A Cascoded Transistor Second Stage Operational Amplifier

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Abstract- *This paper show's cascoded transistor second stage in which second stage consist of PMOS and NMOS cascaded i.e. two PMOS and two NMOS are connected in stack form. This will maintain output resistance which help in maintaining the gain of operational amplifier. This operational amplifier achieved gain of 75 dB, GBW of 28 kHz, UGB of 98 MHz,CMRR of 173 dB and consume power of 22 uW.*

Keywords-Operational amplifier, Cascoded, Gain,UGB, GBW, CMRR.

I. INTRODUCTION

The op-amps are one of the versatile and crucial building block in analog circuit design. Operational amplifier have high gain and used as a feedback system. But while there may be a demand of very high gain, a two stage op-amps are used due to the fact a single stage opamps or a differential amplifier can't provide very high gain. With the intention to increase the gain, there have to be one more element after the differential amplifier [1]. And the best amplifier can most effective common source amplifier. The common source amplifier can be of nmos or the pmos. The pmos common source amplifier is normally used because nmos common source amplifier limits the swing. Consequently the two stage are differential stage and another one is common source stage. In case of one stage op-amps, there may be no problem regarding the phase margin or stability due to the fact differential amplifier is single pole system. However in two stage op-amps, two poles are there one due to the parasitic capacitance of differential amplifier and common source and because of the load capacitance [2]. Consequently the stability aspect should not be forget at the time design of amplifier.
The other parameter's of operational amplifier are input common mode range(ICMR), Slew Rate(SR) and CMRR(Common Mode Rejection Ratio).

II. PROPOSED OTA

Figure 2.1 show the arrangement of transistor for proposed operational amplifier. Two PMOS input transistor are used followed two PMOS near to the Vdd and two NMOS near to

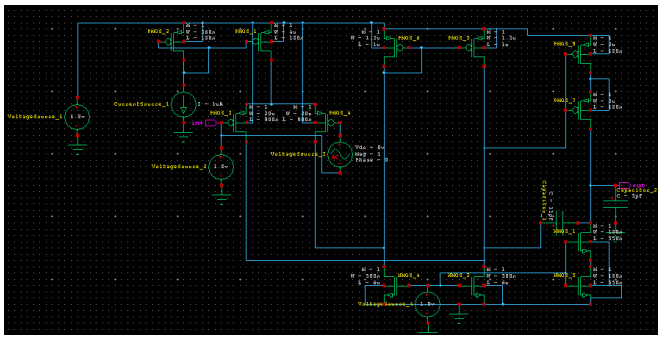

Fig.2.1 Proposed operational amplifier.

the ground are connected. The cascoded transistor is connected which is second stage of this operational amplifier. In this method, two PMOS and two NMOS are connected in stack form. The basic structure is shown in the figure 2.2.

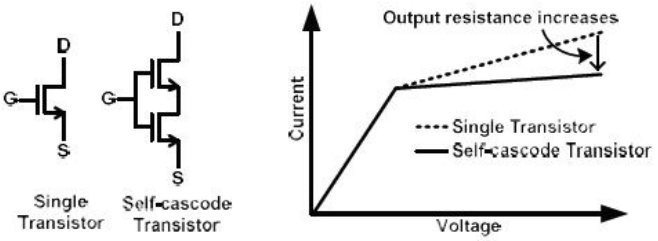

Fig. 2.2 Cascoded transistor[7]

In second stage, transistors are implemented with a self-cascode transistor in Fig. 2.2 to increase the DC-gain of the operational amplifier. The self-cascode transistor is very effective method to increase the transistor output resistance by reducing the channel length modulation [3], [4]. The self cascode transistor's make the output resistance constant and increase as seen from the graph.

The self cascode[3] concept reduce the problem channel length modulation and also increase the output swing.

III. SIMULATION RESULT

Whole simulation done on Tanner Eda tool using 180 nm technology. The parameter obtained are gain, UGB, GBW, CMRR,ICMR and Slew rate. The whole circuit consume 22 uW .

