

Lab 7.

Audio Front End and Playback

Goal

Audio Signal

- ◆ Audio jack
- ◆ Microphone

Signal Conditioning

- ◆ CE Amplifier
- ◆ Lowpass Filter

- ◆ Amplitude
- ◆ DC offset
- ◆ No aliasing

Digital Signal Processing

- ◆ ADC (Arduino)
- ◆ Record/Playback

- ◆ Sampling
- ◆ Save as a file

Hearing range

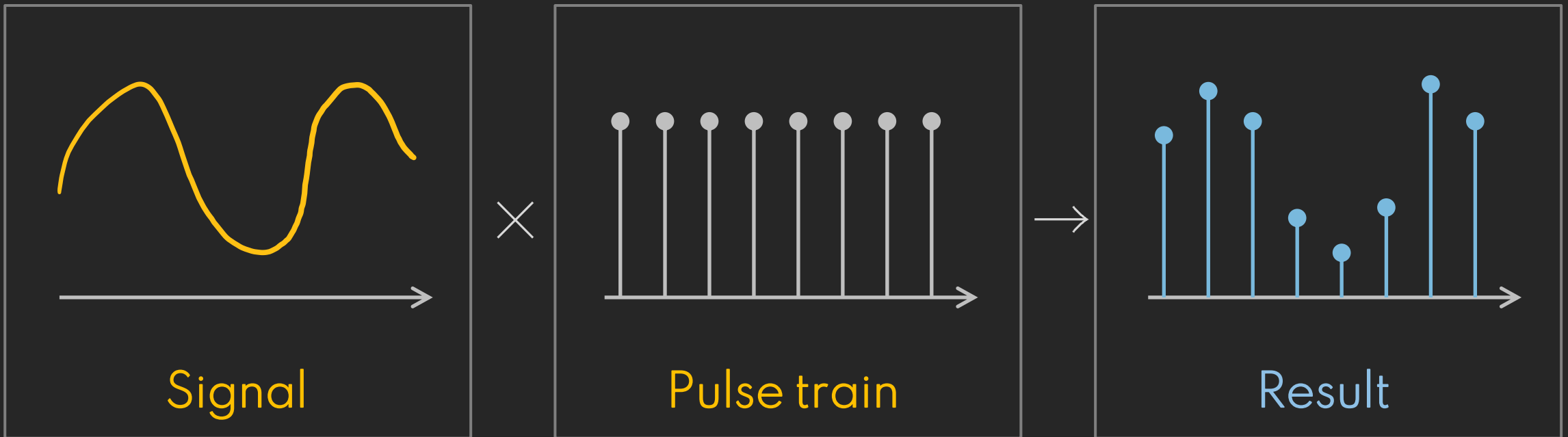


20 ~ 20k
Hz

Hearing

Sampling

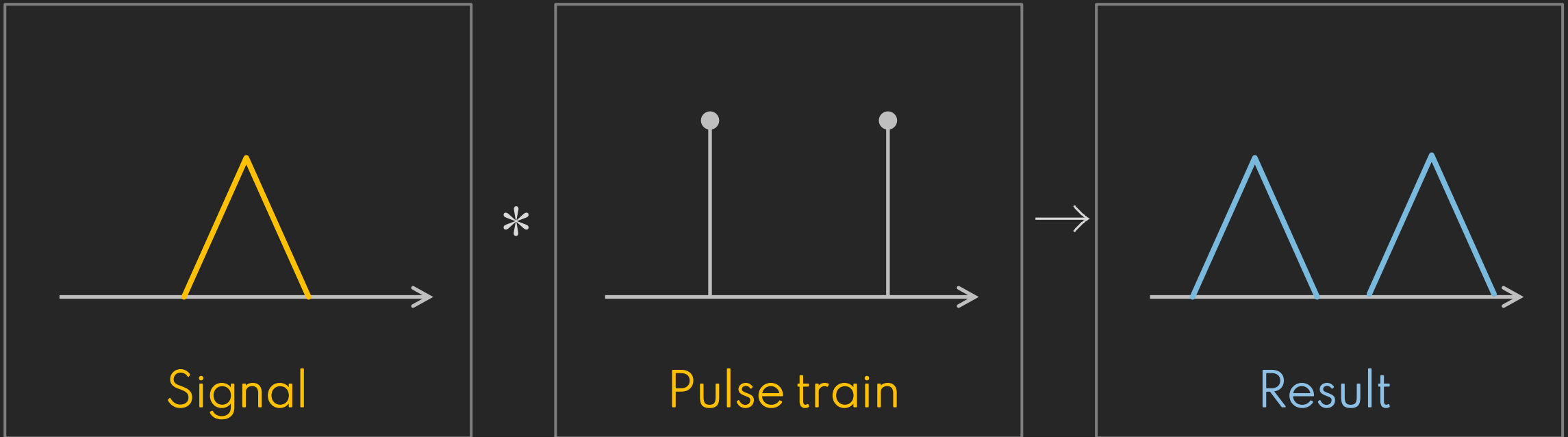
Time-domain: Multiplication



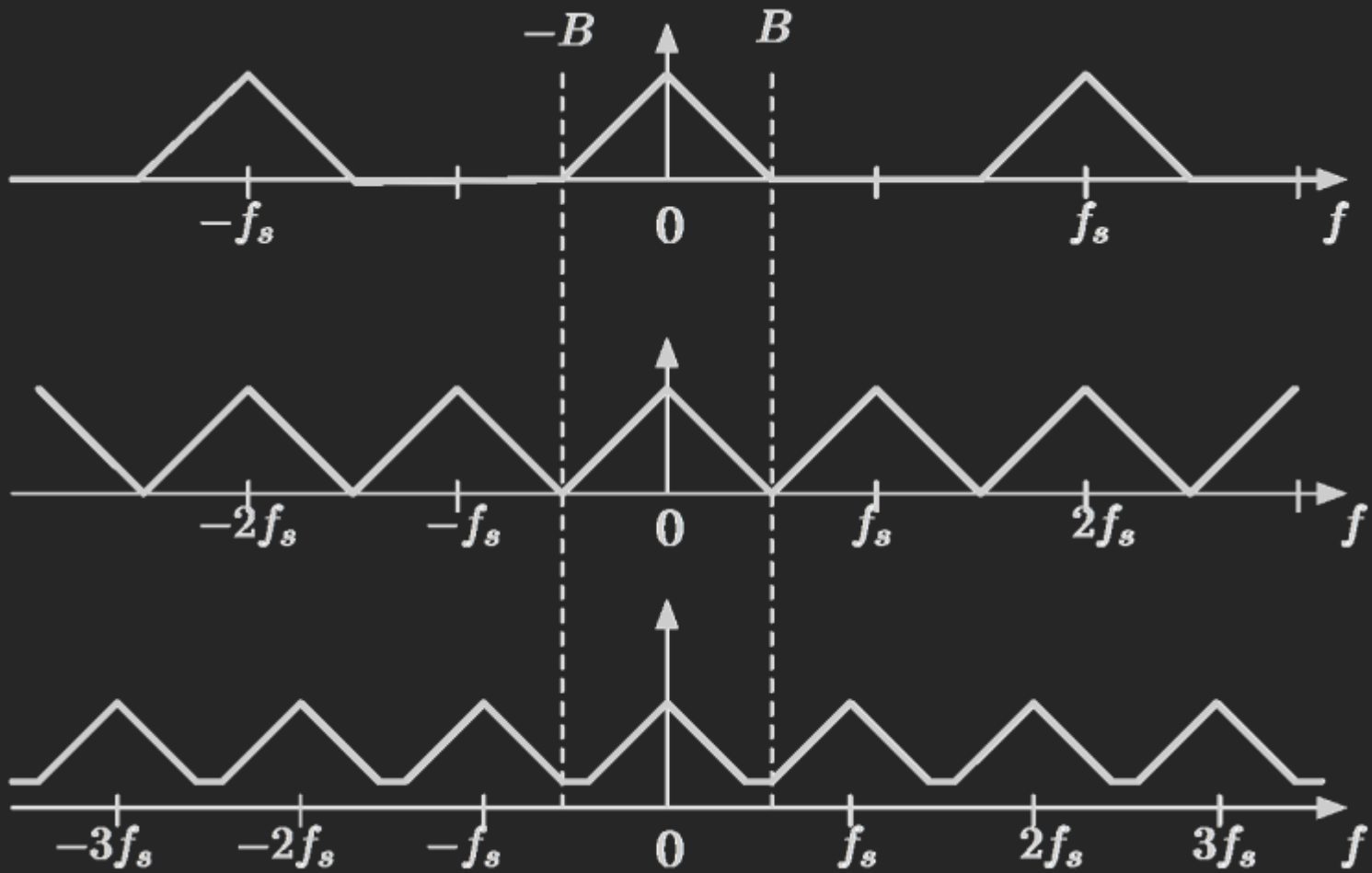
Sampling

Frequency-domain: Convolution

Basically,
Ctrl + C
Ctrl + V



Aliasing

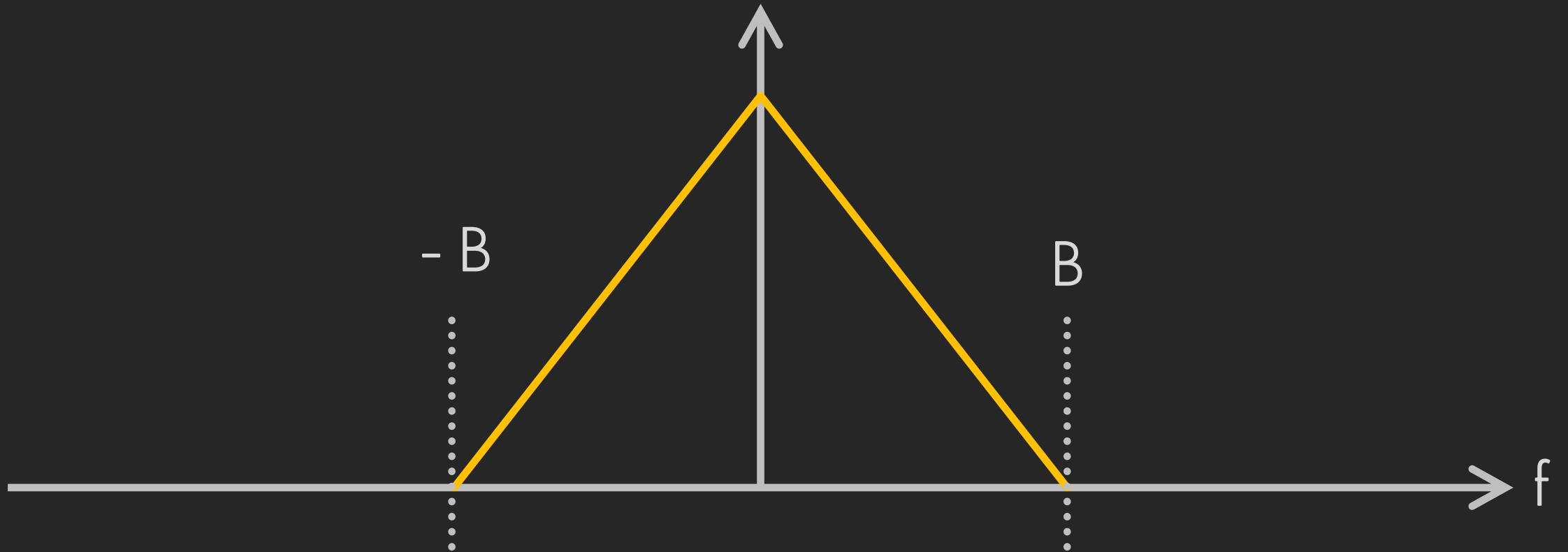


How to prevent it?

