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High Gain Operational Transconductance Amplifier

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Abstract - **In recent years interests have been seen in wireless system and software radio using sigma-delta modulators to digitize signals near the front end of radio receivers. Such applications necessitate clocking the modulators at a high frequency (MHz or above). A continuous-time implementation using trans-conductors and integrators rather than discrete time implementation using switched capacitors is preferred for high frequency operation.A novel cross coupled operational trans-conductance amplifier (OTA) has been developed with high linearity at high frequency which can be used in design of continuous time sigma delta modulator. The proposed cross coupled OTA achieves gain of 35dB, third order Intermodulation (IM3) of - 73dB at a high frequency range of 70 MHz with an effective Transconductance of 3.34mA/V. The proposed OTA is implemented in 180nm CMOS technology**

Keywords — Analog and Mixed Signal IC Design, OTA, Linearization, Source Degeneration and Cross Coupling

I. Introduction

Filters are to be implemented using an OTA–C topology. Henceforth the main piece of the modulator is the OTA. The principle details of circle channel are high linearity, high tuneablity and high DC-acquire [1]. The base contribution of the modulator is dictated by the information alluded clamor seen at the trans-conductor, and the most extreme info is restricted by the linearity of trans-conductor, since semiconductors have nonlinear conduct at high recurrence and present consonant twists [2]. Generally, the unique scope of by and large modulator is controlled by the information trans-conductor. The twisting of the other transconductor in the arrangement stream will create in band upheaval and moreover degenerate the SNDR and DR of modulator [3]. Thusly, the transconductor ought to be significantly straight.The twisting of the other transconductor in the plan stream will produce in band clamor and furthermore debase the SNDR and DR of modulator [3]. Hence, the transconductor should be profoundly straight.

Table 1: Specifications of proposed OTA

OTA parameters	Values
DC-gain	35dB
Gm	3.34mA/V
IM3 at 70MHz	-73dB

II. OPERATIONAL TRANSCONDUCTANCE AMPLIFIER DESIGN

This paper will zero in on the plan of operational transconductance enhancer (OTA). The presentation of the sigma delta modulator is represented by the circle. The effortlessness and linearity are the fundamental highlights of the OTA planned for any application. Huge transconductances are required for the band pass resonator working at 70 MHz, and their execution generally utilizes enormous measurement semiconductors and tail-current. Not with standing, semiconductors with enormous size present parasitic posts at lower frequencies. The utilization of huge tail current will likewise expand the force utilization and further diminish the DC gain of semiconductors [4]. An overall differential pair has a decent recurrence reaction because of the shortfall of low-recurrence parasitic posts. The issue of this geography is that the DC acquire is extremely restricted. Cascode yield stages can help the acquire however present parasitic shafts at the cascode hub. A productive OTA dependent on the integral differential sets was accounted for in [9], and is shown Figure 2.When contrasted and operation amps OTA's are a lot quicker and doesn't experience the ill effects of transmission capacity and slew rate requirements. There are different sorts of linearity strategies like source degeneration utilizing resistors, cross coupling methods thus on. This paper consolidates both the procedures to improve linearity and gain of the operational transconductance speaker.

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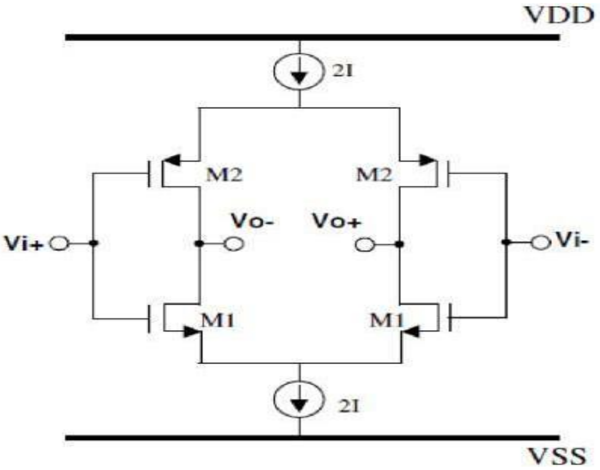

Figure 2: Differential amplifier based OTA

The OTA utilizes two differential sets M1 and M2 as the driving stage, and both differential sets draw from a similar tail current. The successful transconductance increments yet the force utilization isn't expanded. One piece of the differential yield current comes from N-type sets M1, and the other from P-type sets M2. With the assistance of little sign semiconductor model, the successful OTA transconductance is given by,

$$Gm=gm1+gm2 \qquad (1)$$

Where gm1 and gm2 are little sign transconductances of M1 and M2, separately. There are a few circuit methods detailed with improved linearity of MOS transconductors. Most usually utilized linearization techniques are nonlinear term dropping, weakening and source degeneration [1]. Nonlinear term undoing is acknowledged by methods for ideal arithmetical amount of nonlinear term. Anyway the direct reach is extremely limited and a decent wiping out is difficult to accomplish [10]. In the lessening procedure, the information voltage is diminished or constricted by a few variables in extent to improve the linearity. The downside is that a higher addition is needed to remunerate the information lessening, bringing about huge zone and more force utilization. Contrasted with the two methods, source degeneration is a procedure generally utilized.

