

A new paradigm for radio frequency power amplification (RF-PA)

Abstract

The constant evolution of mobile devices and applications leads to faster data transmission in both guided and wireless transmission. The advent of the fourth generation of mobile networks (4G) and fixed networks has resulted in an increase in the number of smart phones and tablets and consequently the volume of data transmitted. The latter, in turn, has led to the adoption of multi-carrier techniques, such as OFDM (Orthogonal Frequency Multiplexing), which are spectrally efficient for the digital data transmission, to support the required data rates. However, increasing the data rate is achieved at the expense of power efficiency, given the level of envelope fluctuations characteristic of these techniques. With the advent of the fifth generation of mobile telephony (5G), transmission rates are estimated to be 10 to 20 times greater than 4G, which makes energy efficiency in radio frequency power amplification (RF-PA) stage more critical. Consequently, higher energy efficiency will be required for both mobile devices and network level, which can't be achieved by current RF PA technologies.



With the new 5G technologies, there is a growing need for more effective RF PA technologies. Koala Tech innovation QDA (Quantized Digital Amplification) represents a new paradigm on RF PA that permits a significant reduction in energy consumption with a broad spectrum of application, from actual 4G and Wi-fi, to the new 5G, Wi-fi 6 and wired communications. QDA addresses the longstanding topic of the energy efficiency in wireless communications networks due to its impact on coverage, signal quality and operational costs, and the consequent negatives impacts on environment. Koala Tech (KT) technology creates a disruption over traditional RF PA and opens a way for a new level of energy efficiency in telecommunications. This new paradigm is based on 8 patents that result from the R&D projects conducted by KT Founders in the last 4 years.

Challenges

The new technology pathways in telecommunications demand different ways to reduce the huge amount of wasted energy in present and future wireless communications, contributing both for reducing the operational costs and achieve eco-sustainability.

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Koala Tech aims to be a reference in innovative wireless communications systems contributing to a more energy efficient, sustainable, and secure RF communications systems worldwide. KT dedicates to continuously develop new concepts and technologies on power efficiency and secure solutions for wireless communications systems. KT has two R&D lines in parallel in order to answer the identified energy efficiency and security challenges:

- Energy Efficiency: application on 4G and 5G macro, metro, micro base stations and user devices and satellite and military communications.



Figure 1. Intervention Area No. 1

- Physical layer security: QDA based security solution can be employed application on future 5G and NOMA based 5G systems and communication systems such as military communications, using Multi-Carrier (MC) or Single-Carrier (SC) techniques.

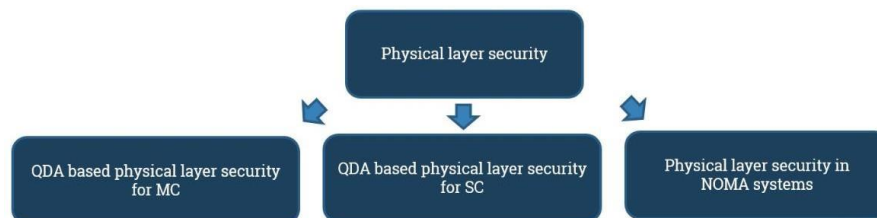


Figure 2. Intervention Area No. 2

The Solution

Koala Tech is high-tech spinoff from NOVA Lisbon University support by an the SMENT Digital and the IFD investment fund. The company is focused on the design of energy efficient RF PA stages able to increase energy efficiency several times on wireless communications systems (5G and Wi-Fi 6).

Koala Tech proposes a new disruptive technology concept, QDA (Quantized Digital Amplification), for power amplification on telecommunication systems, that will permit an significant improvement in power amplification efficiency, with a wide range of application from actual 4G and Wi-fi, to the new 5G, Wi-fi 6 and wired communications, from the network radio transmitters (e.g. Base Station – BTS, Wi-Fi Access Point - AP) to the wireless user equipment (e.g. mobile handsets, computers, tablets, IoT).

The approach proposed by QDA for RF PA stage of a Wireless transceiver consists on a digital decomposition of the original complex signal into a set of constant envelope signals that are amplified by switched amplifiers and combined. This allows a modular approach that simplifies implementation of RF PA:

- a digital signal processing part that permits higher flexibility on addressing a wider range of applications, with different types of signals and bandwidth needs, by a simple firmware reprogramming.
- a power amplifier hardware that can be implemented in diverse technologies (CMOS – Complementary Metal Oxide Semiconductor, GaN – Gallium Nitride, GaS – Gallium Arsenide and Bipolar) and a digital controlled power combiner.

Main advantages of QDA technology can be summarized as:

- **Broad spectrum** of application since this amplification method can be applied to both single carrier and multi-carrier signals and do not have a specific constellation, bandwidth, or signal as a target.
- **Suited for broadband** since the power amplifiers operation does not need to change over time.
- **Fully digital**, with switched amplifiers the implementation can be fully digital up to PAs inputs without the need of DACs (Digital to Analogue Converter). Thus, whole QDA system can be viewed as a DAC that amplifies the signal.
- **Easy to Integrate and Adapt** to any existing standard, from 2G to 5G in wireless communications.
- **Versatility**, suitable for any multi-carrier or single carrier system with a variable envelope.
- **Higher flexibility and scalability** achieved by programming flexibility and digital processing of the signals on FPGA (Field Programmable Gate Array) or DSP (Digital Signal Processor).
- **Maximum energy efficiency** since all the amplifiers work in compression point or near it (without any nonlinear repercussions in the amplified signals)



QDA also means a significant reduction in the carbon footprint of the existing and future wireless and mobile communications systems networks. Therefore, the QDA technology will contribute to reducing up to 70% the negative impacts on the environment caused by mobile cellular networks transmitters, with wider cross-sector impact in environmental protection, CO₂ and greenhouse gas reduction, social costs and public health.

Koala Tech team is composed with highly qualified engineers with PhD, and with more than 15 years of experience in signal processing, microelectronics, and telecommunications sectors. The team is also composed with high skilled engineers, with extensive experience in the research fields where the company develops activities. With the new disruptive approach of QDA technology, Koala Tech is actively providing solutions and paving the way towards more sustainable and energy efficient future in telecommunications.

References

Koala Tech LDA

<https://koalatech.pt>

<https://www.linkedin.com/company/koala-tech>