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WELCOME TO IMS2021!

STEVE KENNEY AND **JOHN PAPAPOLYMEROU**, IMS2021 GENERAL CO-CHAIRS

IMS2021 will certainly be a different experience than in past years. Our theme, "Connecting for a Smarter, Safer World," could not be more appropriate. First, we should explain that IMS2021 is really two events: live, in-person in Atlanta, 7-9 June at the Georgia World Congress Center (GWCC), and virtual 20-25 June. Attendance is expected to be somewhat down in Atlanta due to travel restrictions, vaccine schedules and other difficulties. But we applaud the ~200 companies who will be exhibiting this year live in Atlanta. Many of our non-U.S. authors and exhibitors cannot make it to live event, and we have consolidated our technical sessions to include a mix of live and virtual presenters. However, we have a full program planned for the virtual event!

In planning the virtual event, we have certainly benefited from the knowledge gained by the IMS2020 Virtual symposium, and the heroic efforts of that year's steering committee led by Tim Lee. However, we are expanding our investment in the virtual event experience by contracting vFairs and will use their virtual platform that is tailored for large events. The vFairs platform will enable virtual attendees to view and hear pre-recorded papers. It will also allow interaction with the authors via a chat room, as well as networking between individuals and small groups via chat and video conferencing. Exhibition attendees will be able to enter a virtual booth and interact live with exhibitors to hear about the latest microwave products and technologies.

We are planning six parallel technical sessions, 35 workshops, three technical lectures, as well as MicroApps and Industry Workshops. Except for the plenary session and select other sessions to be live- streamed, the virtual event will follow the live event by two weeks. This is done out of the logistical necessity of managing the two events separately. But it allows attendees from all over the world to have on demand access to any Microwave Week event in which they are registered. Attendees at the live event are also eligible to attend the virtual event for free to see all of the sessions and workshops they might have missed.

We hope to see many of you here in Atlanta for IMS2021! For those not able to travel, we understand and hope to see you at the IMS2021 virtual event following the live event. It will certainly be a memorable event as some of us gather for the first time in more than a year. Please visit the IMS2021 website (https://ims-ieee.org) for more details and updates.

Stay safe!

Steve and John

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AUDITORIUM 1

SUNDAY WORKSHOPS

10:00 – 16:00 | Sunday, 20 June 2021

	WORKSHOP TITLE	WORKSHOP ABSTRACT
WMC	**Cryogenic RF and mmW Technology and Circuit Platforms: A Path Toward Quantum-Computing** **Sponsor:** IMS; RFIC Organizers: Adrien Morel, CEA-LETI; Didier Belot, CEA-LETI; Michael Schroeter, TU Dresden	Cryogenic electronics will have a strong impact on our society through applications as Quantum Computing but also, space communication, and high performance computing. Quantum computers, for instance, have the potential to radically advance our computational capability and are predicted to strongly impact fields such as medicine, chemistry, science and finance by allowing to solve computational problems that cannot readily be solved by classical computers. The hardware implementations of quantum computers rely on various quantum bit (qubit) technologies, such as superconducting qubits, spin qubits and Majorana fermions. All of these Qubits require cryogenic temperatures (<4K) to operate efficiently, and need, and restitute Analog-RF signals for their manipulation, and results respectively. Thus, there is a need for cryogenic electronics with a large array of functionalities, operating under extremely low noise conditions with limited power budgets. Achieving this will require enhanced understanding of existing transistor technologies, 3D integrated systems and novel nanoelectronic devices employing unique low-temperature effects. With these new devices, new ultra-low noise, ultra-low power, and wide-band circuits and systems are emerging, preparing the next computing revolution. In this Workshop we will explore state of art status of Quantum computing applications and their associated technology and circuits analog-RF platforms.
WFC	**Enabling Technologies for Efficient Ultra-High Speed Wireless Communication Systems Towards 100 Gb/s** **Sponsor:** IMS Organizers: Christian Carlowitz, Friedrich-Alexander University Erlangen-Nürnberg; Noriaki Kaneda, Nokia Bell Labs	Recently, major advances in analog frontends for ultra-high speed wireless communication systems targeting data rates towards 100 Gbps have been demonstrated at high frequencies between 100 and 300 GHz. 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 frontend designs in different frequency ranges (75-300 GHz), technologies (SiGe, InP, CMOS), with antenna to baseband integration, phased array / MIMO, synchronous sampling receivers / ADCs as well as efficient real-time basebands.
WMD	**Machine Learning and AI Techniques with Intelligent Systems for Wireless Communication, Sensing, and Computation** **Sponsor:** IMS; RFIC Organizers: Markus Gardill, University of Würzburg, Bavaria, Germany; SungWon Chung, Neuralink Corporation, California, USA; Young-Kai Chen, DARPA, Virginia, USA	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, microwave device modeling, wireless power amplifier linearization, and 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 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 in mixed-signal and photonic integrated circuit techniques in order to accelerate energy-efficient multi-dimensional signal processing for intelligent RF/mm-wave systems with 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.
WME	**Millimeter-Wave and Terahertz Technologies for multi-Gbps Wireline Interconnects** **Sponsor:** IMS Organizers: Ahmet Cagri Ulusoy, Karlsruhe Institute of Technology; Jim Buckwalter, University of California, Santa Barbara; Telesphor Kamgaing, Intel Corporation	High frequency communication has traditionally been used for wireless transmission between devices and network access points. With the continuous data demand in the 5th and 6th generation wireless communication standards (5G and 6G), assuring extremely high datarates at different levels of the system or platform is critical. While electrical cables have traditionally been used to address data transmissions in datacenters and many enclosed platforms, it is becoming more evident that alternative interconnects will play a critical role in future platforms. This workshop will review most recent advances in using millimeter wave and Terahertz interconnects in conjunction with waveguide channels including dielectric waveguides and parallel plate waveguides. Selected experts from both the academia and the industry will discuss end to end components and challenges associated with those novel wireline interconnects. Topics addressed will include semiconductor technology selection, mm-Wave wireline transceivers, high frequency packaging, waveguide channels and materials as well as relevant equalization techniques. Each speaker will base their presentation on full interconnects that they have designed and characterized experimentally. This includes the transceiver, the waveguide, the packaging and testing. Transceivers addressed in those talks will have carrier frequencies in the range of 130 GHz to 325 GHz.

SUNDAY WORKSHOPS

10:00 – 16:00 | Sunday, 20 June 2021

WORKSHOP ABSTRACT	WORKSHOP TITLE	
Short-range microwave radar sensors are capable of remotely detecting the precise movements of the subjects and wirelessly estimating the distance from the sensor to the subject. In recent years, they have been attracting a lot of attention in biomedical applications for noncontact sensing of vital signs. Biomedical radars are not to be deployed stand-alone, but as part of multi-modal wireless sensor networks by which the radar hardware settings are to be controlled remotely as to enable a diverse range of applications ranging from vital sign monitoring to people counting and activity monitoring. Due to the importance of vital signs, breathing rate and heart rate have been widely used in health care. In the past few years, various systems and approaches have been proposed to detect and monitor breath and heartbeat. Radar sensing has enabled several interactive human-machine interfaces too, such as human sensing and tracking for presence, occupancy, and counting. Moreover, techniques beyond vital sensing for touchless Human Computer Interaction (HCI) have been developed. Our human hands are natural tools for performing actions and gestures to interact with the physical world. Traditional radar signal processing involves 2D FFT to transform the raw ADC data into range-Doppler image, followed by moving target indicators to remove static targets on range-Doppler images (RDI), minimum variance distortion-less response beamformer to transform RDI across channels into range-angle images. This is followed by constant false alarm rate detector and clustering algorithm to localize the human target. Over the past few years, a new class of human sensing systems has spawned that uses WiFi signals to perform human sensing. The fundamental principle that enables human sensing using WiFi signals is that when a user moves in a wireless channel, his/her movements cause the wireless channel metrics such as channel state information, received signal strength, signal polarization, and angle-of-arrival of the signal to change. The patterns of change in wireless channel metrics are unique for different human movements. By learning these patterns of change for any given movement, a WiFi-based human sensing system can recognize that movement. Meanwhile, advances in machine learning, parallelization and the speed of graphics processing units (GPUs), combined with the availability of open, easily accessible implementations, have brought deep neural networks (DNNs) to the forefront of research in many fields. Likewise, deep learning has offered significant performance gains in the classification of radar micro-Doppler signatures, and WiFi based human sensing paving the way for new civilian applications of RF technologies that require a greater ability to recognize a larger number of classes that are similar in nature.	**Non-contact Vital Sign Detection and Human Motion Tracking using WiFi and Radar Techniques** **Sponsor:** IMS Organizers: Aly Fathy, University of Tennessee; Changhi Li, Texas Tech University; Jenshan Lin, University of Florida	WFF
Emerging RF technologies for 5G, such as MIMO, scaled phased arrays, and millimeter-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 including those expected to play a key role in 6G. 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 millimeter-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.	**Platforms, Testbeds, and Trials – The Next Step for 5G and Future Wireless-Network** **Sponsor:** IMS; ARFTG Organizers: Alberto Valdes-Garcia, IBM Research; Christian Fager, Chalmers University of Technology; Zhizhang Chen, Dalhousie University	WMF
The amount of new radar based 3D sensing applications at millimeter-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, as 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.	**Recent Advances in mm-Wave Radar Circuits and Systems for emerging Sensing Applications** **Sponsor:** IMS Organizers: Amelie Hagelauer, University of Bayreuth, Germany; Vadim Issakov, Infineon Technologies AG and Otto-von-Guericke University Magdeburg, Germany	WFH

AUDITORIUM 1

SUNDAY WORKSHOPS

10:00 – 16:00 | Sunday, 20 June 2021

	WORKSHOP TITLE	WORKSHOP ABSTRACT
WFJ	**Microwave Acoustics and RF MEMS enabling 5G** **Sponsor:** IMS Organizers: Andreas Tag, Qorvo; Songbin Gong, Univ. of Illinois at Urbana Champaign	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-6 GHz 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.
WFK	**Beamforming in Massive MIMO for Millimeter-Wave New Radio** **Sponsor:** IMS Organizers: Abbas Omar, University of Magdeburg; David Chen, Dalhousie University	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 Millimeter-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 Frontend. The IEEE-MTTS community, on the other hand, must be in some doubt about the costs of providing such a huge amount of RF Frontends, 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 Frontend 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 Frontend and the Digital Signal Processing, Linearity and Efficiency of PA's, 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.

RFIC INDUSTRY SHOWCASE

10:00–12:00 | **Sunday, 20 June 2021** | **Auditorium 6**

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 submit a pre-recorded technical presentation to be shown during the virtual conference.

The RFIC Industry Showcase highlights eight outstanding industry papers, which are listed below. These papers received nominations for this recognition from the TPC sub-committees and godparents in a double-blind review. From these top eight papers, a two stage double-blind review process was conducted with a committee of eight judges selected from the TPC that did not have conflict of interest. Finally, the Best Paper Chair and other key Steering Committee members finalize the top three winners after rigorous reviews and discussions. The top three will be displayed on the RFIC website and on a rolling slideshow prior to the Joint RFIC/IMS Plenary Session. Each winner will receive a plaque and will be recognized in an upcoming *Microwave Magazine* article. This year's Industry Paper Award finalists are:

Chair: Fred Lee, Twenty/Twenty Therapeutics

Doubly-Tuned Transformer-Based Class-E Power Amplifiers in 130nm BiCMOS for mmWave Radar Sensors | RTu1E-1
Texas Instruments, USA
Tolga Dinc, Siraj Akhtar, Sachin Kalia, Baher Haroun, Swaminathan Sankaran

A High-Power SOI-CMOS PA Module with Fan-Out Wafer-Level Packaging for 2.4GHz Wi-Fi 6 Applications | RTu1G-5
[1]CEA-Leti, France, [2]Keysight Technologies, France, [3]Amkor Technology, Portugal
P. Reynier[1], A. Serhan[1], D. Parat[1], R. Mourot[1], M. Gaye[2], P. Kauv[2], A. Cardoso[3], A. Gouvea[3], S. Nogueira[3], A. Giry[1]

A 128Gb/s PAM4 Linear TIA with 12.6pA/√Hz Noise Density in 22nm FinFET CMOS | RTu2G-2
Intel, USA
Saeid Daneshgar, Hao Li, Taehwan Kim, Ganesh Balamurugan

An FBAR Driven -261dB FOM Fractional-N PLL | RTu2H-1
Broadcom, USA
Dihang Yang, David Murphy, Hooman Darabi, Arya Behzad, Richard Ruby, Reed Parker

A Sub-100fs JitterRMS, 20-GHz Fractional-N Analog PLL Using a BAW Resonator Based 2.5GHz On-Chip Reference in 22-nm FD-SOI Process | RTu2H-2
Texas Instruments, USA
Sachin Kalia, Salvatore Finocchiaro, Ashwin Raghunathan, Bichoy Bahr, Tolga Dinc, Gerd Schuppener, Siraj Akhtar, Tobias Fritz, Baher Haroun, Swaminathan Sankaran

A 24.5–29.5GHz Broadband Parallel-to-Series Combined Compact Doherty Power Amplifier in 28-nm Bulk CMOS for 5G Applications | RTu3E-3
Samsung, Korea
Seokhyeon Kim, Hyun-Chul Park, Daehyun Kang, Donggyu Minn, Sung-Gi Yang

A 5G FR2 (n257/n258/n261) Transmitter Front-End with a Temperature-Invariant Integrated Power Detector for Closed-Loop EIRP Control | RTu3E-4
[1]Samsung, USA, [2]Samsung, Korea
Chechun Kuo[1], Helen Zhang[1], Anirban Sarkar[1], Xiaohua Yu[1], Venumadhav Bhagavatula[1], Ashutosh Verma[1], Tienyu Chang[1], Ivan Siu-Chuang Lu[1], Daeyoung Yoon[2], Sangwon Son[1], Thomas Byunghak Cho[2]

A Fully-Digital 0.1-to-27Mb/s ULV 450MHz Transmitter with Sub-100µW Power Consumption for Body-Coupled Communication in 28nm FD-SOI CMOS | RTu3G-1
[1]STMicroelectronics, France, [2]IEMN (UMR 8520), France, [3]University of California, Berkeley, USA
Guillaume Tochou[1], Robin Benarrouch[1], David Gaidioz[1], Andreia Cathelin[1], Antoine Frappé[2], Andreas Kaiser[2], Jan Rabaey[3]

THREE MINUTE THESIS (3MT®) COMPETITION

12:00 – 14:00 | **Sunday, 20 June 2021** | **Auditorium 5**

Now in its fifth 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.

ORGANIZERS/CO-CHAIRS:

John Bandler, Co-Chair, *McMaster University*	**Erin Kiley,** Co-Chair, *MCLA*
Aline Eid, Member	**Daniel Tajik,** Member

MASTER OF CEREMONIES: Sherry Hess, *Product Marketing Group Director, Cadence*

JUDGES:

Sarah Hartman-Caverly, *Assistant Librarian, Penn State Berks*

Rachelle Ho, *Ph.D. Candidate, McMaster University*

Amy Hubbard, *Professor of Communicology, University of Hawaii at Mānoa*

Elizabeth Indianos, *E. Indianos Artworks & Adjunct Faculty, St. Petersburg College*

Ronald C. McCurdy, *Professor of Music, University of Southern California*

THIS YEAR'S FINALISTS ARE:

Dieff Vital, *Florida International University*
Making Self-Diagnosis Smart Using Microwaves | We2B

Qiming Zhao, *University of Toronto*
Realizing Virtual Reality for Waves | Tu3A

Alden Fisher, *Purdue University*
Communicating at the Speed of Life | Tu1B

Ajibayo Adeyeye, *Georgia Institute of Technology*
Let's Play: Microwave Pon | (We1)

Paula Palacios, *HFE RWTH-Aachen*
How to Communicate When Things Heat Up | WeIF)

Renuka Bowrothu, *University of Florida*
Say Bye-Bye to Spotty Wi-Fi! | We2B

Hussein M. E. Hussein, *Northeastern University*
Shout as You Wish, I Can Still Hear My Friends | Tu4A

Stavros Vakalis, *Michigan State University*
Security Screening Using Ambient 5G Signal | WeIF1

Muhammad Arsalan, *Infineon Technologies AG*
The Human Brain on a Chip | Tu2A

Valentina Palazzi, *University of Perugia*
Tireless Ears for Sensing Vibrations | Tu2B

Patrícia Bouça, *University of Aveiro*
Living the Larvacean Lifestyle! | We1D

Shaghayegh Vosoughitabar, *Rutgers University*
1 + 1 = 1 x 2 | We3C

Yali Zhang, *University of Minnesota, Twin Cities*
Make the Connection Using Nanometer-Sized "Joints" | Tu3)

Soheil Nouri, *University of Arkansas*
Let's Know Our Enemies Before We Fight Them! | We2D

Mutee ur Rehman, *Georgia Institute of Technology*
Developing Microwave Technology for Faster Internet | We2C

Daniel Chen, *Michigan State University*
A Marching Band of Antennas | Th1D

Enrique López Oliver, *University of Perugia*
Printing our Next Space Communication System | Tu4B

Andrea Ashley, *University of Colorado*
This is a Two-way Conversation | Tu2C

Zikang Tong, *Stanford University*
Making 99% of the Matter in the Universe | Th1C)

Prateek Kumar Sharma, *GLOBALFOUNDRIES*
One Hand Clapping Eureka: A New Solution for 5G | Tu1H

Vijaya Kumar Kanchetla, *Indian Institute of Technology Bombay*
Radio That Keeps You on Track | Tu4G

Christopher Sutardja, *Stanford University*
Portable Imaging of Detailed Features Underneath the Skin | Tu1E

Ricardo Figueiredo, *University of Aveiro*
In Science We Trust, But Do Scientists Trust Each Other? | ARFTG

Divya Duvvuri, *University of Virginia*
Sensing a New Revolution in Agriculture | WeIF1

Giordano Cicioni, *University of Perugia*
Sensing the Environment Like a Sunflower | Th2E

5G and Beyond: Enabling a Fully Connected, Mobile, and Intelligent Society over the Next Decade

IMS KEYNOTE SPEAKER:

Asha R. Keddy, Corporate Vice President and 5G Executive Sponsor, *Intel Corporation*, General Manager, *Next Generation and Standards*

ABSTRACT: The additive nature of today's technology megatrends such as 5G, AI, IOT, Edge Computing and the Cloud is fueling the need for computing and communications to converge into one intelligent, resilient and distributed networking fabric. As the industry continues to commercialize and evolve 5G to address enterprise and industry vertical requirements, it is also embarking on efforts that will set the foundation for next generation networks. In this keynote, Asha Keddy, Intel Corporate VP and GM of Next Generation & Standards, will share her thoughts on why the integrated design of compute and communications will be fundamental to the next generation, highlight initial candidate technology development areas and performance KPIs, and discuss the industry, academic and government collaborations that are needed for 5G and next generation networks to deliver broader economic and societal benefits.

BIO: Asha Keddy is corporate vice president and 5G executive sponsor at Intel Corporation. She is responsible for the research, engineering and development of new disruptive technologies, product innovation, business use cases, and partnerships ultimately establishing core capabilities that are foundational to 5G wireless and connected computing. In this role, she directs research and development, with a specific emphasis on solutions that offer deterministic and low-latency operation of wired and wireless networks, especially 5G, Wi-Fi 6 and optical. Keddy's organization ultimately solves technical challenges facing global enterprise segments and operators enabling a range of industrial, enterprise and consumer applications. Keddy is also responsible for Intel's contributions to industry standards and the company's leadership in IEEE, 3GPP, Open-RAN Alliance and multiple industry fora. With more than 20 years of mobile broadband experience, Keddy is a highly sought-after speaker on a broad array of topics related to diversity and inclusion in the high-tech workforce, accelerating the future of network transformation with 5G, AI, edge computing and the IoT and other key topics.

Keddy holds multiple patents, as well as a bachelor's degree in computer engineering from the University of Mumbai and a master's degree in computer science from Clemson University.

Transceiver Roadmap for 2035 and Beyond

RFIC KEYNOTE SPEAKER:

Prof. Bram Nauta, Distinguished Professor, *University of Twente, The Netherlands*

ABSTRACT: During the past decades wireless communication has made an enormous growth. Triggered by a large R&D effort, the integration of transceivers in CMOS technology has made low-cost mass production possible. For many applications like Bluetooth, a single-chip CMOS transceiver can now do the job. On the other hand, for complex transceivers like in modern smart-phones, still more discrete RF components such as filters, switches and diplexers are being added to protect the transceiver from strong interferers which are often produced by the device itself. To satisfy the future bandwidth hunger, the number of frequency bands will further increase, modulation schemes will become more complex, more antennas will be used and carrier aggregation will be the norm. To limit the number of discrete RF components, linearity of the transceivers is key. Since more computing power will be needed in future transceivers as well, newer CMOS technologies are also wanted. CMOS technology will scale in favor of fast-switching digital circuits, but not for classical analog functions, like amplifiers. For the next fifteen years re-thinking of basic circuits and systems will be needed to make highly integrated linear transceivers, in a technology that is designed for digital circuits.

BIO: Bram Nauta received the M.S. and Ph.D. degrees in electrical engineering from the University of Twente, Enschede, The Netherlands in 1987 and 1991, respectively. From 1991 to 1998 he worked at the Mixed-Signal Circuits and Systems Department of Philips Research, Eindhoven, The Netherlands. In 1998 he returned to the University of Twente, where he is currently a distinguished professor and head of the IC Design group. His current research interest is high-speed analog CMOS circuits, software defined radio, cognitive radio, and beamforming. He has served as the editor-in-chief of the IEEE Journal of Solid-State Circuits, the president of the IEEE Solid-State Circuits Society, and on the technical program committees for many conferences. He is fellow of the IEEE and member of the Royal Netherlands Academy of Arts and Sciences (KNAW).

The following Keynotes took place during the in-person event in Atlanta, GA on 7 June 2021. The video recordings for these talks are available on-demand in the virtual platform for viewing.

Reimagine the Future – Smart & Connected Solutions

IMS KEYNOTE SPEAKER:

Suresh Venkatarayalu, Chief Technology Officer, *Honeywell*

BIO: Suresh Venkatarayalu is Chief Technology Officer (CTO). In this role, Suresh is responsible for our end-to-end new product development and introduction processes, including efforts to develop new, breakthrough technologies and software for the Industrial Internet of Things. Suresh oversees Engineering, Research and Development functions as well as Honeywell Technology Solutions. He also serves as Vice President and Chief Technology Officer for Honeywell's Safety and Productivity Solutions (SPS) business group.

Suresh joined Honeywell in 1995 as a software engineer and systems analyst for Aerospace and then held a series of engineering and IT leadership positions. His previous roles included CTO for our former Automation and Control Solutions business group and President of Honeywell Technology Solutions where he was responsible for more than 50 percent of Honeywell's global technology design centers across India, China and the Czech Republic. A graduate in computer science engineering from Bharathidasan University (India), Suresh has completed his post-graduation work in general management from the Indian Institute of Management in Kozhikode.

New Horizons for Millimeter-Wave Sensing

RFIC KEYNOTE SPEAKER:

Dr. Ahmad Bahai, Chief Technology Officer and Senior Vice President, *Texas Instruments*

ABSTRACT: This talk will provide an overview of the rapidly evolving millimeter-wave sensor market, including radar, imagers, and spectroscopy. The research and development opportunities at device, packaging and system/algorithm levels are both challenging and exciting and technologies such as low-cost deep submicron CMOS, SiGe, and other compound materials are promising from different performance and figure of merit criteria. Many cases demand a hybrid integration as a system-in-package. This talk will cover some of the most important current and upcoming technologies and trade-offs for the millimeter-wave sensor market.

BIO: Ahmad Bahai, Ph.D, is a senior vice president and chief technology officer (CTO) of Texas Instruments responsible for guiding break-through innovation, corporate research and Kilby Labs. Throughout his career, Dr. Bahai has held a number of leadership roles, including director of research labs and chief technology officer of National Semiconductor, technical manager of a research group at Bell Laboratories, and founder of Algorex, a communication and acoustic IC and system company that was acquired by National Semiconductor. He holds an M.S. degree in Electrical Engineering from Imperial College, University of London and a Ph.D. in Electrical Engineering from the University of California, Berkeley. He is an IEEE Fellow; he was a professor in residence at UC Berkeley from 2001-2010; and he currently serves as an adjunct professor at Stanford University.

MONDAY

MONDAY WORKSHOPS

13:00 – 17:00 | Monday, 21 June 2021

	WORKSHOP TITLE	WORKSHOP ABSTRACT
WMA	**Advanced Multichip Modules and Packaging for 5G and Beyond** **Sponsor:** IMS Organizers: Harrison Chang, Advanced Semiconductor Engineering Group; Kamal Samanta, Sony Europe BV, UK; Lim Lee, Boeing, USA Half-day	The realization of advanced 5G/Beyond millimetre-wave Front-End Multichip Modules (MCMs) and their packaging, pose daunting design challenges to fit significant electrical functionality within a relatively small space, yet meeting or exceeding electrical, mechanical, thermal and reliability requirements for both the UE and BS use cases. As a result, it will be important, more than ever, to solve signal integrity, reduction of insertion losses imposed by various interconnects and packaging techniques at the chip, module and board levels must be analyzed and optimized with co-engineering across different design disciplines. This workshop is organized to address current and future design and manufacturing techniques by bringing together the subject matter experts from the IEEE Electronic Packaging Society(EPS) and the MTT-S communities. Presentations will cover the state-of-the-art in advanced MCM and packaging processes and materials, and circuit and system design for signal diversity, RFIC and beam-forming approaches that would leverage emerging capabilities. In particular, the workshop will highlight advances in 2.5D, 3D heterogeneous integration, Antenna in Package (AiP), embedded high-Q passives, wafer-level packaging and testing challenges, 3D antenna with TEV and EZL, Ka-band phased array module for 5G base station, 28GHz module with software-defined radio, and system-in-package based eWLB transceiver at 60 and 77GHz.
WFG	**Past and Future of Microwave Passive Components (in Memory of Professor Arthur A. Oliner)** **Sponsor:** IMS Organizers: Aly Fathy, University of Tennessee; Ke Wu, Ecole Polytechnique (University of Montreal); Maurizio Bozzi, University of Pavia; Tatsuo Itoh, University of California Los Angeles Half-day	The workshop presents a roadmap of microwave passive components and transmission lines, starting from a historical overview and the state-of-the-art, and providing an outlook to the forthcoming technologies, solutions, and applications. Transmission lines and passive components have always represented a fundamental part of electronic systems, due to the functions they perform and the need to interconnect different elements, devices, and sub-circuits. The investigation of novel passive components as well as compact and broadband transmission lines have attracted large interest in the microwave community, and today it covers a significant portion of the scientific literature. This workshop has a twofold aim: to illustrate which are the roots of the microwave community in the area of passive components (well represented by the scientific activity of late Prof. Arthur A. Oliner, to whom the workshop is dedicated), and to indicate the current trends and the future lines of development in the area of passive components, also considering the wide range of applications that require advances passive components and transmission lines.
WMG	**Recent Advances in the Efficient Small- and Large-Signal Stability Analysis ofMmicrowave Circuits** **Sponsor:** IMS Organizers: Almudena Suarez, University of Cantabria (SPAIN); Marco Pirola, Politecnico di Torino (ITALY) Half-day	Instability is a fundamental problem in the design of microwave circuits, giving rise to an experimental behaviour qualitatively different from the expected one, which will degrade or fully disrupt the circuit performance. Undesired behaviours include oscillations, frequency divisions, hysteresis, and chaos. Their posteriori correction is impossible in integrated technologies, whereas in hybrid technologies trial and error procedures turn out to be inefficient in most cases, since they are applied without an identification and understanding of the instability phenomenon causing malfunction. As a result, the problem will arise again in new prototypes, thus increasing the production cycles and the final cost. Due to its relevance, the stability investigation has been an ever-present effort in the microwave field and significant advances have been achieved in recent times. Two rigorous analysis methods are those based on the Nyquist criterion and pole-zero identification. The Nyquist criterion can only be applied if the complex function considered does not exhibit poles in the right-hand side of the complex plane (RHS). This can be achieved by calculating the circuit characteristic determinant at the terminals of the intrinsic nonlinearities, which will be demanding/impossible in some cases. On the other hand, the pole-zero identification method relies on the fact that all the transfer functions that can be defined in a linear system share the same denominator and therefore should exhibit the same poles. The method is easily combined with commercial software and provides insight into the evolution of the circuit dynamics versus relevant parameters. It has recently been extended to transfer functions obtained experimentally (when lacking rigorous models of the circuit components). Other advances include techniques to minimize uncertainties resulting from possible cancellations/ quasi-cancellations of RHS zeroes and poles, often due to a low observability. To address this problem, a new methodology has recently been proposed based on partitioning the structure into simpler blocks that must be stable under either open–circuit (OC) or short– circuit (SC) terminations. First, pole–zero identification to define the OC/SC stable blocks, which, due to the limited block size, can be applied reliably. Then, the characteristic determinant of the complete system is calculated at the ports defined in the partition. Finally, the workshop addresses advances in the exploitation of nonlinear effects for engineering applications, for instance, the deterministic, but noise-like behavior called chaos, used for random sequence generation, communications, radar and other. Considering that most designers are familiar with stability in linear system but less experienced for the large signal case, the first talk seamlessly introduces the attendees to the large-signal stability analysis that is dealt with in the other four talks.

