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Design & Simulation of Carbon Nanotube Based Operational Transconductance Amplifier at 65nm for Nanoelectronic Applications

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Abstract—The purpose of this paper is to design and simulate carbon nanotube based Based Operational Transconductance Amplifier (OTA) at 65nm. Carbon Nanotube (CNT) Based devices present a bright future and promise to sustain FET scaling for the validation of Moore's Law. In Silicon based devices, the gate oxide thickness has already entered the nanometer range; channel scattering from the rough oxide interface and tunneling through the thin oxide are becoming prevalent problems. Carbon nanotube based devices do not have these difficulties due to their extra ordinary electrical properties. One of the major applications of CNTs is the development of a CNTFET. In a CNTFET, the channel between source and drain regions/ electrodes is realized by using semiconducting single wall CNTs (SWCNT). The source and drain regions are the heavily doped regions and the CNT channel is undoped. Design & Simulation of CNT Based OTA at 65nm better results in terms of DC voltage gain, average power and output resistance. It has been observed that by using an optimum number of CNTs (N), the overall performance can be significantly optimized. The optimum number of CNTs (N) found in this work is 20. The simulation is done using HSPICE.The proposed CNT based FC-OTAs have been compared with a conventional CMOS based FC-OTA. A comparative analysis of the proposed CNT based FC-OTAs with the conventional CMOS based FC-OTAs has shown a significant improvement.

Index Terms— CMOS, CNTFET, CNT,Low Power Consumption, Moore's Law, OTA.

1 Introduction

Principle of Operational Transconductance Amplifier (OTA): The operational transconductance amplifier (OTA) is a basic building block of electronic systems. The function of a transconductor is to convert an input voltage into an output current. The transconductance amplifier can be configured to amplify or integrate either voltages or currents[1-5]. The versatility of an OTA allows its use in many electronic systems such as filters, analog-to digital converters, and oscillators. An OTA is also used as the core amplifier for an operational amplifier. The operational transconductance amplifier is an essential element of many analog systems. The amplifier has two voltage inputs and a single current output. Fully-differential versions are available and are commonly used in integrated circuits. The output current of an OTA is proportional to the difference between the input voltages[6-10].

2 Proposed Circuit for Operational Transconductance Amplifier

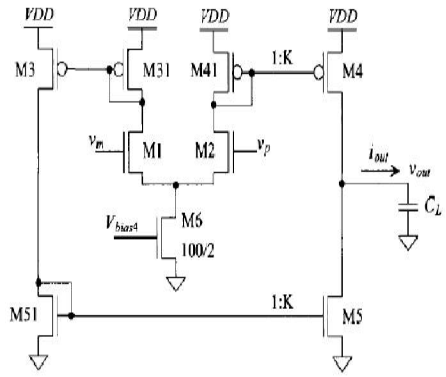

FIGURE 1 AN OPERATIONAL TRANSCONDUCTANCE AMPLIFIER

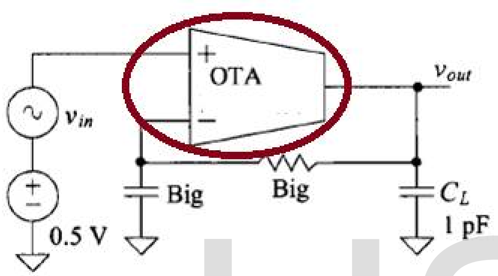

Figure 2 test setup for AC Response of the OTA

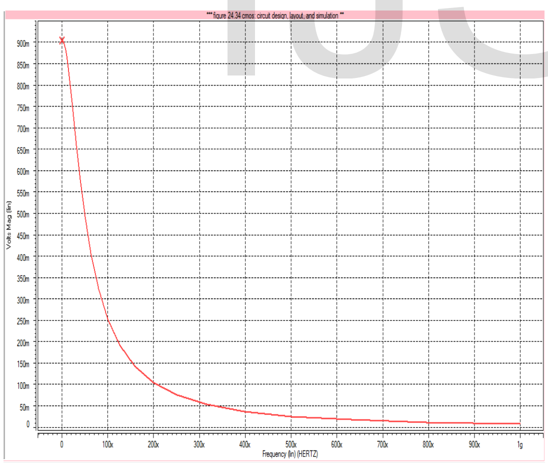

Figure 3 Simulation waveform of Output voltage

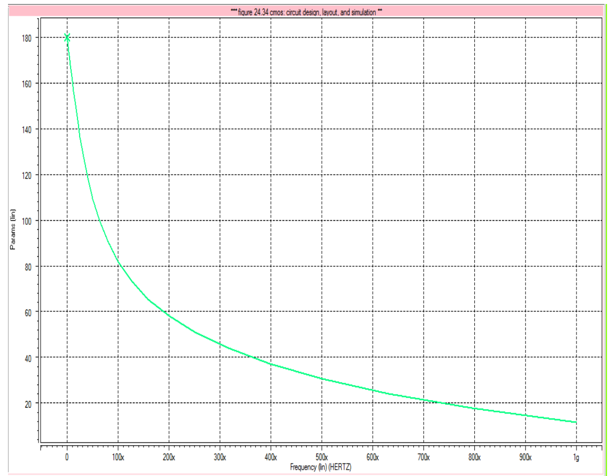

Figure .4 Waveform Phase Margin in 180⁰

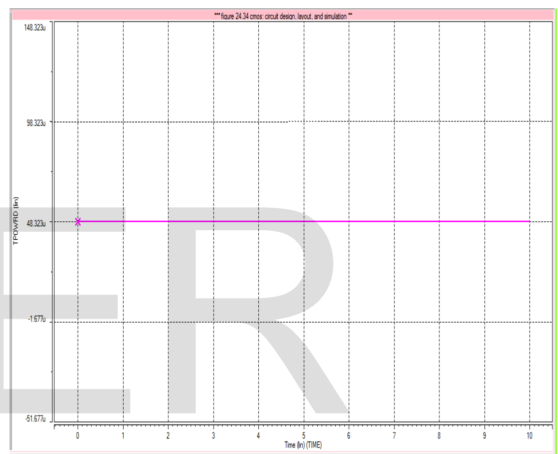

Figure 5 Average Power

Table 1 Parameters of CNT-OTA using H-spice

S.No.	Parameter	Value
1	Band width in GHz	3.3373E+07
2	Phase Margin in degree	1.7299E+02
3	Slew Rate in V/µs	2.7742E+02
4	Average Power in µW	4.8323E-05
5	Output Resistance KΩ	1.9966k
6	Unity Gain Frequency in dB	6.0188E+06

3. CONCLUSIONS

In this work, CNT-based OTAs are designed, simulated using HSPICE at 65nm technology. The OTAs designed are based on the CNT and CNTFET, a promising technology for future highly ICs.

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