessen; RWTH Aachen Univ.; R. Negra; RWTH Aachen Univ.</p>	16:40
<p>We3E-6: Novel Reconfigurable Filtering Crossover Based on Evanescent-Mode Cavity Resonators</p> <p>J. Lai; UESTC; T. Yang; UESTC; P.-L. Chi; National Chiao Tung Univ.; R. Xu; UESTC</p>			16:50
			17:00
			17:10
			17:20
			17:30

MTT-S AWARDS BANQUET 18:30 – 21:30 WEDNESDAY, 24 JUNE 2020

AWARDS

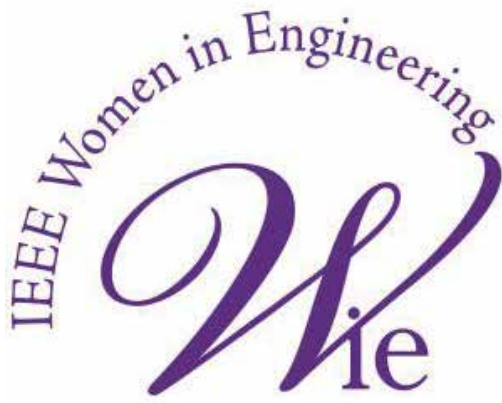
MTT-S AWARD	2020 AWARD RECIPIENT AND DESCRIPTION
Honorary Life Member	Jozef Modelski For past and continuing outstanding services to the Society
Microwave Career Award	Robert Weigel For a Career of Leadership, Meritorious Achievement, Creativity and Outstanding Contributions in the Field of Microwave Theory and Techniques
Distinguished Service Award	Wolfgang Heinrich In Recognition of a Distinguished Record of Service to the MTT Society and the Microwave Profession over a Sustained Period of Time
Distinguished Educator Award (established in 1992)	Ian Hunter For Outstanding Achievements as an Educator, Mentor, and Role Model for Microwave Engineers and Engineering Students
Microwave Application Award	Ming Yu For the Development of Computer Aided and Robotic Tuning for Filters and Multiplexers
N. Walter Cox Award (established in 1992)	Ryan Miyamoto For Exemplary Service to the Society in a Spirit of Selfless Dedication and Cooperation
IEEE MTT-S Outstanding Young Engineer Award (established in 2001)	Joseph Bardin For Outstanding Early Career Achievements for Fundamental Work in the Area of Ultra-low-noise technology with Application to Emerging Sensor and Communication Systems
	Shahriar Shahramian For Outstanding Early Career Achievements in mm-Wave Phased-Arrays and Transceivers and for Being an Educational Role Model with the Signal Path Video Series
	Thomas Ussmueller For Outstanding Early Career Achievements in Fundamental Work in the Field of Microwave Technology, Especially Radio Frequency Integrated Circuits, and to Exemplary Service to the Society
	Jiang Zhu For Outstanding Early Career Achievements in Consumer Applications of RF, Antenna and Electromagnetic Devices in the Areas of Wireless Communications, Human Body Interaction and Sensing

MTT-SOCIETY BEST PAPER AWARDS	
Microwave Prize	Bhaskara Rupakula, Gabriel M. Rebeiz For their paper "Third-Order Intermodulation Effects and System Sensitivity Degradation in Receive-Mode 5G Phased Arrays in the Presence of Multiple Interferers," <i>IEEE Transactions on Microwave Theory and Techniques</i> , Vol. 66, Issue 12, pp. 5780 – 5795, Year 2018"
IEEE Microwave Magazine Best Paper Award (established in 2009)	Francisco Mesa, Raúl Rodríguez-Berral, Francisco Medina For their paper "Unlocking Complexity Using the ECA: The Equivalent Circuit Model as An Efficient and Physically Insightful Tool for Microwave Engineering," <i>IEEE Microwave Magazine</i> , Vol. 19, No. 4, pp. 44-65, June 2018
IEEE Microwave and Wireless Components Letters Tatsuo Itoh Prize (established in 2009) (renamed 2010)	Wei Chen, Yida Li, Rongaiang Li, Aaron Voon-Yew Thean, Yong-Xin Guo For their paper "Bendable and Stretchable Microfluidic Liquid Metal-Based-Filter," <i>IEEE Microwave and Wireless Components Letters Tatsuo Itoh Prize</i> , Vol. 28, Issue 3, pp.203-205, March 2018
IEEE Transactions on Terahertz Science & Technology Best paper Award	Jacob W. Kooi, Rodrigo A. Reeves, Arthur W. Lichtenberger, Theodore J. Reck, Andy K. Fung, Sander Weinreb, James W. Lamb, Rohit S. Gawande, Kieran A. Cleary, Goutam Chattopadhyay For their paper "A Programmable Cryogenic Waveguide Calibration Load With Exceptional Temporal Response and Linearity," <i>IEEE Transactions on Terahertz Science & Technology</i> , Vol. 8, No. 4, pp. 434–445, July 2018

IEEE FELLOWS

THE IEEE GRADE OF FELLOW is conferred by the Board of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. The total number selected in any one year does not exceed one-tenth of one percent of the total voting Institute membership. The accomplishments that are being honored have contributed importantly to the advancement or application of engineering, science and technology, bringing the realization of significant value to society. Seventeen MTT-S members were elected to the grade of Fellow, effective 1 January 2020:

IEEE FELLOWS	
Filippo Capolino	<i>for contributions to development of electromagnetic phenomena in metamaterials and periodic structures</i>
William Chappell	<i>for leadership in the development of reconfigurable radio frequency and microwave systems</i>
Xudong Chen	<i>for contributions to optimization methods for electromagnetic inverse scattering</i>
Jung-chih Chiao	<i>for contributions to wireless and battery-less medical implants</i>
Thomas Crowe	<i>for leadership in the development of terahertz devices and instrumentation</i>
Edward Godshalk	<i>for development of microwave on-wafer probing and measurement techniques</i>
Akira Inoue	<i>for development of inverse class-F power amplifiers for mobile phones</i>
Nuria Llombart Juan	<i>for contributions to millimeter and submillimeter wave quasi-optical antennas</i>
Gong-ru Lin	<i>for contributions to ultrafast fiber lasers and highspeed laser diodes for optical communications</i>
Kartikeyan Machavaram	<i>for contributions to high-power millimeter wave and terahertz sources</i>
Chul Soon Park	<i>for development of low power millimeter-wave circuits and packages</i>
Ullrich Pfeiffer	<i>for development of silicon-based millimeter-wave and terahertz circuits and systems</i>
Dennis Prather	<i>for contributions to diffractive optical systems</i>
Jaume Anguera Pros	<i>for contributions to small multiband antennas for wireless telecommunication devices</i>
Jae-sung Rieh	<i>for contributions to silicon-germanium integrated circuits for wireless communications</i>
Manfred Schindler	<i>for development in microwave switch technology for radar and wireless communication systems</i>
Shiwen Yang	<i>for development of time-modulated antenna arrays</i>



Thursday

	403A	403B	404AB
08:00	<p>Th1B: Late-breaking News in Silicon Technologies and Circuits</p> <p>Chair: Deuk Heo, Washington State University Co-Chair: James Buckwalter, University of California, Santa Barbara</p>	<p>Th1C: Advanced Radar Systems for Automotive and Vehicular Applications</p> <p>Chair: Markus Gardill, Universität Würzburg Co-Chair: Martin Vossiek, Friedrich-Alexander-Universität Erlangen-Nürnberg</p>	<p>Th1D: Chip-Scale Interconnects and Packaging Technologies</p> <p>Chair: Rhonda Franklin, University of Minnesota, Twin Cities Co-Chair: Florian Herrault, HRL Laboratories, LLC</p>
08:10	<p>Th1B-1: An E-Band Power Amplifier Using High Power RF Device with Hybrid Work Function and Oxide Thickness in 22nm Low-Power FinFET</p> <p>Q. Yu; Intel; Y.-S. Yeh; Intel; J. Garret; Intel; J. Koo; Intel; S. Morarka; Intel; S. Rami; Intel; G. Liu; Intel; H.-J. Lee; Intel</p>	<p>Th1C-1: A Fast-Chirp MIMO Radar System Using Beat Frequency FDMA with Single-Sideband Modulation</p> <p>M.Q. Nguyen; Johannes Kepler Universität Linz; R. Feger; Johannes Kepler Universität Linz; J. Bechter; ZF Friedrichshafen; M. Pichler-Scheder; LCM; A. Stelzer; Johannes Kepler Universität Linz</p>	<p>Th1D-1: Polyolithic Integration for RF/MM-Wave Chipelets Using Stitch-Chips: Modeling, Fabrication, and Characterization</p> <p>T. Zheng; Georgia Tech; P.K. Jo; Georgia Tech; S. Kochupurackal Rajan; Georgia Tech; M.S. Bakir; Georgia Tech</p>
08:20	<p>Th1B-2: A Highly Rugged 19dBm 28GHz PA Using Novel PAFET Device in 45RFSOI Technology Achieving Peak Efficiency Above 48%</p> <p>S. Syed; GLOBALFOUNDRIES; S. Jain; GLOBALFOUNDRIES; D. Lederer; GLOBALFOUNDRIES; W. Liu; GLOBALFOUNDRIES; E. Veeramani; GLOBALFOUNDRIES; B. Chandhoke; GLOBALFOUNDRIES; A. Kumar; GLOBALFOUNDRIES; G. Freeman; GLOBALFOUNDRIES</p>	<p>Th1C-2: A System Analysis of Noise Influences on the Imaging Performance of Millimeter Wave MIMO Radars</p> <p>A. Dürr; Universität Ulm; D. Schwarz; Universität Ulm; C. Waldschmidt; Universität Ulm</p>	<p>Th1D-2: A W-Band Chip-to-Printed Circuit Board Interconnect</p> <p>B. Deutschmann; Technische Universität Hamburg-Harburg; A.F. Jacob; Technische Universität Hamburg-Harburg</p>
08:30			
08:40	<p>Th1B-3: Efficiency Enhancement Technique Using Doherty-Like Over-The-Air Spatial Combining in a 28GHz CMOS Phased-Array Transmitter</p> <p>A. Sayag; Technion; I. Melamed; Technion; E. Cohen; Technion</p>	<p>Th1C-3: Millimeter-Wave Interferometric Radar for Speed-Over-Ground Estimation</p> <p>E. Klinefelter; Michigan State Univ.; J.A. Nanzer; Michigan State Univ.</p>	<p>Th1D-3: A Low-Loss Balun-Embedded Interconnect for THz Heterogeneous System Integration</p> <p>T.-Y. Chiu; National Tsing Hua Univ.; Y.-L. Lee; Atom Element Matter; C.-L. Ko; NARLabs-TSRI; S.-H. Tseng; NARLabs-TSRI; C.-H. Li; National Tsing Hua Univ.</p>
08:50			
09:00	<p>Th1B-4: A Multi-Standard 15–57GHz 4-Channel Receive Beamformer with 4.8dB Midband NF for 5G Applications</p> <p>A.A. Alhamed; Univ. of California, San Diego; O. Kazan; Univ. of California, San Diego; G.M. Rebeiz; Univ. of California, San Diego</p>	<p>Th1C-4: Root-MUSIC Based Power Estimation Method with Super-Resolution FMCW Radar</p> <p>T. Iizuka; NTT; Y. Toriumi; NTT; F. Ishiyama; NTT; J. Kato; NTT</p>	<p>Th1D-4: W Band Carbon Nanotubes Interconnects Compatible with CMOS Technology</p> <p>P. Roux-Lévy; XLIM (UMR 7252); J.M. De Saxce; XLIM (UMR 7252); C.F. Siah; CINTRA (UMI 3288); J. Wang; CINTRA (UMI 3288); B.K. Tay; CINTRA (UMI 3288); P. Coquet; CINTRA (UMI 3288); D. Baillargeat; XLIM (UMR 7252)</p>
09:10			
09:20		<p>Th1C-5: Learning Representations for Neural Networks Applied to Spectrum-Based Direction-of-Arrival Estimation for Automotive Radar</p> <p>M. Gall; InnoSenT; M. Gardill; InnoSenT; J. Fuchs; FAU Erlangen-Nürnberg; T. Horn; InnoSenT</p>	<p>Th1D-5: Suspended SiC Filter with DRIE Silicon Subcovers</p> <p>E.T. Kunkee; Northrop Grumman; D.-W. Duan; Northrop Grumman; A. Sulian; Northrop Grumman; P. Ngo; Northrop Grumman; N. Lin; Northrop Grumman; C. Zhang; Northrop Grumman; D. Ferizovic; Northrop Grumman; C.M. Jackson; Northrop Grumman; R. Lai; Northrop Grumman</p>
09:30			
09:40			

