ANALOG ELECTRONCS CIRCUITS
PROJECT COMPONENT

SUBWOOFER AMPLIFIER CIRCUIT

PROJECT REPORT

ANALOG ELECTRONIC CIRCUITS-ECE2002

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Subwoofer Amplifier Circuit

ABSTRACT:

In the year 1970, the term subwoofer was given by “Ken Kreiser”. A 100W Subwoofer Amplifier is a loudspeaker which generates low-frequency audio signals.

A Subwoofer is a loudspeaker which produces audio signals of low frequencies. It is basically used to improve the bass quality of audio signals. Here we design a subwoofer amplifier producing audio signals at low frequencies from 20 Hz to 200Hz and with an output power of 100W, used to drive a 4 ohm load.The subwoofer amplifier circuit is used to enhance the quality of the audio signals.

2. PRINCIPLE

Audio Signal is first filtered to remove the high frequency signals and allow only the low frequency signals to pass through it. This low frequency signal is then amplified using a voltage amplifier. This low power signal is then amplified using a transistor driven class AB power amplifier.

Components required:

The required components for 100W Subwoofer Amplifier Circuit Construction are: 10

Resistors(in Ohms) :

- R1=6K, R2=6K,
- R3=130K, R4=22K ,
- R5=15K , R6=3.2K ,
- R7 =300 Ohms, R8= 30 Ohms , R9=3k, R10 =3 K.

