IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Comparison of Two Stage Folded Cascode Operational Amplifier with Conventional CMOS Operational amplifier in 90nm Technology

Karan Chandel[1], Dr. Mandeep Sandhu[2]

[1] P.G. Scholar, Electronics and Communication Engineering, Rayat and Bahra University Mohali
[2]Assistant Professor, Electronics and Communication Engineering, Rayat and Bahra University Mohali

Keyword - CMOS, folded cascode,Opamp,90nm

***Abstract*—Folded cascade configuration is basically a development in the cascade configuration in order to maximize the advantages. Now a days this has become predominating due to its some inherent advantages.**

This paper describe all about the behavior of folded cascade amplifier at particular supply voltage, input signal and with 90nm technology. also comparison (in terms of result obtained) has been drawn between conventional operational amplifier and folded cascode amplifier with same set of specifications and technology.

***Key words*:-** CMOS, folded cascode,Opamp,90nm technology,comparision

1. INTRODUCTION

Operational amplifier are the directly coupled high gain amplifier usually consist of one or more differential stage followed by a level transistor. Ideal characteristic OPAmp is very much fascinating in terms of its use and popularity. Folded cascode is a way to improve the characteristics of a normal operational amplifier to drive it toward the ideal OpAmp. This Paper is segmented in to five parts. Namely Conventional Operational Amplifier,Folded Cascode configuration and comparison with normal cascode difference, result obtained after simulation,comparision of result with conventional operational amplifier and finally at last the conclusion.

A. Conventional Operational Amplifier

Basic Conventional two stage Operational Amplifier is a combination of three subsections

a) Differntial stage
b) Additional Gain stage
c) Biasing Arrangment

OpAmp is such a versatile device that it has so many applications such as amplifier, oscillator, filter, precision rectifier,comparator etc.

Particular application requires specific type of feedback like listed below.

Positive feedback results it in to an Oscillators.

Neagative Feedback results it into a amplifier.

No feedback result it into an excellent comparator.

Figure 1 shows two stage opamp

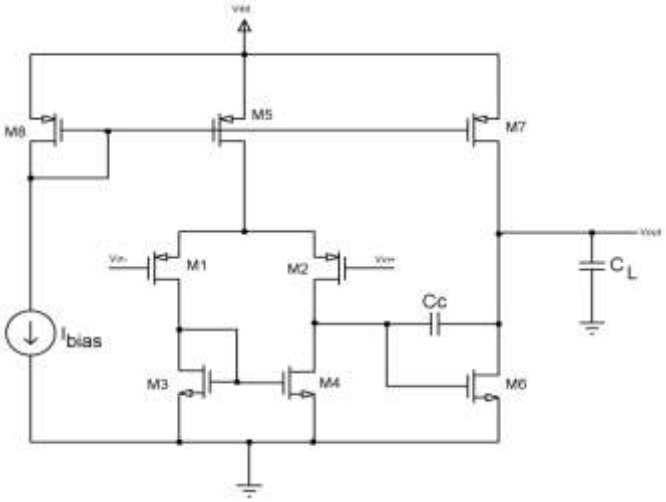

Fig. 1. Block Diagram of two stage opamp

B. Folded Cascode Configuration

Cascode configuration is basically a combination of common emitter followed by Common base stage or Common Source followed by common Gate stage. This type of configuration I,e, cascode has input characteristics of as the common emitter amplifier and output characteristics of Common Base amplifier. Following advantages can be achieved using cascode configurations.

1) High Voltage Gain
2) No Miller Effect hence suitable for high frequency applications.
3) High Bandwidth

a) Conventional Cascode
b) Folded Cascode

a. Conventional Cascode: Conventional Cascode consist of Common Source followed by Common Gate FET.
The only binding condition is that both transistor must be either p channel or n-channel.

Diagram as shown in figure 2 below.