AUDITORIUM 5

RFIC TECHNICAL LECTURE

12:30 – 14:00 | Monday, 21 June 2021

	LECTURE TITLE	LECTURE ABSTRACT
TUTL1	**A Tour Through the World of Si IC Power Amplifiers** **Speaker:** Peter Asbeck, Professor, University of California, San Diego, USA	While power amplifier design enjoys a rich history, it remains a vibrant and exciting area with many opportunities for innovation. This presentation reviews fundamentals of microwave and mm-wave power amplifier operation and implementation in Si ICs, and provides background to ongoing research. Si technologies afford major leverage for power amplifiers, including very high ft and fmax, excellent switches, vast integration opportunities for combination with LNAs, DACs and digital circuits, in addition to their cost advantage. They also pose challenges, stemming from limited voltage handling, conducting substrates, only modest carrier mobility, and thermal issues. The presentation highlights the ways in which advantages are exploited, and disadvantages are addressed. Power limits for Si transistors along with tradeoffs with ft, will be discussed along with comparisons between SiGe HBT and CMOS (bulk planar, SOI, finFET and LDMOS). Cascode and stacking strategies will be reviewed and techniques for power combining will then be presented, with emphasis on application of transformers, and distinctions between single-ended and differential operation. The lecture will go over load pull and matching requirements, together with a quick review of harmonic matching considerations, amplifier classes, factors affecting efficiency, and basic reliability issues. Turning to the area of power amplifier architectures and design, the principles of switching-mode operation will be reviewed, and power DACs and switched capacitor power amplifiers will be discussed. Classical architectures for high backoff efficiency — envelope tracking, Doherty and outphasing — will be outlined, along with other load modulation approaches. Finally, application areas and representative IC examples will be discussed, including moderate power ICs in the microwave region, 5G-oriented mm-wave communications, and above 100GHz. The presentation concludes with a discussion of future areas of Si power amplifier research, including opportunities for covering wider frequency ranges, and adapting to different environmental conditions (such as VSWR) while maintaining high linearity (with the possible use digital or analog predistortion, including AI techniques). Possibilities for reaching "THz" frequencies (>300GHz) will also be described.

AUDITORIUM 1

MONDAY WORKSHOPS

13:00 – 17:00 | Monday, 21 June 2021

	WORKSHOP TITLE	WORKSHOP ABSTRACT
WMB	**Calibrated Testbeds for the Characterization, Optimization and Linearization of Multi-Input Power Amplifiers** **Sponsor:** IMS; ARFTG Organizers: Apolinar Reynoso Hernandez, CICESE, Ensenada, Mexico; Karun Rawat, IIT Roorkee, Roorkee, India	With the deployment of sub 6 GHz 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 two 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. Proposed Speakers with Presentation Titles/Topics: 1. "Performing Multi-channel Spectral Analysis with GHz Bandwidth with a VNA," Jean-Pierre Teyssier, Keysight, USA 2. "Calibrated Multiport Large-Signal Measurement Setups for Outphasing, Doherty and Load Modulated Balanced Power Amplifiers," Tibault Reveyrand, XLIM - University of Limoges - CNRS, France 3. "Characterization and Linearization of Dual-Input Outphasing PAs using a VNA," Thaimi Niubo-Aleman and Apolinar Reynoso Hernandez, CICESE, Ensenada, Mexico 4. "Adaptive Neural Network Control of Broadband MIMO PAs," Rui Ma, Mitsubishi, USA-Japan 5. "Doherty-Chireix Continuum: Theory and Characterization," Patrick Roblin and Chenyu Liang, Ohio State University, Ohio, USA 6. "Linearization and Efficiency Maximization for Dual-Input PAs and Transmitters," Christian Fager, Chalmers, Sweden 7. "LMBA: a flexible PA architecture," Steve Cripps and Roberto Quaglia, Cardiff, UK 8. "Dual-Input PA Architectures for High-Efficiency Radar and Telecommunication Transmitters," Tommaso Cappello, University of Bristol, UK

EXHIBITOR TALKS

09:00 – 18:00 | Monday, 21 June 2021 | **AUDITORIUM 6**

COMPANY NAME	SPEAKER NAME	TALK TITLE
A.L.M.T. Corp.	Takara Okubo	New Composite Material of Silver and Diamond for High-performance Device
Analog Devices	Hossein Yektaii	5G Millimeter Wave: A Paradigm Shift in System Engineering and DPD Implementation
Analog Devices	John Wise	Advances in Multi-Beam Beamforming Technology
Anritsu Co.	Stanley Oda	Advantages of Distributed Measurement Ports in VNA Applications
Anritsu Co.	Steve Reyes	Broadband On-wafer VNA Measurements up to 220 GHz
APITech	Aaron Singer	Powerfilm Surface Mount Resistives for Commercial Wireless
AR RF/Microwave Instrumentation	Dean Landers	Getting to the Source: Integrated Circuits (ICs) and Component EMC Testing
Berkeley Nucleonics Corporation	John Reynolds	BNC | RF Microwave Division
Cicor Group	Alexander Kaiser	ADVANCED THIN-FILM TECHNOLOGY Solutions for Aerospace, Sensors, Telecommunication and High-Frequency Applications
Copper Mountain Technologies	Brian Walker	VNA Calibration, Kits, Error Terms and Calculation
dSPACE Inc.	Thomas Sutton	Echoing the World! Testing Automotive Radar Sensors
Empower RF Systems, Inc.	George Bollendorf	Modern Architecture for Combining Integrated Solid State Amplifiers for Very High Power
ETS-Lindgren	Garth D'Abreu	State-of-the-Art Automotive Test Methods for the Comprehensive Evaluation of Module and Vehicle Mounted Antenna-Dependent ADAS Features
Gamma Electronics	Kimberly Hahn, Andrew Michener, Nathan Street	Save Time and Money with Gamma RF Weatherproofing
Gel-Pak	Darby Davis	Mitigating Thin Die Migration From Waffle Pack Chip Trays
Gel-Pak	Darby Davis	Mitigate Costly Component Out of Pocket Defect Condition during Semiconductor IC Transport/Handling
GLOBALFOUNDRIES	Peter Rabbeni	Differentiated Silicon to address Broadband Satellite Communication requirements
IHP GmbH	Dr. René Scholz	Overview on MPW & Service Offerings and Process Design Kit Features
In Phase Technology Inc		Multi-target Radar Repeater with Moving Target Capability
Keysight Technologies	Matt Ozalas	New RF Circuit Simulation Techniques for mmWave Design Challenges
Keysight Technologies	Jennifer Stark	Making Wideband mmWave Signal Analyzer Measurements
LPKF Laser & Electronics	Rory Grondin	In-house PCB Prototyping Enables Creative PCB Design
M2 Global Technology Ltd.	Dr. Tony Edridge & Archie Wohlfahrt	RF Passive Isolator & Circulator Theory (101)

EXHIBITOR TALKS

09:00 – 18:00 | Monday, 21 June 2021 **AUDITORIUM 6**

COMPANY NAME	SPEAKER NAME	TALK TITLE
Maury Microwave	Osman Ceylan	Understanding the True Performance of Your Device-Under-Test by Including Measurement Uncertainty
Microchip Technology Inc.	Will Krzewick / Mike Ziehl	Microchip Technology on the Leading Edge: Precision Phase Noise Measurement of Chip Scale Atomic Clock (CSAC) Oscillators and Exploring New RF Technology for 5G, Satellite Internet and Other Applications
Microsanj LLC	Dr. Ali Shakouri, and Dr Peter Aaen	Thermal Challenges in High Speed and High-Power Microwave Devices
Mini-Circuits	Mark Murphy	Introducing RF Energy Products with Mini-Circuits
Mini-Circuits	Erick Olsen	Space Upscreening from Mini-Circuits
MRSI, Mycronic Group	Limin Zhou	Compound Semiconductor Chips Bonding Reliability Challenges and Solutions
Oak-Mitsui Technologies	Robert Carter	Impact of High Performance Copper and Embedded Capacitance on RF & Power/Signal Integrity
Optomec	Bryan Germann	Aerosol Jet® Digitally Printed Interconnects for Millimeter Wave RF Devices
Pentek	Bob Sgandurra	Leveraging Software and IP for Faster RFSoC Application Development
pSemi, a Murata Company	Robert Wagner	Over-the-Air (OTA) Testing For 5G mmWave ICs and Modules
Qorvo	Paul Prudhomme	SWaP-C Solutions for Advanced Radar Systems
Qorvo	Suma Kapilavai	Solving 5G RF Design Challenges with Small Signal Solutions
Renesas Electronics	Tumay Kanar	mmWave 5G Front-ends with Dynamic Array Power (DAP™) Optimization
Rogers Corporation	John Coonrod	Designers Guide to the Transition from Microwave to Millimeter-Wave, When Using PCB Technology
Rohde & Schwarz	Markus Loerner & Florian Ramian	How to Tackle Increasing RFFE Integration
Samtec, Inc.	Steve McGeary and Mike Dunne	Market Drivers For Precision RF
Skyworks Solutions	Mike Hill	Circulator size reduction in broadband devices
Southwest Microwave	Donald Bradfield	Pushing Board to Board Interconnect Performance
Tabor Electronics	Mark Elo	Real Time Waveform Streaming using direct to RF Arbitrary Waveform Transceivers
TCNJ/LTI	Allen Katz	The Importance of Linearizers Onboard Satellites
Telonic Berkeley Inc	Kanak Vaghela	RF Filter Products
Tower Semiconductor	Amol Kalburge	Accelerate beyond 5G with Tower
Wireless Telecom Group	Dr. Lee McMillan	Anatomy of a Noise Source
Xilinx	Anthony Collins	Xilinx's Adaptive Radio SoCs and Digital RF IP enables the next generation of competitive OpenRAN Radio Solutions

Tu1A: Emerging Machine Learning Techniques for CAD of RF/Microwave Circuits

Chair: Sourajeet Roy, Indian Institute of Technology
Co-Chair: Riccardo Trinchero, Politecnico di Torino

09:00

Tu1A-1: A Polymorphic Polynomial Chaos for Fast Uncertainty Quantification of RF/Microwave Circuits in Presence of Design Variables
M. Yusuf, IIT Roorkee; S. Roy, IIT Roorkee

09:10

09:20

Tu1A-2: Structured Black-Box Parameterized Macromodels of Integrated Passive Components
A. Zanco, Politecnico di Torino; T. Bradde, Politecnico di Torino; M. De Stefano, Politecnico di Torino; S. Grivet-Talocia, Politecnico di Torino; G. Hoehne, Infineon Technologies; P. Brenner, Infineon Technologies

09:30

09:40

Tu1A-3: Domain-Constrained Metamodels for Expedited Robust Design of Compact Microwave Components
A. Pietrenko-Dabrowska, Gdansk University of Technology; S. Koziel, Reykjavik University

09:50

10:00

Tu1A-4: Compressed Machine Learning-Based Inverse Model for the Design of Microwave Filters
M. Sedaghat, Isfahan University of Technology; R. Trinchero, Politecnico di Torino; F. Canavero, Politecnico di Torino

10:10

10:20

Tu1A-5: Machine Learning Based Uncertainty Quantification of Extrapolated Design Space and Frequency Response for RF Structures
O.W. Bhatti, Georgia Tech; N. Ambasana, Georgia Tech; M. Swaminathan, Georgia Tech

10:30

10:40

Tu1A-6: Question and Answer

Tu1B: Enabling Advanced Technologies and Components for Transceiver and Communication Systems

Chair: Kamran Ghorbani, Rmit University
Co-Chair: Kavita Goverdhanam, US Army CCD-C5ISR

Tu1B-1: 5.9–7.1GHz High-Linearity LNA Using Innovative 3D Device Level Co-Integration of GaN HEMT and RF-SOI
J. Loraine, X-FAB; H. Saleh, X-FAB; F. Drillet, X-FAB; O. Sow, X-FAB; I. Lahbib, X-FAB; G. U'Ren, X-FAB

Tu1B-2: A -115dBc/Hz Integrated Optoelectronic Oscillator in a BiCMOS Silicon Photonic Technology
G. Dziallas, IHP; A. Fatemi, IHP; A. Peczek, IHP; M. Tarar, Universität Ulm; D. Kissinger, Universität Ulm; L. Zimmermann, IHP; A. Malignaggi, IHP; G. Kahmen, IHP

Tu1B-3: A Fiber-Free DC–7GHz 35W Integrated Semiconductor Plasma Switch
A. Fisher, Purdue Univ.; Z. Vander Missen, Purdue Univ.; T.R. Jones, Univ. of Alberta; D. Peroulis, Purdue Univ.

Tu1B-4: Flexible Phased Array Shape Reconstruction
O.S. Mizrahi, Caltech; A. Fikes, Caltech; A. Hajimiri, Caltech

Tu1B-5: A mmWave Switch Using Novel Back-End-Of-Line (BEOL) in 22nm FinFET Technology
Q. Yu, Intel; J. Garrett, Intel; J. Waldemer, Intel; Y. Ma, Intel; S. Ravikumar, Intel; G. Liu, Intel; S. Rami, Intel

Tu1B-6: Question and Answer

Tu1C: Advances in Planar Filters and Multiplexers

Chair: Pei-Ling Chi, National Chiao Tung University
Co-Chair: Tao Yang, University of Electronic Science and Technology of China

Tu1C-1: 5G Millimeter-Wave Substrate-Integrated Waveguide Quad-Channel Diplexer with High In-Band and Wideband Isolation
P. Chi, National Chiao Tung Univ. ; H. Shih, National Chiao Tung Univ. ; T. Yang, Univ. of Electronic Science and Technology of China

Tu1C-2: High Common-Mode Rejection Wideband Balanced Bandpass Filter Based on Dual-Mode Semicircular Patch Resonator and DGSs
Q. Zhang, USTC; Y. Wang, NUDT; R. Chen, USTC; W. Chen, USTC; C. Chen, USTC

Tu1C-3: Compact Surface-Mount Shielded and Multilayer Dual-Band Filter
D. Yang, UESTC; Y. Dong, UESTC

Tu1C-4: Design of 5G SISL BPFs Using Differential Inductor-Based Resonators
W. Xu, UESTC; K. Ma, UESTC

Tu1C-5: Dual-Band, Dual-Mode, Microstrip Resonator Loaded, Compact Hybrid SIW Bandpass Filter
Y. Zheng, UESTC; Y. Dong, UESTC

Tu1C-6: Question and Answer

Tu1D: WPT Technologies for IoT and Bio-Medical Applications

Chair: Marco Dionigi, University of Perugia
Co-Chair: Seungyoung Ahn, Korea Advanced Institute of Science and Technology

Tu1D-1: Efficient and Compact Dual-Band Wireless Power Transfer System Through Biological Tissues Using Dual-Reference DGS Resonators
X. Jiang, Kyushu Univ.; F. Tahar, Kyushu Univ.; T. Miyamoto, Kyushu Univ.; A. Barakat, Kyushu Univ.; K. Yoshitomi, Kyushu Univ.; R.K. Pokharel, Kyushu Univ.

Tu1D-2: Design of Disposable Film-Type Capacitive Wireless Charging for Implantable Medical Devices
M. Tamura, Toyohashi University of Technology; K. Murai, Toyohashi University of Technology; M. Matsumoto, Toyohashi University of Technology

Tu1D-3: High Efficiency Metamaterial-Based Multi-Scale Wireless Power Transfer for Smart Home Applications
W. Lee, Univ. of Florida; Y.-K. Yoon, Univ. of Florida

Tu1D-4: Millimeter-Wave Hybrid RF-DC Converter based on a GaAs Chip for IoT-WPT Applications
D. Matos, Instituto De Telecomunicacoes; R. Correia, Instituto De Telecomunicacoes; N. Carvalho, Instituto De Telecomunicacoes

Tu1D-5: Ranging On-demand Microwave Power Transfer in Real-time
E. Fazzini, Univ. of Bologna; A. Costanzo, Univ. of Bologna; D. Masotti, Univ. of Bologna

Tu1D-6: Question and Answer

Tu1E: Circuits and Systems for Microwave and mm-Wave Sensing, Radar and Communications

Chair: Gernot Hueber, Silicon Austria Labs
Co-Chair: Duane Howard, Amazon Web Services, Inc.

Tu1E-1: Doubly-Tuned Transformer-Based Class-E Power Amplifiers in 130nm BiCMOS for mmWave Radar Sensors

T. Dinc, Texas Instruments; S. Akhtar, Texas Instruments; S. Kalia, Texas Instruments; B. Haroun, Texas Instruments; S. Sankaran, Texas Instruments

Tu1E-2: Portable Thermoacoustic Imaging for Biometric Authentication Using a 37.3dBm Peak Psat 4.9GHz Power Amplifier in 55nm BiCMOS

C. Sutardja, Stanford Univ.; A. Cathelin, STMicroelectronics; A. Arbabian, Stanford Univ.

Tu1E-3: A Compact 196GHz FSK Transmitter for Point-to-Point Wireless Communication with Novel Direct Modulation Technique

L. Chen, Univ. of Michigan; S. Nooshabadi, Caltech; A. Cathelin, STMicroelectronics; E. Afshari, Univ. of Michigan

Tu1E-4: A 135–155GHz 9.7%/16.6% DC-RF/DC-EIRP Efficiency Frequency Multiply-by-9 FMCW Transmitter in 28nm CMOS

S. Park, IMEC; D.-W. Park, IMEC; K. Vaesen, IMEC; A. Kankuppe, IMEC; B. van Liempd, IMEC; P. Wambacq, IMEC; J. Craninckx, IMEC

Tu1E-5: A Low Power 35GHz HEMT Oscillator for Electron Spin Resonance Spectroscopy

N. Sahin-Solmaz, EPFL; A.V. Matheoud, EPFL; G. Boero, EPFL

Tu1F: High Performance mm-Wave Front-End Circuits

Chair: Kamran Entesari, Texas A&M University
Co-Chair: Domine Leenaerts, NXP Semiconductors

Tu1F-1: A 39GHz T/R Front-End Module Achieving 25.6% PAEmax, 20dBm Psat, 5.7dB NF, and -13dBm IIP3 in 22nm FD-SOI for 5G Communications

Z. Zong, Vrije Universiteit Brussel; J. Nguyen, Vrije Universiteit Brussel; Y. Liu, IMEC; Y. Zhang, IMEC; X. Tang, Vrije Universiteit Brussel; G. Mangraviti, IMEC; P. Wambacq, Vrije Universiteit Brussel

Tu1F-2: A 22.2–43GHz Gate-Drain Mutually Induced Feedback Low Noise Amplifier in 28-nm CMOS

A. Ershadi, Texas A&M Univ.; S. Palermo, Texas A&M Univ.; K. Entesari, Texas A&M Univ.

Tu1F-3: A Millimeter-Wave LNA in 45nm CMOS SOI with Over 23dB Peak Gain and Sub-3dB NF for Different 5G Operating Bands and Improved Dynamic Range

S. Li, Georgia Tech; T.-Y. Huang, Georgia Tech; Y. Liu, Georgia Tech; H. Yoo, Samsung; Y. Na, Samsung; Y. Hur, Samsung; H. Wang, Georgia Tech

Tu1F-4: A 140GHz T/R Front-End Module in 22nm FD-SOI CMOS

X. Tang, IMEC; J. Nguyen, IMEC; G. Mangraviti, IMEC; Z. Zong, IMEC; P. Wambacq, IMEC

Tu1F-5: A 10–110GHz LNA with 19–25.5dB Gain and 4.8–5.3dB NF for Ultra-Wideband Applications in 90nm SiGe HBT Technology

O. Kazan, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

Tu1G: Advanced Techniques for Power Amplifier Modules, Sub-THz and BIST

Chair: Alvin Joseph, GLOBALFOUNDRIES
Co-Chair: Fred Lee, Twenty Twenty Therapeutics

Tu1G-1: A 27.5dBm EIRP D-Band Transmitter Module on a Ceramic Interposer

A.A. Farid, Univ. of California, Santa Barbara; A.S.H. Ahmed, Univ. of California, Santa Barbara; M.J.W. Rodwell, Univ. of California, Santa Barbara

Tu1G-2: 305–325GHz Non-Reciprocal Isolator Based on Peak-Control Gain-Boosting Magnetless Non-Reciprocal Metamaterials

Y. Wang, Tsinghua Univ.; W. Chen, Tsinghua Univ.; X. Li, Tsinghua Univ.; S. Li, Tsinghua Univ.; P. Zhou, Southeast Univ.

Tu1G-3: 300–335GHz Highly Efficient Beam-Steerable Radiator Based on Tunable Boundary Conditions

Y. Wang, Tsinghua Univ.; W. Chen, Tsinghua Univ.; X. Li, Tsinghua Univ.; J. Chen, Tsinghua Univ.; L. Chen, Tsinghua Univ.; S. Li, Tsinghua Univ.

Tu1G-4: Sequential Loopback Built-In Self-Test Algorithm for Dual-Polarization Millimeter-Wave Phased-Array Transceivers

S. Choi, POSTECH; Y. Aoki, Samsung; H.-C. Park, Samsung; S.-G. Yang, Samsung; H.-J. Song, POSTECH

Tu1G-5: A High-Power SOI-CMOS PA Module with Fan-Out Wafer-Level Packaging for 2.4GHz Wi-Fi 6 Applications

P. Reynier, CEA-LETI; A. Serhan, CEA-LETI; D. Parat, CEA-LETI; R. Mourot, CEA-LETI; M. Gaye, Keysight Technologies; P. Kauv, Keysight Technologies; A. Cardoso, Amkor Technology; A. Gouvea, Amkor Technology; S. Nogueira, Amkor Technology; A. Giry, CEA-LETI

Tu4F: High-Performance Fractional-N PLLs and Building Blocks

Chair: Joseph Cali, BAE Systems
Co-Chair: Howard Luong, Hong Kong University of Science and Technology

Tu4F-1: A 3.3–4.5GHz Fractional-N Sampling PLL with a Merged Constant Slope DTC and Sampling PD in 40nm CMOS

G. Jin, Zhejiang Univ.; F. Feng, Zhejiang Univ.; X. Gao, Zhejiang Univ.; W. Chen, UESTC; Y. Shu, UESTC; X. Luo, UESTC

Tu4F-2: A 18.9–22.3GHz Dual-Core Digital PLL with On-Chip Power Combination for Phase Noise and Power Scalability

S. Karman, Politecnico di Milano; F. Tesolin, Politecnico di Milano; A. Dago, Politecnico di Milano; M. Mercandelli, Politecnico di Milano; C. Samori, Politecnico di Milano; S. Levantino, Politecnico di Milano

Tu4F-3: A 2.3–3.9GHz Fractional-N Frequency Synthesizer with Charge Pump and TDC Calibration for Reduced Reference and Fractional Spurs

J. Jiang, Texas A&M Univ.; T. Yan, Texas A&M Univ.; D. Zhou, Texas A&M Univ.; A.I. Karsilayan, Texas A&M Univ.; J. Silva-Martinez, Texas A&M Univ.

Tu4F-4: A PVT-Compensated 0.1–67GHz Injection-Locked Frequency Divider with Replica-Based Automatic Tuning

M. Baert, KU Leuven; W. Dehaene, KU Leuven

10:00 10:20 10:40 11:00 11:20 11:40

SCHEDULE

MICROAPPS

10:00 – 17:00 | **Tuesday, 22 June 2021** | **AUDITORIUM 6**

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SESSION CODE	TIME	TITLE	SPEAKER/S	COMPANY
TUMA1	10:00 – 10:15	3D Modeling Success with Conical Inductors	Merve Kacar	*Modelithics*
TUMA2	10:15 – 10:30	Solving Large-Scale Verification Simulation Challenges in RFICs	TBD	*Cadence*
TUMA3	10:30 – 10:45	Streamlined and Scalable Workflows With Sonnet Technology File (.STF)	Brian Rautio	*Sonnet Software*
TUMA5	11:00 – 11:15	Addressing Thermal Challenges in High Speed and High-Power Microwave Devices	Doug Gray, Dustin Kendig	*Microsanj*
TUMA6	11:15 – 11:30	AWR V16 Release Advances RF/microwave Chip, Package, Board Co-Design	David Vye	*Cadence*
TUMA7	11:30 – 11:45	Cadence AWR Software Distributed, High-Performance Computing Accelerates Design Cycles	David Vye	*Cadence*
TUMA8	11:45 – 12:00	Cadence Clarity and Celsius Simulators Within Microwave Office Software	John Dunn	*Cadence*
TUMA9	12:00 – 12:15	Cascade Analysis Case Study in AWR Visual System Simulator	Irfan Ashiq, Jeff Earls	*NI*
TUMA10	12:15 – 12:30	Stripline Circuitry for Millimeter-Wave and Very High Speed Digital		*Rogers Corporation*
TUMA11	12:30 – 12:45	Using EM Simulation for Calculating the Spiral Inductor Q Factor	John Dunn	*Cadence*
TUMA12	12:45 – 13:00	A Microwave Differential Delay Shifter	Jonathan Leitner	*Menlo Micro*
TUMA13	13:00 – 13:15	A Thin Film Microwave Feed Network	Gregory Alton	*Knowles*
TUMA14	13:15 – 13:30	Advanced Rigid Organic Substrates for High Frequency Packaging Applications	Daniel Schulze	*MST/Dyconex AG*
TUMA15	13:30 – 13:45	Miniaturized SIW using High K Ceramics	TBD	*Knowles*
TUMA16	13:45 – 14:00	Mitigate Costly Component Out of Pocket Defect Condition During SemiCon-ductor IC Transport/Handling Presented by Darby Davis, Gel-Pak	Craig Blanchette Darby Davis	*BAE Systems* *Gel-Pak*
TUMA17	14:00 – 14:15	mmWave Material Test Becomes Easy and Repeatable	TBD	*EM Labs*
TUMA18	14:15 – 14:30	Ultra-low loss tunable filter implementation and design optimization	TBD	*Menlo Micro*
TUMA19	14:30 – 14:45	"Millimeterwave 5G solutions and 7mm compact sub 6Ghz 5G Solution"	TBD	*JQL Electronics*
TUMA20	14:45 – 15:00	Improve Bondline Control & Reliability with Reinforced Matrix Preforms	Joseph Hertline	*Indium Corporation*
TUMA22	15:15 – 15:30	Thermal Management for High Frequency PCB's	TBD	*Rogers Corporation*
TUMA23	15:30 – 15:45	Biasing and Sequencing GaAs and GaN RF Power Amplifiers using LT Power	Daniel Oliver, Eamon Nash	*Analog Devices, Inc.*
TUMA24	15:45 – 16:00	Broadband Bias Tee Design Using Accurate Models at mmWave Frequencies	Chris DeMartino, Hugo Morales	*Modelithics*
TUMA25	16:00 – 16:15	DPDT Design for High Speed Digital & RF Applications	Jonathan Leitner	*Menlo Micro*
TUMA26	16:15 – 16:30	Extreme Reliability Testing - Mil-STD Levels and Beyond...	Jonathan Leitner	*Menlo Micro*
TUMA27	16:30 – 16:45	Linearizers for V-Band Satellite Uplink Amplifiers	TBD	*LincTech*
TUMA28	16:45 – 17:00	Pulse Shape Duplication for High Power SSPA's	TBD	*Emprower RF*

INDUSTRY WORKSHOPS | 09:00 – 16:40 | Tuesday, 22 June 2021 | AUDITORIUM 6

SESSION CODE	TIME	TITLE	SPEAKER/S	COMPANY
TuIW1	9:00 – 10:40	Low Noise Measurement Workshop	Brooks Hanley, Joanne Mistler, Rich Hoft	*Keysight Technologies*
TuIW2	9:00 – 10:40	Performance Validation of 5GNR mmWave Devices: From Chipset to Production Line	Allen Henley	*LitePoint*
			Jari Vikstedt	*ETS-Lindgren*
TuIW3	11:00 – 12:20	Emerging EMC Requirements for 5G mmWave Devices	Bob DeLisi	*UL*
			Jason Coder	*NIST*
			Garth D'Abreu, Ross Carlton	*ETS-Lindgren*
TuIW5	13:30 – 15:10	5G NR Signal Analysis and the Move to 6G	Aidin Taeb, Denis Gregoire, Hemraj Sodhi, Martha Zemede	*Keysight Technologies*
TuIW6	13:30 – 15:10	Modern RF Frontend Design and Testing	Markus Loerner	*Rohde & Schwarz*
TuIW7	15:50 – 17:30	Designing Accurate mmWave RF Systems by Accounting for Board Layout Parasitics	Ian Rippke, Murthy Upmaka	*Keysight Technologies*
TuIW8	15:50 – 17:30	Meet 5G System Challenges Head On	Matthew Diessner	*Wireless Telecom Group (Boonton, CommAgility, Holzworth, Microlab, Noisecom)*

AUDITORIUM 5

TECHNICAL LECTURES

12:00 – 13:30 | Tuesday, 22 June 2021

	LECTURE TITLE	LECTURE ABSTRACT
TUTL1	**Micro-motion Sensing Radar – Theory, System Architectures, and Circuit Implementations** **Speaker:** Jenshan Lin, University of Florida	Microwave radars have been used in many applications covering long distance (e.g., Doppler weather radar and airplane radar) to short distance (e.g., automobile radar and motion-sensing security radar). Stimulated by successful demonstrations of new system architectures and detection methods from many research groups in the 21st century, there have been growing interests of using short-range microwave radar techniques to detect small-scale motions or fine features of motions on humans and animals (e.g., heartbeat, respiration, acoustic vibration, finger gesture, gaits) for various applications (e.g., biology, medicine, security, emergency rescue, human-machine interface). As such radar techniques allow vast amount of body motion data to be collected for statistical analysis, biometric sensing becomes possible. This lecture will cover the fundamentals of micro-motion sensing radar. Different detection methods, system architectures, and circuit implementations will be discussed. The lecture will review key historical developments in this field. It will explain to audience why a very simple single-tone continuous wave (CW) radar can detect very small and very low frequency cardiorespiratory body motions without being affected by the high 1/f noise in electronic circuits (e.g., in CMOS circuits). The lecture will also explain why it is very challenging to accurately separate heartbeat motion signals from respiration motion signals, and several methods proposed to overcome this challenge will be discussed. While the lecture will focus on hardware implementations, a few signal processing algorithms will also be introduced. In addition, the speaker will comment on the applications and possible future developments.