6 Capacitors: C1,C2,C3,C4,C5,C6

- C1, C2 =0.1uF
- C3,C5,C6 =10uF
- C4 =1uF

4 Transistors :

- Q1 =2N222A,
- Q2=TIP41,
- Q3=TIP41,
- Q4 =TIP147 PNP

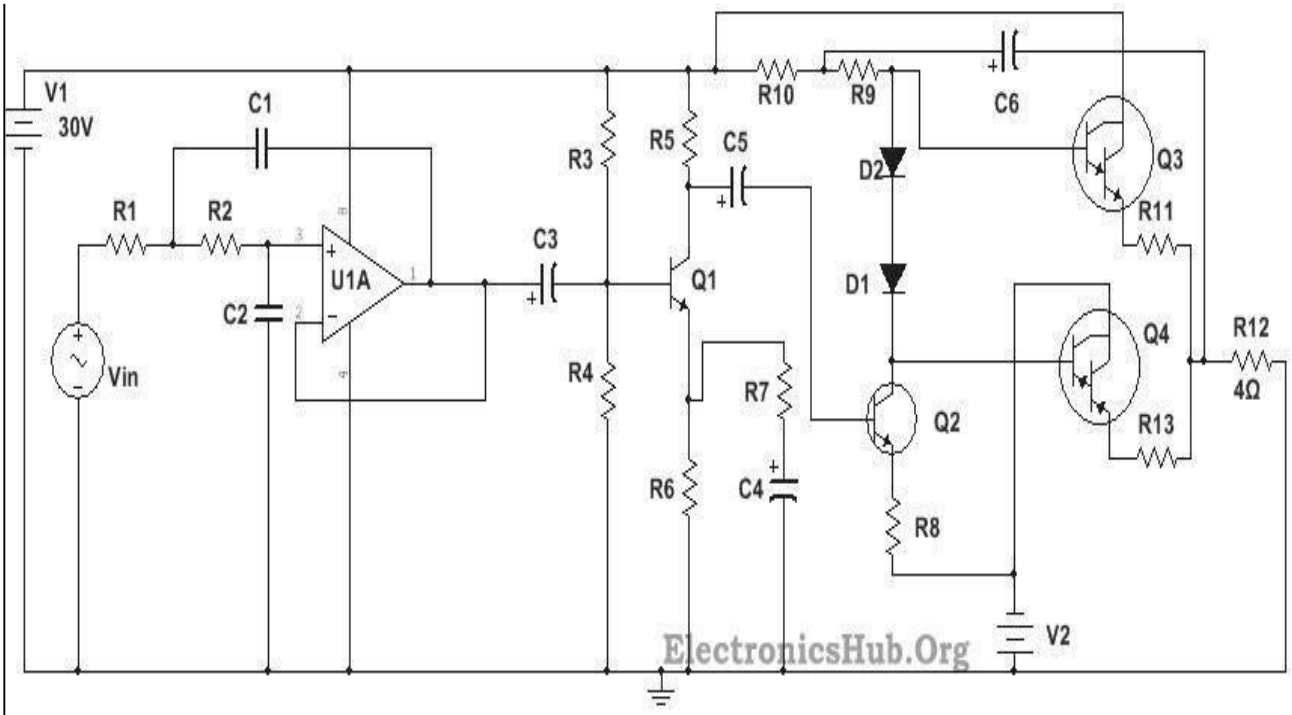
Voltage Source: Dual Supply =+/-30V

2 Diodes:

D1, D2 =1N4007.

Components required for the circuit:

- 555 Timer IC
- Condenser Mic
- 8 Ohm Speaker
- BC547 Transistor
- Resistors - 470 Ohm, 1k, 10k, 47k, 100k, 680k ohm
- Capacitors - 10µF, 1nF, 100nF
- Battery - 9v
- Breadboard and connecting wires


V1
30V
C1
R1
R2
U1A
C2
Vin
C3
R3
R5
C5
Q1
R4
R7
R6
C4
R10
R9
C6
D2
D1
Q3
R11
Q4
R12
4Ω
R13
Q2
R8
V2
ElectronicsHub.Org

DESIGN OF SUBWOOFER AMPLIFIER

Here we designed a Sallen Key low pass filter using OPAMP LM7332. The cut off frequency was assumed to be 200Hz and the Quality factor is assumed to be 0.707. Also assuming the number of poles to be equal to 1 and value of C1 to be equal to 0.1uF, value of C2 can be calculated to be 0.1uF. Assuming R1 and R2 to be same, the value can be found by substituting known values in the equation

$$R1 = R2 = Q/(2*pi*fc*C2)$$

This gives a value of 5.6K for each resistor. Here we select 6K resistors as R1 and R2. Since we want a closed loop gain filter, we do not require resistors at the non inverting terminal, which is shorted to the output terminal.

PRE AMPLIFIER DESIGN:

The preamplifier is based on class A operation of transistor 2N222A. Since the required output power is 100W and load resistor is 4 Ohms, here we require a supply voltage of 30V.

Assuming the collector quiescent current to be 1mA and collector quiescent voltage to be half of supply voltage, i.e.15V, the value of load resistor is calculated to be equal to 15K.

R5 = (Vcc/2Icq)

Base current is given by, Ib = Icq/hfe

Substituting the values, hfe or AC current gain, we get the base current to be equal to 0.02mA. The bias current, Ibias is assumed to be ten times the base current, i.e. 0.2mA.

The emitter voltage is assumed to be 12% of the supply voltage, i.e. 3.6V. The base voltage, Vb is then equal to Ve +0.7, i.e. 4.3V.

Values of R3 and R4 are then calculated as givenR3 = (Vcc – Vb)/ Ibias and R4 = Vb/Ibias

