IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 8, August 2019

Simulation Study of High Performance Low Pass filter at Nanoscale

Sarah Khwaja[1]

Bachelor of Engineering from Jamia Millia Islamia, India[1]

Abstract: This paper presents a design and simulation study of high performance low-pass filter based on Cascode OTA using 0.9 V. The cascode OTA is used as the active building block. It is a new class of Operational Amplifier (OP-AMP). It has flexibility and tunability unlike Op Amp. Further, CNT technology is used along with MOS technology to design and simulate proposed structure at 45nm technology node. The proposed structure can be used. Figure 2 shows the schematic diagram of one of the important application of CNT, that is, Carbon Nanotube Field Effect Transistor (CNTFET). In a CNTFET, the channel is made up of parallel combination of SWCNTs. The source and drain regions are highly doped regions and the CNT channel is undoped. The important advantages of CNTFET include 1D ballistic transport of charge carriers, high mobility, large drive current and very low power consumption for low power applications. It is observed that the proposed LPF is also consuming low power of 28.43 µW.

Keywords: CMOS, CNTFET, DC Gain, Cascode -OTA, Power consumption, Filters, LPF

I. INTRODUCTION

OTA is a building block whose differential input voltage produces an output current. It is also called as voltage controlled current source. There is usually an additional input for a current to control the amplifier's transconductance. The OTA is similar to a standard operational amplifier in that it has a high impedance differential input stage and that it may be used with negative feedback. Cascode OTA is a new class of OTA. It has improved gain (due to high output resistance) and bandwidth due to reduced Miller capacitance. In order to ensure further improvement in Cascode OTA performance, we have proposed Carbon Nanotube Field Effect Transistors (CNTFETs) based Circuits that promise to deliver much better performance than existing CMOS based Cascode Operational Transconductance Amplifiers. CNTFET technology can easily club with the bulk CMOS technology on a single chip and utilizes the same infrastructure at 45nm. An active low pass filter is an analog circuit that is widely used in communication systems and signal processing to pass a range of frequencies & reject the higher frequency. It can be easily designed by a conventional operational amplifier. But CMOS operational transconductance amplifier can be used to design a LPF resulting reduced power dissipation & fabrication cost [1-6].

II. CASCODE OPERATIONAL TRANSCONDUCTANCE AMPLIFIER (COTA)

The signal processing is well known that needs several functions for obtaining the desired signal and removing the unwanted signals. Analog filter is an important subsystem for achieving their functions. First of all, RLC circuits are preferred to use as a filter in the system but they had drawbacks if the band of frequency was changed. Manually tuned of capacitors and inductors was required but it is not practically used. Next generation of electronic design using large scale integrated circuit was exhibited. Versatile amplifier named OPAMP and RC were preferred to design as well as analog filter. Although, the manual tunability can be done but the completed system is quite large and cannot provided electronically controlled feature. OTA has more advantages compared to OP-AMP like higher input-output isolation, higher input impedance, high output impedance, higher gain or higher bandwidth with additional applications. Flexibility and tunability are the big advantages of OTAs. The output current io of the ideal OTA can be expressed by equation (1)

$$io = gm\,(vp - vn) \qquad (1)$$

Where gm is the transconductance, vp and vn are positive and negative input terminals respectively. The ideal OTA has infinite output resistance. All of io flows in the external capacitive load and none flows in the OTA's own output resistance .Towards increasing the OTA output resistance, the current mirrors are cascoded. Cascode amplifier configuration improves gain due to high output resistance and bandwidth due to reduced Miller capacitance.

III. PROPOSED COTA BASED LOW PASS FILTER

The Cascode transconductance Operational transconductance (COTA) circuit is used to design LPF at 45nm. Figure Shows the Cascode OTA and proposed LPF is simulated using 0.9 V.

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 8, Issue 8, August 2019

Figure 1 shows the schematic diagram of one of the important application of CNT, that is, carbon nanotube field effect transistor (CNTFET). In a CNTFET, the channel is made up of parallel combination of SWCNTs. The source and drain regions are highly doped regions and the CNT channel is undoped. The important advantages of CNTFET include 1D ballistic transport of charge carriers, high mobility, large drive current and very low power consumption [7-11].

