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Embedded Amplification: The Key to Implementing High-Frequency mm-Wave and Terahertz Transceivers

Millimeter-wave and terahertz frequencies are poised to drive next-generation communication systems, radar imaging, and sensing applications, with signal amplification serving as a critical element in the transceivers used for these platforms.

However, as the operation frequency of the front-end of a transceiver increases approaching tera Hertz frequencies, i.e. 300 GHz to 3THz, in applications such as high-resolution imaging and beyond 6G communication networks, signal and power amplification become increasingly challenging, often emerging as the primary bottleneck in implementing such systems.
This talk presents embedded amplification as a key solution to address the low available gain from transistors at such high frequencies. Examples of state-of-the-art advancements in this area, demonstrating how embedded amplification has contributed to improving the operational frequency of amplifiers, will be surveyed.

Hadi Bameri received his Ph.D. in Electrical and Computer Engineering from the University of California, Davis, where his research was focused on the design and implementation of sub-terahertz power amplifiers and signal amplifiers. In 2021, he joined Samsung Semiconductor Inc. in San Jose, CA, where he works on developing 5G transceivers, automotive radars, and ultra-low-power transceivers for the next generation of wearable smart gadgets. Dr. Bameri has authored several papers on RF and millimeter-wave topics. He was awarded the Nonresident Supplemental Tuition (NRST) Fellowship from the University of California, Davis in 2015 and 2016. Dr. Bameri has also served as a reviewer for several journals, including the IEEE Journal of Solid-State Circuits (JSSC) and IEEE Transactions on Microwave Theory and Techniques (TMTT).

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Challenges and Solutions for Antenna-on-Package Technology: Today and Beyond

Antenna-on-package (AoP) has become a prominent solution and is receiving widespread commercial acceptance for communication and radar applications in millimeter-wave (mmWave) frequencies. Designing these antennas on package poses a series of challenges and requires innovative solutions. In commercial applications such as radar, cost and manufacturing constraints limit the size and use of certain packages. These challenges become stringent at sub-THz frequencies, putting further bounds on the design and on the characterization of the antenna and package in the absence of the silicon die with the active circuitry. With the increased demand for AoP, independent characterization of package structures has become a necessity due to differences in fabrication methodologies and timelines of silicon-based ICs and the package.

This tutorial sheds light on some of these challenges and solutions for AoP at mmWave frequencies for automotive and industrial radar applications that are available today. It also discusses the challenges for independent package characterization and provides solutions for problems such as material characterization, probe proximity, and antenna radiation pattern estimation in real scenarios.

Aditya Jogalekar received his B.Tech degree in Electrical Engineering in India in 2017, and his MSEE and PhD degrees in Electrical Engineering from The University of Texas at Dallas in 2020 and 2023, respectively. He is currently a design engineer in TI's Radar ADAR Business Unit and has been involved in developing next-generation antenna-on-package (AoP) and launch-on-package (LoP) radar devices utilizing advanced packaging technology.

Dr. Jogalekar has authored seven papers and four US patents in the RF and mmWave area. He has served as a reviewer for several journals, including the IEEE Transactions on Component, Packaging, and Manufacturing Technology (TCPMT) and the IEEE Transactions on Antennas and Propagation (TAPS).

His research interests include mmWave interconnects, antenna, waveguide, and their integration in package, and design of active front-ends.