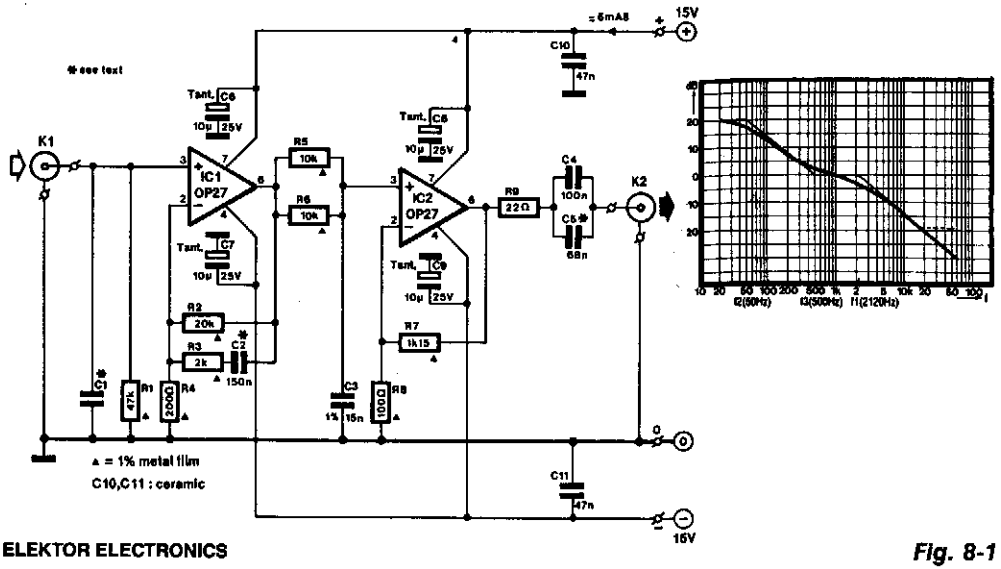
8

Audio Signal Amplifiers

The sources of the following circuits are contained in the Sources section, which begins on page 661. The figure number in the box of each circuit correlates to the entry in the Sources section.

Preamplifier for Magnetic Phono Cartridge
Simple Tape Playback Amplifier
Low-Noise Phono Preamp
Simple 40-dB Gain Amplifier
Ultra-Low-Noise Magnetic Phono Preamp
Impedance-Matching Preamp
Low-Noise Amplifier
Low-Noise 1 000 × Preamp
Simple Microphone Preamp
Electric Guitar Matching Amplifier
Universal Audio Line Amplifier
CD4049 Amplifier
Low-Noise Audio Preamp
Low-Impedance Microphone Preamp
Microphone Preamp
General-Purpose Preamp

PREAMPLIFIER FOR MAGNETIC PHONO CARTRIDGES



ELEKTOR ELECTRONICS

Fig. 8-1

This amplifier is intended to be added to preamplifiers that have no phono input. Such a phono input is required for normal record players with a dynamic pick-up, of which millions are still around. Moreover, the amplifier does not only bring the output of the pick-up to line level, it also adds the correction to the frequency response (according to RIAA requirements).

When recording gramophone records, the frequency characteristic is lifted at the high end. This lift must be countered in the playback (pre)amplifier. The corrections to the frequency response characteristic are according to a norm set by the Record Industries Association of America (RIAA) and also by the IEC.

The corrective curve provided by the amplifier is shown in the graph (bold line). The thin line shows the ideal corrective curve. The sharp bends in this at 50 and 500 Hz are nearly obtained in the practical curve by network R3/C2; just above 2 kHz is approached in practice by filter R5/R6/C3. The arrangement of R3/C2 in the feedback loop of IC1 gives noticeably better results than the usual (passive) filter approach.

Circuit IC1 provides a dc amplification of 40 dB, which drops to about 20 dB when the frequency rises above 500 Hz. To minimize the (resistor) noise and the load of the op amp at higher frequencies, the value of R3 is a compromise. The associated polystyrene capacitor, C2, should have a tolerance of 1 to 2%.

