School of Electrical, Computer and Energy Engineering

M.S. Final Oral Defense
Design techniques for Ultra Low Noise Low Drop-out (LDO) Regulator

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Abstract

Modern day deep sub-micron SOC architectures often demand very low supply noise levels. As supply voltage decreases with decreasing deep submicron gate lengths, noise on the power supply starts playing a dominant role in noise-sensitive analog blocks, especially high precision ADC, PLL, and RF SOC’s. Most handheld and portable applications alongside highly sensitive medical instrumentation circuits tend to use low noise regulators as on-chip or on board power supply. Nonlinearities associated with LNA’s, mixers and oscillators up-convert or intermodulate low frequency noise with the signal band. Specifically, synthesizer and TCXO phase noise, LNA and mixer noise figure, and adjacent channel power ratios of the PA are heavily influenced by the supply noise and ripple. This poses a stringent requirement on a very low noise power supply with high accuracy and fast transient response. Low Dropout (LDO) regulators are preferred over switching regulators for these applications due to their attractive low noise and low ripple features. Linear low dropout (LDO) regulators shield sensitive blocks from high frequency fluctuations on the power supply while providing high accuracy, fast response supply regulation.

This research thesis focuses on developing innovative techniques to reduce the noise of any generic wideband LDO, stable with or without any load capacitor. The proposed techniques include Switched RC filtering to reduce the Bandgap reference noise while using Chopping techniques to reduce the error amplifier noise. MOS-R based filter is used to reduce the noise due to bias currents. The residual chopping ripple was reduced using a Switched Capacitor notch filter. Using these techniques, the integrated noise of a wideband LDO was brought down to 15uV in the integration band of 10Hz–100KHz. These techniques can be integrated into any generic LDO without any significant area overhead.