Challenge

Power amplifiers (PA) are the most power-hungry devices in communication systems and must operate as efficiently as possible to save energy and costs. With the increasing demand for high data rates for modern communication services and applications, PAs must support wide bandwidth to cover multiband and multichannel usage in a single device. Additionally, high-order modulation schemes can provide high data rates but demand superior linearity over operation frequencies and output power to fulfil the required spectral mask. These requirements are in contrast to each other and are difficult to achieve simultaneously. Especially considering the downlink side, which operates in idle mode for most of the time, high efficiency is not only required for a wide frequency range but also over the whole dynamic output power range up to 16dB and more. Doherty PAs (DPA) are a common topology to improve efficiency at back-off power, but the main problems are narrow bandwidth, limited back-off power, and design difficulties.

A solution is proposed to provide high-efficiency signal amplification over a large bandwidth and linear dynamic output power range.

Solution

The efficiency of state-of-the-art 2-way Doherty amplifiers is limited in the dynamic output power range from 6-8 dB and narrow bandwidth. 3-way Doherty amplifiers trade in more dynamic output at the cost of even less bandwidth. Our solution tackles all challenges while keeping the design as flexible and simple as possible. Instead of introducing a third directly dependent path, e.g., the 3-way Doherty, to extend the dynamic output power range, we employ two core amplifiers. One is an active load modulated PA operating in high-efficiency mode from low to the end of the mid output power region. This core amplifier is combined with a second core amplifier implemented as a balanced power amplifier operating in reflective mode at these output power levels. The high output power region is covered by the second core amplifier introduced by a simple load transformation. Thereby, both core amplifiers can be designed independently without reducing the bandwidth like in a 3-way DPA.
Meanwhile, high-efficiency signal amplification is provided not only over frequency but also over output power. In a symmetric 8 dB power split design, 16 dB of high efficient dynamic output power range can be achieved. With further extensions in the second core amplifier, up to 20 dB and more is possible.

Advantages

- High efficiency signal amplification
- Large dynamic output power range
- Wide bandwidth
- Linearity
- Low complexity
- Flexibility
- Scalable to different technologies
- Easy to design and adopt with current PAs

Status

- International patent application pending and German patent application pending.
- Development status: Proof of concept and ongoing research

RWTH Aachen University is looking for partners for patent exploitation, research partners for joint development or contract research.