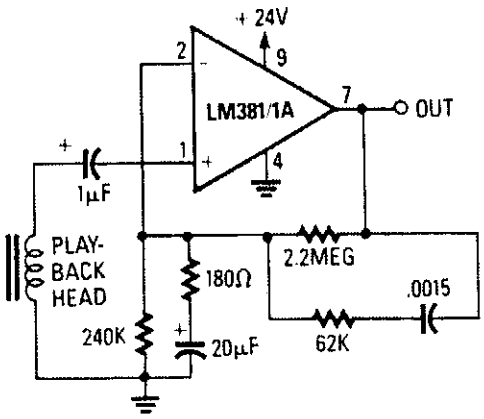
To raise the 2-mV output of the dynamic pick-up to line level at 1 kHz, linear amplifier IC2 has been added. This stage has a gain of 22 dB, so a signal of 250 mV is available at its output.

Capacitors C4/C5 at the output, in conjunction with the input impedance of the following preamplifier, form a high-pass filter with a cut-off frequency of 20 Hz; this serves to suppress any rumble or other low frequency noise. The value of C1 is normally given in the instruction booklet of the dynamic pick-up.

The power supply for the amplifier must be of good quality. Particularly, the transformer should be class A1 with a small stray magnetic field.

When the amplifier is built into the record player (best), the power supply should not be included unless it is very well screened; otherwise, hum is unavoidable.

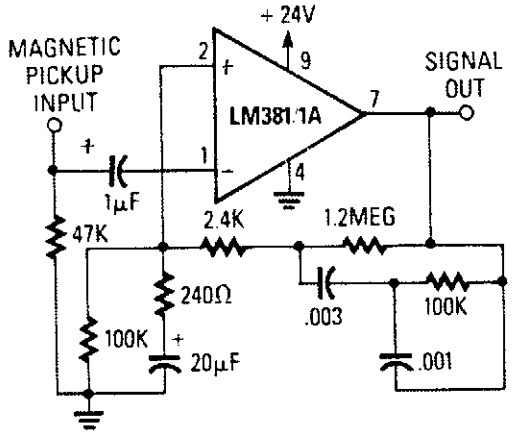
SIMPLE TAPE PLAYBACK AMPLIFIER



RADIO-ELECTRONICS *Fig. 8-2*

This circuit uses an LM381/1A as a tape preamp. The feedback network includes NAB Equalization.

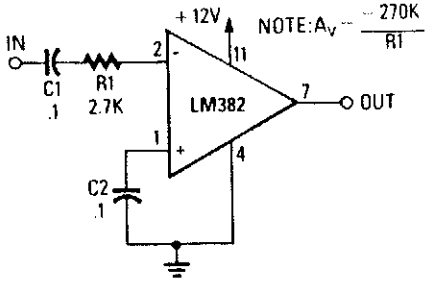
LOW-NOISE PHONO PREAMP



RADIO-ELECTRONICS *Fig. 8-3*

This circuit uses an LM381/1A as a low-noise phono preamp. The feedback network provides RIAA compensation.

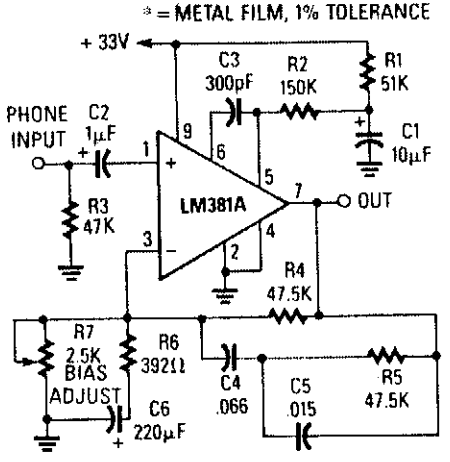
SIMPLE 40-dB GAIN AMPLIFIER



RADIO-ELECTRONICS *Fig. 8-4*

An LM382 low-noise preamp is used here to obtain a 40-dB gain amplifier, using only the IC and three peripheral components.