Tu2A: AI/ML Methods and Applications for Microwaves

Chair: Abhijit Chatterjee, Georgia Institute of Technology
Co-Chair: Rui Ma, Mitsubishi Electric US, Inc.

11:00

Tu2A-1: A Novel Deep-Q-Network Based Fine-Tuning Approach for Planar Bandpass Filter Design

M. Ohira, Saitama University; K. Takano, Saitama University; Z. Ma, Saitama University

11:20

Tu2A-2: Deep Learning Assisted End-to-End Synthesis of mm-Wave Passive Networks with 3D EM Structures: A Study on a Transformer-Based Matching Network

S. Er, Georgia Tech; E. Liu, Georgia Tech; M. Chen, Georgia Tech; Y. Li, Georgia Tech; Y. Liu, Georgia Tech; T. Zhao, Georgia Tech; H. Wang, Georgia Tech

11:40

Tu2A-3: A Multi-Fidelity Surrogate Optimization Method Based on Analytical Models

R.E. Sendrea, Florida International Univ.; C.L. Zekios, Florida International Univ.; S.V. Georgakopoulos, Florida International Univ.

12:00

Tu2A-4: Efficient On-Chip Acceleration of Machine Learning Models for Detection of RF Signal Modulation

J. Woo, Georgia Tech; K. Jung, Georgia Tech; S. Mukhopadhyay, Georgia Tech

12:10

Tu2A-5: Resource Efficient Gesture Sensing Based on FMCW Radar Using Spiking Neural Networks

M. Arsalan, M. Chmurski, A. Santra, M. El-Masry, Infineon Technologies; R. Weigel, FAU Erlangen-Nürnberg; V. Issakov, OvG Universität Magdeburg

12:20

Tu2A-6: Question and Answer

Tu2B: Additive Manufacturing Based RF Sensors and RFIDs for Rugged IoT and Digital Twins in Smart Cities

Chair: Dominique Baillargeat, University of Limoges
Co-Chair: Valentina Palazzi, University of Perugia

11:00

Tu2B-1: Ultra-Low-Cost Passive 3D-Printed Vibration Transducers for Condition Monitoring by Means of Wireless Chipless Transponders

V. Palazzi, Università di Perugia; P. Mezzanotte, Università di Perugia; F. Alimenti, Università di Perugia; M.M. Tentzeris, Georgia Tech; L. Roselli, Università di Perugia

11:20

Tu2B-2: A Novel Additively 4D Printed Origami-Inspired Tunable Multi-Layer Frequency Selective Surface for mm-Wave IoT, RFID, WSN, 5G, and Smart City Applications

Y. Cui, Georgia Tech; S.A. Nauroze, Georgia Tech; R. Bahr, Georgia Tech; M.M. Tentzeris, Georgia Tech

11:40

Tu2B-3: 3D Printed Chipless Tag Based on Spectral Encoding Scheme

S. Terranova, Università di Pisa; F. Costa, Università di Pisa; G. Manara, Università di Pisa; S. Genovesi, Università di Pisa

12:00

Tu2B-4: Inkjet-Printed RF Gas Sensors Based on Conductive Nanomaterials for VOCs Monitoring

J. George, XLIM (UMR 7252); A. Abdelghani, XLIM (UMR 7252); P. Bahoumina, IMS (UMR 5218); E. Cloutet, LCPO (UMR 5629); N. Bernardin, Isorg; K. Frigui, XLIM (UMR 7252); H. Hallil, IMS (UMR 5218); C. Dejous, IMS (UMR 5218); S. Bila, XLIM (UMR 7252); D. Baillargeat, XLIM (UMR 7252)

Tu2B-5: Question and Answer

Tu2C: Advanced Reconfigurable and Integrated Filtering Components

Chair: Hjalti Sigmarsson, University of Oklahoma
Co-Chair: Eric Naglich, Booz Allen Hamilton, Inc.

11:00

Tu2C-1: Self-Tuning N-Path Filter

S. Desrochers, BAE Systems; M. Hickle, BAE Systems

11:20

Tu2C-2: Non-Reciprocal MMIC-Based Dual-Band Bandpass Filters

A. Ashley, University of Colorado Boulder; D. Psychogiou, University of Colorado Boulder

11:40

Tu2C-3: A Tunable Quarter-wavelength Coaxial Filter With Constant Absolute Bandwidth Using a Single Tuning Element

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

12:00

Tu2C-4: Miniaturized Reconfigurable Filtering Power Divider with Arbitrary Output Phase Difference and Improved Isolation

X. Zhu, UESTC; T. Yang, UESTC; P.-L. Chi, National Chiao Tung Univ.; R. Xu, UESTC

Tu2C-5: Question and Answer

Tu2D: Leveraging Electro-Magnetic Fields for Physical Security

Chair: Kaiyuan Yang, Rice University
Co-Chair: Alenka Zajic, Georgia Institute of Technology

11:00

Tu2D-1: High Accuracy RF-PUF for EM Security Through Physical Feature Assistance Using Public Wi-Fi Dataset

Md.F. Bari, Purdue Univ.; B. Chatterjee, Purdue Univ.; K. Sivanesan, Intel; L.L. Yang, Intel; S. Sen, Purdue Univ.

11:20

Tu2D-2: Using the ANOVA F-Statistic to Rapidly Identify Near-Field Vulnerabilities of Cryptographic Modules

V.V. Iyer, Univ. of Texas at Austin; A.E. Yilmaz, Univ. of Texas at Austin

11:40

Tu2D-3: A Multipole Approach towards On-Chip Metal Routing for Reduced EM Side-Channel Leakage

M. Nath, Purdue Univ.; D. Das, Purdue Univ.; S. Sen, Purdue Univ.

12:00

Tu2D-4: Channel Modeling for Physically Secure Electro-Quasistatic In-Body to Out-of-Body Communication with Galvanic Tx and Multimodal Rx

A. Datta, Purdue Univ.; M. Nath, Purdue Univ.; B. Chatterjee, Purdue Univ.; N. Modak, Purdue Univ.; S. Sen, Purdue Univ.

Tu2D-5: Question and Answer

11:10 11:30 11:50 12:30

RFIC/IMS JOINT PANEL SESSION | 12:30 – 14:00 | Tuesday, 22 June 2021 | AUDITORIUM 5

RF Startups: A Dead Horse in the Era of Software Unicorns and Pandemics?

PANEL SESSION CHAIRS — RFIC: Jennifer Kitchen, *Arizona State University* | **IMS: Ruonan Han,** *MIT*; **Rui Ma,** *MERL*

PANEL ORGANIZERS AND MODERATORS:

Oren Eliezer, *Ambiq*
Joseph Cali, *BAE Systems*
François Rivet, *University of Bordeaux;*
Jacques C. Rudell, *University of Washington;*
Jim Ahne, *Guerilla RF*

PANELISTS:

Amitava Das, *Tagore Technology;*
Joy Laskar, *Maja Systems*
Wouter Steyaert, *Tusk IC;*
Tomi-Pekka Takalo, *CoreHW*
Harish Krishnaswamy, *MixComm*

ABSTRACT:

RFIC and microwave startups are not an easy job, especially when compared with many successful software startup companies that appeared to have effortlessly reached a high number of users without ever delivering a physical hardware product. Many of these companies have already exceeded billion-dollar valuation, thereby qualifying as a "unicorn."

In contrast, RFIC and microwave 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, all of which have become particularly difficult under the Covid-19 social-distancing restrictions. What's more, nowadays these entrepreneurs face competition from the software unicorns for attention and funds of potential investors, as well as attracting young talent into the 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, their business strategies to compete in a given market, and what challenges they have been facing. They will also discuss the uncertainties, as well as opportunities, that the pandemic brings about. 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, opinions and questions!

INTER-SOCIETY TECHNOLOGY PANEL (ISTP) SESSION | 13:30 – 14:30 | Tuesday, 22 June 2021 | AUDITORIUM 5

5G Health Impact – Fiction or Facts?

PANEL ORGANIZERS:

Abbas Omar, *University of Magdeburg*
Raafat Mansour, *University of Waterloo*
Ke Wu, *École Polytechnique de Montréal*

MODERATOR:

Jeffrey Herd, *Massachusetts Institute of Technology, Lincoln Laboratory*

PANELISTS:

Chung-Kwang Chou, *Consultant*
Josh Mitteldoft, *Washington University*
Katia Grenier, *LAAS-CNRS*
Ted Rappaport, *New York University*
James Lin, *University of Illinois at Chicago*
Rodney Croft, *University of Wollongong*

ABSTRACT:

With the intention to extend the mobile services to millimeter-wave bands within the framework of 5G, concerns and hopes have been raised both professionally and publically. The main concerns raised by the general public are related to the potential health hazards of human exposure to millimeter-wave radiation and the increased level of electromagnetic (EM) radiation with the full deployment of 5G systems and widespread use of wireless devices. Thermal effects of EM radiations have been well studied. Based on the information provided in the international standards and the substantial body of sciences underpinning them, there is no evidence of harms and issues from 5G when human exposure does not exceed the standards. However, other mechanisms for non-thermal health effects are being questioned. These include, among others, possible DNA changes with consequent gene manipulations and nerve stimulations. Moreover, while models can provide reasonably accurate information about the EM level generated from wireless infrastructure, the actual radiation emitted from antennas mounted on the mast of cell sites may differ from the modeled levels due to the complex nature of the environment. Factors such as multipath scattering and the RF emission from other wireless sources are difficult or impractical to model and predict. The wireless environment with a full deployment of 5G remains to be unknown to many. Experts of various disciplines from multiple IEEE societies will come together and discuss different concerns and expectations related to the health impact of 5G technology.

Tu3A: Advances in Numerical Methods for Electromagnetics and RF Circuits

Chair: Constantine Sideris, University of Southern California
Co-Chair: Vladimir Okhmatovski, University of Manitoba

13:30 – 13:40 **Tu3A-1: Quantum Method for Finite Element Simulation of Electromagnetic Problems**
J. Zhang, Carleton Univ.; F. Feng, Tianjin Univ.; Q.J. Zhang, Carleton Univ.

13:50 – 14:00 **Tu3A-2: Discontinuous Galerkin Time Domain Modeling of Metasurface Geometries with Multi-Rate Time Stepping**
Q. Zhao, Univ. of Toronto; C.D. Sarris, Univ. of Toronto

14:10 – 14:20 **Tu3A-3: High-Order Accurate Integral Equation Based Mode Solver for Layered Nanophotonic Waveguides**
J. Hu, Univ. of Southern California; E. Garza, Univ. of Southern California; C. Pérez-Arancibia, Pontificia Universidad Católica de Chile; C. Sideris, Univ. of Southern California

14:30 – 14:40 **Tu3A-4: Parallel Non-Monte Carlo Transient Noise Simulation**
A. Goulet, McGill Univ.; M. Farhan, Cadence Design Systems, Inc.; M. Kassis, Cadence Design Systems, Inc.; R. Khazaka, McGill Univ.

14:50 – 15:00 **Tu3A-5: Closed-Form Evaluation of Michalski-Zheng's Mixed Potential Layered Media Green's Function Using Spectral Differential Equation Approximation Method**
V.I. Okhmatovski, Univ. of Manitoba

15:10 **Tu3A-6: Question and Answer**

Tu3B: Advanced Fabrication Techniques for Up to TeraHertz Packaging

Chair: Valentina Palazzi, University of Perugia
Co-Chair: Georgios Dogiamis, Intel Corporation

13:30 **Tu3B-1: A Monolithic Vertical Integration Concept for Compact Coaxial-Resonator-Based Bandpass Filters Using Additive Manufacturing**
K. Zhao, Univ. of Colorado; D. Psychogiou, University of Colorado at Boulder

13:50 **Tu3B-2: Additively Manufactured, Low Loss 20GHz DC Contact RF MEMS Switch Using Laterally Actuated, Fix-Free Beam**
O.F. Firat, Oregon State Univ.; J. Wang, Univ. of South Florida; T.M. Weller, Oregon State Univ.

14:10 **Tu3B-3: Additively Manufactured Wavemode Transition for Broadband E-Band Applications**
K. Lomakin, FAU Erlangen-Nürnberg; L. Engel, FAU Erlangen-Nürnberg; J. Fleischmann, FAU Erlangen-Nürnberg; G. Gold, FAU Erlangen-Nürnberg

14:30 **Tu3B-4: Study of Nanowire-based Integrated Via Technology for CMOS Application in Millimeter-Wave Frequencies**
Y. Zhang, Univ. of Minnesota, Twin Cities; J. Um, University of Minnesota-Twin Cities; B. Stadler, University of Minnesota-Twin Cities; R. Henderson, The University of Texas at Dallas; R. Franklin, Univ. of Minnesota

14:50 **Tu3B-5: THz-Wave Waveguide Packaging with Multiple THz On-Chip Transitions Integrated in Single Chip**
C.-G. Choi, POSTECH; H.-H. Jeong, POSTECH; H.-J. Song, POSTECH

15:10 **Tu3B-6: Question and Answer**

Tu3C: New Solutions for Non-Planar Filters Design

Chair: Simone Bastioli, RS Microwave
Co-Chair: Ming Yu, Chinese University of Hong Kong

13:30 **Tu3C-1: A True Inline Coaxial-Cavity Filter with Two Symmetric Zero**
S. Tamiazzo, Commscope; G. Macchiarella, Politecnico di Milano - Dipartimento di Elettronic; F. Seyfert, INRIA- Sophia Antipolis- Méditerranée

13:50 **Tu3C-2: Flexible Design of Generalized Strongly Coupled Resonator Triplet Filters by Regulating Redundant Resonant Modes**
Y. Zeng, CUHK; Y. Yang, Xidian Univ.; M. Yu, SUSTech

14:10 **Tu3C-3: Spurious Suppression Through the Control of Their Couplings: Application to TM Cavity Filters**
A. Rehman, Università di Perugia; C. Tomassoni, Università di Perugia

14:30 **Tu3C-4: Expanding the Working Bandwidth of the Manifold Coupled Multiplexers**
Y. Yang, Xidian Univ.; M. Yu, SUSTech; Q. Wu, Xidian Univ.

14:50 **Tu3C-5: Hybridly-Integrated Quasi-Elliptic-Type Bandpass Filters with Symmetrical Quasi-Reflectionless Characteristics**
D. Simpson, University of Colorado Boulder; R. Gómez-García, Universidad de Alcalá; D. Psychogiou, University of Colorado Boulder

15:10 **Tu3C-6: Question and Answer**

Tu3D: Chipless RFID and Resonator-Based Sensors

Chair: Etienne Perret, Université Grenoble Alpes
Co-Chair: Manuel Monge, University of Southern California

13:30 **Tu3D-1: Novel Chipless RFID Concept with High Data Capacity**
I. Ullmann, FAU Erlangen-Nürnberg; K. Root, FAU Erlangen-Nürnberg; M. Vossiek, FAU Erlangen-Nürnberg

13:50 **Tu3D-2: A Simple RCS Calibration Approach for Depolarizing Chipless RFID Tags**
Z. Ali, LCIS (EA 3747); E. Perret, LCIS (EA 3747)

14:10 **Tu3D-3: Vibration Sensors Using Complementary Split-Ring Resonators Based on Pendulum Structure for Frequency Detection**
K.-W. Lin, National Cheng Kung Univ.; C.-L. Yang, National Cheng Kung Univ.

14:30 **Tu3D-4: Wireless Measurement of the Pressure from the Ka-Band Radar Echo of a 3D-Printed Microfluidic Depolarizing Sensor**
T. Marchal, LAAS-CNRS; D. Henry, LAAS-CNRS; P. Pons, LAAS-CNRS; H. Aubert, LAAS-CNRS

14:50 **Tu3D-5: Question and Answer**

Tu4A: Nonlinear Analysis, Simulation, and Design Techniques

Chair: Tushar Sharma, NXP Semiconductors

Co-Chair: Fabrizio Bonani, Politecnico di Torino

Tu4A-1: Nonlinear Analysis of a High-Power Oscillator Inductively Coupled to an External Resonator

V. Ardila-Acuña, Univ. of Cantabria; F. Ramirez, Univ. of Cantabria; A. Suarez, Univ. of Cantabria

Tu4A-2: A 2.3GHz -10.8dBm Threshold Parametric Frequency Selective Limiter with 1.7dB Loss

H.M.E. Hussein, Northeastern Univ.; C. Cassella, Northeastern Univ.

Tu4A-3: Analysis of Noise and Dynamical Effects in Zero-IF Self-Oscillating Mixers

M. Pontón, Universidad de Cantabria; S. Sancho, Universidad de Cantabria; A. Herrera, Universidad de Cantabria; A. Suárez, Universidad de Cantabria

Tu4A-4: IMS Fast Method for Large-Scale Signaling Analysis of Nonlinear Circuits Including Worst-Case Eye and Bit Error Rate Analysis

Y. Dou, Purdue Univ.; D. Jiao, Purdue Univ.; J. Yan, Intel; J. Zhu, Intel; A. Norman, Intel

Tu4A-5: Question and Answer

Tu4B: Advanced Technologies for Non-Planar Filters Manufacturing

Chair: Stephane Bila, Xlim - CNRS-Unversite De Liroges

Co-Chair: Dick Snyder, RS Microwave

Tu4B-1: 3-D-Printed Dual-Mode Filter Using an Ellipsoidal Cavity With Asymmetric Responses

E. López-Oliver, Univ. of Perugia; C. Tomassoni, Univ. of Perugia

Tu4B-2: Cross Coupling in Folded Interdigital Filters Using Quarter-Wavelength Resonators with Non-Planar Structures

A. Anand, Nuvotronics

Tu4B-3: Dual-Band Filters in Rectangular Waveguide Based on Resonant Apertures

J.F. Valencia Sullca, S. Cogollos, M. Guglielmi, V.E. Boria, Univ. Politècnica de València

Tu4B-4: Narrow-Band Band-Pass Filters for Terahertz Applications

C.M. Cooke, Northrop Grumman; J. Arroyo, K. Zhang, Cubic; A. Escorcia, K. Nguyen, W.R. Deal, Northrop Grumman

Tu4B-5: Dual-Mode WR-3 Waveguide Filter with E-Plane Cut

D. Miek, CAU; P. Boe, CAU; F. Kamrath, CAU; M. Höft, CAU

Tu4B-6: Micromachined Bandpass Filters with Enhanced Stopband Performance and Q-Factor of 950 at 700GHz

O. Glubokov, KTH; X. Zhao, KTH; J. Campion, KTH; U. Shah, KTH; J. Oberhammer, KTH

Tu4B-7: Question and Answer

Tu4C: Acoustic Filters for Advanced Communication Systems

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

Co-Chair: Amelie Hagelauer, University of Bayreuth

Tu4C-1: Wideband 6GHz RF Filters for Wi-Fi 6E Using a Unique BAW Process and Highly Sc-Doped AlN Thin Film

D. Kim, Akoustis; G. Moreno, Akoustis; F. Bi, Akoustis; M. Winters, Akoustis; R. Houlden, Akoustis; D. Aichele, Akoustis; J.B. Shealy, Akoustis

Tu4C-2: A Synthetic Wideband SAW Filter Using Parallel DMS

H. Xue, UESTC; Y. Dong, UESTC

Tu4C-3: Physics Based Modeling of Electrostriction Based BAW Resonators

W. Peng, Univ. of Michigan; M. Zolfagharloo Koohi, Univ. of Michigan; S. Nam, Univ. of Michigan; A. Mortazawi, Univ. of Michigan

Tu4C-4: A Near Zero TCF Acoustic Resonator with High Electromechanical Coupling of 13.5% at 3.5GHz

A.E. Hassanien, Univ. of Illinois at Urbana-Champaign; R. Lu, Univ. of Texas at Austin; S. Gong, Univ. of Illinois at Urbana-Champaign

Tu4C-5: Novel Temperature-Compensated, Silicon SAW Design for Filter Integration

R. Ruby, Broadcom Corp.; S. Gilbert, Broadcom Ltd; S. Lee, Broadcom Ltd; J. Nilchi, Broadcom Ltd; S. Kim, Sawnics

Tu4C-6: Question and Answer

Tu4D: Sensor and characterization methods for biological and electronic materials

Chair: Rashaunda Henderson, University of Texas at Dallas

Co-Chair: Malgorzata Celuch, QWED Sp. z o.o

Tu4D-1: Sub-Nanoliter Sensing of Dielectric Properties of Liquid-in-Flow at 190 GHz

G. Sterzl, Univ. of Stuttgart; U. Dey, Univ. of Stuttgart; J. Hesselbarth, Univ. of Stuttgart

Tu4D-2: Microwave Sensor Dedicated to the Determination of the Dielectric Properties of 3D Biological Models from 500MHz to 20GHz

O. Peytral-Rieu, LAAS-CNRS; K. Grenier, LAAS-CNRS; D. Dubuc, LAAS-CNRS

Tu4D-3: Measurements of Dielectric Materials of High Anisotropy Ratio with TM0n0 Cavity

J. Cuper, Warsaw Univ. of Technology; B. Salski, Warsaw Univ. of Technology; J. Krupka, Warsaw Univ. of Technology; P. Kopyt, Warsaw Univ. of Technology

Tu4D-4: Quantitative Error Metrics and Test Patterns for Enhanced Dielectric Resonator Imaging of Microwave Materials

P. Korpas, Warsaw Univ. of Technology; D. Mieczkowska, QWED; M. Olszewska-Placha, QWED; J. Rudnicki, QWED; M. Celuch, QWED

Tu4D-5: Question and Answer

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

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.

Th1F-1: A 27–46 GHz Low Noise Amplifier With Dual-Resonant Input Matching and A Transformer-Based Broadband Output Network
Authors: Y. Hu, Rice Univ.; T. Chi, Rice Univ.

Th2A-4: Asynchronous 256-Element Phased-Array Calibration for 5G Base Station
Authors: Y. Aoki, Samsung Electronics Co., Ltd.; Y. Hwang, Samsung Electronics, Co., Ltd.; S. Kim, Samsung Electronics, Co., Ltd.; Y. Kim, Samsung Electronics, Co., Ltd.; S. Yang, Samsung Electronics, Co., Ltd.

Th2C-1: 80-110 GHz Broadband Linear PA with 33% Peak PAE and Comparison of Stacked Common-Base and Common-Emitter PA in InP
Authors: Z. Liu, Princeton Univ.; T. Sharma, Princeton Univ.; K. Sengupta, Princeton Univ.

Th3D-2: A Dual-Polarized 1024-Element Ku-Band SATCOM Phased-Array with Embedded Transmit Filter and >10 dB/K G/T
Authors: G. Gültepe, Univ. of California, San Diego; S. Zihir, Renesas Electronics; T. Kanar, Renesas Electronics; G.M. Rebeiz, Univ. of California, San Diego

Th3F-2: Compact V-Band MMIC Square-Law Power Detector with 70dB Dynamic Range Exploiting State-of-the-Art Graphene Diodes
Authors: M. Saeed, RWTH Aachen Univ.; A. Hamed, RWTH Aachen Univ.; B. Uzlu, AMO; E. Baskent, AMO; M. Otto, AMO; Z. Wang, AMO; R. Negra, RWTH Aachen Univ.

Tu1C-1: 5G Millimeter-Wave Substrate-Integrated Waveguide Quad-Channel Diplexer with High In-Band and Wideband Isolation
Authors: P. Chi, National Chiao Tung Univ.; H. Shih, National Chiao Tung Univ.; T. Yang, Univ. of Electronic Science and Technology of China

Tu1D-1: Efficient and Compact Dual-Band Wireless Power Transfer System Through Biological Tissues Using Dual-Reference DGS Resonators
Authors: X. Jiang, Kyushu Univ.; F. Tahar, Kyushu Univ.; T. Miyamoto, Kyushu Univ.; A. Barakat, Kyushu Univ.; K. Yoshitomi, Kyushu Univ.; R.K. Pokharel, Kyushu Univ.

Tu2C-3: A Tunable Quarter-wavelength Coaxial Filter With Constant Absolute Bandwidth Using a Single Tuning Element
Authors: G. B., Univ. of Waterloo; R. Mansour, Univ. of Waterloo

Tu2D-3: A Multipole Approach towards On-Chip Metal Routing for Reduced EM Side-Channel Leakage
Authors: M. Nath, Purdue Univ.; D. Das, Purdue Univ.; S. Sen, Purdue Univ.

Tu2D-4: Channel Modeling for Physically Secure Electro-Quasistatic In-Body to Out-of-Body Communication with Galvanic Tx and Multimodal Rx
Authors: A. Datta, Purdue Univ.; M. Nath, Purdue Univ.; B. Chatterjee, Purdue Univ.; N. Modak, Purdue Univ.; S. Sen, Purdue Univ.

Tu3B-1: A Monolithic Vertical Integration Concept for Compact Coaxial-Resonator-Based Bandpass Filters Using Additive Manufacturing
Authors: K. Zhao, Univ. of Colorado; D. Psychogiou, University of Colorado at Boulder

Tu4A-1: Nonlinear Analysis of a High-Power Oscillator Inductively Coupled to an External Resonator
Authors: V. Ardila-Acuña, Univ. of Cantabria; F. Ramirez, Univ. of Cantabria; A. Suarez, Univ. of Cantabria

Tu4B-2: Cross Coupling in Folded Interdigital Filters Using Quarter-Wavelength Resonators with Non-Planar Structures
Authors: A. Anand, Nuvotronics

Tu4D-3: Measurements of Dielectric Materials of High Anisotropy Ratio with TM0n0 Cavity
Authors: J. Cuper, Warsaw Univ. of Technology; B. Salski, Warsaw Univ. of Technology; J. Krupka, Warsaw Univ. of Technology; P. Kopyt, Warsaw Univ. of Technology

We1B-5: A Barrier Function Method for Optimal Placement of Decoupling Capacitors on Resonant Plane Pairs
Authors: I. Erdin, Celestica

We1E-5: Deep Sub-Wavelength Millimeter-Wave Radar Interferometry with a Novel Ego-Motion Based Calibration Technique
Authors: W. Xu, Shanghai Jiao Tong Univ.; C. Gu, Shanghai Jiao Tong Univ.; J.-F. Mao, Shanghai Jiao Tong Univ.

We2B-2: In-Package Additively Manufactured Sensors for Bend Prediction and Calibration of Flexible Phased Arrays and Flexible Hybrid Electronics
Authors: X. He, Georgia Tech; M.M. Tentzeris, Georgia Tech

We2G-2: An Over 67-GHz Bandwidth 21-dB Gain 4.5-Vppd Linear Modulator Driver for 100-Gbaud Coherent Optical Transmitter
Authors: T. Jyo, NTT Device Technology Laboratories; M. Nagatani, NTT Device Technology Laboratories; Y. Ogiso, NTT Device Innovation Center; S. Yamanaka, NTT Device Innovation Center; H. Nosaka, NTT Device Technology Laboratories

We3B-2: Simultaneous Channel Phased-Array Calibration Using Orthogonal Codes and Post-Coding
Authors: T. Phelps, Univ. of California, San Diego; Z. Zhang, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

We3F-1: A 75-305-GHz Power Amplifier MMIC With 10-14.9-dBm Pout in a 35-nm InGaAs mHEMT Technology
Authors: F. Thome, Fraunhofer IAF; A. Leuther, Fraunhofer IAF

WeIF1-14: 3D Integrated 300°C Tunable RF Oscillator Exploiting AlGaN/GaN HEMT for High Temperature Applications
Authors: P. Palacios, RWTH Aachen Univ.; T. Zweipfennig, RWTH Aachen Univ.; A. Ottaviani, IMS CHIPS; M. Saeed, RWTH Aachen Univ.; C. Beckmann, RWTH Aachen Univ.; M. Alomari, IMS CHIPS; G. Lükens, RWTH Aachen Univ.; H. Kalisch, RWTH Aachen Univ.; J.N. Burghartz, IMS CHIPS; A. Vescan, RWTH Aachen Univ.; R. Negra, RWTH Aachen Univ.

WeIF1-27: A High Efficiency D-band 32-Channel Radial Waveguide Power Divider/Combiner
Authors: X.J. Deng, Univ. of Electronic Science and Technology of China; Y.B. Rao, Univ. of Electronic Science and Technology of China; K. Huang, China Academy of Engineering Physics; J. Zhou, Univ. of Electronic Science and Technology of China; W. Su, China Academy of Engineering Physics; X. Luo, Univ. of Electronic Science and Technology of China

WeIF1-27: A High Efficiency D-band 32-Channel Radial Waveguide Power Divider/Combiner
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WeIF1-14: 3D Integrated 300°C Tunable RF Oscillator Exploiting AlGaN/GaN HEMT for High Temperature Applications
Authors: P. Palacios, RWTH Aachen Univ.; T. Zweipfennig, RWTH Aachen Univ.; A. Ottaviani, IMS CHIPS; M. Saeed, RWTH Aachen Univ.; C. Beckmann, RWTH Aachen Univ.; M. Alomari, IMS CHIPS; G. Lükens, RWTH Aachen Univ.; H. Kalisch, RWTH Aachen Univ.; J.N. Burghartz, IMS CHIPS; A. Vescan, RWTH Aachen Univ.; R. Negra, RWTH Aachen Univ.