- ◆ Increase f_s
- ◆ LPF

Sampling Theorem

Sufficient sample-rate $> 2B$



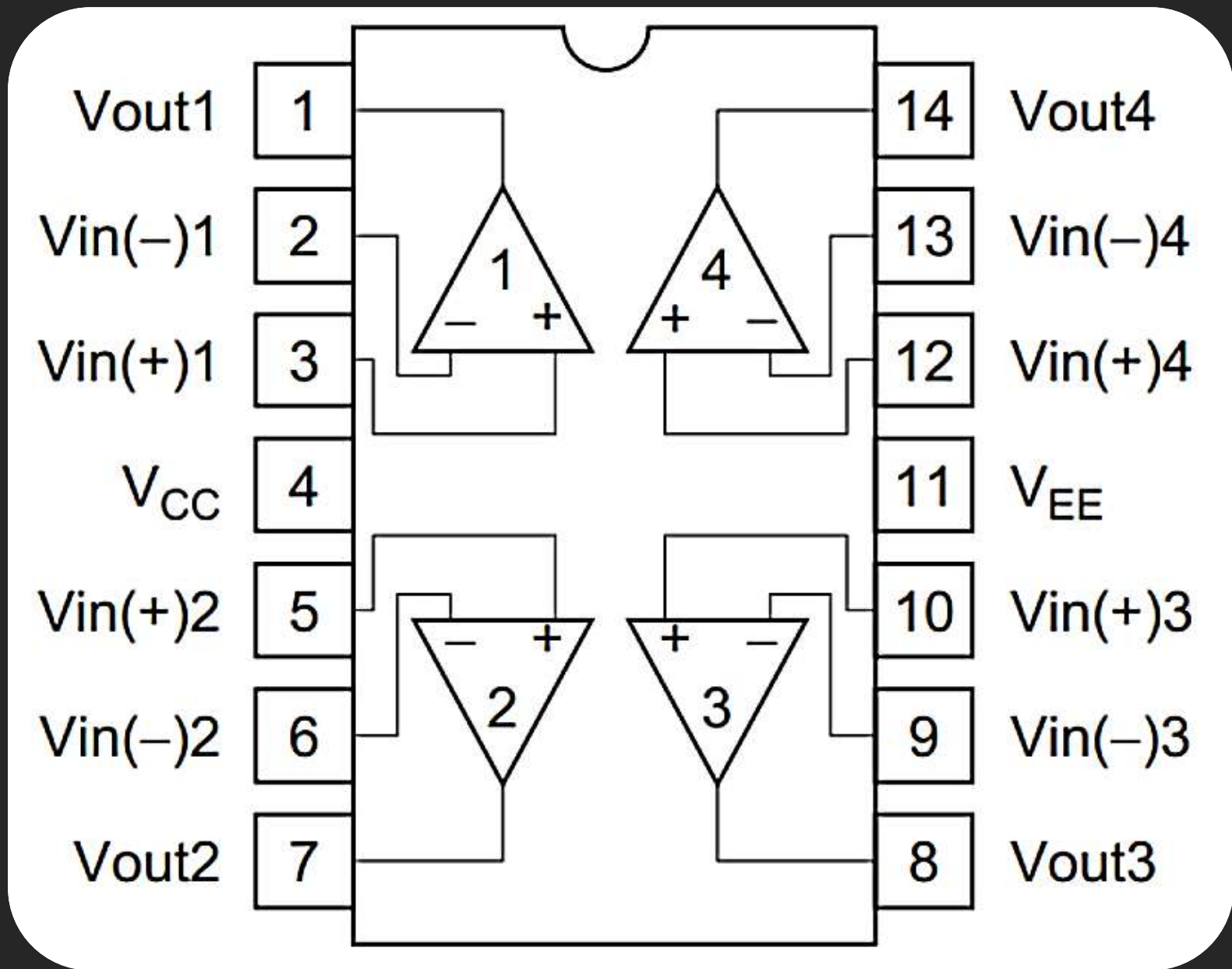
Circuit



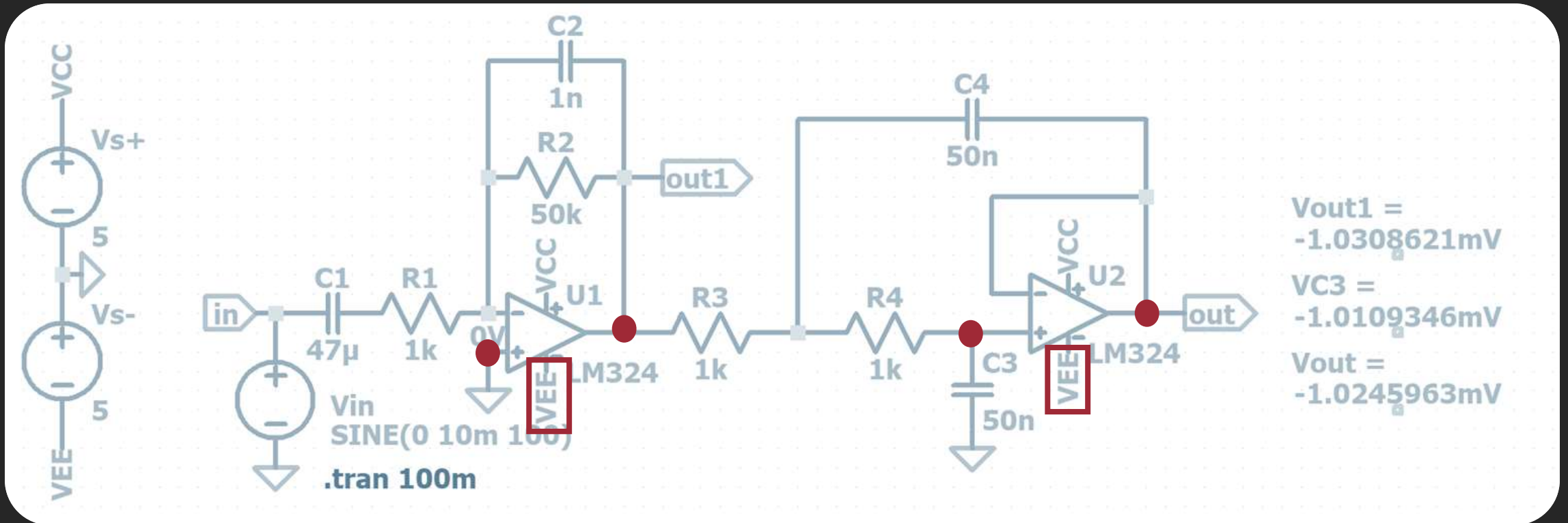
