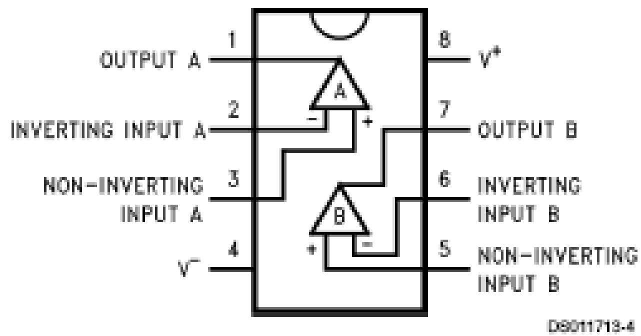
Op-Amps: Experiment Guide

In this lab, we are going to study operational amplifiers and circuits with op-amps. The op-amp chip that we are going to use is LMC 6482 from National Instrument. The configuration of the chip is shown below. It has two amplifiers in one chip with 8 pins. The pin configuration is also shown in the same figure (There is a node on the chip indicating pin 1). The power supply to the chip is -4 V for V^- and +6 V for V^+ in this lab (Maximum V^+-V^- is 30V). For more information, please refer to the device specification.



Part 1: Noninverting Amplifier

(a) DC measurements:

(1) Build up the noninverting amplifier as shown in Fig 1. Use +25V channel and -25V channel of the DC power supply for the V_{DD} and V_{SS}, the +25V should be set up to +6V and -25V channel should be set up to -4V. Use 6V channel of the DC power supply for V_{in}, and measure both input and output using oscilloscope. R_1 is 5k and R_2 is 5k. Change V_{in} from -2V to 3V to verify the proper amplification range of DC inputs.

(2) Fix the DC input 0.5V, measure the amplifier gain (V_{out}/V_{in}) for R_2= 2 k, 5k, 10kΩ (turn R_2) and compare with the calculated gain. (You need to take out the pot from the circuit to measure its value.)

(b) AC measurement:

(1) Now, set the input signal to a 1 kHz, 0.5 V_{PP}, 0 VDC offset (on the function generator display) Sine wave from the function generator. Use a 10kΩ potentiometer as R_2. Adjust R_2 to see the gain change. Can you get a gain less than unity by turning R_2? Why?

(2) Turn the potentiometer R_2 until the gain is 2 and then adjust the Vpp and DC offset to the input signal. Observe the input and output waveforms as you vary the DC offset for large Vpp (say 2.5V). Draw the input and output for a case that gives clipping, label all the axes and indicate the amplitude, and DC offset value.

*Do not take apart your circuit if you want to do the cascaded connection from Part 3.

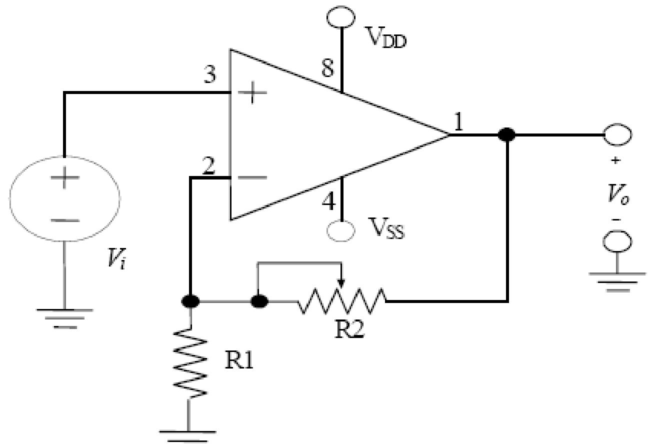


Fig 1:Non-inverting Amplifier

Part 2: Inverting Amplifier

Using the unused op-amp of the chip, build the inverting amplifier as shown in Fig 2 (please use the unused op-amp now, especially if you want to do part 3). R_1 is 5k and R_2 is the 10k pot. While you are building a circuit, it is safer for the circuits if you turn the DC power supply OUTPUT OFF. Let the input signal be a 1 kHz, 2.5V_{PP} sine wave, 0 VDC offset, turn R_2 to max. What's happening to the output signal as you change R_2? Adjust the input offset to make the output more complete. Now adjust the potentiometer and observe the resulting change in the amplitude and offset of the output. Adjust these two parameters until the gain is at its maximum and there's no clipping. What range of output voltage do you have in this circuit? Verify the correct amplification (range of the output signal) of both AC and DC signals. What is the phase difference between V_{out} and V_{in} and where is it from?