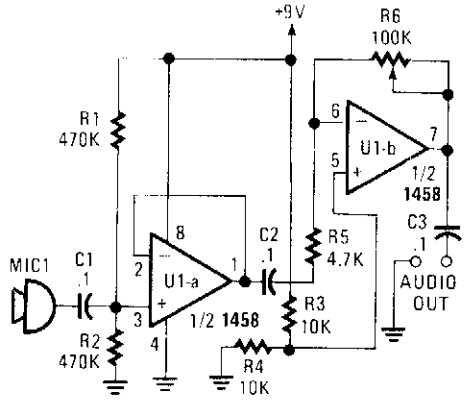
ULTRA-LOW-NOISE MAGNETIC PHONO PREAMP



RADIO-ELECTRONICS *Fig. 8-5*

This phono preamp uses an LM381/1A in a circuit that includes RIAA equalization. Adjust R7 for a voltage that is equal to half of the supply voltage ($\approx$16.5 V).

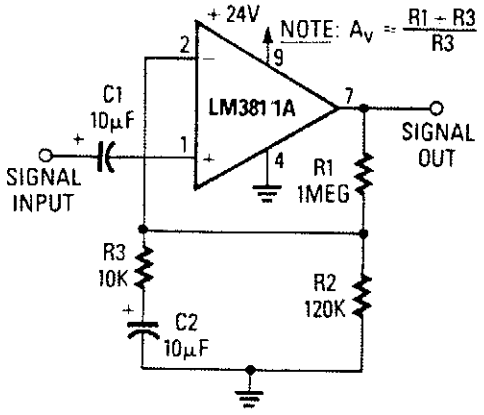
IMPEDANCE-MATCHING PREAMP



POPULAR ELECTRONICS *Fig. 8-6*

This circuit will match a crystal microphone to a device that requires a low-impedance dynamic microphone.

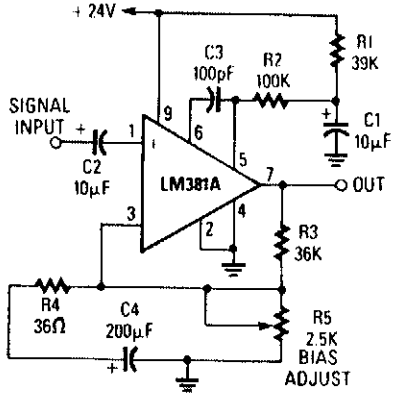
LOW-NOISE AMPLIFIER



RADIO-ELECTRONICS *Fig. 8-7*

This low-noise LM381/1A noninverting amplifier has a gain of 100.

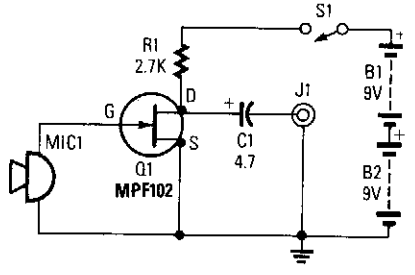
LOW-NOISE 1 000 × PREAMP



RADIO-ELECTRONICS *Fig. 8-8*

An LM381A is used here as a low-noise preamp with a gain of approximately 1 000×. Adjust R5 for 12 V at pin 7, assuming a 24-V supply.

