Audio Amplification Circuit Design

Purpose

1. Master principle and design method of small signal amplifier circuit

2. Understand the principle of integrated amplifier

3. Master design procedure and debugging method of electrical circuit

Design an audio amplifier circuit, the input of microphone is smaller than 10mV, the technical indices of the circuit:

1. Input impedance>100KΩ

CMRR (Common Mode Rejection Ratio)>60dB

2. Passband: 300Hz~3KHz

3. Maximum undistorted output power ≥1W

Load impedance RL=16Ω

Source voltage: 10V

4. The input of preamplifier<10mV

Requirements

Design circuit, give more than two schemes, use multisim to simulate the circuit, select proper parameters and elements, then connect elements, debug and test.

Principle:

Preamplifier: Microphone signals are usually way below the nominal operating level, so a lot of gain is required, usually around 30-60 dB, sometimes even more. Preamplifier is an electronic amplifier that converts a weak electrical signal into an output signal strong enough to be noise-tolerant and strong enough for further processing, or for sending to a power amplifier and a loudspeaker.

Bandpass filter: A band-pass filter or bandpass filter is a device that passes frequencies within a certain range and rejects frequencies outside that range. After pre amplification of signals there still some noise or other signals would remain. To keep only the human voice(80Hz~3.4KHz) in the output signal, we need to pass only the certain frequency signal and block others. To do this, a band pass filter is required.

Power amplification circuit: The small signal that comes from the pre amplifier and bandpass filter is not strong enough to drive a speaker. So, to do this a power amplifier is needed to amplify the signal and remove signal distortions.

Lastly Combine modules:

Block Diagram of a Voice Amplifier:

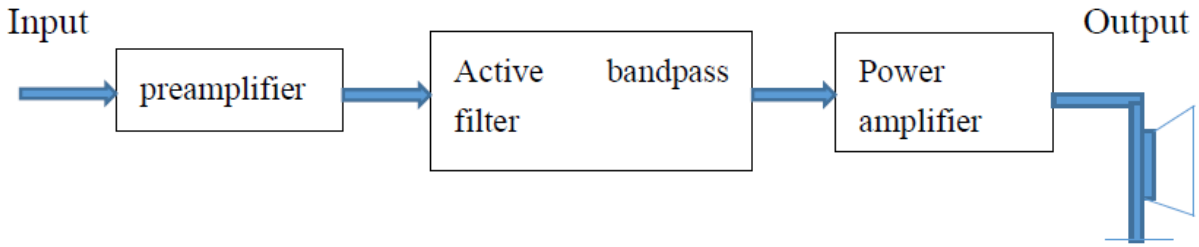


Fig.1 Diagram of voice amplifier

After creating all the necessary circuits shown in the blocks, they all need to be assembled together to form a single working circuit which can be used to drive a speaker.

Chips:

SSM2135S

Voltage Gain: 100dB

Gain Bandwidth Product: 3.5 MHz

Source Voltage Range: 4V-36 V DC

Input Impedance: 4 MΩ

CMMR: 87 – 112 db

Output current: 40mA

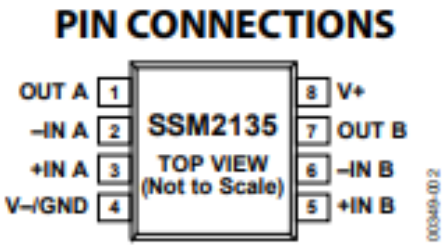


Figure 1. 8-Lead Narrow Body SOIC (R Suffix)

AD8544AR

Voltage Gain: 100dB

Gain Bandwidth Product: 980 kHz

VS = 2.5 V to 6 V

CMRR: 40- 45 dB

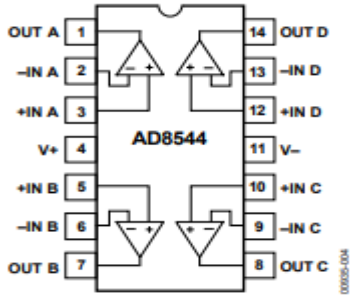
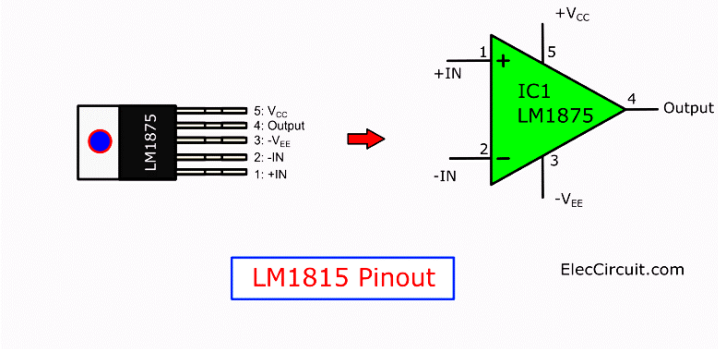


