

# ECE 311 - Fundamentals of Electronics Lab

## Frequency Limitations of Op-Amp Circuits

Department of Electrical and Computer Engineering  
University of Idaho

**Title:** Frequency Limitations of Op-Amp Circuits

**Objective:** To observe the frequency limitations imposed by the op-amp's gain-bandwidth product (GBP) and slew rate (SR) on the inverting and non-inverting amplifiers and to determine the GBP and SR for the LM348.

**Preliminary:** (Due at the beginning of the next laboratory period)

Consider an inverting amplifier depicted in Figure 1 with  $R_1=10\text{k}\Omega$  and  $R_2=1\text{k}\Omega$ . The op-amp is an LM348. Refer to the Typical Performance Characteristics found in the LM348 data sheets.

- 1) From the labeled Open Loop Frequency Response, what is the expected GBP for the op-amp? Note that the GBP is approximately the frequency where the GAIN is 0dB (this is 1V/V) if we assume op-amp has a single dominant pole over this frequency range.

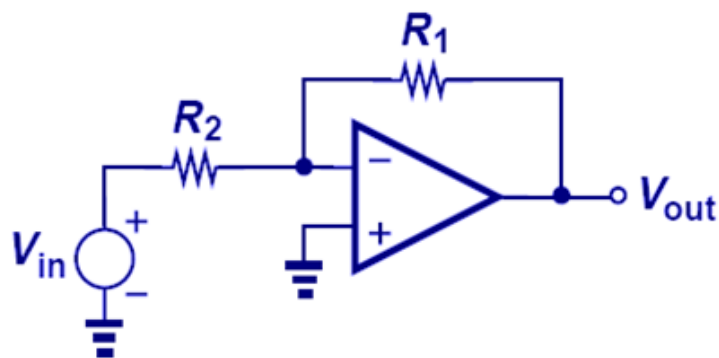


Figure 1: The inverting amplifier configuration.

- 2) What is the expected GBP for an inverting amplifier depicted in Figure 1?
- 3) For  $V_{in} = 1V_{peak}$ , what is the expected maximum frequency one may achieve before  $V_{out}$  begins to distort due to SR?

Consider a non-inverting amplifier depicted in Figure 2 with  $R_2=18\text{k}\Omega$  and  $R_1=1\text{k}\Omega$ . The op-amp is an LM348. Refer to the Typical Performance Characteristics found in the LM348 data sheets.

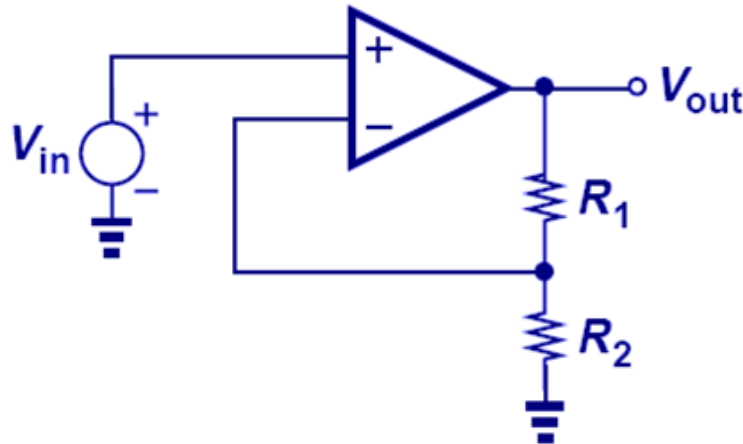


Figure 2: The non-inverting amplifier.

- 4) What is the expected GBP for a non-inverting amplifier depicted in Figure 2?
- 5) For  $V_{in} = 0.5V_{peak}$ , what is the expected maximum frequency one may achieve before  $V_{out}$  begins to distort due to SR?

### Laboratory Procedure:

#### *Inverting amplifier measurements*

- 1) Construct the inverting amplifier discussed in the preliminary. Measure  $R_2$  and  $R_1$ . Calculate the expected gain of the amplifier.
- 2) Measure the gain and bandwidth of the amplifier. What is the value of the GBP for this inverting amplifier ( $GBP_{INV AMP}$ )? Using your calculated value for  $GBP_{INV AMP}$ , determine the GBP for the op-amp. How does this compare to the value obtained from the data sheet?
- 3) Set the amplitude of  $V_{in}$  to  $1V_{peak}$  and a frequency of 1kHz.
- 4) Increase the frequency until  $V_{out}$  begins to show signs of being distorted. How does the value of this frequency compare to the value predicted by the data sheet?
- 5) Continue to increase the frequency until  $V_{out}$  has changed from sinusoidal to almost a triangle wave. From this, determine the SR of the op-amp. How does this value compare to that predicted by the data sheet?

*Non-inverting amplifier measurements*

- 6) Construct the inverting amplifier discussed in the preliminary. Measure  $R_2$  and  $R_1$ . Calculate the expected gain of the amplifier.
- 7) Measure the gain and bandwidth of the amplifier. What is the value of the GBP for this inverting amplifier ( $GBP_{\text{NON-INV AMP}}$ )? Using your calculated value for  $GBP_{\text{NON-INV AMP}}$ , determine the GBP for the op-amp. How does this compare to the value obtained from the data sheet and from part 2)?
- 8) Set the amplitude of  $V_{\text{in}}$  to  $0.5V_{\text{peak}}$  and a frequency of 1kHz.
- 9) Increase the frequency until  $V_{\text{out}}$  begins to show signs of being distorted. How does the value of this frequency compare to the value predicted by the data sheet?
- 10) Continue to increase the frequency until  $V_{\text{out}}$  has changed from sinusoidal to almost a triangle wave. From this, determine the SR of the op-amp. How does this value compare to that predicted by the data sheet and that measured in 5)?