Workshop on High-Frequency Devices and Semiconductor Technology

15 December 2022 (Thursday)

Onsite-Online Event, Hong Kong and Macau

Venue: Room 15-202, 15/F, Lau Ming Wai Academic Building, City University of Hong Kong (CityU)
Onsite (with limited seats) is for the participants in CityU
Online (Zoom) is for the participants outside CityU

Schedule

Time	Presentation title	Speaker
15:00 – 15:30	Functional-Material Integrated High-Frequency Devices for Millimeter-wave and Terahertz Applications	Dr. Hang Wong
15:30 – 16:00	Power-Efficient Low-Phase-Noise MM-Wave VCO and Frequency Generator	Dr. Jun Yin
16:00 – 16:30	Silicon-Based Wideband-Harmonic-Shaping VCO	Dr. Yong Chen
16:30 – 17:00	The Development of High-Power CMOS Terahertz Source for Imaging Application	Dr. Liang Gao

Registration: https://events.vtools.ieee.org/event/register/336974

Functional-Material Integrated High-Frequency Devices for Millimeter-wave and Terahertz Applications

Dr. Hang Wong

Associate Professor, Department of Electrical Engineering

Deputy Director, State Key Laboratory of Terahertz and Millimeter Waves

City University of Hong Kong, Hong Kong, China

Abstract

Technology market forecasts high-frequency products will boost up rapidly in the coming decades not only the popular microwave electronics but also that of unreleased millimeter-wave and terahertz inventions. Scientists put hard efforts to demonstrate both feasibility and capability of the new allocated frequency spectrum by ITU from 110 to 450 GHz that can be commercialization through the introduction of emerging applications of wireless systems such as 6G communications, terahertz imaging, millimeter-wave detection and sensing, low-orbit space communications, intelligent ultra-fast wireless, green energy network, etc. In this talk, the speaker is going to introduce recent high-frequency electronic developments by other world-leading antenna research groups and share state-of-the-art antenna technologies invented at the State Key Laboratory of Terahertz and Millimeter Waves, City University of Hong Kong. Breaking through the bottleneck of PIN diode at high-frequency devices, the speaker will demonstrate some examples of using functional materials to design millimeter-wave and terahertz reconfigurable, tunable, and switchable devices including antennas, metasurfaces, polarizers, modulators, and filters.

Biography

Hang Wong received a Ph.D. degree from City University of Hong Kong in 2006. He was an acting assistant professor in the Department of Electrical Engineering, Stanford University, in 2011. He joined the Department of Electrical Engineering in 2012 and is currently an Associate Professor and the Deputy Director of the State Key Laboratory of Terahertz and Millimeter Waves. He had several visiting professorships at University of Waterloo; Canada, University of College London, UK; and University of Limoges, France in 2013, 2014, and 2015 respectively. His research interests include designs of wideband antennas, reconfigurable antennas, millimeter-wave antennas, terahertz antennas, functional-material antennas and related applications. He has published over 250 papers, 22 patents, and 2 book chapters, with Google citations of 6400+ and an H-index of 46. He is the chair of the IEEE Antennas and Propagation /Microwave Theory and Techniques (MTT) Chapter of Hong Kong, the IEEE APS Region-10 Representative, and the associate editor of IEEE Transactions on Antennas and Propagation. Dr. Wong was the general co-chair of 2020 Asia Pacific Microwave Conference; and the general chair of 2021 Cross Strait Radio Science and Wireless Technology Conference. Dr. Wong's contribution has been highly recognized by numerous technical awards and best paper awards at the international conferences at the countries of USA, UK, France, Korea, Japan, and China. He pioneered an L-probe dual-polarization antenna technology in 2004, invented a magneto-electric antenna in 2006, and developed the first generation of Beidu's handheld antenna in 2008. Parts of his antenna inventions were adopted by industry leaders to Beidu nagaviation system, Zigbee wireless sensing network, and 5G MIMO base-station antennas. He was awarded the top 2% most-cited scientist by Stanford University in 2021 and 2022.

