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High Performance Voltage Differencing Inverting Buffer Amplifier (VDIBA)

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***Abstract:** This paper presents Low Voltage bulk driven technique based low-voltage low-power variant of recently proposed an active element namely Voltage Differencing Inverting Buffered Amplifier (VDIBA). The proposed configuration operates at lower supply voltage 0.6V with the total quiescent power consumption of 1.36mW at the biasing current of 10 µA. The simulations are performed using CADENCE 180 nm CMOS technology parameters with 0.6V supply voltage to validate the effectiveness of the proposed circuit.*
Index: Terms: Low-Voltage, VDIBA, Low-Power,Analog Circuit Design.

I. INTRODUCTION

As the technology is scaling and demand of portable electronic equipmentsis growing day by day, it has motivated the researchers in developing low-voltage low-power analog signal processing circuits. Low-voltage low-power design involves various promising techniques so that the complete analog circuit could meet the proposed design requirements. Various low-voltage, low-power design techniques have been reported in many literatures explaining techniquies like sub-threshold MOSFETs, level shifter approach, self-cascade approach, bulkdriven approach and use of FGMOS instead of simple MOSFETs [2–11].Blolek et al. [14] have introduced and explains behavioral model of new active element like Voltage Differencing Buffered Amplifier (VDBA),Voltage Differencing Current Conveyor (VDCC) Voltage Differencing Transconductance Amplifier (VDTA),. These active elements are obtained by replacement of current differencing unit in Current Differencing Buffered Amplifier (CDBA), Current Differencing Transconductance Amplifier (CDTA) etc. by the voltage differencing unit. The differential OTA at the input stage is used to generate the voltage difference in these newly introduced active elements. Theseabove suggested topologies have simpler structure as well as increased electronic tunability. Recently, NobertHerencsar et al. [1] have introduced to an active element VDIBA that has gained wide popularity due to its simpler structure consisting only six MOS transistors.

The input stage and the output stage of VDIBA consistof operational transcoductance amplifier and unity gain inverting buffer respectively. Tunability feature of built-in OTA in these blocks is helpful for compensating the unwanted parameter variation caused because of PVT variations. Though these modifications are attention-grabbing and give advantage of advanced electronic management, they lack the characteristics of low voltage and low power active component. Therefore, the major aim of this paper is to introduce low-voltage low-power variant of typical VDIBA developed by using bulk driven technique that may well be utilized in more difficult applications.

The paper is organized as follows: basics of Bulk Driven Technique are given in Section II. New low-voltage low-power and high operating frequency variants of VDIBA are introduced and analyzed in Section III. Section IV deals with the simulation results and finally the paper is concluded in Section V.

II. BULK DRIVEN TECHNIQUE

Amplifiers operating at very low supply voltages are best for bio-medical and sensor applications where energy can be harvested from its environment1. In biomedical devices such as ambulatory heart detectors and hearing aids very low power consumption is used to increase the battery life. There is equal importance for low voltage and lower power operation in portable applications as low voltage operation enables the use of lesser of batteries thereby being advantageous for size and weight considerations and the battery life gets improved by low power consumption. For low voltage the main idea is to make the circuit operate in the weak inversion region. There are various approaches like floating gate approach, self-cascode structures.

The principle of the bulk-driven technique is that the input is given on the body that is less than the threshold voltage and a voltage is being set on the gate terminal so as to form a channel. The thickness of the depletion zone i.e. the conduction channel is affected by the bulk voltage. A bulk-driven symmetrical OTA operating in weak inversion can result in both reduced power consumption

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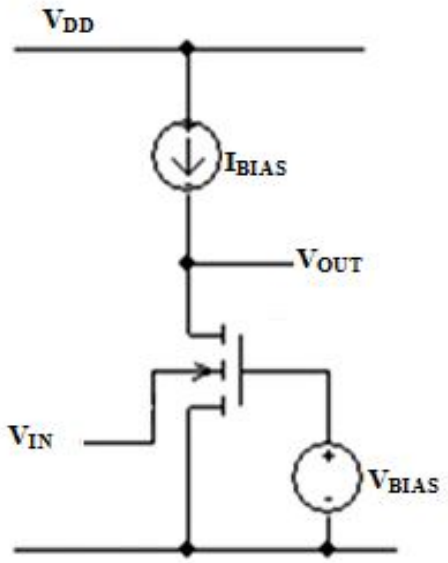
and high linearity. The utilization of this technique makes it conceivable to design low-voltage OpAmps with very large value of input CMRR and low power dissipation on the CMOS technologies.

