INTERNATIONAL MICROWAVE SYMPOSIUM

Program Book

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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Sunday

Workshop Title		Workshop Abstract
WSA	**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**	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.
WSB	**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**	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.
WSC	**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**	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 the 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.

Workshop Abstract	Workshop Title	
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.	**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**	WSD
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.	**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**	WSE
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.	**mm-Wave Phased-Array Transceiver Design: From Basics to Advancements** **Sponsor:** RFIC **Organizer:** A. Frappé, IEMN (UMR 8520), J. Kitchen, Arizona State University, R. Pullela, MaxLinear **08:00 – 17:15**	WSF
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.	**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**	WSG
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.	**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**	WSH

Workshop Title		Workshop Abstract
WSI	**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**	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 it 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.
WSJ	**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**	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.
WSK	**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**	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.
WSL	**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**	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.
WSM	**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**	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 Friss 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.

Workshop Abstract	Workshop Title	
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 10E-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 1-10E-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 10E-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 standartization discuss several aspects of 5G wireless infrastructure.	**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**	WSN

THREE MINUTE THESIS

(3MT®) COMPETITION

LACC

15:00 – 17:00 **SUNDAY, 21 JUNE 2020**

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 Hosted by John Bandler and Erin Kiley	10:00 – 12:00
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.

RFIC WELCOME RECEPTION FEATURING INDUSTRY SHOWCASE AND STUDENT PAPER AWARD FINALISTS

LACC

19:00 – 21:00 SUNDAY, 21 JUNE 2020

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 Schrögendorfer, 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 Elkhouly, 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

Issakov[1], C. Heine[1], V. Lammert[1], J. Stoegmueller[1], M. Meindl[2],
U. Stubenrauch[1], C. Geissler[1]

[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 Muhonen[1], Scott Parker[1], Kaushik Annam[2]

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. Serhan[1], D. Parat[1], P. Reynier[1], M. Pezzin[1], R. Mourot[1], F. Chaix[1],
R. Berro[1], P. Indirayanti[2], C. De Ranter[2], K. Han[2], M. Borremans[2],
E. Mercier[1], A. Giry[1]

[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.

RFIC 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 Nagulu[1,] Mykhailo Tymchenko[2], Andrea Alù[2], Harish Krishnaswamy[1]

[1]Columbia University, USA, [2]University 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 Binaie[1], Sohail Ahasan[1,] Armagan Dascurcu[1], Mahmood Baraani Dastjerdi[1], Robin Garg[2], Manoj Johnson[2], Arman Galioglu[1], Arun Natarajan[2], Harish Krishnaswamy[1]

[1]Columbia University, USA, [2]Oregon 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 Ginzberg[1], Dror Regev[2], Emanuel Cohen[1]

[1]Technion, Israel, [2]Toga 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 Chu[1], Steven Callender[2], Yanjie Wang[3], Jacques C. Rudell[1], Stefano Pellerano[2], Christopher Hull[2]

[1]University of Washington, USA, [2]Intel, 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 Eltaliawy[1], John R. Long[1], Ned Cahoon[2]

[1]University of Waterloo, Canada, [2]GLOBALFOUNDRIES, 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 4×4 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*

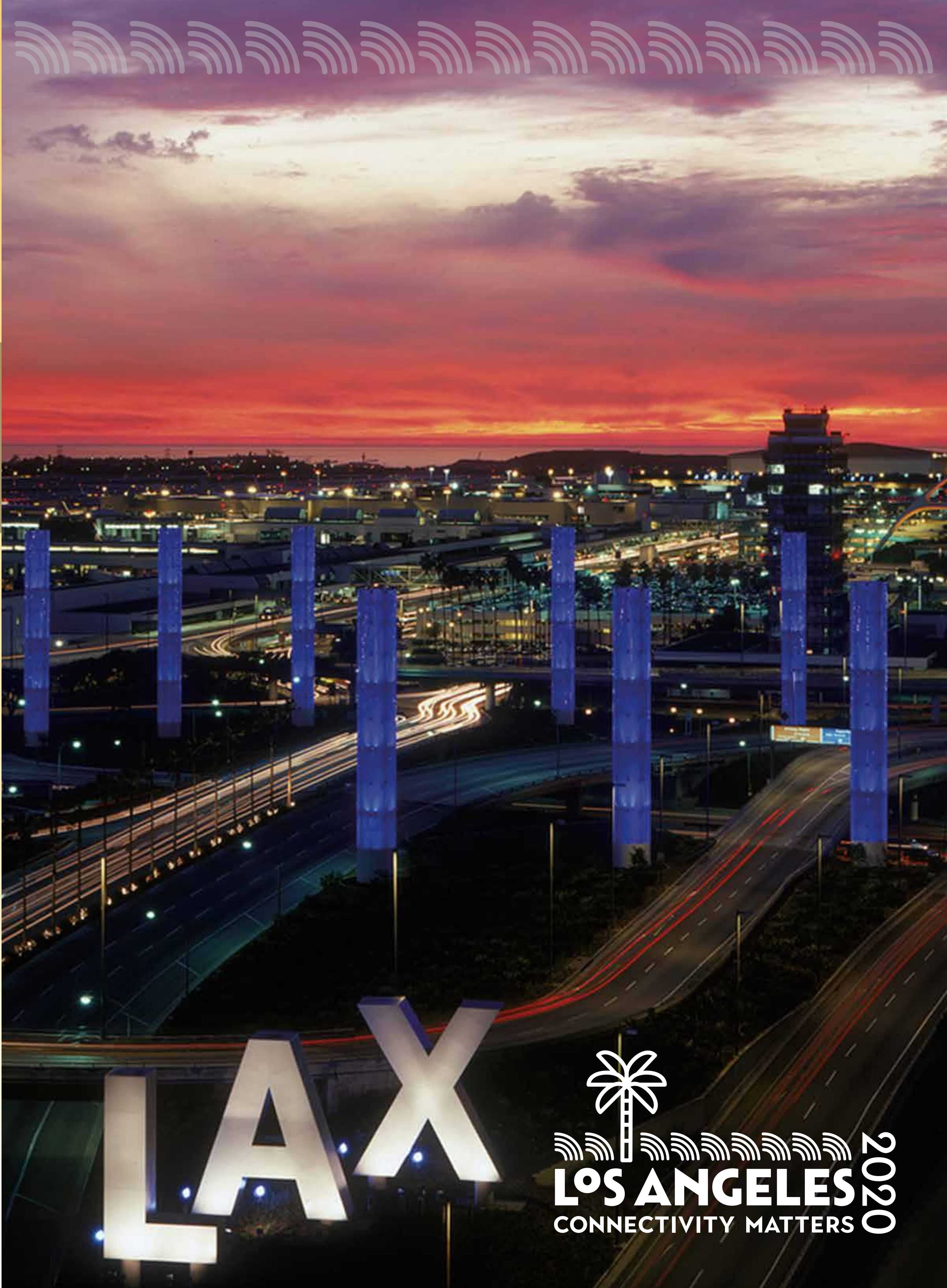
Characterization of Partially Overlapped Inductors for Compact Layout Design in 130nm RFCMOS and 22nm FinFET Processes | RMo2D-2 | 10:30

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.



LOS ANGELES 2020
CONNECTIVITY MATTERS

Monday

RFIC TECHNICAL SESSIONS 08:00 – 09:40 | MONDAY, 22 JUNE 2020 | LACC

	402AB	403A	403B	404AB
	Mo1A: High Spectral Purity Phase-Locked Loops **Chair:** Fa Foster Dai, Auburn University **Co-Chair:** Joseph D. Cali, BAE Systems	**Mo1B: Microwave and mmWave Radar Systems** **Chair:** Ed Balboni, Analog Devices **Co-Chair:** Duane Howard, Jet Propulsion Laboratory	**Mo1C: Circulators and Full-Duplex Transceivers** **Chair:** François Rivet, IMS (UMR 5218) **Co-Chair:** Magnus Wiklund, Qualcomm	**Mo1D: Switches and Delay Elements for Receiver Front-Ends** **Chair:** Domine M.W. Leenaerts, NXP Semiconductors **Co-Chair:** Danilo Manstretta, Università di Pavia
08:00	**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	**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	**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.	**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.
08:20	**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.	**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	**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.	**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
08:40	**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	**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	**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	**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
09:00	**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	**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	**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. AlShammary; Univ. of California, Santa Barbara; J. Buckwalter; Univ. of California, Santa Barbara	**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
09:20		**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	**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. Alù; Univ. of Texas at Austin; H. Krishnaswamy; Columbia Univ.	
9:40				

402AB	403A	403B	404AB	
Mo2A: Reconfigurable RF Front-End Blocks **Chair:** Magnus Wiklund, Qualcomm **Co-Chair:** François Rivet, IMS (UMR 5218)	**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	**Mo2C: Digital Power Amplifiers** **Chair:** Jeffrey Walling, Qualcomm **Co-Chair:** Justin (ChiaHsin) Wu, AmLogic	**Mo2D: Novel RF Devices and Modeling Approaches** **Chair:** Edward Preisler, Tower Semiconductor **Co-Chair:** Hsieh-Hung Hsieh, TSMC	
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.	**Mo2B-1: D-Band Phased-Array TX and RX Front Ends Utilizing Radio-on-Glass Technology** M. Elkhouly; 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	**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	**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	10:10
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. Pezzin; CEA-LETI; R. Mourot; 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	**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	**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	**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.	10:30
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.	**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. Elkhouly; Nokia Bell Labs; Y. Baeyens; Nokia Bell Labs; S. Shahramian; Nokia Bell Labs	**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	**Mo2D-3: Parasitic Model to Describe Breakdown in Stacked-FET SOI Switches** K. Muhonen; Qorvo; S. Parker; Qorvo; K. Annam; Univ. of Dayton	10:50
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.-W. Chen; Univ. of Southern California	**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	**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	**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	11:10
	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.	**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		11:30
				11:50

