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Design, Simulation and Performance Analysis of 180nm CMOS OTA

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***Abstract*— A very large scale analog integrated circuit (analog VLSI) designing is very typical and requires much adjusting nature to achieve application based objectives. Now days, challenges of analog integrated circuit designer are making block of lesser power supplies with little or no reduction in performance analysis. Operational trans-conductance amplifier (OTA) is one of the most important and significant building-blocks of analog Very Large Scale Integration (VLSI). Here we will design an OTA (operational trans-conductance amplifier) i.e. a voltage to current amplifier and whose differential input voltage produces an output current. Here single stage operational trans-conductance amplifier is designed in 0.18 micron (i.e., 180 nm) technology with the entire transistor in the saturation region using TANNER EDA tool. The simulated output dc and ac response is shown for a supply voltage of 5.0V.**

***Keywords*— CMOS, Operational Trans-conductance Amplifier, Gain, Bandwidth, Trans-conductance.**

I. INTRODUCTION

The drift towards low voltage low power silicon chip systems has been springing up due to the longer battery life and increasing demand of smaller size for portable applications in all marketing sections including medical, computers, telecommunications, consumer electronics and the implementation of high performance signal processing and signal conditioning block. Op-amps are among the most widely used electronic devices [4] today, being used in a vast array of consumer, industrial, and scientific devices [1]. The OTA is an amplifier whose differential input voltage produces an output current or we can say that it is a VCCS device. The very first paper on Trans-conductance Amplifier was promulgated in literature nearly 35 years ago. This paper explains a bipolar OTA. At this time thus in open loop gain commercial OTA was not used. The maximum input voltage used for a typical OTA is of only 30mv order, but for trans-conductance purposes it is used in decades. Thus a number of researches have been done to increment the input voltage and to linearize OTA. Some of the important features of OTA are its high speed in comparison with conventional low output impedance OTA and their bias dependent trans-conductance program capability. Now days research has been done on CMOS OTA and its various application in digital and analog communication field. During Analyzing various category is taken into account [2]. Its schematic symbol and equivalent circuit model for an Operational Trans-conductance Amplifier (OTA) are shown in Figure 1.(a), (b) respectively. The OTA changes an input voltage to an output current in according to a trans-conductance gain equation i.e. Gm=io/vi. Ideally the output and input resistances are infinite i.e. (Ri=Ro=∞) such that i1=I *Ro=0 and the output current is imbibed exclusively by the load. The conventional OTA is categorized as a class A amplifier and is capable of producing maximum output currents equal to the bias current utilized. The equivalent circuit model betoken the trans-conductance amplifier generates an output current (io) relative to an input voltage (vi) based on the trans-conductance gain Gm. The open circuit voltage gain of the conventional OTA model in Figure 1.1 (b) is given by A=Gm*Ro.

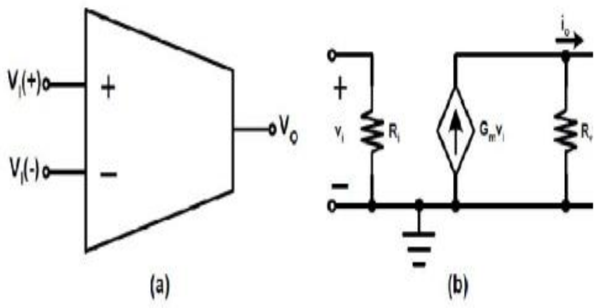

Fig 1. OTA Schematic Symbols and Equivalent Circuit

A. OTA Application

It is used in industrial and commercial application [7]. In communication system, ADC and DACs, modulators, comparators, multiplexers and sample and hold circuits OTA are used. The CMOS Operational Trans-conductance Amplifier (OTA) is a specific device with characteristics particularly suited to applications viz. multiplexing, analog multiplication, amplitude modulation, gain control, comparators and switching circuitry [5] and currently devices with reduced power supply is manufactured [3].