In this technique, a fixed voltage is associated with the gate terminal and the input is given into the bulk terminal as shown in Fig.1. With the zero-bias voltage on the bulk terminal the transistors are in weak inversion. The two fundamental favorable circumstances of utilizing the bulk-driven system are that the bulk- driven differential sets in an OpAmp and incredibly enhance the transconductance and the threshold voltage of the transistor vanishes and both negative and positive bias voltages (VBS) are conceivable.



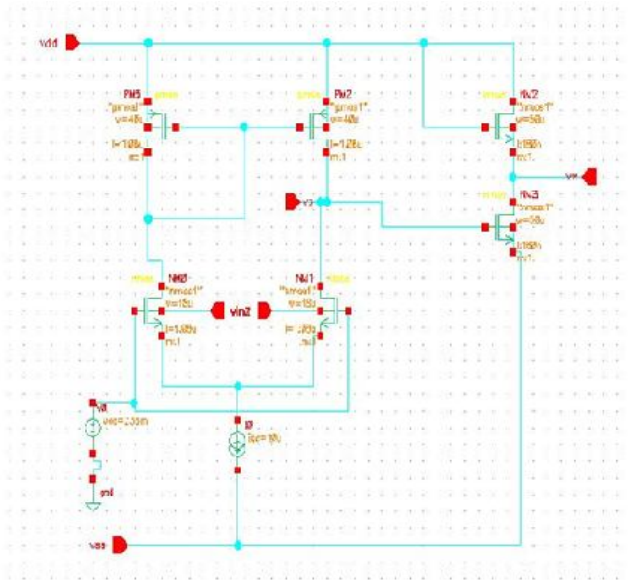
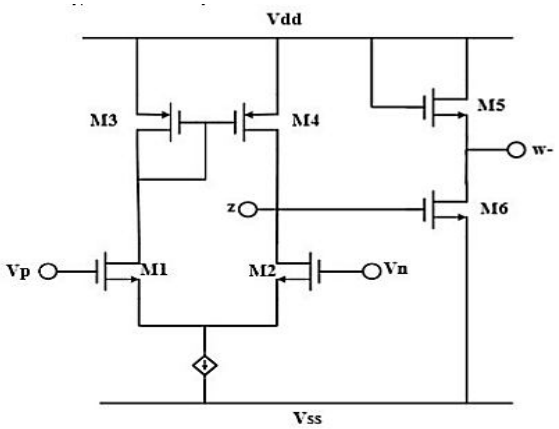


Fig.1- Block Diagram of Bulk Driven nMOS[1] Fig.2 CMOS implementation of VDIBA

III. PROPOSED LOW-VOLTAGE LOW-POWER BULK DRIVEN BASED VDIBA

CMOS implementation and equivalent circuit symbol of standard VDIBA [2] is shown in Fig. 2 and 3 respectively. The input stage of VDIBA consisting transistors M1-M4 makes the OTA stage that convertsthe differential input voltageintocurrent.TheoutputstagefashionedbyM5-M6is a unity gain inverting buffer with M5 operating as nMOS load.Thecircuithas highimpedanceinputportsofOTAi.e.p andn,ahighimpedanceoutputportzanda lowerimpedance outputvoltage port w. Port relations of VDIBA are representedbyfollowingmatrixwhere g_m is the transconductance parameter of OTA stage and β which is ideally unity; denotes the non-ideal voltage transfergainbetween portszandw.

The proposed configuration offers many attractive features such as low static power dissipation alongwith high outputresistanceofthefirststage.



.Fig.2 CMOS implementation of VDIBA

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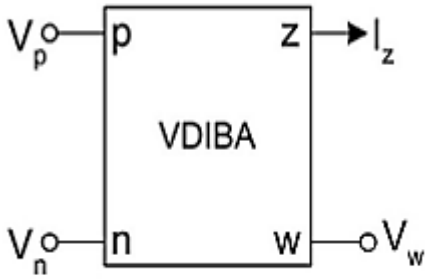

Fig.3-Symbol of Standard VDIBA.