	402AB	403A	403B
	Mo3A: RFIC Systems and Applications I: Biomedical and Radar Systems **Chair:** Oren Eliezer, Apogee Semiconductor **Co-Chair:** Yao-Hong Liu, IMEC	**Mo3B: Millimeter-Wave Transceivers and Building Blocks** **Chair:** Shahriar Shahramian, Nokia Bell Labs **Co-Chair:** Hongtao Xu, Fudan University	**Mo3C: mmWave Power Amplifiers** **Chair:** Patrick Reynaert, KU Leuven **Co-Chair:** Oleh Krutko, Xilinx
13:40	**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	**Mo3B-1: 60GHz Variable Gain & Linearity Enhancement LNA in 65nm CMOS** D. Bierbuesse; RWTH Aachen Univ.; R. Negra; RWTH Aachen Univ.	**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
14:00	**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;	**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.	**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.
14:20	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**	**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.	**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
14:40	**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	**Mo3B-4: A Bidirectional 56–72GHz to 10.56GHz Tranceiver 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.	**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
15:00		**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. Shrivas; IMEC; K. Vaesen; IMEC; P. Wambacq; IMEC	**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.
15:20			

402AB	403A	403B	
Mo4A: RFIC System and Applications II: Wideband Wireless Communication and Quantum Computing **Chair:** Renyuan Wang, BAE Systems **Co-Chair:** Rocco Tam, NXP Semiconductors	**Mo4B: Millimeter-Wave and Terahertz Circuits and Systems for Sensing and Communications** **Chair:** Omeed Momeni, University of California, Davis **Co-Chair:** Ruonan Han, MIT	**Mo4C: High-Performance Frequency-Generation Components** **Chair:** Mohyee Mikhemar, Broadcom **Co-Chair:** Wanghua Wu, Samsung	
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	**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	**Mo4C-1: A $0.082mm^2$ 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 $1/f^3$ PN Corner** H. Guo; University of Macau; Y. Chen; University of Macau; P.-I. Mak; University of Macau; R.P. Martins; University of Macau	15:50
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	**Mo4B-2: A High-Speed 390GHz BPOOK Transmitter in 28nm CMOS** C. D'heer; Katholieke Univ. Leuven; P. Reynaert; Katholieke Univ. Leuven	**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	16:10
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	**Mo4B-3: A SiGe Millimeter-Wave Front-End for Remote Sensing and Imaging** M. Frounchi; Georgia Tech; J.D. Cressler; Georgia Tech	**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	16:30
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	**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	**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	16:50
			17:10
			17:30

Workshop Title		Workshop Abstract
WMA	**Enabling Technologies for Efficient Ultra-High Speed Wireless Communication Systems Towards 100Gb/s** **Sponsor:** IMS **Organizer:** C. Carlowitz, *FAU Erlangen-Nürnberg;* N. Kaneda, *Nokia Bell Labs* **08:00 – 17:15**	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.
WMB	**Recent Advances in mm-Wave Circuits and Systems for Emerging Radar Sensing Applications** **Sponsor:** IMS; RFIC **Organizer:** A. Hagelauer, *Universität Bayreuth;* I. Nasr, *Infineon Technologies;* V. Issakov, *OvG Universität Magdeburg* **08:00 – 17:15**	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.
WMC	**Platforms, Trials, and Applications – The Next Step for 5G and Future Wireless Networks** **Sponsor:** IMS **Organizer:** A. Valdes-Garcia, *IBM T.J. Watson Research Center;* C. Fager, *Chalmers University of Technology;* Z. Chen, *Dalhousie University* **08:00 – 17:15**	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.
WME	**Wireless Power Transmission – Myths and Reality** **Sponsor:** IMS **Organizer:** N.B. Carvalho, *Universidade de Aveiro;* Z. Popovic, *University of Colorado Boulder* **08:00 – 17:15**	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.

Workshop Abstract	Workshop Title	
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 multiport 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.	**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**	WMF
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.	**Materials by Design for Microwave and mm-Wave Communications** **Sponsor:** IMS **Organizer:** N. Orloff, *NIST;* T.M. Wallis, *NIST* **08:00 – 17:15**	WMG
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.	**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**	WMH

MONDAY
TECHNICAL LECTURES

LACC

12:00 – 17:00 MONDAY, 22 JUNE 2020

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 puling and finally we will look at several designs 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 combline bandpass filter and the second is a microstrip combline bandpass filter. Example project files will be made available to attendees.

RF BOOTCAMP

LACC

08:00 – 16:45 MONDAY, 22 JUNE 2020

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

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 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

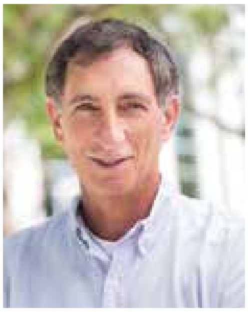
ABSTRACT:

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

	406AB	408A	408B	409AB
	Tu1E: Novel Components, Waveguides, and Methods for Radiating Structures	**Tu1F: High Power Amplifiers for HF Through S Band**	**Tu1G: Innovative RF Switches and Applications**	**Tu1H: Advances in RF and Microwave CAD Techniques**
	Chair: Dan Jiao, Purdue University **Co-Chair:** Werner Thiel, ANSYS, Inc.	**Chair:** Marc Franco, QORVO, Inc. **Co-Chair:** Robert Caverly, Villanova University	**Chair:** Guoan Wang, University of South Carolina **Co-Chair:** John Ebel, US Air Force Research Laboratory	**Chair:** Erin Kiley, Massachusetts College of Liberal Arts **Co-Chair:** Jose Rayas-Sanchez, ITESO - The Jesuit University of Guadalajara
08:00 08:10	**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	**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	**Tu1G-1: RF-MEMS Switched Capacitor Using Ta/Ta2O5 Electrodes** J.-C. Orlianges; XLIM (UMR 7252); M. Laouini; XLIM (UMR 7252); C. Hallepee; XLIM (UMR 7252); P. Blondy; XLIM (UMR 7252)	**Tu1H-1: High-Dimensional Variability Analysis via Parameters Space Partitioning** Y. Tao; Carleton Univ.; F. Ferranti; IMT Atlantique; M. Nakhla; Carleton Univ.
08:20 08:30	**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	**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	**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	**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.
08:40 08:50	**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)	**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.	**Tu1G-3: Fully Printed VO2 Switch Based Flexible and Reconfigurable Filter** S. Yang; KAUST; W. Li; KAUST; M. Vaseem; KAUST; A. Shamim; KAUST	**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.
09:00 09:10	**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”	**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	**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	**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
09:20	**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	**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.	**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	**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 .
09:30 09:40				**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

Microwave Field, Device & Circuit Techniques | Passive Components | Active Components | Systems & Applications | Emerging Technologies & Applications | Focus & Special Sessions | Late Breaking News

RFIC TECHNICAL SESSIONS 08:00 – 09:40 | TUESDAY, 23 JUNE 2020 | LACC

402AB	403A	403B	404AB	
Tu1A: mmWave Signal Generation **Chair:** Ehsan Afshari, University of Michigan **Co-Chair:** Andreia Cathelin, STMicroelectronicsy	**Tu1B: 5G Focus Session on Advances in Mixer-First Receivers** **Chair:** Ramesh Harjani, University of Minnesota **Co-Chair:** Harish Krishnaswamy, Columbia University	**Tu1C: Linearization and Efficiency Enhancement Techniques** **Chair:** Margaret Szymanowski, NXP Semiconductors **Co-Chair:** Sungwon Chung, Neuralink	**Tu1D: Mixed-Signal and Power Management Techniques for RF Transceivers** **Chair:** Antoine Frappé, IEMN (UMR 8520) **Co-Chair:** Bahar Jalali Farahani, Cisco Systems	
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	**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	**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	**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.	**08:00** 08:10
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	**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	**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	**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.	**08:20** 08:30
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	**Tu1B-3: A 9–31GHz 65nm CMOS Down-Converter with >4dBm OOB B1dB** Z.G. Boynton; Cornell Univ.; A. Molnar; Cornell Univ.	**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	**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.	**08:40** 08:50
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	**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	**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	**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; ECRIEE; W. Lv; ECRIEE; D. Pan; USTC; Z. Xie; USTC; Y. Dai; ECRIEE; L. Sun; USTC	**09:00** 09:10
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		**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		**09:20** 09:30
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406AB

Tu2E: Advances in Microwave to Terhertz Photonics and Nanotechnology

Chair: Mona Jarrahi, University of California, Los Angeles

Co-Chair: Luca Pierantoni, Universita 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. Dambrine; 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 Koohi; 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-Placha; 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.

