

The ABC's of AKG:
Microphone Basics
&
Fundamentals of Usage



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INTRODUCTION:

The outline of this manual is simple; first, we will present an overview of the basic technical characteristics of microphones, including how they work, what their acoustical pickup patterns are, and what their electrical characteristics are. We then move on to a discussion of basics of usage, such as how multiple microphones interact with one another, what their target working distances are, and how they behave in a variety of operating environments. Our aim is to keep our coverage as simple and as "user friendly" as possible.

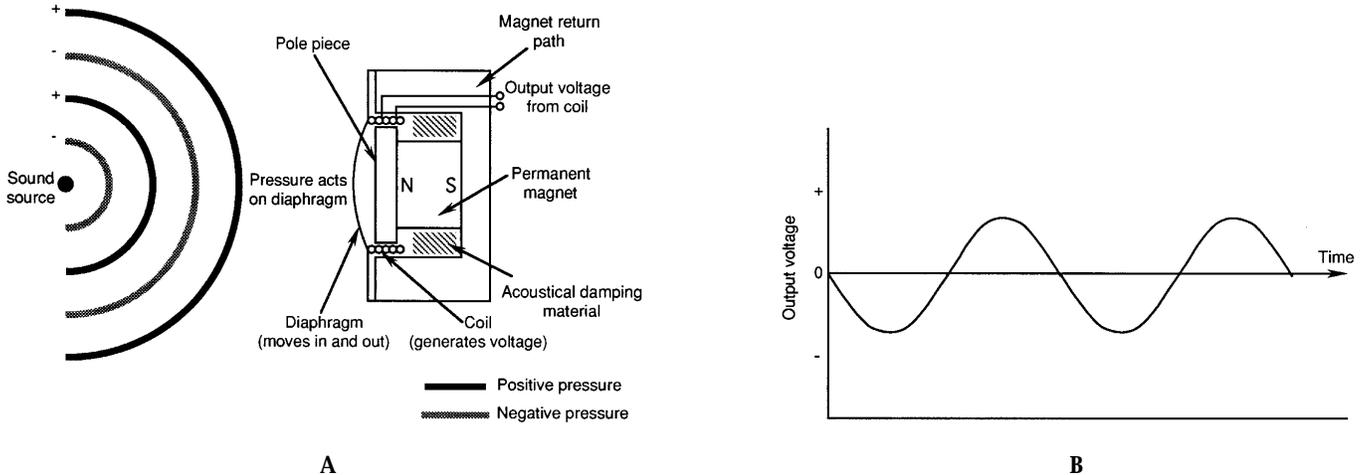
Finally, we will pick a number of basic applications and teach you what to look for in choosing an AKG microphone for those applications. For the most part these applications will be areas of speech and vocal pickup, since they easily account for 80 to 90% of all microphone applications. Our primary vehicle for this study will be applications in worship spaces, since those applications are varied enough and, by analogy, extend to all other speech requirements. The specific requirements of modern musical recording and sound reinforcement will not be covered here; these will be discussed in another manual.

If you have ever wondered why there are so many models in the AKG microphone line to choose from, you will have no doubt by the time you have finished studying this manual. There is a purpose for each one of them.

1.0.0 "A" HOW THEY WORK:

There are two operating principles used in AKG microphones: the dynamic principle and the capacitor principle. The dynamic microphone consists of a light diaphragm coupled to a small aluminum coil immersed in a strong magnetic field. When sound impinges on it, the diaphragm moves in and out. The motion of the coil in the fixed magnetic field develops a voltage across the coil that is analogous to the pressure acting on the diaphragm, as shown in Figure 1.

