ABSTRACT

High performance circuits for power management and millimeter wave applications

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The main focus of this work is to design and implement highly-efficient low-cost integrated circuits and systems for power management and millimeter wave applications. Novel system architectures and new circuit design techniques are introduced to achieve the required goals in terms of small silicon area and power consumption while at the same time achieve high performance. Four key building blocks in power management and a switchable harmonic mixer with pre-amplifier and poly-phase generator as a core part of a millimeter wave receiver are proposed, implemented and experimentally measured.

First, two externally compensated low drop-out voltage regulators (LDOs) with high power supply rejection (PSR) at high frequencies are presented. Complete PSR analysis is included together with detailed measurement results. The LDOs achieve a PSR of -56dB at 10MHz with a dropout voltage of only 0.15V. They are implemented on different CMOS processes, 0.13μm and 90nm, where they occupy small active areas of $0.049mm^2$ and $0.015mm^2$, respectively.

Second, an output-capacitorless LDO is presented. The LDO employs a novel topology that is adaptive to load current variations to ensure stability at light load condition and to provide fast transient response and high PSR. It is implemented in 90nm CMOS technology, and it uses a small on-chip capacitance of only 0.95pF. Measurements show that LDO achieves a fast settling time of 0.25μs and high PSR of -50dB at 1MHz while occupying an active area of $0.016mm^2$. With dropout voltage of 0.15V, the LDO achieves a load regulation of 58.3μV/mA for a load current step of 120mA.

Third, a buck converter working at high switching frequency (10/20MHz) and using small on-chip and off-chip passive components is presented. The converter utilizes a novel simple controller to minimize the area ($0.126mm^2$) and quiescent current consumption (25 ~ 48μA), with power efficiency that is better than linear regulators.

Finally, a switchable harmonic mixer with pre-amplifier and poly-phase generator are presented as a part of a novel millimeter wave dual-band receiver (31/24 GHz) implemented in 0.18μm SiGe BiCMOS technology. Complete receiver measurements show a conversion gain higher than 18dB with a band rejection exceeding 40dB and power consumption of only 60mW.