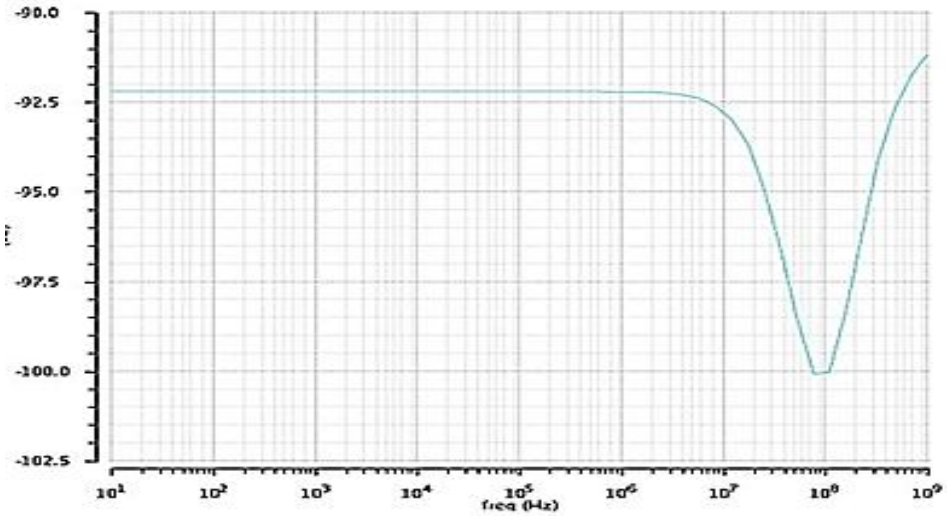

Fig.4Schematic of Improved VDIBA

The schematic of Improved VDIBA has been created by using virtuoso schematic composer as shown in Fig.4. For the simulations, DC power supply voltage shave been taken as $+V_{DD}$ =-V_{SS}= ±0.6V. The bias current is set at 10µA.

IV. RESULTS AND SIMULATION

The designed circuits are simulated using CADENCE in TSMC180nmCMOStechnology using ±0.6Vpowersupply. The Fig.5 shows the graph between the output currentIz and input voltages Vp and Vn. The linearity can be viewed which varies from (-350mV) – (+350mV) where the biasing currentis10µA

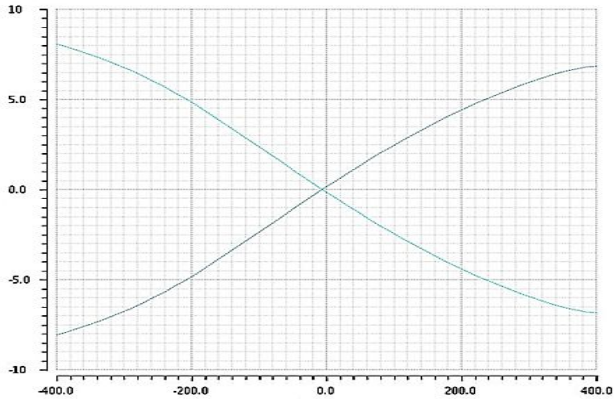

Fig.5 DC analysis of Improved VDIBA for Iz versus V_P,V_N

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Table 1 Result of Proposed VDIBA

Parameter	Proposed VDIBA
Technology	180nm
Supply voltage	0.6V
Linearity	(-350-+350)mV
Frequency	31.6MHz
Power dissipation	1.30mW

The Table.1 provides all the detailed results of simulationsdoneoncadenceofthepproposedcircuit.
Fig.6 shows the ac analysis of proposed VDIBA with the frequency of 31.6MHz.

Fig.6 AC Analysis of Improved VDIBFig.7 shows the power dissipation of proposed VDIBA which is 1.30mW.

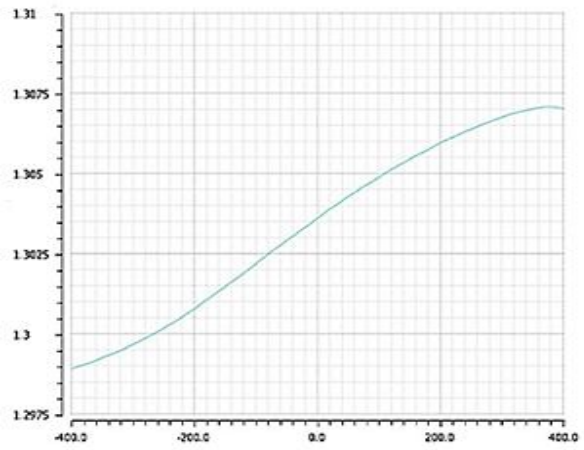

Fig6 Power Dissipation of the improved VDIBA circuit

V. CONCLUSION

This paper presents Low Voltage Bulk driven based voltage differencing inverting buffered amplifier. It operates at a lower supply voltage and has reduced power dissipation. The proposed VDIBA is used in the realization of a low voltage filterapplications and several attractive features such as independently tunable filter parameters, cascadability and low sensitivity. Therefore, the proposed VDIBA may be useful in lowvoltage low-power analog signal processing orgenerationapplications.