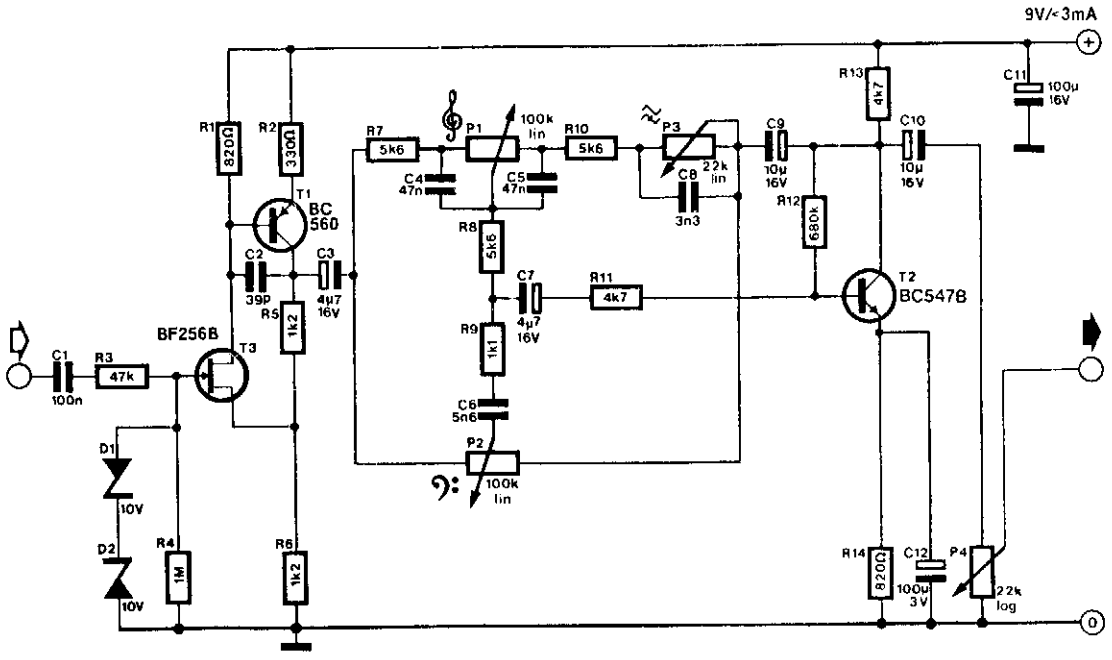
SIMPLE MICROPHONE PREAMP



POPULAR ELECTRONICS *Fig. 8-9*

This preamp uses a small dynamic microphone coupled to the gate of Q1. R1 is a load resistor. Audio is taken out between the negative side of C1 and ground. Output will be between 10 and 100 mVpp, depending on the microphone.

ELECTRIC GUITAR MATCHING AMPLIFIER



ELEKTOR ELECTRONICS

Fig. 8-10

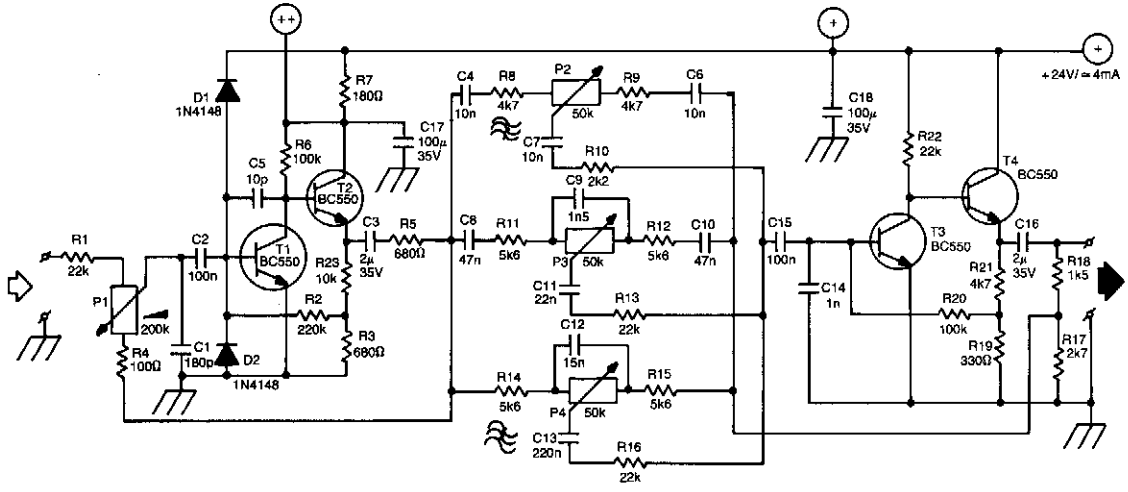
An electric guitar often has to be connected to a mixing panel, a tape deck or a portable studio. As far as cabling is concerned, that is no problem, but matching the high impedance of the guitar element to the low impedance of the line input of the mixing panel or tape deck is a problem. Even the so-called high impedance inputs of those units are not suitable for the guitar output. When the guitar is connected to such an input, hardly any signal is left for the panel or deck to process.