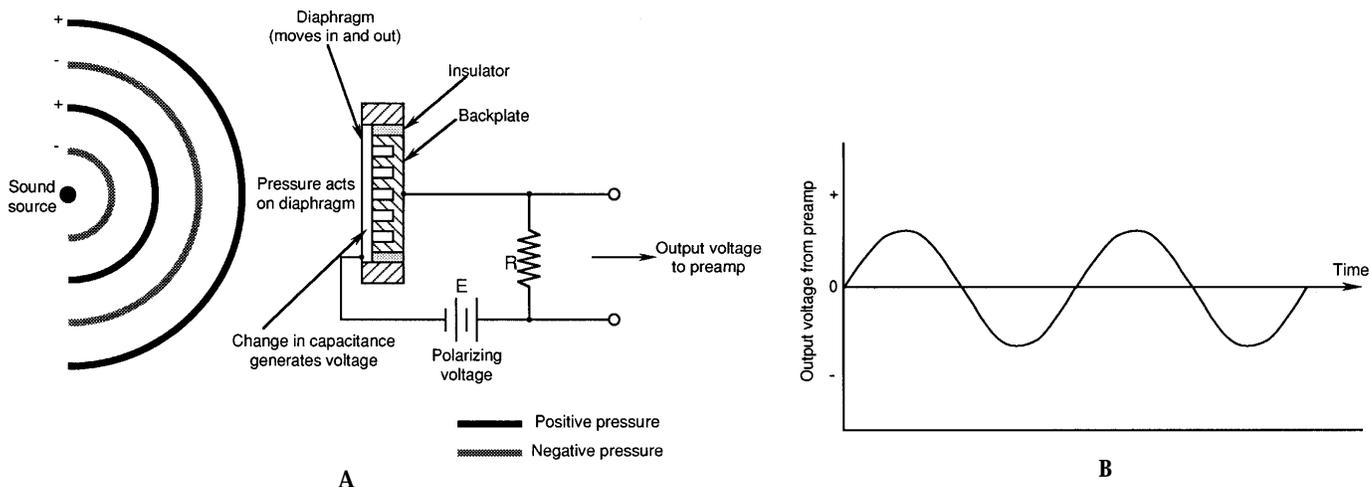
Figure 1



Here, simple alternating sound waves are shown impinging on the diaphragm (A), producing the output voltage shown at B.

Microphones using the variable capacitor principle are universally referred to in the industry as condenser microphones, the term condenser being a holdover from past engineering terminology. A condenser microphone consists of a fixed backplate in close proximity to a diaphragm, as shown in Figure 2.

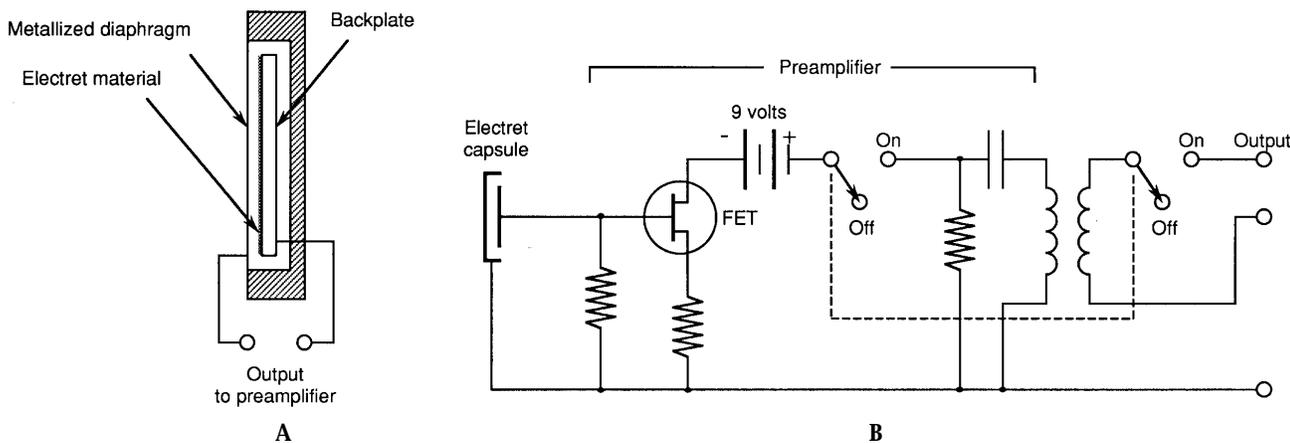
Figure 2



A fixed electrical polarizing charge is maintained between the backplate and diaphragm, and when the diaphragm moves under the influence of sound waves, the voltage between the diaphragm and backplate varies accordingly.