406AB	408A	408B	
<p>Th1E: Advances in RF Energy Harvesting</p> <p>Chair: Alessandra Costanzo, University of Bologna</p> <p>Co-Chair: Smail Tedjini, University of Grenoble-Alpes France</p>	<p>Th1F: Phased Arrays and Beamformer Technologies</p> <p>Chair: Frank E. van Vliet, TNO, Netherlands</p> <p>Co-Chair: Christian Waldschmidt, Ulm University</p>	<p>Th1G: Advanced Silicon PAs for 5G and Automotive Applications</p> <p>Chair: Kaushik Sengupta, Princeton University</p> <p>Co-Chair: Joe Qiu, Army Research Office</p>	08:00
<p>Th1E-1: A W-Band Rectenna Using On-Chip CMOS Switching Rectifier and On-PCB Tapered Slot Antenna Achieving 25% Effective-Power-Conversion Efficiency for Wireless Power Transfer</p> <p>P. He; Southeast Univ.; J. Xu; Southeast Univ.; D. Zhao; Southeast Univ.</p>	<p>Th1F-1: Design Considerations and FPGA Implementation of a Wideband All-Digital Transmit Beamformer with 50% Fractional Bandwidth</p> <p>S. Pulipati; MERL; R. Ma; MERL</p>	<p>Th1G-1: A 28GHz Linear and Efficient Power Amplifier Supporting Wideband OFDM for 5G in 28nm CMOS</p> <p>Y.-W. Chang; National Taiwan Univ.; T.-C. Tsai; National Taiwan Univ.; J.-Y. Zhong; National Taiwan Univ.; J.-H. Tsai; National Taiwan Normal Univ.; T.-W. Huang; National Taiwan Univ.</p>	08:10
<p>Th1E-2: An Ultra-Low-Power Power Management Circuit with Output Bootstrapping and Reverse Leakage Reduction Function for RF Energy Harvesting</p> <p>Z. Zeng; Texas A&M Univ.; S. Shen; HKUST; B. Wang; Hamad Bin Khalifa University; J.J. Estrada-López; Texas A&M Univ.; R. Murch; HKUST; E. Sánchez-Sinencio; Texas A&M Univ.</p>	<p>Th1F-2: FPGA-Based 2-D FIR Frost Beamformers with Digital Mutual Coupling Compensation</p> <p>S. Pulipati; Florida International Univ.; V. Ariyaratna; Florida International Univ.; A.L. Jayaweera; Univ. of Moratuwa; C.U.S. Edussooriya; Univ. of Moratuwa; C. Wijenayake; University of Queensland; L. Belostotski; Univ. of Calgary; A. Madanayake; Florida International Univ.</p>	<p>Th1G-2: A Balanced Power Amplifier with Asymmetric Coupled-Line Couplers and Wilkinson Baluns in a 90nm SiGe BiCMOS Technology</p> <p>Y. Gong; Georgia Tech; J.D. Cressler; Georgia Tech</p>	08:20
<p>Th1E-3: Compact and High Efficiency Rectifier Design Based on Microstrip Coupled Transmission Line for Energy Harvesting</p> <p>F. Zhao; UESTC; D. Inerra; UESTC; G. Wen; UESTC</p>	<p>Th1F-3: In-situ Self-Test and Self-Calibration of Dual-Polarized 5G TRX Phased Arrays Leveraging Orthogonal-Polarization Antenna Couplings</p> <p>A. Nafe; Univ. of California, San Diego; A.H. Aljuhani; Univ. of California, San Diego; K. Kibaroglu; Univ. of California, San Diego; M. Sayginer; Univ. of California, San Diego; G.M. Rebeiz; Univ. of California, San Diego</p>	<p>Th1G-3: Load Modulated Balanced mm-Wave CMOS PA with Integrated Linearity Enhancement for 5G Applications</p> <p>C.R. Chappidi; Princeton Univ.; T. Sharma; Princeton Univ.; Z. Liu; Princeton Univ.; K. Sengupta; Princeton Univ.</p>	08:30
<p>Th1E-4: High-Efficiency Sub-1GHz Flexible Compact Rectenna Based on Parametric Antenna-Rectifier Co-Design</p> <p>M. Wagih; Univ. of Southampton; A.S. Weddell; Univ. of Southampton; S. Beeby; Univ. of Southampton</p>	<p>Th1F-4: Scalable, Deployable, Flexible Phased Array Sheets</p> <p>M. Gal-Katziri; Caltech; A. Fikes; Caltech; F. Bohn; Caltech; B. Abiri; Caltech; M.R. Hashemi; Caltech; A. Hajimiri; Caltech</p>	<p>Th1G-4: A 22–37GHz Broadband Compact Linear mm-Wave Power Amplifier Supporting 64-/256-/512-QAM Modulations for 5G Communications</p> <p>F. Wang; A. Wang; H. Wang; Georgia Tech</p>	08:40
<p>Th1E-5: 920MHz Band High Sensitive Rectenna with the High Impedance Folded Dipole Antenna on the Artificial Magnetic Conductor Substrate</p> <p>N. Yasumaru; Kanazawa Institute of Technology; N. Sakai; Kanazawa Institute of Technology; K. Itoh; Kanazawa Institute of Technology; T. Tamura; Kanazawa Institute of Technology; S. Makino; Kanazawa Institute of Technology</p>	<p>Th1F-5: 28GHz Active Monopulse Networks with Amplitude and Phase Control and -30dB Null-Bandwidth of 5GHz</p> <p>H. Chung; Univ. of California, San Diego; Q. Ma; Univ. of California, San Diego; G.M. Rebeiz; Univ. of California, San Diego</p>	<p>Th1G-5: Two W-Band Wideband CMOS mmW PAs for Automotive Radar Transceivers</p> <p>Y. Xue; C. Shi; East China Normal Univ.; G. Chen; Shanghai Eastsoft Microelectronics; J. Chen; Univ. of Houston; R. Zhang; East China Normal Univ.</p>	08:50
		<p>Th1G-6: An 18.5W Fully-Digital Transmitter with 60.4% Peak System Efficiency</p> <p>R.J. Bootsman; Technische Universiteit Delft; D.P.N. Mul; Technische Universiteit Delft; Y. Shen; Technische Universiteit Delft; R.M. Heeres; Ampleon; F. van Rijs; Ampleon; M.S. Alavi; Technische Universiteit Delft; L.C.N. de Vreede; Technische Universiteit Delft</p>	09:00
			09:10
			09:20
			09:30
			09:40

MICROAPPS SCHEDULE

09:40 – 14:05 THURSDAY, 25 JUNE 2020

MicroApps offers a lot of information in 15 minutes! These presentations of application notes target the working engineer or technician and are color coded by general topic area below.

START TIME	TITLE	SPEAKERS
9:40	Unveiling the True Performance of Your Wi-Fi Chipset	Walt Strickler – Boonton - Wireless Telecom
9:55	USB Noise Source with Internal Current and Temperature Correction for ENR Uncertainty Improvement	Su Chen Ho – Keysight Technologies
10:10	UWB emissions - Improvements in Spectrum Analyzers to cover with new test requirements	Kay-Uwe Sander – Rohde & Schwarz
10:25	Speed up Beamformer test with Multi-channel mmWave Vector Signal Transceiver	Alejandro Buritica – National Instruments
10:40	Direct RF Data Conversion and Transceiver Architectures in RF Instrumentation	Tom Costello – Astronics Test Systems
10:55	New Techniques for 5G Transmitter Measurements	Lawrence Wilson – Rohde & Schwarz
11:10	FCC Part 30 Emissions Measurements for 5G FR2 Devices	Jari Vikstedt – ETS-Lindgren
11:25	Frequency Converting Measurements In The THz Range Made Easy	Andreas Henkel – Rohde & Schwarz
11:40	Advanced Imaging Techniques Address the Thermal Challenges Presented by Advanced Microwave Devices	Dustin Kendig – Microsanj
11:55	Real Time S-Parameter Uncertainty Calculations using the Traceability Chain to a National Metrology Institute and taking advantage of Correlated Uncertainties in the Overall Calculation	Mike Leffel – Rohde & Schwarz USA
12:10	Advanced methods to analyze ultra-wide automotive radar signals	Dr. Wolfgang Wendler – Rohde & Schwarz
12:25	Implementing a mmWave Device Interface for ATE Applications	Dale Johnson, David Hu – Marvin Test Solutions
12:40	Breaking Bandwidth on RF Converter Frontends	Rob Reeder – Texas Instruments
12:55	New highly integrated transceiver with RF front end (RFFE)	Larry Hawkins – RichardsonRFPD
13:10	Predicting Performance of Xinger Passive Components on Customized PCB Layouts	David Senior, Chong Mei, Samir Tozin – TTM Technologies
13:25	The Perfection of Translation Loop: Eliminating the Spurious Signals when Generating Ultralow Jitter High Frequency Signal	Kazim Peker – Analog Devices
13:40	RF & High-Speed Mixed Signal Contacting Solutions for Probing on Board-to-Board Connectors	Matthias Zapatka, Alexander Thaler, Otmar Fischer – INGUN USA, Inc.
13:55	Application advantages of modular VNA architectures	Stanley Oda – Anritsu Company

5G Cell Phone ≤ 6GHz, FR1

5G Millimeterwave, FR2

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INDUSTRY WORKSHOPS 08:00 – 11:50 THURSDAY, 25 JUNE 2020

Industry workshops cover contemporary topics spanning the state of the art in RF, microwave, and mm-wave areas. These two-hour workshops include in-depth technical presentations from and discussions with experts in the industry. Don't miss this opportunity to expand your knowledge and interact with colleagues in these very relevant fields!

SESSION TIME	SESSION TITLE	EVENT COMPANY	SPEAKERS
8:00 – 9:40	5G Performance Verification Test Challenges of Modern Wireless Devices	ETS-Lindgren	Jari Vikstedt, ETS-Lindgren; Harry Skinner, Intel
	mmWave Over-the-air (OTA) Test - Best Practices for Fast and Reliable Results	National Instruments	Alejandro Buritica, National Instruments ; Assaf Toledano, Anokiwave
	Best Practices for Thermal on Wafer S-parameter Measurements	Formfactor	Gavin Fisher, IMECHE; Craig Kirkpatrick, IEEE
10:10 – 11:50	Practical GaN Power Amplifier Design - Modeled vs Measured Performance, Tricks and Tips for Avionics and Satcom Applications	Wolfspeed, A Cree Company	Kasyap Patel, Cree-Wolfspeed
	Measuring S-Parameters and Power with Uncertainty	Maury Microwave Corp.	
	Best Practices for Efficient EM Simulation	Cadence Design Systems, Inc.	John Dunn, Cadence Design Systems, Inc.



