DESIGN AND SIMULATION OF ADVANCED BUFFERED AMPLIFIER FOR LOW POWER BIOMEDICAL APPLICATIONS

Sarah Khwaja

Bachelor of Engineering (Gold Medalist), Jamia Millia Islamia, India

ABSTRACT

In this paper, Advanced Buffered Amplifier is designed using Cascode Operational transconductance amplifier at 45 nm technology using 0.9V. The proposed structure uses carbon nanotube field effect transistors. It is observed that the proposed Buffered Amplifier has Bandwidth of 467GHz, Power Dissipation of 0.35 μ W, Output Impedance of 1.6 K Ω , Input Impedance of 6.5 K Ω , Phase Margin of 187degree. Further, in the proposed structure, Bandwidth is 29.72 % higher, Power Dissipation is 42.85 % lower, Output Impedance is 11.11 % lower, Input Impedance is 8.3 % higher as compared with its CMOS counterpart. The proposed advanced buffered amplifier is electronically tunable. It can be used for Low Power Biomedical Applications due to low power, low voltage and low amplitude of signal.

Keywords: CMOS, CNTFET, COTA, Power consumption, Buffered Amplifier

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1. INTRODUCTION

Cascode Operational transconductance amplifier (COTA) is a new class of O.T.A. It has improved gain (due to Band output resistance) and bandwidth due to reduced Miller capacitance [1-2]. In order to ensure further improvement in Cascode COTA performance, Carbon Nanotube Field Effect Transistors (CNTFETs) based Circuits that promise to deliver much better performance than existing CMOS based Cascode Operational transconductance amplifiers is proposed [2-4]. CNTFET technology can easily club with the bulk CMOS technology on a single chip and utilizes the same infrastructure at 45 nm [5-7].

2. DESIGN OF ADVANCED BUFFERED AMPLIFIER

A buffer amplifier (sometimes simply called a buffer) is one that provides electrical impedance transformation from one circuit to another, with the aim of preventing the signal source from being affected by the load.

Figure 1. The off-axis and top views of MWCNTs with three walls

3. PROPOSED COTA BASED ADVANCED BUFFERED AMPLIFIER

The Cascode Operational Transconductance Amplifier circuit is used to design Buffered amplifier. The proposed Buffered amplifier is simulated using 0.9 V at 45 nm. In the Cascode Operational transconductance amplifier based Advanced Buffered Amplifier, there is no need of negative feedback and feedback resistor. Further the proposed Amplifier consumes very low power and simple circuitry. Furthermore, the proposed advanced buffered amplifier is electronically tunable [8-12].

Figure 2. Different configurations of Single wall CNT.

The carbon nanotubes exist in two forms: (i) Single wall carbon nanotube (SWCNT) and (ii) multiwall carbon nanotube as shown in Figure 1. 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 [8-9]. 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. 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 important advantages of CNTFET include 1D ballistic transport of charge carriers, high mobility, large drive current and very low power consumption [11]. Nanotube diameter and chiral angles are given as [12-22]

$$d_t = \frac{\sqrt{3}a_{c-c}\sqrt{m^2 + mn + n^2}}{\pi}$$

$$\theta = \tan^{-1} \frac{\sqrt{3}n}{2m + n}$$

Figure 3. Carbon nanotube field effect transistor (CNTFET) (a) Schematic; (b) Top-View

Figure 4. Cascode Operational Transconductance Amplifier [9]

Figure 5. Advanced Buffered amplifier

Figure 6. Frequency response of Proposed Buffered Amplifier

Figure 7. Average Power of Proposed Buffered amplifier

Figure 8. Biasing Voltages used in Proposed Buffered amplifier

Table 1 Performance Measuring Parameters at 0.9 V using 45 nm technology node

S. No.	Parameter	Proposed Buffered Amplifier	Conventional Buffered Amplifier
1	Bandwidth	467 GHz	360 GHz
2	Power Dissipation	0.35 uW	0.63 uW
3	Output Impedance	1.6 K	1.8 K
4	Input Impedance	6.5 K	6 K
5	Phase Margin	1870	1860

4. CONCLUSION

In this work, Simulation study of Advanced Buffered Amplifier for Low Power Biomedical Applications is proposed. The proposed structure uses carbon nanotube field effect transistor. In the proposed structure, Bandwidth is 29.72 % higher, Power Dissipation is 42.85 % lower, Output Impedance is 11.11 % lower, Input Impedance is 8.3 % higher as compared with its CMOS counterpart. Furthermore, the proposed advanced buffered amplifier is electronically tunable. It can be used for Low Power Biomedical Applications.

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