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Design and Performance Analysis of Low Power Band Pass Filter at 32 nm Technology

Sarah Khwaja

Bachelor of Engineering from Jamia Millia Islamia, India

Abstract: In this paper, design and simulation of High performance Band-pass filter based on CNTFET-COTA using 32nm technology node is proposed. The Cascode Operational Transconductance Amplifier (COTA) is an amplifier whose differential input voltage produces an output current. It is a Voltage Controlled Current Source (VCCS). There is usually an additional input for a current to control the amplifier's transconductance. The COTA is similar to a standard operational amplifier in that it has a differential input stage and that it may be used with negative feedback. The COTA 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 to design and simulate proposed structure at 32 nm technology node. The proposed structure uses Carbon Nanotube Field Effect Transistor (CNTFET). In a CNTFET, the channel is made up of parallel combination of SWCNTs. It is observed that the proposed BPF is also consuming low power of 553 nW.

Keywords: CMOS, CNTFET, DC Gain, Cascode -COTA, Power consumption, Filters, BPF

I. INTRODUCTION

Cascode OTA is a new class of OTA. It has improved gain (due to Band output resistance) and bandwidth due to reduced Miller capacitance. In order to ensure further improvement in Cascode COTA 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 32nm. An active band pass filter is an analog circuit that is widely used in communication systems and signal processing.

II. DESIGN OF BAND PASS FILTER

Band pass filters are used in electronic systems to separate a signal at one frequency or within a band of frequencies from signals at other frequencies. Band pass filters have two stop bands, one above and one below the pass band. Such a filter could also reject unwanted signals at lower and higher frequencies outside of the pass band, so it could be useful in situations where the signal of interest has been contaminated by signals at a number of different frequencies. Flexibility and tunability are the big advantages of OTAs. The output current io of the ideal COTA 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 Band output resistance and bandwidth due to reduced Miller capacitance.

III. PROPOSED COTA BASED BAND PASS FILTER

The Cascode Operational Transconductance Amplifier (COTA) circuit is used to design BPF. The proposed BPF is simulated using 0.9 V at 32 nm. Figure 1 shows the structure of MOSFET like 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, Band mobility, large drive current and very low power consumption [7-11].

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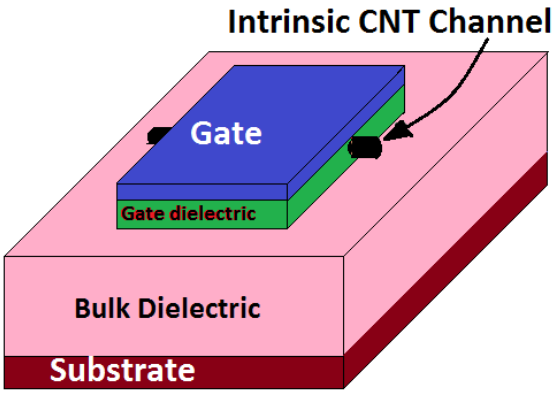

Figure 1. Structure of MOSFET like CNTFET [2]

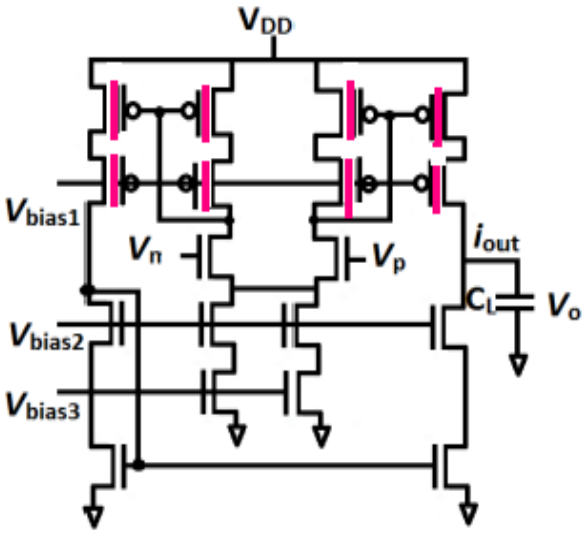

Figure 2. COTA [9]

