7: “CMOS OP AMPS” [1, pg. 93]
ECE 3200 Electronics II
updated 26 June 2012

References


Objectives

1. To investigate a CMOS operational amplifier

2. To develop an ability to construct and debug circuits with a large number of active components

3. To improve and further develop an ability to effectively communicate technical information via a written report

Pre-Laboratory Assignment
(MUST BE COMPLETED INDIVIDUALLY)

As always, include a copy of the pre-lab results in your notebook.

1. You will perform experiments E1.1, E2.1, and E3.1 in experiment #10 of [1]. Read those experiments.

2. (E1.1) Complete P1.1(a). Compute $r_o$ for each device. Complete P1.1(d) and estimate the DC open-loop gain $v_f/v_{ab}$ of the CMOS operational amplifier of Figure 10.2. Proceed as in Example 8.5 of Sedra and Smith [2]. Assume that nodes B and F are not connected in your DC analysis. Tabulate your results as in Example 8.5 of Sedra and Smith [2].

3. Use SPICE to find the DC open-loop gain $v_f/v_{ab}$ of the CMOS operational amplifier of Figure 10.2 as shown in Figure 1 using the .tf command. Assume that $k_n=0.3$ mA/V^2, $k_p=1$ mA/V^2, $V_{tn}=1$V, and $V_{tp}=-1.3$V where $k_n = \mu_n C_{ox} W/L$ and $k_p = \mu_p C_{ox} W/L$. Compare your result to part 2 of the pre-lab. Figure 2 shows the CMOS operational amplifier configured as a 10x amplifier.

4. (E3.1) Complete P3.1. Note that $R_2=100k$ and $R_1=1k$. Use an otherwise ideal op-amp having a constant open-loop gain as determined in part 2 of the pre-lab.

5. This is a relatively complex circuit. There may be significant debugging required to produce a working op-amp. Prepare a list of at least 5 measurements that you can make to isolate problems in the event that your circuit is not working correctly.

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Figure 1. CMOS Operational Amplifier [1]

note: pasted from LTspice into GIMP (gimp.org), used "zealous crop", then "copy" to put in document
Procedures

NOTE: THESE DEVICE ARE EXTREMELY SENSITIVE TO ESD (electrostatic discharge). IT IS EASY TO DESTROY YOUR MOSFET ICs! Place your breadboard on the anti-static mat. The instructor will place the IC in your breadboard for you. Only persons with a wrist strap should be in contact with the breadboard during wiring, measurement, etc. Make sure that your circuit ground is connected to the earth ground. PERSONS WHO VIOLATE THESE RULES WILL BE HEAVILY PENALIZED.
Figure 2b. Simulation Results for a 11x Noninverting Amplifier Using a CMOS Operational Amplifier

Follow our standard practice of fully documenting your results using notes, graphs, printouts from the scope, etc. Disregard “Analysis” steps unless otherwise directed.

1. Perform E1.1 “DC Operation” [1].

2. Perform “AC UNITY GAIN OPERATION E2.1 Over-Compensated Operation with a Dominant Load Pole” [1]. Complete the analysis section. DEMONSTRATE YOUR WORKING CIRCUIT TO THE LAB INSTRUCTOR. THE LAB INSTRUCTOR WILL INITIAL YOUR LAB NOTEBOOK TO INDICATE THAT YOUR CIRCUIT WAS OPERATIONAL. This is in addition to the “normal” initials required at the end of the experiment.

3. Perform “HIGHER-GAIN OPERATION E3.1 An Amplifier with a Nominal Gain of +100” [1].

Exercises
None.

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