Th2D-3: Development of a Compact 28-GHz Software-Defined Phased Array for a City-Scale Wireless Research Testbed
Authors: X. Gu, IBM T.J. Watson Research Center; A. Paidimarri, IBM T.J. Watson Research Center; B. Sadhu, IBM T.J. Watson Research Center; C. Baks, IBM T.J. Watson Research Center; S. Lukashov, IBM T.J. Watson Research Center; M. Yeck, IBM T.J. Watson Research Center; Y. Kwark, IBM T.J. Watson Research Center; T. Chen, Columbia Univ.; G. Zussman, Columbia Univ.; I. Seskar, Rutgers Univ.; A. Valdes-Garcia, IBM T.J. Watson Research Center

Th2E-1: Surface Cancellation in Wideband Ground Penetrating Radar Employing Genetic Algorithm AI for Waveform Synthesis
Authors: A. Tang, Jet Propulsion Lab; E. Decrossas, Jet Propulsion Lab; Y. Gim, Jet Propulsion Lab; R. Huang, Univ. of California, Los Angeles; R. Beauchamp, Jet Propulsion Lab; M.-C.F. Chang, Univ. of California, Los Angeles

Th2E-2: D-Band FMCW Radar Sensor for Industrial Wideband Applications with Fully-Differential MMIC-to-RWG Interface in SIW
Authors: S. Hansen, Fraunhofer FHR; C. Bredendiek, Fraunhofer FHR; G. Briese, Fraunhofer FHR; N. Pohl, Ruhr-Universität Bochum

Th2E-3: Towards Chipless RFID Technology Based on Micro-Doppler Effect for Long Range Applications
Authors: A. Azarfar, LCIS (EA 3747); N. Barbot, LCIS (EA 3747); E. Perret, LCIS (EA 3747)

We2F-1: A 35–100GHz Continuous Mode Coupler Balun Doherty Power Amplifier with Differential Complex Neutralization in 250nm InP
Authors: T.-Y. Huang, Georgia Tech; S. Li, Georgia Tech; N.S. Mannem, Georgia Tech; H. Wang, Georgia Tech

WeIF1-48: A Reconfigurable Dual-Polarized 1024-Element Ka-Band SATCOM Transmit Phased-Array with Large Scan Volume and +48dBW EIRP
Authors: K.K.W. Low, Univ. of California, San Diego; S. Zihir, Renesas Electronics; T. Kanar, Renesas Electronics; G.M. Rebeiz, Univ. of California, San Diego

WeIF1-49: A 366nW, -74.5dBm Sensitivity Antenna-Coupled Wakeup Receiver at 4.9GHz with Integrated Voltage Regulation and References
Authors: D. Duvvuri, Univ. of Virginia; X. Shen, Univ. of Virginia; P. Bassirian, Univ. of Virginia; H.L. Bishop, Univ. of Virginia; X. Liu, Univ. of Virginia; C.-H. Chen, Univ. of Virginia; A. Dissanayake, Univ. of Virginia; Y. Zhang, Univ. of Virginia; T.N. Blalock, Univ. of Virginia; B.H. Calhoun, Univ. of Virginia; S.M. Bowers, Univ. of Virginia

WeIF1-63: Multichannel Substrate Integrated Waveguide Diplexer Made of Dual-Mode Cavities and Split-Type Dual-Band Response
Authors: K. Zhou, École Polytechnique de Montréal; K. Wu, École Polytechnique de Montréal

IEEE youngprofessionals

CONNECTED FUTURE SUMMIT

09:00 – 16:30 | Wednesday, 23 June 2021 | AUDITORIUM 5

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PRESENTATION TITLE	SPEAKER	AFFILIATION	TIME
Connected Future with 5G and Beyond: Perspectives from 3GPP	Richard Burbidge	*Intel*	09:00 – 09:40
Next Generation Wi-Fi: Wi-Fi 6/6E and Beyond	Carlos Cordeiro	*Intel*	09:40 – 10:20
Communications in the 6G Era	Haish Viswanathan	*Nokia*	10:20 – 11:00
Break			11:00 – 11:10
RF, mmWave and subTHz Semiconductor Trends & the Outlook Towars 6G	Jon Strange	*Mediatek*	11:10 – 11:50
Test and Validation in the 6G Era: From DC to Daylight	Roger Nichols	*Keysight*	11:50 – 12:30
LUNCH Break			12:30 – 13:30
SOI and SiGe Technologies for mm-Wave Applications	Ned Cahoon	*Global Foundries*	13:30 – 14:10
Commercial mmW 5G with Scalable Active Antennas	Nitin Jain	*Anokiwave*	14:10 – 14:50
OTA Test of Integrated mmWave Wireless Devices	Kate A. Remley	*NIST*	14:50 – 15:30
Break			15:30 – 15:45
Panel Discussions	All Speakers		15:45 – 16:30

SCHEDULE

INDUSTRY WORKSHOPS

09:00 – 16:40 | Wednesday, 23 June 2021 | AUDITORIUM 6

SESSION CODE	TIME	TITLE	SPEAKER/S	COMPANY
WeIW1	9:00 – 10:40	Advanced EW Signal Analysis Techniques with Wideband Oscilloscopes and 89600 VSA Software	Andy Owen, Philip Gresock, Raj Sodhi	*Keysight Technologies*
WeIW2	9:00 – 10:40	Best Practices for on Wafer S-Parameter Measurements To Thz Over a Wide Temperature Range	Gavin Fisher	*FormFactor*
WeIW3	11:00 – 12:20	Exploring the Engineering Journey of a mm-Wave Filter Design from Design Simulation to Test and Measurement	Diamond Liu	*Engineering*
WeIW4	11:00 – 12:20	Phase Noise Theory and Measurement	Brooks Hanley, Joanne Mistler, Rich Hoft	*Keysight Technologies*
WeIW5	15:00 – 16:20	Measuring S-Parameters and Power with Uncertainty	Steve Dudkiewicz	*Maury Microwave*
WeIW6	15:00 – 16:40	New Sub Terahertz R&D Testbed for 6G Research	Greg Jue	Keysight Technologies

MICROAPPS

10:00 – 17:00 | **Wednesday, 23 June 2021** | **AUDITORIUM 6**

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SESSION CODE	TIME	TITLE	SPEAKER/S	COMPANY
WEMA31	10:30 – 10:45	Wideband Amplifiers Need Wideband Biasing Circuits	Daniel Oliver, Eamon Nash	*Analog Devices, Inc.*
WEMA33	11:00 – 11:15	Advanced Methods to Analyze Ultra-Wide Automotive Radar Signals	Martin Schmähling	*Rohde & Schwarz*
WEMA34	11:150 – 11:30	Advantages of Distributed Measurement Ports in VNA Applications	Stanley Oda	*Anritsu*
WEMA35	11:30 – 11:45	Analysis of WLAN 802.11ay Signals with Channel Bonding (CB2 and CB3)	Werner Dürport	*Rohde & Schwarz*
WEMA36	11:45 – 12:00	Applications of RF on Fiber for Signal Processing		*Lin Phontonics*
WEMA37	12:00 – 12:15	Contactless Waveguide Flange and Its mmW-THz Test Setup Applications		*Eravant*
WEMA38	12:15 – 12:30	Continuous S-parameter measurements to 500 GHz	Gavin Fisher	*FormFactor*
WEMA39	12:30 – 12:15	Correcting Multichannel Microwave Digitizer Front-End Anomalies Within Phased Arrays Using Novel Mixed-Signal Calibration Routines	Chas Frick, Mike Jones	*Analog Devices*
WEMA40	12:45 – 13:00	Direct RF Data Conversion and Transceiver Architectures in RF Instrumentation	Thomas Costello	*Astronics Test Systems*
WEMA41	13:00 – 13:15	Faster OTA Validation From Direct Far Field to Indirect Far Field	Alejandro Buritica	*National Instruments*
WEMA42	13:15 – 13:30	Fixture Removal Technique with a 1-Port Reflect Model on a VNA	Subbaiah Pemmaiah	*Copper Mountain Technologies*
WEMA43	13:30 – 13:45	Improve 5G Testing with Reliable Microwave/RF Cable Assemblies	Paul Pino	*W. L. Gore & Associates, Inc.*
WEMA44	13:45 – 14:00	Improved Strategies for Adaptive Frequency Sweeps	Ralf Ihmels	*Mician, Inc.*
WEMA45	14:00 – 14:15	Improving High-Bandwidth RF Front-End Validation	Alejandro Buritica	*National Instruments*
WEMA46	14:15 – 14:30	Measurement Repeatability Benefits When Using Video Overlay Probe Positioning Markers	Gavin Fisher	*FormFactor*
WEMA47	14:30 – 14:45	Modular Implementation of the Latest RFSoC Chip from Xilinx		*Pentek*
WEMA48	14:45 – 15:00	New Japan Radio – WaveEyes® Intelligent Microwave Sensors	Hiroshi Hosaka, Joe Simanis	*New Japan Radio*
WEMA49	15:00 – 15:15	Next-Generation Solution for High-Performance RF Testing	Sascha Laumann	*Rohde & Schwarz*
WEMA52	15:45 – 16:00	Performing 4-port Broadband VNA Measurements from 70 kHz to 220 GHz	TBD	*Anritsu*
WEMA53	16:00 – 16:15	Predicting Performance of Xinger Passive Components on Customized PCB Layouts	Chong Mei, David Senior, Samir Tozin	*TTM Technologies*
WEMA54	16:15 – 16:30	Programmable 5G Small Cell Architectures for Private Networks	Paul Moakes	*CommAgility (Wireless Telecom Group)*
WEMA55	16:30 – 16:45	Pulse to Pulse Phase Stability Measurement	Wolfgang Wendler	*Rohde & Schwarz*
WEMA56	16:45 – 17:00	Relating Active Beamforming IC Parameters to Phased Array Antenna Performance		*Resesas*

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

We1B: Advances in Surrogate Modeling, Optimization, and Design Automation

Chair: Jose Rayas-Sanchez, ITESO - The Jesuit University of Guadalajara

Co-Chair: Erin Kiley, Massachusetts College of Liberal Arts

09:00 **We1B-1: Multi-Objective Efficiency and Phase Distortion Optimizations for Automated Design of Power Amplifiers Through Deep Neural Networks**

L. Kouhalvandi, Istanbul Technical Univ.; O. Ceylan, Maury Microwave Corp.; S. Ozoguz, Istanbul Technical Univ.

09:20 **We1B-2: Constrained Surrogates and Dimensionality Reduction for Low-Cost Multi-Objective Optimization of Compact Microwave Components**

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

09:40 **We1B-4: Multilevel Parameterized Model Order Reduction for Variability Analysis of Circuits**

S. Essahli, IMT Atlantique; Y. Tao, Carleton Univ.; F. Ferranti, IMT Atlantique; M. Nakhla, Carleton Univ.; C. Person, IMT Atlantique

10:00 **We1B-5: A Barrier Function Method for Optimal Placement of Decoupling Capacitors on Resonant Plane Pairs**

I. Erdin, Celestica

10:20 **We1B-6: Question and Answer**

We1C: Recent Advances in Passive Components

Chair: Holger Maune, Technische Universität Darmstadt

Co-Chair: Shuhei Amakawa, Hiroshima University

09:00 **We1C-1: A W-Band 1-dB Insertion Loss Wilkinson Power Divider Using Silicon-Based Integrated Passive Device**

C. Hsiao, National Chiao Tung Univ.; C. Wu, Rutgers Univ.; C. Kuo, National Chiao Tung Univ.

09:20 **We1C-2: Highly Miniaturized and Broadband 3dB Quadrature Hybrid Using Slow-Wave Coupling Line**

Y. Cao, Univ. of Central Florida; K. Chen, Univ. of Central Florida

09:40 **We1C-3: A Dual-Band Balun BPF Using Double-Sided Parallel-Strip Line**

J. Ge, Univ. of South Carolina; W. Jiang, Zhejiang Xintang Zhixin Technology; G. Wang, Univ. of South Carolina

10:00 **We1C-4: Four-Way Filtering Crossover Based on Quadruple-Mode Cavity Resonator**

J.-Y. Lin, UTS; Y. Yang, UTS; S.-W. Wong, Shenzhen Univ.

10:20 **We1C-5: A Compact K-/Ka-Band Rectangular-to-Coplanar Waveguide Transition with Integrated Diplexer**

K. Erkelenz, Hamburg Univ. of Technology; L. Bohl, Hamburg Univ. of Technology; A. Sieganschin, Hamburg Univ. of Technology; A. Jacob, Hamburg Univ. of Technology

10:40 **We1C-6: Question and Answer**

We1D: Advances in MEMS, Acoustic and Ferrite Technologies for RF and Microwave Systems

Chair: Jack Ebel, Air Force Research Laboratory

Co-Chair: Pierre Blondy, Xlim - CNRS- Unversite De Liroges

09:00 **We1D-1: A Switchless Quad Band Filter Bank Based on Ferroelectric BST FBARs**

S. Nam, Univ. of Michigan; M. Zolfagharloo Koohi, Univ. of Michigan; W. Peng, Univ. of Michigan; A. Mortazawi, Univ. of Michigan

09:20 **We1D-2: Barium Strontium Titanate Thick Films for Tunable Software-Defined Radio Front-Ends**

P. Bouça, Universidade de Aveiro; R. Figueiredo, Universidade de Aveiro; A. Wlódarkiewicz, Universidade de Aveiro; A. Tkach, Universidade de Aveiro; J.N. Matos, Universidade de Aveiro; P. M. Vilarinho, Universidade de Aveiro; N.B. de Carvalho, Universidade de Aveiro

09:40 **We1D-3: A Novel Multi-Electrode RF-MEMS Switch for Bipolar Actuation Bias Leakage Reduction**

E. Jouin, XLIM (UMR 7252); P. Andrieu, CEA-Cesta; M. Girard, CEA-Cesta; P. Blondy, XLIM (UMR 7252)

10:00 **We1D-4: Design & Development of 2KW Front-End Circulator-Switch Assembly for Space Applications**

S. Aich, ISRO; Ch.V.N. Rao, ISRO; R. Jyoti, ISRO; A. Kumar, ISRO; J. Trivedi, ISRO; T. Paul, ISRO; B. Patel, ISRO; S.K. Garg, ISRO; M.K. Patel, ISRO; A.K. Hait, ISRO

10:20 **We1D-5: Low-Loss and High Power Handling Acoustic Delay Lines Using Thin-Film Lithium Niobate on Sapphire**

R. Lu, Univ. of Illinois at Urbana-Champaign; Y. Yang, Univ. of Illinois at Urbana-Champaign; A.E. Hassanien, Univ. of Illinois at Urbana-Champaign; S. Gong, Univ. of Illinois at Urbana-Champaign

10:40 **We1D-6: Question and Answer**

We1E: Wireless Sensor Systems and Components

Chair: Alessandra Costanzo, Università di Bologna

Co-Chair: Lora Schulwitz, Maxar Technologies

09:00 **We1E-1: Enhanced PWM Backscattering System for Battery-Free Wireless Sensors**

M.H. Ouda, Univ. of Cambridge; R. Penty, Univ. of Cambridge; M. Crisp, Univ. of Cambridge

09:20 **We1E-2: 5.8GHz Low-Power Tunnel-Diode-Based Two-Way Repeater for Non-Line-of-Sight Interrogation of RFIDs and Wireless Sensor Network**

A. Adeyeye, Georgia Institute of Technology; C. Lynch, Georgia Institute of Technology; A. Eid, Georgia Institute of Technology; J. Hester, Atheraxon; M. Tentzeris, Georgia Institute of Technology

09:40 **We1E-3: Multi-Mode Millimeter-Wave Near-Field Imaging**

D. Hoffmann, Univ. Stuttgart; J. Hesselbarth, Univ. Stuttgart

10:00 **We1E-4: A 61-GHz Rectifier Using Internal Voltage Cancellation and Body-Biasing Techniques in 22-nm FDSOI**

A. Harutyunyan, Fraunhofer Institute For Photonic Microsystems; M. Landwehr, Fraunhofer Institute For Photonic Microsystems

10:20 **We1E-5: Deep Sub-Wavelength Millimeter-Wave Radar Interferometry with a Novel Ego-Motion Based Calibration Technique**

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

10:40 **We1E-6: Question and Answer**

We1F: Advanced Frequency Conversion Circuits and Oscillators

Chair: Hiroshi Okazaki, NTT DoCoMo, Inc.

Co-Chair: Jahnavi Sharma, Intel Corporation

09:00

We1F-1: A 60GHz Folded Switching Stage Down-Conversion Mixer with 21dB Conversion Gain in 22nm FDSOI Technology

M.V. Thayyil, Technische Universität Dresden; S. Seyyedrezaei, Technische Universität Dresden; N. Joram, Technische Universität Dresden; F. Ellinger, Technische Universität Dresden

09:20

We1F-2: High Conversion Gain Up-Converter with +5 dBm OP1dB in InP DHBT Technology for Ultra Capacity Wireless Applications

M. Hossain, FBH; T. Shivan, FBH; M. Brahem, FBH; H. Yacoub, FBH; W. Heinrich, FBH; V. Krozer, FBH

09:40

We1F-3: A K-Band Active Up/Down Bidirectional Mixer in 130-nm CMOS

J. Pan, Wuhan Univ.; J. He, Wuhan Univ.; Y. Peng, Wuhan Univ.; H. Wang, Wuhan Univ.; S. Chang, Wuhan Univ.; Q. Huang, Wuhan Univ.; J. Li, CETC 55

10:00

We1F-4: A 60GHz CMOS-SOI Stacked Push-Push Frequency Doubler with 12dBm Output Power and 20% Efficiency

M. Eladwy, Univ. of Waterloo; J. Xia, Univ. of Waterloo; A. Ben Ayed, Univ. of Waterloo; S. Boumaiza, Univ. of Waterloo

10:20

We1F-5: A High-Performance Low Power Compact Wideband X-Band DCO Based on Transformer Coupled Feedback

N. Yahav, Intel; R. Levinger, Intel; J. Kadry, Intel; G. Horovitz, Intel

10:40

We1F-6: Question and Answer

We1G: Microwave Photonics and Nanotechnology

Chair: Mona Jarrahi, University of California, Los Angeles

Co-Chair: Luca Pierantoni, Universita Politecnica delle Marche

09:00

We1G-1: Silicon Photonic Radar Transmitter IC for mm-Wave Large Aperture MIMO Radar Using Optical Clock Distribution

S. Kruse, Univ. of Paderborn; S. Gudyriev, Univ. of Paderborn; T. Schwabe, Univ. of Paderborn; P. Kneuper, Univ. of Paderborn; H. Kurz, Volkswagen AG; J. Scheytt, Univ. of Paderborn

09:20

We1G-2: A 25–40GHz Wideband Tunable Silicon Photonic Reconfigurable Receiver Front-End for mm-Wave Channel Selection/Jammer Rejection

R. Rady, Texas A&M Univ.; C.K. Madsen, Texas A&M Univ.; S. Palermo, Texas A&M Univ.; K. Entesari, Texas A&M Univ.

09:40

We1G-3: Focal-Plane Array for Terahertz Time-Domain Imaging

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

09:50

We1G-4: Broadband Terahertz Detection with 100dB Dynamic Range Through a High Switching-Contrast Plasmonic Nanocavity

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

10:00

We1G-5: Microwave Detection Using 2-Atom-Thick Heterojunction Diodes

M. Aldrigo, IMT Bucharest; M. Dragoman, IMT Bucharest; S. Iordanescu, IMT Bucharest; D. Vasilache, IMT Bucharest; A. Dinescu, IMT Bucharest; G. Biagetti, Università Politecnica delle Marche; L. Pierantoni, Università Politecnica delle Marche; D. Mencarelli, Università Politecnica delle Marche

10:20

We1G-6: High-Frequency Tellurene MOSFETs with Biased Contacts

K. Xiong, Cornell Univ.; G. Qiu, Purdue Univ.; Y. Wang, Purdue Univ.; L. Li, Cornell Univ.; A. Göritz, IHP; M. Lisker, IHP; M. Wietstruck, IHP; M. Kaynak, IHP; W. Wu, Purdue Univ.; P.D. Ye, Purdue Univ.; A. Madjar, Lehigh University; J.C.M. Hwang, Cornell Univ.

10:40

We1G-7: Question and Answer

09:10 09:30 09:50 10:10 10:30

Tu2E: mm-Wave Circuits for 5G Systems

Chair: Jane Gu, University of California, Davis
Co-Chair: Arun Natarajan, Oregon State University

10:00 Tu2E-1: A Global Multi-Standard/Multi-Band 17.1–52.4GHz Tx Phased Array Beamformer with 14.8dBm OP1dB Supporting 5G NR FR2 Bands with Multi-Gb/s 64-QAM for Massive MIMO Arrays
A.A. Alhamed, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

10:20 Tu2E-2: A High-Linearity, 24–30GHz RF, Beamforming and Frequency-Conversion IC for Scalable 5G Phased Arrays
A. Paidimarri, IBM T.J. Watson Research Center; M. Yoshiyama, Fujikura; J.-O. Plouchart; A. Valdes-Garcia; W. Lee, IBM T.J. Watson Research Center; Y. Okuyama, Fujikura; M. Yeck; C. Ozdag; S. Chakraborty, IBM T.J. Watson Research Center; Y. Yamaguchi, Fujikura; B. Sadhu, IBM T.J. Watson Research Center

10:40 Tu2E-3: A 17.3-mW 0.46-mm² 26/28/39GHz Phased-Array Receiver Front-End with an I/Q-Current-Shared Active Phase Shifter for 5G User Equipment
X. Yu, A. Jain, A. Singh, O. Elsayed, C. Kuo, H. Nagarajan, D. Yoon, V. Bhagavatula, I.S.-C. Lu, S. Son, T.B. Cho, Samsung

11:00 Tu2E-4: A 28GHz Optically Synchronized CMOS Phased Array with an Integrated Photodetector
M. Gal-Katziri, Caltech; C. Ives, Caltech; A. Khakpour, Caltech; A. Hajimiri, Caltech

Tu2F: mm-Wave and Sub-THz Power Amplifiers

Chair: Steven Callender, Intel Corporation
Co-Chair: Margaret Szymanowski, Crane Aerospace & Electronics

10:00 Tu2F-1: A 130–151GHz 8-Way Power Amplifier with 16.8–17.5dBm Psat and 11.7–13.4% PAE Using CMOS 45nm RFSOI
S. Li, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

10:20 Tu2F-2: One Stage Gain Boosted Power Driver at 184GHz in 28nm FD-SOI CMOS
S. Sadlo, STMicroelectronics; M. De Matos, IMS (UMR 5218); A. Cathelin, STMicroelectronics; N. Deltimple, IMS (UMR 5218)

10:40 Tu2F-3: A Compact H-Band Power Amplifier with High Output Power
A.S.H. Ahmed, Marki Microwave; U. Soylu, Univ. of California, Santa Barbara; M. Seo, Sungkyunkwan Univ.; M. Urteaga, Teledyne Scientific & Imaging; M.J.W. Rodwell, Univ. of California, Santa Barbara

11:00 Tu2F-4: A Linear and Efficient Power Amplifier Supporting Wideband 64-QAM for 5G Applications from 26 to 30GHz in SiGe:C BiCMOS
T.-C. Tsai, KIT; C. Bohn, KIT; J. Hebeler, KIT; M. Kaynak, KIT; A.Ç. Ulusoy, KIT

Tu2G: Circuit Techniques for High-Speed Transceiver Front-ends

Chair: Bahar Jalali, Acacia Communications
Co-Chair: Alyssa Apsel, Cornell University

10:00 Tu2G-1: A Sub-0.25pJ/Bit 47.6-to-58.8Gb/s Reference-Less FD-Less Single-Loop PAM-4 Bang-Bang CDR with a Deliberately-Current-Mismatch Frequency Acquisition Technique in 28nm CMOS
X. Zhao, University of Macau; Y. Chen, University of Macau; L. Wang, University of Macau; P.-I. Mak, University of Macau; F. Maloberti, University of Macau; R.P. Martins, University of Macau

10:20 Tu2G-2: A 128Gb/s PAM4 Linear TIA with 12.6pA/√Hz Noise Density in 22nm FinFET CMOS
S. Daneshgar, Intel; H. Li, Intel; T. Kim, Intel; G. Balamurugan, Intel

10:40 Tu2G-3: A 3GS/s >55dBFS SNDR Time-Interleaved RF Track and Hold Amplifier with >67dBc SFDR up to 3GHz in 22FDX
E. Wittenhagen, Technische Universität Berlin; P. Artz, Technische Universität Berlin; P. Scholz, Technische Universität Berlin; F. Gerfers, Technische Universität Berlin

11:00 Tu2G-4: A 6–31GHz Tunable Reflection-Mode N-Path Filter
S. Hari, North Carolina State Univ.; C.J. Ellington, North Carolina State Univ.; B.A. Floyd, North Carolina State Univ.

Tu1H: Advanced N-Path Techniques and Associated Interference Mitigation

Chair: Alyosha Molnar, Cornell University
Co-Chair: Francois Rivet, University of Bordeaux

10:00 Tu1H-1: A Frequency-and-Spatial Blocker Tolerant Butler Matrix Based 4×4 MIMO Receiver Using a Switched-Capacitor Quadrature Coupler
P.K. Sharma, GLOBALFOUNDRIES; N. Nallam, IIT Guwahati

10:20 Tu1H-2: A 3.5-to-6.2-GHz Mixer-First Acoustic-Filtering Chipset with Mixed-Domain Asymmetric IF and Complex BB Recombination Achieving 170MHz BW and +27dBm IIP3 at 1×BW Offset
H. Seo, Univ. of Illinois at Urbana-Champaign; M. Sha, Univ. of Illinois at Urbana-Champaign; J. Zhou, Univ. of Illinois at Urbana-Champaign

10:40 Tu1H-3: A 3.7–6.5GHz 8-Phase N-Path Mixer-First Receiver with LO Overlap Suppression Achieving <5dB NF and >5dBm OOB B1dB
S. Huang, Cornell Univ.; A. Molnar, Cornell Univ.

11:00 Tu1H-4: A Widely Tunable N-Path Frequency-Selective Limiter for Self-Adaptive Interference Suppression
L.G. Salem, Univ. of California, Santa Barbara

11:20 Tu1H-5: A Noise-Cancelling Self-Interference Canceller with +7dBm Self-Interference Power Handling in 0.18µm CMOS
M. Essawy, Oregon State Univ.; A. Aghighi, Oregon State Univ.; H. Bialek, Oregon State Univ.; A. Nagulu, Columbia Univ.; H. Krishnaswamy, Columbia Univ.; A. Natarajan, Oregon State Univ.

11:40

Tu2H: New Design Techniques for Frequency Generation

Chair: Wanghua Wu, Samsung Electronics America, Inc.

Co-Chair: Andreia CATHELIN, STMicroelectronics

10:00

Tu2H-1: An FBAR Driven -261dB FOM Fractional-N PLL

D. Yang, Broadcom; D. Murphy, Broadcom; H. Darabi, Broadcom; A. Behzad, Broadcom; R. Ruby, Broadcom; R. Parker, Broadcom

10:20

Tu2H-2: A Sub-100fs JitterRMS, 20-GHz Fractional-N Analog PLL Using a BAW Resonator Based 2.5GHz On-Chip Reference in 22-nm FD-SOI Process

S. Kalia, S. Finocchiaro, A. Raghunathan, B. Bahr, T. Dinc, Texas Instruments; G. Schuppener, S. Akhtar, T. Fritz, B. Haroun, S. Sankaran, Texas Instruments

Tu2H-3: Near-Field-Coupled Bondless BAW Oscillators in WCSP Package with 46fs Jitter

B. Bahr, Texas Instruments; A. Kiaei, Texas Instruments; M. Chowdhury, Texas Instruments; B. Cook, Texas Instruments; S. Sankaran, Texas Instruments; B. Haroun, Texas Instruments

10:40

Tu2H-4: Tuning-Less Injection-Locked Frequency Dividers with Wide Locking Range Utilizing 8th-Order Transformer-Based Resonator

Q. Jiang, SUSTech; Q. Pan, SUSTech

11:00

11:20

11:40

AUDITORIUM 5

TECHNICAL LECTURES

12:00 – 13:30 | Wednesday, 23 June 2021

	LECTURE TITLE	LECTURE ABSTRACT
TUTL1	**Fully Integrated Terahertz Imaging and Spectroscopy: From Device to System** **Speaker:** Ehsan Afshari, University of Michigan	There is an increasing interest in low-cost mmWave and THz systems for imaging. The lecture has 4 major parts.: First, motivations and applications of imaging and sensing will be reviewed. The lecture will then cover the fundamentals of device operation at high frequencies, and designs of basic circuit elements and major circuit building blocks at frequencies above 100 GHz. Finally, design and optimization of THz systems on chip will be discussed. The lecture is intended to enable RF circuit designers to implement circuits and systems at mmWave and THz frequencies through practical examples.