Power-Efficient Low-Phase-Noise MM-Wave VCO and Frequency Generator

Dr. Jun Yin
Associate Professor
State Key Laboratory of Analog and Mixed-Signal VLSI
University of Macau, Macao, China

Abstract

The emerging wireless communication and radar systems at millimeter-wave (mm-Wave) frequencies de-mand a power-efficient wideband local oscillator (LO) with low phase noise. As the frequency increases, the quality factors of the on-chip varactor and switched capacitor sharply drop, resulting in a severe tradeoff among phase-noise, frequency tuning range (FTR), and power consumption for fundamental mm-Wave oscillators.

This talk will start with the various mode-switching techniques that increase the oscillator's FTR without impairing its phase noise performance. With the proposed inductive mode-switching technique, the 42.9-to-50.6 GHz VCO prototype demonstrates a phase noise of −103.6 dBc/Hz @ 1MHz offset at 46GHz with a power consumption of 21mW. This talk will also introduce the harmonic extraction techniques that provide another direction for the mm-Wave frequency generation. By extracting the third-harmonic tone, the fundamental oscillator can operate at a much lower frequency, relieving the phase noise, power, and FTR tradeoffs. With the proposed current-mode implicit frequency tripling technique, the 54.9-to-63.5GHz LO generator demonstrates a phase noise of −100.7 dBc/Hz @ 1MHz offset at 60GHz with a power consumption of 9mW.

Biography

Jun Yin received the B.Sc. and the M.Sc. degrees in Microelectronics from Peking University in 2004 and 2007, respectively, and the Ph.D. degree in Electronic and Computer Engineering (ECE) from Hong Kong University of Science and Technology in 2013. He is currently with the State-Key Laboratory of Analog and Mixed-Signal VLSI at the University of Macau as an Associate Professor. Dr. Yin is serving as an As-sociate Editor for IEEE Transactions on Circuit and Systems I (TCAS-I) and a TPC member for Interna-tional Solid-State Circuits Conference (ISSCC), Asian Solid-State Circuit Conference (A-SSCC), and Eu-ropean Solid-State Circuit Conference (ESSCIRC). His research interests include RF-to-mm-Wave frequen-cy generation circuits and low-power CMOS wireless transceivers for IoT applications.

Silicon-Based Wideband-Harmonic-Shaping VCO

Dr. Yong Chen
Associate Professor
State Key Laboratory of Analog and Mixed-Signal VLSI
University of Macau, Macao, China

Abstract

This talk will introduce the state-of-the-art radio frequency (RF) voltage-controlled oscillator (VCO), and then discuss a silicon-based wideband-harmonic-shaping RF VCO. I will detail its full realization and illustrate how to effectively combine the high-order harmonics without the need of manual harmonic tuning to achieve a better figure of merit and lower flicker phase-noise corner over a wide frequency range. Finally, the state-of-the-art of RF VCO is summarized and its tendency will be discussed as well.

Biography

Yong Chen (S'10-M'11-SM'20) received the B.Eng. degree in electronic and information engineering, Communication University of China (CUC), Beijing, China, in 2005, and the Ph.D. in Engineering degree in microelectronics and solid-state electronics, Institute of Microelectronics of Chinese Academy of Sciences (IMECAS), Beijing, China, in 2010. From 2010 to 2013, he worked as Post-Doctoral Researcher in Institute of Microelectronics, Tsinghua University, Beijing, China. From 2013 to 2016, he was Research Fellow in VIRTUS/EEE, Nanyang Technological University, Singapore. He is now an Assistant Professor of the State Key Laboratory of Analog and Mixed-Signal VLSI (AMSV) of University of Macau, Macao, China, since March 2016. His research interests include integrated circuit designs involving analog/mixed-signal/RF/mm-wave/sub-THz/wireline.

