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NOISE & INTERFERENCE FILTER FOR SHORTWAVE RECEIVER

Construction of a simple, inexpensive active audio filter

HIGH-GRADE voice communication requires an audio frequency range (band) of from 330 Hz to about 3000 Hz. If some degradation of the voice tone can be tolerated, a narrower band of, say, 500 to 2000 Hz is possible. On the other hand, if a wider bandwidth is allowed, noise and adjacent signals can make the voice difficult to hear or understand. Many inexpensive and moderately priced communications receivers have insufficient selectivity—too wide a band—to provide optimum performance. To improve selectivity would generally require extensive modification, but a good audio filter can help considerably if it is used at the receiver's output.

With the availability of high-quality, low-cost operational amplifiers, active filters are generally the least expensive and easiest type to build for operation at low audio frequencies. Active filters differ from passive filters in that the former employ active elements, usually op amps, to obtain the desired filter response. One very effective type of active filter is the "voltage-controlled voltage source" (VCVS). It is the construction of a VCVS filter that we will be discussing.

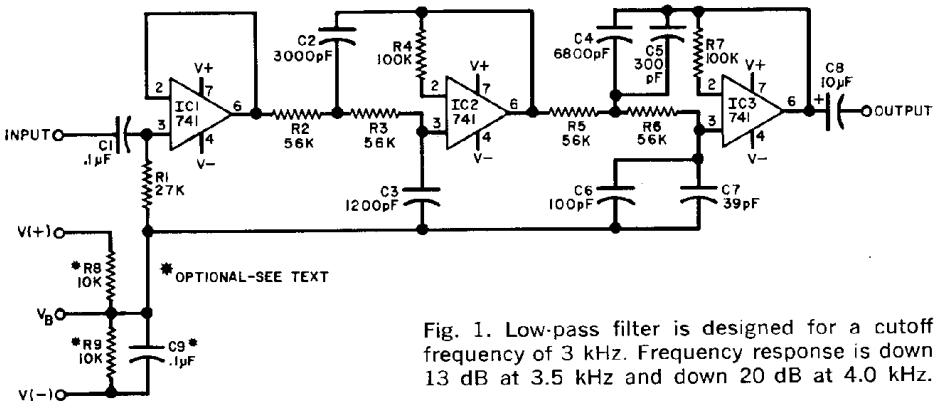

Fig. 1. Low-pass filter is designed for a cutoff frequency of 3 kHz. Frequency response is down 13 dB at 3.5 kHz and down 20 dB at 4.0 kHz.

PARTS LIST

C1,C9—0.1-μF Mylar capacitor
C2—3000-pF, 5% capacitor
C3—1200-pF, 5% capacitor
C4—6800-pF, 5% capacitor
C5—300-pF, 5% capacitor
C6—100-pF, 5% capacitor
C7—39-pF, 5% capacitor
C8—10-μF, 25-volt electrolytic capacitor
IC1-IC3—741 op amp integrated circuit
R1—27,000-ohm, 10% resistor
R2,R3,R5,R6—56,000-ohm, 5% resistor
R4,R7—100,000-ohm, 10% resistor
R8,R9—10,000-ohm, 10% resistor
Misc.—Printed circuit board or perforated phenolic board, sockets, and flea clips; solder; mounting hardware; etc.
Note: The following items are available from Northwest Engineering Co., 801 Duchess, Bothell, WA 98011: printed circuit board No. AF-07-PCB for $2.50; complete kit of parts (No. AF-07K) for $8.25. Include shipping costs for 3 oz and 10 oz respectively.

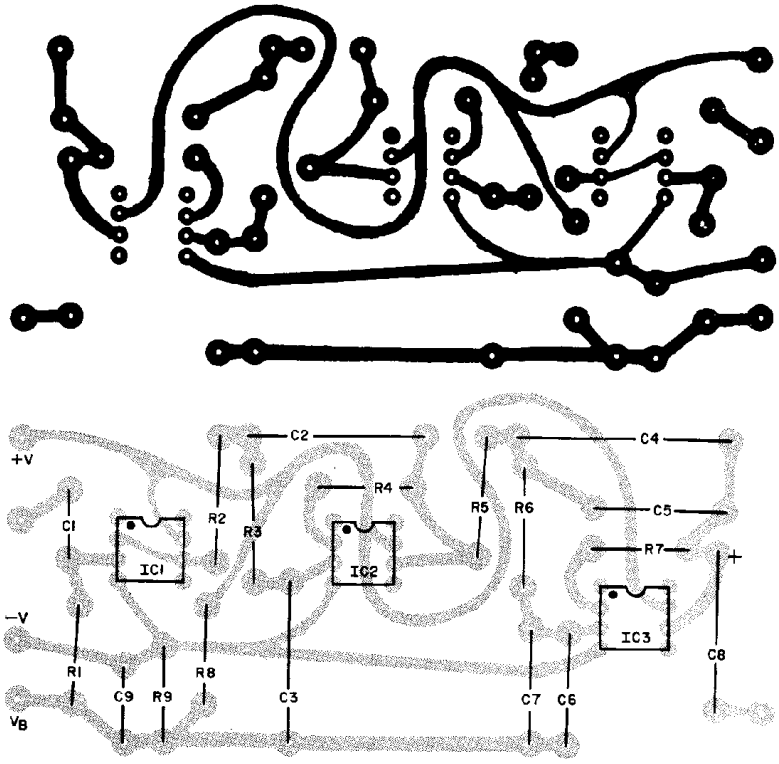

Fig. 2. Actual-size foil pattern (above) and component layout guide.

Theory of Operation. The schematic diagram of the VCVS active filter is shown in Fig. 1. A high-impedance buffer circuit made up of *IC1*, *R1*, and *C1* drives *IC2* and *IC3* which form a four-pole active filter. The filter was designed so that resistors *R2*, *R3*, *R5*, and *R6* are all of the same value. As long as all four resistors have the same value, changing that value changes the cutoff frequency but has no effect on the shape of the filter's response. The values of the resistors can be calculated from the equation: $R = (168{,}000)/F$, where F is the desired cutoff frequency in kilohertz.

To adequately control the shape of the filter's response, all frequency-controlling elements (*C1-C7*, *R2*, *R3*, *R5*, and *R6*) should have a 5-percent tolerance. With the values specified in the Parts List and given on the schematic diagram, the filter's cutoff frequency will be 3 kHz.

The filter can be operated from a single power supply with between 6 and 30 volts output if assembled as shown. Single power supply operation requires the use of *R8* and *R9* to provide the necessary bias voltage to operate the op amps (*IC1-IC3*) and V_B is not used. If two supplies (or a dual) are used, their outputs can range from a low of ±3 volts to a high of ±15 volts; in this case, the filter can be built without *R8*, *R9*, and *C9* and V_B is common.

Construction and Use. Owing to the fact that integrated circuits are used in the VCVS active filter, printed circuit board assembly is recommended. (An actual-size etching and drilling guide and a components installation diagram are given in Fig. 2.) However, if sockets or Molex "Solderconns" are used, the filter can readily be assembled on perforated phenolic board.

The filter can be used wherever voice-band filtering is required. For shortwave receivers, the headphone output can be used to drive the filter, with the filter driving a standard high-impedance headset. Alternatively, the filter can be permanently installed between the detector and the audio output amplifier in the receiver.

Another possibility would be to use the filter to limit the frequency range of a microphone's output before modulation in a transmitter. This effectively concentrates more of the available output power into the critical 300-3000-Hz voice band. ◈