

Op Amp Circuits

Inverting and non-inverting amplifier, integrator, differentiator

Experiment: Procedure/Observation

(I) Inverting amplifier

1. Wire up the inverting amplifier circuit shown in the figure, with $R_1 = 1\text{ k}$, $R_2 = 10\text{ k}$. Remember to connect the supply ($\pm 15\text{ V}$). Apply a sinusoidal input with a peak of 0.1 V and frequency 1 kHz . Observe V_i and V_o on the oscilloscope and confirm that the magnitude and phase of V_o is what you would expect.
2. Increase the input amplitude from 0.1 V to 2 V , and observe the output waveform. Explain your observation.
3. Keep the input amplitude at 0.5 V , and increase the frequency until the output waveform becomes triangular. From the waveform, calculate the slew rate and compare it with the data sheet of the op amp you are using.
4. Record the gain of the amplifier versus frequency for $10\text{ Hz} < f < 1\text{ MHz}$. Take sufficient number of readings in the frequency range where the gain changes significantly with frequency. For each frequency point, measure both input and output amplitudes. (It is important to keep track of the input amplitude since the output of the function generator may drop slightly at high frequencies.)
If you observe distortion in the output waveform (i.e., it deviates from a pure sinusoid), reduce the input amplitude suitably.
5. Record the frequency response for $R_1 = 1\text{ k}$, $R_2 = 100\text{ k}$. Plot the frequency response for $R_2 = 10\text{ k}$ and that for $R_2 = 100\text{ k}$ together (same graph), with the gain in dB and frequency on log scale.

(II) Non-inverting amplifier

Repeat items (I)-1 to (I)-5 of the inverting amplifier procedure for the non-inverting amplifier circuit shown in the figure.

(III) Integrator

1. Wire up the integrator circuit shown in the figure with $R = 10\text{ k}$, $C = 0.01\text{ }\mu\text{F}$, $R' = 470\text{ k}$. Note that R' is used to prevent the op amp from entering saturation (because of a non-zero DC component in the input voltage or the op amp bias current). Verify that, with a square wave input ($\pm 2\text{ V}$, 1 kHz), the output voltage is triangular.

2. With a square wave input, the output voltage would be triangular. Compute the frequency at which an input square wave of $\pm 2\text{ V}$ will produce an output voltage going from -2 V to $+2\text{ V}$. Verify experimentally.
3. Keep the input voltage as in (2). Replace R' with a 500 k pot. Change the pot from minimum to maximum, and observe its effect on the output waveform. Explain your observation.

(IV) Differentiator

1. For the differentiator circuit shown in the figure with a triangular wave input ($\pm 2\text{ V}$, 2.5 kHz), $R = 10\text{ k}$, $C = 0.01\text{ }\mu\text{F}$, what do you expect for $V_o(t)$?
2. Wire up the circuit and observe $V_o(t)$. Is it close to your expectation?
3. Connect a small capacitor $C' = 0.001\text{ }\mu\text{F}$ in parallel with R , and observe $V_o(t)$. Explain your observation.