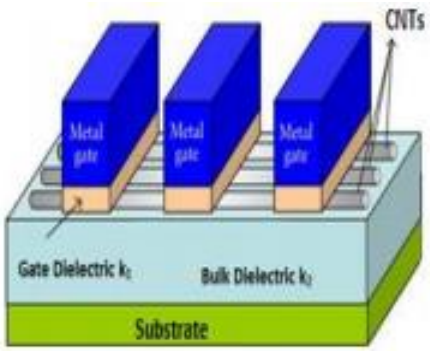

Figure 1. Schematic of a CNTFET

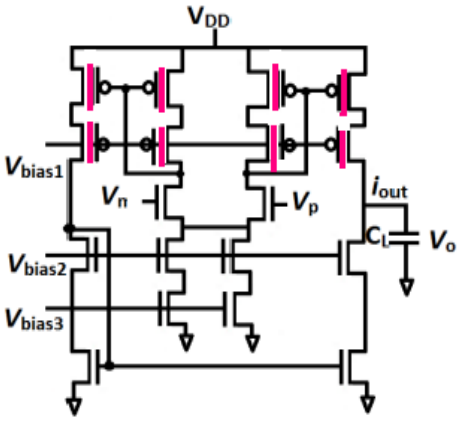

Figure 2. Cascode OTA

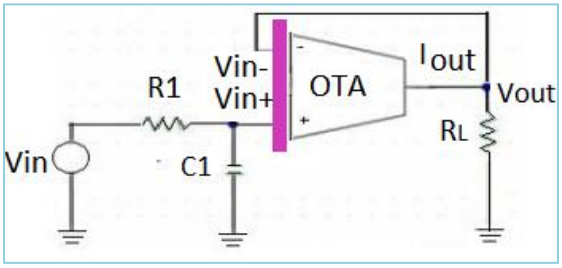

Figure 3. Proposed Low Pass Filter

Application of Cascode Operational Transconductance Amplifiers (COTAs) in Low Pass Filter. The active filter design using operational amplifier has a serious limitation over the applications in the high frequency regions.

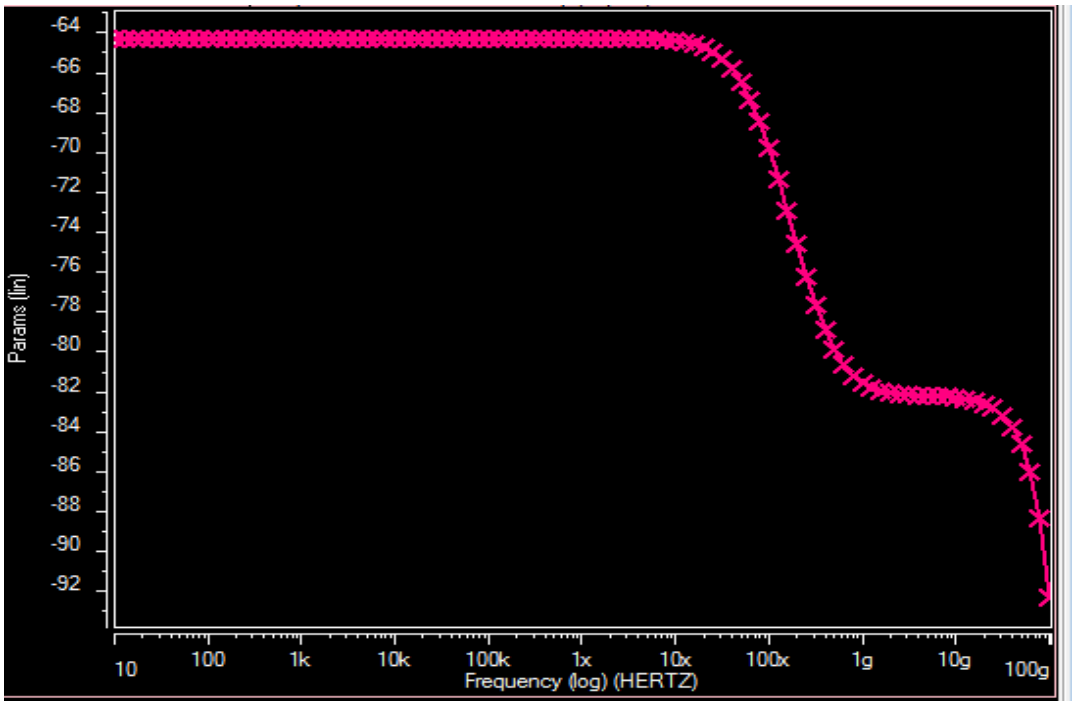

Figure 4. Frequency response of Proposed LPF

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 8, Issue 8, August 2019

To overcome these limitations active filters using OTAs are popular due to the salient features of OTA such as , the adjustable transconductance (gm) over wide range of bias current, excellent matching between amplifiers, the linearity of transconductance with bias current , controlled impedance buffers and high output signal to noise ratio, which popularizes OTA in active filter design. Filters can be readily built using COTAs. Considerable flexibility in controlling those specific filter characteristics that are usually of interest is possible with COTAs . In this paper, we have implemented Low pass filter.

