Technically Speaking

Microphone Types and Operation

The following discussion will describe the various types of microphones in terms of four factors that help define them. - Generating Elements, Pickup Patterns, Frequency Response and Impedance - It is not our intent to go deeply into applications or to cover every type of microphone. Are intention is to give you some basic background on microphones that are generally in use. For a more complete discussion on microphones and their applications please call us anytime with your questions at Carey Sound at (336) 379-1943.

Generating Elements - All microphones have two basic components: the diaphragm and the generating element. The diaphragm is a membrane which vibrates in accordance with the pressure variations of sound. The generating element converts the diaphragm vibrations into electrical voltage. This generating element is one of four factors which determine the type of microphone. The kinds of generating elements vary greatly in expense, fidelity, complexity, ruggedness and longevity.

Dynamic Generating Elements - The diaphragm of a dynamic microphone is attached directly to a coil of wire (voice coil) located close to a magnet. When the voice coil vibrates, a voltage is produced. The dynamic microphone is a proven tool for the public address and instrumental miking. It provides excellent fidelity, extremely stable performance characteristics and a high degree of ruggedness - all at a reasonable price. These same characteristics are ideal for conventional sound reinforcement and recording as well. In addition, the diaphragm of a well-designed dynamic microphone is able to withstand the close miking and high sound levels often employed by musicians; all without damaging the microphone or distorting its output. The many desirable features inherent in the dynamic microphone make it a good choice for most applications.

Condenser Generating Elements - The diaphragm of a condenser microphone is a movable plate of a condenser (capacitor), a common component in electrical circuits. When polarized by applying a direct current voltage, motion of a diaphragm in relation to a fixed backplate produces an output voltage. The extremely high impedance or the condenser generating element is matched to typical inputs by an impedance converter in the microphone. Condenser microphones, many of which are capable of very wide frequency response, have been widely used in recording studios for years. Their relatively high output level have made them the microphone of choice for miking choirs and for use on pulpits.

Modern day electret type condenser microphones and offer ruggedness comparable to dynamic microphones. The electret microphone can often yield superior performance at frequency extremes (high and low) when compared to dynamic types. Because electrets utilize an impedance converter to match the diaphragm signal to the mixer input they require either a battery or phantom power for operation. Phantom power is a means by which power is supplied to the microphone from either a mixer or external power supply by way of the microphone cable. Phantom power eliminates the need for batteries and the problem of replacing dead batteries. Even though electret microphones are more complex in construction, their performance advantages are making them an increasingly attractive choice for exacting applications.

Microphone Pickup Patterns - A microphone's pickup pattern is three dimensional in character and shows how the microphone responds to sound from different locations. Omnidirectional microphones pick up sound from all directions. Unidirectional microphone reject or reduce sound from their sides or rear. The pickup pattern is the second of four factors which determine the type of microphone.

Omnidirectional Pickup Pattern - The pickup pattern of an omnidirectional microphone may be represented as a inflated balloon with the microphone at the center. Usually a polar pattern is used to represent the pickup pattern. The polar pattern shows the loss in output (in dB) experienced as a constant-output sound source moves 360° around a fixed microphone at a fixed distance from the microphone.

In systems where extremely close working distances are employed, say touching the lips to six inches, the omnidirectional microphone, if it can be used, has several advantages in its favor:

1. For a given price, an omnidirectional microphone generally has a smoother frequency response than its cardioid counterpart. Such smoothness of response is important because any roughness invites feedback.
2. An omnidirectional microphone is significantly less susceptible to breath pops than its cardioid counterpart.
3. An omnidirectional microphone is significantly less sensitive to mechanical shock than its cardioid counterpart.
4. An omnidirectional microphone is often more rugged than its cardioid counterpart.

Unidirectional PIckup Pattern - The most common unidrectional microphone is called a cardioid. Cardioid is a mathematically descriptive term that denotes the geometric form of the pickup pattern. The pattern happens to be crudely heart shaped (hence the term "cardioid"). The apple would be a good model of the cardioid pattern with the stem representing the microphone.

The pickup pattern of a cardioid microphone - relatively dead at the sides and the rear - tends to increase the working distance (the distance between the sound source ant the microphone). The limiting factor is when the distance becomes so great that amplifier gain must be increased until:

1. The sound becomes over-reverberant due to room reflections
2. The pickup of random background noise becomes excessive.
3. Sound system feedback results from P.A. or monitor speakers.

The increase in working distance is theoretically 1.7 to 1. For instance, if the maximum effective working distance of an omnidirectional microphone is ten inches, the theoretically a cardioid microphone can be used at seventeen inches with the same effectiveness!
The feedback-reducing characteristics of a cardioid microphone would seem to make a clear-cut case for the use of a cardioid microphone by professional performers. In marginal feedback situations, the cardioid will produce a higher level in the room before feedback occurs. This situation is often encountered is portable P.A. systems and other systems employing high-level stage monitors, where high levels of direct speaker sound reaches the microphone from the sides or rear. Usually in such instances, the loudspeakers are closer to the microphones than would be desirable from a sound-system design standpoint, and care must be taken to maintain proper gain without feedback.
In all but a few very specialized types of cardioid pickup patterns a cardioid microphone give a big bass sound. The simple cardioid microphone has a frequency response which varies strongly with working distance! The close-up emphasis of bass tones is called "proximity effect", provides a big, no-mistake-about-it bass sound - and for certain vocal applications, this is a popular sound.

Microphone Frequency Response - The third factor that determines microphone type is frequency response. Response information for each microphone will help you select for special results. For instance, a microphone with a "rising" response will emphasize the brightness of a trumpet or other brass instrument; one with proximity effect will add bass boost to a close working "thin voiced" singer. Choose an appropriately shaped response for special requirements; rolling-off the frequencies of unwanted background noise and room reverberation; brightening high frequencies for increasing intelligibility. When choosing a microphone, be certain its frequency response is wide enough to reproduce the sounds you need to reproduce with no perceptible change in quality.

Microphone Impedance - Microphone impedance is the fourth factor that determines microphone type. High impedance microphones (high-Z) have a higher output than low impedance (low-Z) types. However, low-Z microphones permit the use of longer cables without high-frequency rolloff. Therefore, if microphone cables will be longer than fifteen to twenty feet, only low-Z microphone should be used if the maximum clarity of extended high-frequency response is desired! Low impedance microphones have become the industry standard due to their versatility and the availability of equipment which accept low impedance inputs.

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