Figure 4. 14-Lead SOIC and 14-Lead TSSOP (R and RU Suffixes)

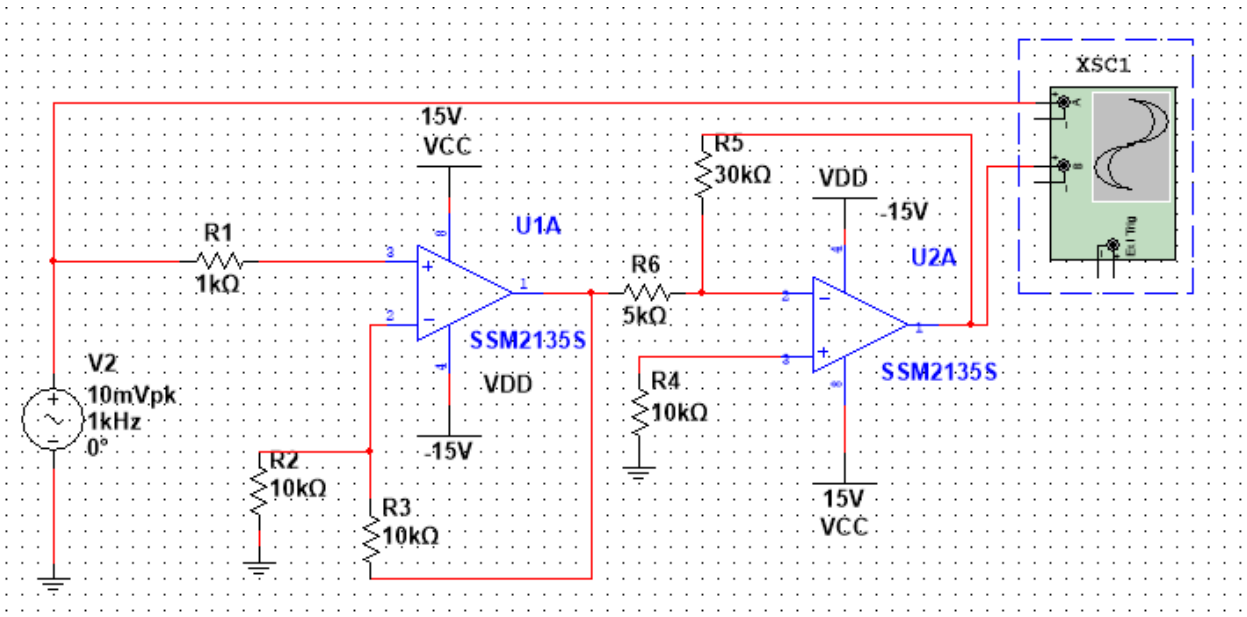
LM1875

voltage range： 16 ~ 60V
static current： 50mA
output power: 25W
rated gain: 26dB
working voltage: ±25V
Source voltage (Vs) 60V
Input voltage (Vin) -VEE-VCC V



Circuit design:

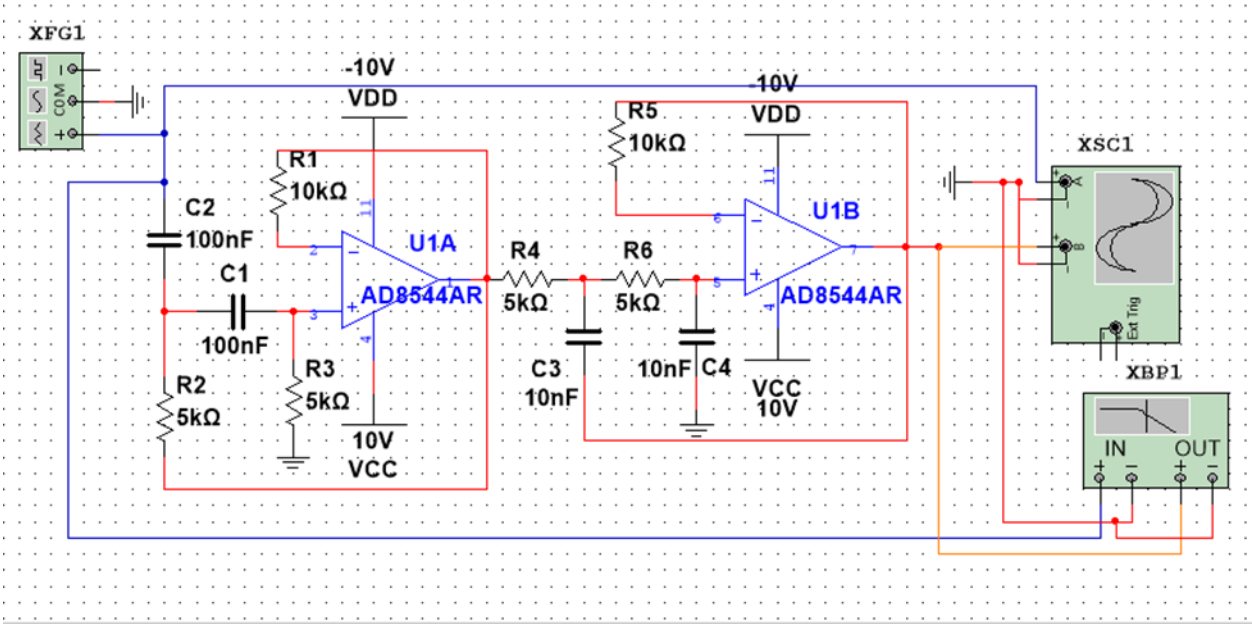
Preamplifier: The preamplifier shown below used two SSM2135S op amp to form a non-inverting and inverting cascade.



Active bandpass filter:

The frequency range which can be heard by human ears is 20Hz~20KHz, and the human voice frequency range is 80Hz~3.4KHz, but the audio signal frequency range is about 300Hz~3KHz, that's why a bandpass filter is necessary after preamplifier.

AD8544AR is used to create the bandpass filter.



Analysis:

(1) High Pass Frequency:

fp1=1/(2π*C √ R2R3) =318Hz~=300Hz

C=C1=C2=100nf, R2=R3=5K

(2) Low Pass Frequency:

fp2=1/(2π*R √ C3C4) =3183Hz~=3000Hz

C3=C4=10nf， R=R4=R6=5K

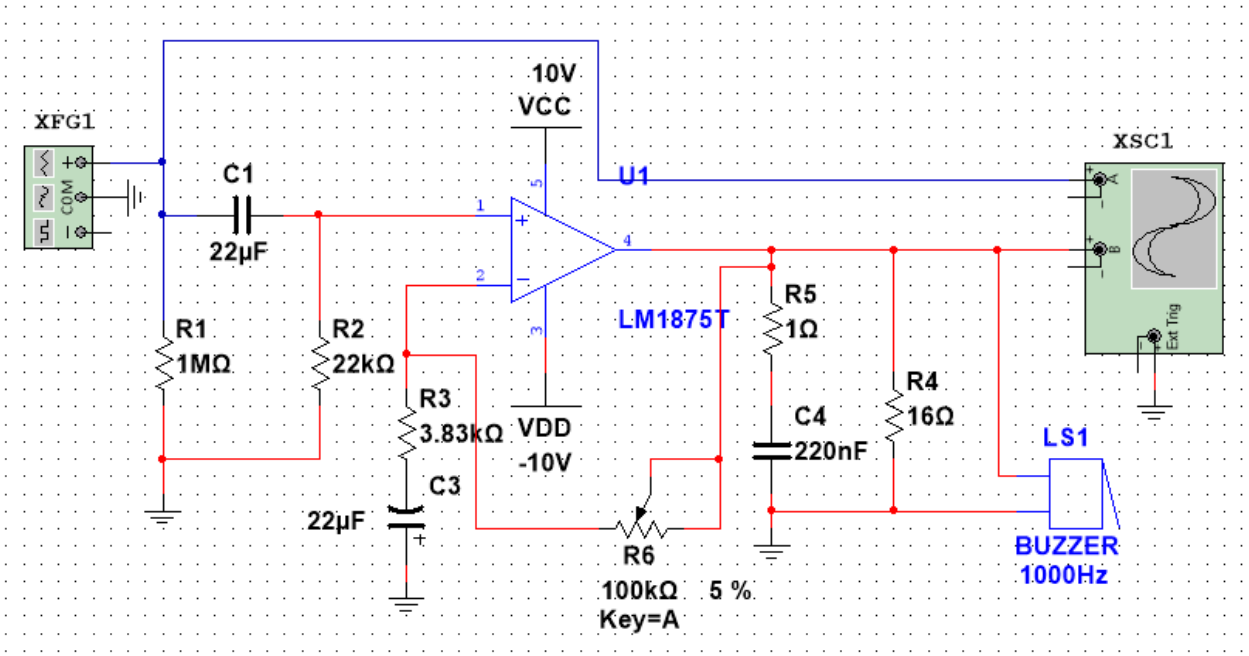
Power amplifier circuit:

This part offers power to load, so the output power should be as high as possible, with high transfer effect and low distortion.

A LM1875 is applied in this circuit.

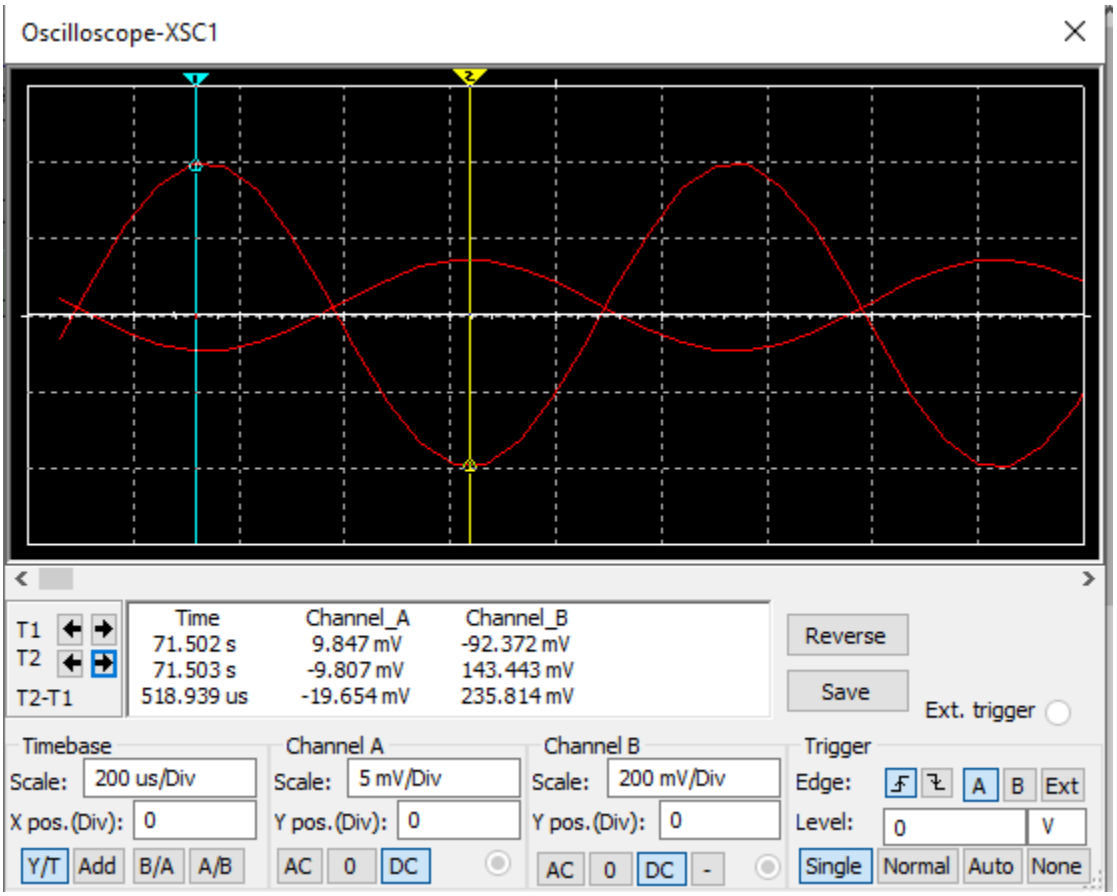
Analysis:

Gain: 353AVRR



Multisim simulation:

Preamplifier:

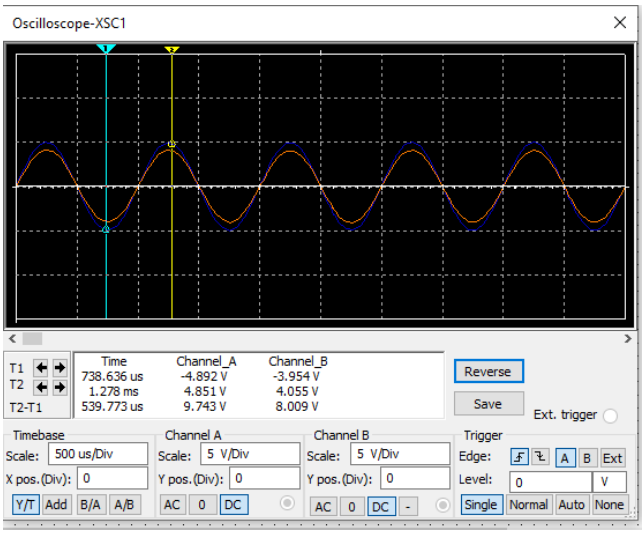


Input peak：9.847 mv

Output peak：143.443 mv

Gain：14.63

Bandpass filter:



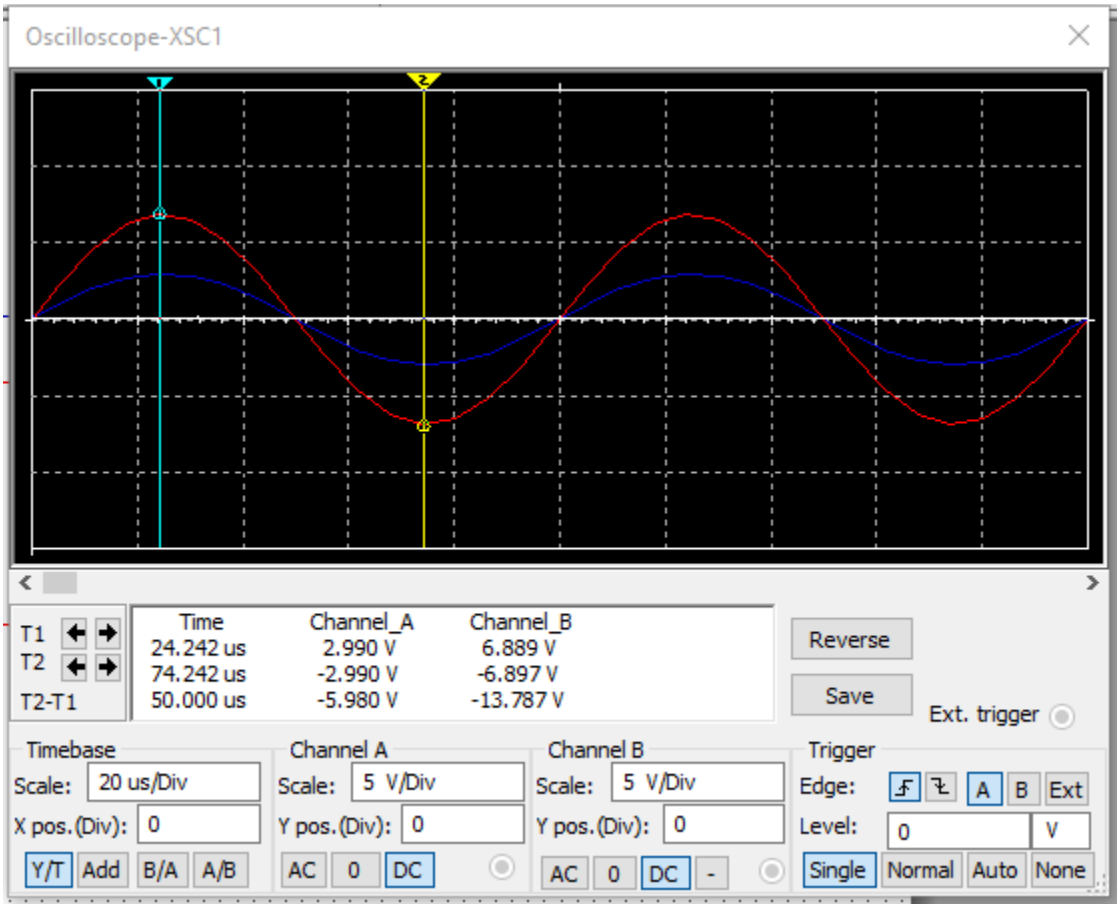
Input peak：4.892 V

Output peak：3.954 V

Gain：1.24

The passband is 300Hz~3KHz.

Power amplifier:

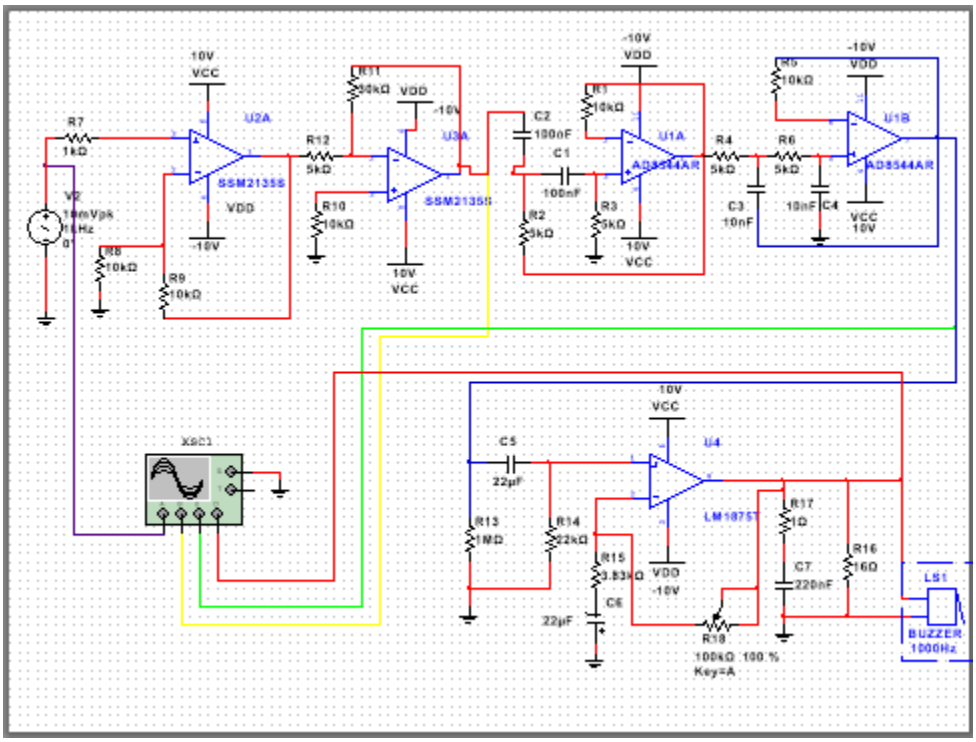


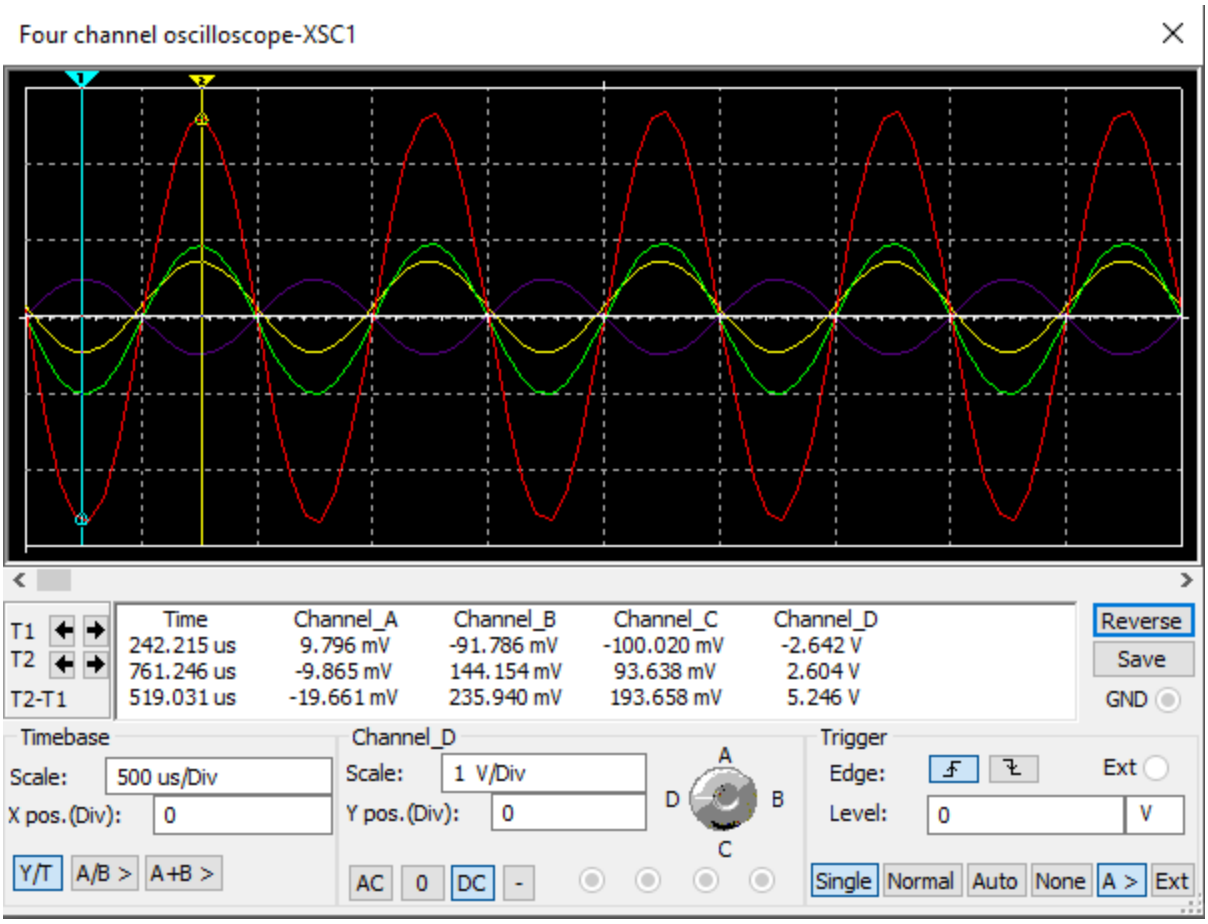
Input peak：2.990 v

Output peak：6.889v

Gain：2.30

Combine:


10V
VCC
U2A
SSM2135S
VDD
-10V
R7
1kΩ
V2
10mVpk
1kHz
0°
R8
10kΩ
R9
10kΩ
R11
50kΩ
VDD
-10V
U3A
SSM2135S
R12
5kΩ
R10
10kΩ
10V
VCC
C2
100nF
C1
100nF
-10V
VDD
R1
10kΩ
U1A
AD8544AR
R2
5kΩ
R3
5kΩ
10V
VCC
R4
5kΩ
R5
10kΩ
-10V
VDD
U1B
AD8544AR
R6
5kΩ
C3
10nF
C4
10nF
VCC
10V
XSC1
10V
VCC
C5
22µF
U4
LM1875T
R13
1MΩ
R14
22kΩ
R15
3.83kΩ
C6
22µF
VDD
-10V
R17
1Ω
C7
220nF
R16
16Ω
LS1
BUZZER
1000Hz
R18
100kΩ 100 %
Key=A



Input peak: 9.796 mV

Output peak: 2.642 V

Gain： 269.70

Maximum undistorted output power：

Pom=Uom2/RL= (2.642 *2.642)/ (2*16) = 0.218W

Does the design satisfy the design requirements?

Not really. At the output stage I have got only around 2.5 V which certainly not enough to drive a speaker.

For the preamplifier and bandpass filter, I have created by myself. Then I tried a lot to create the power amplifier circuit. I also took a look at the internet for amplifier circuits but most of the time the circuits didn't work or some component cannot be found in the mulitisim database. So, I had to recreate the example circuit given in the pdf.