Today, the polarizing charge used in most condenser microphones is "built in" to the microphone by means of what is called a prepolarized (electret), a permanently charged layer on the backplate or on the rear of the diaphragm itself. External polarization is normally used in the highest quality studio microphones. Figure 3 shows a section view of an prepolarized condenser microphone, with the electret polarizing material located on the backplate.

Figure 3



All condenser microphones are provided with a preamplifier located adjacent to the diaphragm. The reason for this is to convert the very high electrical impedance of the variable condenser element to a suitably low value so that the signal can be easily transmitted down a standard low-level microphone cable with negligible losses. Some prepolarized microphones are directly powered with an internal 9 volt battery, as shown in the diagram.

By far, most condenser microphones are remotely powered by a 48-volt dc source (so-called "phantom" powering) provided by the console or other speech input equipment. Some microphones, such as the AKG C1000S, are capable of either 9 volt battery or phantom powering.



C1000S

1.1.0 Microphone Pickup Patterns:

The most fundamental characteristic of a microphone is its three-dimensional pickup pattern. Perhaps 90% of all microphones fall into two pickup categories: omnidirectional (also called omni) and the cardioid family. The cardioids are basically unidirectional, and there are three variations: the primary cardioid pattern, the hypercardioid, and the supercardioid. AKG offers a variety of polar patterns in their hand-held condenser and dynamic microphones.

A few designs, often referred to as rifle, line, or shotgun microphones, have a long interference tube which makes them highly directional at mid and high frequencies. Such exotic designs as these are not used in normal applications but are very useful when sound pickup must take place at some distance from the source.

1.1.1 Omnidirectional:

Figure 4

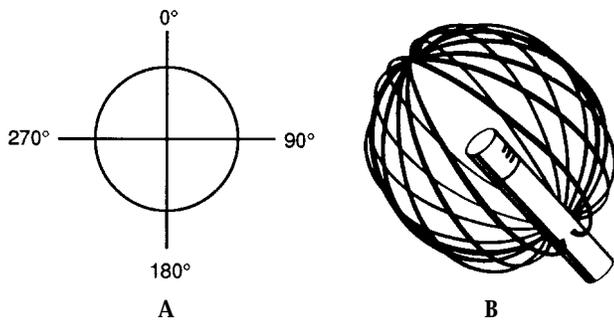


Figure 4 shows the basic omnidirectional pattern in a two dimensional representation known as a polar plot (A), while a three-dimensional representation is shown at B. The omni pattern is attained by restricting sound entry into the microphone to a single point at the front of the diaphragm. Because of this there is very little distinction based on the direction of the impinging sound, and the microphone will respond equally to sound from all directions. At very high frequencies there will be some departure from this, and the microphone will show a preference for sounds arriving from the front. For many applications this will be negligible.