RFIC TECHNICAL SESSIONS 10:10 – 11:50 | TUESDAY, 23 JUNE 2020 | LACC

402AB	403A	403B	
Tu2A: Ultra-Low Power Transceivers **Chair:** Chun Huat Heng, NUS **Co-Chair:** Gernot Hueber, Silicon Austria Labs	**Tu2B: 5G Focus Session on Millimeter-Wave Components and Systems** **Chair:** Tim Larocca, Northrop Grumman **Co-Chair:** Jane Gu, University of California, Davis	**Tu2C: Sub-6 GHz Receiver Front-End Circuits** **Chair:** Kamran Entesari, Texas A&M University **Co-Chair:** Gary Hau, Qualcomm	
Tu2A-1: A 66.97pJ/Bit, 0.0413mm^2 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.	**Tu2B-1: A 16-Element Fully Integrated 28GHz Digital Beamformer with In-Package 4×4 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	**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	10:10 10:20
Tu2A-2: A 67-µW Ultra-Low Power PVT-Robust MedRadio Transmitter S. Mondal; Univ. of California, San Diego; D.A. Hall; Univ. of California, San Diego	**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; Pharrowtech; Y. Zhang; IMEC; W.-M. Wu; IMEC; S.-H. Chen; IMEC; B. Debaillie; IMEC; P. Wambacq; IMEC	**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	10:30 10:40
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	**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; ECRIEE; X. Zhang; Rice Univ.; B. Liao; ECRIEE; Y. Zhu; ECRIEE; Y. Wang; Tsinghua Univ.	**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	10:50 11:00
Tu2A-4: A mm-Scale Sensor Node with a 2.7GHz 1.3µW 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	**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	**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	11:10 11:20
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. Wenzloff; Univ. of Michigan	**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	**Tu2C-5: A 0.08mm^2 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	11:30 11:40
			11:50

STUDENT DESIGN COMPETITIONS

LACC

09:30 – 17:00 TUESDAY, 23 JUNE 2020

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

LACC

12:00 – 13:30 TUESDAY, 23 JUNE 2020

Lecture Title		Course Syllabus
TTA1	**Quantum Computing: an RF Control Perspective** **Speaker:** Evan Jeffrey, Google, Inc. **12:00 – 13:30**	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.
TTA1	**Trends in Automotive Radars: Waveform, System Implementation, and IC Technologies** **Speaker:** Cicero Vaucher, NXP Semiconductors **12:00 – 13:30**	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.

LACC

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 – Xpeedic 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
- 🟧 Components & Materials
- ⬜ Instrumentation and Measurement Techniques
- 🟩 5G Millimeterwave, FR2
- 🟦 CAD and Modeling Products and Techniques
- ⬜ Systems
- 🟪 Antenna and Antenna Components
- 🟩 High Power Devices, including GaN Devices

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IMS STUDENT PAPER COMPETITION

10:10 – 11:50 TUESDAY, 23 JUNE 2020

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, Nezih 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 5-6GHz 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

Polylithic 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 Agricultral 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 | WEIF1
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 Werbunat, 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 ±70° Beam Scanning | We3F
Student Finalists: Kevin Kai Wei Low, Univ. of California, San Diego, Samet Zihir, 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, Alcatera LLC, 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

INDUSTRY WORKSHOPS

LACC

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	Xpeedic Technology, Inc.	Feng Ling, Xpeedic Technology, Inc.; Lijun Chen, Xpeedic Technology Co. Ltd.
	Enabling Technologies for Silicon Beamformers for 5G and Satcom Systems	Integrated Device Technology, Inc.	

	402AB	403A	403B	404AB
	Tu3A: Integrated Millimeter-Wave Transmission Lines **Chair:** Jun Choi, University at Buffalo **Co-Chair:** Maurizio Bozzi, University of Pavia	**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	**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	**Tu3D: Microwave Characterization of Liquid and Biological Materials** **Chair:** Malgorzata Celuch, QWED Sp. z o.o **Co-Chair:** Arnaud Pothier, Xlim - CNRS-Unversite De Liroges
13:40	**Tu3A-1: Dual Image Dielectric Guide (DIDG) for Polarization Diversity Applications at Millimeter Wave Frequency** M. Noferesti; INRS-EMT; T. Djerafi; INRS-EMT	**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	**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	**Tu3D-1: An SIW Oscillator for Microfluidic Lossy Medium Characterization** M. Abdolrazzaghi; Univ. of Alberta; N. Kazemi; Univ. of Alberta; M. Daneshmand; Univ. of Alberta
13:50				
14:00	**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.	**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	**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	**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.
14:10				
14:20	**Tu3A-3: Travelling-Wave SIW Transmission Line Using TE20 Mode for Millimeter-Wave Antenna Application** Z. Wang; UESTC; Y. Dong; UESTC	**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	**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	**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
14:30				
14:40	**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	**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. Ture; Fraunhofer IAF; A. Leuther; Fraunhofer IAF; F. Schäfer; MPI for Radio Astronomy; A. Navarrini; INAF; P. Serres; IRAM; O. Ambacher; Fraunhofer IAF	**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	**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
14:50				
15:00	**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	**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	**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	
15:10				
15:20				

406AB	408A	409AB	
Tu3E: Acoustic Devices for Ultra-high Frequency Applications and RF Filter Synthesis **Chair:** Brice Ivira, Broadcom Corporation **Co-Chair:** Amir Mortzawi, University of Michigan	**Tu3F: Broadband, High-Performance GaN and GaAs Power Amplifiers** **Chair:** Charles Campbell, QORVO, Inc. **Co-Chair:** Gayle Collins, Obsidian Microwave, LLC.	**Tu3H: Advances in Microwave Semiconductor Devices** **Chair:** Patrick Fay, University of Notre Dame **Co-Chair:** Tony Ivanov, US Army CERDEC	
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	**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	**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; F.M. Ghannouchi; Univ. of Calgary	13:40 13:50
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	**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	**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)	14:00 14:10
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	**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	**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	14:20 14:30
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	**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	**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	14:40 14:50
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.	**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	**Tu3H-5: High-Power RF Characterization of Diamond Schottky Barrier Diodes at X-Band** X. Konstantinou; Michigan State Univ.; C.J. Herrera-Rodriquez; Michigan State Univ.; A. Hardy; Fraunhofer USA CCD; J.D. Albrecht; Michigan State Univ.; T. Grotjohn; Michigan State Univ.; J. Papapolymerou; Michigan State Univ.T	15:00 15:10
			15:20

IMS/RFIC JOINT PANEL SESSION

12:00 – 13:15 TUESDAY, 23 JUNE 2020

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 ourhands off thecar steering wheel ?In any case, our carsare ready to stealcontrol from us and to do withoutthe major responsible for road accidents: man. This panel will ask the questionof how muchconfidence we havein the electronics of ourcars and whetherwe can trust it.Automotive radar is the visionand artificial intelligence is the decision making. We will discuss the reliability of thisvision and thisdecision making of our carsto decide if it is wise enough to stop drivingor if we should our hands on the steeringwheel?

5G SUMMIT

13:30 – 17:00 TUESDAY, 23 JUNE 2020

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.

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IEEE 5G SUMMIT

IEEE ComSoc IEEE Communications Society

MTT-S IEEE MICROWAVE THEORY & TECHNIQUES SOCIETY

	402AB	403A	403B	404AB
	Tu4A: Innovative Wave Transmission, Manipulation and Generation **Chair:** Christian Damm, Ulm University **Co-Chair:** Jason Soric, Raytheon Company	**Tu4B: High-Performance Low-Noise Amplifiers** **Chair:** Chinchun Meng, National Chiao Tung University **Co-Chair:** Luciano Boglione, Naval Research Laboratory	**Tu4C: Advanced Design Techniques for Voltage Controlled Oscillators** **Chair:** Nils Pohl, Ruhr University Bochum **Co-Chair:** Hiroshi Okazaki, NTT DoCoMo, Inc.	**Tu4D: Microwave Systems and Methods for Permittivity Measurements** **Chair:** Pawel Kopyt, Warsaw University of Technology **Co-Chair:** Rashaunda Hnderson, University of Texas at Dallas
15:50 16:00	**Tu4A-1: A Fine Picosecond Pulse Generator Based on Novel SRD Topology and Tapered NLTL** M. Rahman; Polytechnique Montréal; K. Wu; Polytechnique Montréal	**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.	**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.	**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
16:10 16:20	**Tu4A-2: Liquid Crystal Based Parallel-Polarized 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	**Tu4B-2: A Compact Frequency-Tunable VGA for Multi-Standard 5G Transceivers** R. Ben Yishay; ON Semiconductor; D. Elad; ON Semiconductor	**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	**Tu4D-2: High-Resolution Millimeter-Wave Tomography System for Characterization of Low-Permittivity Materials** A. Och; P.A. Hölzl; 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
16:30 16:40	**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.	**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	**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	**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
16:50 17:00	**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	**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.	**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	**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
17:10 17:20 17:30	**Tu4A-5: Equivalent Circuit Models for Full-Tensor Anisotropic Composite Right/Left-Handed Metamaterials** T. Nagayama; Kagoshima 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.	**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.	**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

406AB

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 Heterogenous Neural Network

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

408A

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

409AB

Tu4H: Advanced Transistor Modeling and Characterization

Chair: Rob Jones, Raytheon Company

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

15:50

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

16:00

16:10

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

A.E. Parker; Macquarie Univ.

16:20

16:30

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

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

16:40

16:50

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

17:00

17:10

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

17:20

17:30

IEEE youngprofessionals

JW MARRIOTT L.A. LIVE, DIAMOND BALLROOM

AMATEUR (HAM) RADIO SOCIAL

19:00 – 21:00 TUESDAY, 23 JUNE 2020

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 N0JY)!

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!