	403A	403B	404AB
	<p>Th2B: Late-breaking News from the Terahertz Frontier</p> <p>Chair: Nils Pohl, Ruhr University Bochum Co-Chair: James Buckwalter, University of California, Santa Barbara</p>	<p>Th2C: Networked and Distributed Radar and Imaging Systems</p> <p>Chair: Christian Waldschmidt, Ulm University Co-Chair: Martin Vossiek, Ulm University</p>	<p>Th2D: 3D Packaging and Additive Manufacturing</p> <p>Chair: Kamal Samanta, Sony Corp. Co-Chair: Dominique Baillargeat, Xlim - CNRS- Université De Liroges</p>
10:10	<p>Th2B-1: First Demonstration of G-Band Broadband GaN Power Amplifier MMICs Operating Beyond 200GHz</p> <p>M. Cwiklinski; Fraunhofer IAF; P. Brückner; Fraunhofer IAF; S. Leone; Fraunhofer IAF; S. Krause; Fraunhofer IAF; C. Friesicke; Fraunhofer IAF; H. Maßler; Fraunhofer IAF; R. Quay; Fraunhofer IAF; O. Ambacher; Fraunhofer IAF</p>	<p>Th2C-1: A Self-Mixing Receiver for Wireless Frequency Synchronization in Coherent Distributed Arrays</p> <p>S. Mghabghab; Michigan State Univ.; J.A. Nanzer; Michigan State Univ.</p>	<p>Th2D-1: RF Systems on Antenna (SoA): A Novel Integration Approach Enabled by Additive Manufacturing</p> <p>X. He; Georgia Tech; Y. Fang; Georgia Tech; R.A. Bahr; Georgia Tech; M.M. Tentzeris; Georgia Tech</p>
10:20			
10:30	<p>Th2B-2: 475-GHz 20-dB-Gain InP-HEMT Power Amplifier Using Neutralized Common-Source Architecture</p> <p>H. Hamada; NTT; T. Tsutsumi; NTT; H. Matsuzaki; NTT; H. Sugiyama; NTT; H. Nosaka; NTT</p>	<p>Th2C-2: A Digital Interferometric Array with Active Noise Illumination for Millimeter-Wave Imaging at 13.7fps</p> <p>S. Vakalis; Michigan State Univ.; J.A. Nanzer; Michigan State Univ.</p>	<p>Th2D-2: Wireless 3D Vertical Interconnect with Power Splitting Capability</p> <p>A. Dave; Univ. of Minnesota; R. Franklin; Univ. of Minnesota</p>
10:40			
10:50	<p>Th2B-3: A High-Isolation and Highly Linear Super-Wideband SPDT Switch in InP DHBT Technology</p> <p>T. Shivan; FBH; M. Hossain; FBH; R. Doerner; FBH; T.K. Johansen; Technical Univ. of Denmark; K. Nosaeva; FBH; H. Yacoub; FBH; W. Heinrich; FBH; V. Krozer; FBH</p>	<p>Th2C-3: Wireless Coherent Full-Duplex Double-Sided Two-Way Ranging (CFDDS-TWR) Approach with Phase Tracking Based Multipath Suppression for Submillimeter Accuracy Displacement Sensing</p> <p>M. Gottinger; FAU Erlangen-Nürnberg; M. Hoffmann; FAU Erlangen-Nürnberg; M. Vossiek; FAU Erlangen-Nürnberg</p>	<p>Th2D-3: 3D Printed One-Shot Deployable Flexible "Kirigami" Dielectric Reflectarray Antenna for mm-Wave Applications</p> <p>Y. Cui; Georgia Tech; S.A. Nauroze; Georgia Tech; R.A. Bahr; Georgia Tech; M.M. Tentzeris; Georgia Tech</p>
11:00			
11:10	<p>Th2B-4: 240-GHz Reflectometer with Integrated Transducer for Dielectric Spectroscopy in a 130-nm SiGe BiCMOS Technology</p> <p>D. Wang; Fraunhofer IPMS; M.H. Eissa; IHP; K. Schmalz; IHP; T. Kämpfe; Fraunhofer IPMS; D. Kissinger; Universität Ulm</p>	<p>Th2C-4: Phase Recovery in Sensor Networks Based on Incoherent Repeater Elements</p> <p>D. Werbunat; Universität Ulm; B. Meinecke; Universität Ulm; M. Steiner; Universität Ulm; C. Waldschmidt; Universität Ulm</p>	<p>Th2D-4: Evaluation of Micro Laser Sintering Metal 3D-Printing Technology for the Development of Waveguide Passive Devices up to 325GHz</p> <p>V. Fiorese; STMicroelectronics; C. Belem Gonçalves; STMicroelectronics; C. del Rio Bocio; Universidad Pública de Navarra; D. Titz; Polytech'Lab (EA 7498); F. Gianesello; STMicroelectronics; C. Luxey; Polytech'Lab (EA 7498); G. Ducourmau; IEMN (UMR 8520); E. Dubois; IEMN (UMR 8520); C. Gaquière; IEMN (UMR 8520); D. Gloria; STMicroelectronics</p>
11:20			
11:30	<p>Th2B-5: A 311.6GHz Phase-Locked Loop in 0.13μm SiGe BiCMOS Process with -90dBc/Hz In-Band Phase Noise</p> <p>Y. Liang; NTU; C.C. Boon; NTU; Y. Dong; NTU; Q. Chen; NTU; Z. Liu; NTU; C. Li; NTU; T. Mausolf; IHP; D. Kissinger; Universität Ulm; Y. Wang; UESTC; H.J. Ng; KIT</p>	<p>Th2C-5: Fusion of Radar and Communication Information for Tracking in OFDM Automotive Radar at 24GHz</p> <p>J.B. Sanson; Instituto de Telecomunicações; D. Castanheira; Instituto de Telecomunicações; A. Gameiro; Instituto de Telecomunicações; P.P. Monteiro; Instituto de Telecomunicações</p>	
11:40			
11:50			

406AB	408A	408B	
<p>Th2E: Novel Applications of Wireless Power Transfer</p> <p>Chair: Nuno Borges Carvalho, Instituto De Telecomunicacoes</p> <p>Co-Chair: Marco Dionigi, University of Perugia</p>	<p>Th2F: In-Band Full-Duplex Cancellers and Transceivers</p> <p>Chair: Kenneth E. Kolodziej, Massachusetts Institute of Technology, Lincoln Laboratory</p> <p>Co-Chair: Kate Remley, National Institute of Standards and Technology</p>	<p>Th2G: Phased Array and Beamformer Integrated Circuits</p> <p>Chair: Jeremy Dunworth, Qualcomm Research</p> <p>Co-Chair: Donald LaFrance, Lockheed Martin Corp.</p>	10:10
<p>Th2E-1: High Isolation Simultaneous Wireless Power and Information Transfer System Using Coexisting DGS Resonators and Figure-8 Inductors</p> <p>A. Barakat; Kyushu Univ.; R.K. Pokharel; Kyushu Univ.; S. Alshhaw; Kyushu Univ.; K. Yoshitomi; Kyushu Univ.; S. Kawasaki; JAXA</p>	<p>Th2F-1: A BST Varactor Based Circulator Self Interference Canceller for Full Duplex Transmit Receive Systems</p> <p>C.F. Campbell; Qorvo; J.A. Lovseth; Collins Aerospace; S. Warren; Qorvo; A. Weeks; Univ. of Central Florida; P.B. Schmid; Qorvo</p>	<p>Th2G-1: A Fundamental-Frequency 122GHz Radar Transceiver with 5.3dBm Single-Ended Output Power in a 130nm SiGe Technology</p> <p>E. Aguilar; FAU Erlangen-Nürnberg; V. Issakov; OvG Universität Magdeburg; R. Weigel; FAU Erlangen-Nürnberg</p>	10:20
<p>Th2E-2: Conductive Coupler for Wireless Power Transfer Under Seawater</p> <p>M. Tamura; Toyohashi University of Technology; K. Murai; Toyohashi University of Technology; M. Matsumoto; Toyohashi University of Technology</p>	<p>Th2F-2: In-Band Full-Duplex Self-Interference Canceller Augmented with Bandstop-Configured Resonators</p> <p>R. Sepanek; BAE Systems ; M. Hickie; BAE Systems ; M. Stuenkel; BAE Systems</p>	<p>Th2G-2: An Integrated Bistatic 4TX/4RX Six-Port MIMO-Transceiver at 60GHz in a 130-nm SiGe BiCMOS Technology for Radar Applications</p> <p>M. Voelkel; FAU Erlangen-Nürnberg; S. Pechmann; FAU Erlangen-Nürnberg; H.J. Ng; IHP; D. Kissinger; Universität Ulm; R. Weigel; FAU Erlangen-Nürnberg; A. Hagelauer; Universität Bayreuth</p>	10:30
<p>Th2E-3: The K-Band Communication Transmitter/Receiver Powered by the C-Band HySiC Energy Harvester with Multi-Sensors</p> <p>S. Yoshida; Kagoshima Univ.; K. Matsuura; Univ. of Tokyo; D. Kobuchi; Univ. of Tokyo; N. Yabuta; Sophia University; T. Nakaoka; Sophia University; K. Nishikawa; Kagoshima Univ.; S. Kawasaki; JAXA</p>	<p>Th2F-3: An Integrated Full-Duplex/FDD Duplexer and Receiver Achieving 100MHz Bandwidth 58dB/48dB Self-Interference Suppression Using Hybrid-Analog-Digital Autonomous Adaptation Loops</p> <p>Y. Cao; Univ. of Illinois at Urbana-Champaign; X. Cao; Univ. of Illinois at Urbana-Champaign; H. Seo; Univ. of Illinois at Urbana-Champaign; J. Zhou; Univ. of Illinois at Urbana-Champaign</p>	<p>Th2G-3: A Power Efficient BiCMOS Ka-Band Transmitter Front-End for SATCOM Phased-Arrays</p> <p>S. Rasti-Boroujeni; Univ. of Waterloo; A. Wyrzykowska; Univ. of Waterloo; M. Mazaheri; Univ. of Waterloo; A. Palizban; Univ. of Waterloo; S. Ituah; Univ. of Waterloo; A. El-Gouhary; Univ. of Waterloo; G. Chen; Univ. of Waterloo; H. Gharaei-Garakani; Univ. of Waterloo; M. Nezhad-Ahmadi; Univ. of Waterloo; S. Safavi-Naeini; Univ. of Waterloo</p>	10:40
<p>Th2E-4: A Wireless Power Transfer System (WPTS) Using Misalignment Resilient, On-Fabric Resonators for Wearable Applications</p> <p>D. Vital; Florida International Univ.; J.L. Volakis; Florida International Univ.; S. Bhardwaj; Florida International Univ.</p>	<p>Th2F-4: A Full-Duplex Transceiver with CMOS RF Circulation and Code-Domain Signal Processing for 104dB Self-Interference Rejection and Watt Level TX Power Handling</p> <p>A. Hamza; Univ. of California, Santa Barbara; A. Nagulu; Columbia Univ.; H. AlShammary; Univ. of California, Santa Barbara; C. Hill; Univ. of California, Santa Barbara; E. Lam; Univ. of California, Santa Barbara; H. Krishnaswamy; Columbia Univ.; J.F. Buckwalter; Univ. of California, Santa Barbara</p>	<p>Th2G-4: A K-Band Low-Complexity Modular Scalable Wide-Scan Phased Array</p> <p>F. Akbar; Univ. of Michigan; A. Mortazawi; Univ. of Michigan</p>	10:50
<p>Th2E-5: A 3D Rectenna with All-Polarization and Omnidirectional Capacity for IoT Applications</p> <p>S. Wang; National Central Univ. ; H.-Y. Chang; National Central Univ.</p>	<p>Th2F-5: Transmit-Receive Cross-Modulation Distortion Correction in a 5–6GHz Full Duplex Quadrature Balanced CMOS RF Front-End</p> <p>N. Ginzberg; Technion; T. Gidoni; Tel Aviv University; D. Regev; Toga Networks; E. Cohen; Technion</p>	<p>Th2G-5: A Compact Ultra-Broadband GaN MMIC/T/R Front-End Module</p> <p>Q. Lin; Qinghai Nationalities University; H. Wu; Chengdu Ganide Technology; Y. Chen; Chengdu Ganide Technology; L. Hu; Chengdu Ganide Technology; S. Chen; Qinghai Nationalities University; X. Zhang; Qinghai Nationalities University</p>	11:00
<p>Th2E-6: RF Energy On-Demand for Automotive Applications</p> <p>G. Paolini; Univ. of Bologna; M. Shanawani; Univ. of Bologna; A. Costanzo; Univ. of Bologna; F. Benassi; Univ. of Bologna; D. Masotti; Univ. of Bologna</p>			11:10
			11:20
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			11:50



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- 6436 mi Ischia
- 7200 mi Yerevan

Connecting the Unconnected Enabled by Wireless Broadband Technologies

PANEL ORGANIZERS AND MODERATORS:

Timothy Lee, *Boeing*; **Kartik Kulkarni**, *Oracle*

PANELISTS:

Vint Cerf, *Google*; **Alan Mickelson**, *University of Colorado, Boulder*; **Vincent Kaabunga**, *IEEE Africa Committee, Chair*; **Constantinos Karachalios**, *IEEE Standards Association*; **Jin Bains**, *Facebook Connectivity Lab*; **Mei-Lin Fung**, *People-Centered Internet*

ABSTRACT:

The major theme of IMS2020 is “Connectivity Matters.” Connectivity is vital to addressing many of the UN Sustainable Development Goals (SDGs) that provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth & all while tackling climate change and working to preserve our oceans and forests. The question is: what the microwave engineering community should be doing to advance the use of our technology to solving some of the world’s toughest problems. In two words: CONNECTIVITY MATTERS. This Panel bring together global experts from the technical and policy communities to address the challenge and progress for digital inclusion to the 4 billion people who are unconnected. We are now seeing the emergence of new technology like 5G or low-earth orbit (LEO) satellites. How can the changing landscape, enabled by mobile carriers, equipment makers and individual engineers, be reached?

