

Project 5: Noise Filter

This circuit can be used to eliminate the background noise on a tape, revealing voices and other sounds more easily. It will be installed between the tape recorder and an amplifier as shown in Fig. 27. The basic idea is the use of a noise source to add energy to the undetectable voices (see stochastic resonance), increasing their level when taped. Then, when listening to the tape, the researcher can reduce or eliminate the background noise to more easily find the voices.

Operation

The circuit is an amplifier stage that cuts the signals between two silent zones or between two detectable signals. This means that this circuit cuts the signal when the ratio of signal to noise falls below a certain level.

With the values shown in the diagram of Fig. 28, the circuit cuts signals with amplitudes below 30 mV. If a signal with an amplitude greater than 30 mV is

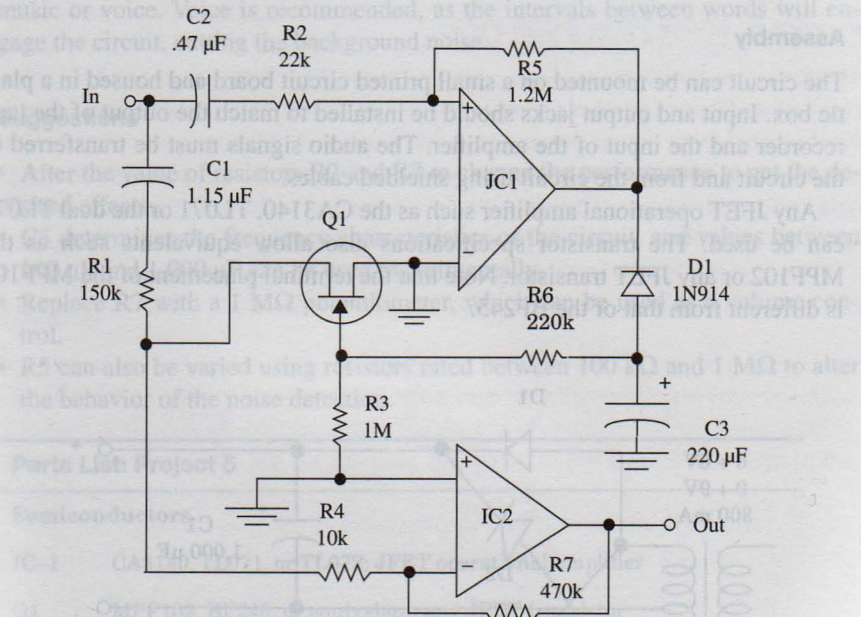


Figure 27 Noise filter.

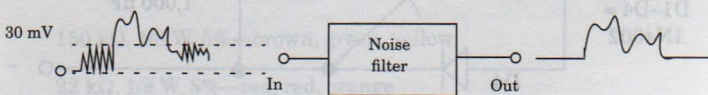


Figure 28 Operation of the noise filter.

present, operational amplifier A1 has a high enough output to bias Q1. This implies an increase in gain at the operational amplifier A2, and the amplified signals appear in its output.

When the amplitude of the input signal is below 30 mV, Q1 is not biased and the gain of the circuit is reduced to less than 1/40 of the initial value.

To operate with signals over 30 mV, it is enough to increase the value of R2. Values between 10 kΩ and 100 kΩ can be used experimentally.

The gain of the circuit is determined by R7. Values between 100 kΩ and 1 MΩ can be used experimentally.

The circuit needs a symmetric, or two-voltage, positive/negative power supply as shown in Fig. 29.

Voltages between 9 and 15 Vdc can be used to power this circuit. Current drain is very low, less than 10 mA, allowing the use of batteries as power supplies. Some operational amplifiers can be powered from lower voltages. The CA3140, for instance, can be powered from voltages as low as 3 V. IC1 and IC2 don't need a heatsink, as the current drain is very low.

Assembly

The circuit can be mounted on a small printed circuit board and housed in a plastic box. Input and output jacks should be installed to match the output of the tape recorder and the input of the amplifier. The audio signals must be transferred to the circuit and from the circuit using shielded cables.