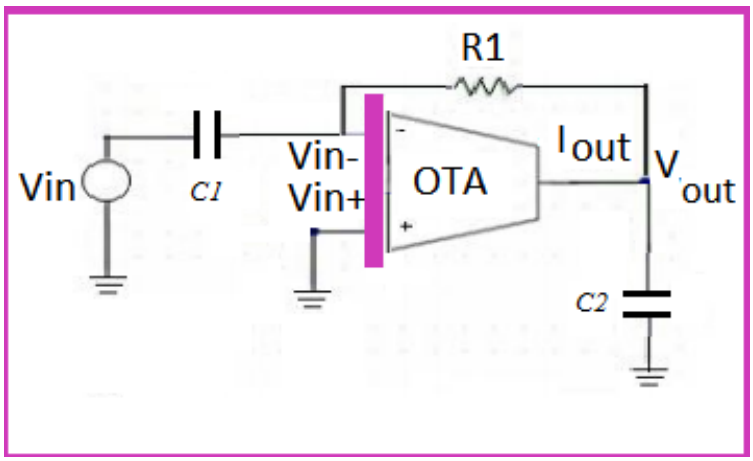

Figure 3. Proposed Band Pass Filter

The active filter design using operational amplifier has a serious limitation over the applications in the Band frequency regions. To overcome these limitations active filters using COTAs are popular due to the salient features of COTA 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 Band output signal to noise ratio, which popularizes COTA 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 .

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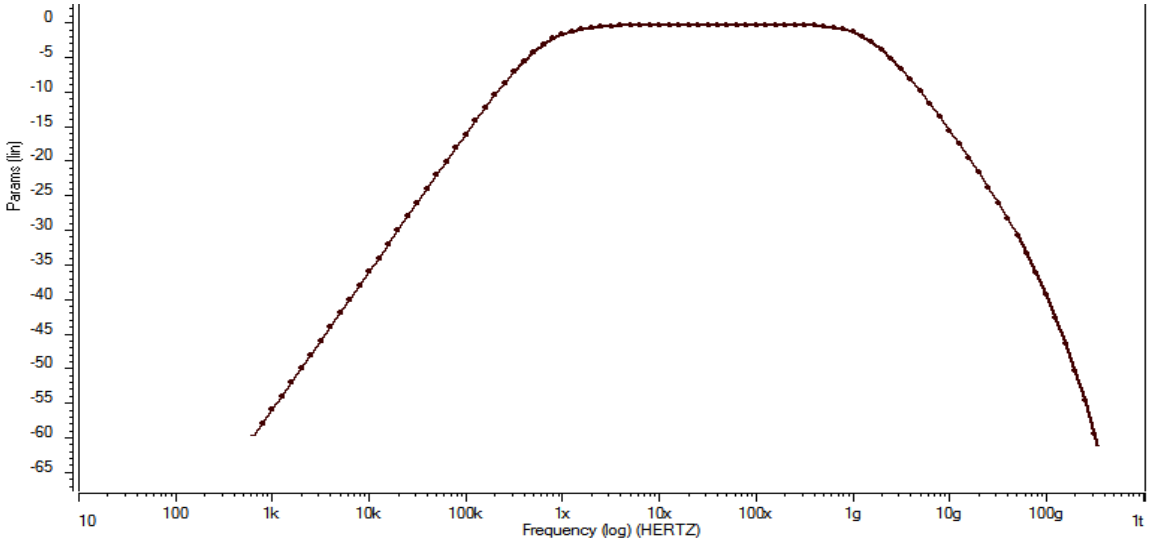

