PA Design for Linearity

PAWR Workshop, Sunday Jan 18th 2026, 13:30

Organizers:
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Modern communication systems demand energy-efficient power amplifiers (PAs) capable of delivering sufficient output power to fulfil link budget requirements. While digital predistortion (DPD) is widely adopted in current systems, a certain level of inherent PA linearity is required to ensure effective linearization through DPD. Additionally, with the evolution toward massive MIMO and higher-frequency operation, the number of antenna elements, and thus PAs, increases significantly. This makes individual DPD implementation per array element increasingly impractical, creating a strong need for intrinsically more linear PAs.

Although most PA designers, even at an early stage, are familiar with optimizing for output power and efficiency, achieving and evaluating linearity remains more challenging. Not only does it require a different design mindset and simulation strategy beyond traditional load-pull techniques, but the very definition of linearity is non-trivial. Multiple figures of merit — such as IMD, ACPR, EVM, and NPR — exist to quantify linearity, each emphasizing different aspects of performance depending on the application. This diversity of metrics further complicates the design process and calls for a deeper understanding of which linearity characteristics matter most in a given system context.

This workshop aims to provide to PA designers of all experience levels with both theoretical background and practical tools for addressing linearity. It will first cover relevant theoretical considerations and circuit-level techniques, followed by a practical demonstration from a leading microwave design software vendor on how to assess PA linearity through simulation.

Understanding Nonlinear Distortion Impairments in RF Power Amplifiers

Speaker: Jose Carlos Pedro, Full Professor, University of Aveiro

Up to turn of the 21st century, nonlinear distortion of RF power amplifiers, RFPAs, was a major field of study and innovation. In those days, engineers knew they had no alternative than to design highly linear RFPAs, simply because they could not rely on bulky, costly, narrowband and underperforming analog pre-distorters, APDs. Then, the simple and inexpensive digital pre-distorter, DPD, was invented, and the research on

this field has largely stopped. Nowadays, it appears we are seeing the epilogue of DPD and so a resurrected interest on the RFPA design for linearity. So, this talk will first review the most important techniques we have available for linear RFPA design, understanding the small- and large-signal nonlinear distortion generation mechanisms, to then extend these theoretical two-tone based modeling tools to more complex signals and, finally, to their possible correction via APD

Bias and Bias Line Effects on Wideband RF Power Amplifier Performance

Speaker: Taylor Barton, Associate Professor & Lockheed Martin Faculty Fellow, University of Colorado, Boulder

Bias network design in power amplifiers is often overlooked as a cause of nonlinear and memory effects, especially for wide instantaneous signal bandwidths. This talk will focus on practical details of these bias line effects, and discuss some passive and active solutions for improving linearity. Measured results from sub-6 GHz hybrid power amplifiers will be presented to demonstrate how these nominally dc networks modify the overall RF performance.

GaN-on-SiC Technology for 5G and 6G

Speaker: Romain Mathieu, RF Integrated Circuits Design Engineer, United Monolithic Semiconductors (UMS)

As networks move from 5G to 5G Advanced and toward 6G, ever tighter linearity requirements under wideband, high-PAPR waveforms are redefining microwave front-end design. Our presentation will highlight why GaN-on-SiC is the preferred technology to address requirements for FR2 and emerging FR3 bands, using the United Monolithic Semiconductor (UMS) technologies portfolio to showcase practical design approaches that maintain linearity and efficiency with concise UMS case studies to guide next-generation telecom.

Doherty Amplifiers: Perfectly Linear… Until You Turn Them On

Speaker: Vittorio Camarchia, Associate Professor of Electronics, Politecnico di Torino

The Doherty architecture promises high efficiency at power back-off, yet practical implementations introduce nonlinearity through load modulation, phase/impedance imbalance, and device/bias memory effects. This talk highlights where distortion really

comes from in modern GaN Doherty PAs: AM/PM, gain expansion/compression, and shows how these mechanisms evolve with frequency. We will discuss pragmatic mitigation strategies, including phase/impedance compensation, driver co-design, output combiner networks designs to mitigate phase distortion, tailored to adapt to load modulation architectures. Measured results from sub-6-GHz and Ka-band prototypes illustrate linearity–efficiency trade-offs using EVM/ACPR and NPR metrics and demonstrate how targeted fixes can recover linearity without surrendering Doherty's efficiency advantage.

Practical Demonstration: Easy Linearity evaluation in Keysight ADS using the envelope simulator

Speaker: Nabil Khalid, Keysight EDA

In this demo, we will walk attendees through setting up an envelope simulation for a simple single-stage PA in Keysight ADS. We will demonstrate the required steps in the software to create linearity metrics such as ACPR, AM/AM and AM/PM using a modulated signal provided by the workshop organizers, and also how to create behavioral models of these amplifiers for sharing with other circuit designers and system designers.