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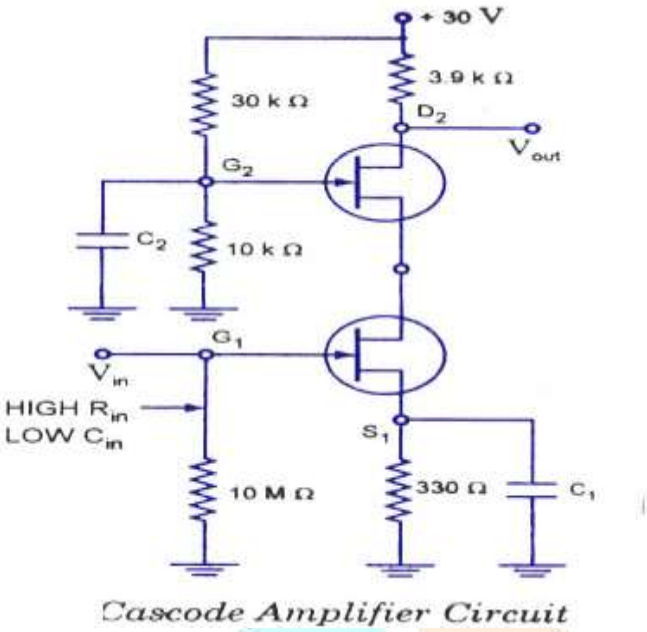

Fig. 2. Conventional Cascode

Advantages of Normal Cascode :-

The biggest advantage of conventional cascode is that it provides very high current gain

Another advantage includes its suitability at high frequency due to absence of Miller effect.

In fig 2 , only one pair of transistor is shown, but it have many number of pairs present. More the pairs more will be the gain. Hence number of pair are in proportion to the gain desired.

Disadvantages of Normal Cascode :-

1. Cascode Configuration requires two transistors with high voltage supply. These two transistors should be biased through sufficient VDS in process ,striking a lesser limit on the voltage supply.
2. The cascode amplifier requires a large number of resistors and capacitors to provide bias and prevent undesirable feedback.

b. Folded Cascode Configuration: Folded cascode configuration is further development in the convention Cascode as it removes the condition that both transistor must be same I,e, both either n-channel or both p-channel. shown in figure 3.

Advantages of Folded Cascode 1. It removes the biggest disadvantage of conventional cascode as it requires low power supply.

2. The Gain Bandwidth Product becomes Constant.

C. Design Methodology Folded Cascode opamp

1) Power Supply: The power supply is 1.80 V

2) W/L Ratio: W/L ratio is the most important parameter in the analog design. in 90nm technology, W/L for NMOS for PMOS is 1.20.

3) Input Signal: The input signal should be given between 1 to 1.20 V.

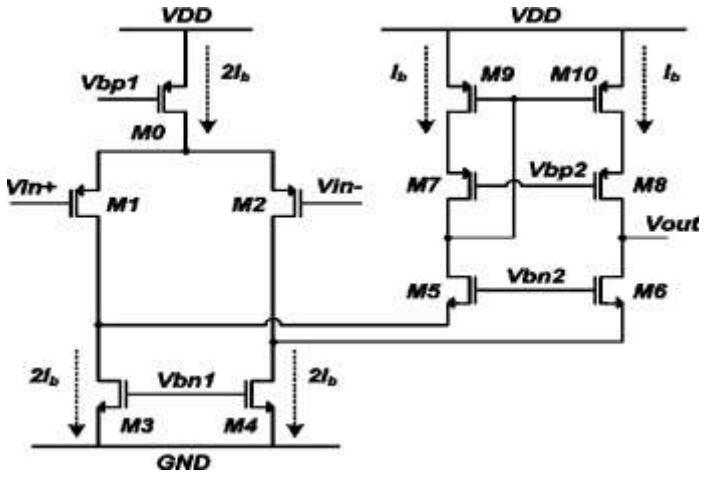

Fig. 3. Folded cascode operational amplifier

D. Analysis:-

1) Output Offset: Output offset voltage is the dc voltage between two output terminals (or the output terminal and ground for circuits with one output) when the input terminal(s) are grounded. It result due to the mismatch in the transistors used.

The simulated result is shown below in fig4.

The observed value of output offset voltage is 2 Volts.

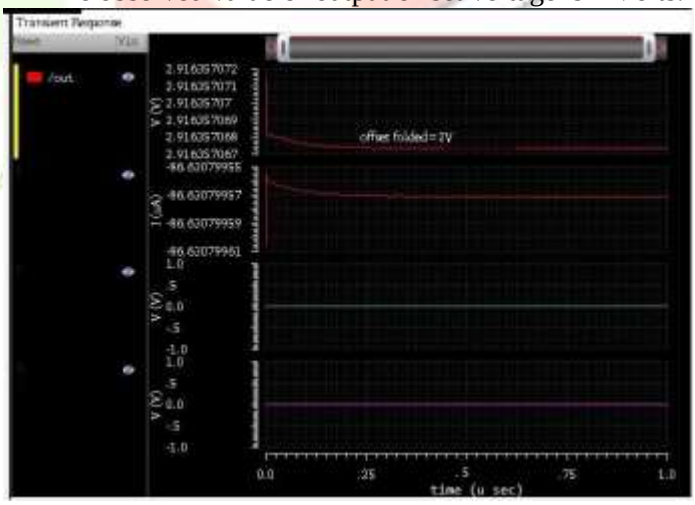

Fig. 4. Output offset voltage

It can be nullified by allowing 2 Volt power supply between both the input terminals.