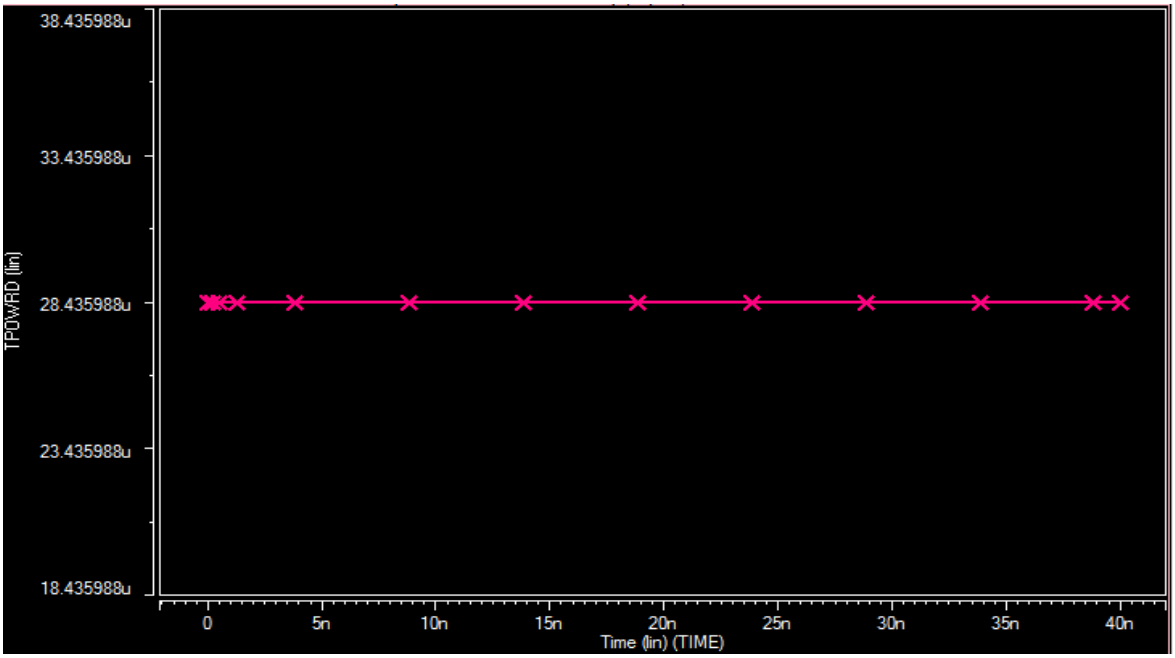

Figure 5. Average Power of Proposed LPF

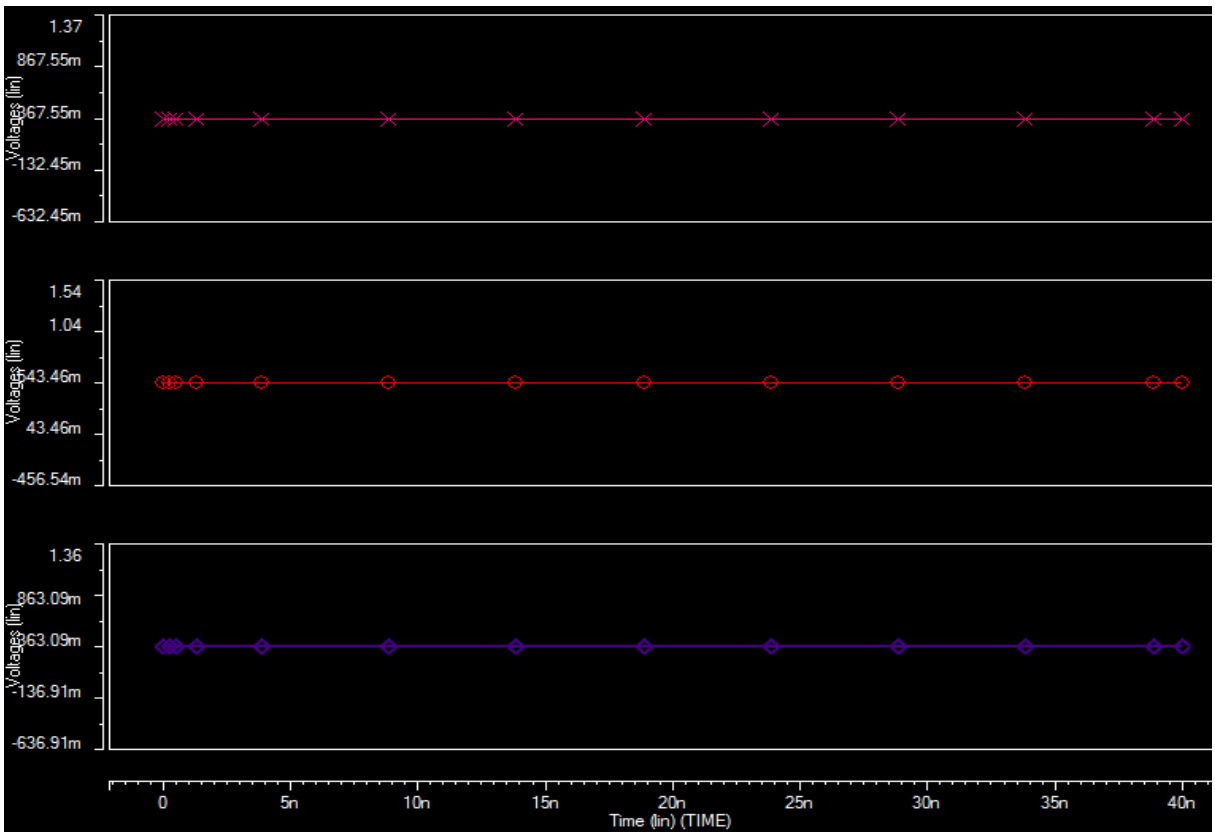

Figure 6. Biasing Supply used in Proposed LPF

IV. CONCLUSION

Cascode Operational Transconductance Amplifiers (COTA) based Low pass filter is designed and simulated at 45nm technology using 0.9V for analog applications. It has been designed and simulated using novel carbon nanotube based MOS structures and conventional MOSFETs. The proposed structure is useful in nanoelectronic circuits. It is observed that the proposed LPF is also consuming low power.

REFERENCES

[1]. J.Appenzeller,"Carbon nanotubes for high performance electronics (Invited paper)" Proceedings of the IEEE 96(2), 206, 2008.
[2]. Liang Zuo, and Syed K. Islam,"Low-Voltage Bulk-Driven Operational Amplifier with Improved Transconductance", IEEE Transactions on Circuits and Systems—I: Regular Papers, vol.60, no. 8, pp-2084-2091, August 2013.
[3]. Li Tianwang, Ye Bo and Jiang Jinguang," A novel fully differential telescopic operational transconductance amplifier", Journal of Semiconductors , IOP Science, vol. 30, no. 8, August 2009.
[4]. Xuguang Zhang and Ezz I. El-Masry,"A Novel CMOS OTA Based on Body-Driven MOSFETs and its Applications in OTA-C Filters", IEEE Transactions on Circuits and Systems—I: Regular Papers, vol. 54, no. 6, pp 1204-1212 , June 2007.