Dr. Chen serves as an Associate Editor of IEEE Transaction on Very Large Scale Integration (TVLSI) Systems since 2019, an Associate Editor of IEEE Access since 2019, an Associate Editor of IET Electronics Letters (EL) since 2020, an Editor of International Journal of Circuit Theory and Applications (IJCTA) since 2020 and a Guest Editor of IEEE Transactions on Circuits and Systems II: Express Briefs in 2021. He serves as a Vice-Chair ('19-'21) and Chair ('21-'23) of IEEE Macau CAS Chapter, a Tutorial Chair of ICCS ('20), a conference local organization committee of A-SSCC ('19), a member of IEEE Circuits and Systems Society, Circuits and Systems for Communications (CASCOM) Technical Committee ('20-'21), a member of Technical Program Committee (TPC) of A-SSCC ('21), APCCAS ('19-'20), ICTA ('20-'21), NorCAS ('20-'21) and ICSICT ('20), a Review Committee Member of ISCAS ('21), and a TPC Co-Chair of ICCS ('21).

Dr. Chen was the recipient of the "Haixi" (three places across the Straits) postgraduate integrated circuit design competition (Second Prize) in 2009, the co-recipient of the Best Paper Award at the IEEE Asia Pacific Conference on Circuits and Systems (APCCAS) in 2019 and the co-recipient of the Macao Science and Technology Invention Award (First Prize) in 2020. His team reported 3 chip inventions at the IEEE International Solid-State Circuits Conference – ISSCC (Chip Olympics): mm-wave PLL ('19) and VCO ('19), and radio-frequency VCO ('21).

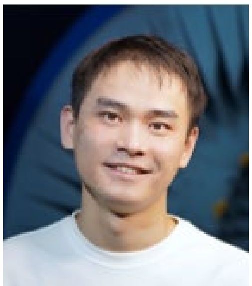
The Development of High-Power CMOS Terahertz Source for Imaging Application

Dr. Liang Gao
Postdoc
State Key Laboratory of Terahertz and Millimeter Waves
City University of Hong Kong, Hong Kong, China

Abstract

The terahertz source is one of the critical components in the active terahertz imaging system for illumination. Compared to conventional III-V sources, the emerging CMOS-based source has many advantages like low cost, small form factor, and high yield. Moreover, the high integration level of the CMOS process and the on-chip antenna integration capability at terahertz frequency make a fully integrated system possible, enabling the massive deployment of terahertz applications in daily life. Previous CMOS sources have successfully output the mW-level output power at the low end of the terahertz band (~0.3THz). It has been verified that the CMOS transistor can detect higher frequencies up to 1THz. However, it is much more challenging to generate high output power at the middle terahertz band (0.4 THz - 0.7 THz) as it is far beyond the fmax of the CMOS transistor. The output power and efficiency of the reported CMOS sources are extremely small and not suitable for a practical imaging application. In order to build up the fully CMOS-based terahertz imaging system at the middle terahertz band for higher imaging resolution, we tried to push the limit of CMOS for the high-efficiency, high-power source up to 700 GHz. To this end, we increased the fundamental oscillation frequency and proposed systematic design methodologies to synthesize the oscillator with optimized harmonic power generation efficiency for the active part. We also proposed several high-efficiency and compact on-chip antenna structures and design procedures to remove the expensive silicon lens for the passive part. We further proposed several coupled oscillator topologies for the system part to improve the area efficiency, output frequency, and array scale. In the workshop, I will explain the details of our efforts in developing and improving the performance of the CMOS terahertz source and report our up-to-date design with a nearly 10-mW output source at 675 GHz.

Biography



Liang Gao is now a postdoc. with the State Key Laboratory of Terahertz and Millimeter Waves, City University of Hong Kong, Hong Kong. He received the B.Eng. degree in electronic information science and technology from Sun Yat-sen University, Guangzhou, China, in June 2018 and the Ph.D. degree in electrical engineering from City University of Hong Kong, Hong Kong, in July 2022. His current research interests include integrated circuit and on-chip antenna design at millimeter-wave and terahertz frequencies, with a particular focus on improving the performance of silicon-based terahertz sources.

*** ALL ARE WELCOME ***

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