INPUT 50 Ω
9kHz-6.5GHz
PROBE PWR
CAL OUT
STEP

Wednesday

	402AB	403A	403B	404AB
	We1A: Non-Planar Filters I **Chair:** Simone Bastioli, RS Microwave **Co-Chair:** Miguel Laso, Public University of Navarre (UPNA)	**We1B: Advances in Wireless Sensors** **Chair:** Jasmin Grosinger, Graz University of Technology **Co-Chair:** Etienne Perret, Grenoble Institute of Technology	**We1C: Millimeter-Wave and Terahertz Transmitter Components** **Chair:** Theodore Reck, Virginia Diodes Inc. **Co-Chair:** Adrian Tang, Jet Propulsion Laboratory	**We1D: Novel Microwave Technologies for Biomedical Sensing** **Chair:** Souvik Dubey, Abbott Labs **Co-Chair:** Hung-Wei Wu, Kun Shan University
08:00 08:10	**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.	**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)	**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	**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.
08:20 08:30	**We1A-2: Design of Extracted-Pole Filters: An Application-Oriented Synthesis Approach** G. Macchiarella; Politecnico di Milano; S. Tamiazzo; CommScope	**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	**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	**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.
08:40 08:50	**We1A-3: A Dispersive Coupling Structure for In-Line Helical Resonator Filters with Transmission Zeros** Y. Zhang; CUHK; K.-L. Wu; CUHK	**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; Alcatera; J.C.M. Hwang; Lehigh University; M.-C.F. Chang; Univ. of California, Los Angeles	**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	**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.
09:00 09:10	**We1A-4: Synthesis of Extracted Pole Filters Without the Extra Spikes** Y. Yang; CUHK; Y. Zeng; CUHK; M. Yu; CUHK; Q. Wu; Xidian Univ.	**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	**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	**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
09:20 09:30	**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	**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	**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	**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.
09:40				

406AB

We1E: High Frequency Non-Reciprocal Techniques using Novel Material, Device and Circuit Approaches

Chair: Dimitris Pavlidis, Florida International University

Co-Chair: Yuanxun Ethan Wang, University of California, Los Angeles

We1E-1: Lamb Wave Resonator Loaded Non-Reciprocal RF Devices

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

We1E-2: Microwave Applications of Zirconium-Doped Hafnium Oxide Ferroelectrics: From Nanoscale Calculations up to Experimental Results

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

We1E-3: Novel Non-Reciprocal Microwave Spin Wave and Magneto-Elastic Wave Devices for On-Chip Signal Processing

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.

We1E-4: Organic Ferrimagnetic Material Vanadium Tetracyanoethylene for Non-Reciprocal Microwave Applications

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.

We1E-5: Non-Reciprocal Lithium Niobate-on-Silicon Acoustoelectric Delay Lines

H. Mansoorzare; Univ. of Central Florida; R. Abdolvand; Univ. of Central Florida

We1E-6: A Highly Linear Non-Magnetic GaN Circulator Based on Spatio-Temporal Modulation with an IIP3 of 56dBm

J.A. Bahaonde; Columbia Univ.; I. Kymissis; Columbia Univ.; H. Krishnaswamy; Columbia Univ.

408A

We1F: Advances in 5G Millimeter-wave Systems and Architectures

Chair: Gent Paparisto, Cadence Design Systems, Inc.

Co-Chair: Christian Fager, Chalmers University of Technology

We1F-1: Demonstrating 139Gbps and 55.6bps/Hz Spectrum Efficiency Using 8×8 MIMO Over a 1.5-km Link at 73.5GHz

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

We1F-2: Digital Predistortion of Millimeter-Wave Phased Array Transmitter with Over-The-Air Calibrated Simplified Conductive Feedback Architecture

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

We1F-3: On the Effectiveness of Near-Field Feedback for Digital Pre-Distortion of Millimeter-Wave RF Beamforming Arrays

A. Ben Ayed; Univ. of Waterloo; G. Scarlato; Univ. of Waterloo; P. Mitran; Univ. of Waterloo; S. Boumaiza; Univ. of Waterloo

We1F-4: High-Frequency Vector-Modulated Signal Generation Using Frequency-Multiplier-Based RF Beamforming Architecture

I. Jaffri; Univ. of Waterloo; A. Ben Ayed; Univ. of Waterloo; A.M. Darwish; U.S. Army Research Laboratory; S. Boumaiza; Univ. of Waterloo

We1F-5: Aperture-Array & Lens+FPA Multi-Beam Digital Receivers at 28GHz on Xilinx ZCU 1275 RF SoC

S. Pulipati; V. Ariyarathna; Md.R. Khan; S. Bhardwaj; A. Madanayake; Florida International Univ.

We1F-6: A 3D Detect-Array for Low-Complexity W-Band Beam Sensing and Direction-of-Arrival Estimation

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

408B

We1G: Emerging Next Generation GaN RF Technologies for 5G and MMW Applications

Chair: Jeong-Sun Moon, HRL Laboratories

Co-Chair: Kenneth Mays, Boeing

We1G-1: Emerging High Power mm-Wave RF Transistors

Y.-K. Chen; DARPA; A. Sivananthan; Booz Allen Hamilton; T.-H. Chang; HetInTec

We1G-2: Advanced GaN HEMT Modeling Techniques and Power Amplifiers for Millimeter-Wave Applications

S. Shinjo; Mitsubishi Electric; M. Hangai; Mitsubishi Electric; Y. Yamaguchi; Mitsubishi Electric; M. Miyazaki; Mitsubishi Electric

We1G-3: Qorvo's Emerging GaN Technologies for mmWave Applications

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

We1G-4: High-Speed Graded-Channel GaN HEMTs with Linearity and Efficiency

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

We1G-5: Advances in the Super-Lattice Castellated Field Effect Transistor (SLCFET) for High Power Density, Energy Efficient RF Amplification

J. Chang; Northrop Grumman; S. Afroz; Northrop Grumman; B. Novak; Northrop Grumman; J. Merkel; Northrop Grumman; K. Nagamatsu; Northrop Grumman; R. Howell; Northrop Grumman

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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
- 🟧 Components & Materials
- ⬜ Instrumentation and Measurement Techniques
- 🟫 5G Millimeterwave, FR2
- 🟦 CAD and Modeling Products and Techniques
- ⬛ Systems
- 🟪 Antenna and Antenna Components
- 🟩 High Power Devices, including GaN Devices

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IMS INTERACTIVE FORUM

13:40-15:20 WEDNESDAY, 24 JUNE 2020

WEIF1 CHAIR: ZAHER BARDAI, *CONSULTANT* | CO-CHAIR: JEFFREY NANZER, *MICHIGAN STATE UNIVERSITY*

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. Djerafi; 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. Maktoomi; 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. Perregrini; 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

402AB

We2A: Non-Planar Filters II

Chair: Ming Yu, Chinese University of Hong Kong

Co-Chair: Giuseppe Macchiarella, Politecnico di Milano

10:10

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

10:20

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

10:30

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

10:40

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

10:50

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

11:00

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

11:10

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

11:20

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

11:30

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

11:40

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

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 20μW, 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 Zihir, 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 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

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.

IMS TECHNICAL SESSIONS 10:10 – 11:50 | WEDNESDAY, 24 JUNE 2020 | LACC

406AB	408A	408B	
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	**We2F: 5G Arrays and Beamformers** **Chair:** Kwang-Jin Koh, Lockheed Martin Corp. **Co-Chair:** Tumay Kanar, Renesas Electronics America	**We2G: Load Modulated Power Amplifiers** **Chair:** Leo de Vreede, Delft University of Technology **Co-Chair:** Paul Draxler, MaXentric Technologies, LLC	
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	**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	**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	10:10 10:20
We2E-2: UIR-Loaded Dual-Mode SIW Filter with Compact Size and Controllable Transmission Zeros Y. Zhu; UESTC; Y. Dong; UESTC	**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. Zihir; IDT; G.M. Rebeiz; Univ. of California, San Diego	**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	10:30 10:40
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	**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	**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	10:50 11:00
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	**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.	**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	11:10 11:20
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	**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	**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	11:30 11:40
			11:50

LACC

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 Zemede, 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.

IMS PANEL SESSION

LACC

12:00 – 13:15 WEDNESDAY, 24 JUNE 2020

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

LACC

12:00 – 13:30 WEDNESDAY, 24 JUNE 2020

Lecture Title		Course Syllabus
TWA1	**N-Path Mixers and Filters: Concept, Theory and Applications** **Speaker:** Alyosha Molnar, Cornell Univ. **12:00 – 13:30**	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.
TWB2	**Fundamentals of Phased Arrays** **Speaker:** Marinos Vouvakis, University of Massachusetts Amherst **12:00 – 13:30**	Phased arrays have been the linchpin technology behind 5G wireless networks, LEO & MEO broadband high-speed internet connectivity and to some extend 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.