III. LINEARIZATION TECHNIQUES

The contrast between the two constructions is the way the current source is associated. Design 2(a) has higher normal mode voltage swing at input. Likewise the clamor contributed by current source is infused to a solitary yield and seems like differential commotion at the yield hub. In structure 2(b), the clamor goes through the two branches equally, and appears as though regular mode commotion.

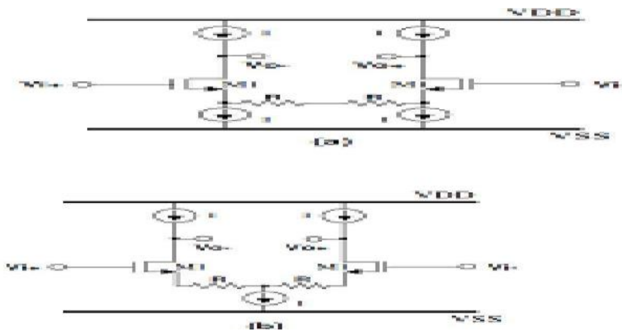

Figure 3(a): Source degeneration using separate current sources.
Figure3 (b): Source degeneration using same current source

IV. IMPLEMENTATION OF SOURCE DEGENERATION

The proposed cross coupled OTA consolidates the two methods revealed in [4], [3] and [2].[4] utilizes source declined OTA and has IM3 of - 62dB,dc increase of 14dB and Unity acquire recurrence of 4.7GHz and is appeared beneath in figures 2.3,2.4 and 2.5.In request to assess the addition of OTA utilizing source degeneration[4] AC examination is acted in rhythm to get gain.PSS investigation is performed by applying two tone signal trial of 70MHz and 71MHz to get Intermodulation product(IM3).

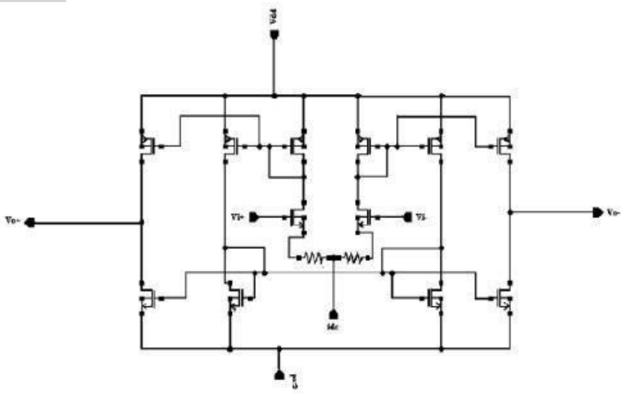

Figure 4.1: OTA using source degeneration [4]

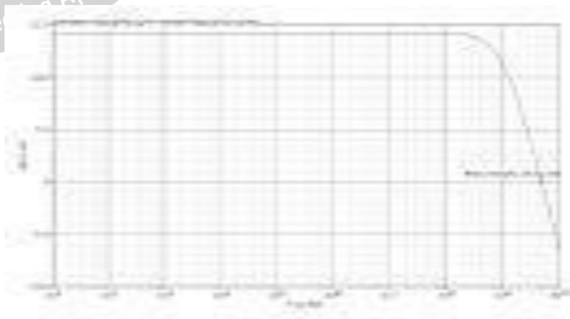

Figure 4.2: Response of AC analysis showing gain and UGB

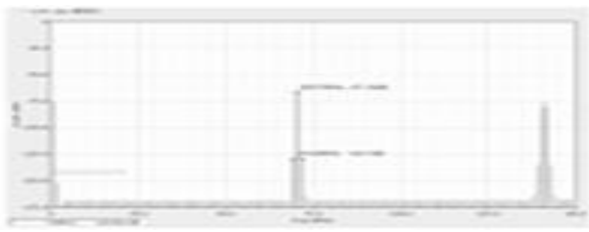

Figure 4.3: Response of pss analysis for a two tone test

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The proposed OTA is shown below. source degeneration and cross-couple cancellation are employed to achieve a high linearity

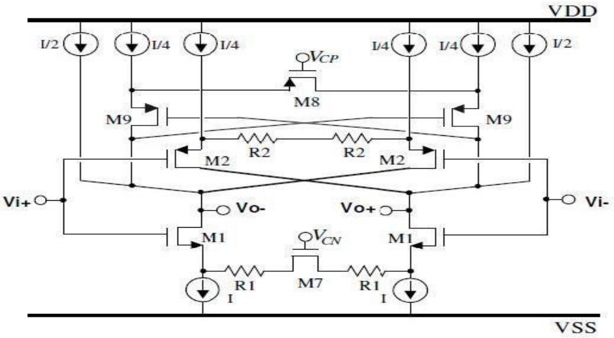

Figure 4.4: Proposed OTA

Current sources are carried out by semiconductor M3, M4 and M5. The elements of M5 (M6) are multiple times the size of M4 (M2) to give M2 the appropriate inclination current and lessen the bungle. A force supply of1.8 V is utilized so there is some headroom for the construction. Poly-poly resistors, rather than semiconductors, are utilized to carry out source degeneration resistors as a result of little obstruction and the nonlinearity of dynamic components.