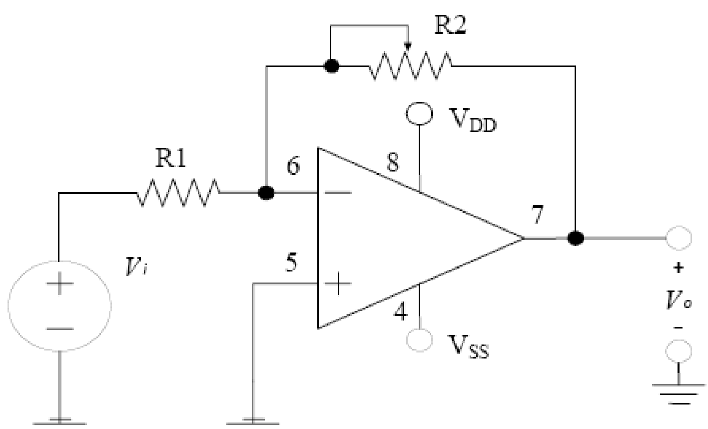


Fig 2 Inverting Amplifier

Part 3: Cascaded connection (optional)

Now we will study a cascade connection of two amplifiers. Connect the output of the non-inverting amp to act as the input voltage for the inverting amp. Use R_2 = 10k in the inverting circuit and R_2'=5k in the noninverting circuit. The input signal should be a 1 kHz, 50mV_{PP} (on the function generator display) sine wave and you have to pick the correct offset for the circuit to amplify linearly. Adjust the input signal to make sure there is no clipping in the circuit. Measure the gain of each stage separately and then the overall gain of this cascaded circuit.

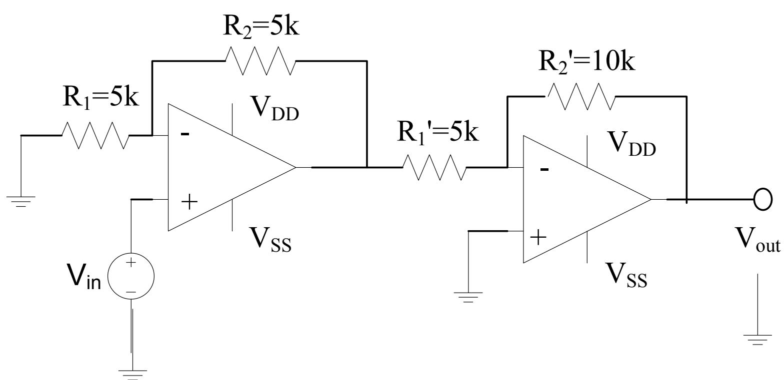


Fig 3 Cascade amplifier structure

Part 4: Integrator

Put a 0.1 uF capacitor instead of R_2 in a new inverting amplifier (Fig 3) and measure the time constant. Use a 60 Hz, 500mV_{PP} square wave as input. After getting the waveforms and triggering correct, measure time constant RC (how will you measure it? Hint: you prelab question 4). Compare measured time constant with theory. Now change the function generator back to a sine wave input, sweep frequency from 1Hz to 100kHz and observe the change of the gain.

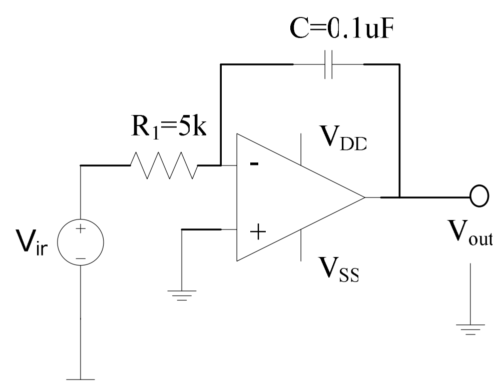


Fig 4 Integrator

Part 5: Differentiator

Build the inverting amplifier but put 0.1 uF capacitor in stead of R_1 as shown in Fig 4. Use R_2=5k Input a 500 Hz 500 mVpp triangle wave. Zoom into the waveform to measure time constant RC (Hint: prelab question 5). Compare measured time constant with theory. Add DC offset to the input signal, is there any change on the output signal? Why?

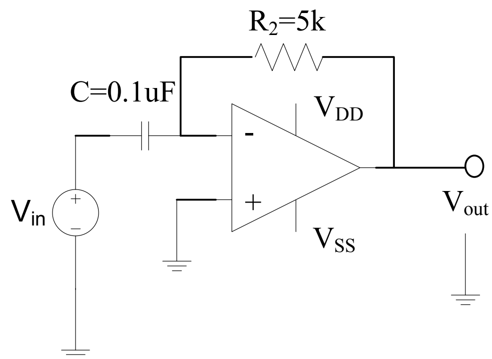


Fig 5 Differentiator