

Design of Folded Cascode OTA in Different Regions of Operation Through g_m/I_D Methodology

H. Daoud Dammak, S. Bensalem, S. Zouari, and M. Loulou

Abstract—This paper presents an optimized methodology to folded cascode operational transconductance amplifier (OTA) design. The design is done in different regions of operation, weak inversion, strong inversion and moderate inversion using the g_m/I_D methodology in order to optimize MOS transistor sizing.

Using 0.35 μ m CMOS process, the designed folded cascode OTA achieves a DC gain of 77.5dB and a unity-gain frequency of 430MHz in strong inversion mode. In moderate inversion mode, it has a 92dB DC gain and provides a gain bandwidth product of around 69MHz. The OTA circuit has a DC gain of 75.5dB and unity-gain frequency limited to 19.14MHz in weak inversion region.

Keywords—CMOS IC design, Folded Cascode OTA, g_m/I_D methodology, optimization.

I. INTRODUCTION

The evolution of the microelectronics industry is distinguished by the raising level of integration and complexity. It aims to decrease exponentially the minimum feature sizes used to design integrated circuits. The cost of design is a great problem to the continuation of this evolution. Senior designer's knowledge and skills are required to ensure a good analogue integrated circuit design. To fulfill the given requirements, the designer must choose the suitable circuit architecture, although different tools partially automating the topology synthesis appeared in the past [1]-[4].

The optimization becomes an important method; a heuristic process was developed in [5]. Nominal circuits design was considered in [6]-[7], sizing problems were discussed in [8]-[10], and worst-case optimization in [11]-[13]. Several optimization tools were developed, such as equation based GPCAD [14]-[15], AMG using a symbolic simulator and the simulation based ASTRX/OBLX [16]-[18]. Recently, the sizing problem from different aspects are addressed in numerous papers ([13], [19]-[24]).

Designing high-performance base band analog circuits is still a hard task toward reduced supply voltages and increased frequency. Current tendency focus on some radio-software receivers which suppose a RF signal conversion just after the antenna. Thus, a very higher sampling frequency and resolution analog-to-digital converter design is required. The OTA is a basic element in this type of circuit whether switched capacitors technique is kept for ADC design.

Our target was to design a folded cascode OTA circuit in sight of Sigma Delta analog-to-digital converter design using for wide band radio applications.

This paper is organized as follows. Folded cascode OTA structure is analyzed in section II. Section III presents the OTA circuit design in the three regions of operation. Section IV gives design window. Finally some concluding remarks are provided after evaluating our study toward other works.

II. FOLDED OTA STRUCTURE

A. NMOS Input Transistor

The input stage provides the gain of the operational amplifier. Due to the greater mobility of NMOS device, PMOS input differential pair presents a lower transconductance than carrier a NMOS pair. Thus, NMOS transistor has been chosen to ensure the largest gain required.

B. Architecture Analysis

The main bottleneck in an analog circuit is the operational amplifier. Different types of OTA configuration are available to the designer who tend to improve performances requirements design [25]. We opt for a "folded cascode" op-amp due to its large gain and high bandwidth performances. Fig.1 presents the folded cascode OTA (the name "folded cascode" comes from folding down p-channel cascode active loads of a diff-pair and changing the Mosfets to n-channels).

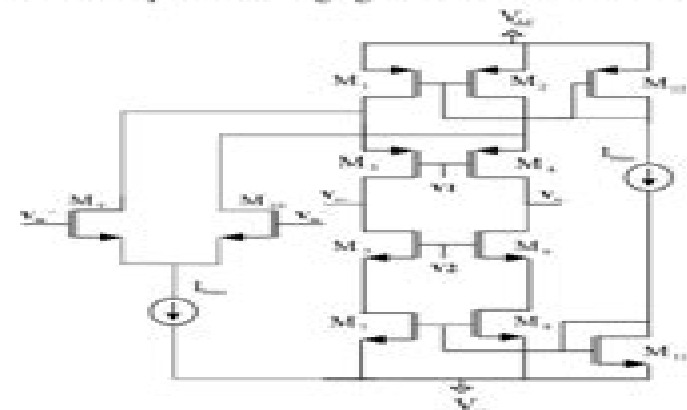


Fig. 1 Folded cascode OTA topology

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