	402AB	403A	403B	404AB
	We3A: Recent Advances in Passive Components **Chair:** Holger Maune, Technische Universität Darmstadt **Co-Chair:** Thomas Lingel, TTM	**We3B: Advanced Nonlinear Measurement Techniques and Results** **Chair:** Marcus Da Silva, National Instruments **Co-Chair:** Sherif Ahmed, Entrepreneur	**We3C: Millimeter-Wave and Submillimeter-Wave Components** **Chair:** Dietmar Kissinger, Ulm University **Co-Chair:** William Deal, Northrop Grumman Corporation	**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
15:50	**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.	**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	**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.	**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.
16:00				
16:10	**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.	**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	**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	**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
16:20	**We3A-3: A Geometrically Shaped Hemispherical Cavity Resonator with Extended Spurious-Free Region** J. Li; Shenzhen Univ.; T. Yuan; Shenzhen Univ.			
16:30	**We3A-4: Low-Loss Continuous True Time Delay with Delay Summing** K. Park; Yonsei Univ.; B.-W. Min; Yonsei Univ.	**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. Gasmi; OMMIC; C. Edoua Kacou; OMMIC; M. Prigent; XLIM (UMR 7252); R. Quéré; XLIM (UMR 7252)	**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	**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
16:40				
16:50	**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.	**We3B-4: Pulse Profiling Active Load Pull Measurements** Y. Alimohammadi; Cardiff University; E. Kuwata; Cardiff University; X. Liu; Cardiff University; T. Husseini; Al-Furat Al-Awsat Technical University; J.J. Bell; Cardiff University; L. Wu; Huawei Technologies; P.J. Tasker; Cardiff University; J. Benedikt; Cardiff University		**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
17:00				
17:10	**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	**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		**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. Pepeljugoski; 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
17:20				
17:30				

406AB

We3E: Tunable and Active Filters

Chair: Sanghoon Shin, Naval Research Laboratory

Co-Chair: Julien LINTIGNAT, University of Limoges

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

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

We3E-2: BPFs with Parametrically Compensated Passband Insertion Loss and Selectivity

L.K. Yeung; Univ. of California, Los Angeles; X. Zou; Univ. of California, Los Angeles; Y.E. Wang; Univ. of California, Los Angeles

We3E-3: Fully-Reconfigurable Non-Reciprocal Bandpass Filters

D. Simpson; University of Colorado Boulder; D. Psychogiou; University of Colorado Boulder

We3E-4: A Dual-Mode Frequency Reconfigurable Waveguide Filter with a Constant Frequency Spacing Between Transmission Zeros

G. B.; Univ. of Waterloo; R.R. Mansour; Univ. of Waterloo

We3E-5: Behavior of Lossy Spiral Inductors and Their Applications to the Design of Tunable Band Reject Filters

H. Jia; Univ. of Waterloo; R.R. Mansour; Univ. of Waterloo

We3E-6: Novel Reconfigurable Filtering Crossover Based on Evanescent-Mode Cavity Resonators

J. Lai; UESTC; T. Yang; UESTC; P.-L. Chi; National Chiao Tung Univ. ; R. Xu; UESTC

408A

We3F: Beamforming for Satellite Communications and Sensors

Chair: Byung-Wook Min, Yonsei University

Co-Chair: David Ricketts, North Carolina State University

We3F-1: A Scalable Switchable Dual-Polarized 256-Element Ka-Band SATCOM Transmit Phased-Array with Embedded RF Driver and ±70° Beam Scanning

K.K.W. Low; Univ. of California, San Diego; S. Zihir; IDT; T. Kanar; IDT; G.M. Rebeiz; Univ. of California, San Diego

We3F-2: A 28-GHz Full Duplex Front-End and Canceller Using Two Cross-Polarized 64-Element Phased Arrays

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.

We3F-3: Affordable, Multi-Function Flight-Worthy Airborne Phased-Array Sensor

J. Navarro; Boeing

We3F-4: A Scalable 256-Element E-Band Phased-Array Transceiver for Broadband Communications

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

We3F-5: A Dual-Polarized 1024-Element Ku-Band SATCOM Transmit Phased-Array with ±70° Scan and 43.5dBW EIRP

G. Gültepe; Univ. of California, San Diego; S. Zihir; IDT; T. Kanar; IDT; G.M. Rebeiz; Univ. of California, San Diego

408B

We3G: Digital Predistortion and Supply Modulation

Chair: John Wood, Wolfspeed, A Cree Company

Co-Chair: Jonmei Yan, MaXentric Technologies, LLC

We3G-1: Closed-Loop Sign Algorithms for Low-Complexity Digital Predistortion

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

We3G-2: OTA-Based Data Acquisition and Signal Separation for Digital Predistortion of Multi-User MIMO Transmitters in 5G

X. Wang; Univ. College Dublin; Y. Li; Univ. College Dublin; C. Yu; Southeast Univ.; W. Hong; Southeast Univ.; A. Zhu; Univ. College Dublin

We3G-3: L-Band Floating-Ground RF Power Amplifier for Reverse-Type Envelope Tracking Systems

S. Paul; FBH; W. Heinrich; FBH; O. Bengtsson; FBH

We3G-4: High Efficiency, High Bandwidth Switch-Mode Envelope Tracking Supply Modulator

F. Hühn; FBH; F. Müller; FBH; L. Schellhase; FBH; W. Heinrich; FBH; A. Wentzel; FBH

We3G-5: Exploiting the Marx Generator as a 100MHz High-Speed Multilevel Supply Modulator

P. Gjurovski; RWTH Aachen Univ.; L. Huessen; RWTH Aachen Univ.; R. Negra; RWTH Aachen Univ.

15:50
16:00
16:10
16:20
16:30
16:40
16:50
17:00
17:10
17:20
17:30

WEDNESDAY

Microwave Field, Device & Circuit Techniques | Passive Components | Active Components | Systems & Applications | Emerging Technologies & Applications | Focus & Special Sessions | Late Breaking News

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," *IEEE Transactions on Microwave Theory and Techniques*, 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," *IEEE Microwave Magazine*, 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," *IEEE Microwave and Wireless Components Letters* Tatsuo Itoh Prize, 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," *IEEE Transactions on Terahertz Science & Technology*, 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	*for contributions to development of electromagnetic phenomena in metamaterials and periodic structures*
William Chappell	*for leadership in the development of reconfigurable radio frequency and microwave systems*
Xudong Chen	*for contributions to optimization methods for electromagnetic inverse scattering*
Jung-chih Chiao	*for contributions to wireless and battery-less medical implants*
Thomas Crowe	*for leadership in the development of terahertz devices and instrumentation*
Edward Godshalk	*for development of microwave on-wafer probing and measurement techniques*
Akira Inoue	*for development of inverse class-F power amplifiers for mobile phones*
Nuria Llombart Juan	*for contributions to millimeter and submillimeter wave quasi- optical antennas*
Gong-ru Lin	*for contributions to ultrafast fiber lasers and highspeed laser diodes for optical communications*
Kartikeyan Machavaram	*for contributions to high-power millimeter wave and terahertz sources*
Chul Soon Park	*for development of low power millimeter-wave circuits and packages*
Ullrich Pfeiffer	*for development of silicon-based millimeter-wave and terahertz circuits and systems*
Dennis Prather	*for contributions to diffractive optical systems*
Jaume Anguera Pros	*for contributions to small multiband antennas for wireless telecommunication devices*
Jae-sung Rieh	*for contributions to silicon-germanium integrated circuits for wireless communications*
Manfred Schindler	*for development in microwave switch technology for radar and wireless communication systems*
Shiwen Yang	*for development of time-modulated antenna arrays*

WOMEN IN MICROWAVES

IEEE Women in Engineering
Wie

Thursday

	403A	403B	404AB
	Th1B: Late-breaking News in Silicon Technologies and Circuits **Chair:** Deuk Heo, Washington State University **Co-Chair:** James Buckwalter, University of California, Santa Barbara	**Th1C: Advanced Radar Systems for Automotive and Vehicular Applications** **Chair:** Markus Gardill, Universität Würzburg **Co-Chair:** Martin Vossiek, Friedrich-Alexander-Universität Erlangen-Nürnberg	**Th1D: Chip-Scale Interconnects and Packaging Technologies** **Chair:** Rhonda Franklin, University of Minnesota, Twin Cities **Co-Chair:** Florian Herrault, HRL Laboratories, LLC
08:00	**Th1B-1: An E-Band Power Amplifier Using High Power RF Device with Hybrid Work Function and Oxide Thickness in 22nm Low-Power FinFET** 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	**Th1C-1: A Fast-Chirp MIMO Radar System Using Beat Frequency FDMA with Single-Sideband Modulation** 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	**Th1D-1: Polylithic Integration for RF/MM-Wave Chiplets Using Stitch-Chips: Modeling, Fabrication, and Characterization** T. Zheng; Georgia Tech; P.K. Jo; Georgia Tech; S. Kochupurackal Rajan; Georgia Tech; M.S. Bakir; Georgia Tech
08:10			
08:20	**Th1B-2: A Highly Rugged 19dBm 28GHz PA Using Novel PAFET Device in 45RFSOI Technology Achieving Peak Efficiency Above 48%** S. Syed; GLOBALFOUNDRIES; S. Jain; GLOBALFOUNDRIES; D. Lederer; GLOBALFOUNDRIES; W. Liu; GLOBALFOUNDRIES; E. Veeramani; GLOBALFOUNDRIES; B. Chandhoke; GLOBALFOUNDRIES; A. Kumar; GLOBALFOUNDRIES; G. Freeman; GLOBALFOUNDRIES	**Th1C-2: A System Analysis of Noise Influences on the Imaging Performance of Millimeter Wave MIMO Radars** A. Dürr; Universität Ulm; D. Schwarz; Universität Ulm; C. Waldschmidt; Universität Ulm	**Th1D-2: A W-Band Chip-to-Printed Circuit Board Interconnect** B. Deutschmann; Technische Universität Hamburg-Harburg; A.F. Jacob; Technische Universität Hamburg-Harburg
08:30			
08:40	**Th1B-3: Efficiency Enhancement Technique Using Doherty-Like Over-The-Air Spatial Combining in a 28GHz CMOS Phased-Array Transmitter** A. Sayag; Technion; I. Melamed; Technion; E. Cohen; Technion	**Th1C-3: Millimeter-Wave Interferometric Radar for Speed-Over-Ground Estimation** E. Klinefelter; Michigan State Univ.; J.A. Nanzer; Michigan State Univ.	**Th1D-3: A Low-Loss Balun-Embedded Interconnect for THz Heterogeneous System Integration** 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.
08:50			
09:00	**Th1B-4: A Multi-Standard 15–57GHz 4-Channel Receive Beamformer with 4.8dB Midband NF for 5G Applications** A.A. Alhamed; Univ. of California, San Diego; O. Kazan; Univ. of California, San Diego; G.M. Rebeiz; Univ. of California, San Diego	**Th1C-4: Root-MUSIC Based Power Estimation Method with Super-Resolution FMCW Radar** T. Iizuka; NTT; Y. Toriumi; NTT; F. Ishiyama; NTT; J. Kato; NTT	**Th1D-4: W Band Carbon Nanotubes Interconnects Compatible with CMOS Technology** 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)
09:10			
09:20		**Th1C-5: Learning Representations for Neural Networks Applied to Spectrum-Based Direction-of-Arrival Estimation for Automotive Radar** M. Gall; InnoSenT; M. Gardill; InnoSenT; J. Fuchs; FAU Erlangen-Nürnberg; T. Horn; InnoSenT	**Th1D-5: Suspended SiC Filter with DRIE Silicon Subcovers** 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
09:30			
09:40			

406AB

Th1E: Advances in RF Energy Harvesting

Chair: Alessandra Costanzo, University of Bologna

Co-Chair: Smail Tedjini, University of Grenoble-Alpes France

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. He; Southeast Univ.; J. Xu; Southeast Univ.; D. Zhao; Southeast Univ.