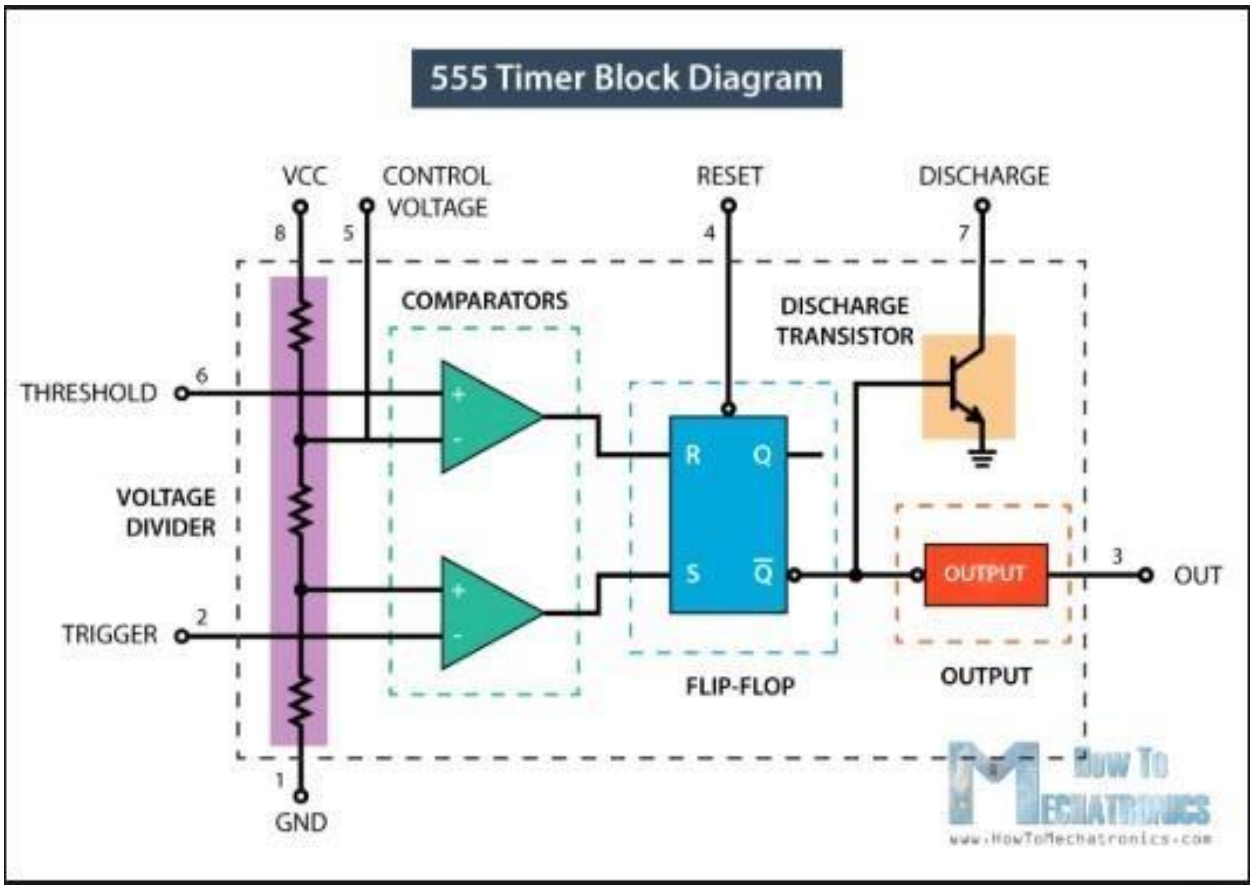
Substituting the values, we get R3 to be equal to 130 K and R4 to be equal to 22K

The emitter resistor is calculated to be equal to 3.6K (Ve/Ie). However this resistance is shared between two resistors, R6 and R7, where R7 is used as feedback resistor to reduce the decoupling effect of C4. Value of R7 is calculated by the values of R5 and gain and found to be equal to 300Ohms. Value of R6 is then equal to 3.2K.

Since capacitive reactance of C4 should be less than the emitter resistance, we calculate the value of C4 to be equal to 1uF.

WORKING OF 555TIMER IC:

555 timer IC is used to produce time delays and oscillations. It has three operating modes, bistable, monostable and astable mode.
The IC consists of 25 transistors, 2 diodes and 15 resistors.
The internal circuit consists of a voltage divider, two comparators, a flip flop, an output stage and a discharge transistor.

