Load Insensitive Power Amplifier

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In the upcoming fifth generation (5G) networks, multiple-input multiple-output (MIMO) systems are expected to be massively deployed and each transmitter composed of hundreds of active antenna elements. This enables narrow and more precise radiation beams, which saves a huge amount of energy directing the electromagnetic power directly to the intended mobile receivers.

However, these closely spaced antenna elements suffer from mutual coupling, which is perceived by the antenna feeding amplifiers as a load impedance change, degrading the amplifiers' efficiency, output power and linearity. Thus, it is necessary to prevent the undesired coupled waves from reaching the amplifiers' output port, which, unfortunately, requires too bulky and expensive magnetic isolators, compromising the miniaturization of MIMO transmitter arrays.

Therefore, within the scope of a research project with the company Ampleon Netherlands B.V., an RF power transistor manufacturer, an automatic system that can dynamically restore the output power and efficiency of the amplifier operating under variable loading scenarios was developed. This is accomplished by dynamically adapting the supply voltage of the amplifier according to the sensed load impedance, by following a developed theoretical model.

A proof of concept amplifier was designed and implemented, for operation at 3.6 GHz and using the Doherty architecture – commonly seen in telecommunication applications due to its high average efficiency with modern telecommunication signals. The load impedance is measured using a miniaturized impedance meter that was specifically conceived for this purpose, with very low losses and the capability to generate a load-dependent signal that controls the supply voltage of the amplifier. The laboratory tests have been performed for various non-optimal loads, achieving an output power improvement of 1.4 dB (1.38x) and an average efficiency increase of more than 10 % in the worst-case scenario.

FIGURE 1
Photography of the final complete system featuring an output stage based Doherty power amplifier, a real time load impedance tracking system, and an adaptive supply voltage and input signal control.

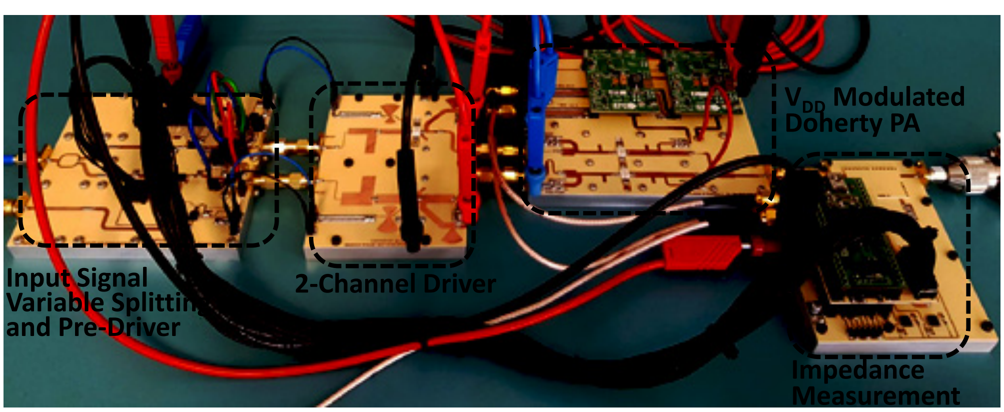

FIGURE 2
Measured gain, output power and average efficiency of the proposed system when operated with modern telecommunication signals.