electret microphone preamplifier

This compact, low-noise, battery-powered preamplifier can be used to boost the signal from electret and low impedance dynamic microphones.

Microphones frequently have to be connected to amplification and/or recording equipment via several metres of screened cable. Since the output of a microphone is very small (typically a few millivolts) there is often significant signal loss, and microphonic noise may also be generated by the cable. This article describes the construction of a good-quality microphone with built-in preamplifier, using a commercial electret or moving coil capsule. The built-in preamplifier boosts the output level to several hundred millivolts, which allows the signal to be fed direct to the 'auxiliary' or 'line' inputs of amplifiers or tape decks. If a mixer is being used the need for microphone preamps on each mixer input is dispensed with.

Readers are probably familiar with the principle of the moving coil, dynamic microphone, which basically operates like a loudspeaker in reverse. A diaphragm is coupled to a cylindrical coil, which is suspended in the field of a powerful permanent magnet. Sound pressure waves deflect the diaphragm, and hence the coil, which cuts the magnetic flux lines and generates an output current and voltage that is an electrical analogue of the acoustic signal.

The electret microphone, which has become very popular in recent years, operates in a similar manner to a capacitor microphone, but is cheaper and less bulky. The diaphragm of the microphone is made of the electret material. This is a thin insulating plastic film, which has been polarised with a permanent electric chrage (this is usually done by heating the film and placing it in a strong electric field). The diaphragm forms one plate of a capacitor, the other plate of which is a fixed metal backplate. Since the diaphragm is charged a potential difference exists between the diaphragm and the backplate, which is related to the charge on the diaphragm and the capicitance of the microphone capsule by the equation

$$U = \frac{Q}{C},$$

where U is voltage, Q is charge, and C is capacitance. C is related to the distance between the plates of the capacitor by the equation

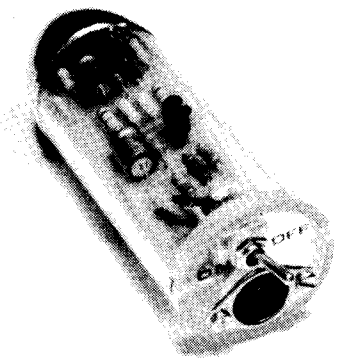
$$C = \frac{k}{d}$$

where k is a constant. Therefore

$$U = \frac{Qd}{k}.$$

When sound pressure waves deflect the diaphragm, the distance d varies, and since the charge Q is fixed the output voltage varies in sympathy with the deflection of the diaphragm.

Since the microphone capsule is effectively a very small capacitor (only a few pF), its impedance at audio frequencies is extremely high, and its output must be fed to a very high impedance buffer stage. This usually consists of a FET source-follower incorporated into the microphone capsule, which acts as an impedance transformer with an output impedance of a few hundred ohms.



Preamplifier Circuit

The complete circuit of the microphone preamplifier is given in figure 1. If an electret microphone capsule is used, the built-in FET buffer will require a DC power supply. This will usually be lower than the 9 volts required by the rest of the circuit, so the voltage is dropped by R8 and decoupled by C3. The value of R8 shown is for the Philips LBC 1055/00 microphone capsule, and other capsules may require a different value.

Resistor R1 is a load for the FET buffer. Here again, 2k2 is the recommended value for the Philips electret capsule, and different values may be required for other capsules. If a moving coil microphone capsule is used then R1, R8 and C3 may be omitted.

The preamplifier itself consists of a two stage amplifier T1 and T2. Its input impedance is approximately 8 k, and its gain is determined by the ratio R7:R3 — about 100 with the values shown. The current consumption of the preamp is extremely low, typically 1.5 mA.

With some microphone capsules having a higher output voltage, it may be necessary to reduce the gain of the preamp to prevent overloading. This is done by decreasing the value of R7. To restore the correct DC bias con-

ditions it will also be necessary to reduce the value of R6, and this will result in a slight increase in current consumption. However, reducing the value of R7 does lower the output impedance of the preamp, which means that longer cables can be driven without attenuation of high frequency signals.

Performance

The output voltage of the specified electret capsule is typically 6.3 mV/Pa ('Pa' is Pascal; 1 Pascal = 1 N/m^2 = 10 μbar). To put this figure into context, the threshold of audibility (0 dB SPL) is taken as occurring at a sound pressure level of 0.0002 μbar, and the threshold of pain, 120 dB higher at 200 μbar. However, overloading of the electret capsule begins at around 104 dB SPL, so the maximum output voltage that can be expected in normal use is around 20 mV, or 2 V at the preamp output.