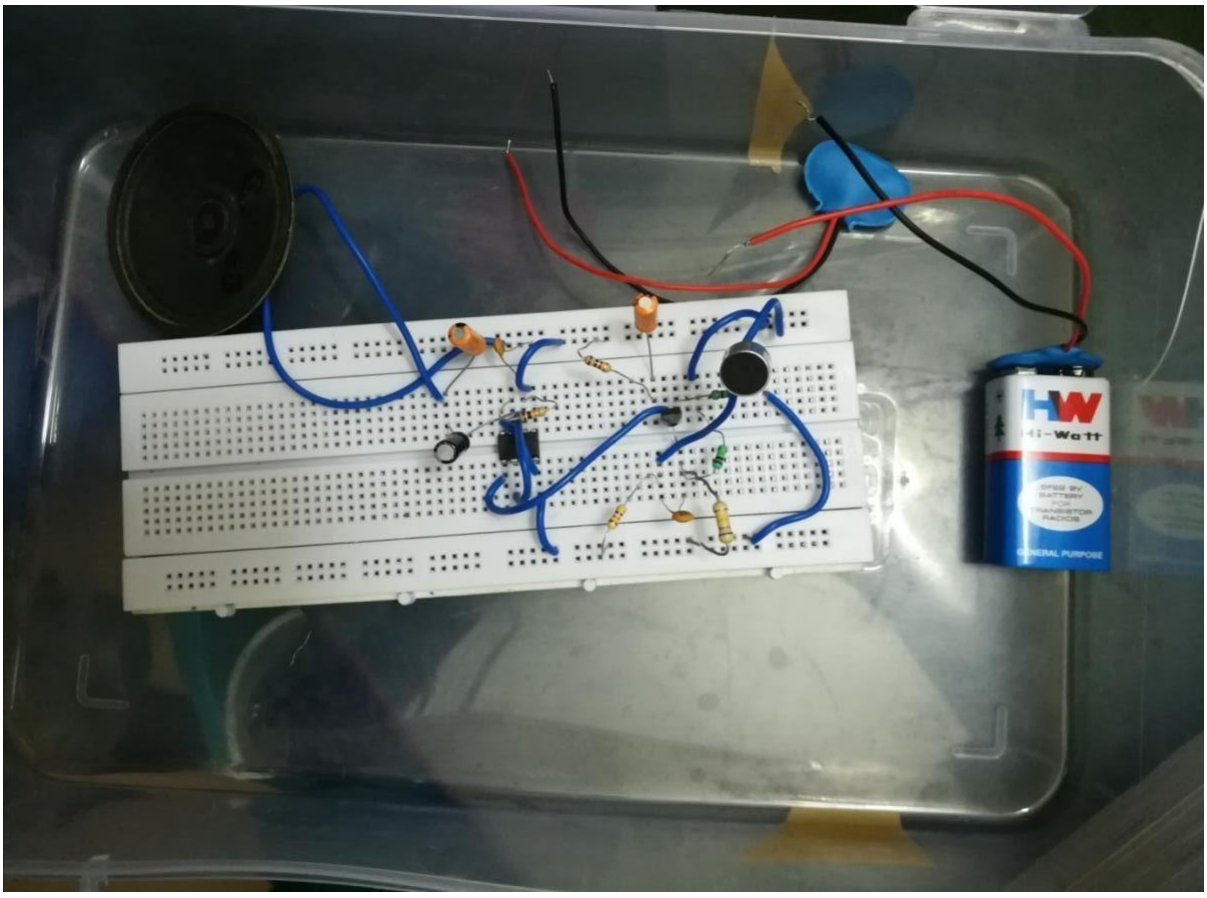


WORKING OF THE REDUCED CIRCUIT:

This circuit is divided into two parts: part one is **Preamplifier circuit**, which consist a BC547 transistor, a Condenser Mic and some resistors & capacitors. Second part consist a 8ohm speaker and a 555 timer IC, which is oscillating in **Astable multivibrator mode**, with approx. 66KHz frequency.

- The **reduced subwoofer amplifier circuit** is shown in above diagram. Control PIN 5 of 555, has been used here which is generally kept grounded through .01uf capacitor. Control PIN 5 is the point of 2/3Vcc inside the 555 timer IC, so we can change this 2/3Vcc voltage through this PIN. And changing the voltage at this PIN change the width of output pulse, irrespective of value of RC components in 555 timer circuit.
- It follows the same principal of Pulse Width Modulation (PWM) to modulate the output wave. We have used this functionality of Control PIN in this circuit.
  Speaker does not respond to high frequency, so when there is no voltage at control PIN 5, speaker doesn't produce any sound. When we create some sound near Condenser Mic, that sound is converted into electric signal by the Transistor, and this electric signal is fed to the control PIN 5 of 555 IC. The output pulse at PIN 3 modulate due to this voltage at control PIN, and speaker detects this DC component of Output pulse and produce sound. Basically when there is voltage at PIN 5, width of the output PULSE increases for a moment and that is detected by Speaker, Resistor R1 is used for biasing of condenser Mic and R2 and R3 is used to provide proper biasing to transistor. We can test this circuit by blowing some air from mouth towards the Mic, the speaker will generate sound accordingly.