1.1.2 Cardioid:

Figure 5

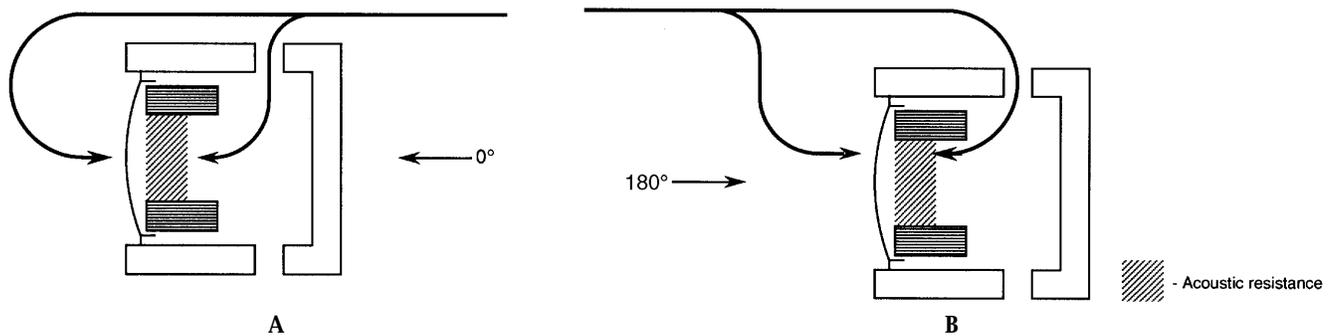
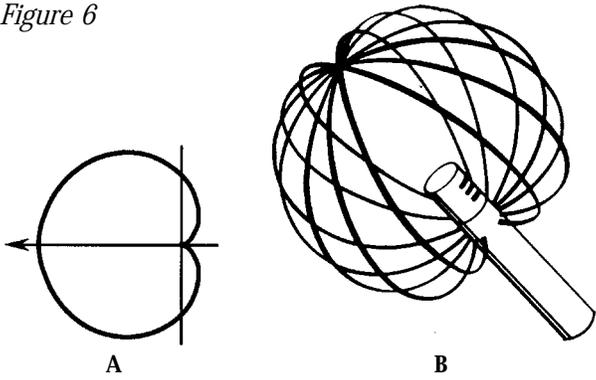


Figure 5 shows details of a cardioid microphone. Note here that there are two paths to the diaphragm: one in front and the other openings on the sides. For sound sources which are located on-axis, or 0° incidence (shown at A), sound arriving at the microphone at the front opening will always lead, or "be ahead" of sound entering by way of the back opening. This is because it travels over a shorter path, and as a result there will be output from the microphone.

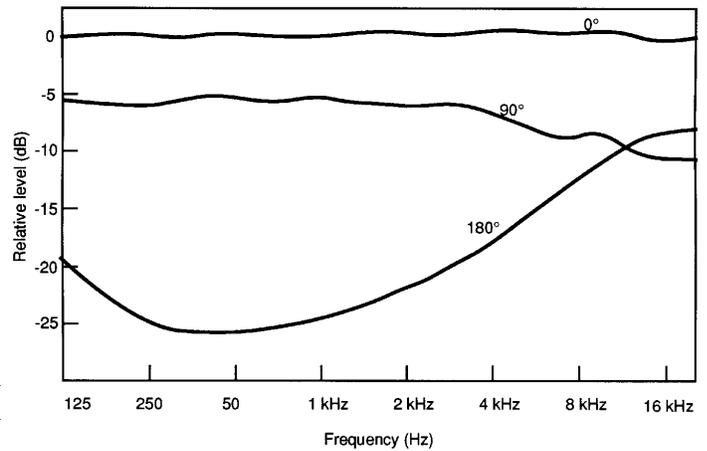
For a sound source located at the back (180° incidence), the two sounds arriving at the diaphragm will be opposite and equal, and thus will cancel, as shown at B. Acoustical resistance is used in the construction of the microphone to ensure that the front and back paths will be equal for signals arriving from 180° incidence.

Figure 6



For intermediate positions the response will vary, as shown in the polar plot of Figure 6A. A three-dimensional representation of the cardioid pattern is shown in Figure 6B.

Figure 7



The internal structure of a cardioid microphone is much more complex than an omni microphone. Great care must be taken in designing the back path so that its cancellation action for 180° sources is uniform over the widest possible frequency range. An example of an excellent cardioid microphone measured at 0°, 90°, and 180° is shown in Figure 7. As you can see, the back rejection at 180° is of the order of 20 to 25 dB in the mid-frequency range, but the cardioid action diminishes at both very high and very low frequencies.

1.1.3 Hypercardioid and Supercardioid:

These are variations on the basic cardioid pattern which may be very useful for certain applications. If the back path length is varied slightly, the off-axis angle at which the output is minimum can be varied. There are two additional patterns resulting from these changes, and they are known as hypercardioid and supercardioid. These patterns have the effect of changing the "reach" of the microphone, and they may be very useful in certain sound reinforcement applications by providing more gain before feedback than the standard cardioid pattern. These variations will be discussed in the following section.