We2B: Heterogeneous and High-Density Flex RF Package Integration

Chair: P. Markondeya Raj, Florida International University

Co-Chair: Prem Chahal, Michigan State University

11:00

We2B-1: Batch-Fabricated Substrate-Embedded Ka Band Self-Biased Circulators Using Screen-Printed Strontium Hexaferrite/PDMS Composite

R. Bowrothu, Univ. of Florida; H.-I. Kim, Univ. of Florida; C. Smith, Univ. of Florida; X.N. Guan, HRL Laboratories; S. Cui, HRL Laboratories; F. Herrault, HRL Laboratories; D.P. Arnold, Univ. of Florida; Y.-K. Yoon, Univ. of Florida

11:20

We2B-2: In-Package Additively Manufactured Sensors for Bend Prediction and Calibration of Flexible Phased Arrays and Flexible Hybrid Electronics

X. He, Georgia Tech; M.M. Tentzeris, Georgia Tech

11:40

We2B-3: Additive Manufacturing of a Wide-Band Capable W-Band Packaging Strategy

M. Craton, Michigan State Univ.; P. Chahal, Michigan State Univ.; J. Albrecht, Michigan State Univ.; J. Papapolymerou, Michigan State Univ.

12:00

We2B-4: An Ultra-High-Frequency Wirelessly-Powered Smart Bandage for Wound Monitoring and Sensing Using Frequency Modulation

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

12:20

We2B-5: Question and Answer

We2C: Integrated Waveguides and Composite Structures

Chair: Jun Choi, University at Buffalo

Co-Chair: Maurizio Bozzi, University of Pavia

We2C-1: Half-Mode Slab Air-Filled Substrate Integrated Waveguide (SAFSIW)

N.-H. Nguyen, IMEP-LAHC (UMR 5130); A. Ghiotto, IMS (UMR 5218); A. Vilcot, IMEP-LAHC (UMR 5130); K. Wu, Polytechnique Montréal; T.P. Vuong, IMEP-LAHC (UMR 5130)

We2C-2: Substrate Integrated Waveguides in Glass Interposers for mmWave Applications

M. ur Rehman, Georgia Tech; A. Watanabe, Georgia Tech; S. Ravichandran, Georgia Tech; M. Swaminathan, Georgia Tech

We2C-3: Stripline-Based W-Band Frequency Scanning Composite Right/Left-Handed Leaky-Wave Antenna with a Tapered Aperture for Narrow Beamwidth

Z. Li, SUNY Buffalo; N. Chordas-Ewell, SUNY Buffalo; J.H. Choi, SUNY Buffalo; D. Ren, NXP Semiconductors; R. Wu, NXP Semiconductors; Z. Qamar, Univ. of Oklahoma; N. Aboserwal, Univ. of Oklahoma; J.L. Salazar-Cerreno, Univ. of Oklahoma

We2C-4: Ultra-Wideband Complex Permittivity Extraction of IC Packaging Materials Beyond 100GHz

T. Pfahler, FAU Erlangen-Nürnberg; G. Gold, FAU Erlangen-Nürnberg; K. Lomakin, FAU Erlangen-Nürnberg; L. Engel, FAU Erlangen-Nürnberg; J. Schür, FAU Erlangen-Nürnberg; M. Vossiek, FAU Erlangen-Nürnberg

We2C-5: Question and Answer

We2D: Advanced Microwave and mm-Wave Device Modeling Techniques

Chair: Shahed Reza, Sandia National Laboratories

Co-Chair: Q.J. Zhang, Carleton University

We2D-1: Accurate Non-Linear Large Signal Physics-Based Modeling for Ka-Band GaN Power Amplifier Design with ASM-HEMT

J. Hodges, Macquarie Univ.; S.A. Albahrani, Fraunhofer IAF; B. Schwitter, Altum RF; S. Khandelwal, Macquarie Univ.

We2D-2: Impact of Wave Propagations on Figures of Merit in Millimeter-Wave Transistors

S. Nouri, Univ. of Arkansas; A.G. Avval, Univ. of Arkansas; S.M. El-Ghazaly, Univ. of Arkansas

We2D-3: Modeling Base-Collector Heterojunction Barrier Effect in InP DHBTs for Improved Large Signal Performance

V.P. Sriperumbuduri, BTU; H. Yacoub, FBH; T.K. Johansen, FBH; A. Wentzel, FBH; R. Doerner, FBH; M. Rudolph, BTU

We2D-4: Dynamic Threshold Control and Higher-Order Processes for Magnetics Based Microwave Devices

A. Venugopal, Univ. of Minnesota; R.H. Victora, Univ. of Minnesota

We2D-5: Question and Answer

We2E: Instrumentation for Biomedical Measurements

Chair: Chung-Tse Michael Wu, Rutgers University

Co-Chair: JC Chiao, Southern Methodist University

We2E-1: An Ultrasensitive 14-GHz 1.12-mW EPR Spectrometer in 28-nm CMOS

L. Zhang, Univ. of California, Berkeley; A. Niknejad, Univ. of California, Berkeley

We2E-2: Non-Contact Fingertip Microwave Plethysmography Based on Near-Field Sensing with Super-Regenerative Oscillator

Y. Yuan, Rutgers Univ.; C.-T.M. Wu, Rutgers Univ.

We2E-3: Phase Correction in Asynchronous FMCW Radar Systems for Accurate Noncontact Cardiopulmonary Monitoring

J. Liu, Shanghai Jiao Tong Univ.; C. Gu, Shanghai Jiao Tong Univ.; Y. Zhang, Shanghai Jiao Tong Univ.; J.-F. Mao, Shanghai Jiao Tong Univ.

We2E-4: Dielectric Lens Designs for Antenna Beam Shaping in a Subdermal Tumor Treatment Device

I.H. Uluer, Oregon State Univ.; M.J. Jaroszeski, Univ. of South Florida; T.M. Weller, Oregon State Univ.

We2E-5: Question and Answer

11:10 11:30 11:50 12:10 12:30 12:40

We2F: LATE NEWS - Millimeter-Wave Power Amplifiers

Chair: Mark van der Heijden, NXP Semiconductors

Co-Chair: Jose Garcia, University of Cantabria

We2F-1: A 35–100GHz Continuous Mode Coupler Balun Doherty Power Amplifier with Differential Complex Neutralization in 250nm InP

T.-Y. Huang, Georgia Tech; S. Li, Georgia Tech; N.S. Mannem, Georgia Tech; H. Wang, Georgia Tech

We2F-2: A 200GHz InP HBT Direct-Conversion LO-Phase-Shifted Transmitter/Receiver with 15dBm Output Power

M. Seo, Sungkyunkwan Univ.; A.S.H. Ahmed, Marki Microwave; U. Soylu, Univ. of California, Santa Barbara; A.A. Farid, Univ. of California, Santa Barbara; Y. Na, Sungkyunkwan Univ.; M.J.W. Rodwell, Univ. of California, Santa Barbara

We2F-3: 6.25 W/mm and Record 33.8% PAE at 94 GHz from N-polar GaN Deep Recess MIS-HEMTs with ALD Ru Gates

W. Liu, B. Romanczyk, M. Guidry, N. Hatui, C. Wurm, W. Li, P. Shrestha, X. Zheng, S. Keller, U. Mishra, Univ. of California, Santa Barbara

We2F-4: A V-Band Doubly Hybrid NMOS/PMOS Four-Way Distributed-Active-Transformer Power Amplifier for Nonlinearity Cancellation and Joint Linearity/Efficiency Optimization

T.-W. Li, Georgia Tech; S. Li, Samsung; H. Miri Lavasani, Case Western Reserve Univ.; H. Wang, Georgia Tech

We2F-5: Question and Answer

We2G: Analog and Mixed Signal ICs for Wireline and Optical Communication

Chair: Edward Gebara, Nanowave Technologies, Inc.

Co-Chair: Christian Carlowitz, Friedrich-Alexander-Universität Erlangen-Nürnberg

We2G-1: A 0.01-mm² 1.2-pJ/Bit 6.4-to-8Gb/s Reference-Less FD-Less BBCDR Using a Deliberately-Clock-Selected Strobe Point Based on a $2\pi/3$-Interval Phase

X. Zhao, University of Macau; Y. Chen, University of Macau; X. Zheng, CAS; P.-I. Mak, University of Macau; R.P. Martins, University of Macau

We2G-2: An Over 67-GHz Bandwidth 21-dB Gain 4.5-Vppd Linear Modulator Driver for 100-Gbaud Coherent Optical Transmitter

T. Jyo, NTT Device Technology Laboratories; M. Nagatani, NTT Device Technology Laboratories; Y. Ogiso, NTT Device Innovation Center; S. Yamanaka, NTT Device Innovation Center; H. Nosaka, NTT Device Technology Laboratories

We2G-3: PAM-4 Driver Amplifier Using Distributed Power Combining

C. Bohn, KIT; J. Hebeler, KIT; C. Koos, KIT; T. Zwick, KIT; A.Ç. Ulusoy, KIT

We2G-4: A 64-Gbaud Transimpedance Amplifier in 130nm SiGe Technology with Effective Broadband Techniques

M.-Z. Wu, National Tsing Hua Univ.; S. Hong, National Tsing Hua Univ.; H.-M. Su, National Tsing Hua Univ.; S.S.H. Hsu, National Tsing Hua Univ.

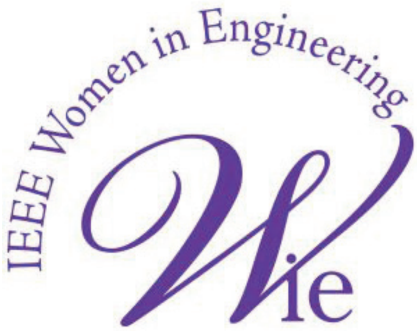
We2G-5: Question and Answer

11:00
11:10
11:20
11:30
11:40
11:50
12:00
12:10
12:20
12:30
12:40

WOMEN IN ENGINEERING | 13:00–15:00 | Wednesday, 23 June 2021

PROGRAM OVERVIEW:

A look at the past, present and future of Women in Microwaves. Visit ims-ieee.org/WIM for details on speakers and topics.



IMS INTERACTIVE FORUM 13:00 – 15:00 Wednesday, 23 June 2021 AUDITORIUM 3

CHAIRS:

PREMJEET CHAHAL, *Michigan State University* | **MICHAEL CRATON,** *Massachusetts Institute Of Technology, Lincoln Laboratory*

TAIYUN CHI, *Rice University* | **AMANPREET KAUR,** *Oakland University*

WeIF1-1: Contribution of the Evanescent Modes to the Power Radiated by an Aperture

L. Polo-López, J. Córcoles, J.A. Ruiz-Cruz, Universidad Autónoma de Madrid

WeIF1-2: Active Cloaking with an Incident-Field Estimation Algorithm

P. Ang, Univ. of Toronto; G.V. Eleftheriades, Univ. of Toronto

WeIF1-3: A Low EM Susceptibility VCO with Four-Leaf-Clover-Shaped Inductor Verified via Chip-Level 3D Near-Field Measurement Technique

Y.-C. Chang, T.-Y. Lin, C.-P. Hsieh, NARLabs-TSRI; P.-Y. Wang, GUC; S.S.H. Hsu, National Tsing Hua Univ.; D.-C. Chang, NARLabs-TSRI

WeIF1-4: Millimeter-Wave Resonant Spectroscopy of Sub-Wavelength Dielectric Particle

U. Dey, Univ. Stuttgart; Y. Li, Univ. Stuttgart; J. Hesselbarth, Univ. Stuttgart

WeIF1-5: A 440 – 540 GHz Transmitter in 130 nm SiGe BiCMOS

A. Güner, T. Mausolf, J. Wessel, Innovations for High Performance Microelectronics; D Kissinger, Ulm Univ.; K. Schmalz, Innovations for High Performance Microelectronics

WeIF1-6: A Compact SIW K-/Ka-Band Diplexer with Integrated Reactive Power Divider

K. Erkelenz, N. Sielck, A. Sieganschin, T. Jaschke, A.F. Jacob, Technische Universität Hamburg-Harburg

WeIF1-7: A 24–30GHz Low-Loss Compact Differential Four-Way Power Divider

S. Lee, KAIST; J. Park, KAIST; S. Hong, KAIST

WeIF1-8: A Wide-Band 90 Degree HMSIW Schiffman Phase-Shifter for 28GHz Millimeter-Wave Applications

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

WeIF1-9: Triple-Mode Bandpass Filter Based on TM Dielectric Rod Resonators

P. Boe, CAU; D. Miek, CAU; F. Kamrath, CAU; M. Höft, CAU

WeIF1-10: A CMOS 1.3–1.7GHz Q-Enhanced LC Band-Pass RF Filter with 1.5–67% Tunable Fractional Bandwidth

H. Nie, Zhejiang Univ.; Z. Huang, T. Yu, D. Liu, Zhejiang Integrated Beam Tech; X. Yu, Zhejiang Univ.; Q.J. Gu, Univ. of California, Davis; Z. Xu, Zhejiang Univ.

WeIF1-11: A Flexible Non-Radiative Dielectric Waveguide with a 1-dB Loss PCB-to-NRD Coupler for mm-Wave Array Applications

J. Zhang, Stanford Univ.; A. Arbabian, Stanford Univ.

WeIF1-12: Guideline for Test-Structures Placement for On-Wafer Calibration in Sub-THz Si Device Characterization

C. Yadav, NIT Calicut; M. Cabbia, IMS (UMR 5218); S. Fregonese, IMS (UMR 5218); M. Deng, IMS (UMR 5218); M. De Matos, IMS (UMR 5218); T. Zimmer, IMS (UMR 5218)

WeIF1-13: Characterization of the Impairment and Recovery of GaN-HEMTs in Low-Noise Amplifiers Under Input Overdrive

S. Krause, FBH; P. Beleniotis, BTU; O. Bengtsson, FBH; M. Rudolph, BTU; W. Heinrich, FBH

WeIF1-14: 3D Integrated 300°C Tunable RF Oscillator Exploiting AlGaN/GaN HEMT for High Temperature Applications

P. Palacios, T. Zweipfennig, RWTH Aachen Univ.; A. Ottaviani, IMS CHIPS; M. Saeed, C. Beckmann, RWTH Aachen Univ.; M. Alomari, IMS CHIPS; G. Lükens, H. Kalisch, RWTH Aachen Univ.; J.N. Burghartz, IMS CHIPS; A. Vescan, R. Negra, RWTH Aachen Univ.

WeIF1-15: Parallel Plate Coupler Based Doherty Power Amplifier Design for 5G NR Handset Applications

K. Takenaka, Y. Noguchi, Y. Takenouchi, H. Okabe, T. Wada, Murata Manufacturing

WeIF1-16: A 26GHz GaN-MMIC with Integrated Switches for Discrete Level Supply Modulation

O. Bengtsson, FBH; S. Paul, FBH; C. Schulze, FBH; S. Chevtchenko, FBH; W. Heinrich, FBH

WeIF1-17: Investigation on a Desirable DPD Architecture and Trapping Characteristics for GaN Power Amplifier Linearization

P. Song, Z. Mokhti, Q. Mu, Wolfspeed

WeIF1-18: A 24-GHz Butler-Matrix-Based Switched Beamformer in GaAs

Q.-Y. Jiang, Y.-S. Lin, National Central Univ.

WeIF1-19: Ultra-Wideband Photonic VCO and Synthesizer

D. Eliyahu, A. El Amili, R. Moss, G. Keseyan, A. Savchenkov, S. Ganji, L. Maleki, OEwaves

WeIF1-20: 28GHz Distributed-MIMO Comprehensive Antenna Calibration for 5G Indoor Spatial Division Multiplex

N. Tawa, NEC; T. Kuwabara, NEC; Y. Maruta, NEC; T. Kaneko, NEC

WeIF1-21: Chipless RFID Temperature and Humidity Sensing

F. Requena, LCIS (EA 3747); N. Barbot, LCIS (EA 3747); D. Kaddour, LCIS (EA 3747); E. Perret, LCIS (EA 3747)

WeIF1-22: Passive Non-Cooperative Millimeter-Wave Imaging Using 5G Signals of Opportunity

S. Vakalis, S. Mghabghab, J.A. Nanzer, Michigan State Univ.

WeIF1-23: Novel Discontinuity Modeling with Machine Learning and Application to Microwave Test Fixture De-Embedding

C.-T. Tseng, P. Tsai, C.-P. Yang, S. Lu, H. Chang, Advanced Semiconductor Engineering

WeIF1-24: Implementation of A Flat-Bottom Luneburg Lens Based on Conformal Transformation Optics

B. Yang, North Carolina A&T State University; Y. Oh, North Carolina State Univ.; X. Hu, North Carolina A&T State University; J.J. Adams, North Carolina State Univ.

WeIF1-25: Robust Contactless Waveguide Flange for Fast Measurements

C. Mayaka, Eravant; Y. Shu, Eravant; D. Doshi, Eravant

WeIF1-26: PAPR Deviation Impact in the Wideband Power Amplifier Characterization with Realistic Modulated Load-pull System

S. Chaudhary, Universidade de Aveiro; M. Jordão, Universidade de Aveiro; N.B. de Carvalho, Universidade de Aveiro; M. Vanden Bossche, NI; A. Cooman, Ampleon

WeIF1-27: A High Efficiency D-band 32-Channel Radial Waveguide Power Divider/Combiner

X. Deng, UESTC; Y. Rao, UESTC; K. Huang, CAEP; J. Zhou, UESTC; W. Su, CAEP; X. Luo, UESTC

WeIF1-28: Extremely Wide-Band Ridge Waveguide Radial Combiners

M.M. Fahmi, DRDC; R.R. Mansour, Univ. of Waterloo

WeIF1-29: Performance Improvements of Reverse-Saturated SiGe HBT Millimeter-Wave Switches with Floating Emitter Configuration

Y. Gong, Georgia Tech; H.P. Lee, Georgia Tech; J.D. Cressler, Georgia Tech

WeIF1-30: High-Q Contactless Air-filled Substrate-integrated Waveguide (CLAF-SIW) Resonator for Wireless Sensing Applications

A. Amirkabiri, Univ. of Manitoba; D. Idoko, Univ. of Manitoba; B. Kordi, Univ. of Manitoba; G.E. Bridges, Univ. of Manitoba

WeIF1-31: Design for a Self-Packaged All-PCB Wideband Filter with Good Stopband Performance

B.A. Belyaev, RAS; A.M. Serzhantov, Siberian Federal University; Ya.F. Bal'va, RAS; An.A. Leksikov, RAS

WeIF1-32: A Plasma-Switch Impedance Tuner for Real-Time, Frequency-Agile, High-Power Radar Transmitter Reconfiguration

C. Calabrese, Baylor Univ.; J. Roessler, Baylor Univ.; A. Egbert, Baylor Univ.; A. Fisher, Purdue Univ.; C. Baylis, Baylor Univ.; Z. Vander Missen, Purdue Univ.; M. Abu Khater, Purdue Univ.; D. Peroulis, Purdue Univ.; R.J. Marks, Baylor Univ.

WeIF1-33: Plastic Microwave Fibers at Millimeter-wave and THz Frequencies as a Low Cost Data Link

J. Vaes, KU Leuven; K. Dens, KU Leuven; G. Ducournau, IEMN (UMR 8520); P. Reynaert, KU Leuven

WeIF1-34: A CMOS LNA with Transformer-Based Integrated Notch Filterf or Ku-Band Satellite Communication

J. Zhang, Southeast Univ.; D. Zhao, Southeast Univ.; X. You, Southeast Univ.

WeIF1-35: Low-cost Compact Analogue Phase-Shifter based-on CVD Graphene-diode for Smart Surfaces Applications

M. Saeed, RWTH Aachen Univ.; A. Hamed, RWTH Aachen Univ.; E. Baskent, RWTH Aachen Univ.; B. Uzlu, AMO; Z. Wang, AMO; R. Negra, RWTH Aachen Univ.

WeIF1-36: 60-GHz Microstrip pHEMT Subharmonic Down-/Up-Converters with an Extended CPWG RF Section for Flip-Chip Optimization

C. Meng, National Chiao Tung Univ.; Y.-S. Chen, National Chiao Tung Univ.; Y.-S. Li, National Chiao Tung Univ.; G.-W. Huang, NARLabs-TSR

WeIF1-37: Circulator Load Modulated Amplifier: A Non-Reciprocal Wideband and Efficient PA Architecture

H. Zhou, Chalmers Univ. of Technology; J.-R. Perez-Cisneros, Chalmers Univ. of Technology; C. Fager, Chalmers Univ. of Technology

WeIF1-38: A 28–90-GHz GaN Power Amplifier MMIC Using an Integrated fT-Doubler Topology

M. Cwiklinski, Rohde & Schwarz; P. Brückner, Fraunhofer IAF; S. Leone, Fraunhofer IAF; C. Friesicke, Fraunhofer IAF; F. van Raay, Fraunhofer IAF; S. Wagner, Fraunhofer IAF; R. Quay, Fraunhofer IAF

WeIF1-39: A 28-GHz Passive Outphasing Load Modulator in 40-nm GaN

C. Hill, Univ. of California, Santa Barbara; J.F. Buckwalter, Univ. of California, Santa Barbara

WeIF1-40: An Out-of-Band Digital Predistortion Scheme and Its Verification for Power Amplifiers with Strong Nonlinearity

X. Xia, UESTC; Y. Liu, UESTC; C. Li, UESTC; L. Du, UESTC; C. Shi, UESTC; S. Shao, UESTC; L. Lei, CETC 54; Y. Tang, UESTC

WeIF1-41: Self-Injection Locked Oscillation of Multi-Mode Laser in Heterogeneously Integrated Silicon Photonics

K. Wei, Drexel Univ.; A.S. Daryoush, Drexel Univ.

WeIF1-42: Frequency Scanning Reflectarray Based on Composite Right/Left-Handed Transmission Lines

K. Xu, SUNY Buffalo; N. Chordas-Ewell, SUNY Buffalo; Z. Li, SUNY Buffalo; J.H. Choi, SUNY Buffalo

WeIF1-43: Integration of 5.8GHz Doppler Radar and Machine Learning for Automated Honeybee Hive Surveillance and Logging

N. Aldabashi, Bangor Univ.; S. Williams, Bangor Univ.; A. Eltokhy, MSA University; E. Palmer, S&A Produce; P. Cross, Bangor Univ.; C. Palego, Bangor Univ.

WeIF1-44: A 256-Element Dual-Beam Dual-Polarization Ku-Band Phased-Array with 5 dB/K G/T for Simultaneous Multi-Satellite Reception

G. Gültepe, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

WeIF1-45: A Pulse-Modulated RF Power Amplifier System with Output Direct Absorptive Band-Pass Filter Connection

H.-S. Yang, Taipei Tech

WeIF1-46: Cryogenic Low-Drop-Out Regulators Fully Integrated with Quantum Dot Array in 22-nm FD-SOI CMOS

D. Andrade-Miceli, A. Esmailiyan, Equal1 Labs; P. Bisiaux, Univ. College Dublin; E. Blokhina, Equal1 Labs; T. Siriburanon, Univ. College Dublin; I. Bashir, M. Asker, D. Leipold, R.B. Staszewski, Equal1 Labs

WeIF1-47: Hybrid Asymmetrical Load Modulated Balanced Amplifier with Wide Bandwidth and Three-Way-Doherty Efficiency Enhancement

Yuchen Cao, Univ. of Central Florida; Kenle Chen, Univ. of Central Florida

WeIF1-48: A Reconfigurable Dual-Polarized 1024-Element Ka-Band SATCOM Transmit Phased-Array with Large Scan Volume and +48dBW EIRP

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

WeIF1-49: A 366nW, -74.5dBm Sensitivity Antenna-Coupled Wakeup Receiver at 4.9GHz with Integrated Voltage Regulation and References

D. Duvvuri, X. Shen, P. Bassirian, H.L. Bishop, X. Liu, C.-H. Chen, A. Dissanayake, Y. Zhang, T.N. Blalock, B.H. Calhoun, S.M. Bowers, Univ. of Virginia

WeIF1-50: A Full Ka-band Highly Linear Efficient GaN-on-Si Resistive Mixer

D. Parveg, M. Varonen, M. Kantanen, J. Pusa, VTT Technical Research Centre of Finland

WeIF1-51: Hybrid ET Supply Modulator IC with an Adaptive Quiescent Current Controller for its Linear Amplifier

H. Oh, J. Shin, W. Choi, Y. Chen, H. Jeon, Y. Choi, H. Koo, Y. Yang, Sungkyunkwan Univ.

WeIF1-52: A Frequency and Bandwidth Reconfigurable 3–6GHz Cryogenic SiGe BiCMOS LNA with a Power Consumption of ≤ 2.9mW

Z. Zou, M. Hosseini, R. Kwende, S. Raman, J.C. Bardin, UMass Amherst

WeIF1-53: A Single-Ended Coupler-Based VSWR Resilient Joint Mm-Wave True Power Detector and Impedance Sensor

D. Munzer, N. S. Mannem, Hua Wang, Georgia Institute of Technology

WeIF1-54: A 140μW Front-end with 5.7 dB NF and +10 dBm OOB-IIP3 using Passive Voltage-Mode Boosting Mixer

Amin Mohammadpour, Univ. of Pavia

WeIF1-55: Reduced-height Waveguide Y-Junction Circulator Based on Two Asymmetrical Gyromagnetic Posts

I. Marah, Cobham; A. Ghiotto, Bordeaux-INP; J.-M. Pham, Univ. of Bordeaux; A. Verger, Cobham; E. Laroche, Cobham

WeIF1-56: A Machine Learning Approach-based Chipless RFID System for Robust Detection in Real-world Implementations

S. Jeong, J. Hester, R. Bahr, M. Tentzeris, Georgia Institute of Technology

WeIF1-57: Terahertz Input-Reflectionless Waveguide Filter

J.P. Lee, Korea Univ.; H.-Y. Tsao, Univ. of Virginia; S. Lee, Korea Univ.; S. Barker, Univ. of Virginia

WeIF1-58: SiC Substrate-Integrated Waveguides for High-Power Monolithic Integrated Circuits Above 110 GHz

M. J. Asadi, L. Li, W. Zhao, K. Nomoto, Cornell Univ.; P. Fay, Univ. of Notre Dame; H. Xing, D. Jena, J. Hwang, Cornell Univ.

WeIF1-59: Neural Network Tuning for Analog-RF Self-Interference Cancellation

K. Kolodziej, A. Cookson, B. Perry, MIT Lincoln Laboratory

WeIF1-60: Switched Dual-Band SAW Filter Using Vanadium Oxide Switches

A. F. Azarnaminy, J. Jiang, R. Mansour, Univ. of Waterloo

WeIF1-61: Ferroelectric-on-Si Super-High-Frequency Fin Bulk AcousticResonators with Hf0.5Zr0.5O2 Nano-Laminated Transducers

F. Hakim,R. Tabrizian, Univ. of Florida

WeIF1-62: Active MMIC Transversal Filter-Based Negative Group Delay/Non-Foster Circuit in 0.1-μm GaAs pHEMT Technology

M. Zhu, Rutgers Univ.; A. Chen, California State Univ., Northridge; C.-Y. Hsiao, C.-N. Kuo, National Chiao Tung Univ. ; C.-T. M. Wu, Rutgers Univ.

WeIF1-63: Multichannel Substrate Integrated Waveguide Diplexer Made of Dual-Mode Cavities and Split-Type Dual-Band Response

K. Zhou, .K. Wu, École Polytechnique de Montréal

WeIF1-64: Cu/Co Metaconductor Based Coplanar Waveguide with Sub 0.1 dB/mm Insertion Loss at 28 GHz

H.-I. Kim, R. Bowrothu, .Y.-K. Yoon, Univ. of Florida

RFIC PANEL SESSION | 12:30 – 14:00 | Wednesday, 23 June 2021 | AUDITORIUM 5

Automotive Radars and AI: Is My Car Really Safe?

PANEL SESSIONS CHAIR: Jennifer Kitchen, *Arizona State University*

PANEL ORGANIZERS AND MODERATORS:

François Rivet, *University of Bordeaux*

Magnus Wiklund, *Qualcomm*

PANELISTS:

Margaret Huang, *Intel*

Karam Noujeim, *Anritsu Juergen Hasch, Bosch Manju Hedge, Uhnder*

Mohammad Emadi, *Zadar Labs*

Yue Lu, *DiDi Chuxing*

ABSTRACT:

Are we ready to take our hands off the car steering wheel? In any case, our cars are ready to steal control from us and remove the largest cause of road accidents: man. This panel will ask the question of how much confidence we have in the electronics of our cars and whether we can trust them. Automotive radar is the vision and artificial intelligence is the decision making. We will discuss the feasibility of this vision to determine if it is wise enough to stop driving or if we should keep our hands on the steering wheel.

IMS PANEL SESSION | 13:00 – 14:30 | Wednesday, 23 June 2021 | AUDITORIUM 5

Will Far-Field WPT Become a Reality?

PANEL SESSIONS CHAIRS: Ruonan Han, *MIT*; **Rui Ma,** *MERL*

PANEL ORGANIZERS AND MODERATORS:

Alessandra Costanzo, *University of Bologna, Italy*
Jenshan Lin, *University of Florida, USA*
Ke Wu, *Ecole Polytechnique de Montréal, University of Montreal, Montreal, QC, Canada*
Nuno Carvalho, *Universidade de Aveiro, Portugal*

PANELISTS:

Alessandra Costanzo, *University of Bologna, Italy*
Bruno Franciscatto, *Huawei*
Greg Kushnir, *EMROD, New Zealand*
Hooman Kazemi, *Raytheon, USA*
Jenshan Lin, *University of Florida, USA*
Ke Wu, *Ecole Polytechnique de Montréal, University of Montreal, Montreal, QC, Canada*
Manos Tentzeris, *Georgia Tech, USA*
Naoki Shinohara, *Kyoto University, Japan*
Nuno Carvalho, *Universidade de Aveiro, Portugal*
Paul Jaffe, *Naval Research Lab*

ABSTRACT:

Wireless Power Transmission is becoming a reality and a million dollar industry, mainly for short-range energy conversion, where mobile phones and electric cars are already taking profit of this approach in battery charging using wireless connections. Nevertheless with the rise of 5G and future 6G solutions, and massive IoT devices long-range WPT start to be an important asset and an important research area that is being followed by academia, industry and research labs. In this panel the panelists will be addressing these topics, will long-range WPT become a reality?, which are the main drawbacks? What would be the main technological driving force for this implementation? Panelists will be divided according to industry, academia and R&D Labs.


