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Title of the circuit:

Design and Implementation of CA5160 BiMOS Operational Amplifier using eSim

Theory/Description:

The CA5160 is a 4 MHz BiMOS operational amplifier that combines a PMOS MOSFET differential input stage with a bipolar second gain stage and a CMOS output stage. It provides very high input resistance, very low input current, and an output voltage swing very close to either supply rail, making it suitable for both single-supply and dual-supply operation.

The objective of this project is to reproduce the internal CA5160 operational amplifier model in eSim based on the manufacturer's datasheet and verify its functionality. The amplifier consists of a PMOS differential input stage using Q6 and Q7, bipolar transistors Q9 and Q10 acting as a mirror pair and differential-to-single-ended converter, a second-stage bipolar transistor Q11, CMOS output transistors, bias circuitry, offset-null provisions, and internal frequency compensation.

To validate the reproduced circuit, the amplifier is configured as a unity-gain voltage follower, one of the standard applications provided in the datasheet. The voltage follower demonstrates closed-loop operation, voltage tracking, and transient response of the implemented CA5160 model. The CA5160 has a typical unity-gain crossover frequency of 4 MHz and a slew rate of 10 V/ μ s.

Reason to reproduce with eSim:

The CA5160 is a versatile operational amplifier with very high input resistance and the ability to operate effectively with a single power supply. Reproducing it in eSim contributes a reusable simulation model to the FOSSEE open-source component library for educational and research purposes.

Unlike reproducing only an application circuit, this project focuses on implementing the operational amplifier itself so that it can subsequently be used in a variety of analog designs. The CA5160 can be used in applications such as voltage followers, sample-and-hold systems, DAC circuits, voltage regulators, voltage-controlled oscillators, high-input-resistance voltmeters, and comparator-related circuits.



Expected Outcome/outputs:

The expected outcome is a fully functional CA5160 operational amplifier model in eSim that reproduces the behaviour specified in the datasheet.

Validation will be performed by configuring the implemented amplifier as a unity-gain voltage follower and observing the input and output waveforms.

Successful verification will indicate that the CA5160 model is suitable for reuse in other analog applications. Under the datasheet's specified voltage-follower test conditions, the typical rise time is 0.09 μs and the settling time is 1.8 μs .

Circuit Diagram(s):

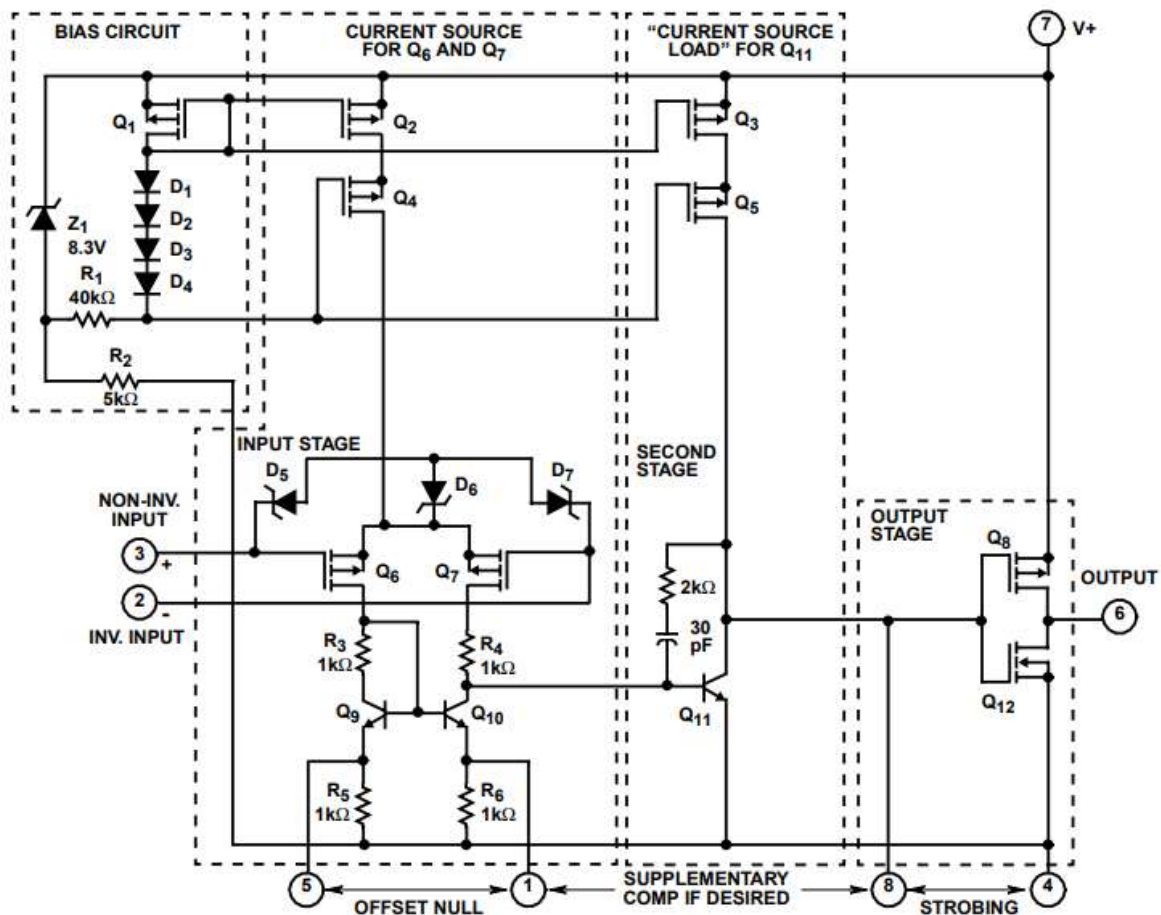


Figure 1 Circuit Diagram of CA5160



Pin Diagram:

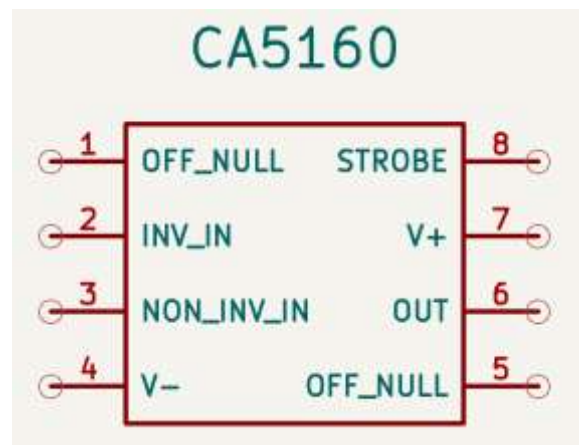


Figure 2 Pin Diagram of CA5160

Schematic Diagram:

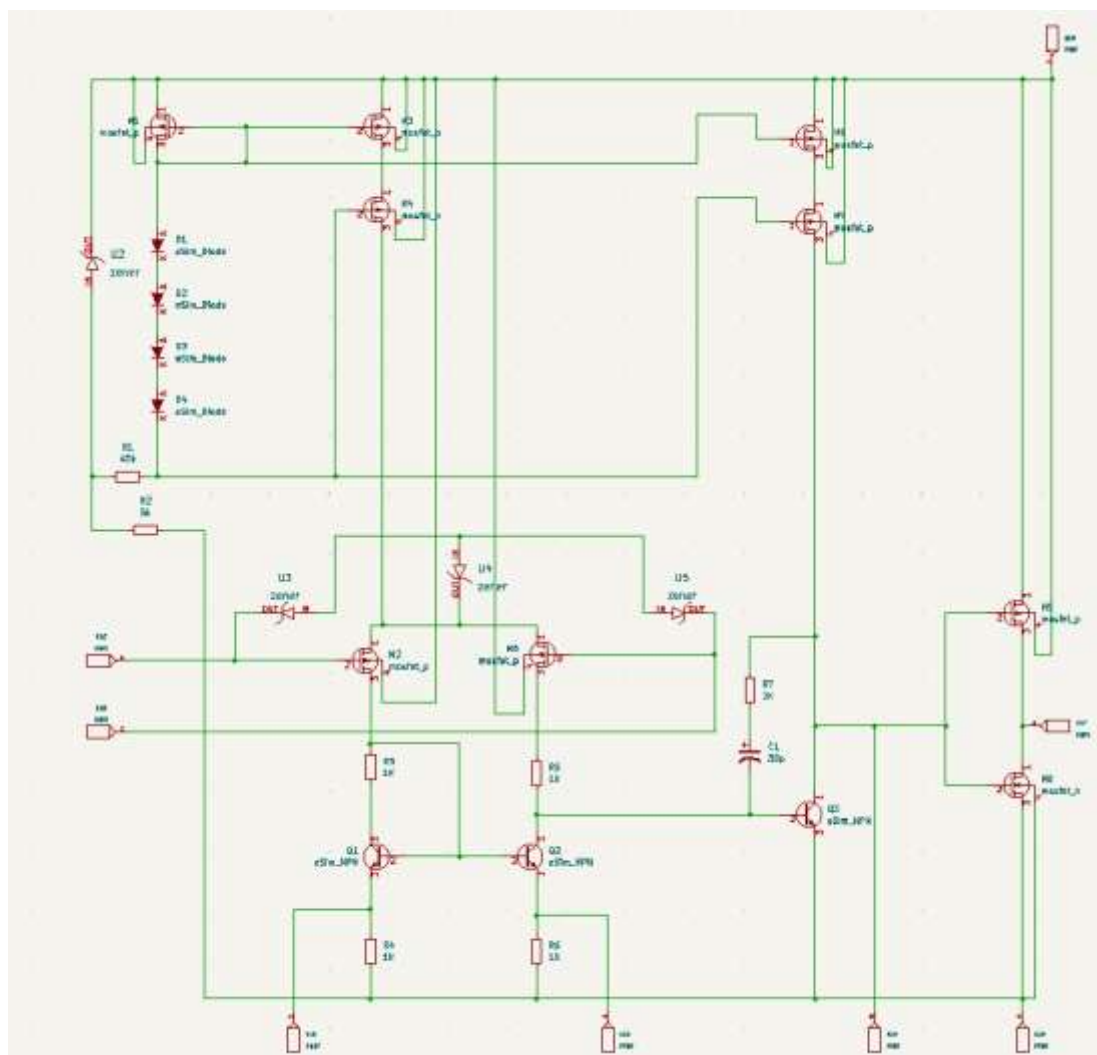


Figure 3 Schematic Diagram of CA5160



Test Circuit:

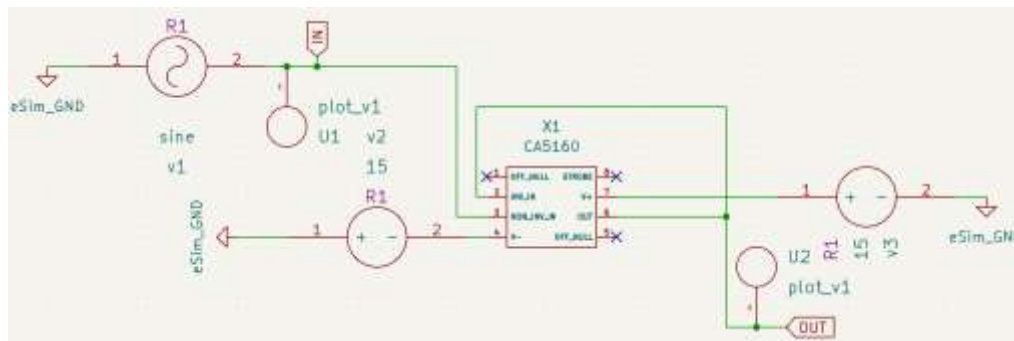


Figure 4 Test Circuit of C5160

Expected Results (Input, Output waveforms):

Input Waveform:

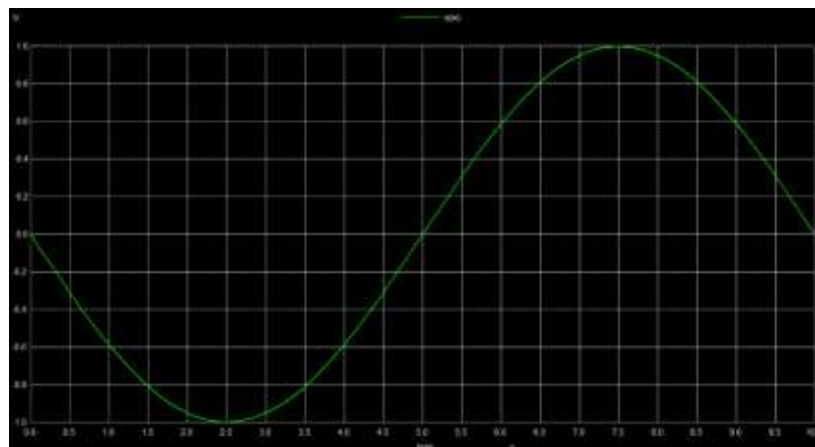


Figure 5 Input Waveform of CA5160 Voltage Follower

Output Waveform:

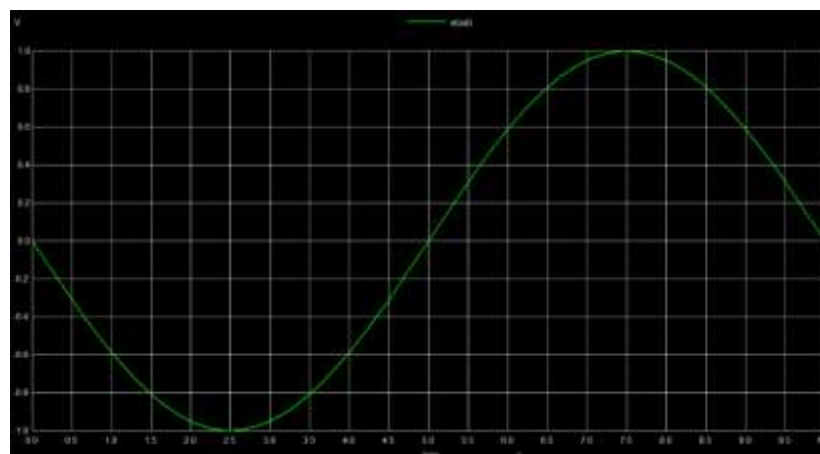


Figure 6 Output Waveform of CA5160 Voltage Follower



Research Paper/Journal/etc.:

Title: CA5160 – 4MHz, BiMOS Microprocessor Operational Amplifiers with MOSFET Input/CMOS Output

Author: Intersil Corporation

Page Number: Schematic Diagram (Page 5 of the datasheet)

Link

<https://www.alldatasheet.com/datasheet-pdf/view/177079/INTERSIL/CA5160.html>

Source/Reference(s):

1. Intersil Corporation, CA5160 Datasheet, September 1998.
2. Sedra, A. S., & Smith, K. C., *Microelectronic Circuits*, Oxford University Press.
3. Boylestad, R. L., *Electronic Devices and Circuit Theory*, Pearson Education.
4. eSim Documentation, FOSSEE Project, IIT Bombay.