➢ Gain,UGB,GBW

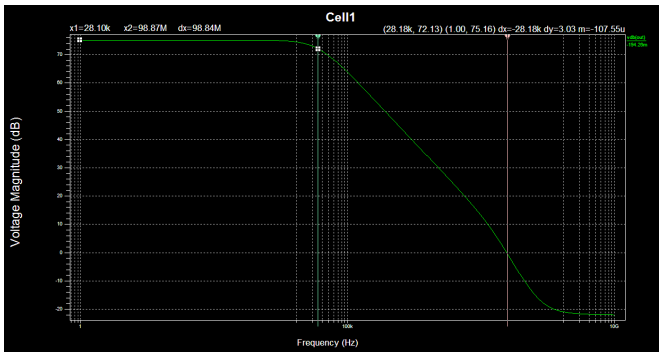

Fig.3.1 Frequency Response

Figure 3.1 shows the frequency response in which gain is of 75 dB, UGB is 98 MHz and GBW is 28 kHz.

➢ Input Common Mode Range(ICMR)

Figure 3.2 shows common mode range of proposed operational amplifier. Graph show the maximum ICMR is 1.71 V and minimum ICMR is 290mV.

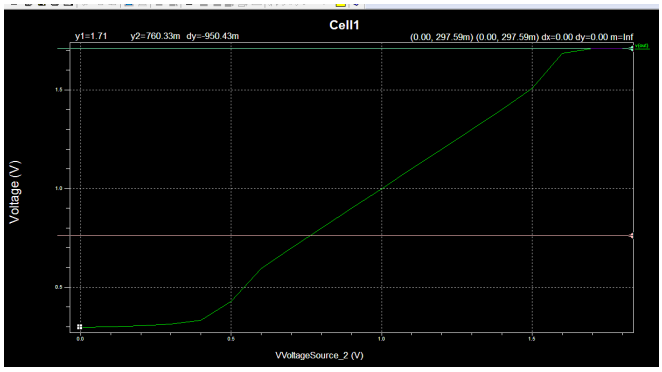

Fig.3.2 ICMR graph

➢ Slew Rate(SR)

Figure 3.3 and 3.4 showing the graph of negative and positive slew rate of proposed operational amplifier. The positive slew rate is 118V/us and negative slew rate is 67.5 V/us.

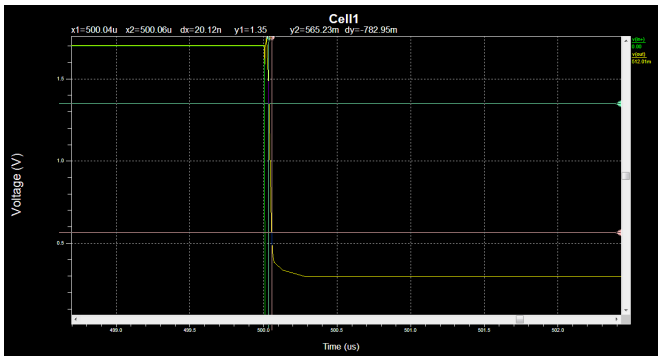

Fig.3.3 Negative slew rate
Fig. 3.4 Positive slew rate

➢ CMRR(Common Mode Rejection Ratio)

The differential gain(Ad) obtained from this operational amplifier is 7 dB and common mode gain (Acm) is -166 dB. So the CMRR is the difference between Ad and Acm[5] and it is 173 dB which make this operational amplifer good candidate for bio-medical application's.

TABLE I. COMPARISON TABLE

	Previous op amp[6]	Proposed op amp
Process	180nm	180nm
Supply-Voltage	1.8V	1.8
DC gain	66dB	75dB
Power	558uW	22uW
UGB	60MHz	98 MHz
ICMR	1.7V & 0.9V	1.7 V & 0.29V
Slew Rate	95 V/us	110 V/us
CMRR	-	173 dB

IV. CONCLUSION

This paper shows the benefits of using cascode transistor. Cascade enhance's the gain of this operational amplifier. This increases the gain to 75 dB. Obtained value of CMRR,UGB and slew rate are 173 dB,98 MHz and 110 V/us.

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