Th1E-2: An Ultra-Low-Power Power Management Circuit with Output Bootstrapping and Reverse Leakage Reduction Function for RF Energy Harvesting

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.

Th1E-3: Compact and High Efficiency Rectifier Design Based on Microstrip Coupled Transmission Line for Energy Harvesting

F. Zhao; UESTC; D. Inserra; UESTC; G. Wen; UESTC

Th1E-4: High-Efficiency Sub-1GHz Flexible Compact Rectenna Based on Parametric Antenna-Rectifier Co-Design

M. Wagih; Univ. of Southampton; A.S. Weddell; Univ. of Southampton; S. Beeby; Univ. of Southampton

Th1E-5: 920MHz Band High Sensitive Rectenna with the High Impedance Folded Dipole Antenna on the Artificial Magnetic Conductor Substrate

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

408A

Th1F: Phased Arrays and Beamformer Technologies

Chair: Frank E. van Vliet, TNO, Netherlands

Co-Chair: Christian Waldschmidt, Ulm University

Th1F-1: Design Considerations and FPGA Implementation of a Wideband All-Digital Transmit Beamformer with 50% Fractional Bandwidth

S. Pulipati; MERL; R. Ma; MERL

Th1F-2: FPGA-Based 2-D FIR Frost Beamformers with Digital Mutual Coupling Compensation

S. Pulipati; Florida International Univ.; V. Ariyarathna; 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.

Th1F-3: In-situ Self-Test and Self-Calibration of Dual-Polarized 5G TRX Phased Arrays Leveraging Orthogonal-Polarization Antenna Couplings

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

Th1F-4: Scalable, Deployable, Flexible Phased Array Sheets

M. Gal-Katziri; Caltech; A. Fikes; Caltech; F. Bohn; Caltech; B. Abiri; Caltech; M.R. Hashemi; Caltech; A. Hajimiri; Caltech

Th1F-5: 28GHz Active Monopulse Networks with Amplitude and Phase Control and -30dB Null-Bandwidth of 5GHz

H. Chung; Univ. of California, San Diego; Q. Ma; Univ. of California, San Diego; G.M. Rebeiz; Univ. of California, San Diego

408B

Th1G: Advanced Silicon PAs for 5G and Automotive Applications

Chair: Kaushik Sengupta, Princeton University

Co-Chair: Joe Qiu, Army Research Office

Th1G-1: A 28GHz Linear and Efficient Power Amplifier Supporting Wideband OFDM for 5G in 28nm CMOS

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.

Th1G-2: A Balanced Power Amplifier with Asymmetric Coupled-Line Couplers and Wilkinson Baluns in a 90nm SiGe BiCMOS Technology

Y. Gong; Georgia Tech; J.D. Cressler; Georgia Tech

Th1G-3: Load Modulated Balanced mm-Wave CMOS PA with Integrated Linearity Enhancement for 5G Applications

C.R. Chappidi; Princeton Univ.; T. Sharma; Princeton Univ.; Z. Liu; Princeton Univ.; K. Sengupta; Princeton Univ.

Th1G-4: A 22–37GHz Broadband Compact Linear mm-Wave Power Amplifier Supporting 64-/256-/512-QAM Modulations for 5G Communications

F. Wang; A. Wang; H. Wang; Georgia Tech

Th1G-5: Two W-Band Wideband CMOS mmW PAs for Automotive Radar Transceivers

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

Th1G-6: An 18.5W Fully-Digital Transmitter with 60.4% Peak System Efficiency

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

08:00
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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
- ■ Components & Materials
- ■ Instrumentation and Measurement Techniques
- ■ 5G Millimeterwave, FR2
- ■ CAD and Modeling Products and Techniques
- ■ Systems
- ■ Antenna and Antenna Components
- ■ High Power Devices, including GaN Devices

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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
	Th2B: Late-breaking News from the Terahertz Frontier	**Th2C: Networked and Distributed Radar and Imaging Systems**	**Th2D: 3D Packaging and Additive Manufacturing**
	Chair: Nils Pohl, Ruhr University Bochum **Co-Chair:** James Buckwalter, University of California, Santa Barbara	**Chair:** Christian Waldschmidt, Ulm University **Co-Chair:** Martin Vossiek, Ulm University	**Chair:** Kamal Samanta, Sony Corp. **Co-Chair:** Dominique Baillargeat, Xlim - CNRS- Unversite De Liroges
10:10 10:20	**Th2B-1: First Demonstration of G-Band Broadband GaN Power Amplifier MMICs Operating Beyond 200GHz** 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	**Th2C-1: A Self-Mixing Receiver for Wireless Frequency Synchronization in Coherent Distributed Arrays** S. Mghabghab; Michigan State Univ.; J.A. Nanzer; Michigan State Univ.	**Th2D-1: RF Systems on Antenna (SoA): A Novel Integration Approach Enabled by Additive Manufacturing** X. He; Georgia Tech; Y. Fang; Georgia Tech; R.A. Bahr; Georgia Tech; M.M. Tentzeris; Georgia Tech
10:30 10:40	**Th2B-2: 475-GHz 20-dB-Gain InP-HEMT Power Amplifier Using Neutralized Common-Source Architecture** H. Hamada; NTT; T. Tsutsumi; NTT; H. Matsuzaki; NTT; H. Sugiyama; NTT; H. Nosaka; NTT	**Th2C-2: A Digital Interferometric Array with Active Noise Illumination for Millimeter-Wave Imaging at 13.7fps** S. Vakalis; Michigan State Univ.; J.A. Nanzer; Michigan State Univ.	**Th2D-2: Wireless 3D Vertical Interconnect with Power Splitting Capability** A. Dave; Univ. of Minnesota; R. Franklin; Univ. of Minnesota
10:50 11:00	**Th2B-3: A High-Isolation and Highly Linear Super-Wideband SPDT Switch in InP DHBT Technology** 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	**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** M. Gottinger; FAU Erlangen-Nürnberg; M. Hoffmann; FAU Erlangen-Nürnberg; M. Vossiek; FAU Erlangen-Nürnberg	**Th2D-3: 3D Printed One-Shot Deployable Flexible “Kirigami” Dielectric Reflectarray Antenna for mm-Wave Applications** Y. Cui; Georgia Tech; S.A. Nauroze; Georgia Tech; R.A. Bahr; Georgia Tech; M.M. Tentzeris; Georgia Tech
11:10 11:20	**Th2B-4: 240-GHz Reflectometer with Integrated Transducer for Dielectric Spectroscopy in a 130-nm SiGe BiCMOS Technology** D. Wang; Fraunhofer IPMS; M.H. Eissa; IHP; K. Schmalz; IHP; T. Kämpfe; Fraunhofer IPMS; D. Kissinger; Universität Ulm	**Th2C-4: Phase Recovery in Sensor Networks Based on Incoherent Repeater Elements** D. Werbunat; Universität Ulm; B. Meinecke; Universität Ulm; M. Steiner; Universität Ulm; C. Waldschmidt; Universität Ulm	**Th2D-4: Evaluation of Micro Laser Sintering Metal 3D-Printing Technology for the Development of Waveguide Passive Devices up to 325GHz** 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. Ducournau; IEMN (UMR 8520); E. Dubois; IEMN (UMR 8520); C. Gaquière; IEMN (UMR 8520); D. Gloria; STMicroelectronics
11:30 11:40	**Th2B-5: A 311.6GHz Phase-Locked Loop in 0.13µm SiGe BiCMOS Process with -90dBc/Hz In-Band Phase Noise** 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	**Th2C-5: Fusion of Radar and Communication Information for Tracking in OFDM Automotive Radar at 24GHz** J.B. Sanson; Instituto de Telecomunicações; D. Castanheira; Instituto de Telecomunicações; A. Gameiro; Instituto de Telecomunicações; P.P. Monteiro; Instituto de Telecomunicações	
11:50			

406AB

Th2E: Novel Applications of Wireless Power Transfer

Chair: Nuno Borges Carvalho, Instituto De Telecomunicacoes

Co-Chair: Marco Dionigi, University of Perugia

Th2E-1: High Isolation Simultaneous Wireless Power and Information Transfer System Using Coexisting DGS Resonators and Figure-8 Inductors

A. Barakat; Kyushu Univ.; R.K. Pokharel; Kyushu Univ.; S. Alshhawy; Kyushu Univ.; K. Yoshitomi; Kyushu Univ.; S. Kawasaki; JAXA

Th2E-2: Conductive Coupler for Wireless Power Transfer Under Seawater

M. Tamura; Toyohashi University of Technology; K. Murai; Toyohashi University of Technology; M. Matsumoto; Toyohashi University of Technology

Th2E-3: The K-Band Communication Transmitter/Receiver Powered by the C-Band HySIC Energy Harvester with Multi-Sensors

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

Th2E-4: A Wireless Power Transfer System (WPTS) Using Misalignment Resilient, On-Fabric Resonators for Wearable Applications

D. Vital; Florida International Univ.; J.L. Volakis; Florida International Univ.; S. Bhardwaj; Florida International Univ.