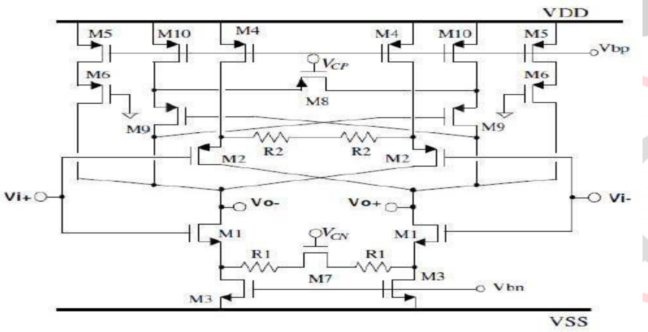

Figure 4.5: Complete OTA structure

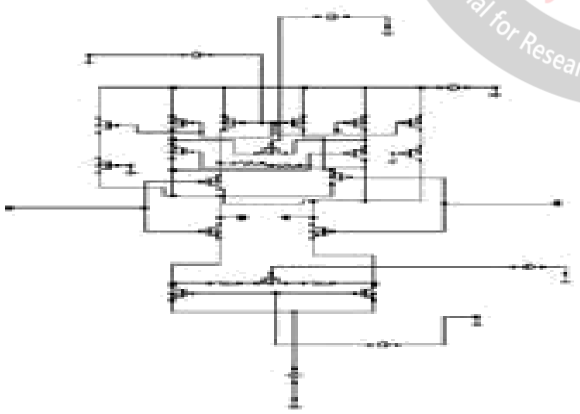

Figure 4.6: Schematic of proposed OTA

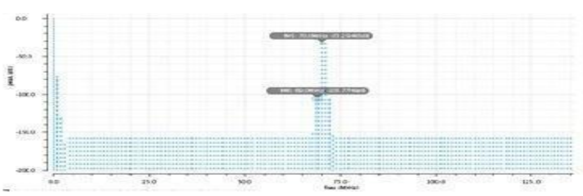

Figure 4.7: PSS analysis to calculate IM3

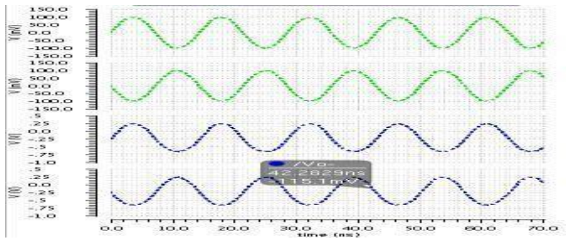

Figure 4.8: Proposed OTA

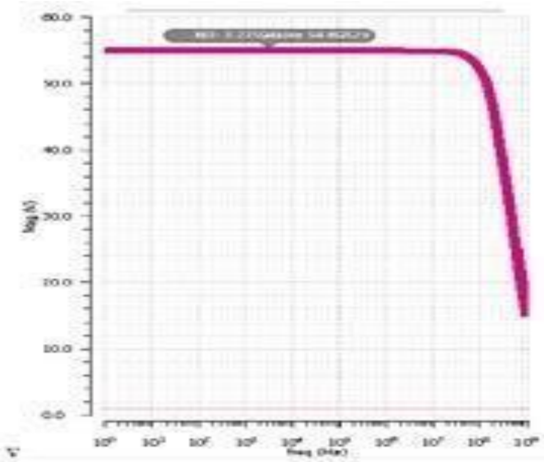

Figure 4.9: Gain of proposed OTA

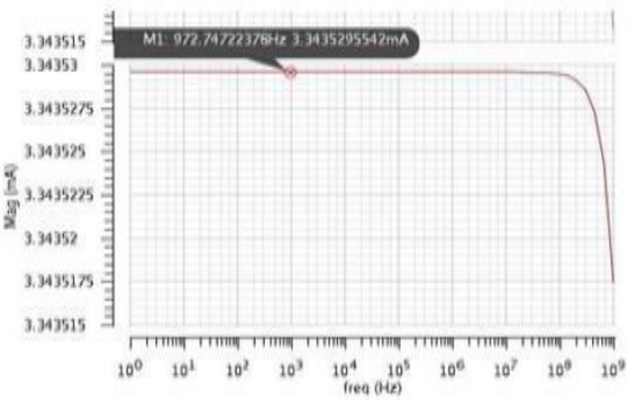

Figure 4.10: Transconductance of proposed OTA

V. CONCLUSION

The Performance Comparison of source deteriorated OTA [4] and Proposed OTA is appeared in table 2. It tends to be seen that the addition has expanded by 19dB and IM3 is nearly same.UGB of proposed OTA has decreased to 1.2GHz. The proposed OTA can be utilized in the plan of persistent time circle channel which is the main square of sigma delta modulator

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