It would be possible to connect the guitar to the (high impedance) microphone input, but it is normally far too sensitive for that purpose; guitar clipping occurs all too readily.

The matching amplifier presented here solves those problems: it has a high-impedance (1 MΩ) input that can withstand voltages of over 200 V. The output impedance is reasonably low. Amplification is ×2 (6 dB). Dual tone control, presence control, and volume control are provided.

The circuit can handle input levels of up to 3 V. Above that level distortion increases, but that is, of course, a good thing with guitar music. Real clipping of the input signal does not occur until much higher levels than are obtainable from a guitar are applied. Power is supplied by a 9-V (PP3) battery from which the circuit draws a current that does not exceed 3 mA.

UNIVERSAL AUDIO LINE AMPLIFIER



ELEKTOR ELECTRONICS

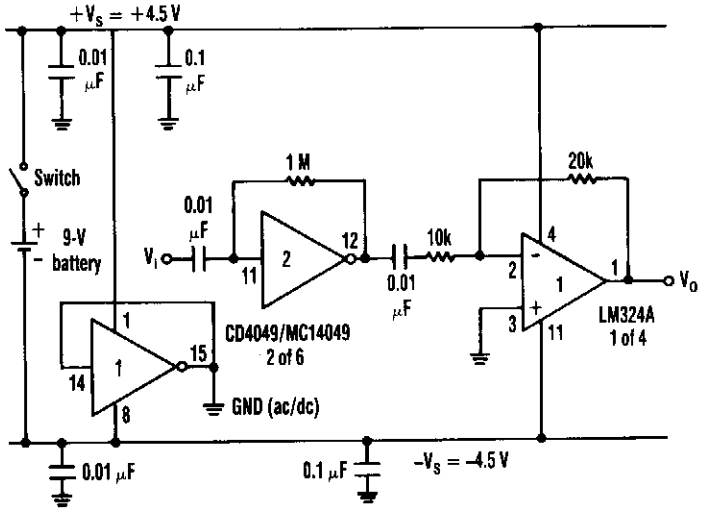
Fig. 8-11

A line amplifier is always a useful unit to have around, whether it is for matching a line signal or raising its level somewhat. This might be needed during a recording session or with a public-address system. Furthermore, a line mixer can be constructed from a number of these amplifiers. The input of the amplifier is high-voltage proof. The output impedance is low.

The circuit is a conventional design: two dc-coupled stages of amplification are separated by a three-fold Baxandall tone control system. The volume control at the input is conspicuous by having its "cold" side connected, not to ground, but to the output of the first amplifier. Because the signal there is out of phase with the input signal, the amplifier obtains negative feedback via P1. The amplification is therefore inversely proportional to the magnitude of the input signal. Thus, it is possible for the amplifier to accept a wide range of input levels. It is quite possible to input a signal taken directly from the loudspeaker terminals of a power amplifier.

The supply voltage is 24 V. At that voltage, the amplifier draws a current of about 4 mA. If several amplifiers are used in conjunction (as, for instance, in a mixer panel), the various supplies (+ and + + in the diagram) can be interlinked. Capacitors C17 and C18, and resistor R7 don't need to be duplicated in that case.

CD4049 AMPLIFIER



INVERTER CHARACTERISTICS

	V supply	
	9V	13.6V
Av	30 V/V	40 V/V
f(–3dB)	2.5 MHz	3.5 MHz nom.
Ioh	–1.25 mA	–3.0 mA min.
Iol	8.0 mA	20.0 mA min.

