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Title of the circuit:

Design and Implementation of CA3130 BiMOS Operational Amplifier using eSim

Theory/Description:

The CA3130 is a high-speed BiMOS operational amplifier that combines a PMOS MOSFET input stage with a CMOS output stage. This architecture provides extremely high input impedance, very low input bias current, high slew rate, and output voltage swing close to both supply rails, making the device suitable for both single-supply and dual-supply operation.

The objective of this project is to reproduce the internal CA3130 operational amplifier model in eSim based on the manufacturer's datasheet and verify its functionality. The amplifier incorporates a PMOS differential input stage, bipolar gain stage, CMOS output stage, bias circuitry, offset-null capability, and optional frequency compensation, enabling it to operate across a wide range of analog applications.

To validate the reproduced circuit, the amplifier is configured as a unity-gain voltage follower, one of the standard application circuits provided in the datasheet. The voltage follower is used only as a functional verification setup because it directly demonstrates correct closed-loop operation, voltage tracking, and stability of the implemented CA3130 model. Successful operation in this configuration confirms that the reproduced operational amplifier can subsequently be used for numerous other analog applications such as precision rectifiers, voltage regulators, peak detectors, sample-and-hold amplifiers, comparators, and sensor interface circuits.

Reason to reproduce with eSim:

The CA3130 is a versatile operational amplifier used extensively in analog circuit design. Reproducing it in eSim contributes to the FOSSEE open-source component library by providing a reusable simulation model for educational and research purposes.

Unlike reproducing only an application circuit, this project focuses on implementing the operational amplifier itself so that it can later be employed in a wide variety of analog designs. Verification using the voltage follower configuration ensures that the reproduced device exhibits the expected behaviour described in the datasheet. Once validated, the same CA3130 model can be readily used for applications including voltage followers, precision rectifiers, peak detectors, voltage regulators, sample-and-hold circuits, comparator circuits, and photodiode sensor interfaces.



Expected Outcome/outputs:

The expected outcome is a fully functional CA3130 operational amplifier model in eSim that accurately reproduces the behaviour specified in the datasheet.

Validation will be performed by configuring the implemented amplifier as a unity-gain voltage follower.

Successful verification indicates that the CA3130 model is suitable for use in other analog applications.

Circuit Diagram(s):