II. DESIGN OF CMOS OTA

The first basic OTA design is differential OTA. It has some important characteristics like high input impedance, high voltage gain and output current source with high impedance. In this paper we will design a CMOS Ota with a current mirror circuit. The circuit in which output current is forced to equal the input current is said to be a current mirror circuit. It is special case of constant current bias. An advantage of current mirror circuits is that it takes fewer components, simple to design and easy to fabricate.

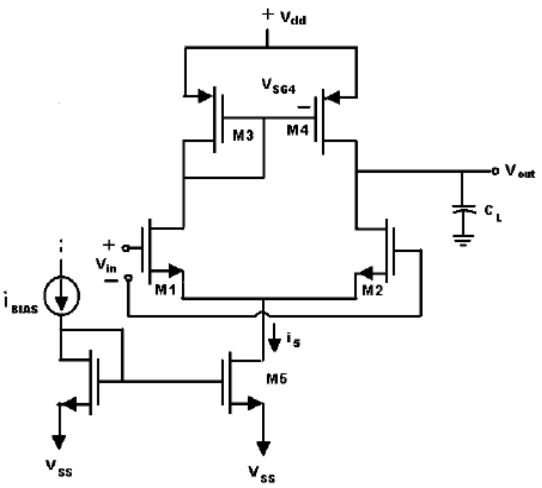

Fig 2. CMOS OTA Circuit

In this design we uses (L) of every MOS as 180 nm and during Ac analysis width (W) of NMOS transistors is taken as 360nm and PMOS transistors as 810 nm with a power supply vdd of 5.0 volt and similarly during DC analysis width of 1800 and 270 nm is used.

III. SIMULATION RESULT

After designing the circuit in s-edit we simulate our circuit in t-spice. T-Spice Pro is part of a complete integrated circuit design tool suite for layout, verification and simulation offered by Tanner EDA.

1) *T-Spice: Analog / digital circuit simulator*

2) *W-Edit: Waveform viewer*

B. DC Transfer Analysis

DC transfer analysis is utilized to study the current or voltage at one set of points in a circuit as a function of the current and voltage at another set of points. This is done by sweeping the source variables over specified values, and recording the output.

A list of sources to be swept, and the voltage values across which the sweeps are to take place follow the (.dc) command, indicating the transfer analysis which is

.dc info [sweep] info [sweep] info

C. AC Analysis

AC analysis characterizes the circuit's behavior dependence on small- signal input frequency. The .ac command used to do an AC analysis. Following the .ac keyword is information related to the frequencies to be swept during the analysis.

.ac {lin|oct|dec} num start stop [sweep info]

D. Results

1) DC characteristic

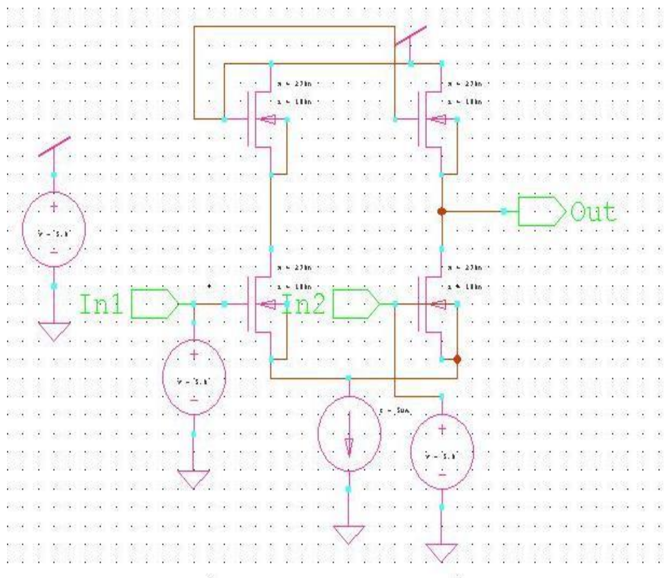

Fig 3. DC analysis current mirror circuit

.print dc v(Out2) v(Out1)
.dc lin vSource_v_dc_2 0 1.8 0.01
.tf v(Out1) vSource_v_dc_1
.tf v(Out2) vSource_v_dc_2