13:40

408A

Th3B: Robert J Trew: More than 50 Years of Service to the Microwave Community

Chair: Samir El-Ghazaly, University of Arkansas

Co-Chair: George Haddad, National Science Foundation

Th3B-1: Remembering Dr. Robert James Trew

H.M. Trew; U.S. Department of the Treasury

13:50

Th3B-2: Following the Evolution of High-Frequency Electronics: From Diodes to Transistors – A Memorial to the Life of Dr. Robert J. Trew (1944–2019)

M.S. Gupta; Univ. of California, San Diego

14:10

Th3B-3: Robert J. Trew and the Microwave Community

M. Golio; Golio Endeavors

14:30

Th3B-4: Bob Trew: Teacher, Researcher, Mentor, and Friend

A. Riddle; Quanergy Systems

14:50

15:00

15:10

15:20

403B

Th3C: Emerging Technologies for Radar Detection, Tracking, and Imaging

Chair: Rudy Emrick, Northrop Grumman Corporation

Co-Chair: Danny Elad, ON Semiconductor

Th3C-1: K-Band MIMO FMCW Radar Using CDMA for TX-Separation Based on an Ultra-Wideband SiGe BiCMOS Radar Chipset

B. Welp; Fraunhofer FHR; A. Shoykhetbrod; Fraunhofer FHR; S. Wickmann; Fraunhofer FHR; G. Briese; Fraunhofer FHR; G. Weiß; MBDA Deutschland; J. Wenderoth; MBDA Deutschland; R. Herschel; Fraunhofer FHR; N. Pohl; Fraunhofer FHR

Th3C-2: Measurement-Based Performance Investigation of a Hybrid MIMO-Frequency Scanning Radar

A. Shoykhetbrod; Fraunhofer FHR; H. Cetinkaya; Fraunhofer FHR; S. Nowok; Fraunhofer FHR

Th3C-3: Ultra-Wideband FMCW Radar with Over 40GHz Bandwidth Below 60GHz for High Spatial Resolution in SiGe BiCMOS

B. Welp; Fraunhofer FHR; G. Briese; Fraunhofer FHR; N. Pohl; Fraunhofer FHR

Th3C-4: Harmonic Micro-Doppler Detection Using Passive RF Tags and Pulsed Microwave Harmonic Radar

N. Nourshamsi; Michigan State Univ.; C. Hilton; Michigan State Univ.; S. Vakalis; Michigan State Univ.; J.A. Nanzer; Michigan State Univ.

Th3C-5: Localization and Tracking Bees Using a Battery-Less Transmitter and an Autonomous Unmanned Aerial Vehicle

J. Shearwood; Bangor Univ.; S. Williams; Bangor Univ.; N. Aldabashi; Bangor Univ.; P. Cross; Bangor Univ.; B.M. Freitas; Universidade Federal do Ceará; C. Zhang; China Agricultural University; C. Palego; Bangor Univ.

404AB

Th3D: Late-breaking News in Millimeter-Wave Communication and Radar Systems

Chair: Ethan Wang, University of California, Los Angeles

Co-Chair: James Buckwalter, University of California, Santa Barbara

Th3D-1: A 25–29GHz 64-Element Dual-Polarized/Dual-Beam Small-Cell with 45dBm 400MHz 5G NR Operation and High Spectral Purity

H. Chung; Univ. of California, San Diego; Q. Ma; Univ. of California, San Diego; Y. Yin; Univ. of California, San Diego; L. Gao; Univ. of California, San Diego; G.M. Rebeiz; Univ. of California, San Diego

Th3D-2: Linearization of mm-Wave Large-Scale Phased Arrays Using Near-Field Coupling Feedback for >10Gb/s Wireless Communication

R. Murugesu; Nokia Bell Labs; M.J. Holyoak; Nokia Bell Labs; H. Chow; Nokia Bell Labs; S. Shahramian; Nokia Bell Labs

Th3D-3: Modular Scalable 80- and 160-GHz Radar Sensor Platform for Multiple Radar Techniques and Applications

W.A. Ahmad; IHP; M. Kucharski; IHP; A. Ergintav; IHP; D. Kissinger; Universität Ulm; H.J. Ng; KIT

Th3D-4: A Radar System Concept for 2D Unambiguous Angle Estimation Using Widely Spaced MMICs with Antennas On-Chip at 150GHz

P. Grüner; Universität Ulm; M. Klose; Universität Ulm; C. Waldschmidt; Universität Ulm

Th3D-5: Wide-Band Frequency Synthesizer with Ultra-Low Phase Noise Using an Optical Clock Source

M. Bahmanian; Universität Paderborn; S. Fard; Universität Paderborn; B. Koppelman; Universität Paderborn; J.C. Scheytt; Universität Paderborn

403A

Th3E: Late-breaking News in III-V MMICs

Chair: Hasan Sharifi, HRL Laboratories

Co-Chair: James Buckwalter, University of California, Santa Barbara

Th3E-1: A 20W 2–20GHz GaN MMIC Power Amplifier Using a Decade Bandwidth Transformer-Based Power Combiner

M. Roberg; Qorvo; M. Pilla; Qorvo; T.R. Mya Kywe; Qorvo; R. Flynt; Qorvo; N. Chu; Qorvo

Th3E-2: A 120-mW, Q-Band InP HBT Power Amplifier with 46% Peak PAE

A. Arias-Purdue; P. Rowell; M. Urteaga; K. Shinohara; A. Carter; J. Bergman; Teledyne Scientific & Imaging; K. Ning; Univ. of California, Santa Barbara; M.J.W. Rodwell; Univ. of California, Santa Barbara; J.F. Buckwalter; Univ. of California, Santa Barbara

Th3E-3: Transformer-Based Broadband mm-Wave InP PA Across 42–62GHz with Enhanced Linearity and Second Harmonic Engineering

Z. Liu; Princeton Univ.; T. Sharma; Princeton Univ.; C.R. Chappidi; Princeton Univ.; S. Venkatesh; Princeton Univ.; K. Sengupta; Princeton Univ.

Th3E-4: A 300- μ W Cryogenic HEMT LNA for Quantum Computing

E. Cha; Chalmers Univ. of Technology; N. Wadefalk; Low Noise Factory; G. Moschetti; Qamcom Research & Technology; A. Pourkabirian; Low Noise Factory; J. Stenarson; Low Noise Factory; J. Grahm; Chalmers Univ. of Technology



408B

Th3G: Phased Array Silicon Components

Chair: Sorin Voinnigescu, University of Toronto

Co-Chair: Cynthia Hang, Raytheon Company

Th3G-1: A DC-32GHz 7-Bit Passive Attenuator with Capacitive Compensation Bandwidth Extension Technique in 55nm CMOS

Z. Zhang; Zhejiang Univ.; N. Li; Zhejiang Univ.; H. Gao; Zhejiang Univ.; M. Li; Zhejiang Univ.; S. Wang; Zhejiang Univ.; Y.-C. Kuan; National Chiao Tung Univ.; X. Yu; Zhejiang Univ.; Z. Xu; Zhejiang Univ.

Th3G-2: A Low Power 60GHz 6V CMOS Peak Detector

Z. Tibenszky; Technische Universität Dresden; C. Carta; Technische Universität Dresden; F. Ellinger; Technische Universität Dresden

Th3G-3: A 35GHz Hybrid π -Network High-Gain Phase Shifter with 360° Continuous Phase Shift Range

D. Wei; Fudan Univ.; X. Ding; Univ. of California, Davis; H. Yu; Univ. of California, Davis; Q.J. Gu; Univ. of California, Davis; Z. Xu; Zhejiang Univ.; Y.-C. Kuan; National Chiao Tung Univ.; S. Ma; Fudan Univ.; J. Ren; Fudan Univ.

Th3G-4: A 68-dB Isolation 1.0-dB Loss Compact CMOS SPDT RF Switch Utilizing Switched Resonance Network

X. Fu; Y. Wang; Z. Li; A. Shirane; K. Okada; Tokyo Institute of Technology

Th3G-5: A CMOS Balun with Common Ground and Artificial Dielectric Compensation Achieving 79.5% Fractional Bandwidth and $<2^\circ$ Phase Imbalance

G. Yang; Tianjin Univ.; R. Chen; Southeast Univ.; K. Wang; Tianjin Univ.

Th3G-6: A 20.8–41.6-GHz Transformer-Based Wideband Power Amplifier with 20.4-dB Peak Gain Using 0.9-V 28-nm CMOS Process

C.-W. Wang; National Taiwan Univ.; Y.-C. Chen; National Taiwan Univ.; W.-J. Lin; National Taiwan Univ.; J.-H. Tsai; National Taiwan Normal Univ.; T.-W. Huang; National Taiwan Univ.

13:30

13:40

13:50

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14:30

14:40

14:50



ADVANCED PRACTICE AND INDUSTRY PAPER COMPETITIONS

The Advanced Practice Paper Competition (APPC) recognizes outstanding technical contributions that apply to practical applications. All finalist papers are on advanced practices and describe an innovative RF/microwave design, integration technique, process enhancement, and/or combination thereof that results in significant improvements in performance and/or in time to production for RF/microwave components, subsystems, or systems.

The Industry Paper Competition (IPC) recognizes outstanding technical contributions from industry sources. All finalist papers are from the RF/microwave industry and describe innovation of a product or system application that potentially has the highest impact on an RF/microwave product and/or system which will significantly benefit the microwave community and society at large.

ADVANCED PAPER COMPETITION

A CMOS Balun with Common Ground and Artificial Dielectric Compensation Achieving 79.5% Fractional Bandwidth and $<2^\circ$ Phase Imbalance

G. Yang, Tianjin Univ., R. Chen, Southeast Univ., K. Wang, Tianjin Univ.

300W Dual Path GaN Doherty Power Amplifier with 65% Efficiency for Cellular Infrastructure Applications

M. Masood, S. Embar R., P. Rashev, J. Holt, NXP Semiconductors, J.S. Kenney, Georgia Tech

RF Systems on Antenna (SoA): A Novel Integration Approach Enabled by Additive Manufacturing

X. He, Y. Fang, R.A. Bahr, M.M. Tentzeris, Georgia Tech

Load Modulated Balanced mm-Wave CMOS PA with Integrated Linearity Enhancement for 5G Applications

C.R. Chappidi, T. Sharma, Z. Liu, K. Sengupta, Princeton Univ.