Any JFET operational amplifier such as the CA3140, TL071 or the dual TL072 can be used. The transistor specifications also allow equivalents such as the MPF102 or any JFET transistor. Note that the terminal placement of the MPF102 is different from that of the BF245.

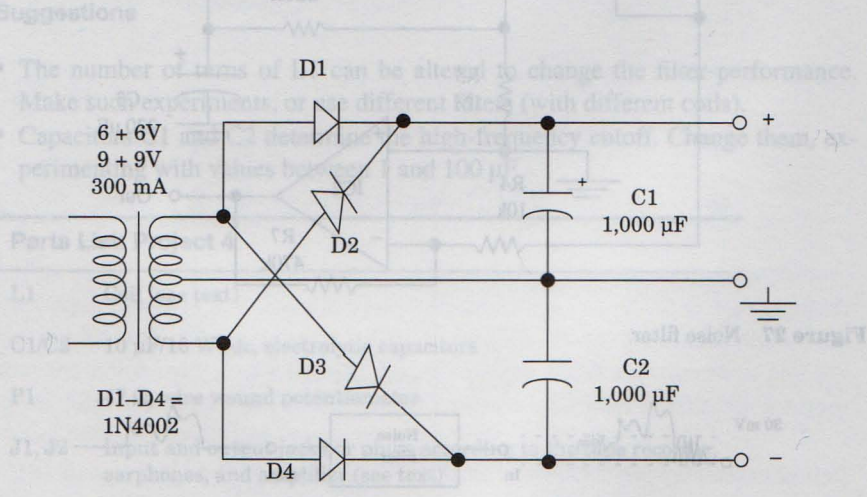


Figure 29 Symmetric or two-voltage source for operational amplifiers.

As the circuit has a high-impedance input and high gain, special care with the signal cables is needed to avoid hum. As in the other cases, the hum (60 Hz noise picked up from the ac power line) can cover the noise as well as the voices recorded on the tape, compromising the experiments.

Using the Circuit

The circuit is placed between the signal source (tape recorder) and the amplifier as shown in Fig. 28. The circuit will cut noise, allowing some sound peaks through. If no sound is heard, you must increase the output level of your tape recording, trying to find a level that will give the best voice detection results. Careful experimentation must be conducted to find the ideal point.

Notice that this circuit has a high-impedance output and input. This means that earphones, headphones, and loudspeakers can't be driven directly from its output. If the circuit tends to distort when plugged into the output of a tape recorder (monitor) add a 100 Ω resistor in parallel with the filter's input.

Initial operation tests can be made using a tape with common content such as music or voice. Voice is recommended, as the intervals between words will engage the circuit, cutting the background noise.

Suggestions

- Alter the value of resistors R2 and R7 to change the performance to get the desired effects.
- C3 determines the frequency characteristics of the circuit, and values between 100 μF and 1,000 μF can be used experimentally.
- Replace R7 with a 1 M Ω potentiometer, which can be used as a volume control.
- R5 can also be varied using resistors rated between 100 k Ω and 1 M Ω to alter the behavior of the noise detection.

Parts List: Project 5

Semiconductors

IC-1 CA3140, TL071, or TL072; JFET operational amplifier

Q1 MPP102, BF245, or equivalent; any JFET transistor

D1 1N914, 1N4148, etc., general-purpose silicon diode

Resistors

R1 150 k Ω , 1/8 W, 5%—brown, green, yellow

R2 22 k Ω , 1/8 W, 5%—red, red, orange

R3 1 M Ω , 1/8 W, 5%—brown, black, green

R4	10 k Ω , 1/8 W, 5%—brown, black, orange
R5	1.2 M Ω 1/8 W, 5%—brown, red, green
R6	220 k Ω , 1/8 W, 5%—red, red, yellow
R7	470 k Ω , 1/8 W, 5%—yellow, violet, yellow

Capacitors

C1	0.15 μ F, ceramic or metal film
C2	0.47 μ F, ceramic or metal film
C3	220 μ F, 25 WVdc, electrolytic

Miscellaneous

Printed circuit board, plastic box, input and output jacks, power supply, wires, shielded cable, solder, etc.
