

GaN-on-Silicon for 5G Radios

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Abstract

5G promises to bring about another wave of performance enhancements that will not only significantly impact the way that we communicate, but will also call for major overhauls of the telecommunications infrastructure. This has reignited a race amongst competing semiconductor technologies for inclusion in next-generation amplifiers, among which gallium nitride (GaN) is a major contender due its high power and temperature handling capabilities. In this paper, we will address the prospects of GaN for new radio 5G (NR-5G) by tackling the full range of devices to systems opportunities and challenges.

This begins with a comparison of the leading GaN MMIC technologies that are distinguished by the substrate of choice, namely GaN-on-Si and GaN-on-SiC. Trade-offs in material and device performance, as well as cost, will be addressed, as well as examples of current and upcoming MMIC designs for the market. Due to the high power of GaN MMIC modules and its relatively young age, reliability and packaging are critical.

Approaches to satisfy both the RF and thermal performance demands of GaN, alongside examples of hybrid GaN PAs will be presented. In addition, a comparison to alternative/competing technologies needs to be considered relative to these GaN based efforts with the advantages of GaN technology for 5G clearly enumerated. The incumbent technology for 4G systems has been silicon LDMOS. It is hard to believe that the manufacturers that have made the large investment in this very successful technology platform will just walk away from the 5G opportunities, especially at frequencies below 6.0 GHz. As the 5G frequency bands move into mmW frequency realm, traditional GaAs based PA's and SiGe BiCMOS have the possibly of providing competitive solutions. This is especially true for GaAs which is already the PA technology of choice for point-to-point applications through 40 GHz. As 5G considers to massive MIMO/phased array solutions above 60 GHz and the required output power per element drops, SiGe BiCMOS will clearly offer completion to GaN based technologies.