High-Voltage-Enabled Operational Amplifier and Active-Decoupling Technique for Wideband Balun-LNA

by

Liu Miao (M-A9-6518-2)

Master of Science in Electrical and Computer Engineering

2011

Faculty of Science and Technology
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A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science in Electrical and Computer Engineering

Faculty of Science and Technology
University of Macau

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Approved by _____
Supervisor

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Abstract

HIGH-VOLTAGE-ENABLED OPERATIONAL AMPLIFIER AND

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Thesis Supervisors: Prof. Pui-In Mak and Prof. Rui Martins
Master of Science in Electrical and Computer Engineering

The first part of this thesis described a high-voltage-enabling circuit technique for enhancing the gain precision and linearity of operational amplifier (OpAmp)-based analog circuits. Without resorting from specialized devices, a $2x V_{DD}$-enabled recycling folded cascade (RFC) OpAmp optimized in 1V GP 65-nm CMOS achieves ~20-dB higher open-loop DC gain and ~20-dB higher IM3 (in closed loop) than its $1x V_{DD}$ counterpart under a similar power budget. These joint improvements save the need of a 2nd stage in the OpAmp when high precision and high linearity are the priorities. A voltage-conscious bias scheme and gate-drain-source engineering ensure all devices are consistently operated within the reliability limits.

Package effects degrade the performances of high frequency circuits such as wideband low-noise amplifiers (LNAs). The second part of this thesis describes an area-saving technique to improve the performance of a balun-LNA covering the range of 50 MHz to 10 GHz in the presence of package effects. A double active-decoupling technique based on a feedback inverter amplifier is proposed. Optimized in GP 65-nm CMOS, the new technique shows 2.3-dB maximum gain loss compensation, 6.6GHz bandwidth recovery for input matching, and 22-dB maximum noise filtering in both supply rails. The added active circuitry draws 16 mW from a single 1.2-V supply, and the required physical capacitor is reduced to 4 pF.

ACKNOWLEDGMENTS

I would like to appreciate many people for their support, help and encouragement during my master study in University of Macau.

First of all, I would like to give my sincerely thanks to my supervisor Prof. Pui-In Mak and co-supervisor Prof. Rui Martins for their enduring guidance and support. Prof. Pui-in Mak shows me how to learn and how to do research when I knew nothing about integrated circuits. He never gives me up, encourages me all along the way during my study, and continues to lead me and push me to the right directions in my research and study. Without his immensely inspiration and patient guidance, none of this work could be possible.

I wish to give my gracious thank to my colleague Mr. Yaohua Zhao who has given me lots of technical guidance and valuable advices, inspired me and helped me in my study and research.

I would like to thank my colleagues Mr. Zushu Yan, Mr. Un-Ka Fai and Mr. Weng-Fai Cheng for their technical help and supports. I also thank Mr. Fan Ng for his help on the computer and network issues.

Other colleagues in the State Key Laboratory of Analog and Mixed-Signal VLSI are Dr. Sai-weng Sin, Ms. Jie Gao, Mr. Fujian Lin, Mr. Zhicheng Lin, Mr. Md. Tawfiq Amin, Mr. U-Wai Lok, Weihan Yu, Ms. Yanjie Xiao, Ms. Wei Wang, Mr. Gengzhen Qi, Mr. Yinsidi Jiao, Mr. Hegong Wei, Ms. Chenyan Cai, Mr. Yang Jiang, Mr. Li Ding, Mr. Si-Seng Wong, Mr. Peng Zhang and Mr. Guohe Yin. It was a great experience working with them. I thank all.

I would like to thank Dr. Peng-Un Mak and Dr. Chi-Kong Wong for their share and help during my period of working as their teaching assistant. And thanks to Dr. Peng-Un Mak, I have found my research direction when I first entered this university.

I also like to thank Mr. Tantan Zhang for his experience sharing and warm suggestions when I start my study in University of Macau.

My friends Ms. Xi Zhang and Mr. Keng-weng Lao care about me a lot, I thank for them for being with me during these days.

My parents and my little sister surely deserve the biggest thanks for their care, love, understanding and supports.

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LIST OF ABBREVIATIONS

AC	: alternating current
Active Decaps	: active-decoupling technique
AMR	: absolute maximum rating
BTI	: bias temperature instability
BW	: bandwidth
CM	: common-mode
CMFB	: common-mode feedback
CMOS	: complementary metal oxide semiconductor
CRs	: cognitive radios
CS	: common source
DC	: direct current
ESD	: electrostatic discharge
FC	: folded cascode
GBW	: gain bandwidth product
HCI	: hot carrier injection
IIP2	: second-order intercept point
IIP3	: third-order intercept point
IM	: intermodulation
LNA	: low-noise amplifier
NF	: noise figure
NMOS	: n-channel metal oxide semiconductor
OpAmps	: operational amplifiers

OTAs : operational transconductance amplifiers

Passive Decaps : passive-decoupling technique

PM : phase margin

PMOS : p-channel metal oxide semiconductor

RFC : recycling folded cascode

TDDB : time dependent dielectric breakdown

UWB : ultra-wideband

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