EXP 1.

Split Supply vs. Single Supply

LM324



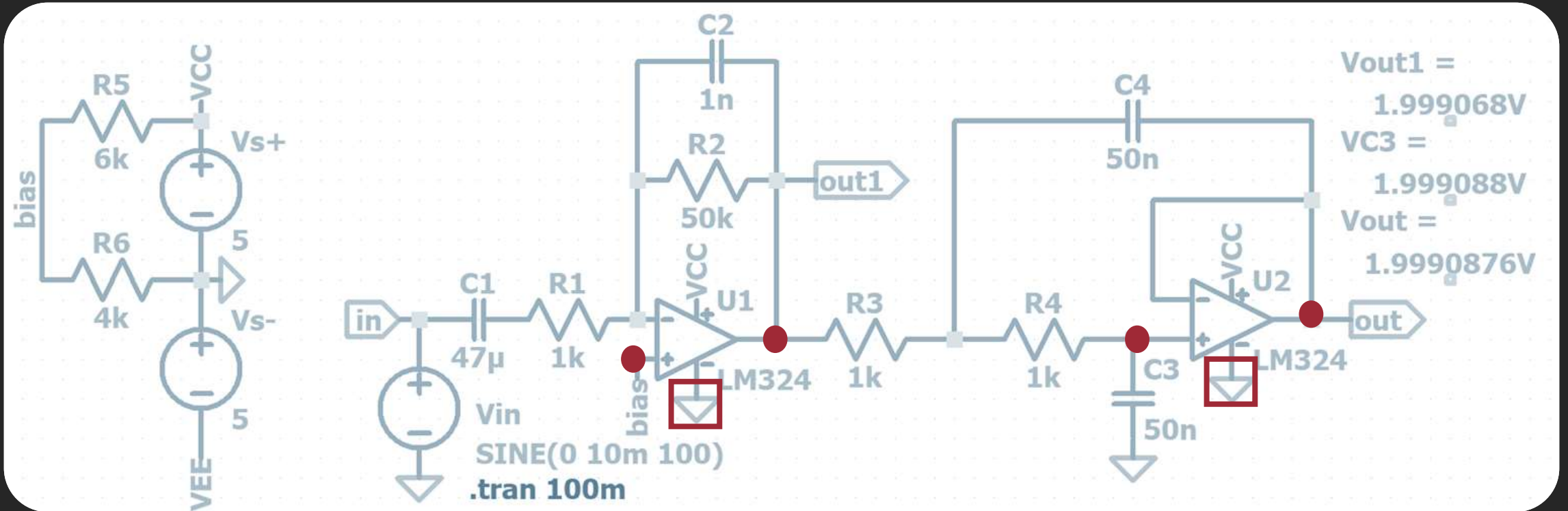
EXP 1 – 1 Split Supply



DC measurement

AC sweep ($20mV_{pp}$, 1~100kHz, 1s)