Analysis and Design of a Concurrent Dual-Band Self-Oscillating Mixer

M. Pontón, A. Herrera, A. Suárez, Universidad de Cantabria

Scalable, Deployable, Flexible Phased Array Sheets

M. Gal-Katziri, A. Fikes, F. Bohn, B. Abiri, M.R. Hashemi, A. Hajimiri, Caltech

Compact Bandpass Filter with Wide Stopband and Low Radiation Loss Using Substrate Integrated Defected Ground Structure

D. Tang, C. Han, Z. Deng, H.J. Qian, X. Luo, UESTC

AFSIW-to-Microstrip Directional Coupler for High-Performance Systems on Substrate

A. Ghiotto, J.-C. Henrion, T. Martin, J.-M. Pham, IMS (UMR 5218), V. Armengaud, CNES

Quasi-Absorptive Substrate-Integrated Bandpass Filters Using Capacitively-Loaded Coaxial Resonators

D. Psychogiou, University of Colorado Boulder, R. Gómez-García, Universidad de Alcalá

High Isolation Simultaneous Wireless Power and Information Transfer System Using Coexisting DGS Resonators and Figure-8 Inductors

A. Barakat, R.K. Pokharel, S. Alshhawy, K. Yoshitomi, Kyushu Univ., S. Kawasaki, JAXA

A Synthesis-Based Design Procedure for Waveguide Duplexers Using a Stepped E-Plane Bifurcated Junction

G. Macchiarella, G.G. Gentili, Politecnico di Milano, L. Accatino, ACConsulting, V. Tornielli di Crestvolant, ESA-ESTEC

A Quadband Implantable Antenna System for Simultaneous Wireless Powering and Biotelemetry of Deep-Body Implants

A. Basir, H. Yoo, Hanyang Univ.

A 28GHz, 2-Way Hybrid Phased-Array Front-End for 5G Mobile Applications

N. Cho, H.-S. Lee, H. Lee, W.-N. Kim, Samsung

A Second Harmonic Separation Symmetric Ports 180° Coupler with Arbitrary Coupling Ratio and Transparent Terminations

P. Li, H. Ren, Washington State Univ., Y. Gu, Univ. of Texas at Arlington, B. Pejcinovic, Portland State Univ., B. Arigong, Washington State Univ.

Ultra-Wideband FMCW Radar with Over 40GHz Bandwidth Below 60GHz for High Spatial Resolution in SiGe BiCMOS

B. Welp, G. Brieese, N. Pohl, Fraunhofer FHR

A 680GHz Direct Detection Dual-Channel Polarimetric Receiver

C.M. Cooke, K. Leong, K. Nguyen, A. Escorcía, X. Mei, Northrop Grumman, J. Arroyo, Cubic Nuvotronics, T.W. Barton, University of Colorado Boulder, C. Du Toit, G. De Amici, D.L. Wu, NASA Goddard Space Flight Center, W.R. Deal, Northrop Grumman

An X-Band Lithium Niobate Acoustic RFFE Filter with FBW of 3.45% and IL of 2.7dB

Y. Yang, L. Gao, S. Gong, Univ. of Illinois at Urbana-Champaign

Automated Spiral Inductor Design by a Calibrated PI Network with Manifold Mapping Technique

X. Fa, S. Li, P.D. Laforg, Univ. of Regina, Q.S. Cheng- SUSTech

Efficient Modeling of Wave Propagation Through Rough Slabs with FDTD

S. Bakirtzis, Univ. of Toronto, X. Zhang, Univ. College Dublin, C.D. Sarris, Univ. of Toronto

High-Frequency Vector-Modulated Signal Generation Using Frequency-Multiplier-Based RF Beamforming Architecture

I. Jaffri, A. Ben Ayed, Univ. of Waterloo, A.M. Darwish, U.S. Army Research Laboratory, S. Boumaiza, Univ. of Waterloo

High-Resolution Millimeter-Wave Tomography System for Characterization of Low-Permittivity Materials

A. Och, P.A. Hölzl- Infineon Technologies, S. Schuster, voestalpine, J.O. Schratte- necker, Intel, P.F. Freidl, Infineon Technologies, S. Scheibhofer, D. Zankl- voestal- pine, V. Pathuri-Bhuvan, Silicon Austria Labs, R. Weigel- FAU Erlangen-Nürnberg

A Dual-Mode Frequency Reconfigurable Waveguide Filter with a Constant Frequency Spacing Between Transmission Zeros

G. B., R.R. Mansour, Univ. of Waterloo

INDUSTRY PAPER COMPETITION

A 0.011-mm² 27.5-GHz VCO with Transformer-Coupled Bandpass Filter Achieving -191dBc/Hz FoM in 16-nm FinFET CMOS

C.-H. Lin- TSMC, Y.-T. Lu- TSMC, H.-Y. Liao- TSMC, S. Chen- TSMC, A.L.S. Loke- TSMC, T.-J. Yeh- TSMC

Series-Combined Coaxial Dielectric Resonator Class-F Power Amplifier System

R.A. Beltran, F. Wang, G. Villagrana, Ophir RF

In-Band Full-Duplex Self-Interference Canceller Augmented with Band-stop-Configured Resonators

R. Sepanek, M. Hickel, M. Stuenkel, BAE Systems

A 135–183GHz Frequency Sextupler in 250nm InP HBT

M. Bao, Ericsson, T.N.T. Do, D. Kuylenstierna, Chalmers Univ. of Technology, H. Zirath, Ericsson

AFSIW-to-Microstrip Directional Coupler for High-Performance Systems on Substrate

A. Ghiotto, J.-C. Henrion, T. Martin, J.-M. Pham, IMS (UMR 5218), V. Armengaud, CNES

Monolithic Integration of Phase-Change RF Switches in a Production SiGe BiCMOS Process with RF Circuit Demonstrations

G. Slovin, N. El-Hinnawy, C. Masse, J. Ros, D. Howard, Tower Semiconductor

A Volume Current Based Method of Moments Analysis of Shielded Planar 3-D Circuits in Layered Media

J.C. Rautio, M. Thelen, Sonnet Software

Design Considerations and FPGA Implementation of a Wideband All-Digital Transmit Beamformer with 50% Fractional Bandwidth

S. Pulipati, R. Ma, MERL

A 28GHz, 2-Way Hybrid Phased-Array Front-End for 5G Mobile Applications

N. Chog, H.-S. Lee, H. Lee, W.-N. Kim, Samsung

Digitally Assisted Load Modulated Balanced Amplifier for 200W Cellular Infrastructure Applications

S. Embar R., M. Masood, T. Sharma, J. Staudinger, NXP Semiconductors, S.K. Dhar, Univ. of Calgary, P. Rashev, G. Tucker, NXP Semiconductors, F.M. Ghannouchi, Univ. of Calgary

Suspended SiC Filter with DRIE Silicon Subcovers

E.T. Kunkee, D.-W. Duan, A. Sulian, P. Ngo, N. Lin, C. Zhang, D. Ferizovic, C.M. Jackson, R. Lai, Northrop Grumman

Acceleration and Extension of Radial Point Interpolation Method (RPIM) to Complex Electromagnetic Structures

K. Sabet, A.I. Stefan, EMAG Technologies

Highly Linear & Efficient Power Spatium Combiner Amplifier with GaN HPA MMIC at Millimeter Wavelength Frequency

S.D. Yoon, J. Kitt, D. Murdock, E. Jackson, M. Roberg, G. Hegazi, P. Courtney, Qorvo

High-Resolution Millimeter-Wave Tomography System for Characterization of Low-Permittivity Materials

A. Och, P.A. Hözl, Infineon Technologies, S. Schuster, voestalpine, J.O. Schrattenecker, Intel, P.F. Freidl, Infineon Technologies, S. Scheiblhofer, D. Zankl, voestalpine, V. Pathuri-Bhuvana, Silicon Austria Labs, R. Weigel, FAU Erlangen-Nürnberg

The Road Ahead for Quantum Computing

Hartmut Neven, Engineering Director,
Quantum Artificial Intelligence Lab, *Google*

ABSTRACT:

The demonstration of quantum supremacy established a proof of principle that quantum computers can outperform classical ones on certain computational tasks. Since achieving this milestone the Google AI Quantum team has been pursuing two development threads, one is to increase the computational volume afforded by a quantum computer and the other is to make good use of the computational volume available. To increase the computational volume, i.e. the number of gate operations that can be performed while still maintaining high output fidelity, we will need to implement quantum error correction. In this talk I will describe the sequence of milestones we hope to achieve en route to a fully error corrected quantum computer. Arguably the question that is the least answered for our community is whether there are commercially or scientifically interesting algorithms beyond the reach of classical machines that can be executed prior to implementing error correction. I will report on first examples.



FRIDAY, 26 JUNE 2020

IMS2020

Friday

95th ARFTG Microwave Measurement Conference Technical Program

	08:00 to 08:10	Welcome and Introduction	Joe Gering, <i>ARFTG President</i> , Jon Martens, <i>General Chair</i> , Peter Aaen, <i>TPC Chair</i>
Oral Session A: Electromagnetic Field Measurements			
A - 1	08:10 to 08:40	Electro-Optic Mapping Techniques for Characterization of Microwave Circuits, Devices and Antenna Systems (Keynote)	Kaz Sabet, <i>EMAG Technologies Inc, Ann Arbor, MI, USA</i>
A - 2	08:40-09:00	Over-the-Air Test of Dipole and Patch Antenna Arrays at 28 GHz by Probing Them in the Reactive Field	Utpal Dey ¹ , Jan Hesselbarth ¹ , Jose Moreir ² , Krzysztof Dabrowiecki ³ ¹ University of Stuttgart, ² Advantest Europe GmbH, ³ Feinmetall GmbH
A - 3	09:00 to 09:20	5G Waveform vs. CW: Near-Field Measurement of De-Coupled Electric and Magnetic Fields for Power Density Assessment	Maryna Nesterova ¹ , Stuart Nicol ¹ , Yuliya Nesterova ² ¹ APREL, Inc., ² Queen's University
A - 4	09:20 to 09:40	Over-the-Air Characterization Of mm-Wave On-Chip Antennas and Tx Modules, Concept and Calibration	Carmine De Martino ¹ , Akshay Visweswaran ² , Marco Spirito ¹ ¹ Delft University of Technology, ² IMEC
Break	09:40 to 10:40	Exhibits and Interactive Forum	
Oral Session B: Sources and Nonlinear Device Measurements			
B-1	10:40 to 11:00	A Cryogenic Quantum-Based RF Source	J. Brevik, A. Boaventura, M. Castellanos-Beltran, C. Donnelly N. Flowers-Jacobs, A. Fox, P. Hopkins, P. Dresselhaus, D. Williams, S. Benz, <i>National Institute of Standards and Technology</i>
B-2	11:00 to 11:20	Modulation Distortion Analysis for Mixers and Frequency Converters	J. Verspecht, T. Nielsen, A. Stav, J. Dunsmore, and J.-P. Teyssier <i>Keysight Technologies, Santa Rosa, CA</i>
B-3	11:20 to 11:40	Swept Notch NPR for Linearity Assessment of Systems Presenting Long-Term Memory Effects	R. Figueiredo ¹ , A. Piacibello ² , V. Camarchia ² , N. Borges Carvalho ³ ¹ University of Aveiro, ² Politecnico di Torino, ³ Instituto de Telecomunicacoes
B-4	11:40 to 12:00	Vector Gain Based Behavioral Models for Distortion Evaluation in mm-Wave Devices	J. van 't Hof ¹ , E. Malotaux ¹ , M. Squillante ² , M. Marchetti ² , L. Galatro ³ , M. Spirito ¹ ¹ Delft University of Technology, ² Anteverta-mw B.V., ³ Vertigo Tech
	12:00 to 13:20	Awards Luncheon	
Oral Session C: VNA Measurements and Calibration			
C-1	13:20 to 13:50	How Did We Get Here? A Short History of VNA Technology (Invited Talk)	Andrea Ferrero, <i>Keysight Technologies</i>
C-2	13:50 to 14:10	Calibration, Repeatability and Related Characteristics of On-wafer, Broadband 70 kHz-220 GHz Single-Sweep Measurements	Andrej Rumiantsev ¹ , Jon Martens ² , Steve Reyes ² ¹ MPI Corporation, ² Anritsu
C-3	14:10 to 14:30	Multi-port Reflectometry Applied to a Varactor-Tuned Sampled-Line	Steven Claessens and Taylor Barton; <i>University of Colorado - Boulder</i>
C-4	14:30 to 14:50	Towards Commercially Available Quartz Calibration Substrates	L. Galatro ¹ , C. De Martino ² , J. van 't Hof ² , M. Alomari ³ , J. Burghart ³ , M. Spirito ² ¹ Vertigo Tech, ² Delft University of Technology, ³ Institut für Mikroelektronik Stuttgart (IMS)
Break	14:50 to 15:40	Exhibits and Interactive Forum	



