Implementation of Broadband and High Efficiency S-band Doherty Power Amplifier Based on GaN HEMTs

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Abstract: In this work, based on Gallium Nitride (GaN) high electron mobility transistors (HEMTs), a high performance Doherty power amplifier (DPA) has been implemented. Specifically, fractional bandwidth of 24% at center frequency of 2 GHz, saturation output power of 263.876 Watts (54.214 dBm), and power added efficiency (PAE) of 54.874% have been successfully demonstrated. GaN HEMT was selected in DPA topology due to its strengths in high power operations and high thermal conductivity. Wide bandwidth was achieved by employing short stub at output of power combiner and low load impedance (25 Ohm) as well. Additional matches for resonance at second and third harmonics were implemented at output of both carrier PA and peak PA to achieve a better PAE. The designed DPA exhitbited outstanding linearity with large input power level and showed excellent third input intermodulation point of 49 dBm.

Keywords: broad band, Doherty power amplifier, GaN, harmonics resonance, low load impedance pull

Introduction and Designing Idea

In modern transmitter of base stations, power amplifiers (PAs) with large saturation output power and good linearity are highly demanded to transmit sufficient power for wireless communications. Compared to conventional technologies based on Si CMOS or GaAs, GaN HEMTs have been regarded as promising candidates for high power and high frequency applications owing to the superior material properties, such as high electron mobility in 2 dimensional electron gas (2-DEG), wide band gap, and high thermal conductivity [1]. Thus, PAs based on GaN HEMTs are expected to achieve ultra-high output power in RF bands. Doherty PA (DPA), first proposed in 1936, has garnered considerable research and industry interests in amplifiers designing due to its enhanced efficiency at back-off power ranges and acceptable linearity [2]. In addition to large saturation power and good linearity, output efficiency (power added efficiency (PAE) and drain efficiency) and bandwidth are also crucial for a PA with good performances. Besides, to work with a full interoperability within the modern communication systems, PAs should also perform well in several RF bands, such as frequency range of 1800 MHz to 2200 MHz, which includes long-term evolution (LTE) band 1 to 2, and LTE band 33 to 37 in 3GPP standard [3]. Hence, designing a Doherty PA, based on GaN HEMTs, with wide bandwidth and high efficiency at a frequency range of 1800 to 2200 MHz becomes the key topic of this work.