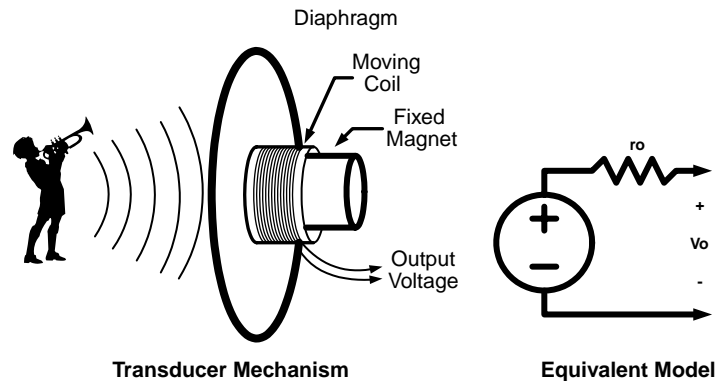
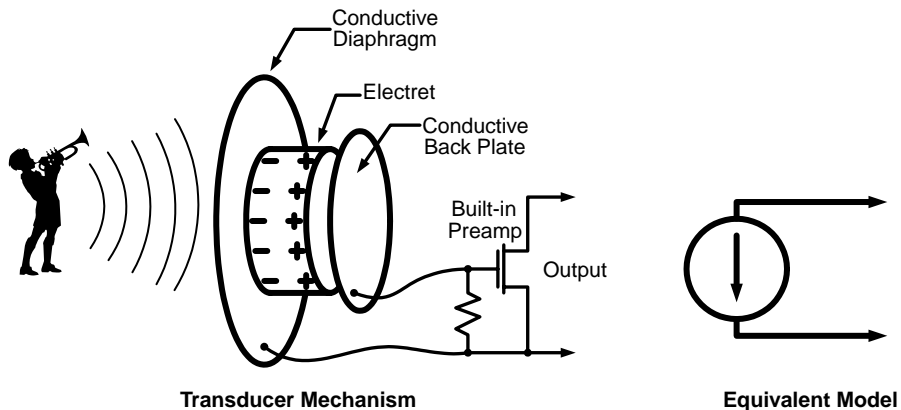


Microphones are specialized forms of pressure transducers used to convert sound into an electrical signal. For common audio applications, two types are typically encountered, dynamic and electret microphones. While both types of microphones work by converting sound pressure into small movements, the mechanism by which the movement is translated into an electrical signal is quite different. In a dynamic microphone, the motion of the diaphragm is used to move a small coil of wire in relation to a magnet. The coil, consisting of many turns of fine wire generates an electric current which is proportional to the speed at which it moves. Electrically, a dynamic microphone appears as a small (mV level) voltage source in series with a resistance, typically on the order of 100-1000 $\Omega$ . Figure 1 shows a simplified version of a dynamic microphone and an equivalent output circuit.

**Figure 1. Dynamic Microphone and Equivalent Circuit**



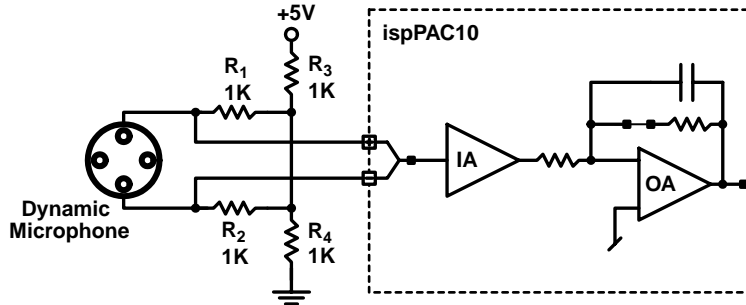
**Figure 2. Electret Microphone and Equivalent Circuit**



While a dynamic microphone operates by sensing the motion of a coil in a magnetic field, an electret microphone operates by sensing a moving electric field. An electret microphone is so-called because it contains a piece of electret attached to the diaphragm. An electret is a material that has a permanent electric polarization and produces an electric field. An electret is the electrostatic equivalent of a permanent magnet. When this piece of electret material is vibrated in front of a metal electrode, it induces a small voltage in the electrode. Because an electret microphone's resulting signal is very small, and the impedance is very high, many electret microphone elements come with an integral amplifier. From an interfacing standpoint, they tend to look like a small constant current source (a

few milliamps) on which an output signal current is superimposed. Figure 2 shows a simplified version of an electret microphone with a pre-amplifier and an equivalent output circuit. Because ispPAC devices have balanced differential inputs, they are well suited to processing the signals that are developed by both dynamic and electret microphones. An example of a 20dB preamplifier for a dynamic microphone is shown in Figure 3.

