Low Noise Operational Amplifier using Current Driving Bulk by CMOS Technology

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Abstract: - A reverse substrate bias operational amplifier using existing driver technology has been designed and implemented using 0.25µm CMOS process to achieve high noise performance. Op amps are efficient and versatile devices. Its applications include signal conditioning, custom conversion, analog equipment, competitive simulation, and various electronic industries meeting custom design requirements. As the trend of low voltage devices continues, designing high-performance analog circuits becomes increasingly difficult. The main module of analog circuits is the work amplifier. In large electronic devices, there is a trade-off between speed, power, and gain, among other drawbacks. Additionally, in order to reduce costs and integrate analog and digital circuits on a single die, analog designers must face the challenges of using the CMOS process. Design and implementation are done in 0.25µm technology using TSMC libraries and with the help of Tanner tools.

Key-Words: – Operational amplifier, Bulk driven technology, Low voltage, TSPICE, Low noise,TSMC Library,CMOS,Tanner.

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1 Introduction

Op-amps are a good example of how simple circuits can be combined to accomplish complex tasks, [1]. An op amplifier is an amplifier with sufficient forward gain such that when negative feedback is used, [2], the closed-loop converter will have a positive effect on the op amplifier's gain, [3]. Operational amplifiers are the most widely used of all circuits in manufacturing, [4]. The input transistor of the op-amp plays an important role in the overall noise because the noise of the transistor interacts with the input of the op-amp, [5]. Low noise is inevitable in CMOS technology, so there is a strong need to use designs that reduce noise. Analog designers face the challenge of designing low-noise amplifiers while taking advantage of the unique features of CMOS technology, [6]. An operational amplifier ("op-amp") is a DC-coupled, high-gain electronic voltage amplifier with variable inputs and usually a single output, [7]. The output voltage produced by an operational amplifier is usually hundreds of thousands of times greater than the differential voltage of the input power, [8].

Operating amplifier is an important building block of various electronic circuits. They originate from analog computers and are used in many linear, nonlinear and frequency-dependent circuits, [9]. Their popularity in electrical engineering is mainly due to the fact that the final characteristics (e.g. gain) are set by external devices and are less dependent on temperature and variation of the op amp itself, [10]. Operational amplifiers are one of the most widely used electronic devices today and are widely used in consumer, commercial and research devices, [11]. Due to the complexity of the process and technology, VLSI technology has developed rapidly, [12]. Due to the density, low voltage, and limited features of standard CMOs, Cmos operates more efficiently than competing implementations. Operational amplifier is a type of differential amplifier, [13]. Other types of differential amplifiers include fully differential amplifiers (similar to op amplifiers, but with two outputs), instrumentation amplifiers (usually consisting of three op amplifiers), isolation amplifiers (similar to instrumentation amplifiers, but with tolerances for different voltages of the op amplifier), [14], and negative feedback (usually consisting of one or more op amps and a power feedback loop), [15].

In the paper, the low noise operational amplifier with current drive bulk technique using 0.25µm CMOS process is presented. The power dissipated is less than 3mv. Using this current drive bulk technique, the threshold voltage required for transistors can be reduced and speed can be increased, [16]. The paper is organized is as follows. In section II, current drive bulk technology is reviewed. Section III describes noise analysis. In section IV, a Simulation result is discussed. Section V, finally draws a conclusion.

2 Current Bulk Driven Technology

The operating mode of body-driven MOSFET is depletion mode . Set the gate voltage to a value sufficient to turn on the transistor. Input voltage is then applied to the physical terminal of the transistor (e.g. positive) to change the current flowing through the transistor. The advantage of the physical drive compared to the driver board is that the starting voltage limit is eliminated and both positive and negative are possible, [17].

$$V_{th} = V_{th0} + \gamma\,(\sqrt{2\Phi_F - VBS}) - \sqrt{|\,2\Phi_F|} \qquad (1)$$

The equation-1describes pickup voltage of the MOS transistor as:

a function of the VBS body source voltage is calculated as:
Where
V_{THO} zero bias threshold voltage,
γ bulk effect factor,
Ø Fermi potential

For p channel transistors, $2Ø_F$=- 0.7V, γ=-0.5V and V_{th0}=-0.6V, typically And the volume is usually >0V, which increases the starting voltage. However, we can reduce the threshold voltage by matching VBS<0V, [18]. We want the body's negative pressure to be as high as possible in order to keep the radiation level as low as possible. But this will refer to the body-source diode (for example, the base-emitter diode of a parasitic bipolar transistor (BJT), so turn on the BJT). Therefore, VBS is limited to the current value that the BJT can handle, [19]. This is the concept of the new Current Driven Body (CDB) circuit. Current-driven lumped differential pairs in op-amps greatly increase the input multimode diversity because the lumped driver element allows the input diversity to be nicely coupled to the buffer By properly designing the discrete drivers, the device can maintain the satisfaction of the entire rail-to-rail ICMR, [20]. Running the current system can have many negative effects on the end device.