Figure 4. Frequency response of Proposed BPF

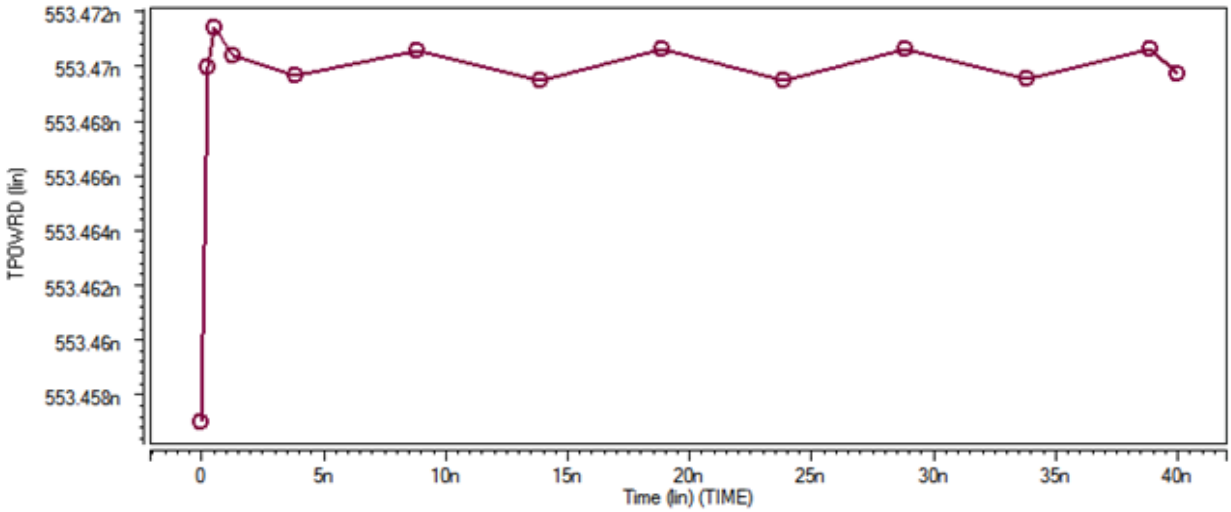

Figure 5. Average Power of Proposed BPF

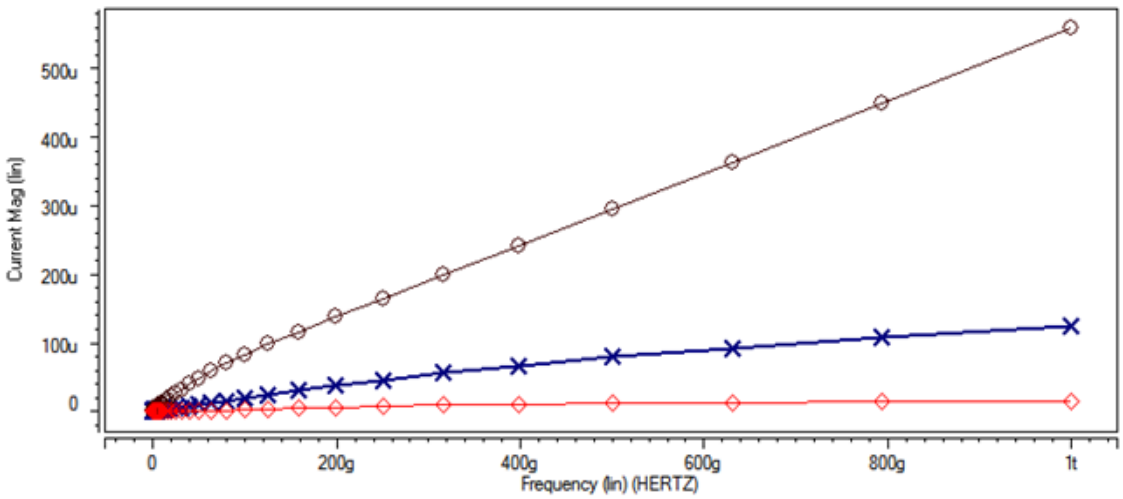

Figure 6. Biasing Currents used in Proposed BPF

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IV. CONCLUSION

Cascode Operational Transconductance Amplifiers (COTA) based Band pass filter is designed and simulated at 32 nm 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 BPF is also consuming low power of 553 nW. The simulated results are showing better. It is shown from the frequency response characteristics of Band Pass filter that the filtering can be performed successfully over the designed range with a reasonable accuracy.

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