School of Electrical, Computer and Energy Engineering

PhD Final Oral Defense

High Slew-Rate Adaptive Biasing Hybrid Envelope Tracking

Supply Modulator for LTE Applications

by

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Abstract

As wireless communication enters smartphone era, more complicated communication technologies are being used to transmit higher data rate. Power amplifier (PA) has to work in back-off region, while this inevitably reduces battery life for cellphones. Various techniques have been reported to increase PA efficiency, such as envelope elimination and restoration (EER) and envelope tracking (ET). However, state of the art ET supply modulators failed to address high efficiency, high slew rate, and accurate tracking concurrently.

In this dissertation, a linear-switch mode hybrid ET supply modulator utilizing adaptive biasing and gain enhanced current mirror operational transconductance amplifier
(OTA) with class-AB output stage in parallel with a switching regulator is presented. In comparison to a conventional OTA design with similar quiescent current consumption, proposed approach improves positive and negative slew rate from 50 V/µs to 93.4 V/µs and -87 V/µs to -152.5 V/µs respectively, dc gain from 45 dB to 67 dB while consuming same amount of quiescent current. The proposed hybrid supply modulator achieves 83% peak efficiency, power added efficiency (PAE) of 42.3% at 26.2 dBm for a 10 MHz 7.24 dB peak-to-average power ratio (PAPR) LTE signal and improves PAE by 8% at 6 dB back off from 26.2 dBm power amplifier (PA) output power with respect to fixed supply. With a 10 MHz 7.24 dB PAPR QPSK LTE signal the ET PA system achieves adjacent channel leakage ratio (ACLR) of -37.7 dBc and error vector magnitude (EVM) of 4.5% at 26.2 dBm PA output power, while with a 10 MHz 8.15 dB PAPR 64QAM LTE signal the ET PA system achieves ACLR of -35.6 dBc and EVM of 6% at 26 dBm PA output power without digital pre-distortion (DPD). The proposed supply modulator core circuit occupies 1.1 mm2 die area, and is fabricated in a 0.18 µm CMOS technology.