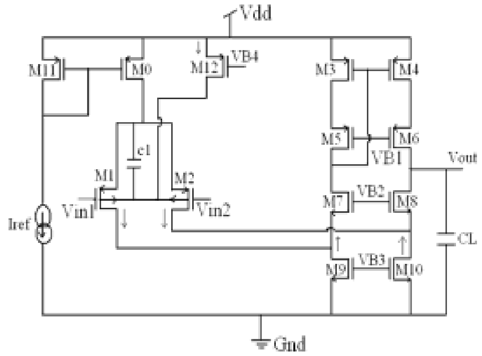

Fig 1: Circuit diagram of low noise amplifier

Driving equipment has the ability to allow its inputs to be extended to the greatest possible disadvantage, [21]. Designing the input stage of the op-amp using different components effectively improves the input mode multi-mode (ICMR) and mode rejection ratio (CMRR) compared to using a driver board, [22].

3 Low Noise Amplifier Design

This operational amplifier is designed using TSMC 0.25um CMOS process. In this design, the PMOS transistor was chosen as a different introduction to the CMOS technology of the P chip because the n-well (the body of the PMOS transistor) can be connected to a potential different from the quality of electronic products. , when the sheet NMOS Common follows the transistor body. PMOS transistors can be made with n-hole insulation . In the case of constant MO tail current. It should be said that the substrate offset must be optimized in different inversion areas to reduce noise. Additionally, the body-cavity junction current cannot exceed the maximum value, [23]. Only when the conditions are met, operation of MOS transistor under weak inversion can achieve better noise than under strong inversion, [24]. Low voltage is taken into account, [25]. This article creates a folded cascode because fast stabilization amplifiers, interface circuits, switched capacitor filters, ADCs, DACs, etc., [26]. It is widely used in electronic data processing applications such as and provides higher operating frequency and better power, [27]. Provides noise suppression. The scheme of the discussion is shown in the Figure. 1 with current driving bulk (CDB) for input differential pair.

Negative voltage must be applied from VB1 to VB4. The input transistor of the op-amp plays an important role in the noise in the circuit because the noise of the following transistors also includes the input of the op amp. The circuit design has four advantages: high voltage, low dissipation, low distortion and small capacitance value. In strong inversion, noise is found to be roughly independent of the substrate offset VBS. On the contrary, the forward biased body increases the low noise of PMOS transistors by 8dB/V, but the expected noise of VBS does not smell of weak inversion, while the dependence on strong inversion increases.

4 Noise Analysis

In our design, PMOS with reverse substrate bias and operating in the saturation region should be selected as the input difference pair to reduce vibration noise, and at the same time, existing driver technology should be applied. This circuit works well in the subthreshold region compared to the saturation region . But the problem is that the design circuit only works in the subthreshold area when vbs < vth, so consider this is beyond the saturation condition of our design and we need to return the substrate bias and not the front substrate bias in our design. Therefore, it is recommended to use PMOS to use current driver devices such as M12, as shown in Figure 1. All noise injected by the current driver enters the generator as a signal type and is limited. The noise analysis of the circuit is shown in Figure 2.

Since the current-driven bulk transistors M1 and M2 are encoded in stages, we do not expect any interference with current technology, [5]. However, when the large type transformer is replaced, the body-drain voltage of the input pair will change, which will lead to switching, [26]. We reduce this variation by adding coupling capacitor C1 between the body and the gap between the input pairs. Schematic (Sedit) and layout (Ledit) views of the designed circuit were simulated using tanner as shown in Figure 2 and Figure 3. Low noise and distortion indicate that the op amplifier is accurate because the two main sources of error, Noise and distortion, are tightly controlled. The performance comparison of the generator we designed and the performance design is shown in Table 1.

The frequency response of the folded cascode op amp is related to the load capacitance CL. The amplitude and phase diagram is shown in Figure 4 and Figure 5 with 54db gain. The DC analysis of the circuit is shown in Figure 7. The integration further increases the bandwidth in our design. Reduce equipment size and reduce energy consumption. This should be attributed to the reverse substrate tendency of the driver body, which uses current technology to reduce noise and use more energy. But higher power consumption can help improve the matching value, current gap and balancing voltage.

5 Simulation Results

The operational amplifier with current driving bulk technology for input differential pair has been simulate during tanner tools. The schematic (Sedit) and layout (Ledit) view of a designed circuit is simulated using tanner which is shown in Figure 2 and Figure 3.