ELECTRONIC DESIGN

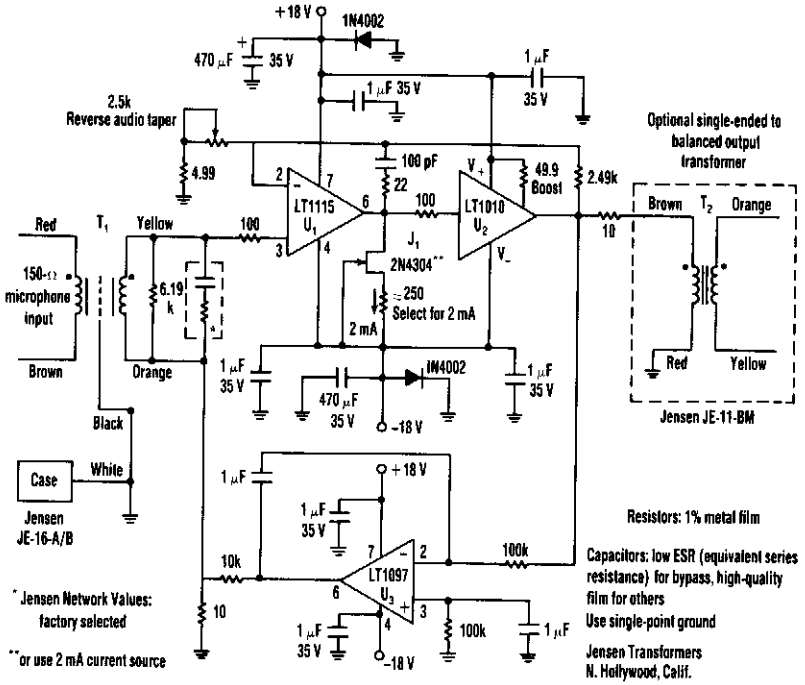
Fig. 8-12

When an inverter is biased with one resistor from its input to output in the range of 100 kΩ to 10 MΩ and is capacitor coupled, it exhibits amplifier characteristics (see the table).

Furthermore, when a split power-supply bus is needed and only one battery is used, the inverter can be configured to supply a pseudo-dc ground of relatively low impedance, coincident with the ac ground (see the figure). Depending on the magnitude of the dc ground return currents, anywhere from one inverter to several in parallel are sufficient. Also, the supply buses must be capacitor bypassed.

The configured input-to-input shorted inverter now acts as a voltage regulator that sinks and sources current. In this configuration, the inverter is forced to operate at the midpoint of its transfer characteristic. This divides the battery potential into two equal parts—as referenced to the defined dc ground by virtue of its internal gain and physical structure. Op amps such as the LM324A, can be powered from one battery while being referenced to the dc ground that is generated by the inverter. This novel technique surpasses the use of discrete resistors for battery potential dividing. It can be employed in other applications where individual component savings and improved design performance are needed.

LOW-NOISE AUDIO PREAMP

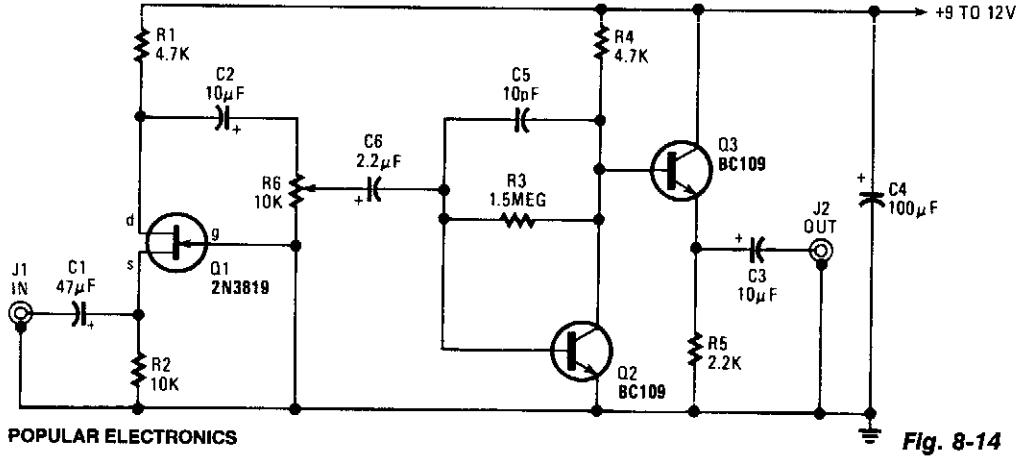


ELECTRONIC DESIGN

Fig. 8-13

A low-noise LT1115 (Linear Technology, Inc.) op amp is coupled to a class-A buffer amplifier to produce a variable gain (12-to-50 dB) microphone preamp. THD is less than 0.01% from 80 Hz to over 20 kHz. The transformers must be properly grounded and shielded.