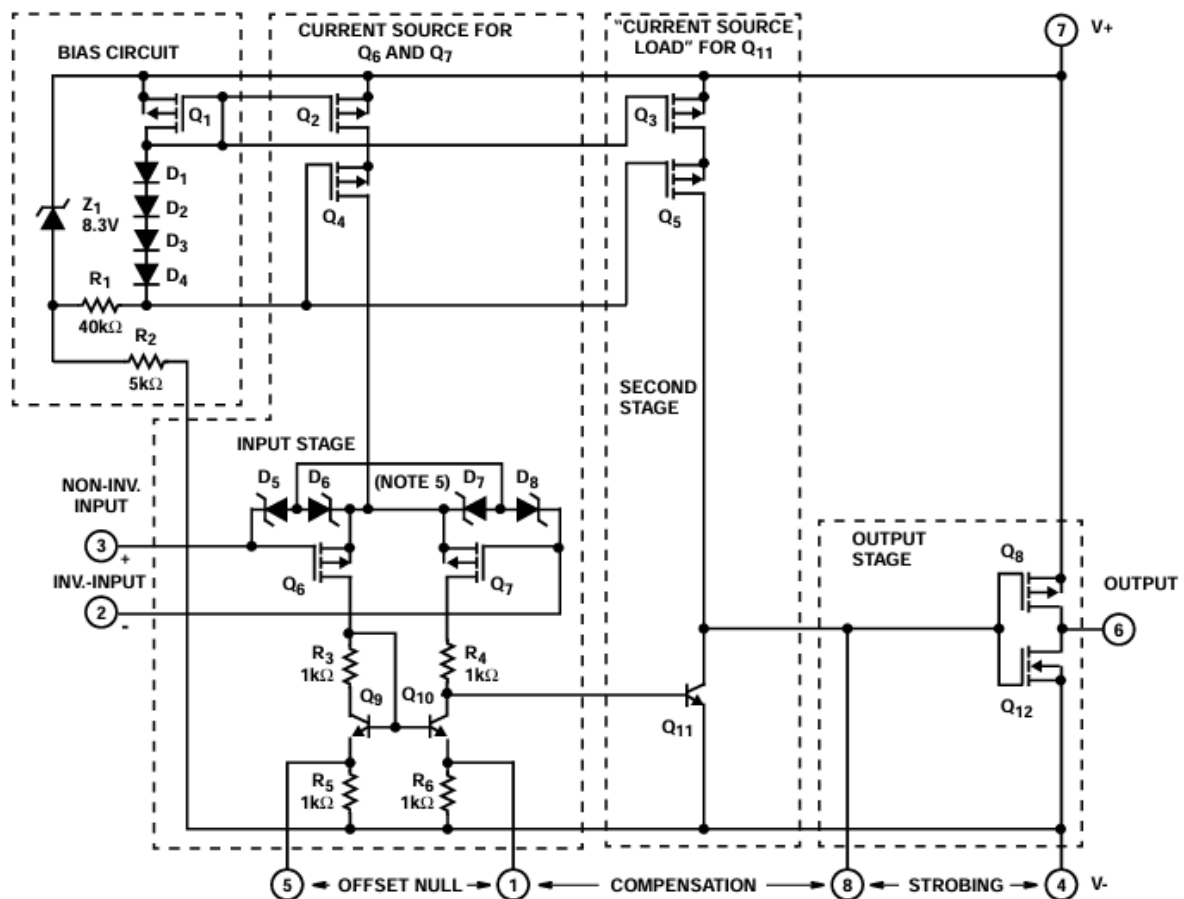


Figure 1 Circuit Diagram of CA3130



Pin Diagram:

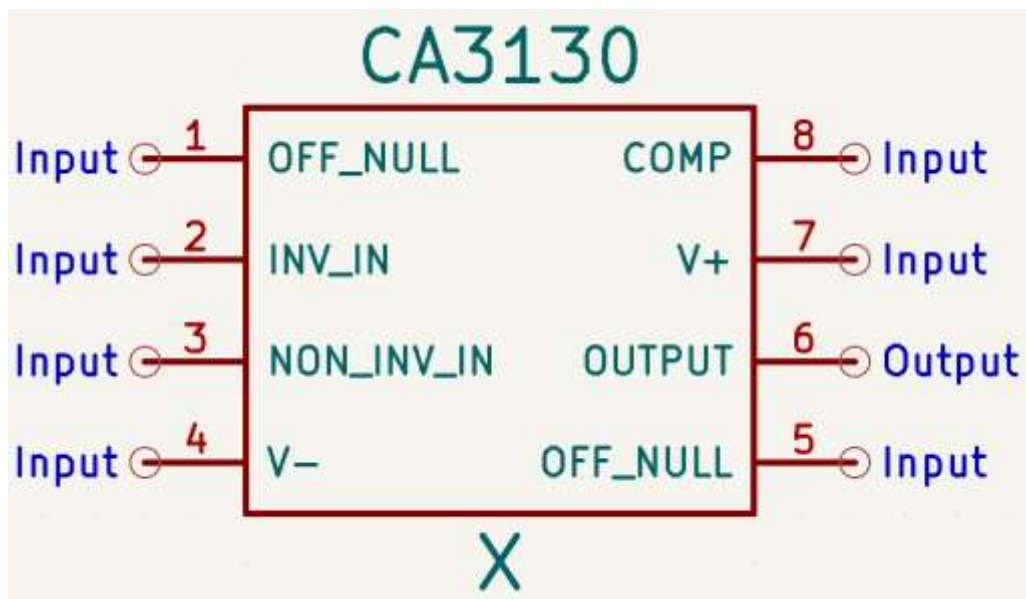


Figure 2 Pin Diagram of CA3130

Schematic Diagram:

