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Review of Efficiency CMOS Class AB Power Amplifier Topology in Gigahertz Frequencies

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This paper reviewed the efficiency of CMOS class AB power amplifier topology especially in gigahertz frequencies. CMOS class AB power amplifier is a compromise between class A and class B in terms of linearity and efficiency between 50% to 78.5%. However, CMOS class AB power amplifier cannot have good linearity and efficiency simultaneously due to the breakdown in gate-oxide voltage and effects from hot carrier. The breakdown of oxide prevents optimum drain signal and the effect from hot carrier will reduce the quality of the overall PA design. Several works from year 1999 to 2019 with different topology such as multiple gated transistor, cascode, feedforward linearization, differential circuit, transformer combining method with common source harmonic termination and combination of a dual-switching transistor with a third harmonic tuning technique are discussed and the performances of the power amplifier are compared. The best three CMOS class AB power amplifier topologies were chosen in terms of high efficiency. The topologies are two stages with integrated input and interstage matching, Doherty amplifier combined with drain modulation based architectures and self-biased cascode topology that obtained power added efficiency of 45%, 43% and 42%, respectively. Key performance indicators for class AB power amplifier include frequency, power added efficiency, gain and output power are also discussed in this paper.

Keywords: power amplifier; CMOS class AB; topology; frequency; power added efficiency; gain

I. INTRODUCTION

Power amplifier (PA) acts as a crucial part of a transmitter in a radio frequency (RF) transceiver. While PA helps to amplify the signal power high enough for its propagation and need highly efficiency as it becomes a very power-hungry block that takes 50~80% of the total power consumption. PA can be classified into several classes either a linear (class A, B, C, AB) or non-linear switching gates (class D, E, F). The linear power amplifier has excellent linearity with typical efficiency achieved for class A is 25%, class AB is 35-60%, class B is 60% and class C is70%. For non-linear switching the typically maximum efficiency can be achieved is 100%. Main characteristics of the PA design are linearity, efficiency, gain and output power. Due to different performances in each PA classes, there will always be a trade-off between linearity and efficiency.

Linear switching PAs such as PA of class A and B operates based on their load-line curve. This curve shows the optimum voltage supply and current needed to enable the load receives maximum power from the transistor in the circuit design. Biasing condition refers to the electricity flow in the transistor of the amplifier. Class A is biased at the load line's centre causing the transistor to be fully active (ON) and conducts at 180^0 of the operating signal. Class A has the highest linearity yet least efficiency among other PA classes. Meanwhile, class B has a push pull operation between the transistors where it is not being biased within range of ± 0.7 V causing it to

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