LOW-IMPEDANCE MICROPHONE PREAMP

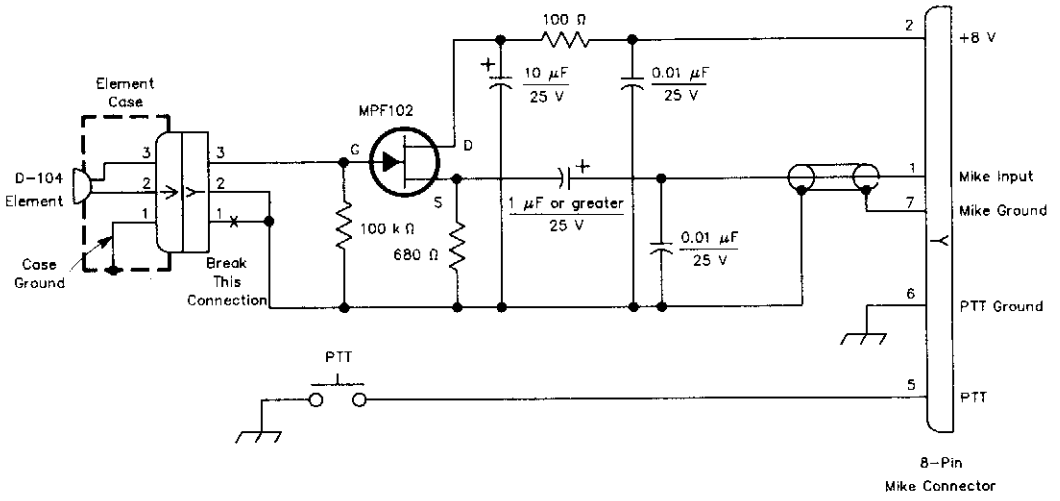


POPULAR ELECTRONICS

Fig. 8-14

This amplifier uses a common-gate FET amplifier to match a low-Z microphone.

MICROPHONE PREAMP

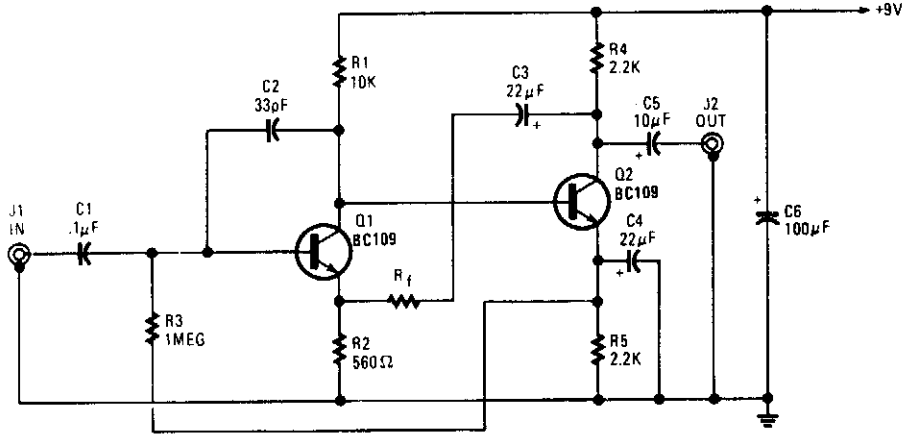


QST

Fig. 8-15

This circuit is used to interface a high-impedance microphone to a radio transceiver that requires a low-impedance microphone. The supply voltage can be either a battery or taken from the transceiver the circuit is used with.

GENERAL-PURPOSE PREAMP



POPULAR ELECTRONICS

Fig. 8-16

This amplifier is useful for audio and video applications. Gain is set by R_f and the voltage gain of this amplifier is approximately $1 + R_f/560$, where R_f is in ohms. Bandwidth depends on gain selected, but typically it is several MHz. $R_f = 5.1$ kΩ, which produces a gain of $10\times$ (20 dB) voltage.