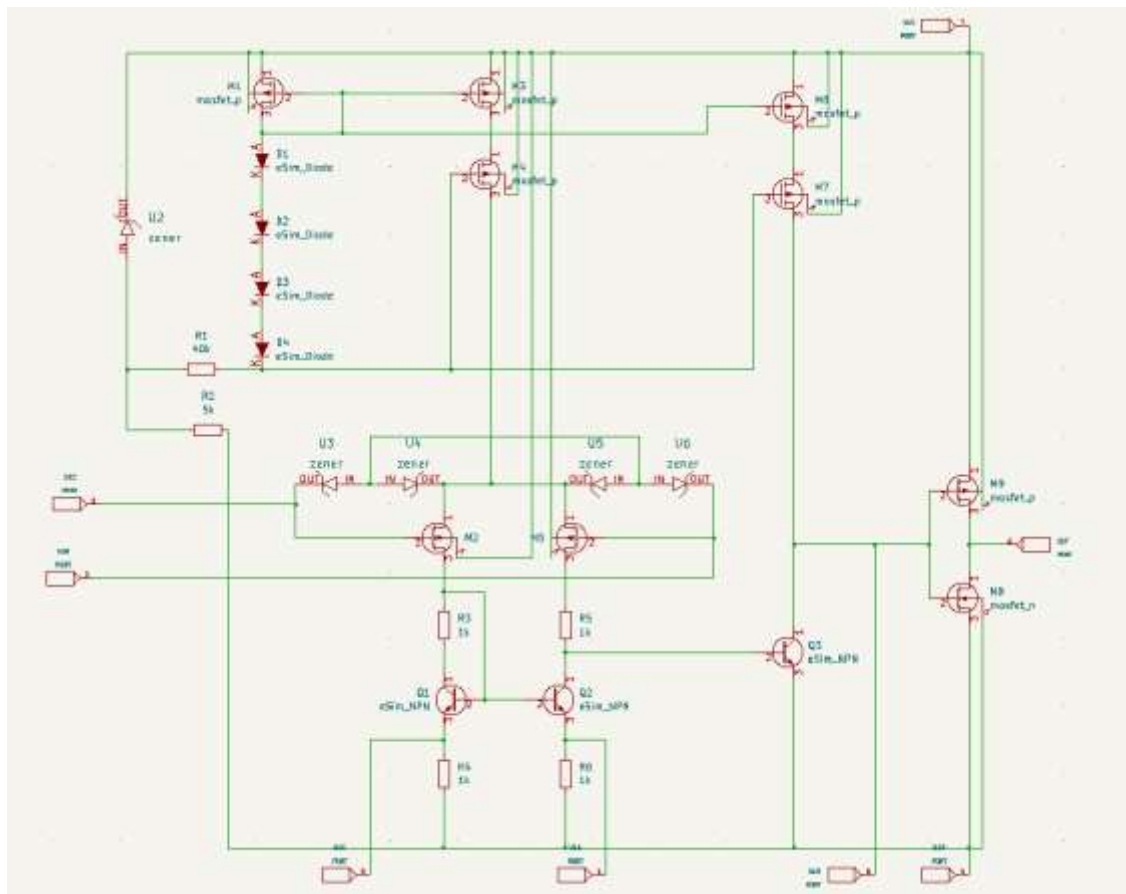


Figure 3 Schematic Diagram of CA3130



Test Circuit:

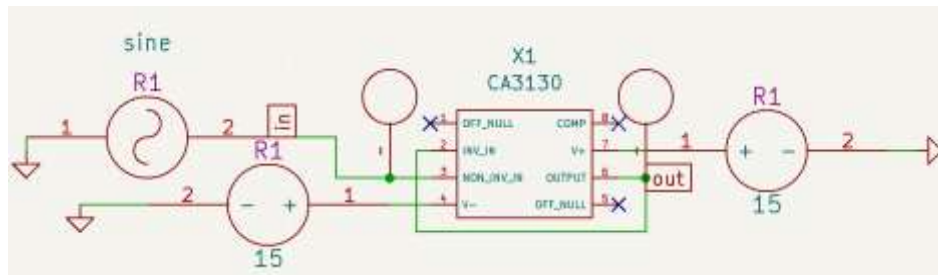


Figure 4 Test Circuit CA3130

Results (Input, Output waveforms):