EXP 1 - 2 Single Supply



DC measurement
AC sweep (20mV_{pp} , 1~100kHz, 1s)

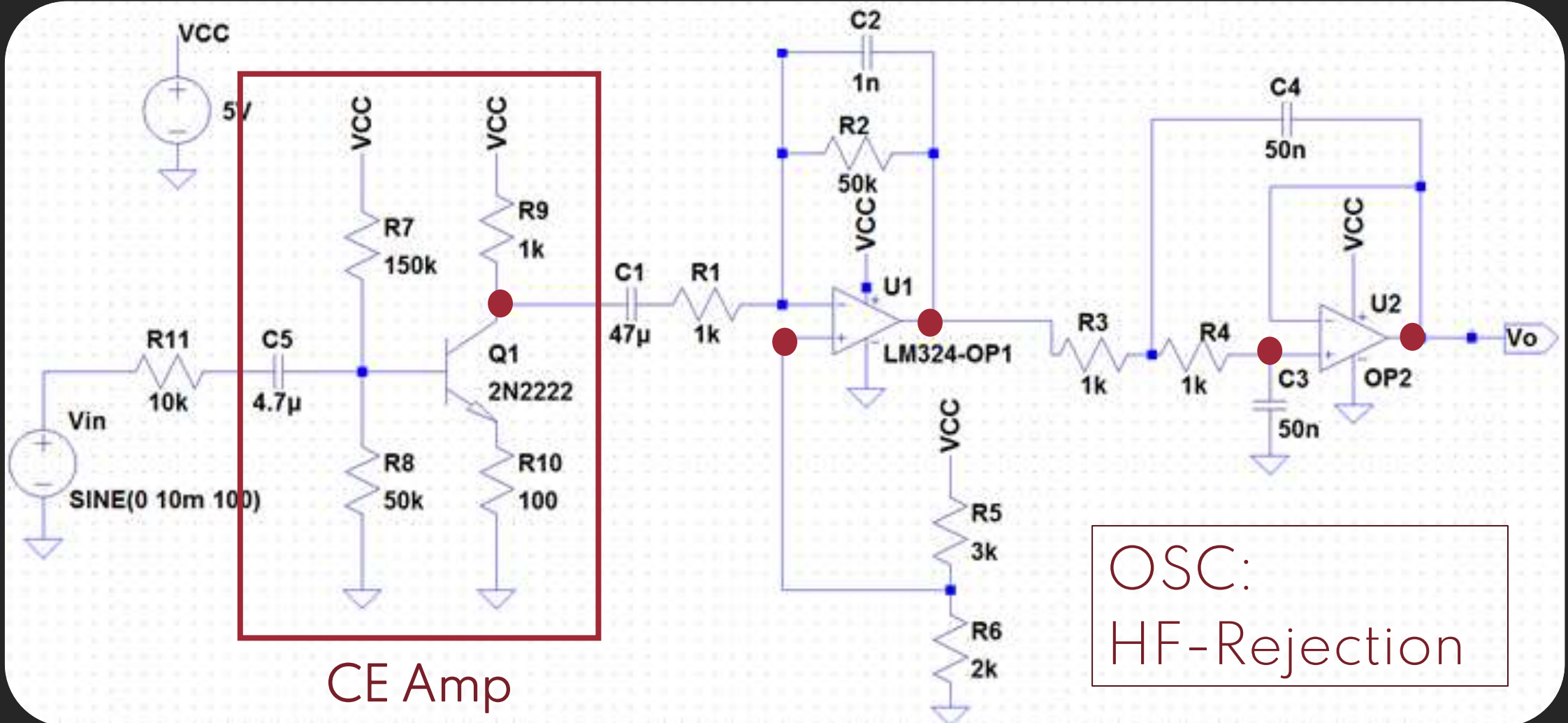
OSC:
AC Coupling

EXP 2.