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

Time	We3B	We3C	We3D	We3E
	We3B: Innovations in Calibration and Measurement Techniques from MHz to THz **Chair:** Jon Marten, Anritsu Co. **Co-Chair:** Marcus DaSilva, National Instruments	**We3C: Nonlinear and Nonreciprocal Transmission Lines** **Chair:** George Eleftheriades, University of Toronto **Co-Chair:** Jason Soric, Raytheon Company	**We3D: Advance in Phase Change Materials for Microwave Applications** **Chair:** Pierre Blondy, Xlim - CNRS-Unversite De Liroges **Co-Chair:** Raafat Mansour, University of Waterloo	**We3E: Linearization and Transmitter Techniques for Power Amplifiers** **Chair:** John Wood, Wolfspeed, A Cree Company **Co-Chair:** Al Katz, Linearizer Technology Inc.
15:00 15:10	**We3B-1: Calibration Technique for THz Time-Domain Spectrometers Enabling Vectorial Scattering Parameter Measurements** M. Mueh, Ulm Univ.; S. Brandl, Ulm Univ.; P. Hinz, Ulm Univ.; C. Waldschmidt, Ulm Univ.; C. Damm, Ulm Univ.	**We3C-1: Voltage-Tunable Thin Film Graphene-diode-based Microwave Harmonic Generator** M. Elsayed, A. Ghareeb, RWTH Aachen Univ.; P. Palacios, HFE RWTH-Aachen; B. Uzlu, Advanced Microelectronic Center Aachen (AMICA) AMO GmbH; E. Baskent, RWTH Aachen Univ.; Z. Wang, Advanced Microelectronic Center Aachen (AMICA) AMO GmbH; R. Negra, RWTH Aachen Univ.	**We3D-1: Scalable Non-Volatile Chalcogenide Phase Change GeTe-Based Monolithically Integrated mmWave Crossbar Switch Matrix** T. Singh, Univ. of Waterloo; R.R. Mansour, Univ. of Waterloo	**We3E-1: Current-Injected Load-Modulated Outphasing Amplifier for Extended Power Range Operation** J. Garcia, Univ. of Cantabria; M. Ruiz, Univ. of Cantabria ; A. Cordero, Univ. of Cantabria ; D. Vegas, Univ. of Cantabria
15:20 15:30	**We3B-2: Simultaneous Channel Phased-Array Calibration Using Orthogonal Codes and Post-Coding** T. Phelps, Univ. of California, San Diego; Z. Zhang, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego	**We3C-2: A Distributed Mixer-Based Nonreciprocal CRLH Leaky Wave Antenna for Simultaneous Transmit and Receive** S. Vosoughitabar, Rutgers Univ.; M. Zhu, Rutgers Univ.; C.-T.M. Wu, Rutgers Univ.	**We3D-2: Switch Stacking for OFF-State Power Handling Improvements in PCM RF Switches** N. El-Hinnawy, Tower Semiconductor; G. Slovin, Tower Semiconductor; C. Masse, Tower Semiconductor; P. Hurwitz, Tower Semiconductor; J. Rose, Tower Semiconductor; D. Howard, Tower Semiconductor	**We3E-2: A 28-GHz 20.4-dBm CMOS Power Amplifier with Adaptive Common-Gate Cross Feedback Linearization** J. Yool, KAIST; S. Hong, KAIST
15:40 15:50	**We3B-3: Microwave-Microfluidic Sensor in Hybrid 3-D Printing and Laminate Technology for Chemicals Monitoring from Differential Reflection** I. Piekarz, AGH UST; J. Sorocki, AGH UST; N. Delmonte, Università di Pavia; L. Silvestri, Università di Pavia; S. Marconi, Università di Pavia; G. Alaimo, Università di Pavia; F. Auricchio, Università di Pavia; M. Bozzi, Università di Pavia	**We3C-3: Experimental Demonstration of Enhanced Efficiency Non-Magnetic Time-Modulated Circulator** S. Taravati, Univ. of Toronto; G.V. Eleftheriades, Univ. of Toronto	**We3D-3: Multi-Throw SPNT Circuits Using Phase-Change Material RF Switches for 5G and Millimeter Wave Applications** G. Slovin, Tower Semiconductor; N. El-Hinnawy, Tower Semiconductor; C. Masse, Tower Semiconductor; J. Rose, Tower Semiconductor; D. Howard, Tower Semiconductor	**We3E-3: An RF Power Amplifier Behavioural Model with Low-Complexity Temperature Feedback for Transmitter Arrays** G. Jindal, Univ. of Bristol; G.T. Watkins, Toshiba Europe Research; K. Morris, Univ. of Bristol; T. Cappello, Univ. of Bristol
16:00 16:10	**We3B-4: Referenced Frequency Ruler for the Phase Noise Analysis of Oscillators in the High GHz Range** P. Walkemeyer, PTB; B. Lipphardt, PTB; M. Kazda, PTB	**We3C-4: Lightweight Low-Profile Highly-Efficient Magnetless Isolator Comprising Two Time-Modulated Loops** S. Taravati, Univ. of Toronto; G.V. Eleftheriades, Univ. of Toronto	**We3D-4: Wideband SPDT and SP4T RF Switches Using Phase-Change Material in a SiGe BiCMOS Process** F. Amin, Northrop Grumman; T. Beglin, Northrop Grumman; N. Edwards, Northrop Grumman; N. El-Hinnawy, Tower Semiconductor; G. Slovin, Tower Semiconductor; D. Howard, Tower Semiconductor; D. Nichols, Northrop Grumman; R.M. Young, Northrop Grumman	**We3E-4: Frequency-Domain Digital Predistortion for OFDM** A. Brihuega, Tampere Univ. of Technology; L Anttila, Tampere Univ. of Technology; M. Valkama, Tampere Univ. of Technology
16:20 16:30	**We3B-5: Question and Answer**	**We3C-5: Question and Answer**	**We3D-5: A 25–50GHz Phase Change Material (PCM) 5-Bit True Time Delay Phase Shifter in a Production SiGe BiCMOS Process** D. Baltimas, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego	**We3E-5: A High-Accuracy Digital Predistorter Constructed by Reproducing Iterations of ILC with Cascade Architecture** X. Xia, UESTC; Y. Liu, UESTC; C. Li, UESTC; W. Guo, UESTC; C. Shi, UESTC; S. Shao, UESTC; L. Lei, CETC 54; Y. Tang, UESTC
16:40			**We3D-6: Question and Answer**	**We3E-6: Question and Answer**

We3F: MMW and Sub-MMW Power Generation

Chair: Joe Qiu, Army Research Office
Co-Chair: Michael Roberg, QORVO, Inc.

15:00

We3F-1: A 75-305-GHz Power Amplifier MMIC With 10-14.9-dBm Pout in a 35-nm InGaAs mHEMT Technology

F. Thome, Fraunhofer IAF; A. Leuther, Fraunhofer IAF

15:20

We3F-2: 220–325-GHz 25-dB-Gain Differential Amplifier With High Common-Mode-Rejection Circuit in 60-nm InP-HEMT Technology

H. Hamada, T. Tsutsumi, A. Pander, H. Matsuzaki, H. Sugiyama, H. Takahashi, H. Nosaka, NTT Device Technology Laboratories

15:40

We3F-3: A Ka-Band Transformer-Based Switchless Bidirectional PA-LNA in 90-nm CMOS Process

T.-Y. Chiu, National Taiwan Univ.; Y. Wang, National Taiwan Univ.; H. Wang, National Taiwan Univ.

16:00

We3F-4: A 212–260GHz Broadband Frequency Multiplier Chain (×4) in 130-nm BiCMOS Technology

J. Yu, Southeast Univ.; J. Chen, Southeast Univ.; Z. Li, Southeast Univ.; D. Hou, Southeast Univ.; Z. Chen, Southeast Univ.; W. Hong, Southeast Univ.

16:20

We3F-5: A 213–233GHz ×9 Frequency Multiplier Chain with 4.1dBm Output Power in 40nm Bulk CMOS

R. Dong, NICT; S. Hara, NICT; I. Watanabe, NICT; S. Tanoi, NICT; T. Hagino, NICT; A. Kasamatsu, NICT

16:40

We3F-6: Question and Answer

We3G: Innovative Technologies for Machine To Machine and Human To Machine Interactions

Chair: Ken Mays, Boeing
Co-Chair: Rodrigo Camacho, Intel Corporation

15:00

We3G-1: Instinctual Interference-Adaptive Low-Power Receiver with Combined Feedforward and Feedback Control

J. Yang, Purdue Univ.; B. Chatterjee, Purdue Univ.; M. Thorsell, Saab AB; M. Kowalewski, SAAB AB; B. Edward, SAAB Inc.; D Peroulis, Purdue Univ.; S. Sen, Purdue Univ.

15:20

We3G-2: A 4D Gesture Sensing Technique Based on Spatiotemporal Detection with a 60GHz FMCW MIMO Radar

Y. Li, Shanghai Jiao Tong Univ.; C. Gu, Shanghai Jiao Tong Univ.; J.-F. Mao, Shanghai Jiao Tong Univ.

15:40

We3G-3: A Scalable Gesture Interaction System Based on mm-Wave Radar

H. Wu, Intel; J. Ma, Intel

15:50

We3G-4: A Multi-Gbps, Energy Efficient, Contactless Data-Communication Link for Machine-to-Machine (M2M) Interaction with Rotational Freedom

G. Schuppener, Texas Instruments; T. Dinc, Texas Instruments; J. Blauert, Texas Instruments; W. Ahmad, Texas Instruments; D. Garcia, Texas Instruments; H. Ali, Texas Instruments; B. Cook, Texas Instruments; S. Sankaran, Texas Instruments

16:20

We3G-5: Question and Answer

MICROAPPS

10:00 – 13:30 | **Thursday, 24 June 2021** | **AUDITORIUM 6**

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SESSION CODE	TIME	TITLE	SPEAKER/S	COMPANY
THMA57	10:00–10:15	Software Defined Radio Prototyping Platforms	Larry Hawkins	*Richardson RFPD*
THMA58	10:15–10:30	Technical Considerations for Testing 5G Base Station Finals for Digital Pre-distortion (DPD) Characterization.	TBD	*AR Worldwide*
THMA59	10:30–10:45	UWB emissions - Improvements in Spectrum Analyzers to Cover with New tTest Requirements	Kay-Uwe Sander	*Rohde & Schwarz*
THMA60	10:45–11:00	Wi-Fi 7: New features and how to test them	Alejandro Buritica	*National Instruments*
THMA63	11:30–11:45	Broadband Functionality Using RF MEMS – Digital and RF Applications	Jonathan Leitner	*Menlo Micro*
THMA64	11:45–12:00	MEMS Switches for Quantum Computing Applications – 4x4 Switch Matrix	Jonathan Leitner	*Menlo Micro*
THMA65	12:15–12:30	Size of The Prize: Mastering 5G Spectrum Management With Enhanced Filter Solutions	John Yania	*API Tech*
THMA66	12:30–12:45	Tunable and Fixed Filtering Solutions Enhances Dynamic Range and Flexibility of 4G/5G-LTE Measurements	Rafi Hershtig	*K&L Microwave*
THMA67	12:45–13:00	TFLE-Thin Film Lumped Elements Reflective and Non-Reflective Filtering Solutions	Rafi Hershtig	*K&L Microwave*
THMA68	13:00–13:15	5G Connectivity: Challenges and Gold Solutions	Jenny Gallery	*Indium Corporation*

INTER-SOCIETY TECHNOLOGY PANEL (ISTP) SESSION

13:30 – 14:30 | **Tuesday, 22 June 2021** | **AUDITORIUM 5**

All in One...? Integration for the Future of Systems

PANEL ORGANIZERS:

Ke Wu, *École Polytechnique de Montréal*
Steven Reising, *Colorado State University*
Alessandra Costanzo, *University of Bologna*
J.C. Chiao, *Southern Methodist University*

MODERATOR:

Jeffrey Herd, *Massachusetts Institute of Technology, Lincoln Laboratory*

PANELISTS:

J.C. Chiao, *Southern Methodist University*
Steven Reising, *Colorado State University*
William Blackwell, *Massachusetts Institute of Technology, Lincoln Laboratory*
Davide Dardari, *University of Bologna*
Kamran Entesari, *Texas A&M University*
Valter Mariani Primiani, *Universita Politecnica delle Marche*
Y.P. Zhang, *Nanyang Technological University*

ABSTRACT:

RF and microwave integration is the blending of different constituent elements or building blocks into a space through design, processing and packaging to create performance-consistent functional modules or systems or operations. There are multiple levels of integration, namely structure integration, function integration and operation integration. The structure integration can be seen through planar and non-planar waveguide integration such as substrate integration technology and RFICs in which various passive and active circuit elements are processed together within semiconductors. The function integration is more related to T-R architecture design in which communication and other wireless functions such as sensing are merged together. The operation integration involves heterogeneous development of dissimilar physical operations for achieving common objectives such as the fusion of lidar, radar and acoustic devices for autonomous mobility; microfluidics and RF probes for biological cell sensing; or considerations for electromagnetic compatibility in a complex RF environment. As operating frequency continuously increases from GHz to THz for various highly promoted commercial systems and applications, it is recognized that various integration technologies are playing an ever-increasingly important role in the development of antennas, components, circuits and firmware. In fact, such integration technologies have absolutely become mandatory for mass production of RF and wireless systems in form of functional chips, chiplets, modules and instruments. This is because it is no longer performance-tolerant for system developments, based on loss, noise and parasitics. Therefore, it would be imperative for us to discuss the state-of-the-art integration technologies and future developments in this strategic direction. Experts from various disciplines from multiple IEEE societies will come together and talk about the current integration progresses, issues and challenges.

IMS CLOSING SESSION | 15:30 – 17:00 | Thursday, 24 June 2021 | AUDITORIUM 5

Mobility Panel

PANEL SESSIONS CHAIR: Prof. Satish Udpa, *Michigan State University*

PANELISTS PARTICIPATING IN THE PANEL DISCUSSION INCLUDE:

Benedikt Brecht, *Head of Digital Policy, Volkswagen Group.*
Matt MacPherson, *Wireless CTO, Cisco*
Jefferson Wang, *Managing Director at Accenture Strateg,y Leading 5G Initiatives Globally*

THE DISCUSSION WILL BE MODERATED BY

Satish Udpa, *University Distinguished Professor at Michigan State University*

The mobility industry is in the midst of a major revolution, fueled in part by a confluence of developments in the areas of AI, Communications, Sensor technologies, Electric drives and Computing, and motivated by concerns of safety, environment and comfort. Advances in mobility will affect just about every aspect of our social lives and impact almost every sector of the economy. A key enabler of growth in this industry is ubiquitous wireless communications. This panel discussion will bring key leaders in industry together and have them don their prognosticator's hat to share their views on where wireless communications is headed, particularly as it relates to mobility. Recognizing that the industry is increasingly moving towards CV2X that will be enabled further by 5G, what should we expect with regard to in-vehicle services and safety/security issues? What comes next, particularly after 3GPP Release 15 and 16? Long Term? What kinds of cybersecurity enhancements will we see? Protection vs Repair Issues? What will be the impact of the confluence of 5G and Edge Computing? All questions, that the mobility community is seeking answers to from the wireless communications community.

Th1A: Characterization and integration Techniques for 5G Wireless Systems

Chair: Ethan Wang, University of California, Los Angeles

Co-Chair: Aida Vera Lopez, Intel Corporation

09:00 **Th1A-1: Investigation of the Impact of Zero-Forcing Precoding on the Variation of Massive MIMO Transmitters' Performance with Channel Conditions**

M. Almoneer, Univ. of Waterloo; P. Mitran, Univ. of Waterloo; S. Boumaiza, Univ. of Waterloo

09:20 **Th1A-2: USRP-Based mmWave Prototyping Architecture with Real-Time RF Control**

A. Gaber, National Instruments; A. Nahler, National Instruments; W. Nitzold, National Instruments; M. Anderseck, National Instruments

09:40 **Th1A-3: Automatic Distributed MIMO Testbed for Beyond 5G Communication Experiments**

H. Bao, Chalmers Univ. of Technology; I.C. Sezgin, Chalmers Univ. of Technology; Z.S. He, Chalmers Univ. of Technology; T. Eriksson, Chalmers Univ. of Technology; C. Fager, Chalmers Univ. of Technology

10:00 **Th1A-4: OLED Touch Display-Integrated Phased-Array Antennas and RF Front-Ends Packaging Technology for Beyond 5G Wireless Devices**

J. Park, POSTECH; D. Park, Dongwoo Fine-Chem; W. Hong, POSTECH

10:20 **Th1A-5: A Tunable Multi-Mode Quadrature Balanced N-Path Diplexer with Nonlinear Cross-Modulation Distortion Correction**

N. Ginzberg, Technion - Israel Institute of Technology; E. Zolkov, Technion - Israel Institute of Technology; T. Gidoni, Tel-Aviv University; E. Cohen, Technion - Israel Institute of Technology

10:40 **Th1A-6: Question and Answer**

Th1B: MMW and Sub-MMW Subsystems and Systems

Chair: William Deal, Northrop Grumman Corporation

Co-Chair: Emanuel Cohen, Technion - Israel Institute of Technology

Th1B-1: A 258-GHz CMOS Transmitter with Phase-Shifting Architecture for Phased-Array Systems

T. Hagiwara, N. Yamaki, K. Sekine, H. Sakai, K. Sahara, K. Takano, Tokyo University of Science; S. Hara, NICT; S. Lee, Hiroshima Univ.; R. Dong, S. Tanoi, NICT; S. Kubo, THine Electronics; S. Miura, THine Electronics; A. Kasamatsu, NICT; T. Yoshida, S. Amakawa, Hiroshima Univ.; K. Sakakibara, Nagoya Institute of Te

Th1B-2: A 24.6–32.5GHz Millimeter-Wave Frequency Synthesizer for 5G Wireless and 60GHz Applications

N. Mahalingam, SUTD; Y. Wang, SUTD; B.K. Thangarasu, SUTD; K.S. Yeo, SUTD; K. Ma, Tianjin Univ.

Th1B-3: A Packaged 135GHz 22nm FD-SOI Transmitter on an LTCC Carrier

A.A. Farid, Univ. of California, Santa Barbara; A.S.H. Ahmed, Univ. of California, Santa Barbara; A. Simsek, Univ. of California, Santa Barbara; M.J.W. Rodwell, Univ. of California, Santa Barbara

Th1B-4: Photo-Induced Coded-Aperture Imaging at 740GHz Using Mesa Arrays for Achieving Subwavelength Resolution

Y. Deng, Univ. of Notre Dame; Y. Shi, Univ. of Notre Dame; P. Li, Univ. of Notre Dame; P. Fay, Univ. of Notre Dame; L. Liu, Univ. of Notre Dame

Th1B-5: A 5G mm-Wave Single Chip 8-Channel FEM with Best-in-Class 22% Power Efficiency and Embedded Die Substrate (EDS) Technology

K.-J. Choi, Samsung; H.-J. Yoo, Samsung; J.-O. Ha, Samsung; J.-H. Kim, Samsung; J.-S. Kim, Samsung; B.-H. Jo, Samsung; S.-J. Kim, Samsung; J.-S. Park, Samsung; Y. Na, Samsung; Y.-S. Hur, Samsung

Th1B-6: Question and Answer

Th1C: High Power and Load Invariant PAs

Chair: Robert Caverly, Villanova University

Co-Chair: Zoya Popovic, University of Colorado

Th1C-1: Wideband Class Φ_2 Power Amplifier for HF Applications

Z. Tong, Stanford Univ.; L. Gu, Stanford Univ.; J.M. Rivas-Davila, Stanford Univ.

Th1C-2: Novel Continuous Inverse Class F Power Amplifier for High Power 5G Macro Base Station Application

T. Sharma, NXP Semiconductors; N. Zhu, NXP Semiconductors; J. Roberts, NXP Semiconductors; D.H. Holmes, NXP Semiconductors

Th1C-3: 300W X-Band Solid State Power Amplifier Using Discrete GaN HEMT Devices with Waveguide Interface

M. Harinath, ISRO; S.K. Garg, ISRO; S. Aich, ISRO; T. Paul, ISRO; A. Kumar, ISRO; J. Trivedi, ISRO; R.N. Rath, ISRO; M.K. Patel, ISRO; Ch.V.N. Rao, ISRO; R. Jyoti, ISRO

Th1C-4: Wideband Quasi-Balanced Doherty Power Amplifier with Reciprocal Main/Auxiliary Setting and Mismatch-Resilient Parallel/Series Reconfiguration

H. Lyu, Univ. of Central Florida; K. Chen, Univ. of Central Florida

Th1C-5: Load Insensitive Doherty PA Using Load Dependent Supply Voltages

C.F. Gonçalves, Universidade de Aveiro; F.M. Barradas, Universidade de Aveiro; L.C. Nunes, Universidade de Aveiro; P.M. Cabral, Universidade de Aveiro; J.C. Pedro, Universidade de Aveiro

Th1C-6: Question and Answer

Th1D: Recent advances in radar systems and technologies

Chair: Jacquelyn Vitaz, Raytheon Company

Co-Chair: Richard Al Hadi, Alcatera, Inc.

Th1D-1: Feature Extraction for Dynamic Hand Gesture Recognition Using Block Sparsity Model

Z. Wang, Beijing Institute of Technology; Q. An, Air Force Medical University; S. Li, Beijing Institute of Technology

Th1D-2: A Millimeter-Wave Dynamic Antenna Array for Classifying Objects via Sparse Fourier Domain Sampling

D. Chen, Michigan State Univ.; S. Vakalis, Michigan State Univ.; J.A. Nanzer, Michigan State Univ.

Th1D-3: A 0.1-4.0 GHz Inductor-less Direct-Sequence Spread-Spectrum Based Ground-Penetrating Radar System-on-Chip

R. Huang, Univ. of California, Los Angeles; Y. Zhang, Univ. of California, Los Angeles; E. Decrossas, Jet Propulsion Lab; A. Seshadri, Jet Propulsion Lab; C. Liang, Univ. of California, Los Angeles; M. Chang, Univ. of California, Los Angeles; A. Tang, Jet Propulsion Lab

Th1D-4: Broadband Sub-THz Chirp Linearization Using Particle Swarm Optimization for Precision Metrology Applications

S.M.H. Naghavi, Univ. of Michigan; M. Tavakoli Taba, Univ. of Michigan; B. Yektakhah, Univ. of Michigan; M. Aseeri, KACST; A. Cathelin, STMicroelectronics; E. Afshari, Univ. of Michigan

Th1D-5: High Angular Resolution Digital Beamforming Method for Coherent FMCW MIMO Radar Networks

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-6: Question and Answer

Th1E: LATE NEWS - Broadband and High-Speed Circuits

Chair: Wooram Lee, Pennsylvania State University

Co-Chair: Rüdiger Quay, Fraunhofer Institute for Applied Solid State Physics

Th1E-1: A Highly Linear Dual Stage Amplifier with Beyond 1.75 THz Gain-Bandwidth-Product

M. T. Shivan, Ferdinand-Braun-Institut; M. Hossain, Ferdinand-Braun-Institut; R. Doerner, Ferdinand-Braun-Institut; T. Johansen, Technical Univ. of Denmark; Ha. Yacoub, Ferdinand-Braun-Institut; W. Heinrich, Ferdinand-Braun-Institut; V. Krozer, Ferdinand-Braun-Institut

Th1E-2: A DC to 220 GHz High-Isolation SPST Switch in 22nm FDSOI CMOS

L. Wu, Univ. of Toronto; H. Y. Hsu, Univ. of Toronto; S. Voinigescu, Univ. of Toronto

Th1E-3: A 32 Gb/s CMOS Receiver with Analog Carrier Recovery and Synchronous QPSK Demodulation

S. Lee, Hiroshima Univ.; S. Amakawa, Hiroshima Univ.; T. Yoshida, Hiroshima Univ.; S. Hara, National Institute of Information and Communications Technology; M. Fujishima, Hiroshima Univ.

Th1E-4: Performance Comparison of Broadband Traveling Wave Amplifiers in 130 nm SiGe:C SG13G2 and SG13G3 BiCMOS Technologies

M. Inac, IHP Microelectronics; A. Fatemi, IHP Microelectronics; F. Korndörfer, IHP Microelectronics; H. Rücker, IHP Microelectronics; F.I Gerfers, Technische Univ. Berlin; A. Malignaggi, IHP Microelectronics

Th1E-5: A 39GHz Bandwidth, 2.5GS/s 7-Bit SAR ADC in 22nm FDSOI CMOS

E. Checca, Univ. of Toronto; S.P. Voinigescu, Univ. of Toronto

Th1E-6: Question and Answer

Th1F: Advances in LNA Design for 5G Applications and Beyond

Chair: Joseph Bardin, University of Massachusetts, Amherst

Co-Chair: James Sowers, Maxar Technologies

Th1F-1: A 27–46 GHz Low Noise Amplifier With Dual-Resonant Input Matching and A Transformer-Based Broadband Output Network

Y. Hu, Rice Univ.; T. Chi, Rice Univ.

Th1F-2: A Broadband Variable Gain Low Noise Amplifier Covering 28/38GHz Bands with Low Phase Variation in 90-nm CMOS for 5G Communications

K.-C. Chang, National Taiwan Univ.; Y. Wang, National Taiwan Univ.; H. Wang, National Taiwan Univ.

Th1F-3: A 0.6-V VDD, 3.8-dB Minimum Noise Figure, 19.5–62.5-GHz Low Noise Amplifier in 28-nm Bulk CMOS

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

Th1F-4: A Baseband-65GHz High Linearity-Bandwidth GaN LNA Using a 1.7A/mm High Current Density ScAlN Based GaN HEMT Technology

K.W. Kobayashi, Qorvo; V. Kumar, Qorvo; A. Xie, Qorvo; J.L. Jimenez, Qorvo; E. Beam, Qorvo; A. Ketterson, Qorvo

Th1F-5: Question and Answer

09:00 09:10 09:20 09:30 09:40 09:50 10:00 10:10 10:20 10:30 10:40

Tu3E: CMOS Transmitters and Amplifiers from RF to mm-Wave

Chair: Alexandre Giry, Université Grenoble Alpes - CEA, LETI
Co-Chair: Xun Luo, University of Electronic Science and Technology of China

10:00

Tu3E-1: A Sub-6GHz 5G New Radio Multi-Band Transmitter with a Switchable Transformer in 14nm FinFET CMOS

W. Jung, Samsung; S. Kang, Samsung; D. Jeong, Samsung; K.Y. Son, Samsung; J. Lee, Samsung; J. Lee, Samsung; J.-S. Paek, Samsung

10:20

Tu3E-2: A 0.7–8GHz High IF Frequency-Extended Transmitter Front-End with -47.1-dB EVM at 16QAM in 65-nm CMOS

J. Liu, Zhejiang Univ.; S. Wang, Zhejiang Univ.; Y. Gong, Zhejiang Univ.; D. Liu, Integrated Beam Tech; N. Hui, Zhejiang Univ.; C. Song, Zhejiang Univ.; Q.J. Gu, Univ. of California, Davis; Z. Xu, Zhejiang Univ.

