What is QDA?

In telecommunications, Power Amplifiers (PA) play the starring role in transmitting Radio Frequency (RF) signals through antennas to cell phones. PAs consume *substantial* electricity to amplify low-power RF signals. *Highly inefficient*, PAs waste between 34 to 38% of all consumed base station electricity. The cost: billions! Global wasted *annual* base station power costs, in 2023, total $18 to $20 billion dollars. However, wasted power is not confined to the world's 9 million base stations In 2022 there were 8.9 billion phones under subscription; every one of them had at least one power amplifier. Each PA feasting on significant amounts of battery power, wasting battery energy, and heating cell phones.

QDA cuts the cost of power amplifier operation (power usage) in half. This document describes QDA (**Quantized Digital Amplification)** from an Executive Management perspective as well as from an RF Engineering view. It then lists QDA's benefits.

QDA - Executive Management Perspective

Power amplification efficiency is often held prisoner by the nonlinear behaviors of the signal to be amplified. Wide band signals with wide dynamic ranges, common in systems like 4G and 5G, pose *dramatic* obstacles to signal amplification efficiency, even when using the industry's prevailing practices of good signal amplification. However, **Quantized Digital Amplification (QDA)** provides efficiency increases, 5 times typical efficiencies, while bypassing limitations of the prevailing techniques. It uses a sophisticated Digital Signal Processor to operate on the signal to be amplified, dividing it up into many samples and then runs signal transformations on those samples. The transformed signal parts are then amplified in staggered stages to balance power usage. The different signal parts are then assembled, and after different transformations, it is possible to use *linear amplification* and then combine the signals and issue a unified amplified signal – all delivered while achieving a much greater level of power efficiency.

QDA – RF Engineering Viewpoint

- QDA operates as a system which behaves like a linear amplifier. It starts with a signal processing portion using a quantizer combined with a decomposition of the quantized symbols into Nm polar components that are amplified individually by a nonlinear amplifier. The inputs for the quantizer are the time domain samples of the complex envelope that can be obtained from a multi-carrier or single-carrier signal. The polar components are modulated before being amplified by a separate amplifier. In each branch, the resulting signals are submitted to a mixer for up-conversion before being amplified by the amplifier, which can operate in saturated mode or near to it. The amplification stage is composed of N amplifiers in parallel whose outputs are the inputs of a smart combiner controlled by the signal processing portion that performs the quantization and decomposition. The smart combiner is followed by a transducer connected to an antenna or equivalent.

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QDA – Benefits & Effects of the QDA Solution

- A QDA implementation – whether in a cell phone or base station - *reduces* silicon, circuitry, and parts costs. This silicon reduction is in the range of 10% to 20% and overall will reduce product unit costs.

- In both cell phones and base stations, QDA *increases* the power efficiency of Power Amplifiers from 10% to over 50%. This converts substantial amounts of battery energy or power from making wasteful heat to performing additional useful tasks or operations.

- QDA *reduces* electricity used in base stations by 10 to 15%. With a global waste number of 3 Billion dollars, even a 10% reduction, converting waste heat into additional useful operations performed, is significant.

- QDA *reduces* electricity used by cell phone batteries by 12.5 to 25%. That reduction can extend operational time or permit additional functions to consume the increased available battery capacity.

- In both cell phones and base stations QDA has *a dramatically smaller carbon footprint* from electricity & heat reductions.