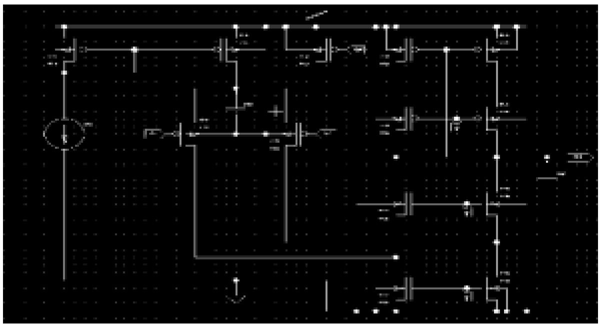

Fig. 2: Schematic diagram of LNA

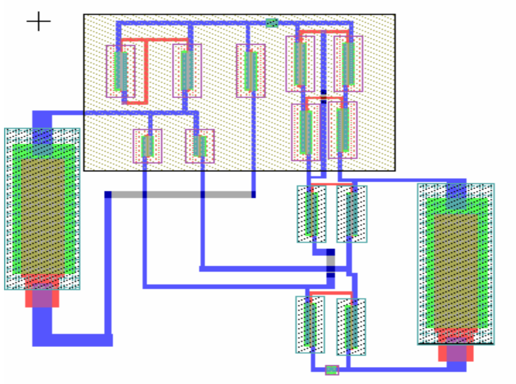

Fig. 3: Layout Diagram of LNA

Low noise and distortion demonstrate that the op-amp is accurate because the two major error sources of noise and distortion have been strictly limited.

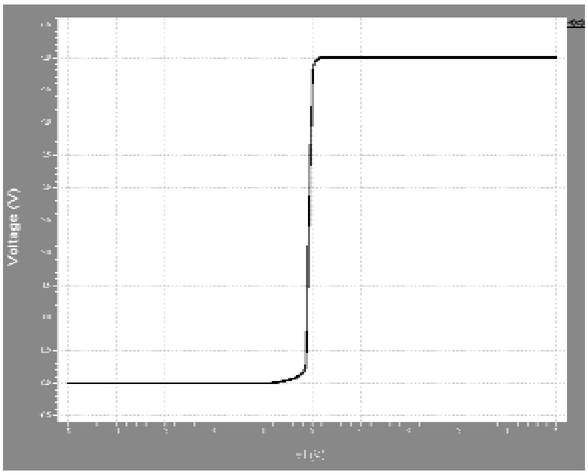

Fig. 4: AC analysis (magnitude plot)

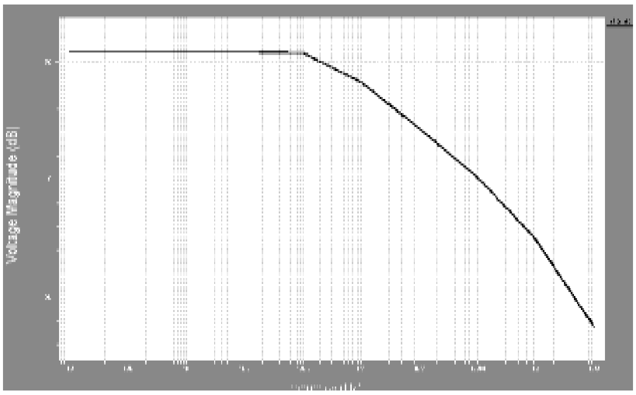

Fig. 5: AC analysis (phase plot)

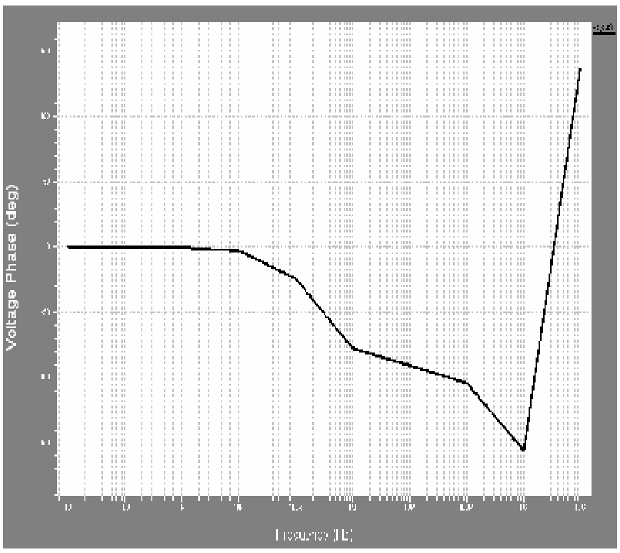

Fig. 6: DC analysis

Figure 4 and Figure 5 discuss the magnitude plot and phase plot of LNA. Figure 6 shows the DC analysis of low noise amplifier.

Table 1. Simulation results of different parameters

Parameter	**Specifications**	**Obtained results**
A_{VD}	54db	54.3dB
UGB	108MHz	108.4MHz
A_{IC}	-	–53.8dB
CMRR	-	108.1dB

Table 1 discusses about the parameter specifications such as UGB ,CMRR simulation results obtained for low noise amplifier.

6 Conclusion

This paper uses body-based MOS devices in the saturation region to create a device with low power consumption, low input voltage, high open-loop gain, and less noise. Most drivers have low noise and can improve the low noise of operational amplifiers. The operational amplifier concept is powered by a 1.3V supply, provides 54dB open-loop gain and less than 3mv power consumption, and is fully integrated with TSMC 0.25µm technology.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- Dr.Vasudeva G carried out the simulation of the Low Noise amplifier with schematic and layout.
- Dr.Bharathi Gururaj is responsible for the tabulation of results.

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Conflict of Interest

The authors have no conflicts of interest to declare.