Th2E-5: A 3D Rectenna with All-Polarization and Omnidirectional Capacity for IoT Applications

S. Wang; National Central Univ. ; H.-Y. Chang; National Central Univ.

Th2E-6: RF Energy On-Demand for Automotive Applications

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

408A

Th2F: In-Band Full-Duplex Cancellers and Transceivers

Chair: Kenneth E. Kolodziej, Massachusetts Institute of Technology, Lincoln Laboratory

Co-Chair: Kate Remley, National Institute of Standards and Technology

Th2F-1: A BST Varactor Based Circulator Self Interference Canceller for Full Duplex Transmit Receive Systems

C.F. Campbell; Qorvo; J.A. Lovseth; Collins Aerospace; S. Warren; Qorvo; A. Weeks; Univ. of Central Florida; P.B. Schmid; Qorvo

Th2F-2: In-Band Full-Duplex Self-Interference Canceller Augmented with Bandstop-Configured Resonators

R. Sepanek; BAE Systems ; M. Hickle; BAE Systems ; M. Stuenkel; BAE Systems

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

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

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

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

Th2F-5: Transmit-Receive Cross-Modulation Distortion Correction in a 5–6GHz Full Duplex Quadrature Balanced CMOS RF Front-End

N. Ginzberg; Technion; T. Gidoni; Tel Aviv University; D. Regev; Toga Networks; E. Cohen; Technion

408B

Th2G: Phased Array and Beamformer Integrated Circuits

Chair: Jeremy Dunworth, Qualcomm Research

Co-Chair: Donald LaFrance, Lockheed Martin Corp.

Th2G-1: A Fundamental-Frequency 122GHz Radar Transceiver with 5.3dBm Single-Ended Output Power in a 130nm SiGe Technology

E. Aguilar; FAU Erlangen-Nürnberg; V. Issakov; OvG Universität Magdeburg; R. Weigel; FAU Erlangen-Nürnberg

Th2G-2: An Integrated Bistatic 4TX/4RX Six-Port MIMO-Transceiver at 60GHz in a 130-nm SiGe BiCMOS Technology for Radar Applications

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

Th2G-3: A Power Efficient BiCMOS Ka-Band Transmitter Front-End for SATCOM Phased-Arrays

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

Th2G-4: A K-Band Low-Complexity Modular Scalable Wide-Scan Phased Array

F. Akbar; Univ. of Michigan; A. Mortazawi; Univ. of Michigan

Th2G-5: A Compact Ultra-Broadband GaN MMIC T/R Front-End Module

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

10:10
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Sister Cities
OF LOS ANGEL
6151 mi Salvador
Nagoya
8977 mi Jakarta
St. P ersburg 5720 mi
Giza
7436 mi Guangzhou
Vanco
8710 mi Mumbai
Athens 6925 mi
Taipei
6499 mi Auckland
Berlin 5759 mi
Pusan
Lusaka
1652 mi Mexico City
Bordeaux 5755 mi
Split 6386 mi
7406 mi Makati
Kaunas 6230 mi
Ischia 6436 mi
Yerevan 7200 mi

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 &ampndash; 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&amprsquo;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?

	408A	403B	404AB	403A
	Th3B: Robert J Trew: More than 50 Years of Service to the Microwave Community”	**Th3C: Emerging Technologies for Radar Detection, Tracking, and Imaging**	**Th3D: Late-breaking News in Millimeter-Wave Communication and Radar Systems**	**Th3E: Late-breaking News in III-V MMICs**
	Chair: Samir El-Ghazaly, University of Arkansas **Co-Chair:** George Haddad, National Science Foundation	**Chair:** Rudy Emrick, Northrop Grumman Corporation **Co-Chair:** Danny Elad, ON Semiconductor	**Chair:** Ethan Wang, University of California, Los Angeles **Co-Chair:** James Buckwalter, University of California, Santa Barbara	**Chair:** Hasan Sharifi, HRL Laboratories **Co-Chair:** James Buckwalter, University of California, Santa Barbara
13:40 13:50	**Th3B-1: Remembering Dr. Robert James Trew** H.M. Trew; U.S. Department of the Treasury	**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	**Th3D-1: A 25–29GHz 64-Element Dual-Polarized/Dual-Beam Small-Cell with 45dBm 400MHz 5GNR 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	**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
14:00 14:10	**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	**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	**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	**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
14:20 14:30	**Th3B-3: Robert J. Trew and the Microwave Community** M. Golio; Golio Endeavors	**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	**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	**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.
14:40 14:50	**Th3B-4: Bob Trew: Teacher, Researcher, Mentor, and Friend** A. Riddle; Quanergy Systems	**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.	**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	**Th3E-4: A 300-μW 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. Grahn; Chalmers Univ. of Technology
15:00 15:10		**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.	**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. Koppelmann; Universität Paderborn; J.C. Scheytt; Universität Paderborn	
15:20				

408B

Th3G: Phased Array Silicon Components

Chair: Sorin Voinnigescu, University of Toronto

Co-Chair: Cynthia Hang, Raytheon Company

13:30

Th3G-1: A DC-32GHz 7-Bit Passive Attenuator with Capacitive Compensation Bandwidth Extension Technique in 55nm CMOS

13:40

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.

13:50

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

14:10

14:10

Th3G-3: A 35GHz Hybrid ϖ-Network High-Gain Phase Shifter with 360° Continuous Phase Shift Range

14:20

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.

14:30

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

14:40

Th3G-5: A CMOS Balun with Common Ground and Artificial Dielectric Compensation Achieving 79.5% Fractional Bandwidth and <2° Phase Imbalance

G. Yang; Tianjin Univ.; R. Chen; Southeast Univ.; K. Wang; Tianjin Univ.

14:50

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.

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 PRACTICE PAPER COMPETITION

A CMOS Balun with Common Ground and Artificial Dielectric Compensation Achieving 79.5% Fractional Bandwidth and <2° 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. Briese, N. Pohl, Fraunhofer FHR

A 680GHz Direct Detection Dual-Channel Polarimetric Receiver
C.M. Cooke, K. Leong, K. Nguyen, A. Escorcia, 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. Schrattenecker, Intel, P.F. Freidl, Infineon Technologies, S. Scheiblhofer, D. Zankl- voestalpine, 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. Hickle, M. Stuenkel, BAE Systems

A 135–183GHz Frequency Sixtupler 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

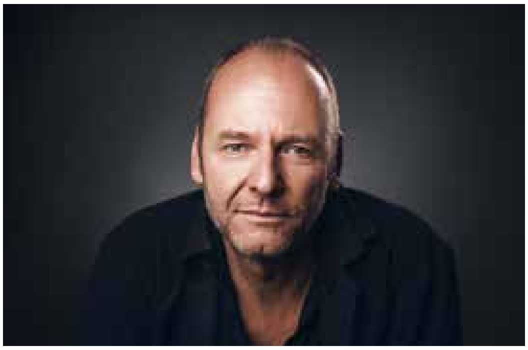
Acceleration and Extension of Radial Point Interpolation Method (RPIM) to Complex Electromagnetic Structures
K. Sabet, A.I. Stefan, EMAG Technologies

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. Hölzl, 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

95th ARFTG Microwave Measurement Conference Technical Program

	08:00 to 08:10	Welcome and Introduction	Joe Gering, *ARFTG President,* Jon Martens, *General Chair,* Peter Aaen, *TPC Chair*
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, *EMAG Technologies Inc, Ann Arbor, MI, USA*
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, *National Institute of Standards and Technology*
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 *Keysight Technologies, Santa Rosa, CA*
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., [2]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, *Keysight Technologies*
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; *University of Colorado – Boulder*
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. Burghartz[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**	

ARFTG IEEE MTT-S IEEE MICROWAVE THEORY & TECHNIQUES SOCIETY

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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, *National Institute of Standards and Technology*
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; *University of Regina*
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]*National Institute of Standards and Technology,* [2]*Colorado School of Mines*	
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]*National Institute of Standards and Technology,* [2]*Bureau Veritas,* [3]*ETS-Lindgren,* [4]*Bluetest AB,* [5]*EMITE,* [6]*Sporton,* [7]*Dell*

Interactive Forum Session

		Backward Unknown-Thru Calibration Method	JeongHwan Kim, Jin-Seob Kang, Jeong-Il Park, Chihyun Cho, *KRISS*
		Active Interferometry-Based Vector Network Analyzer Reference Impedance Renormalization	Haris Votsi[1], Cristian Matei[2], Stavros Iezekiel[1], Peter H. Aaen[3] [1]*University of Cyprus,* [2]*University of Surrey,* [3]*Colorado School of Mines*
		SOLT and SOLR calibration methods using a single multiport “thru” standard connection	Tibault Reveyrand, Silvia Hernandez, Sebastien Mons, Edouard Ngoya, *XLIM, University of Limoges*
		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]*Baylor University,* [2]*Pennsylvania State University,* [3]*Army Research Laboratory*
		Model of Probe Transition Including Probe Mispositioning	Robin Schmidt[1], Dominique Schreurs[2], Michael Dieudonné[1], Pawel Barmuta[2] [1]*Keysight Technologies,* [2]*Katholieke Universiteit Leuven*
		Vector Network Analyzer Calibration for Characterization of Packaged Power MOSFET Device at RF Frequency	Masahiro Horibe and Iku Hirano, *AIST*
		High-Performance Probe for Over-the-Air Measurement	Mohammadreza Ranjbar Naeini, Yuchen Gu, Daniel van der Weide, *University of Wisconsin-Madison*
		Complex Permittivity Measurement Technique for a 3D Printed Rectangular Dielectric Rod using an NRD Guides at 60-GHz Band	Takashi Shimizu and Yoshinori Kogami, *Utsunomiya University*

Workshop Title		Workshop Abstract
WFA	**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**	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 backhauls 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.
WFB	**Space Based Solar Power (SBSP)** **Sponsor:** IMS **Organizer:** C. Jackson, *Northrop Grumman;* J. McSpadden, *Raytheon* **08:00 – 17:15**	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.
WFC	**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**	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-MTTS 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.