Oral Session D: Additional Measurement Topics

D-1	15:40 to 16:00	Cryogenic Calibration of a Quantum-based Radio Frequency Source	Zain Ahmed Khan ^{1,2} , Peter Händel ² , and Magnus Isaksson ¹ A. Boaventura, J. Brevik, D. Williams, A. Fox, M. Castellanos-Beltran, P. Hopkins, P. Dresselhaus, S. Benz, <i>National Institute of Standards and Technology</i>
D-2	16:00 to 16:20	Measurement of Dielectric Properties Using Reflected Group Delay of an Over-Coupled Resonator	Gaurav Walia, Paul Laforge, Muhammed Suleman; <i>University of Regina</i>
D-3	16:20 to 16:40	Setup and Control of a Millimeter-Wave Synthetic Aperture Measurement System with Uncertainties; A. Weiss ¹ , J. Quimby ¹ , R. Leonhardt ¹ , B. Jamroz ¹ , D. Williams ¹ , K. Remley ¹ , P. Vouras ¹ , A. Elsherbeni ² , ¹ <i>National Institute of Standards and Technology</i> , ² <i>Colorado School of Mines</i>	
D-4	16:40 to 17:00	Over-the-Air Testing of Cellular Large-Form-Factor Internet-of-Things Devices in Reverberation Chambers	K. Remley ¹ , C. Bax ² , E. Mendivil ³ , M. Foegelle ³ , J. Kvarnstrand ⁴ , D. Skousen ⁴ , D. Sánchez-Hernández ⁵ , M. García-Fernández ⁵ , L. Chang ⁶ , J. Gutierrez ⁷ , E. Yen ⁷ , J. Harbour ⁷ ¹ <i>National Institute of Standards and Technology</i> , ² <i>Bureau Veritas</i> , ³ <i>ETS-Lindgren</i> , ⁴ <i>Bluetest AB</i> , ⁵ <i>EMITE</i> , ⁶ <i>Sporton</i> , ⁷ <i>Dell</i>

Interactive Forum Session

		Backward Unknown-Thru Calibration Method	JeongHwan Kim, Jin-Seob Kang, Jeong-II Park, Chihyun Cho, <i>KRISS</i>
		Active Interferometry-Based Vector Network Analyzer Reference Impedance Renormalization	Haris Votsi ¹ , Cristian Matei ² , Stavros Iezekiel ¹ , Peter H. Aaen ³ ¹ <i>University of Cyprus</i> , ² <i>University of Surrey</i> , ³ <i>Colorado School of Mines</i>
		SOLT and SOLR calibration methods using a single multiport “thru” standard connection	Tibault Reveyard, Silvia Hernandez, Sebastien Mons, Edouard Ngoya, <i>XLIM, University of Limoges</i>
		Fast Software-Defined Radio-based System Performance Evaluation for Real-time Adaptive RF Systems	Austin Egbert ¹ , Benjamin Kirk ² , Charles Baylis ¹ , Anthony Martone ³ , Robert J. Marks II ¹ ¹ <i>Baylor University</i> , ² <i>Pennsylvania State University</i> , ³ <i>Army Research Laboratory</i>
		Model of Probe Transition Including Probe Mispositioning	Robin Schmidt ¹ , Dominique Schreurs ² , Michael Dieudonné ¹ , Pawel Barmuta ² ¹ <i>Keysight Technologies</i> , ² <i>Katholieke Universiteit Leuven</i>
		Vector Network Analyzer Calibration for Characterization of Packaged Power MOSFET Device at RF Frequency	Masahiro Horibe and Iku Hirano, <i>AIST</i>
		High-Performance Probe for Over-the-Air Measurement	Mohammadreza Ranjbar Naeini, Yuchen Gu, Daniel van der Weide, <i>University of Wisconsin-Madison</i>
		Complex Permittivity Measurement Technique for a 3D Printed Rectangular Dielectric Rod using an NRD Guides at 60-GHz Band	Takashi Shimizu and Yoshinori Kogami, <i>Utsunomiya University</i>

Workshop Title	Workshop Abstract
<p>WFA</p> <p>Cutting-Edge THz Solid-State Technologies, from Devices to Earth/Space Applications: Surfing on Noise, Signal and Power Generation Sponsor: IMS Organizer: F. Danneville, IEMN (UMR 8520); G. Ducournau, IEMN (UMR 8520) 08:00 – 17:15</p>	<p>With the amazing growth of THz technologies, a solid-state approach has been pushed forward to contribute to filling of the THz gap. The workshop aims to provide a deep overview of the recent features of mm-wave/THz active devices and circuits regarding: (i) signal generation (oscillator architecture, harmonic generation, on chip harmonic combination, phase management), (ii) amplification (medium-power/high-power amplifiers, low noise amplifiers architectures, performance) (iii) noise performance of single devices/circuit. Targeting the complete characterization of such advanced technologies, the workshop aims also to focus on advances of characterization methods for solid-state silicon/III-V active devices and noise sources at room temperature up to the sub-THz/THz range. They will include power measurements, linearity as well as common/new noise measurement techniques to accurately extract device and circuit performance up to mm-wave and THz range. This full day workshop aims as well to highlight state-of-the-art performance for a broad range of cutting-edge mm-wave/THz (0.1–1THz) technologies such Si (CMOS/BiCMOS) and III-V (GaAs, InP, GaN). In detail, the noise properties and amplification process of III-V (InP and metamorphic HEMT) and Silicon (CMOS and SiGe HBT) transistors at THz Frequencies will be discussed. Theoretical considerations about how to optimize a technology for low-noise performance and LNA examples in the mm-wave and sub-mm-wave frequency range will be given, as well as PA and TRX applications in the higher mm-wave frequency range. Signal generation (power, efficiency, phase noise) will be covered using several technologies: III-V, Si CMOS THz oscillators, as an enabler for the development of systems in the 0.1 to 1THz frequency range with system waveguide blocks or single-chip THz products for communication, imaging, radiometer, sensing and radar. Last, with the pulling of high frequency applications, packaging and integration approaches as well as system-level example of enabled applications will be discussed. High-data rate communications for future wireless backhubs is now envisaged in the D-band (110–170GHz) as well as in the H-band (around 300GHz). With the mm-wave and sub-mm-wave technologies, these systems can now target 100Gbps, with link budgets that are now close to be completed with several technologies up to the km-range. Other scenarios of THz applications on space (Inter-satellite links, CubeSat) with high performance/compactness as well as at chip-scale with low cost will drive future developments and roadmaps.</p>
<p>WFB</p> <p>Space Based Solar Power (SBSP) Sponsor: IMS Organizer: C. Jackson, Northrop Grumman; J. McSpadden, Raytheon 08:00 – 17:15</p>	<p>Space based solar power is receiving a resurgence of interest from a number of government and international corporations. Because the solar power satellite (SPS) concept provides 24/7 carbon free, constant load power needed for future power grids, research groups around the world are examining the different system and technology components required for this source of clean energy. Many advancements in microwave technology and system architectures have occurred since the early 2000s, and this workshop brings together key international speakers to discuss their achievements. Microwave technology related topics include electronically steerable transmitters, retrodirective beam control systems, and rectennas. The goal of this workshop is to provide an up to date assessment of the SPS system and provide microwave engineers with information on how microwave technology is used within the SPS power beaming subsystems.</p>
<p>WFC</p> <p>Beamforming in Massive MIMO for mm-Wave New Radio Sponsor: IMS Organizer: A. Omar, OvG Universität Magdeburg; D. Choudhury, Intel; Z. Chen, Dalhousie University 08:00 – 17:15</p>	<p>There are two perspectives in dealing with beamforming in massive MIMO. The IEEE-ComSoc community has been used to perform the entire MIMO Signal Processing, including the beamforming one, in the Digital Domain, without much consideration of hardware-implementation challenges. This would require appreciable computational capacity at both base stations and mobile units if it were transferred to Massive MIMO in the mm-wave New Radio, where hundreds and maybe thousands of antennas are involved. Following such a “Fully Digital Solution” perspective necessitates that each of the array elements must have its own RF front-end. The IEEE-MITS community, on the other hand, must be in some doubt about the costs of providing such a huge amount of RF front-ends, with PA/LNA, Up/Down Converting Mixers, DA/AD Converters, Filters, etc. backing each individual array element of a Massive-MIMO antenna array. A major cost factor in this scenario is the heat generation by the PAs and the proximity of the LNAs, whose noise performance strongly depends on the ambient temperature. Despite the fact that oversized fully digital phased arrays have been developed for military purposes, the built-in heatsinking mechanisms are very costly and might not be suitable for commercial purposes. Splitting down the large array into separate medium-size arrays is one of the scenarios recently implemented. However, the directivity of such separate arrays is much lower than that of the large one. Therefore, they are not capable of generating beams as narrow as those generated by the composite array. Multiple beam operations considerably benefit from narrow beams (higher bundling of the power, lower interference between neighboring beams, etc.). The alternative, which is called “Hybrid Solution”, is to use Subarrays, with a single RF front-end per Subarray. Steerable Multiple Beams would need in this case Butler Matrices and/or Rotman Lenses with multiple Couplers and Phase Shifters for each Subarray. The geometry and topology of the Subarrays are also crucial parameters for avoiding the generation of Gratings Lobes with the associated ambiguity. A comparison between these two alternatives in terms of Hardware/Software complexity, power consumption in both the RF front-end and the Digital Signal Processing, Linearity and Efficiency of PAs, Signal Distortion, etc. is one of the main aspects of this workshop. Another aspect to be covered by the workshop is to identify meaningful beamforming architectures from both implementation-feasibility and information-theory perspectives. In particular, optimal architectures can sacrifice a small amount of traffic capacity in favor of significant reduction of implementation complexity. The related analog-digital balance must be in line with the network deployment strategies of MNOs. This workshop is the first IMS forum, which will cover this rapidly evolving topic. The presenters are well known experts in the technical areas emphasized by the workshop. The post-presentation discussions and mutual interaction between speakers and audience will lead to a comprehensive review of the current state-of-the-art, the existing challenges, and the future outlook of this very promising area.</p>
<p>WFF</p> <p>GaN Modeling in the Field: Recent Advances and Remaining Challenges Sponsor: IMS Organizer: M. Roberg, Qorvo; T. Canning, Infineon Technologies 08:00 – 17:15</p>	<p>GaN HEMT based technologies are gaining significant market share in the defense and infrastructure market spaces, due to attractive properties such as high output power density, intrinsic efficiency and breakdown voltage. Practitioners struggling with minimizing physical size and weight are being drawn to GaN technology to solve system problems. Market specifications are evolving to the point that in many products, GaN is no longer optional – it is mandatory. However, modern GaN devices still come with associated challenges, such as significant levels of charge trapping and reliability concerns due to easily achievable high channel temperatures. The traditional interface between technology and design is the transistor model. Some design communities are very comfortable working with empirical data such as harmonic load pull to implement GaN designs, but the increased push towards lower cost/higher integration concepts make working with empirical data time consuming and costly. Both the 5G push to mm-wave and the sub-6GHz market adoption of phased arrays, are pushing the infrastructure market towards low cost integrated solutions. The downside is long design and assembly cycle times, which drives R&D cost. To decrease cycle times, the demand for stable, fast and accurate GaN transistor models, is ever increasing. This workshop will present an overview of the current state-of-the-art in GaN modeling. The progress of the two Si2 Compact Modeling Coalition standardized GaN HEMT models (ASM and MVSG) will be presented, along with advances in the state-of-the-art in model formulation. There will also be feedback from the design community on the challenges of using and designing with the current crop of GaN models</p>