VI. ACKNOWLEDGMENT

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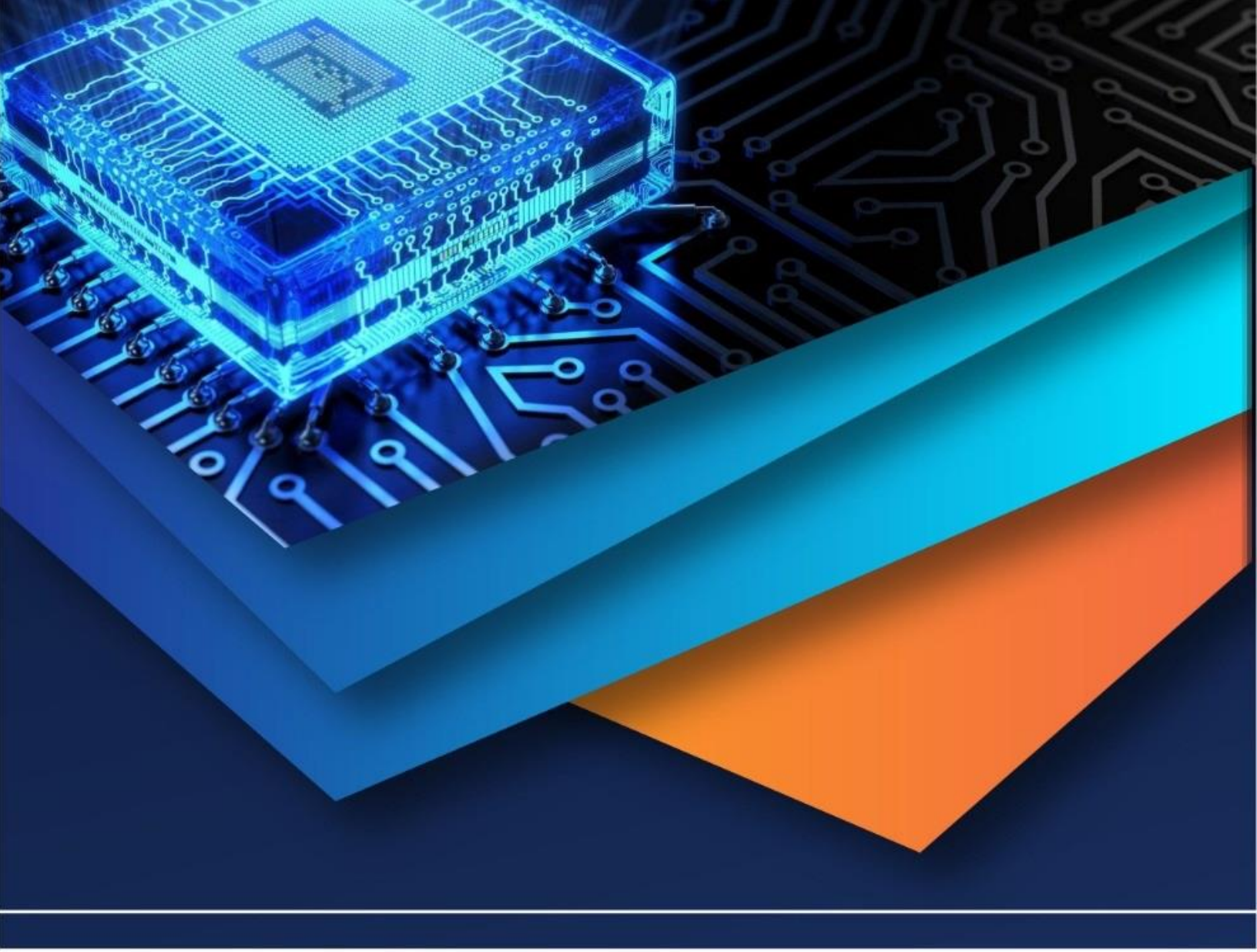

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