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Title of the circuit:

Design and Implementation of Low Power Low Voltage Bulk-Driven Balanced OTA using eSim

Theory/Description:

The Bulk-Driven Balanced Operational Transconductance Amplifier (OTA) is a low-voltage, low-power analog building block that uses the bulk terminal of MOS transistors as the signal input. Unlike conventional gate-driven MOS circuits, the bulk-driven technique allows the input signal to modulate the drain current through the body effect while the gate terminal is biased to keep the transistor in the active region.

The proposed two-stage Bulk-Driven Balanced OTA consists of a bulk-driven NMOS differential input stage, active current-mirror load, bias current source, second gain stage, and capacitive load. The input transistors operate using the bulk-driven principle, thereby reducing the effect of the MOS threshold voltage on the input signal path.

The circuit is reproduced in eSim based on the circuit presented in the reference research paper. The original work was simulated using a 130 nm CMOS technology with a 0.9 V supply. The reported circuit uses a 20 μ A bias current and a 1 pF load capacitance.

Reason to reproduce with eSim:

The objective of this Research Migration Project is to reproduce the Bulk-Driven Balanced OTA circuit in the open-source eSim environment and verify its important voltage and transient characteristics.

Migrating the circuit to eSim provides an open-source simulation model that can be used for studying bulk-driven MOS operation, low-voltage analog design, and OTA characteristics. The circuit can also serve as a reusable analog building block for educational and research purposes.



Expected Outcome/outputs:

The expected outcome is a functional Low Power Low Voltage Bulk-Driven Balanced OTA circuit implemented in eSim.

Validation will be performed by applying a sinusoidal input signal and observing the corresponding transient output voltage waveform. The output voltage swing will be measured and compared with the reference result.

A DC input sweep will also be performed to obtain the output voltage response and verify the linear operating range of the reproduced OTA circuit. The reference work reports an output swing of 550 mV for a 400 mV input swing and a linear output response over an input range of 200 mV to 800 mV.

Circuit Diagram(s):

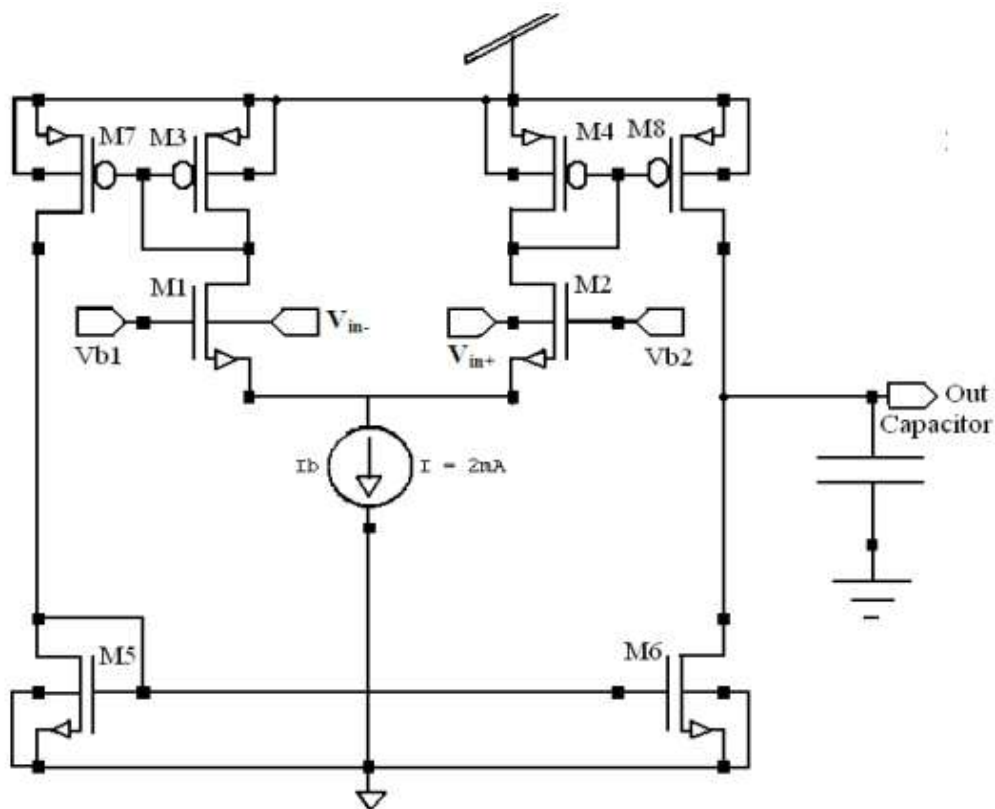


Figure 1 Circuit Diagram of Low Power Low Voltage Bulk-Driven Balanced OTA



Schematic Diagram:

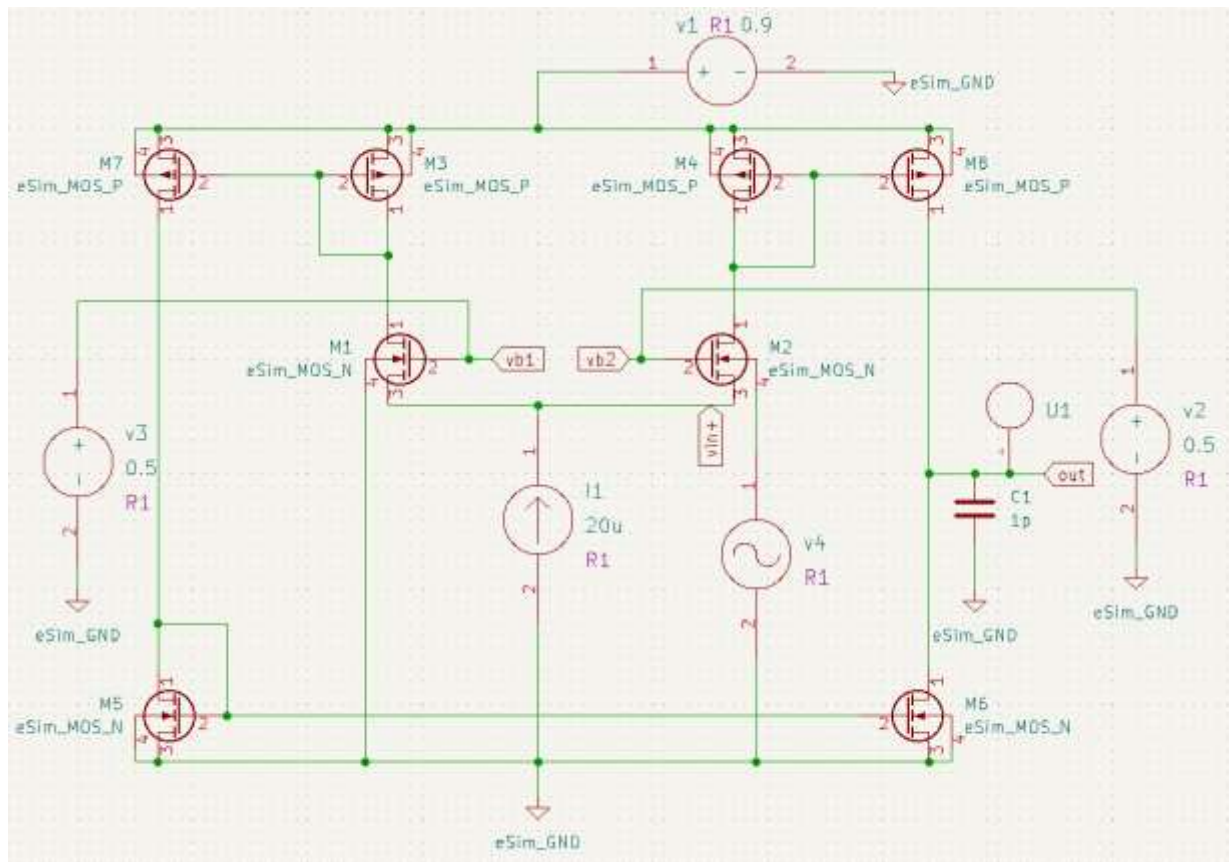


Figure 2 Schematic Diagram of Bulk-Driven Balanced OTA

Results (Output waveforms):

Transient Waveform:

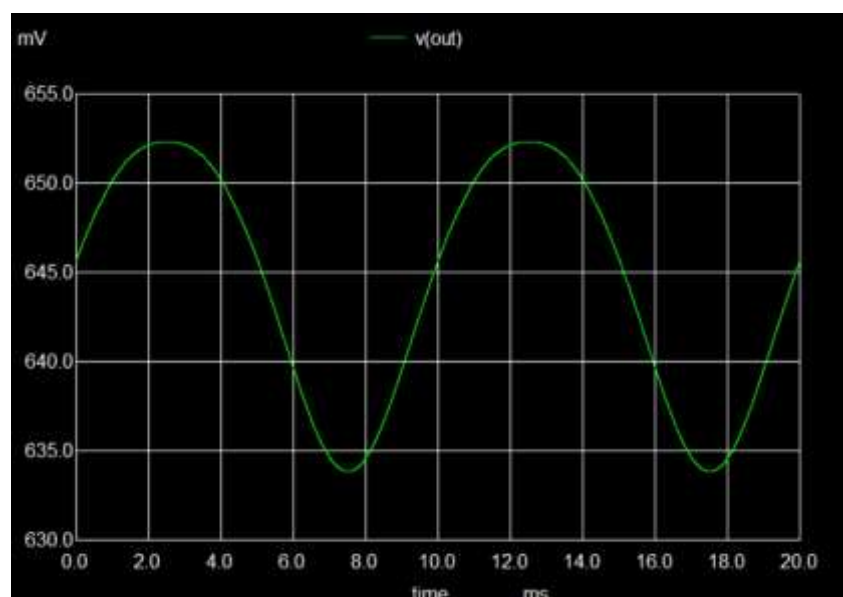


Figure 3 Transient Waveform of Bulk-Driven Balanced OTA



Output Voltage:

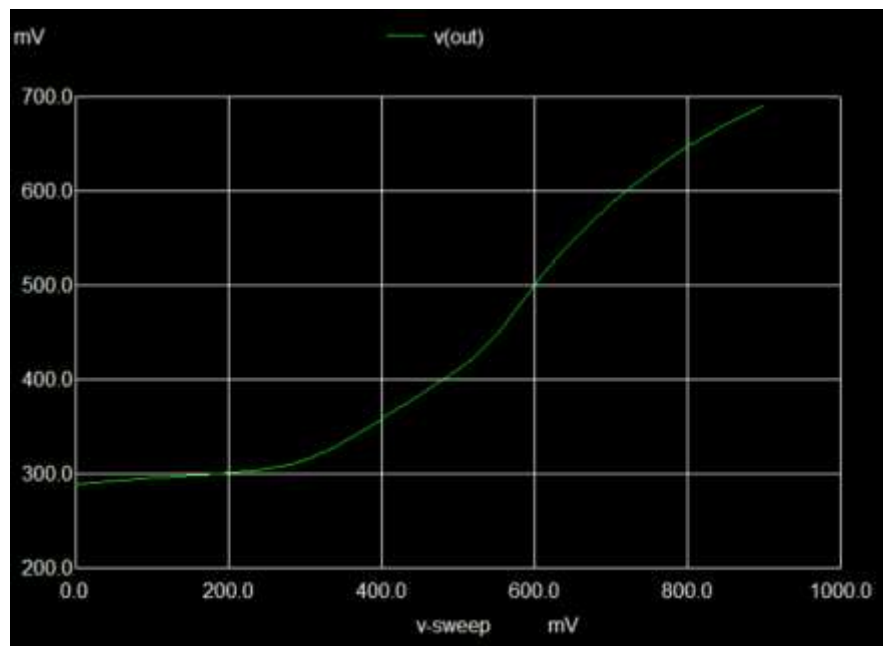


Figure 4 Output Voltage of Bulk-Driven Balanced OTA

Research Paper/Journal/etc.:

Title: Low Power Low Voltage Bulk Driven Balanced OTA

Author: Neha Gupta, Sapna Singh, Meenakshi Suthar and Priyanka Soni

Journal: International Journal of VLSI Design & Communication Systems (VLSICS), Vol. 2, No. 4, December 2011

Page Number: Schematic Diagram (Page 3 of the journal)

Link

<https://arxiv.org/pdf/1201.1970>

Source/Reference(s):

1. Neha Gupta, Sapna Singh, Meenakshi Suthar and Priyanka Soni, "**Low Power Low Voltage Bulk Driven Balanced OTA**," International Journal of VLSI Design & Communication Systems.
2. Boylestad, R. L., *Electronic Devices and Circuit Theory*, Pearson Education.
3. eSim Documentation, FOSSEE Project, IIT Bombay.
4. Sedra, A. S. and Smith, K. C., *Microelectronic Circuits*, Oxford University Press.