Bandwidth: Bandwidth is defined as range of frequencies for which response of the system is normal and proper.. Speed of the response of circuit is defined by the bandwidth, as rise time varies inversely with bandwidth. The BW of folded cascode is 96.96 MHz.

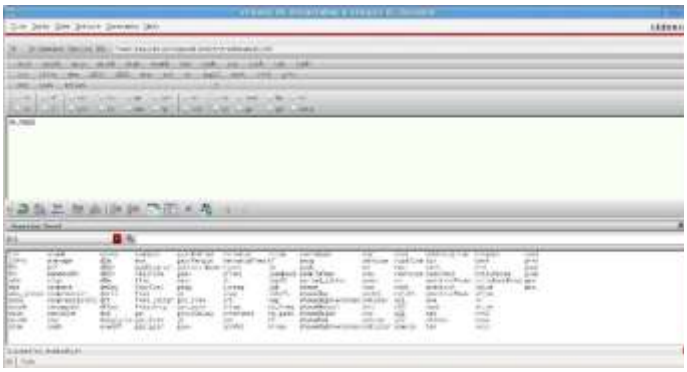

Fig. 5. Band width

2) Gain Phase Margin: Gain and Phase margin are most important parameters for the freequnecy analysis of an amplifier. They speaks about the stability of an amplifier. Folded cascode amplifier provides very high gain so if its phase margin is more than 55(in degrees),it will be acceptable for practical applications.
shown in figure 6 below:

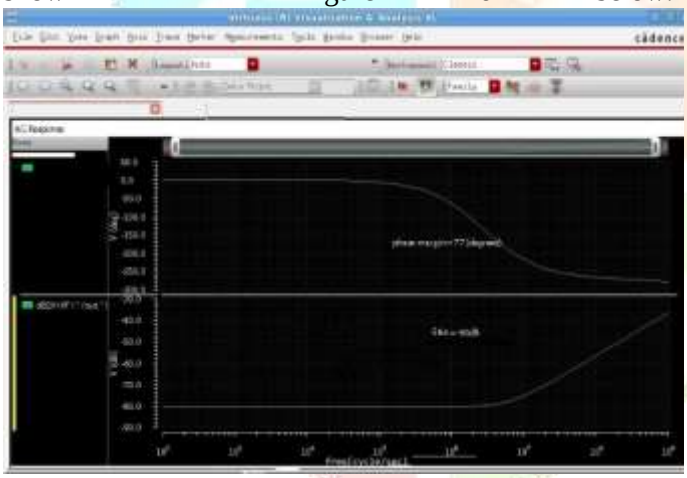

Fig. 6. Gain Margin and Phase Margin of folded cascode

gain found to be 80dB and phase margin = 77(in degrees).

3) Slew Rate: Slew rate is defined as the maximum rate of change of an op amp's output voltage and is given units of volts per microsecond. Slew rate is measured by applying a large signal step, such as 1V, to the input of the op amp, and measuring the rate of change from 10% to 90% of the output signal's amplitude.
Slew rate is shown in figure 7 below:-

