60GHz Injection Locked Power Amplifier

Popular Science Summary

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Since the invention of radio-frequency (RF) wireless communication more than 100 years ago, mobile phones and other wireless communications products for civilian consumption have developed rapidly. Nowadays, the demand for larger high data rate and capacities is rising sharply. The traditional wireless bandwidth is no longer able to meet some high-rate applications requirement. However, 60GHz wireless communication system is our solution,and up to 7 GHz unlicensed wide band around 60GHzis open to use across much of the world. Furthermore, the power amplifier (PA) is a critical part of any transmitter to convert the signal to higher power and drive the antenna. For power amplifiers,efficiency and linearity are most important. Power amplifiers with low efficiency will result in high level of heat dissipation. Linearity is a measure of the signal distortion, which consists of gain compression (AM-AM distortion) and phase distortion (AM-PM distortion).

In this thesis work, an injection locked power amplifier is used to reduce the input driving requirements and improve the efficiency. Simulations have been performed for implementation in 65nm standard CMOS, which is a low-cost technology for fabrication of integrated circuits (chips). The injection locked technique means thata self-oscillating circuit is forced to run at the same frequency as the input signal.Furthermore, an integratedbalun is added to transfer between single-ended and differential signals. The results show that this PA can achieve high efficiency but with poor linearity performance. In order to improve the linearity, differentlinearization techniques are investigated, including adaptive biasing and predistortion. Adaptive biasing is a feedback technique. At high output levels, the power amplifier has less gain, which leads to signal distortion. The adaptive biasing unit can sense the output power in real time and adjust the bias. The bias is then increasedat increased output power in order to restore the power gain at high output levels. Predistortion is another linearization technique.Apredistorter, which has a gain expansion characteristic, is then introduced before the PA to compensate for its gain reduction. Then, considering the advantagesof these two linearization techniques, we combine them together to

achieve evenbetter results. Finally, a two-stage power amplifier is proposed by adding a common source amplifier as the first stage. The first stage can also produce a gain boost at the high output levels, and this expansion gain can be made to match the second-stage gain reductionvery well. The simulation results show that the amplifier can achieve high linearity and efficiency at the same time.