[5]. A.K. Kureshi, M. Hasan, "Comparison of performance of Carbon nanotube FET and bulk CMOS based 6T SRAM cell in deep submicron", Microelectronics Journal 40 (6), page 979–982, 2009.
[6]. S.A.Loan, M. Nizamuddin et.al., "High Performance Carbon Nanotube based Cascode Operational Transconductance Amplifiers", Vol I, Jul 2-4, World Congress on Engineering, London, 2014.
[7]. M. Nizamuddin, S. A. Loan, et.al., "Design, simulation and the comparative analysis of CNTFET based multistage operational amplifiers",Vol-12, Journal of Nanoelectronics and Optoelectronics, U.S.A 2017.
[8]. M. Nizamuddin, et.al., "Carbon Nanotube based three stage Operational Amplifiers, A simulation Study", Volume 3, Issue 2, 2016, Pages 449-453, Journal of Materials Today Proceedings-Elsevier, 2015.
[9]. M. Nizamuddin, S. A. Loan, et.al., "Design, simulation and comparative analysis of CNT based Cascode Operational Transconductance Amplifiers", Volume 26 , Number 39, 02 , Nanotechnology, IOP Publishing Ltd,October 2015.
[10]. S. A. Loan et al., Design of a novel high gain carbon nanotube based operational transconductance amplifier, Proc. IMECS (2014) pp. 797–800.
[11]. S.A.Loan, M.Nizamuddin et.al.,"Design & Comparative Analysis of High Performance Carbon Nanotube-Based Operational Transconductance Amplifiers", Vol. 10, No. 3, NANO: World Scientific, 2015.