Input Waveform:

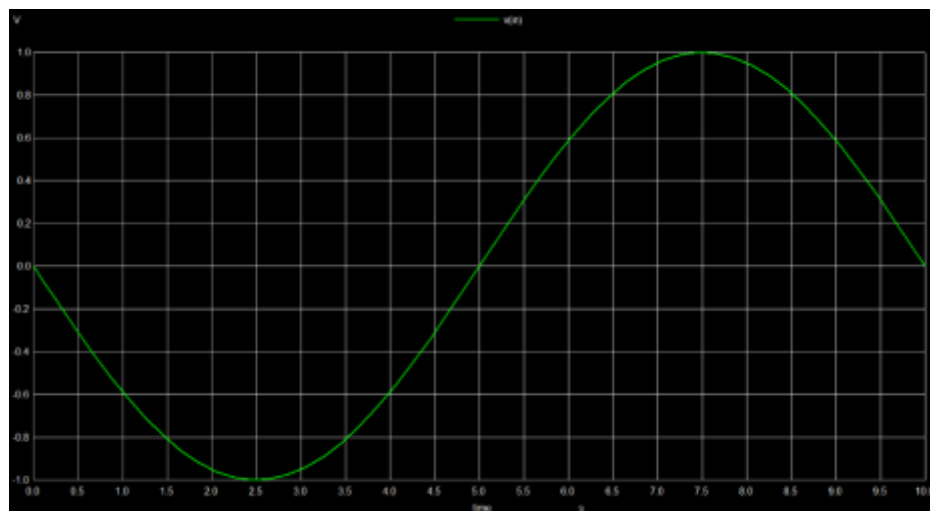


Figure 5 Input Waveform of CA3130 Voltage Follower

Output Waveform:

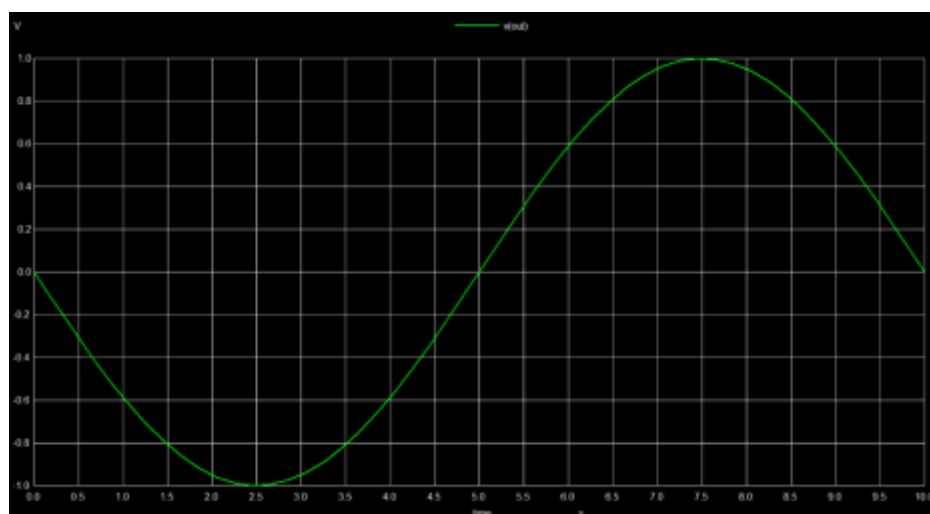


Figure 6 Output Waveform of CA3130 Voltage Follower



Research Paper/Journal/etc.:

Title: CA3130, CA3130A – 15 MHz BiMOS Operational Amplifier with MOSFET Input/CMOS Output

Author: Intersil Corporation

Page Number: Schematic Diagram (Page 4 of the datasheet)

Link

<https://www.renesas.com/us/en/document/dst/ca3130-ca3130a-datasheet>

Source/Reference(s) :

1. Intersil Corporation, CA3130/CA3130A 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.