10:40

Tu3E-3: A 24.5–29.5GHz Broadband Parallel-to-Series Combined Compact Doherty Power Amplifier in 28-nm Bulk CMOS for 5G Applications

S. Kim, Samsung; H.-C. Park, Samsung; D. Kang, Samsung; D. Minn, Samsung; S.-G. Yang, Samsung

11:00

Tu3E-4: A 5G FR2 (n257/n258/n261) Transmitter Front-End with a Temperature-Invariant Integrated Power Detector for Closed-Loop EIRP Control

C. Kuo, Samsung; H. Zhang, Samsung; A. Sarkar, Samsung; X. Yu, Samsung; V. Bhagavatula, Samsung; A. Verma, Samsung; T. Chang, Samsung; I.S.-C. Lu, Samsung; D. Yoon, Samsung; S. Son, Samsung; T.B. Cho, Samsung

Tu3F: RF and mm-Wave VCOs

Chair: Ehsan Afshari, University of Michigan
Co-Chair: Pietro Andreani, Lund University

Tu3F-1: A 10.7–14.1GHz Reconfigurable Octacore DCO with -126dBc/Hz Phase Noise at 1MHz Offset in 28nm CMOS

L. Tomasin, Università di Padova; G. Boi, Infineon Technologies; F. Padovan, Infineon Technologies; A. Bevilacqua, Università di Padova

Tu3F-2: A 2.3-to-3.2GHz Class-G Impedance-Modulation Power Oscillator with 10dBm Peak Pout and 39%/37%/33%/30% Efficiency at 0/3/6/9dB PBOs

Y. Shu, UESTC; H.J. Qian, UESTC; X. Gao, Zhejiang Univ.; X. Luo, UESTC

Tu3F-3: A Novel Miniaturized Tri-Band VCO Utilizing a Three-Mode Reconfigurable Inductor

S. Oh, Seoul National Univ.; J. Oh, Seoul National Univ.

Tu3F-4: A 3.1–51GHz, Sub-8mW, Single-Core LC VCO Based on a Novel Compact Tunable Transmission Line (CTTL) Resonator in 28nm FDSOI CMOS

T. Tapen, Cornell Univ.; A. Cathelin, STMicroelectronics; A. Apsel, Cornell Univ.

Tu3G: RF Systems for Emerging Wireless Applications

Chair: Oren Eliezer, IEEE
Co-Chair: Mona Hella, Rensselaer Polytechnic Institute

Tu3G-1: A Fully-Digital 0.1-to-27Mb/s ULV 450MHz Transmitter with Sub-100μW Power Consumption for Body-Coupled Communication in 28nm FD-SOI CMOS

G. Tochou, STMicroelectronics; R. Benarrouch, STMicroelectronics; D. Gaidioz, STMicroelectronics; A. Cathelin, STMicroelectronics; A. Frappé, IEMN (UMR 8520); A. Kaiser, IEMN (UMR 8520); J. Rabaey, Univ. of California, Berkeley

Tu3G-2: A mm-Wave Transmitter MIMO with Constellation Decomposition Array (CDA) for Keyless Physically Secured High-Throughput Links

N.S. Mannem, Georgia Tech; T.-Y. Huang, Georgia Tech; E. Erfani, Georgia Tech; S. Li, Georgia Tech; H. Wang, Georgia Tech

Tu3G-3: A 0.31THz CMOS Uniform Circular Antenna Array Enabling Generation/Detection of Waves with Orbital-Angular Momentum

M.I.W. Khan, MIT; J. Woo, MIT; X. Yi, MIT; M.I. Ibrahim, MIT; R.T. Yazicigil, Boston Univ.; A. Chandrakasan, MIT; R. Han, MIT

Tu3G-4: An 84.48Gb/s CMOS D-Band Multi-Channel TX System-in-Package

A. Hamani, CEA-LETI; F. Foglia-Manzillo, CEA-LETI; A. Siligaris, CEA-LETI; N. Cassiau, CEA-LETI; B. Blampey, CEA-LETI; F. Hameau, CEA-LETI; C. Dehos, CEA-LETI; A. Clemente, CEA-LETI; J.L. Gonzalez-Jimenez, CEA-LETI

Tu4G: Efficient Radios for IoT, GPS, WiFi, and Cellular

Chair: Roxann Broughton-Blanchard, Analog Devices, Inc.
Co-Chair: Arun Paidimarri, IBM Research

Tu4G-1: An Electrical Balance Duplexer for FDD Radios That Isolates TX from RX Independently in Two Bands

K. Shi, Univ. of California, Los Angeles; H. Darabi, Broadcom; A.A. Abidi, Univ. of California, Los Angeles

Tu4G-2: An LTE-A Multimode RF Transmitter with -64.5dB B41 CIM3 Suppression and 256QAM/HPUE Capability in 28nm CMOS

C. Bryant, MediaTek; M. Collados, MediaTek; B. Abdeljelil, MediaTek; P. Fowers, MediaTek; M. Hassan, MediaTek; D. Ivory-Cave, MediaTek; D. Nalbantis, MediaTek; J. Strange, MediaTek; L. Chen, MediaTek; J. Lin, MediaTek

Tu4G-3: A 2.1mW -109dBm NB-IoT Wake-Up Receiver

T.J. Odelberg, Univ. of Michigan; J. Im, Univ. of Michigan; D.D. Wentzloff, Univ. of Michigan

Tu4G-4: A 300μW Bluetooth-Low-Energy Backchannel Receiver Employing a Discrete-Time Differentiator-Based Coherent GFSK Demodulation

O. Abdelatty, Univ. of Michigan; A. Alghaihab, Univ. of Michigan; Y.K. Cherivirala, Univ. of Michigan; S. Kamineni, Univ. of Virginia; B. Calhoun, Univ. of Virginia; D.D. Wentzloff, Univ. of Michigan

11:20

Tu4G-5: A Compact, Reconfigurable Receiver for IRNSS/GPS/Galileo/Beidou

V.K. Kanchetla, IIT Bombay; A. Kharalkar, IIT Bombay; J. Joy, IIT Bombay; S.C. Jose, IIT Bombay; S.K. Khyalia, IIT Bombay; S. Jain, IIT Bombay; M. Pancholi, IIT Bombay; S. Hameed, IIT Bombay; A.K. Tripathi, IIT Bombay; S. Khalapure, IIT Bombay; R. Zele, IIT Bombay

11:40

Tu4E: mm-Wave Circuits for Emerging Applications

Chair: Jeyanandh Paramesh, Carnegie Mellon University
Co-Chair: Hongtao Xu, Fudan University

10:00

Tu4E-1: A 4Rx, 4Tx Ka-Band Transceiver in 40nm Bulk CMOS Technology for Satellite Terminal Applications

A.C.-W. Wong, EnSilica; G. Devita, EnSilica; S.-M. Wu, EnSilica; F. Lauria, EnSilica; M. Eid, EnSilica; O. Illuromi, EnSilica; S. Ogunkunle, EnSilica; A. Modigliana, Satellite Applications Catapult

10:20

Tu4E-2: A 20–40GHz High Dynamic Range HBT N-Path Receiver with 8.9dBm OOB B1dB and 8.55dB NF Consuming 130mW

R. Ying, Cornell Univ.; A. Molnar, Cornell Univ.

10:40

Tu4E-3: A 2-Channel 136–156GHz Dual Down-Conversion I/Q Receiver with 30dB Gain and 9.5dB NF Using CMOS 22nm FDSOI

C. Wang, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

11:00

Tu4E-4: A 290GHz Low Noise Amplifier Operating Above fmax/2 in 130nm SiGe Technology for Sub-THz/THz Receivers

S.P. Singh, Univ. of Oulu; T. Rahkonen, Univ. of Oulu; M.E. Leinonen, Univ. of Oulu; A. Pärssinen, Univ. of Oulu

11:20

11:40

RFIC SYSTEMS AND APPLICATION FORUM | 12:30 – 14:00 | Thursday, 24 June 2021

CHAIR: OREN ELIEZER, *AMBIQ*

The RFIC Systems and Application Forum is a demo session providing recorded demonstrations of the work reported in seven papers from various sessions of the RFIC Symposium. These will be accompanied by live online discussions with the authors, allowing attendees to meet the authors and learn more about their work, as well as to interact with other attendees of that session. The demo session includes both full systems incorporating more than once RFIC, as well as building- blocks/subsystems that are demonstrated with a system built around them (typically including test equipment). Below is a list of the authors who had volunteered to prepare demos for this session and the corresponding papers and oral presentations sessions.

RTu1E-2 | Portable Thermoacoustic Imaging for Biometric Authentication Using a 37.3dBm Peak Psat 4.9GHz Power Amplifier in 55nm BiCMOS
[1]Stanford University, USA, [2]STMicroelectronics, France
Christopher Sutardja[1], Andreia Cathelin[2], Amin Arbabian[1]

RTu1G-1 | A 27.5dBm EIRP D-Band Transmitter Module on a Ceramic Interposer
University of California, Santa Barbara, USA
Ali A. Farid, Ahmed S.H. Ahmed, Mark J.W. Rodwell

RTu1H-2 | A 3.5-to-6.2-GHz Mixer-First Acoustic-Filtering Chipset with Mixed-Domain Asymmetric IF and Complex BB Recombination Achieving 170MHz BW and +27dBm IIP3 at 1×BW Offset
University of Illinois at Urbana-Champaign, USA
Hyungjoo Seo, Mengze Sha, Jin Zhou

RTu1H-5 | A Noise-Cancelling Self-Interference Canceller with +7dBm Self-Interference Power Handling in 0.18μm CMOS
[1]Oregon State University, USA, [2]Columbia University, USA
Mostafa Essawy[1], Amin Aghighi[1], Hayden Bialek[1], Aravind Nagulu[2], H. Krishnaswamy[2], A. Natarajan[1]

RTu2E-1 | A Global Multi-Standard/Multi-Band 17.1–52.4GHz Tx Phased Array Beamformer with 14.8dBm OP1dB Supporting 5G NR FR2 Bands with Multi-Gb/s 64-QAM for Massive MIMO Arrays
University of California, San Diego, USA
Abdulrahman A. Alhamed, Gabriel M. Rebeiz

RTu3G-1 | A Fully-Digital 0.1-to-27Mb/s ULV 450MHz Transmitter with Sub-100μW Power Consumption for Body-Coupled Communication in 28nm FD-SOI CMOS
[1]STMicroelectronics, France, [2]IEMN (UMR 8520), France, [3]University of California, Berkeley, USA
Guillaume Tochou[1], Robin Benarrouch[1], David Gaidioz[1], Andreia Cathelin[1], Antoine Frappé[2], Andreas Kaiser[2], Jan Rabaey[3]

RTu3G-4 | An 84.48Gb/s CMOS D-Band Multi-Channel TX System-in-Package
CEA-Leti, France
Abedelaziz Hamani, Francesco Foglia-Manzillo, Alexandre Siligaris, Nicolas Cassiau, Benjamin Blampey, Frederic Hameau, Cedric Dehos, Antonio Clemente, Jose Luis Gonzalez-Jimenez

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

Th2A: Array Beamformers and Calibration

Chair: Abbas Omar, University of Magdeburg

Co-Chair: Glenn Hopkins, Georgia Institute of Technology

11:00

Th2A-1: Miniaturised High Power Beam Steering Network Using Novel Non-Planar Waveguide Butler Matrix

T. Paul, H. Mynam, Space Applications Centre; S. Garg, S. Aich, Space Applications Centre (ISRO); A. Kumar, Indian Space Research Organization; J. Trivedi, A. Kumar, M. Patel, C. RAO, R. JYOTI, Space Aplications Centre, ISRO

11:10

11:20

Th2A-2: A Miniaturized 28GHz 4×4 Butler Matrix Using Shielded Ridged Half-Mode SIW

E.T. Der, Univ. of Alberta; T.R. Jones, Univ. of Alberta; M. Daneshmand, Univ. of Alberta

11:30

11:40

Th2A-3: Digital PA Modulator with Phase Shifter for Phased Array Transmitters

F. Hühn, FBH; A. Wentzel, FBH; W. Heinrich, FBH

11:50

12:00

Th2A-4: Asynchronous 256-Element Phased-Array Calibration for 5G Base Station

Y. Aoki, Samsung Electronics Co., Ltd.; Y. Hwang, Samsung Electronics, Co., Ltd.; S. Kim, Samsung Electronics, Co., Ltd.; Y. Kim, Samsung Electronics, Co., Ltd.; S. Yang, Samsung Electronics, Co., Ltd.

12:10

12:20

Th2A-5: Characterization of an Antenna Cluster and Transmitter IC with a Modulated Signal

A.R. Saleem, Aalto Univ.; K. Stadius, Aalto Univ.; J.-M. Hannula, Aalto Univ.; A. Lehtovuori, Aalto Univ.; M. Kosunen, Aalto Univ.; V. Viikari, Aalto Univ.; J. Ryynänen, Aalto Univ.

12:30

12:40

Th2A-6: Question and Answer

Th2C: Compound Semiconductor PA Technologies for mm-Wave and 5G Applications

Chair: Spyridon Pavlidis, North Carolina State University

Co-Chair: Vittorio Camarchia, Politecnico di Torino

Th2C-1: 80-110 GHz Broadband Linear PA with 33% peak PAE and Comparison of Stacked Common-Base and Common-Emitter PA in InP

Z. Liu, Princeton Univ.; T. Sharma, Princeton Univ.; K. Sengupta, Princeton Univ.

Th2C-2: A 190–210GHz Power Amplifier with 17.7–18.5dBm Output Power and 6.9–8.5% PAE

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

Th2C-3: A 24-28 GHz Doherty Power Amplifier with 4 W Output Power and 32% PAE at 6 dB OPBO in 150 nm GaN Technology

M. Bao, Ericsson; D. Gustafsson, Ericsson AB; R. Hou, Ericsson Ab; Z. Ouarch, UMS (United Monolithic Semiconductors); C. Chang, UMS (United Monolithic Semiconductors); K. Andersson, Ericsson AB

Th2C-4: A Bandwidth-Optimized Transformer-Based Doherty Power Amplifier for 5G Power Class 2 Handset Operation at 2.2GHz–2.7GHz

S. Imai, Murata Manufacturing; H. Okabe, Murata Manufacturing; S. Tanaka, Murata Manufacturing

Th2C-5: Question and Answer

Th2D: LATE NEWS - Milimeter-Wave Arrays for Next Generation Wireless

Chair: Jeffrey Nanzer, Michigan State University

Co-Chair: Roberto Vincenti Gatti, University of Perugia

Th2D-1: An Eight-Element 140GHz Wafer-Scale Phased-Array Transmitter with 32dBm Peak EIRP and > 16Gbps 16QAM and 64QAM Operation

S. Li, Univ. of California, San Diego; Z. Zhang, Univ. of California, San Diego; B. Rupakula, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

Th2D-2: A Ka-Band 16-Element Deployable Active Phased Array Transmitter for Satellite Communication

D. You, Tokyo Tech; Y. Takahashi, Tokyo Tech; S. Takeda, Tokyo Tech; M. Moritani, Tokyo Tech; H. Hagiwara, Tokyo Tech; S. Koike, Tokyo Tech; H. Lee, Tokyo Tech; Y. Wang, Tokyo Tech; Z. Li, Tokyo Tech; J. Pang, Tokyo Tech; A. Shirane, Tokyo Tech; H. Sakamoto, Tokyo Tech; K. Okada, Tokyo Tech

Th2D-3: Development of a Compact 28-GHz Software-Defined Phased Array for a City-Scale Wireless Research Testbed

X. Gu, A. Paidimarri, B. Sadhu,C. Baks, S. Lukashov, M. Yeck, Y. Kwark, IBM T.J. Watson Research Center; T. Chen, G. Zussman, Columbia Univ.; I. Seskar, Rutgers Univ.; A. Valdes-Garcia, IBM T.J. Watson Research Center

Th2D-4: Vehicle Roof Embedded Millimeter-Wave Combo-Array System Architecture for Optimum V2X Coverage

J.R. Camacho Perez, Intel; S. Yamada, Intel; D. Choudhury, Intel

Th2D-5: Question and Answer

Th2E: LATE NEWS - Radar and Sensor Technologies

Chair: Changzhi Li, Texas Tech University

Co-Chair: Chia-Chan Chang, National Chung Cheng University

Th2E-1: Surface Cancellation in Wideband Ground Penetrating Radar Employing Genetic Algorithm AI for Waveform Synthesis

A. Tang, Jet Propulsion Lab; E. Decrossas, Jet Propulsion Lab; Y. Gim, Jet Propulsion Lab; R. Huang, Univ. of California, Los Angeles; R. Beauchamp, Jet Propulsion Lab; M.-C.F. Chang, Univ. of California, Los Angeles

Th2E-2: D-Band FMCW Radar Sensor for Industrial Wideband Applications with Fully-Differential MMIC-to-RWG Interface in SIW

S. Hansen, Fraunhofer FHR; C. Bredendiek, Fraunhofer FHR; G. Briese, Fraunhofer FHR; N. Pohl, Ruhr-Universität Bochum

Th2E-3: Towards Chipless RFID Technology Based on Micro-Doppler Effect for Long Range Applications

A. Azarfar, LCIS (EA 3747); N. Barbot, LCIS (EA 3747); E. Perret, LCIS (EA 3747)

Th2E-4: A Wireless MEMS Humidity Sensor Based on a Paper-Aluminium Bimorph Cantilever

F. Alimenti, Università di Perugia; V. Palazzi, Università di Perugia; G. Simoncini, Università di Perugia; R. Salvati, Università di Perugia; G. Cicioni, Università di Perugia; L. Roselli, Università di Perugia; P. Mezzanotte, Università di Perugia

Th2E-5: Question and Answer

Th2F: Integrated Transmit/ Receive Front-End Modules

Chair: Taiyun Chi, Rice University
Co-Chair: Samet Zihir, Renesas Electronics America

11:00

Th2F-1: Hermetically Sealed S-Band LTCC Based Transmit/Receive Module with Integrated Self-Calibration Circuitry for Space-Borne SAR

11:10

H. Tolani, ISRO; Ch.V.N. Rao, ISRO; S. Aich, ISRO; J. Dhar, ISRO; R. Jyoti, ISRO

11:20

Th2F-2: A CMOS 65nm 8–15GHz T/R with Multiple Compensation Techniques

J. Jing, Fudan Univ.; W. Li, Fudan Univ.; J. Hu, Fudan Univ.; J. Gong, Fudan Univ.; J. Ye, Fudan Univ.; C. Wang, Fudan Univ.; H. Xu, Fudan Univ.

11:30

11:40

Th2F-3: An X-Band High Power Tile-Type GaN TR Module for Low-Profile AESA

M. Kimura, Mitsubishi Electric; Y. Tarui, Mitsubishi Electric; H. Shibata, Mitsubishi Electric; E. Kuwata, Mitsubishi Electric; J. Kamioka, Mitsubishi Electric; T. Nagamine, Mitsubishi Electric; S. Abe, Mitsubishi Electric; K. Miyawaki, Mitsubishi Electric; T. Saito, Mitsubishi Electric; Y. Kamo, Mitsubishi Electric; K. Muroi, Mitsubishi Electric

11:50

12:00

Th2F-4: A 4-Channel V-Band Beamformer Featuring a Switchless PALNA for Scalable Phased Array Systems

A. Gadallah, IHP; A. Franzese, IHP; M.H. Eissa, IHP; K.E. Drenkhahn, Technische Universität Ilmenau; D. Kissinger, Universität Ulm; A. Malignaggi, IHP

12:10

12:20

Th2F-5: Question and Answer

12:30

12:40

TECHNICAL LECTURES

AUDITORIUM 5

12:00 – 13:30 | Thursday, 24 June 2021

	LECTURE TITLE	LECTURE ABSTRACT
THTL3	**mm-Wave "Wireless Fiber" to Meet the Capacity Demands of Future Networks** **Speaker:** Amin Arbabian, Stanford University	Here you go: Projections show the number of "Internet of Everything (IoE)" systems growing from the billions today to trillions by the next decade, largely fueled by the emergence of nodes that combine computation, communication, and sensing at the edge. This paradigm shift requires scalable backbone data pipelines to address the relentless growth in network traffic. To meet this challenge we need innovative approaches for the design of future systems both in the mobile link and for the backhaul. Mm-wave frequencies enable higher communication speeds due to the high spatial multiplexing degrees of freedom (DoF) as well as larger bandwidth available at mm-wave frequencies. Even in pure line-of-sight (LoS) environments, with reasonable array sizes, multi-stream parallelism can be attained leading to higher bounds for point-to-point mm-wave link capacity and achievable data rates. Towards this goal, this lecture covers spatial multiplexing over LoS multi-input multi-output (MIMO) systems as a vehicle to achieve Terabit-per-second wireless communication. The lecture will start by analyzing the challenges in silicon integration of scalable high-throughput mm-wave "Wireless Fiber" links. It will then cover tradeoffs in the partitioning of functionality between the transmitter and receiver, as well as between the analog and digital processing domains, and propose a scalable analog processing architecture for the receiver. An efficient transceiver architecture to address the main challenges for analog-based processing techniques enabling bandwidth-, range-, and size-scalable arrays for line-of-sight mm-wave communications is discussed. Finally, the experimental results for a 130 GHz wireless LoS MIMO transceiver, which uses fully packaged transmit and receive arrays and supports multiple independent broadband complex streams, is covered. Moving forward, this analog processing architecture provides a path to achieve robust data transmission at rates approaching 1 Tbps over distances that span tens of meters.

THIS YEAR'S SPC FINALISTS ARE:

Th1A-1: Investigation of the Impact of Zero-Forcing Precoding on the Variation of Massive MIMO Transmitters' Performance with Channel Conditions
Authors: M. Almoneer, P. Mitran, S. Boumaiza, *Univ. of Waterloo*

Th1A-5: A Tunable Multi-Mode Quadrature Balanced N-Path Diplexer with Nonlinear Cross-Modulation Distortion Correction
Authors: N. Ginzberg, E. Zolkov, Technion - Israel Institute of Technology; T. Gidoni, Tel-Aviv University; E. Cohen, Technion - Israel Institute of Technology

Th1B-1: A 258-GHz CMOS Transmitter with Phase-Shifting Architecture for Phased-Array Systems
Authors: T. Hagiwara, N. Yamaki, K. Sekine, H. Sakai, K. Sahara, K. Takano, Tokyo University of Science; S. Hara, NICT; S. Lee, Hiroshima Univ.; R. Dong, NICT; S. Tanoi, NICT; S. Kubo, S. Miura, THine Electronics; A. Kasamatsu, NICT; T. Yoshida, S. Amakawa, Hiroshima Univ.; K. Sakakibara, Nagoya Institute of Te

Th1C-1: Wideband Class Φ_2 Power Amplifier for HF Applications
Authors: Z. Tong, L. Gu, J.M. Rivas-Davila, Stanford Univ.

Th1D-3: A 0.1-4.0 GHz Inductor-less Direct-Sequence Spread-Spectrum Based Ground-Penetrating Radar System-on-Chip
Authors: R. Huang, Y. Zhang, Univ. of California, Los Angeles; E. Decrossas, A. Seshadri, Jet Propulsion Lab; C. Liang, M. Chang, Univ. of California, Los Angeles; A. Tang, Jet Propulsion Lab

Th1D-4: Broadband Sub-THz Chirp Linearization Using Particle Swarm Optimization for Precision Metrology Applications
Authors: S.M.H. Naghavi, M. Tavakoli Taba, B. Yektakhah, Univ. of Michigan; M. Aseeri, KACST; A. Cathelin, STMicroelectronics; E. Afshari, Univ. of Michigan

Th2C-1: 80-110 GHz Broadband Linear PA with 33% peak PAE and Comparison of Stacked Common-Base and Common-Emitter PA in InP
Authors: Z. Liu, Princeton Univ.; T. Sharma, Princeton Univ.; K. Sengupta, Princeton Univ.

Th3C-1: A 44-64 GHz Broadband Back-off Efficient Quadrature Hybrid based Linear Doherty PA with Quasi Non-Foster Tuner in 0.13μm SiGe
Authors: Z. Liu, Princeton Univ.; Y. Yu, Univ. of Electronic Science and Technology of China; K. Sengupta, Princeton Univ.

Th3D-2: A Dual-Polarized 1024-Element Ku-Band SATCOM Phased-Array with Embedded Transmit Filter and >10 dB/K G/T
Authors: G. Gültepe, Univ. of California, San Diego; S. Zihir, T. Kanar, Renesas Electronics; G.M. Rebeiz, Univ. of California, San Diego

Th3F-3: Characterization of Shot Noise Suppression in Nanometer MOSFETs
Authors: S. Das, J.C. Bardin, UMass Amherst

Th3F-4: A 1mW 0.1–3GHz Cryogenic SiGe LNA with an Average Noise Temperature of 4.6K
Authors: M. Hosseini, J.C. Bardin, UMass Amherst

Tu1C-5: Dual-Band, Dual-Mode, Microstrip Resonator Loaded, Compact Hybrid SIW Bandpass Filter
Authors: Y. Zheng, Y. Dong, UESTC

Tu1D-5: Ranging On-demand Microwave Power Transfer in Real-time
Authors: E. Fazzini, A. Costanzo, D. Masotti, Univ. of Bologna

Tu2A-2: Deep Learning Assisted End-to-End Synthesis of mm-Wave Passive Networks with 3D EM Structures: A Study on a Transformer-Based Matching Network
Authors: S. Er, E. Liu, M. Chen, Y. Li, Y. Liu, T. Zhao, H. Wang, Georgia Tech

Tu2C-3: A Tunable Quarter-wavelength Coaxial Filter With Constant Absolute Bandwidth Using a Single Tuning Element
Authors: G.B., R. Mansour, Univ. of Waterloo

Tu2D-1: High Accuracy RF-PUF for EM Security Through Physical Feature Assistance Using Public Wi-Fi Dataset
Authors: Md.F. Bari, B. Chatterjee, Purdue Univ.; K. Sivanesan, L.L. Yang, Intel; S. Sen, Purdue Univ.

Tu3A-2: Discontinuous Galerkin Time Domain Modeling of Metasurface Geometries with Multi-Rate Time Stepping
Authors: Q. Zhao, C.D. Sarris, Univ. of Toronto

Tu3A-4: Parallel Non-Monte Carlo Transient Noise Simulation
Authors: A. Goulet, McGill Univ.; M. Farhan, M. Kassis, Cadence Design Systems, Inc.; R. Khazaka, McGill Univ.

Tu3B-1: A Monolithic Vertical Integration Concept for Compact Coaxial-Resonator-Based Bandpass Filters Using Additive Manufacturing
Authors: K. Zhao, Univ. of Colorado; D. Psychogiou, University of Colorado at Boulder

Tu4A-1: Nonlinear Analysis of a High-Power Oscillator Inductively Coupled to an External Resonator
Authors: V. Ardila-Acuña, F. Ramirez, A. Suarez, Univ. of Cantabria

Tu4B-1: 3-D-Printed Dual-Mode Filter Using an Ellipsoidal Cavity With Asymmetric Responses
Authors: E. López-Oliver, C. Tomassoni, Univ. of Perugia

We1C-5: A Compact K-/Ka-Band Rectangular-to-Coplanar Waveguide Transition with Integrated Diplexer
Authors: K. Erkelenz, L. Bohl, A. Sieganschin, A. Jacob, Hamburg Univ. of Technology

We1E-2: 5.8GHz Low-Power Tunnel-Diode-Based Two-Way Repeater for Non-Line-of-Sight Interrogation of RFIDs and Wireless Sensor Network
Authors: A. Adeyeye, C. Lynch, A. Eid, Georgia Institute of Technology; J. Hester, Atheraxon; M. Tentzeris, Georgia Institute of Technology

We1G-1: Silicon Photonic Radar Transmitter IC for mm-Wave Large Aperture MIMO Radar Using Optical Clock Distribution
Authors: S. Kruse, S. Gudyriev, T. Schwabe, P. Kneuper, Univ. of Paderborn; H. Kurz, Volkswagen AG; J. Scheytt, Univ. of Paderborn

We2B-3: Additive Manufacturing of a Wide-Band Capable W-Band Packaging Strategy
Authors: M. Craton, P. Chahal, J. Albrecht, J. Papapolymerou, Michigan State Univ.

We2C-1: Half-Mode Slab Air-Filled Substrate Integrated Waveguide (SAFSIW)
Authors: N.-H. Nguyen, IMEP-LAHC (UMR 5130); A. Ghiotto, IMS (UMR 5218); A. Vilcot, IMEP-LAHC (UMR 5130); K. Wu, Polytechnique Montréal; T.P. Vuong, IMEP-LAHC (UMR 5130)

We2E-1: An Ultrasensitive 14-GHz 1.12-mW EPR Spectrometer in 28-nm CMOS
Authors: L. Zhang, A. Niknejad, Univ. of California, Berkeley

We3B-1: Calibration Technique for THz Time-Domain Spectrometers enabling Vectorial Scattering Parameter Measurements
Authors: M. Mueh, S. Brandl, P. Hinz, C. Waldschmidt, C. Damm, Ulm Univ.

We3C-1: Voltage-Tunable Thin Film Graphene-diode-based Microwave Harmonic Generator
Authors: M. Elsayed, A. Ghareeb, RWTH Aachen Univ.; P. Palacios, HFE RWTH-Aachen; B. Uzlu, Advanced Microelectronic Center Aachen (AMICA) AMO GmbH; E. Baskent, RWTH Aachen Univ.; Z. Wang, Advanced Microelectronic Center Aachen (AMICA) AMO GmbH; R. Negra, RWTH Aachen Univ.

We3D-1: Scalable Non-Volatile Chalcogenide Phase Change GeTe-Based Monolithically Integrated mmWave Crossbar Switch Matrix
Authors: T. Singh, R.R. Mansour, Univ. of Waterloo

We3E-4: Frequency-Domain Digital Predistortion for OFDM
Authors: A. Brihuega, L. Anttila, M. Valkama, Tampere Univ. of Technology

We3G-1: Instinctual Interference-Adaptive Low-Power Receiver with Combined Feedforward and Feedback Control
Authors: J. Yang, B. Chatterjee, Purdue Univ.; M. Thorsell, M. Kowalewski, B. Edward, SAAB Inc.; D. Peroulis, S. Sen, Purdue Univ.

We3G-2: A 4D Gesture Sensing Technique Based on Spatiotemporal Detection with a 60GHz FMCW MIMO Radar
Authors: Y. Li, C. Gu, J.-F. Mao, Shanghai Jiao Tong Univ.