Output resistance: 5.0883e+003
Trans-conductance: 119u

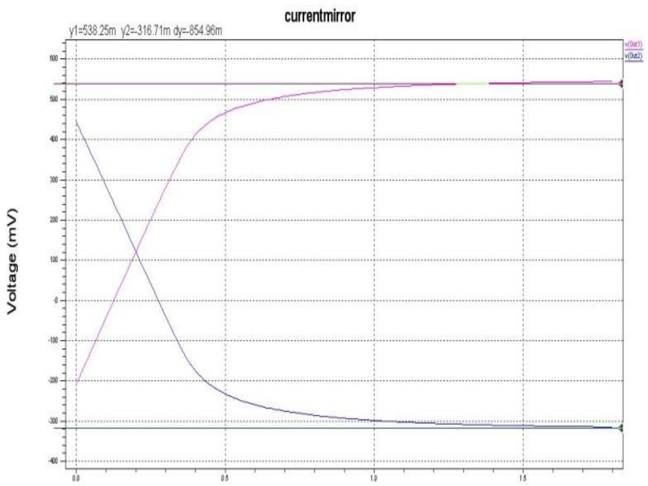

Fig 4. Current Mirror DC analysis Output Waveform

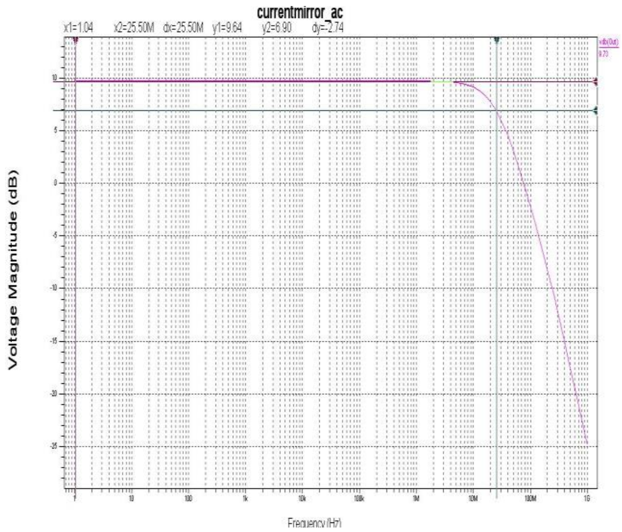

Fig 6. AC Analysis Output Waveforms

2) AC Characteristics

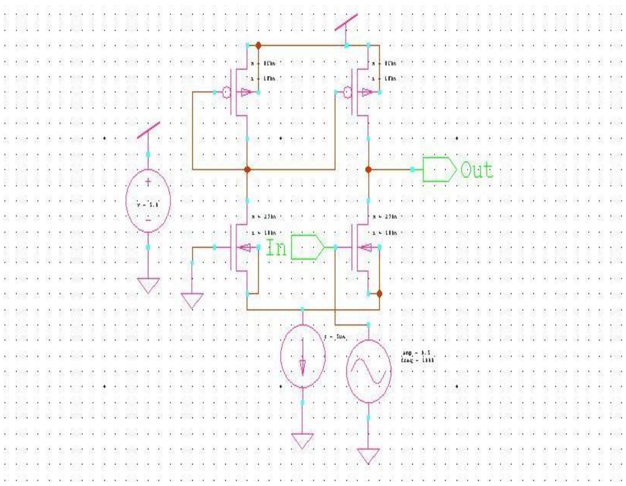

Fig 5. AC analysis Current Mirror Circuit

```
.ac dec 10 1hz 1Ghz
.tf v(Out) vSource_v_sine_1
.print ac vdb(Out)
.op
```

Gain: 9.64 db
Bandwidth: 25.50

IV. CONCLUSION AND FUTURE WORK

Hence in this paper we design, simulate, analyse and optimize the 180nm technology OTA with all the transistors in saturation region. We calculate the gain, bandwidth and trans-conductance with the help of output waveforms and net out list. Further OTA for lesser technology can be analysed and optimized for enhanced trans-conductance [6] and they can be designed for various application.

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