

From electron device physics to communication system impairments – Optimizing RF power amplifier linearity

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FIGURE 1

Design flow of telecommunication transmitters: from research at the physics level to the observed system level behavior.

As a result of a cooperation with a major transistor manufacturer and then with the world largest mobile communications base-station supplier, this work showed how a deep understanding of electron device physics, RF power amplifier (PA) circuit design and of wireless communications systems' impairments could be put together to demonstrate that emission time constants of GaN defects are responsible for the achievable linearity degradation of AlGaIn/GaN HEMT-based PAs. It was shown that the most severe nonlinear communication impairments after digital correction arise when the emission rate is on the order of the signal bandwidth. Moreover, because of

the strong temperature dependence of the emission time constants, self-heating was shown to play a major role in that linearity degradation. To demonstrate the importance of the coupling of electrothermal and trapping effects, two AlGaIn/GaN HEMT dies with the same structure but different GaN defect activation energies were tested under nonlinear digital correction. Now, studies are being made to investigate which AlGaIn/GaN HEMT physical parameters should be changed to optimize the achievable linearity.

Beyond several publications in the most respected journals and conferences of the field, this work received one of the most prestigious awards, the 2024 IEEE Microwave Prize.