Th3C: Wideband, Efficiency-Enhancement Integrated Power Amplifiers in Silicon Technologies

Chair: Steven Bowers, University of Virginia

Co-Chair: Nathalie Deltimple, University of Bordeaux

13:30 Th3C-1: A 44-64 GHz Broadband Back-off Efficient Quadrature Hybrid based Linear Doherty PA with Quasi Non-Foster Tuner in 0.13μm SiGe

Z. Liu, Princeton Univ.; Y. Yu, Univ. of Electronic Science and Technology of China; K. Sengupta, Princeton Univ.

13:50 Th3C-2: A 2–24GHz SiGe HBT Cascode Non-Uniform Distributed Power Amplifier Using A Compact, Wideband Two-Section Lumped Element Output Impedance Transformer

S. Lee, Georgia Tech; I. Ju, Georgia Tech; A. Moradinia, Georgia Tech; M.-K. Cho, Georgia Tech; E. Gebara, I2R Nanowave; H. Gu, Nanowave Technologies; C. Nicholls, Nanowave Technologies; J.D. Cressler, Georgia Tech

14:10 Th3C-3: Frequency Reconfigurable Dual-Band CMOS Power Amplifier for Millimeter-Wave 5G Communications

J. Lee, KAIST; J.-S. Paek, Samsung; S. Hong, KAIST

14:30 Th3C-4: A 60GHz Edge-Coupled 4-Way Balun Power Amplifier with 22.7dBm Output Power and 27.7% Peak Efficiency

H. Liu, SUTD; X. Zhu, UTS; Y. Wang, SUTD; K. Men, SUTD; K.S. Yeo, SUTD

14:50 Th3C-5: Question and Answer

Th3D: Phased Arrays and 5G/SATCOM Wireless Systems

Chair: David Ricketts, North Carolina State University

Co-Chair: Sudipto Chakraborty, IBM Research

13:30 Th3D-1: A 5G 25–29GHz 64-Element Phased-Array with 49–52dBm EIRP, Integrated Up/Down-Converter and On-Chip PLL

Q. Ma, H. Chung, Y. Yin, E. Wagner, B. Ustundag, K. Kibaroglu, M. Sayginer, G.M. Rebeiz, Univ. of California, San Diego

13:50 Th3D-2: A Dual-Polarized 1024-Element Ku-Band SATCOM Phased-Array with Embedded Transmit Filter and >10 dB/K G/T

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

14:10 Th3D-3: Sub-6GHz Multi-Band Multi-Carrier Remote Unit Based on RFSoC

S.S. Pereira, Universidade de Aveiro; L. Almeida, Universidade de Aveiro; A.S.R. Oliveira, Universidade de Aveiro; N.B. de Carvalho, Universidade de Aveiro; P.P. Monteiro, Universidade de Aveiro

14:30 Th3D-4: A 0.5GHz, 50+ MHops/s Frequency-Hopped Wireless Frontend with Multipath Resilience

S. Basak, Univ. of Minnesota; Y.B. Parthaje, Univ. of Minnesota; R. Harjani, Univ. of Minnesota

14:50 Th3D-5: Question and Answer

Th3F: Low Noise Devices and ICs

Chair: Pekka Kangaslahti, Jet Propulsion Laboratory

Co-Chair: Evan Jeffrey, Google, Inc.

13:30 Th3F-1: Low Power 75–110GHz SiGe Dicke Radiometer Front-End

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

13:50 Th3F-2: Compact V-Band MMIC Square-Law Power Detector with 70dB Dynamic Range Exploiting State-of-the-Art Graphene Diodes

M. Saeed, RWTH Aachen Univ.; A. Hamed, RWTH Aachen Univ.; B. Uzlu, AMO; E. Baskent, AMO; M. Otto, AMO; Z. Wang, AMO; R. Negra, RWTH Aachen Univ.

14:10 Th3F-3: Characterization of Shot Noise Suppression in Nanometer MOSFETs

S. Das, UMass Amherst; J.C. Bardin, UMass Amherst

14:30 Th3F-4: A 1mW 0.1–3GHz Cryogenic SiGe LNA with an Average Noise Temperature of 4.6K

M. Hosseini, UMass Amherst; J.C. Bardin, UMass Amherst

14:50 Th3F-5: Question and Answer

Th3E: LATE NEWS - Technologies for 5G Wireless

Chair: Telesphor Kamgaing, Intel Corporation

Co-Chair: Arvind Keerti, Qualcomm Technologies, Inc.

13:30 Th3E-1: Antenna-in-Package Integration for a Wide-Band Scalable 5G Millimeter-Wave Phased-Array Module

X. Gu, D. Liu, IBM Research; Y. Hasegawa, K. Masuko, Fujitsu Ltd.; C. Baks, IBM Research; Y. Suto, Y. Fujisaku, Fujikura Ltd.; B. Sadhu, A. Paidimarri, IBM T.J. Watson Research Center; N. Guan, Fujikura Ltd.; A. Valdes-Garcia, IBM T.J. Watson Research Center

13:50 Th3E-2: Experimental Study of the Effects of Antenna Crosstalk on the Linearity and Efficiency of 5G Sub-6GHz Wideband 2×2 Transmitter Arrays

H. Yu, Univ. of Waterloo; E. Traore, Univ. of Waterloo; M. Almoneer, Univ. of Waterloo; J.G. Lim, Univ. of Waterloo; J. Xia, Univ. of Waterloo; S. Boumaiza, Univ. of Waterloo

14:10 Th3E-3: A S-C- / K-Band Reconfigurable GaAs MMIC Power Amplifier for 5G Applications

A. Der, University of Colorado Boulder; W. Sear, University of Colorado Boulder; Z. Popovic, University of Colorado Boulder; G. Lasser, University of Colorado Boulder; T. Barton, University of Colorado Boulder

14:30 Th3E-4: Uniformly Distributed Near-Field Probing Array for Enhancing the Performance of 5G Millimetre-wave Beamforming Transmitters

Y. Cao, Univ. of Waterloo; A. Ben Ayed, Univ. of Waterloo; J. Xia, Univ. of Waterloo; S. Boumaiza, Univ. of Waterloo

Th3E-5: 18 to 37.5GHz Linear and Efficient 5G Power Amplifier with Adaptive Biasing Technique

M.M.R. Esmael, Analog Devices; M.A.Y. Abdalla, Analog Devices

14:50 Th3E-6: Highly Compact Array MIMO Module for EMI Immune 5G Wireless Communications

H. Cho, Univ. of Florida; W. Lee, Univ. of Florida; Y.-K. Yoon, Univ. of Florida

15:10 Th3E-7: Question and Answer

NVNA Users' Forum

09:00 – 10:30 | **Thursday, 24 June 2021** | **AUDITORIUM 4**

For those of you who are new to us, we are an informal discussion group devoted to sharing information and issues related to the measurements and instrumentation in the vector large-signal network analysis (NVNA/LSNA) of nonlinear microwave circuits and systems. The Forum is also a discussion venue for calibration issues, data representation methods (and models), and other techniques related to these nonlinear measurements.

On-Wafer Users' Forum

11:00 – 12:30 | **AUDITORIUM 4**

For those of you who are new to us, we are an informal discussion group devoted to sharing information and issues related to the on-wafer measurement and calibration practices. The Forum is also a platform to define workgroups and gather experts in the field to progress the field of on-wafer measurements and calibrations.

Forum principles:

Facilitate discussion with like-minded engineers
Open exchange of experience, ideas, discussion of problems
Informal atmosphere


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IOT

97th ARFTG Virtual Program | 09:00 – 12:30 | Friday, 25 June 2021 | AUDITORIUM 4

Session 1: 09:00-10:30 EDT Modeling and Simulation

09:00–09:40	Invited talk: Julius Kusuma, Facebook Connectivity Lab **Measurement-Based Modeling of Backhaul Communication Systems of Complex Terrain**	
09:40 – 10:30	**Q&A for Session 1 Papers**	
	On the Formalism of Heterodyne Mixer Phase Synchronization in Microwave Receivers	Loren Betts (Keysight)
	Basics Investigation of Electromagnetic Sensing for Wood Moisture contents	Masahiro Horibe (AIST)
	Simple Trapping Model for GaN HEMTs	John Wood, Zul Mokhti, and Yueying Liu (Wolfspeed)
	Investigation on Practical Problems in On-Wafer Measurement for Actual Devices	Ryo Sakamaki (National institute of Advanced Industrial Science and Technology) and Masahiro Horibe (AIST)
	A Comparison of Terahertz Permittivity Measurements of Several Dielectric Materials Using Frequency and Time Domain Methods	Christopher Green and Jeffrey Seligman

Session 2: 11:00-12:30 EDT Metrology

11:00–11:40	Invited talk: Dr. John Sevic, Embry–Riddle Aeronautical University **Multiphysics Phase-Field Method to Study Electroformation of Memristive Dielectric Thin Films**	
11:40 – 12:30	**Q&A for Session 2 Papers**	
	Updates to the Traceability of mm-Wave Power Measurements at NIST	Aaron Morgan Hagerstrom, Angela Stelson, Jeff Jargon, and Christian Long (NIST)
	Robust mTRL implementation for probing standards manufactured on PCBs	Michael E Gadringer (Graz University of Technology)
	On the Influence of Thru- and Line-Length-Related Effects in CPW-Based Multiline TRL Calibrations	Gia Ngoc Phung and Uwe Arz (PTB)
	Pre-Silicon Direct Calibration/De-embedding Evaluation and Device Parameters Uncertainty Estimation	Ciro Esposito (TU Dresden)
	Precision Offset Short Calibration Standards for 1.35 mm Coaxial Line Sizes	Masahiro Horibe (AIST)
	Broadband Characterization of Co-planar GSG Wirebonds for RF Heterogeneous 2.5D Integration	Ziad Hatab, Erich Leitgeb, and Michael E Gadringer (Graz University of Technology)

Session 3: 13:30-14:15 EDT Measurements

13:30 – 14:15	**Q&A for session 3 papers**	
	Linearity Characterization of the Self-Enhanced Class J PA Operating Mode through Modulated-Signal Load-Pull Measurements	Frederik Vanaverbeke, Michael B. Satinu (NXP Semiconductors), Michele Squillante (Anteverta-mw B.V.), and Kevin Kim (NXP Semiconductors)
	Automated Noise-Parameter Measurements of Cryogenic LNA	Alexander Sheldon (University of Calgary), Leo Belostotski, Hamdi Mani, Christopher Groppi (Arizona State University), and Karl Warnick (Brigham Young University)
	Combined Wideband Active Load-Pull and Modulation Distortion Characterization with a Vector Network Analyzer	Alberto Maria Angelotti, Gian Gibiino, Alberto Santarelli (University of Bologna), Troels Nielsen, and Jan Verspecht (Keysight Technologies)
	Issues of Multi-Notch NPR Characterization Procedures	Ricardo Figueiredo (University of Aveiro) and Nuno Borges Carvalho (Instituto de Telecomunicacoes)
	Characterization of the frequency dependent match for optimal performance of wideband power amplifiers	Sanket Chaudhary (University of Aveiro), Marina Jordao (Instituto de Telecomu-nicacoes, University of Aveiro), Nuno Borges Carvalho (Instituto de Telecomuni-cacoes), Marc Vanden Bossche (NI), and Adam Cooman (Ampleon)

Session 4: 14:30-15:15 EDT OTA

14:30–15:15	**Q&A for session 4 papers**	
	On Over-the-Air Far-Field Measurements Below Fraunhofer Distance	Jan Fromme, Jiaju Cai, Vincent Kotzsch, Gerardo Orozco, and Marc Vanden Bossche (NI)
	The Antenna Dome Real-Time Distributed Antenna Pattern Characterization System	Ferry A Musters, Marco Spirito, and Richard Coesoij (TU Delft)
	Novel EM-Field Measurement Method by Using a Lambda/2 Dipole LED Antenna as a Signal Strength Indicator	Daiki Ikeno, Yuji Koita, Masashi Nakatsugawa, Tamami Maruyama (National Institute of Technology, Hakodate College), and Yasuhiro Tamayama (Nagaoka University of Technology)
	Extended Range mmWave for Fixed Wireless Applications	Randall S. Fassbinder (US Cellular), Laetitia Falconetti (Ericsson), Sam Guirguis (Qualcomm), Elisiario Cunha Neto (Ericsson), Arturo Ortega (Qualcomm), Narothum Saxena (US Cellular), Michael Chard, Kausik Ray Chaudhuri (Qualcomm), Atanu Halder (US Cellular), Rahul D. Patel (Ericsson), and Michael Irizarry (US Cellular)
	Design and Realization of a Compact Size Active Antenna for UHF Satellite Communication	Abdellatif Bouyedda (XLIM), Bruno Barelaud (XLIM), and Laurent Gineste (EXOTIC-SYSTEMS)
	Calibration Method for an RF I-V Based HF RFID Impedance Measurement System	Benjamin J. B. Deutschmann, Michael E. Gadringer, Richard Fischbacher (Graz University of Technology), Lukas Görtschacher (NXP Semiconductors), Franz Amtmann (NXP Semiconductors), Erich Merlin (NXP Semiconductors), Ulrich Muehlmann (NXP Semiconductors), and Jasmin Grosinger (TU Graz)
	Dynamic Range Definitions and Measurement Applied To Radar Digital Receiver Exciter (DREX)	John O Mortensen (UCCS), Rick Sturdivant (MPT), and Mark Wickert (UCCS)

FRIDAY WORKSHOPS

10:00 – 16:00 | Friday, 25 June 2021

	WORKSHOP TITLE	WORKSHOP ABSTRACT
WSA	**Low Power Radios and Wireless Technologies for Indoor Positioning and Localization** **Sponsor:** RFIC Organizers: Arun Paidimarri, IBM; Gernot Huber, Silicon Austria Labs; Oren Eliezer, Ambiq; Yao-Hong Liu, IMEC	The Internet of things and low power wireless devices encompass many protocols and standards, each optimized for their specific set of applications, with the unifying themes being battery-operation, low average data rates, power-efficient processing, low cost/size and extensive integration with sensors, processors and power management. This workshop presents several talks on the architectures and circuits for existing standards and applications, and explores research that will inform the next generation of these technologies. Application spaces that are increasingly gaining traction are wearables and indoor localization and positioning, with prime examples being smart buildings, distance-bounded security, and, most recently, COVID tracking. This workshop will also cover several state-of-the-art technologies in wearable devices and in indoor localization in the context of low-power wireless communications.
WSD	**Coherent Optical Communications for Cloud Data Centers, Metro, and Submarine Networks** **Sponsor:** IMS; RFIC Organizers: Bahar Jalali Farahani, Acacia Communications; Ricardo Aroca, Acacia Communications	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 elements of optical communication systems have been subject of prior workshops at RFIC. This workshop, however, brings together a multidisciplinary team of expertise to inform audience of 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 perspectives. Emerging applications for coherent detection such as LiDAR will be discussed and utilizing emerging technologies of AI and machine learning in next generation of optical communication systems will be explored.
WSE	**Cryogenic Electronics for Quantum Computing and Beyond: Applications, Devices, and Circuits.** **Sponsor:** RFIC Organizers: Fabio Sebastiano, Delft University of Technology; Joseph Bardin, UMass Amherst	With rapid advances in the performance of qubit technology, quantum computing has attracted intense interest of the media and research community. Several opportunities have emerged for circuit designers, as the quantum devices require classical electronics for their control and read-out. In particular, cryogenic operation of the electronics is required to allow their proximity to quantum processors, which are typically cooled to cryogenic temperature in the range of 20 mK. However, applications of cryogenic electronics reach beyond quantum computing. These applications include both the realization of interfaces for devices such as quantum processors, which must be operated cryogenically, as well as the implementation of systems that outperform their room temperature counterparts (e.g., front-ends for radio telescopes). This workshop will present an overview of cryogenic electronics from applications down to device operation, with a specific emphasis on integrated circuits. The workshop consists of 8 talks from experts in the field, organized into three main themes: cryogenic applications, cryogenic devices, and cryogenic circuits. First, typical applications requiring operation at cryogenic temperatures will be presented to highlight requirements for electronic components, their current limitations, and future perspectives. The first talk will focus on quantum-computing applications, while the second targets the need of cryogenic detectors for particle physics. Next, the operation of semiconductor devices at cryogenic temperatures will be discussed, including industry-standard semiconductors, such as SiGe (third talk) and CMOS (fourth talk), to point out advantages and drawbacks in device operation, always with an eye to their use into practical circuits. 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 circuit-design techniques and architecture to exploit (or circumvent) cryogenic design operation to meet the system requirements.
WSF	**Fully Integrated Silicon vs. Hybrid RFFE Systems for mm-Wave 5G Highly Efficient PA Design Trade-offs** **Sponsor:** RFIC Organizers: Debopriyo Chowdhury, Broadcom; Donald Lie, Texas Tech University; Patrick Reynaert, KU Leuven	Low noise amplifiers (LNA), power amplifiers (PA), switches and phase shifters can all be integrated into one silicon RF-front-end (RFFE) IC for mmWave 5G, and even multichannel integration may be possible. However, the advantages in costs, robustness, and manufacturability for an all-silicon RFFE IC approach is not yet clear, when compared to a hybrid III-V /silicon solution for 5G. The power efficiency of mmWave 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. At the same time, hybrid integration approaches increase rapidly in cost as complexity increases, as will be covered in this workshop. Can newer technologies enable an all-silicon RF front end that can match the performance of hybrid solutions? As we go to mm-wave frequencies, achieving high efficiency and linearity simultaneously for the PA becomes extremely challenging, and novel RF linearization techniques are required to improve these 5G mmWave 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.

AUDITORIUM 1

FRIDAY WORKSHOPS

10:00 – 16:00 | Friday, 25 June 2021

WORKSHOP ABSTRACT	WORKSHOP TITLE	
Presently, power amplifiers do not fulfill all of the requirements of linearity, energy efficiency, and bandwidth that are required for 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 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.).	**Highly Linear and Linearized Power Amplifiers for mm-Wave Communications** **Sponsor:** RFIC Organizers: Jeffrey Walling, Skyworks; Margaret Szymanowski, Crane Aerospace and Electronics	**WSG**
5G networks target order-of-magnitude increase in data traffic to support growing demand in mobile networks. Massive multiple-input, multiple-output (MIMO) technology will increase capacity by delivering high data rates to multiple users, support real-time multimedia services and reduce energy consumption by targeting signals to individual users utilizing digital beamforming. Additionally, element-level digital beamforming that supports emerging multi-beam communications and directional sensing will expand the use of mm-wave 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 for both civilian 5G NR and defense applications. Talks will focus on development of digital beamformers as well as efficient implementation and packaging of MIMO arrays at RF and mm-wave.	**MIMO and Digital Beamforming Systems for 5G and Beyond** **Sponsor:** IMS; RFIC Organizers: Arun Natarajan, Oregon State University; Kamran Entesari, Texas A&M University	**WSH**
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 cover the following topics on mm-wave phased arrays: (1) silicon-based mm-wave phased-array basics, (2) phase and gain control circuits, (3) phased-array antenna and antenna interface design, (4) package, antenna and module co-design and calibration for the end-to-end design, (5) phased-array measurements: on-chip and over-the-air, and (6) current 5G NR phased-array systems, limitations, and an outlook toward 6G.	**mm-Wave Phased-Array Transceiver Design: From Basics to Advancements** **Sponsor:** RFIC Organizers: Bodhisatwa Sadhu, IBM T. J. Watson Research Center; Kenichi Okada, Tokyo Institute of Technology	**WSI**
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, fast hopping, and long term stability across a wide operation frequency range. The first talk address LO frequency synthesis and 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 discusses the design challenge and techniques for broadband fast Hopping DDFS. And the last talk introduces a new low cost reference clock generation method, molecular clock, for wireless network synchronization and navigation.	**Recent Advances in Frequency Generation Techniques for Sub-6GHz, mm-Wave, and Beyond** **Sponsor:** RFIC Organizers: Ruonan Han, Massachusetts Institute of Technology; Wanghua Wu, Samsung Semiconductor	**WSJ**
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 the 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 Organizers: Antoine Frappé, University of Lille; Jennifer Kitchen, Arizona State University; Raja Pullela, MaxLinear	**WSL**

FRIDAY WORKSHOPS

10:00 – 16:00 | Friday, 25 June 2021

	WORKSHOP TITLE	WORKSHOP ABSTRACT
WSK	**Satellite Systems: A Top-Down Review of Satellites, Space Communication and Hardware** **Sponsor:** RFIC Organizers: Steven Turner, BAE Systems; Tim LaRocca, Northrop Grumman	Want to understand the "Go" in GoGo Wireless In-flight Satellite Internet? Interested in learning about satellite orbits, link budgets, 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.
WSB	**100-300GHz mm-Wave Wireless for 0.1-1Tb/s Networks** **Sponsor:** RFIC Organizers: Jane Gu, UC Davis; Mark Rodwell, UCSB	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.
WSC	**CMOS mm-Wave Imaging Radars: State-of-the-Art and a Peek into the Future!** **Sponsor:** RFIC Organizers: Vadim Issakov, Otto-von-Guericke University Magdeburg; Venkatesh Srinivasan, Texas Instruments	Advances in mm-wave CMOS technology has 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, sophisticated 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.
WFB	**Cutting-Edge THz Solid-State Technologies, from Devices to Earth/ Space Applications: Surfing on Noise, Signal and Power Generation.** **Sponsor:** IMS Organizers: François Danneville, University of Lille, CNRS; Guillaume Ducournau, University of Lille, CNRS;	With the amazing growth of THz technologies, solid-state approach has been pushed forward to contribute of the THz gap filling. The WS aims to provide a deep overview of the recent features of mmW/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, performances) (iii) noise performance of single devices/circuit. Targeting the complete characterization of such advanced technologies, the WS 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. Especially, power measurements, linearity as well as common/new noise measurement techniques will be covered to accurately extract the noise performance up to mmW and THz range. State-of-the-art performance for a broad range of cutting-edge mmW/THz (0.1-1 THz) technologies such as Si (CMOS/ BiCMOS) and III-V (GaAs, InP, GaN) will be presented throughout the full day WS. In detail, the noise properties and amplification process of InP HEMT at THz Frequencies will be discussed. Theoretical considerations about how to optimize a technology for low-noise performance and LNA examples in the mmW and sub-mmW frequency range will be given, as well as PA and TRX applications in the higher mmW frequency range. Signal generation (power, efficiency, phase noise) will be covered using several technologies: III-V, CMOS THz oscillators, as an enabler the development of systems in the 0.1 to 1THz frequency range with system waveguide blocks or single-chip THz products for communication, imaging, 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 (110-170 GHz) as well as in the H-band (around 300 GHz). With the mm-wave and sub-mm-wave technologies, these systems can now target 100 Gbps, 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.

FRIDAY WORKSHOPS

10:00 – 16:00 | Friday, 25 June 2021

WORKSHOP ABSTRACT	WORKSHOP TITLE	
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 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, 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 include reconfigurable millimeter 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 Organizers: Nathan Orloff, National Institute of Standards and Technology; T. Mitch Wallis, National Institute of Standards and Technology	WFD
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 Novel Microwave Functionality** **Sponsor:** IMS Organizers: Chris Nordquist, Sandia National Laboratories; Dimitra Psychogiou, University of Colorado Boulder	WFE
Spatiotemporal metastructures represent an emerging class of dynamic and multifunctional microwave systems. These systems present unique, efficient, and multifunctional operations that are not available in conventional microwave components and traditional static metamaterials. Such operations are endowed by peculiar properties of the space-time modulation technique which leads to structures featuring nonreciprocal shifts in their temporal frequencies, spatial frequencies, and phase. The space-time modulation technique is a promising paradigm for nonreciprocity and frequency generation in several microwave applications such as magnet-free isolators and circulators, pure frequency mixers, nonreciprocal phase shifters, unidirectional beam splitters, compact transceiver front-ends, versatile multifunctional diffraction gratings, travelling-wave parametric amplifiers, full-duplex beam-steering devices and multifunctional metasurfaces.	**Spatiotemporal Metastructures for Microwave Applications** **Sponsor:** IMS Organizers: George Eleftheriades, University of Toronto; Sajjad Taravati, University of Toronto	WMH

FRIDAY WORKSHOPS

10:00 – 16:00 | Friday, 25 June 2021

	WORKSHOP TITLE	WORKSHOP ABSTRACT
WFI	**State-of-the-Art Characterization and Test Techniques from Design to Production of Antenna in Package/Module and on Chip** **Sponsor:** ARFTG; IMS Organizers: Marc Vanden Bossche, NI	Following industry trends, phased array antennas and beamforming techniques have had a prominent place in IMS talks in recent years. These antennas have been around for decades, but surfaced as solutions for essential industrial applications while carrier frequencies increase and applications range from telecom to radar. Presently, the most current form factors for extremely compact phased arrays are the antenna in module and in package (AiM and AiP). Meanwhile, the antenna on chip (AoC) has been demonstrated and explored and will become reality going towards and into the THz frequency range. To become commercially viable, it is essential that these parts can be tested fast in large quantity at a low cost with confidence. There are different approaches to achieve this. A possibility is to spend more effort on extensive pre-characterization during the design to reduce test during production. Or maybe built-in testing is the way to go. On the other hand, adapted near field characterization techniques can replace the anechoic chamber and meet the requirements of the production test. Finally, reverberation chamber techniques could offer a solution for some test requirements. The goal of this workshop is to give an overview of different over the air characterization techniques from design to production test. Hereby two categories of production test are distinguished: go / no-go test and parametric tests such as EVM measurements. In addition, the differences between the characterization and test of base station panels and that of user equipment needs to be taken into account. This workshop will go over the different existing and new OTA characterization techniques that can be used from design to production test. Additionally, some presentations will explain which characteristics of phased array antennas need to be measured and how they can be tested, characterized and calibrated using some clever techniques to speed up the test process.
WMI	**Wireless Power Transmission – Myths and Reality** **Sponsor:** IMS Organizers: Nuno Carvalho, Universidade de Aveiro; Zoya Popovic, University of Colorado, Boulder	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 millimeter 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.
WFA	**Advanced Micro-Scale Fabrication and Integration Techniques for Emerging Millimeter- and Submillimeter-wave applications** **Sponsor:** IMS Organizers: Choonsup Lee, NASA Jet Propulsion Laboratory (JPL); Esteban Menargues, SwissTo12; Gerd Hechtfischer, Rohde&Schwarz; Jeffrey Hesler, Virginia Diodes, Inc.; Joachim Oberhammer, KTH Royal Institute of Technology; Ke Wu, Politechnique Montreal; Petronilo Martín-Iglesias, European Space Agency; Yi Wang, University of Birmingham, UK	Micromachining, high-precision CNC-milling, 3D printing, substrate-integrated waveguides: which fabrication and system integration technology will dominate in the future for waveguide-based millimeter and submillimeter-wave systems? What are their advantages and limitations? Which method is suitable for which frequency range and for which applications? Which technology is preferred for prototyping, for low volumes, which one is scalable to high volume production for emerging THz applications? What is left of the initial hype of micromachining and 3D-printing? How much has high-precision CNC-milling progressed in recent years? This workshop, whose speakers are leading in the development and the application of these fabrication methods in industry and academia, aims at providing a fair comparison between these major technologies, shows current trends and development towards the future, and investigates the advantages and limitations in view of different frequency bands from millimeter-wave to THz frequencies, for different applications from telecommunication to space, and for low-volume prototyping up to 24/7 volume production of advanced microwave systems. Performance and commercial aspects and limitations of state-of-the-art high-precision CNC milling in low and medium volume production will be presented by the companies Virginia Diodes and Rohde & Schwarz. Different micromachining techniques, including silicon-micromachined hollow and dielectric waveguides, polymer-micromachining, and laser-machining, will be presented in talks by the NASA-Jet Propulsion Laboratory, KTH Royal Institute of Technology, and Birmingham University. State of the art in commercial 3D printing for microwave applications will be presented by one of the earliest and market-leading companies (SwissTo12). Substrate-integrated waveguide technology will be presented by one of the strongest innovation driver in this field (Polytechnique Montreal). Since space applications are often driving new technology development, a talk by the European Space Agency summarizing manufacturing requirements and ESA's experience with new fabrication methods complements the technology discussions. After a day of intense information exchange, the workshop will conclude with an interactive panel discussion, trying to find answers to the questions above.

IMS2021 EXHIBITORS

IMS2021 VIRTUAL EXHIBITOR LIST AS OF 25 MAY 2021 | *For the most up-to-date information, please visit: ims-ieee.org*

6218 | COMPONENTS/SEMICONDUCTORS

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6220 | COMPONENTS/SEMICONDUCTORS

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6449 | COMPONENTS/SEMICONDUCTORS

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6221 | TEST & MEASUREMENT/SOFTWARE

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Xpeedic Technology Inc.
Yokowo Co. Ltd.

6222 | PCB / INTERCONNECT

ACE-Accurate Circuit Engineering
Advanced Circuitry International
American Standard Circuits Inc.
Benchmark
Cinch Connectivity Solutions
Colorado Engineering Inc.
Corning Inc.
Doosan Corporation
Electro-Materials
Flexco Microwave Inc.
Fujian MIcable Electronic Technology Group Co. Ltd.
Hermetic Solutions Group
Hirose Electric USA
Huang Liang Technologies Co. Ltd
Intelliconnect USA, LLC
MST
Response Microwave Inc.
Rogers Corp.
Samtec Inc.
Sensorview Co. Ltd.
Shenzhen Superlink Technology Co. Ltd
Southwest Microwave Inc.
Transline Technology Inc.
T-Tech
Ventec International Group
W. L. Gore & Associates Inc.
Waka Manufacturing Co.Ltd.

6223 | SYSTEMS / SERVICES

Artech House
Colorado Microcircuits Inc.
dB Control
Endeavor Media
EuMA
European Microwave Week 2021
Everything RF
Exodus Advanced Communications
Filtronic Broadband Limited
Fortify
Hesse Mechatronics
High Frequency Electronics
IEEE Microwave Magazine
IMS2022
In-Compliance
Ironwood Electronics
Kyocera International Inc.
Mercury Systems
Microwave Journal/Signal Integrity Journal
Microwave Product Digest
Microwaves & RF
Ophir RF Inc.
Quarterwave Corp.
Quik-Pak
RF GlobalNet
TMD Technologies Ltd.
Varioprint AG


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