Workshop Abstract	Workshop Title
<p>Microwave magnetic materials and devices provide a rich range of functions and capabilities that cannot be achieved with traditional microwave electronic devices. Magnetic devices provide opportunities for non-reciprocal behavior, frequency-dependent non-linear responses, and size reduction for high-frequency components. If current materials and device challenges are overcome, these unique devices are expected to enable future system capabilities such as full-duplex operation, improved adaptability, and reduced size weight and power. There are many magnetic material and device effects that provide unique performance to complement the excellent performance provided by modern microelectronics. Physical effects that may be exploited for unique device functionality include magnetostriction, magnetoelasticity, spin-waves, ferromagnetism, and piezomagnetism. These and other effects such as piezoelectricity or electromagnetic traveling waves have been combined to enable novel device and component performance by using either multiple materials or a single multiferroic material. This workshop will provide an up-to-date perspective on magnetic materials and devices, while also providing a background on this technology for individuals who are not experts in these devices. Academic and industry speakers will cover a broad range of topics in magnetic materials for realizing RF/microwave devices including integrated ferrite-core microinductors, magnetic tags, tunable filters, tunable and steerable antennas, phase shifters, frequency-selective limiters, auto-tune filters, non-reciprocal devices, and quasi-optical faraday rotators. The speakers will cover diverse material synthesis and integration approaches, including electrodeposition, additive manufacturing, roll-to-roll processing, and bulk materials growth. These approaches have been used to realize magnetic materials and devices ranging from the nanoscale to the macro-scale, with operating bands ranging from VHF to mm-wave frequencies. In some cases, these materials and devices have been integrated monolithically onto silicon CMOS electronics, onto printed circuit boards and other passive components, and into flexible membranes. Speakers will also cover the physics and modeling of these devices, covering the unique properties of the various magnetic materials. This should provide participants with a theoretical basis and understanding that can be applied to other new novel device concepts. The workshop will begin with academic presentations that will provide a good background and overview of the technologies while also covering new developments in the field. Later presentations will focus on the realization and commercialization of devices using these magnetic materials and technologies. These magnetic materials and devices will enable future microwave components and systems to support 5G and other initiatives that require miniature, high-performance device technology.</p>	<p>Microwave Magnetic Materials and Devices for Improved Functionality Sponsor: IMS Organizer: C. Nordquist, Sandia National Laboratories, D. Psychogiou, University of Colorado Boulder 08:00 – 17:15</p> <p style="text-align: right;">WFD</p>
<p>GaN HEMT based technologies are gaining significant market share in the defense and infrastructure market spaces, due to attractive properties such as high output power density, intrinsic efficiency and breakdown voltage. Practitioners struggling with minimizing physical size and weight are being drawn to GaN technology to solve system problems. Market specifications are evolving to the point that in many products, GaN is no longer optional – it is mandatory. However, modern GaN devices still come with associated challenges, such as significant levels of charge trapping and reliability concerns due to easily achievable high channel temperatures. The traditional interface between technology and design is the transistor model. Some design communities are very comfortable working with empirical data such as harmonic load pull to implement GaN designs, but the increased push towards lower cost/higher integration concepts make working with empirical data time consuming and costly. Both the 5G push to mm-wave and the sub-6GHz market adoption of phased arrays, are pushing the infrastructure market towards low cost integrated solutions. The downside is long design and assembly cycle times, which drives R&D cost. To decrease cycle times, the demand for stable, fast and accurate GaN transistor models, is ever increasing. This workshop will present an overview of the current state-of-the-art in GaN modeling. The progress of the two Si2 Compact Modeling Coalition standardized GaN HEMT models (ASM and MVSG) will be presented, along with advances in the state-of-the-art in model formulation. There will also be feedback from the design community on the challenges of using and designing with the current crop of GaN models.</p>	<p>GaN Modeling in the Field: Recent Advances and Remaining Challenges Sponsor: IMS Organizer: M. Roberg, Qorvo; T. Canning, Infineon Technologies 08:00 – 17:15</p> <p style="text-align: right;">WFE</p>
<p>With IMS-2020 coming to Los Angeles, CA, an historic hub of the Aerospace and Defense (A&D) industry, also home to NASA / Jet Propulsion Laboratory (JPL), this workshop gathers together world experts, research and industry leaders to report and discuss the latest RF/MW technology trends and developments that continue on driving innovation in this specific area, as opposed to the more widely covered 5G theme. Areas of interest discussed in this workshop span from solid-state and vacuum electron active devices, to circuit design and techniques. In particular, the following subtopics are covered: · Traveling Wave Tube amplifiers still dominate the space sector; come and learn why from two presentations dedicated to this technology · depletion mode AlGaN/GaN HEMT devices have become ubiquitous in several RF/MW systems, but qualification criteria for reliable spaceborne applications is still an active debate; the latest qualification criteria will be presented by the Aerospace Corporation · an overview of InP, GaAs and GaN technology from a commercial foundry perspective · latest RF/MW technology for SmallSat and radar remote sensing presented by JPL and radar and radiometer payloads for Earth observations presented by Airbus · solid-state device and circuit techniques for high-power dish-antenna radars, and an overview of high-power RF pallets for radar systems · broadband high-power GaN MMIC amplifier design · RF/microwave technology for beamforming in phased-array systems, including a look at multi-channel technologies that have emerged from communications developments · on the education front, an effort from MIT-LL to attract young students and engineers to the electromagnetic (EM) engineering field with hands-on learning through “build-your-own-radar” course work. This full-day workshop is geared towards practitioners in the RF/MW aerospace and defense industry who want to gain a broader perspective on the latest trends and developments as well as nuances specific to each different application. Novices and newcomers to the A&D industry will also gain a comprehensive exposure and understanding of the RF/MW landscape that drives innovation in this specific arena.</p>	<p>Latest Trends and Developments in RF/MW Devices, Circuits and System Technology for Aerospace and Defense Applications Sponsor: IMS Organizer: G. Callet, UMS, G. Formicone; Integra Technologies 08:00 – 17:15</p> <p style="text-align: right;">WFF</p>
<p>The development of 5G systems promises paradigm-shifting applications while presenting unique challenges across materials, devices, modules, and systems. One area that calls for innovative solutions to support the 5G growth is the front-end acoustic filtering at sub-6GHz and beyond. To this end, this workshop features a group of international experts who will present upcoming solutions from the industry as well as innovative approaches from academia. The workshop will first highlight system-level considerations and then delve into new materials and enabling device design/modeling techniques before comprehensive solutions that require co-designing devices, circuits, integration, and packaging are discussed. A panel discussion will conclude the workshop with insights and outlooks for the trending acoustic technology candidates as well as the long-term prospects of acoustic devices in RF front-ends.</p>	<p>Microwave Acoustics and RF MEMS Enabling 5G Sponsor: IMS Organizer: A. Hagelauer, Universität Bayreuth, A. Tag, Qorvo, S. Gong, University of Illinois at Urbana-Champaign 08:00 – 17:15</p> <p style="text-align: right;">WFG</p>

Workshop Title	Workshop Abstract
<p>WFH</p> <p>Toward Non-Invasive Waves and Characterization for Biomedical Applications: from Microwaves to mm-Waves to Nanosecond Pulsed Electric Fields (nsPEF)</p> <p>Sponsor: IMS</p> <p>Organizer: M. Gardill, <i>InnoSenT</i>; S. Chung, <i>Neuralink</i>; Y.-K. Chen, <i>DARPA</i></p> <p>8:00:00 – 11:50</p>	<p>The workshop objective is to gather together knowledge and internationally recognized scientists developing minimally or non-invasive research aimed for biomedical applications. With this workshop, we propose to favor exchanges and promote current technologies based on electromagnetic waves or electric fields for therapeutic treatments or diagnostic. Indeed, the application of electric fields with microseconds and milliseconds and amplitudes of the order of hundreds of kV/m has been used to achieve electroporation or electropermeabilization i.e. the opening of nanometer-size pathways or “pores” across cell membrane. By inserting anti-cancer molecules inside the cells, electrochemotherapy was clinically applied using electrodes in contact for example in the treatment of skin cutaneous and subcutaneous metastases. To reach internal biological targets of the cell such as mitochondria, pulsed electric fields (nsPEF) with nanosecond, picosecond durations and Megavolt/meter intensities have been used. These fields open up prospects for innovative cancer therapies such as those resulting in apoptosis cell death and the possibility to modulate the effects or target specific cellular components. Minimally or non-invasive technologies implies challenging state-of-the-art developments. The coupling of electromagnetic waves with biological cells, tissues with no direct contact relies mainly on weak radiated fields i.e. the principle of an antenna. The main challenges here is to balance the intensity levels by developing generators and/or delivery systems capable to induce electric fields of sufficient intensities to cause local effects on the cells (electroporation). Radiofrequency or microwaves have been applied in the context of cancer treatment therapies particularly hyperthermia and thermal ablation. Recently, potentially new therapeutic means of cancer treatment with electromagnetically-induced heating from continuous and pulsed-wave amplitude-modulated mm-waves have been investigated. Continuous-wave (CW) sinusoidal signals in the MHz range have been also applied for electroporation investigations recently. The findings with these researches are strongly supported by correlations with experimental imaging technologies and numerical modeling and simulations. During this workshop, developments will be presented on subnanosecond or nanosecond pulse generators and delivery systems, thermal mm-wave pulses, temperature and electric fields assessments, numerical modeling at the cell level, innovative characterization techniques under for example, “in vitro” investigations and deep body stimulation. The workshop will end with a panel discussion to debate various contents and to enhance exchanges between the scientists (speakers, attendees, chairs).</p>

FRIDAY TECHNICAL LECTURES

Lecture Title	Course Syllabus
<p>TFA1</p> <p>Silicon-based Millimeter-Wave Phased Array Design</p> <p>Speakers: Bodhisatwa Sadhu, IBM T. J. Watson Research Center; Alberto Valdes-Garcia, IBM T. J. Watson Research Center</p> <p>08:30 – 12:00</p>	<p>In this technical lecture, you will learn key aspects of silicon-based mm-wave phased-array design and characterization. The lecture will cover the following topics: (1) Fundamentals of phased arrays -- theory and intuition, (2) Silicon-based mm-wave phased array architectures, (3) Silicon-based circuit building blocks for phased array systems, (4) Package, antenna and module design and simulation, (5) phased array measurements, (6) phased array system considerations. Both CMOS and SiGe technologies will be covered. The lecture will end with a peek into current research trends and future research outlook of phased array systems.</p>