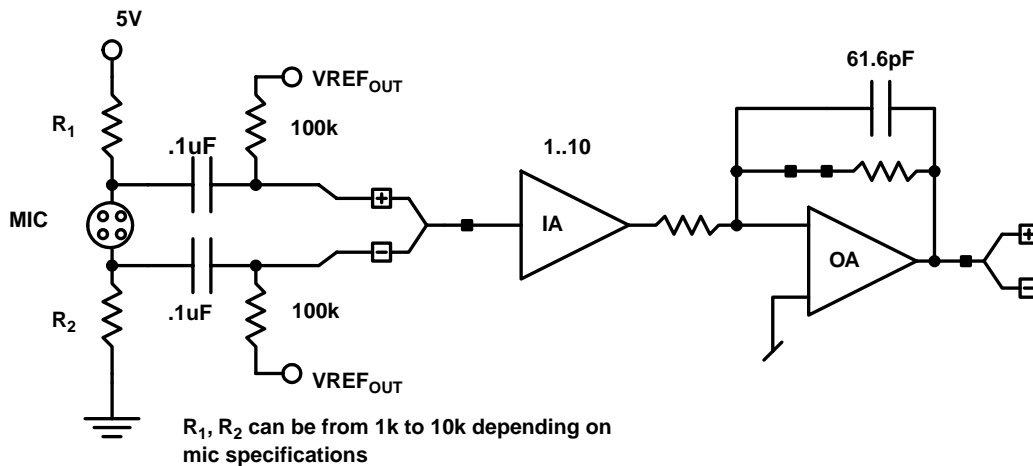
Figure 3. ispPAC10 Dynamic Microphone Interface



Resistors  $R_3$  and  $R_4$  provide a low-impedance reference voltage at approximately 2.5V, while resistors  $R_1$  and  $R_2$  provide a load for the microphone. This arrangement of resistors both biases the input of the ispPAC10 into its common-mode range (1-4V) and also presents a balanced load to the microphone. In this example the differential input impedance is the sum of  $R_1$  and  $R_2$ , or 2k $\Omega$ . Contrary to popular belief, one does not necessarily want the amplifier input impedance to match the microphone's output impedance. With modern solid-state circuits, increasing the amplifier's input impedance increases the amount of output signal available to it from the microphone.

Because an electret microphone typically incorporates an internal preamp which must be powered in order to operate (often just a single FET transistor), a different circuit is required for interfacing these types of microphones to an ispPAC differential input. Figure 4 shows one way to do this.

Figure 4. ispPAC10 Electret Microphone Interface



Resistors  $R_1$  and  $R_2$  provide bias current to the microphone assembly to power the internal amplifier. These resistors are chosen on the basis of how much current is required to bias the electret microphone assembly, and are therefore dependent on the microphone used. Because the output signal is a current, it is converted to a voltage by these two resistors. Since the microphone preamplifier requires some voltage across it to maintain operation, the microphone can't be connected directly to the ispPAC input because the DC voltage would saturate the input amplifier, especially at higher gains. For this reason the microphone is AC-coupled to the amplifier inputs to remove this

DC bias. The AC-coupling network shown will high-pass filter the incoming signal with a corner frequency of approximately 16Hz, which is sufficiently low for many audio applications. By referencing this highpass filter to  $VREF_{OUT}$ , a 2.5V common mode input voltage is presented to the input of the ispPAC10 Input Amplifier. In addition to highpass filtering the input signal, this circuit lowpass filters the signal at 10kHz. This is accomplished by using the filter function provided by the PACblock. Deliberately limiting the bandwidth of an audio signal can be useful in reducing spurious high-frequency noise and interference.

## **Technical Support Assistance**

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