

輸入共模電壓範圍為 0~VDD 之三階低通濾波器

研究生：高正昇

指導教授：洪崇智 教授

國立交通大學

電信工程學系碩士班

摘要

本篇論文介紹了一個輸入共模電壓範圍為 0~VDD 的電壓轉導電流放大器，並且以此轉導放大器為基礎實現一個三階低通濾波器。與傳統的轉導放大器不同的地方在於，傳統架構為一個 P 型差動對加上一個 N 型的差動對來達到 0~VDD 的輸入共模電壓範圍，在這篇論文中採用了一個電壓位移的 N 型差動對再加上一個 N 型的差動對來完成要求，相比於傳統架構，N 型差動對再加上一個 N 型的差動對在設計上有著更方便的特性，並且在製程的漂移上有著更大的抵抗能力，因為 N 型兩差動對中的長寬比都一樣。本篇介紹的主要差動對皆操作於弱反轉區，操作於弱反轉區的差動對跟操作在飽和區的相比有著低功率消耗，低失真的效果。但是一個電壓位移電路也就是電壓跟隨器卻在操作上有著嚴重的缺失。在高輸入共模電壓的時候會造成轉導值的下降甚至到零，基於這點我們提出了一個新的電壓位移電路，修正了高共模電壓時的缺失。本篇提出的電壓轉導電流放大器改變差動對中的直流電流也可以輕易的調整轉導值，這是為了實現一個可調整截止頻率的三階低通濾波器。本電路使用台積電 0.18 製程模擬並下線。結果顯示在共模電壓為 0~1.8V 的範圍內轉導值的飄動約為正負百分之三，並且截止頻率的變範圍在 0.75MHz~1.5 MHz 之間。總功率消耗包括輸出級緩衝器為 4mW。對於輸入差模訊號大小為 300mVpp 頻率為 0.75 MHz 的差模訊號來說總諧波失真接近-35db。

Third-Order GM-C Filter with rail-to-rail input common-mode voltage

Student: Cheng-Sheng Kao

Advisor: Prof Ching-Chih Hung

Department of communication Engineering

National Chiao-Tung University

Abstract

This paper presents a CMOS low-power rail-to-rail transconductor under a supply voltage of 1.8-V. Base on the rail-to-rail transconductor, we build a third-order GM-C filter. Instead of using an n-type and a p-type differential input pairs, we use an n-type and a level-shift n-type differential input pairs to design a rail-to-rail input stage, and both of the differential pairs that work in the weak inversion cost less power than the traditional one. A novel level-shift n-type differential input pair is designed to maintain constant transconductance. The tunable cutoff frequency of the GM-C filter is needed. The total transconductance can be tuning by changing the tail current of the differential pairs. This work designed in TSMC 0.18- μm CMOS technology. Results show that the fluctuation of total transconductance of the proposed transconductor is less than $\pm 3\%$. And the cutoff frequency of the GM-C filter is 0.75MHz to 1.5MHz. The power dissipation of the GM-C filter is less than 4mW. The total harmonic distortion of the filter is about -35db.

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