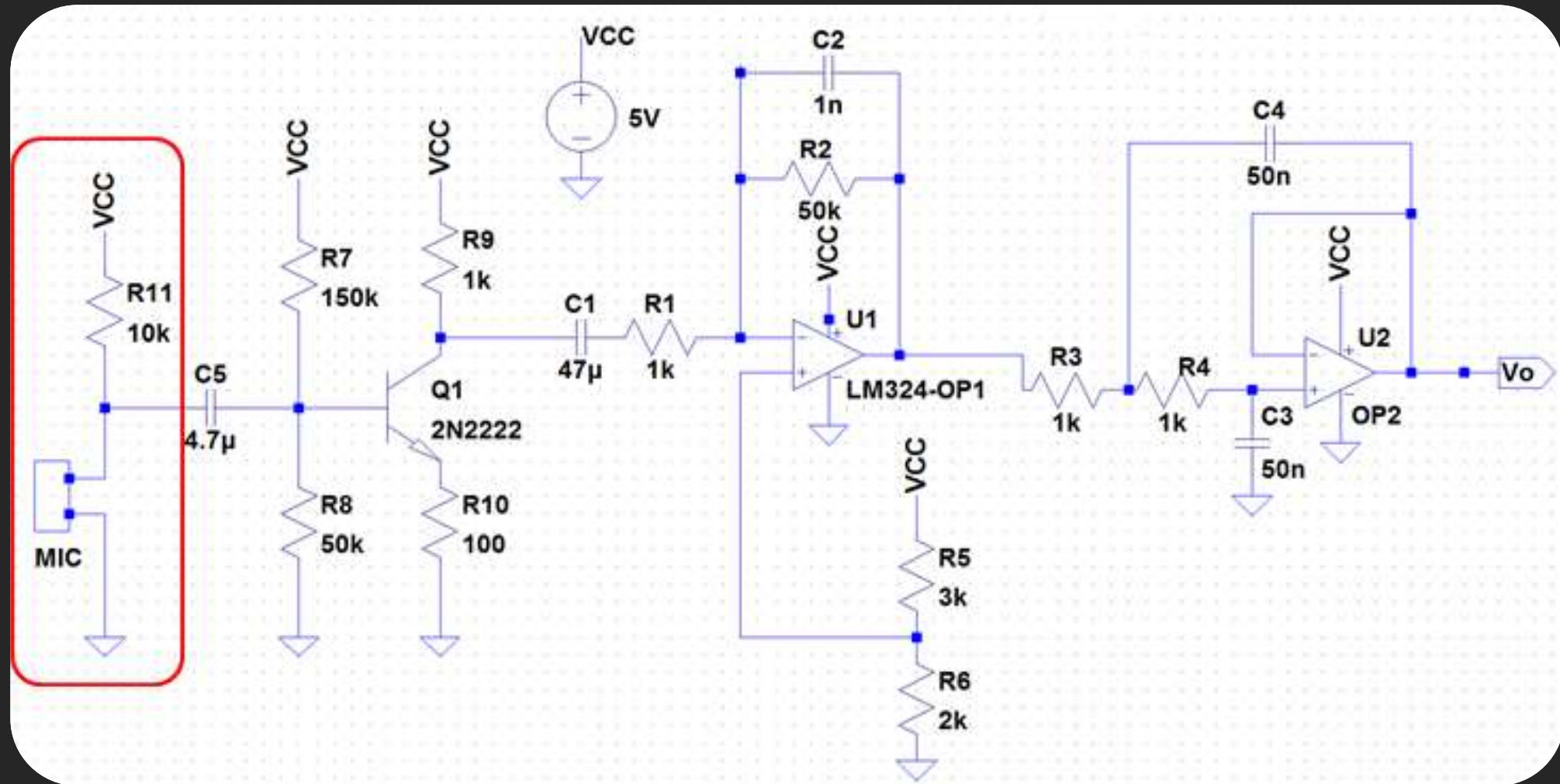
Audio Front End

EXP 2-1

DC measurement
AC sweep (20mV_{pp} , $1\sim 100\text{kHz}$, 1s)



