Lab 7
Current Feedback Operational Amplifiers

In this lab we will demonstrate the inverse relationship between closed-loop gain and bandwidth in conventional operational amplifiers, then experiment with a different type of operational amplifier which is much faster and whose gain and bandwidth are independent of each other (the current feedback amplifier). The amplifier which we will use is the National Semiconductor LM6181, which is designed for low gain (1 to 10 inverting or non-inverting), wide bandwidth (100 MHz) applications.

Note: In working with high-speed op amps, it is necessary that your circuit be neatly constructed to minimize stray capacitances, that a single, short ground bus be used, and that the supply voltages be bypassed at the op amp.

Pre-lab

1. Review the concept of Gain-Bandwidth-Product (GBWP), that the product of closed-loop gain and bandwidth for a VFOA is a constant that can be obtained from the data sheet.
2. Compute the expected bandwidth in each of the three cases of gain 1, 10, and 100.
3. Estimate the largest permitted input signal amplitude to not be slew-rate limited on the output at 5 MHz.
4. Find the data sheet for the LM6181.
5. Find the recommended value of R_F for maximum bandwidth.
6. Find the value of R_F that produces a bandwidth of 5 MHz.
7. Does the data sheet give recommendations for power supply bypass capacitors?

Voltage-Feedback Operational Amplifiers

In this section you will investigate the relationship between gain and bandwidth of a voltage-feedback amplifiers for small amplitude inputs. You will need to use small-amplitude signals such that the gain is not limited by the slew-rate of the amplifier.

1. Construct a non-inverting amplifier using a 411 op amp and measure its small-signal 3 dB bandwidth for closed-loop gain of 1.
2. Increase the gain to 10 and measure the bandwidth.
3. Increase the gain to 100 and measure the bandwidth.

4. What is the feedback ratio β and expected value of the bandwidth in each case?
5. A unity-gain inverting amplifier has half the bandwidth of a unity gain non-inverting amplifier (a follower). This is because the feedback ratio β of the inverting amplifier is the same as that of a non-inverting amplifier of gain 2.
6. Measure the bandwidth of a non-inverting $\times 2$ amplifier .
7. Measure the bandwidth of an inverting $\times 1$ amplifier and see if they agree, and compare with the bandwidth of the follower amplifier from the first part.

Current-Feedback Operational Amplifier

In this section you will examine the CFOA and demonstrate how it outperforms the VFOA in terms of slew rate and bandwidth. You will also demonstrate that the bandwidth of the CFOA is (nearly) independent of the closed-loop gain.

NOTE: The supply voltages for the LM6181 op amps CANNOT exceed ± 18 V, and typically operate off of ± 15 V. Adjust your breadboard voltage to ± 15 V V. Be sure to have power bypass capacitors close to chip.

8. Design and breadboard an inverting amplifier having a gain of -1, using the recommended value of the feedback resistor R_F.
9. Check the small signal operation using a sinusoidal input, and test the frequency response of the amplifier. Are you able to measure the 3 dB frequency?
10. Then measure the small signal step response. Is the step response limited by the amplifier or by the rise time of your function generator or oscilloscope?
11. Measure the saturation levels.
12. Measure the slew rate of the amplifier for a large output signal and compare with specs. Make sure it is not saturating.
13. The open loop specs of the amplifier indicate that one can decrease the bandwidth of the amplifier by increasing the size of the feedback resistor. Use this to design an amplifier having a 3 dB bandwidth of 5 MHz and an inverting gain of 2.
14. Measure the gain and bandwidth and compare.
15. Increase the gain to 20 by reducing the gain resistors R_G. Does the bandwidth change? Measure and Explain.