

ABSTRACT

Linearization and Efficiency Enhancement Techniques for RF and Baseband Analog Circuits

(December 2010)

Mohamed Salah Mohamed Mobarak

Chair of Advisory Committee: Edgar Sanchez-Sinencio

High linearity transmitters and receivers should be used to efficiently utilize the available channel bandwidth. Power consumption is also a critical factor that determines the battery life of portable devices and wireless sensors. Three base-band and RF building blocks are designed with the focus of high linearity and low power consumption. An architectural attenuation-predistortion linearization scheme for a wide range of operational transconductance amplifiers (OTAs) is proposed and demonstrated with a transconductance-capacitor (Gm-C) filter. The linearization technique utilizes two matched OTAs to cancel output harmonics, creating a robust architecture. Compensation for process variations and frequency-dependent distortion based on Volterra series analysis is achieved by employing a delay equalization scheme with on-chip programmable resistors. The distortion-cancellation technique enables an IM3 improvement of up to 22dB compared to a commensurate OTA without linearization. A proof-of-concept lowpass filter with the linearized OTAs has a measured IM3 < -70dB and 54.5dB dynamic range over its 195MHz bandwidth. Design methodology for high efficiency class D power amplifier is presented. The high efficiency is achieved by using higher current harmonic to achieve zero voltage switching (ZVS) in class D power amplifier. The matching network is used as a part of the output filter to remove the high order harmonics. Optimum values for passive circuit elements and transistor sizes have been derived in order to achieve the highest possible efficiency. The proposed power amplifier achieves efficiency close to 60 percent at 400 MHz for -2dBm of output power. High efficiency class A power amplifier using dynamic biasing technique is presented. The power consumption of the power amplifier changes dynamically according to the output signal level. Effect of dynamic bias on class A power amplifier linearity is analyzed and the results were verified using simulations. The linearity of the dynamically biased amplifier is improved by adjusting the preamplifier gain to guarantee constant overall gain for different input signal levels.