Two Stage CMOS Operational Amplifier

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July 1, 2021

Abstract

This paper provides the design of a Two Stage CMOS Operational Amplifier using SkyWater 130nm Technology. It has a NMOS differential amplifier followed by a PMOS Common Source Amplifier to provide high gain of about 40dB. The output from the differential pair is taken as single ended and is fed to the second stage. The entire circuit is biased with the help of constant current source of 10uA and current mirror circuitry. It has internal compensation capacitors to provide stability at high frequency operation giving rise to a gain-bandwidth of about 4.7MHz. This circuit provides better operation and has about 3KHz 3dB cut off. Op Amps play a vital role in amplifying weak signals, this circuit is a solution.

1 Circuit Details

Operational Amplifiers, Op Amps for short are play a very crucial role in the Linear Integrated Circuit Design. It can perform mathematical operations which make it "operational" amplifier, amplifier, comparators, PLLs, Integrators, Filters are few notable circuits that use Op Amp. They play a vital role in biomedical field for amplifying weak biomedical signals, which is important for gaining insights into the signal. The Operational Amplifier design is achieved through skywater 130nm technology. This circuit employs a NMOS differential amplifier M1 and M2 with two input terminals, with a PMOS load M3 and M4. This circuit is provided bias with the help of a current mirror circuit M5 and M6 provided with a constant current source. The output is taken as a single ended output and the gain of the differential amplifier thus obtained is further increased with the help of a Common Source Amplifier M7 which is also biased with the current mirror circuit of M5 and M8. The capacitors provide a stability against the poor phase margin of the circuit by trading off the fast response of the amplifier. Hence for better phase margin an external compensation is a must. The circuit employs different aspect ratio for different MOSFETs for the correct bias and operation of the circuit. The circuit provides a gain of nearly 40dB with a gain bandwidth product of 4.7MHz and about 3KHz 3dB cut off, which makes the operational amplifier circuit to amplifier a 1mV peak to peak to about 2V peak to peak thus weak signals can easily be amplified.

2 Implemented Circuit

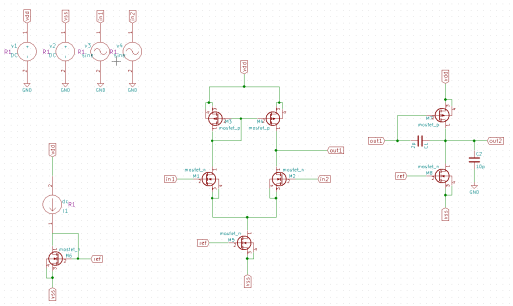

Figure 1: Implemented circuit diagram.

3 Implemented Waveforms

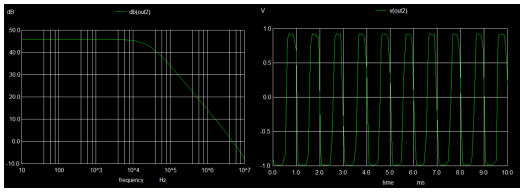

Figure 2: Implemented waveform.

References

[1] N. K. C. 4 71 2 stage cmos opamp simulation(youtube video). https://youtu.be/RM-j-zSoEOc.

[2] S. K. M. Goswami. Dc suppressed high gain active cmos instrumentation amplifier for biomedical application. https://ieeexplore.ieee.org/document/5760217.