EXP 2-2 Audio input

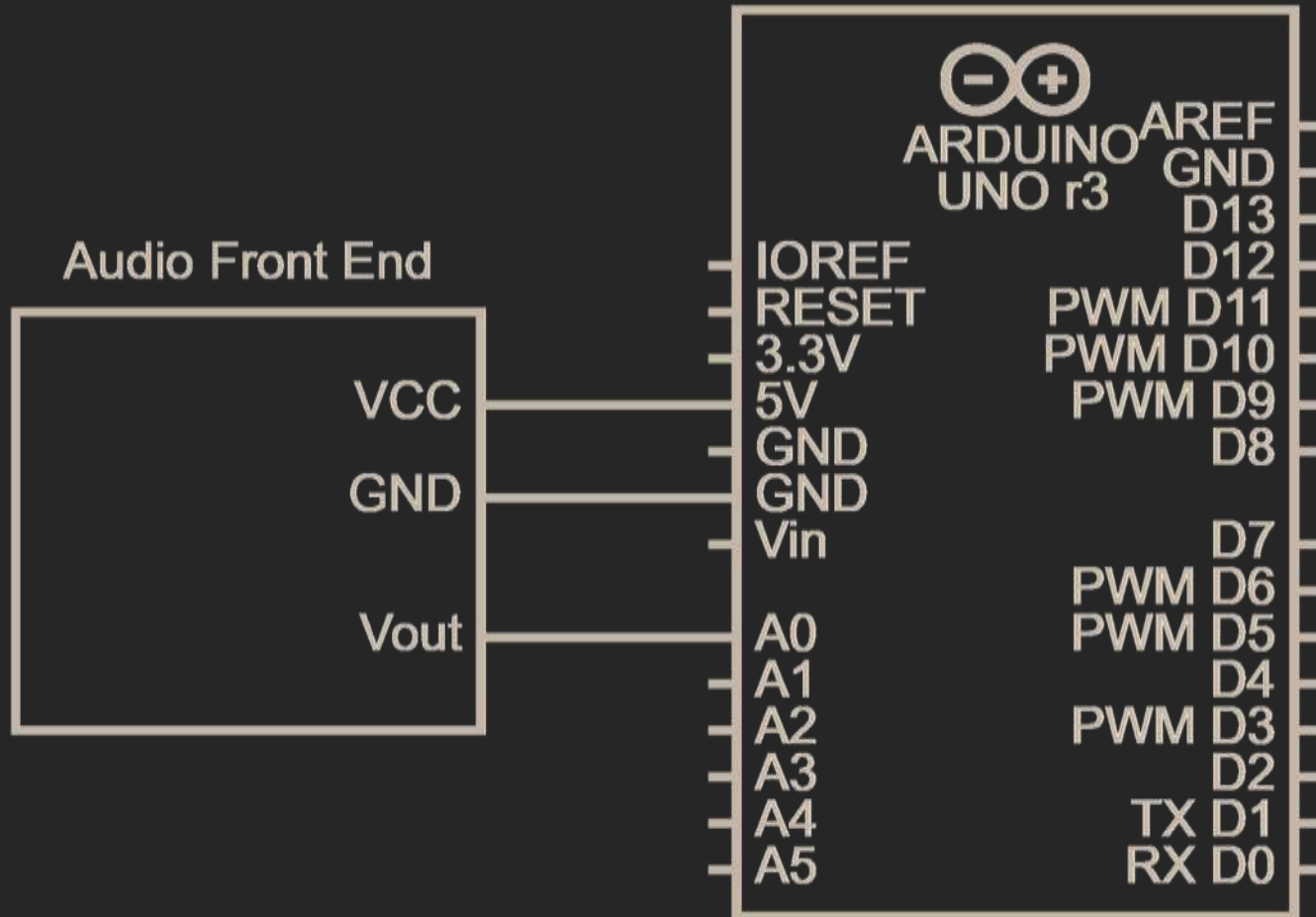


EXP 3.

Record/Playback

EXP 3

For more detail operations, please check the file
Lab07_EXP_Audio Front End and Playback.pptx



1. Construct the circuit
2. Install DAQPlayer
3. Upload
DAQPlayer.ino
4. Run DAQPlayer.exe
5. Save as .wav file

BONUS

1. Unity-Gain Bandwidth
2. Slew Rate

BONUS

Ref: [LMx24, LMx24x, LMx24xx, LM2902, LM2902x, LM2902xx, LM2902xxx Quadruple Operational Amplifiers datasheet \(Rev. W\)](#)

6.8 Operating Conditions

$V_{CC} = \pm 15\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	$R_L = 1\text{ M}\Omega$, $C_L = 30\text{ pF}$, $V_I = \pm 10\text{ V}$ (see Figure 7)	0.5	$\text{V}/\mu\text{s}$
B_1	Unity-gain bandwidth	$R_L = 1\text{ M}\Omega$, $C_L = 20\text{ pF}$ (see Figure 7)	1.2	MHz
V_n	Equivalent input noise voltage	$R_S = 100\text{ }\Omega$, $V_I = 0\text{ V}$, $f = 1\text{ kHz}$ (see Figure 8)	35	$\text{nV}/\sqrt{\text{Hz}}$