IMAGE OF FINAL CIRCUIT:

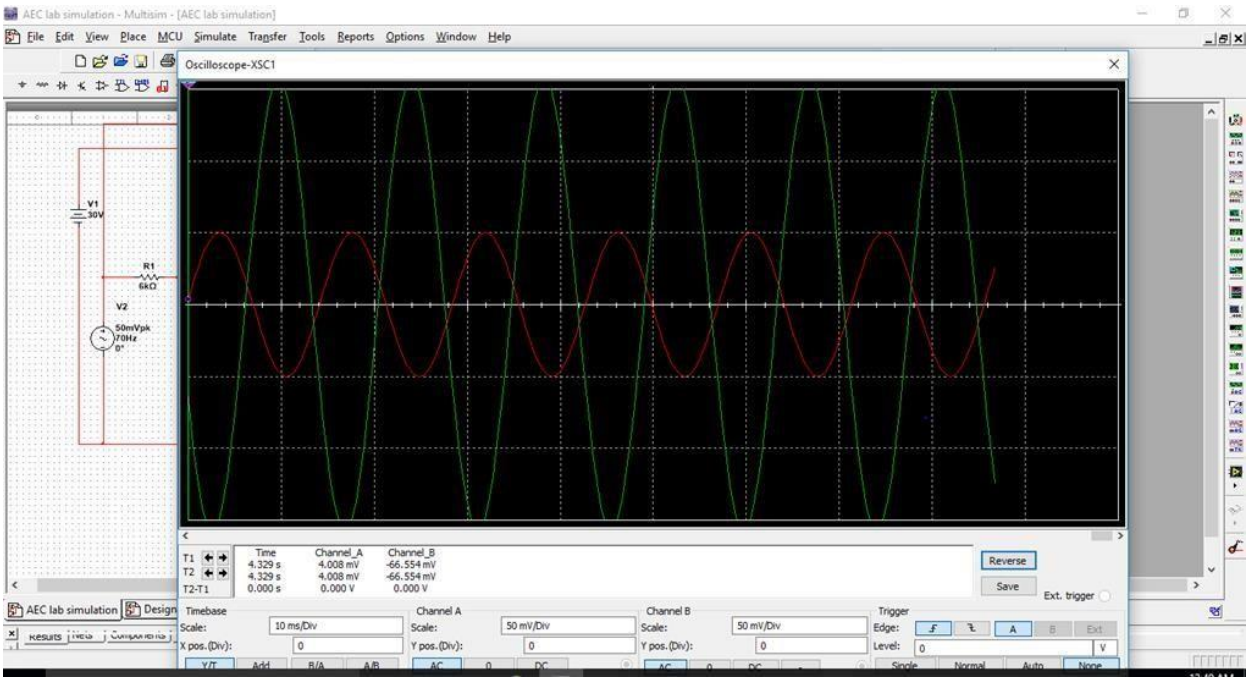


SUBWOOFER AMPLIFIER CIRCUIT APPLICATIONS:

A subwoofer amplifier circuit using IC is used in home theaters to make subwoofers to generate a high bass and high-quality music.

This 100w subwoofer amplifier circuit is also used for low-frequency signals as a power amplifier.

SIMULATION OUTPUT:



LIMITATIONS:

The filter circuit tends to increase the DC level of the audio signal, causing a disruption in the biasing.

The use of linear devices causes power dissipation, thus reducing the efficiency of the circuit. It is a theoretical circuit and output contains distortion.
The circuit doesn't provide any provision to remove noise signal and thus the output may contain noisy disturbance.

CONCLUSION AND FUTURE WORKS

We can test this circuit by blowing some air from mouth towards the Mic, the speaker will generate sound accordingly. The bypass amplifier we use here amplifies the given input and gives us the low frequency output. The transistor together with bypass amplifier gives us the output with low frequency's.

8.REFERENCES

- CircuitDigest.com
- Wikipedia.com
- Electronicshub.com