EXHIBITING COMPANIES

Exhibitors as of 9 April 2020

Account Name	Beijing Hwa-Tech Information System Co., Ltd.	Dynawave Inc.
3D Glass Solutions	Benchmark Electronics Inc.	ECHO Microwave
3G Shielding Specialties	Bliley Technologies, Inc.	Eclipse MDI
3RWAVE	C W Swift	ELDAAS Technologies Pvt. Ltd.
A.J. Tuck Co.	Cadence Design Systems, Inc.	Electro Enterprises, Inc.
A.L.M.T. Corp.	California State Polytechnic University, Pomona	Electro Rent Corp.
A.T. Wall Company	Carlisle IT	Element Six
A-Alpha Waveguide Inc.	CEL	Elite RF LLC
ABF Elettronica S.r.l.	Centerline Technologies	Empower RF Systems, Inc.
Accumet	Century Seals, Inc.	EMWorks
Accurate Circuit Engineering	Cernex, Inc./Cernexwave	ENGIN-IC, Inc.
ACEWAVETECH	Charter Engineering, Inc.	Epoxy Technology, Inc.
ACST GmbH	Chengdu Jingxin Microwave Technology Co., Ltd.	Epson America Inc.
Adesto Technologies Corp.	Chengdu KeyLink Microwave Technology Co., Ltd.	ERG Aerospace
ADMOTEC Co., Ltd.	Chin Nan Precision Electronics Co., Ltd.	Erzia Technologies
Adsantec Inc.	Chuzhou First Technology Co., Ltd.	ETL Systems Ltd.
AdTech Ceramics	Ciao Wireless, Inc.	ETS-Lindgren
Advanced Assembly	Cicor Group	European Microwave Week
Advanced Circuitry International	Cinch Connectivity Solutions	Everbeing International Corp.
Advanced Microwave Technology Co., Ltd.	Cirrex International, Inc.	Everything RF / Microwaves 101
Advanced Test Equipment Rentals	CML Microcircuits (USA) Inc.	evissaP, Inc.
AEM, Inc.	Cobham Advanced Electronic Solutions	Exodus Advanced Communications
AGC-Nelco	Coilcraft, Inc.	EXXELIA
Agile Microwave Technology Inc.	Communications & Power Industries	EZ Form Cable Corp.
AI Technology, Inc.	Component Distributors, Inc.	F&K Delvotec, Inc.
A-INFO Inc.	COMSOL, Inc.	FECO ELASI
Akoustis, Inc.	ConductRF	Ferrite Microwave Technologies
Aldetec, Inc. (UST-Aldetec)	Connectronics, Inc.	Ferro Corporation
Almic Electronics Co., Ltd.	Continental Resources	Filtronetics, Inc.
Altair Engineering, Inc.	Copper Mountain Technologies	Filtronic
Altum RF	Corning Inc.	Fine-Line Circuits Limited
AMCAD Engineering	Corry Micronics Inc.	Flann Microwave Ltd.
AMCOM Communications Inc.	Cosmic Microwave Technology, Inc.	Flexco Microwave Inc.
American Microwave Corp.	COTECHWAVE	Florida International University
American Standard Circuits, Inc.	Crane Aerospace & Electronics	Focus Microwaves Inc.
Ametek CTS US/Instruments for Industries	Crescend, LLC	FormFactor
AMETEK Electronic Interconnect and Packaging	Criteria Labs	Frontlynk Technologies Inc.
Amphenol Printed Circuits	Crystek Corp.	FTG Corp.
Ampleon	CTS Corporation	Fuzhou Micable Electronic Tech Co., Ltd.
AmpliTech Inc.	CTT Inc.	Gamma Electronics, Inc.
Amwav Technology Limited	Cubic Nuvotronics	Geib Refining Corp.
Analog Devices, Inc.	Custom Cable Assemblies, Inc.	Genmix Technology Co., Ltd.
Anapico Ltd.	Custom Microwave Components, Inc.	GEROTRON Communication GmbH
Anokiwave	Custom Microwave Inc. (CMI)	GGB Industries, Inc.
Anritsu Co.	CX Thin Films	GigaLane Co., Ltd.
ANSYS, Inc.	Daa-Sheen Technology Co., Ltd.	Global Communication Semiconductors, LLC
AO Technologies	Daico Industries, Inc.	Global Production Systems Ltd.
APA Wireless Technologies	Dalian Dalicap Tech. Corp.	Global Test Equipment
API Technologies	Danyang Teruilai Electronics Co., Ltd.	GLOBALFOUNDRIES
Applied Thin-Film Products	dB Control	Golden Loch Ind. Co., Ltd.
AR Modular RF	dBm Corp.	Gova Advanced Material Technology Co., Ltd.
AR RF/Microwave Instrumentation	Delphon - Gel-Pak	Gowanda Components Group (GCG)
Arralis	Delta Electronics Mfg. Corp.	Gowanda Electronics (affiliate of GCG)
Artech House	Delta-Sigma Inc.	Greenray Industries, Inc.
ASB Inc.	Denka Corporation	Guangdong DAPU Telecom Technology Co., Ltd.
ASI dba RF Depot Inc.	Design Workshop Technologies Inc.	Guerrilla RF
Association of Old Crows/Naylor	DeWeyl Tool Company, Inc.	Hamilton
Astronics Test Systems	Diamond Antenna & Microwave Corp.	Harbour Industries, LLC
Atlanta Micro, Inc.	Dino-Lite Scopes	HASCO, Inc.
Auden Techno Corp.	Diramics AG	Hermerc Technologies Co., Ltd.
Avalon Test Equipment	DiTom Microwave Inc.	Hermetic Solutions Group
AVX Corporation	Doosan Electro Materials	Herotek Inc.
Axiom Test Equipment	dSpace Inc.	Hesse Mechatronics
B&Z Technologies	Ducommun Inc.	High Frequency Electronics
Barry Industries, Inc.	DYCO Electronics (affiliate of GCG)	Hirose Electric USA

EXHIBITING COMPANIES

Exhibitors as of 9 April 2020

Holworth Instrumentation Inc.
 HRL Laboratories, LLC
 Huang Liang Technologies Co., Ltd.
 HYBOND, Inc.
 HYPERLABS
 IDT Integrated Device Technology
 IEEE Antennas and Propagation Society
 IEEE Electromagnetic Compatibility Society
 IHP GmbH
 IMS 5G Pavilion
 IMS Interactive Forum
 IMS Startup Pavilion
 IMS University Booth
 IMST GmbH
 InCompliance Magazine
 Indium Corp.
 INGUN USA, Inc.
 Innertron, Inc.
 Innovative Power Products, Inc.
 In-Phase Technologies, Inc.
 Inpower Co., Ltd.
 Insulated Wire, Inc.
 Integra Technologies Inc.
 Intelliconnect USA, LLC
 International Manufacturing Services Inc.
 inTEST Thermal Solutions
 Ironwood Electronics
 Isola
 ITEQ Corp.
 ITF Co., Ltd.
 Jet Metal Technologies
 JFW Industries, Inc.
 Jiangsu Caiqin Technology Co., Ltd.
 JMJ Korea
 Johanson Technology, Inc.
 JQL Technologies Corporation
 Junkosha Inc.
 Keysight Technologies
 Knowles Precision Devices
 KOSTECSYS Co., Ltd.
 Kratos General Microwave
 KRYTAR, Inc.
 Kumu Networks
 KVG Quartz Crystal Technology GmbH
 Kwangwoon University
 Kyocera International, Inc.
 L3Harris
 LadyBug Technologies LLC
 Lake Shore Cryotronics, Inc.
 Lanjian Electronics
 Laser Processing Technology, Inc.
 Leader Tech. Inc.
 LEONARDO
 Liberty Test Equipment Inc.
 Lilliput Electronics (USA) Inc.
 Linearizer Technology, Inc.
 Lintek Pty Ltd.
 Linwave Technology Ltd.
 Logus Microwave
 Lorentz Solution, Inc.
 LPKF Laser & Electronics
 M2 Global Technology Ltd.
 MACOM
 Magvention
 Malico Inc.
 Marki Microwave, Inc.
 Marvin Test Solutions
 Massachusetts Bay Technologies
 Materion Brush, Inc.
 MathWorks
 Maury Microwave Corp.
 MaXentric Technologies LLC
 MCV Microwave
 MECA Electronics Inc.
 Mega Circuit Inc.
 Mega Industries, LLC
 MegaPhase
 Menlo Microsystems, Inc.
 Mercury Systems
 Metallife, Inc.
 Metallix Refining Inc.
 Metamagnetics, Inc.
 Metropole Products Inc.
 Mician GmbH
 Micro Harmonics Corp.
 Micro Lambda Wireless, Inc.
 Micro Systems Technologies AG
 MicroApps
 Microchip Technology Inc.
 MicroFab Inc.
 Micro-Mode Products, Inc.
 Microsanj
 Microtech, Inc.
 Microwave Applications Group
 Microwave Communications Labs, Inc.
 Microwave Development Labs Inc.
 Microwave Dynamics
 Microwave Engineering Corporation
 Microwave Journal
 Microwave Product Digest
 Microwave Products Group
 Microwave Town Company LLC
 Microwavefilters & TVC S.r.l.
 Microwaves & RF/Informa
 Miczen Technologies Co., Ltd.
 Millimeter Wave Products Inc.
 Millimeter Wave Systems LLC
 Milliwave Silicon Solutions, Inc.
 Mini-Circuits
 Mini-Systems Inc.
 Mitsubishi Electric US, Inc.
 MixComm
 Modelithics, Inc.
 Modular Components
 Morion US, LLC
 Mouser Electronics, Inc.
 MPI Corp.
 MRSI Systems LLC
 MST LLC
 MtronPTI
 Muegge GmbH
 MUNICOM GmbH
 Murata Software Co., Ltd.
 MWee (Microwave Engineering Europe)
 Nanjing ECT Technologies Co., Ltd.
 NanoSemi, Inc.
 National Instruments
 National Taiwan University
 Naylor Association Solutions
 NDK America
 NEL Frequency Controls, Inc.
 NEO Tech
 Netcom, Inc.
 Networks International Corp. (NIC)
 New Japan Radio
 Norden Millimeter Inc.
 Northrop Grumman
 NTK Technologies, Inc.
 Nuhertz Technologies, LLC
 Oak-Mitsui Technologies, LLC
 OEwaves Inc.
 Ohmega Technologies Inc.
 OML, Inc.
 OMMIC
 OPHIR RF Inc.
 Optelligent, LLC
 Optenni Ltd.
 Optiforms, Inc.
 Orbel Corp.
 Orient Microwave Corp.
 Orolia
 Otava
 Pacific Microchip Corp.
 Palomar Technologies
 Parker Chomerics
 Pasquali Microwave Systems
 Passive Plus Inc.
 Pasternack
 PCB Power Inc.
 Pentek
 Pickering Interfaces, Inc.
 Pico Technology
 Piconics Inc.
 Pivotone Communication Tech., Inc.
 Pixus Technologies
 Planar Monolithics Industries, Inc.
 Plexsa Manufacturing
 Plectek RFI Ltd.
 Plymouth Rock Technologies
 PM Industries Inc.
 Polyfet RF Devices
 Powell Electronics Group
 PPG Cuming Microwave
 Presidio Components, Inc.
 Presto Engineering Inc.
 pSemi Corporation
 Pure Pro Technology Co., Ltd.
 Q Microwave, Inc.
 Qorvo
 Q-Tech Corp.
 Quantum Microwave Components
 Quest Microwave Inc.
 Quik-Pak
 QuinStar Technology, Inc.
 QWED Sp. z o.o.
 R&K Company Ltd.
 Raynool Technology Co., Ltd.
 Raytech Inc.
 Reactel, Inc.
 RelComm Technologies Inc.
 Reldan Metals Co. Div. of ARM, LLC.
 Remcom, Inc.
 Remote Sensing Solutions Inc.
 Remtec, Inc.
 Renaissance/Hxi

EXHIBITING COMPANIES

Exhibitors as of 9 April 2020

Resin Systems Corp.
 Res-Net Microwave, Inc.
 Response Microwave Inc.
 RF Morecom Korea
 RFHIC Corp.
 RF-Lambda USA LLC
 Rflight Communication Electronic Co., Ltd.
 RFMW
 Richardson Electronics, Ltd.
 Richardson RFPD
 Rigol Technologies USA, Inc.
 RJR Technologies, Inc.
 RLC Electronics, Inc.
 Rogers Corp.
 Rohde & Schwarz USA, Inc.
 Roos Instruments Inc.
 Rosenberger North America Akron, LLC
 ROSNOL RF/Microwave Technology Co., Ltd.
 RUPPrtronik
 Rutgers University
 SAF North America LLC
 SAGE Millimeter, Inc.
 Saint-Gobain
 Sainty-Tech Communications Ltd.
 Samtec, Inc.
 San-tron Inc.
 Sawmics Inc.
 Schlegel
 Schmid & Partner Engineering AG
 Scientific Microwave Corp.
 Semi Dice Inc.
 SemiGen
 Sensorview Co., Ltd.
 Sentec E&E Co., Ltd.
 SGMIC Microwave
 Shanghai Huaxiang Computer Comm. Eng.
 Shanghai JunCoax RF Technologies Co., Ltd.
 Shanghai XinXun Microwave Technology Co., Ltd.
 Shengyi Technology Co., Ltd.
 Shenzhen Superlink Technology Co., Ltd.
 Shenzhen Yulongtong Electron Co., Ltd.
 Shin Puu Technology Ltd. Co.
 Siglent Technologies NA
 Signal Hound
 Signal Integrity, Inc.
 Signal Microwave
 SignalCore Inc.
 Signatone
 Sino Nitride Semiconductor
 Skyworks Solutions, Inc.
 Smiths Interconnect
 Societies Pavilion
 Solid Sealing Technology
 SOMACIS
 Sonnet Software Inc.
 Southwest Microwave, Inc.
 Space Machine & Engineering Corp.
 SpaceK Labs, Inc.
 Spectrum Elektrotechnik GmbH
 SRTechnology Corp.
 SSI Cable Corp.
 State Of The Art, Inc.
 Statek Corp.
 Stellar Industries Corp.
 StratEdge Corp.
 Suin Instruments Co., Ltd.
 Sumitomo Electric Device Innovations
 Summit Interconnect
 Sung Won Forming
 SuperApex Corporation
 Susumu International (USA) Inc.
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