Simulation and Performance Evaluation of a Folded Cascode Op-Amp in eSim Environment

Kumar Biswajit Rath
Dept. of Electronics and Communication Engineering
National Institute of Technology, Rourkela
Odisha, India
biswajitrath2004@gmail.com

***Abstract*—This paper presents the design and characterization of a folded cascode CMOS Operational amplifier(Op-Amp) implemented in the eSim–Ngspice environment. The circuit is optimized to operate all MOSFETs in the saturation region, achieving high output impedance, enhanced voltage gain, and improved linearity. The OP-Amp is tested with a differential sinusoidal input of 2 mV and a common-mode voltage of 1 V, producing a peak output voltage of 2.38 V, which corresponds to a differential voltage gain of approximately 61.5 dB. Simulation results demonstrate the capability of the Op Amp for effective differential signal amplification while maintaining stability and precision, highlighting its suitability for high-performance analog signal processing applications**

***Index Terms*—Folded Cascode Op Amp, CMOS, eSim, Differential Amplifier, Voltage Gain, Analog Signal Processing**

I. Circuit Design and Analysis

The given circuit represents a Folded Cascode Operational Amplifier (Op Amp), which is designed to achieve high gain, wide output swing, and improved frequency performance. The circuit operates on the principle of converting a differential input voltage into an output voltage with high linearity and bandwidth.

The differential input stage consists of transistors M1 and M3, which receive the input signals Vin1 and Vin2. The transistor M2 acts as a current source that provides a constant bias current to the input pair, ensuring stable transconductance. The differential currents generated by this stage are then folded through the PMOS transistors M4 and M5 into the NMOS transistors M6 and M7. This folding action allows the input devices to operate at a lower voltage level while maintaining a large output voltage swing, one of the main advantages of the folded cascode structure.

The cascode transistors (M8–M11) serve to enhance the overall gain and output impedance of the amplifier by minimizing voltage variations across the active devices. Multiple bias voltages (V6–V10) are applied to set the proper operating points of each transistor, ensuring that all remain in the saturation region for linear amplification.

At the output stage, compensation capacitors C1 and C2 of 1 pF each are connected between the output nodes (out1 and out2) and ground. These capacitors stabilize the circuit and fine-tune its frequency response, minimizing the risk of oscillations and ensuring reliable AC performance.When a 2 mV differential sinusoidal input is applied with a 1 V common-mode voltage, the circuit produces a peak output voltage of 2.38 V, corresponding to a differential gain of approximately 61.5 dB. In summary, the folded cascode Op Amp achieves high voltage gain, wide output swing, and excellent frequency response, making it an efficient and versatile building block for filters, amplifiers, and mixed-signal integrated systems.

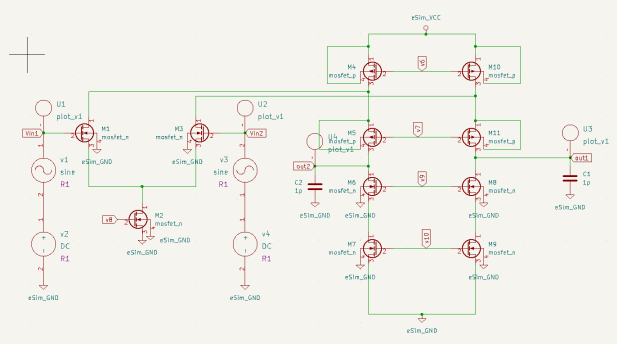

Fig. 1. Implemented a Folded Cascode Operational Amplifier schematic.

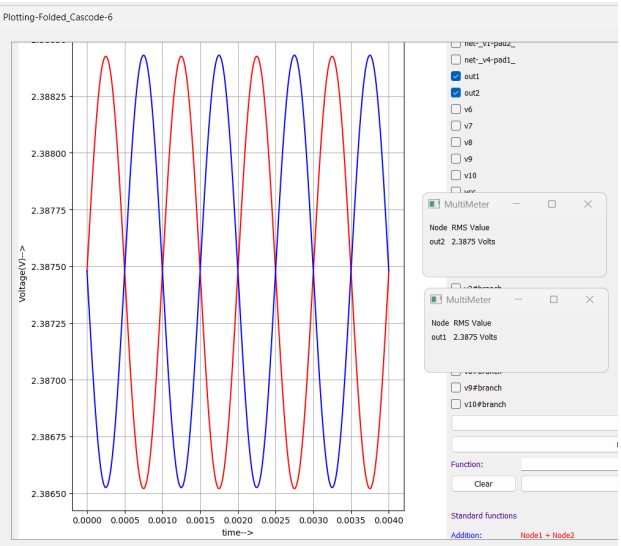

Fig. 2. Simulated differential output waveform

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