7 Parameter Measurement Information

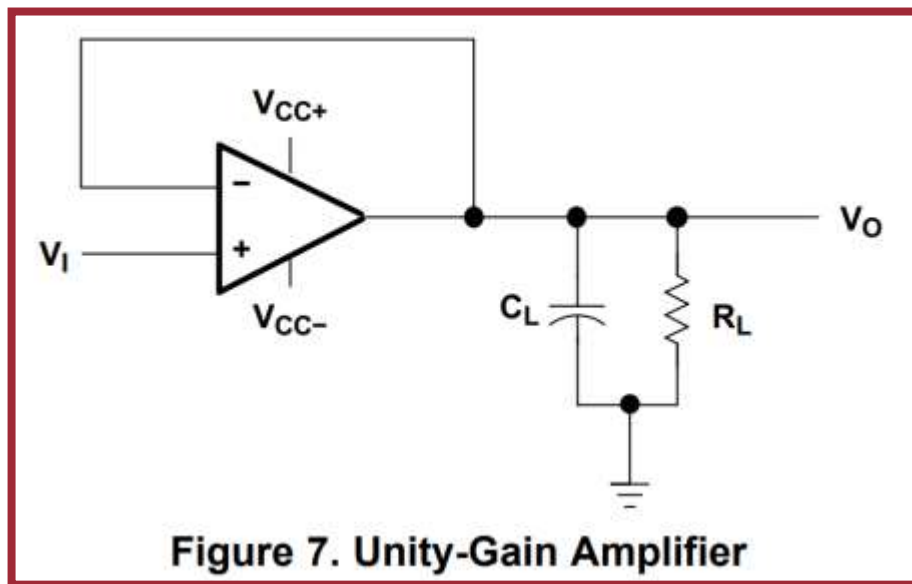


Figure 7. Unity-Gain Amplifier

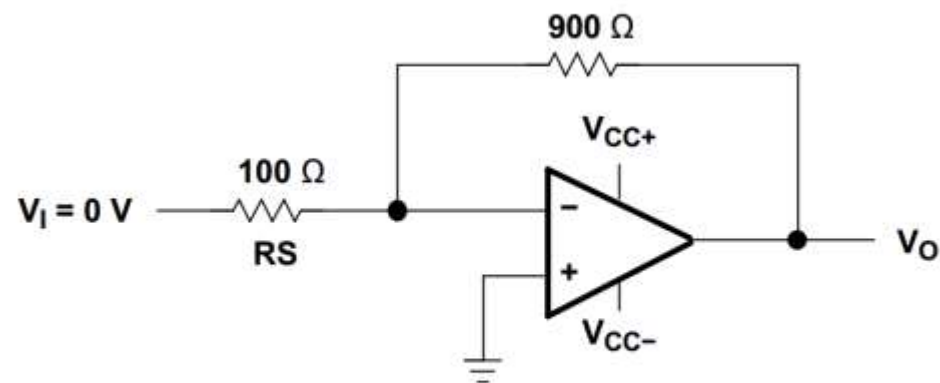
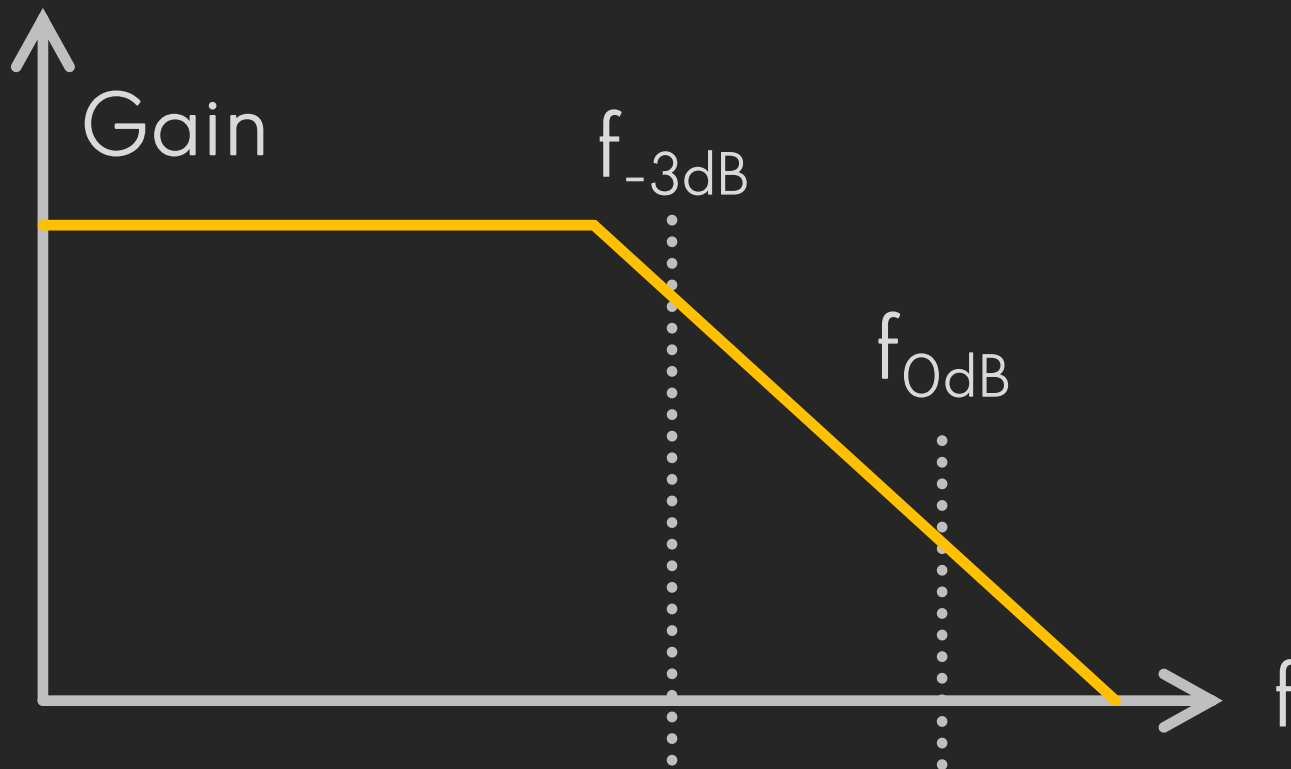


Figure 8. Noise-Test Circuit

Unity-Gain Bandwidth

The frequency at which the gain of an amplifier is equal to 1.



$$\begin{aligned} \text{Gain} &= 1 \\ &= 0 \text{ dB} \end{aligned}$$

Slew Rate

The maximum rate of output voltage change per unit of time.



$$SR = \left. \frac{dv_{out}}{dt} \right|_{max} \quad \frac{V}{\mu s}$$

Ref: <https://www.electrical4u.com/slew-rate/>

Thank You

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