Workshop Abstract	Workshop Title	
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.	**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**	WFD
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.	**GaN Modeling in the Field: Recent Advances and Remaining Challenges** **Sponsor:** IMS **Organizer:** M. Roberg, *Qorvo;* T. Canning, *Infineon Technologies* **08:00 – 17:15**	WFE
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.	**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**	WFF
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.	**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**	WFG

FRIDAY WORKSHOPS

LACC

08:00 – 17:15 **FRIDAY, 26 JUNE 2020**

Workshop Title		Workshop Abstract
WFH	**Toward Non-Invasive Waves and Characterization for Biomedical Applications: from Microwaves to mm-Waves to Nanosecond Pulsed Electric Fields (nsPEF)** **Sponsor:** IMS **Organizer:** M. Gardill, *InnoSenT;* S. Chung, *Neuralink;* Y.-K. Chen, *DARPA* **8:00:00 - 11:50**	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).

FRIDAY
TECHNICAL LECTURES

LACC

12:00 – 13:30 **FRIDAY, 26 JUNE 2020**

Lecture Title		Course Syllabus
TFA1	**Silicon-based Millimeter-Wave Phased Array Design** **Speakers:** Bodhisatwa Sadhu, IBM T. J. Watson Research Center; Alberto Valdes-Garcia, IBM T. J. Watson Research Center **08:30 - 12:00**	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.

EXHIBITING COMPANIES

Exhibitors as of 9 April 2020

Account Name
3D Glass Solutions
3G Shielding Specialties
3RWAVE
A.J. Tuck Co.
A.L.M.T. Corp.
A.T. Wall Company
A-Alpha Waveguide Inc.
ABF Elettronica S.r.l.
Accumet
Accurate Circuit Engineering
ACEWAVETECH
ACST GmbH
Adesto Technologies Corp.
ADMOTECH Co., Ltd.
Adsantec Inc.
AdTech Ceramics
Advanced Assembly
Advanced Circuitry International
Advanced Microwave Technology Co., Ltd.
Advanced Test Equipment Rentals
AEM, Inc.
AGC-Nelco
Agile Microwave Technology Inc.
AI Technology, Inc.
A-INFO Inc.
Akoustis, Inc.
Aldetec, Inc. (UST-Aldetec)
Almic Electronics Co., Ltd.
Altair Engineering, Inc.
Altum RF
AMCAD Engineering
AMCOM Communications Inc.
American Microwave Corp.
American Standard Circuits, Inc.
Ametek CTS US/Instruments for Industries
AMETEK Electronic Interconnect and Packaging
Amphenol Printed Circuits
Ampleon
AmpliTech Inc.
Amwav Technology Limited
Analog Devices, Inc.
Anapico Ltd.
Anokiwave
Anritsu Co.
ANSYS, Inc.
AO Technologies
APA Wireless Technologies
API Technologies
Applied Thin-Film Products
AR Modular RF
AR RF/Microwave Instrumentation
Arralis
Artech House
ASB Inc.
ASI dba RF Depot Inc.
Association of Old Crows/Naylor
Astronics Test Systems
Atlanta Micro, Inc.
Auden Techno Corp.
Avalon Test Equipment
AVX Corporation
Axiom Test Equipment
B&Z Technologies
Barry Industries, Inc.
Beijing Hwa-Tech Information System Co., Ltd.
Benchmark Electronics Inc.
Bliley Technologies, Inc.
C W Swift
Cadence Design Systems, Inc.
California State Polytechnic University, Pomona
Carlisle IT
CEL
Centerline Technologies
Century Seals, Inc.
Cernex, Inc./Cernexwave
Charter Engineering, Inc.
Chengdu Jingxin Microwave Technology Co., Ltd.
Chengdu KeyLink Microwave Technology Co., Ltd.
Chin Nan Precision Electronics Co., Ltd.
Chuzhou First Technology Co., Ltd.
Ciao Wireless, Inc.
Cicor Group
Cinch Connectivity Solutions
Cirexx International, Inc.
CML Microcircuits (USA) Inc.
Cobham Advanced Electronic Solutions
Coilcraft, Inc.
Communications & Power Industries
Component Distributors, Inc.
COMSOL, Inc.
ConductRF
Connectronics, Inc.
Continential Resources
Copper Mountain Technologies
Corning Inc.
Corry Micronics Inc.
Cosmic Microwave Technology, Inc.
COTECHWAVE
Crane Aerospace & Electronics
Crescend, LLC
Criteria Labs
Crystek Corp.
CTS Corporation
CTT Inc.
Cubic Nuvotronics
Custom Cable Assemblies, Inc.
Custom Microwave Components, Inc.
Custom Microwave Inc. (CMi)
CX Thin Films
Daa-Sheen Technology Co., Ltd.
Daico Industries, Inc.
Dalian Dalicap Tech. Corp.
Danyang Teruilai Electronics Co., Ltd.
dB Control
dBm Corp.
Delphon - Gel-Pak
Delta Electronics Mfg. Corp.
Delta-Sigma Inc.
Denka Corporation
Design Workshop Technologies Inc.
DeWeyl Tool Company, Inc.
Diamond Antenna & Microwave Corp.
Dino-Lite Scopes
Diramics AG
DiTom Microwave Inc.
Doosan Electro Materials
dSpace Inc.
Ducommun Inc.
DYCO Electronics (affiliate of GCG)
Dynawave Inc.
ECHO Microwave
Eclipse MDI
ELDAAS Technologies Pvt. Ltd.
Electro Enterprises, Inc.
Electro Rent Corp.
Element Six
Elite RF LLC
Empower RF Systems, Inc.
EMWorks
ENGIN-IC, Inc.
Epoxy Technology, Inc.
Epson America Inc.
ERG Aerospace
Erzia Technologies
ETL Systems Ltd.
ETS-Lindgren
European Microwave Week
Everbeing International Corp.
Everything RF / Microwaves 101
evissaP, Inc.
Exodus Advanced Communications
EXXELIA
EZ Form Cable Corp.
F&K Delvotec, Inc.
FECOA ELASI
Ferrite Microwave Technologies
Ferro Corporation
Filtronetics, Inc.
Filtronic
Fine-Line Circuits Limited
Flann Microwave Ltd.
Flexco Microwave Inc.
Florida International University
Focus Microwaves Inc.
FormFactor
Frontlynk Technologies Inc.
FTG Corp.
Fuzhou MIcable Electronic Tech Co., Ltd.
Gamma Electronics, Inc.
Geib Refining Corp.
Genmix Technology Co., Ltd.
GEROTRON Communication GmbH
GGB Industries, Inc.
GigaLane Co., Ltd.
Global Communication Semiconductors, LLC
Global Production Systems Ltd.
Global Test Equipment
GLOBALFOUNDRIES
Golden Loch Ind. Co., Ltd.
Gova Advanced Material Technology Co., Ltd.
Gowanda Components Group (GCG)
Gowanda Electronics (affiliate of GCG)
Greenray Industries, Inc.
Guangdong DAPU Telecom Technology Co., Ltd.
Guerrilla RF
Hamilton
Harbour Industries, LLC
HASCO, Inc.
Hermerc Technologies Co., Ltd.
Hermetic Solutions Group
Herotek Inc.
Hesse Mechatronics
High Frequency Electronics
Hirose Electric USA

EXHIBITING COMPANIES

Exhibitors as of 9 April 2020

Holzworth 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.
Inspower 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
Plextek 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.
RUPPtronik
Rutgers University
SAF North America LLC
SAGE Millimeter, Inc.
Saint-Gobain
Sainty-Tech Communications Ltd.
Samtec, Inc.
San-tron Inc.
Sawnics Inc.
Schlegel
Schmid & Partner Engineering AG
Scientific Microwave Corp.
Semi Dice Inc.
SemiGen
Sensorview Co., Ltd.
Sentec E&E Co., Ltd.
SGMC 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.
Suzhou Hexagon Communication Technologies Co., Ltd.
SV Microwave Inc.
Switzer
Syrlinks
Tabor Electronics
TACTRON ELEKTRONIK GmbH
Tagore Technology Inc.
Tai-Saw Technology Co., Ltd.
Talent Microwave, Inc.
TAMAGAWA ELECTRONICS VIETNAM
TDK-Lambda Americas
Tecdia Inc.
Tech Briefs Media Group
Technetics Group
Tech-X Corporation
Teledyne Technologies
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