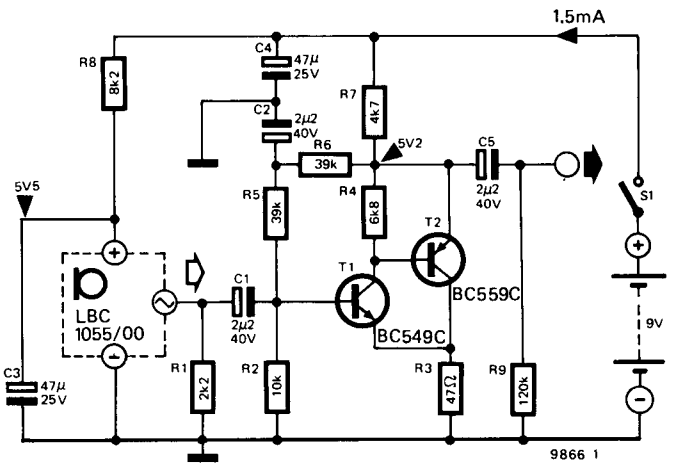
The frequency response of the specified capsule plus preamp combination is flat within 3 dB from 100 Hz to 17 kHz, which is quite good considering the modest cost of the unit.

Construction

A printed circuit board and component layout for the microphone preamplifier are given in figure 2. The circuit board is extremely compact, and the microphone capsule, board, and a small 9 V battery can easily be fitted into a length of plastic pipe or aluminium tubing. The grille that protects the microphone capsule can be made from half a 'tea-egg' infuser, as shown in the photograph, or from a wire mesh coffee strainer.

To make a really professional job the output of the preamp can be taken via a Cannon XLR or locking DIN connector socket mounted in the base of the housing. It is then possible to dispense with the on-off switch by making a shorting link in the connector plug perform this function, as shown in figure 3. When the microphone is unplugged after use the preamp is automatically switched off. ■

1



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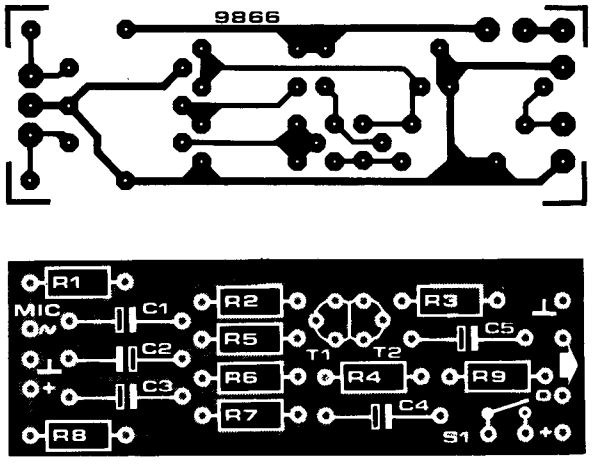

Parts list for figures 1 and 2

Resistors:
R1 = 2k2
R2 = 10 k
R3 = 47 Ω
R4 = 6k8
R5,R6 = 39 k
R7 = 4k7
R8 = 8k2
R9 = 120 k

Capacitors:
C1,C2,C5 = 2µ2/40 V
C3,C4 = 47 µ/25 V

Semiconductors:
T1 = BC 549C or equivalent
T2 = BC 559C or equivalent

Miscellaneous:
Microphone capsule = Philips LBC 1055/00 or similar
9 V battery
S1 = SPST switch (see text)
Plastic or aluminium tubing for microphone housing.

3

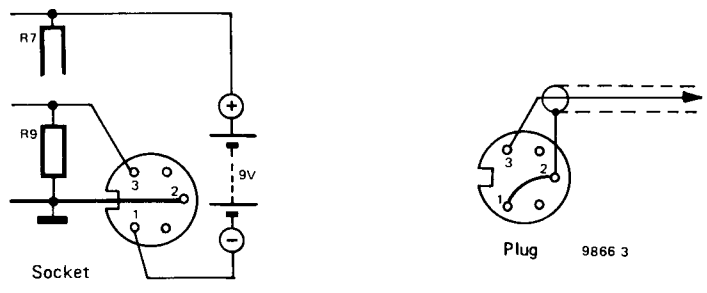

Figure 1. Circuit of the microphone preamplifier.

Figure 2. Printed circuit board and component layout for the preamplifier (EPS 9866).

Figure 3. If the completed microphone is fitted with an output socket then a shorting link can be used to replace S1.

Photo. Completed prototype of the electret microphone with built-in preamp, which is housed in a piece of clear acrylic tube for display purposes.