Long-Term Memory Effects in GaN Devices: From Modeling to Compensation?

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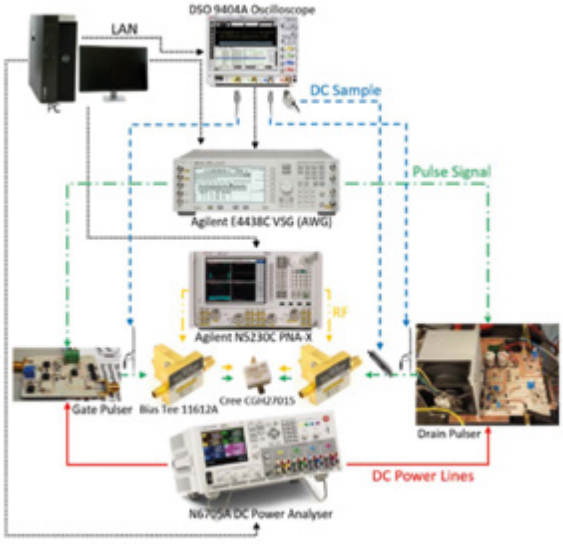
Gallium-nitride (GaN) transistors have highly attractive performance for power amplifiers used in GHz telecommunications, mostly due to their low power density characteristic. However GaN devices present slowly varying distortion effects (usually referred to as long-term memory effects), which impede the verification of the telecommunications' specifications for radar applications and cellular communications (unless a highly complex digital compensation unit is added, running sophisticate algorithms).

The phenomena originating such long-term distortion – electron trapping/detrapping within the transistor– has been a topic to which the Wireless Circuits – Av group has been analyzing in the last years. In this sense, research work has been conducted to characterize these phenomena at the device physics-level, using innovative laboratory setups dedicated to the observation of effects induce by electron trapping/detrapping in GaN devices.

The knowledge developed from this study has made it possible to understand the implication of long-term memory effects at the system-level behavior of power amplifiers. This led to the design of an innovative analog compensation circuit which, integrated into the amplifier circuitry, produces an overall conventional behavior, without apparent long-term distortion, while still taking profit from the benefits of GaN transistors. This is highly important especially for the upcoming transmitter architectures foreseen for 5G communications, consisting of arrays of low power amplifiers, whose distortion compensation will not be possible to achieve through advanced digital processors, but whose linearity level will still have to meet the strict specifications.

In 2019, this work led to three publications in the Q1 journal IEEE Transactions on Microwave Theory and Techniques (the most relevant journal in this topic) and one presentation at the IEEE International Microwave Symposium (the most important conference in this field).



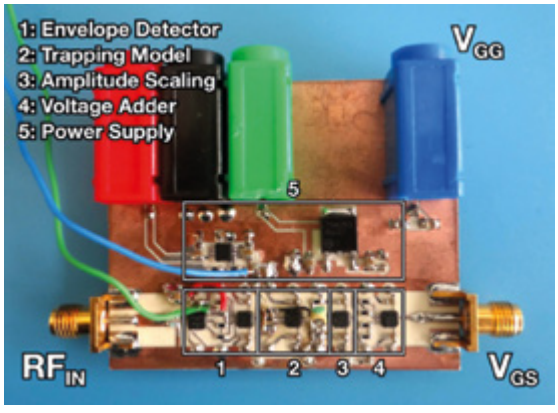


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FIGURE 1
Laboratory setup for characterizing the effects of electron trapping/detrapping in GaN-based amplifiers.

FIGURE 2
Analog compensator designed for compensating the long-term memory effects on GaN-based amplifier circuits.