DESIGN AND PERFORMANCE ANALYSIS OF LOW POWER BAND STOP FILTER

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ABSTRACT

In this paper, design and simulation of High performance Band-stop filter based on CNTFET-COTA using 45 nm technology node is proposed. The Cascade Operational Trans conductance amplifier (COTA) is an amplifier whose differential input voltage produces an output current. It is a voltage controlled current source (VCCS). Further, CNT technology is used to design and simulate proposed structure at 45 nm technology node. The proposed structure uses carbon nanotube field effect transistor. In a CNTFET, the channel is made up of parallel combination of SWCNTs. It is observed that the proposed BSF is also consuming low power of 42 μW .

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

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1. 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 [1-5]. 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 [6]. CNTFET technology can easily club with the bulk CMOS technology on a single chip and utilizes the same infrastructure at 45 nm [7].

2. DESIGN OF BAND STOP FILTER

A filter with effectively the opposite function of the band pass is the band stop or notch filter. Notch filters are used to remove an unwanted frequency from a signal, while affect -ing all other frequencies as little as possible. It is formed by the combination of low pass and high pass filters with a parallel connection instead of cascading connection.

Since it eliminates frequencies, it is also called as band elimination filter or band reject filter or notch filter.

Unlike high pass and low pass filters, band pass and band stop filters have two cut-off frequencies. It will pass above and below a particular range of frequencies whose cut off frequencies are predetermined depending upon the value of the components used in the circuit design. Any frequencies in between these two cut-off frequencies are attenuated.

When the input signal is given, the low frequencies are passed through the low pass filter in the band stop circuit and the high frequencies are passed through the high pass filter in the circuit. This is shown in below block diagram.

Figure 1. Concept of band stop circuit

The R-C band stop filter is similar to a band pass filter in which the shunt arm is replaced by the series arm and the series arm is replaced by the shunt one.

Flexibility and tunability are the big advantages of OTAs. The output current i_o of the ideal COTA can be expressed by equation (1)

$$i_o = g_m (v_p - v_n) \quad (1)$$

Where g_m is the transconductance, v_p and v_n are positive and negative input terminals respectively. The ideal OTA has infinite output resistance. All of i_o 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.

3. PROPOSED COTA BASED BAND STOP FILTER

The Cascode Operational transconductance amplifier (COTA) circuit is used to design BSF. The proposed BSF is simulated using 0.9 V at 32 nm.

Figure 2. (a) Different types (b) different configurations of SWCNT

The carbon nanotubes exist in two forms: (i) Single wall carbon nanotube (SWCNT) and (ii) multiwall carbon nanotube as shown in Figure 1(a). SWCNT are actually tubes of graphite that are normally capped at the ends. They can be visualized as a layer of graphite rolled into a seamless cylinder [8]. Their diameter is around 1nm and length a few microns. They are superior to MWCNT, however, are costlier. MWCNT appear like a coaxial assembly of SWCNTs, like a coaxial cable. They diameter of MWCNT ranges from 5-50 nm and the inter layer spacing is 3.4Å. They are easy to produce in large quantity. However, the structure is complex and the structural imperfections may diminish their unique properties [10]. The wrapping of graphite sheets in SWCNT can be represented by a pair of indices (n, m), called as the chirality vector or roll-up vector, as shown in Figure 1(b). There are three types of SWCNTs based on the chiral vector and chiral angle (θ).

Figure 3. Shows the schematics 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 [11].

Figure 3. Schematic of a CNTFET

Figure 4. COTA [9]

Figure 5. Proposed Band Stop 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 (g_m) 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.

Figure 6. Frequency response of Proposed BSF

Figure 7. Average Power of Proposed BSF

Figure 8. Biasing Currents used in Proposed BSF

4. CONCLUSION

Cascode Operational transconductance amplifiers (COTA) based Band stop filter is designed and simulated at 45 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 Nano electronic circuits. It is observed that the proposed BPF is also consuming low power of 42 μ W. It is shown from the frequency response characteristics of Band Stop filter that the filtering can be performed successfully over the designed range with a reasonable accuracy.

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