

Electrical Engineering Department

PhD Final Oral Defense
High-Efficiency, Wide-Bandwidth Supply Modulators for Polar Transmitters in Wireless Handsets

by
Jennifer Nisha Kitchen
May 15, 2007
1:00pm
GWC 305

Committee:
Dr. Sayfe Kiaei (chair)
Dr. James Aberle
Dr. Bertan Bakkaloglu
Dr. Chaitali Chakrabarti
Dr. Junseok Chae
Dr. Elbadawy Elsharawy

Abstract

Due to the increasing demand for higher data rate wireless access and the limitations on wireless frequency bands, various linear modulation schemes such as multi-level QAM and PSK are being utilized to maximize bandwidth efficiency in wireless systems. Because most linear modulation schemes (i.e. EDGE, CDMA, and WCDMA) require the PA to operate at backed-off power most of the time due to the input signal’s high peak-to-average ratio and variable RF transmitter power control, increasing the PA efficiency over a range of operating powers improves the battery life in wireless handsets. Since PAs are usually the bottleneck in handset design, PAs that maintain good efficiency over output power are required for implementing a high-performance transmitter.

This work focuses on polar modulation of nonlinear power amplifiers (PAs) as a method for simultaneously achieving high efficiency and linearity. More specifically, this research evaluates and addresses the concerns in designing high-performance supply modulators for polar PAs. The focus is supply modulator architecture development, design, and optimization. Two designs are
presented: an integrated SiGe switch-mode supply-modulated class E polar power amplifier; and a combination linear and ΔM switch-mode supply regulator for polar PAs.

The highlights of the switch-mode supply modulated SiGe class E amplifier architecture are 1) monolithic implementation of the switch-mode supply modulator and switch-mode PA, and 2) digital noise-shaping supply modulator to increase PA efficiency and minimize the effect of modulator switching noise on the PA performance.

The highlights of the second design, a combination linear and switch-mode supply modulator, are 1) DC-DC buck converter modulating the supply voltage of a linear regulator (LDO), 2) wide-bandwidth linear regulator design, 3) closed-loop envelope feedback from the PA output, and 4) monolithic implementation of the combined linear and switch-mode regulators.