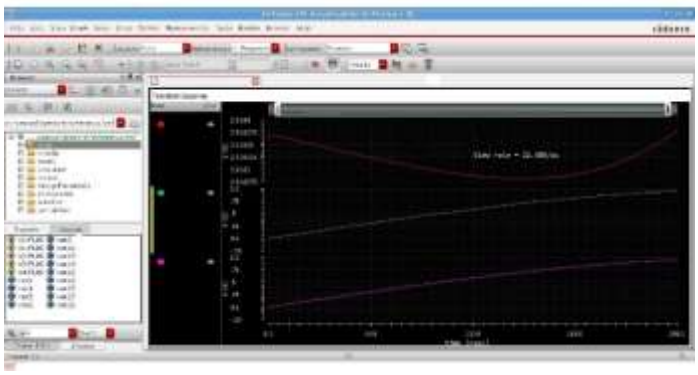

Fig. 7. Slew Rate of folded cascode operational amplifier

The slew rate of two stage opamp
in 90nm technology is shown in figure 8 below

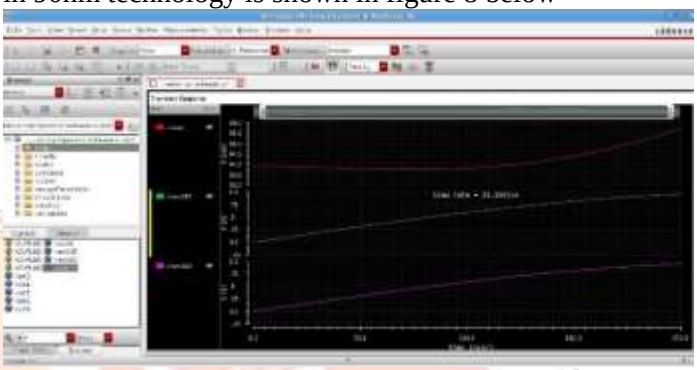

Fig. 8. Slew Rate of conventional operational amplifier

TABLE I
Table wise COMPARISION BETWEEN SIMULATED RESULTS OF CMOS OpAmp and FOLDED CASCODE OPAMP

Parameters	conventional opamp	Folded cascode
Power Supply	1.8 V	1.8 V
Output Offset	83.451mV	2V
Frequency	1 MHz	1MHz
Phase Margin	125(degree)	77 (in degrees)
Bandwidth	90.42 KHz	96.94 MHz
Capacitance	30pF	2pF
Gain	22.14 dB	80 dB
slew rate	21.26V/us	22.48V/us
CMRR	approx 80 dB	160 dB
Input signal voltage	1V	1V
Power Dissipation	277.21uW	274.26uW

4) Power Dissipation : it is defined as the power dissipated in the form of heat by a given circuit during its operation. Low value of power dissipation is desired. The

power dissipation of folded cascode is shown in figure 9.

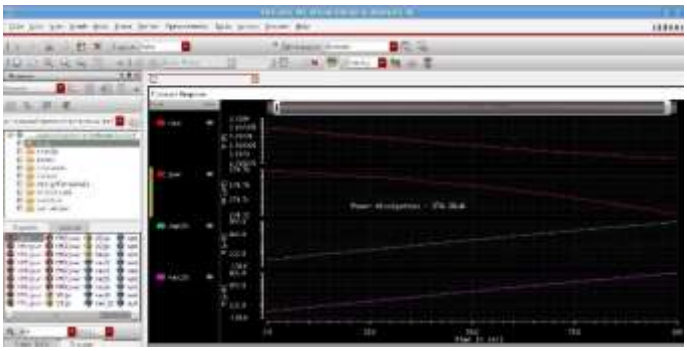

Fig. 9. Power dissipation of folded cascode opamp

The power dissipation of conventional two stage opamp is shown in figure 10 below

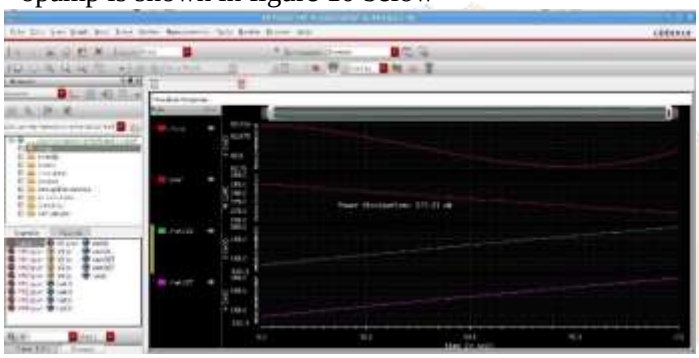

Fig. 10. Power dissipation of conventional opamp

Fig. 11. DC analysis of folded cascode opamp.

I. CONCLUSION

On the basis of result following conclusion can be drawn regarding the advantages of folded cascode opamp over conventional opamp in 90nm ,

1. Power dissipation has decreased from 277.21uW to 274.26uW.
2. Gain has increased from 22 dB to 80dB
3. Slew rate has also increased.
4. CMRR has also increased.
5. Bandwidth has increased.

ACKNOWLEDGMENT

E. DC Analysis of Folded Cascode opamp

DC analysis of a device means to know about its quiescent point. If Q-point remains stable output will be more towards as desired but if they varies than it may lead to distortion of signal or in other words out will deviate from as desired. So DC Analysis is very much crucial during the system design.

First and foremost, praises and thanks to the God, the Almighty, for His showers of blessings, throughout our research work, to complete the research successfully.

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