1.2.0 Some Important Characteristics of Omni and Cardioid Family Microphones:

1.2.1 Omni:

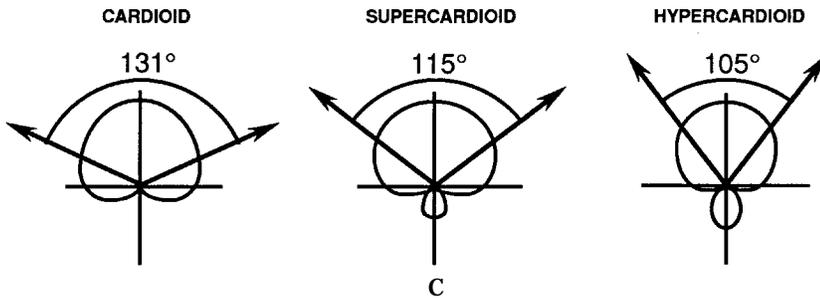
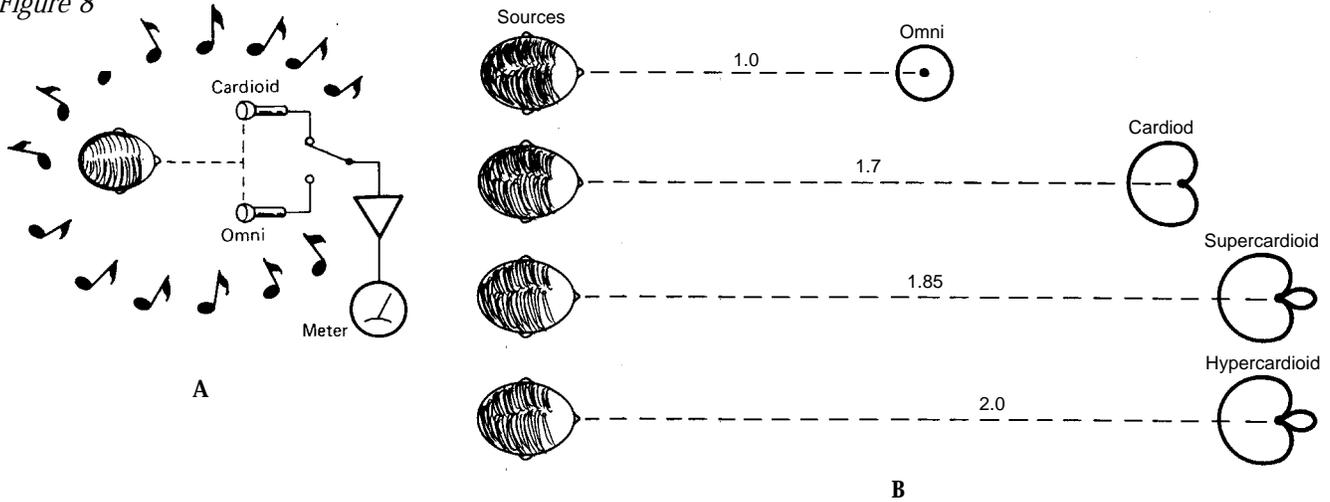
1. Most omni microphones, especially the condensers, have very smooth frequency response and as such are widely used in speech reinforcement and recording.
2. Omni microphones have relatively little handling noise and do not exhibit the proximity effect of bass rise that cardioids have. (See Proximity Effect in section 1.2.2)
3. Because of their well damped diaphragms, omni microphones are generally more rugged than cardioids.

1.2.2 Cardioid Family:

1. A cardioid microphone has greater "reach" than an omni. Because of its forward-oriented pickup pattern, it has a high ratio of on-axis response to random directional response. Figure 8A shows a comparison of omni and the cardioid microphones in terms of equivalent working distances. What this figure demonstrates is that cardioid microphone may be used at 1.7 times the working distance of an omni while still giving the same overall suppression of random noise in the room. The hypercardioid pattern can be used at 2-times the distance of an omni for the same overall effect, while the supercardioid pattern can be used 1.9 times the distance for the same effect.

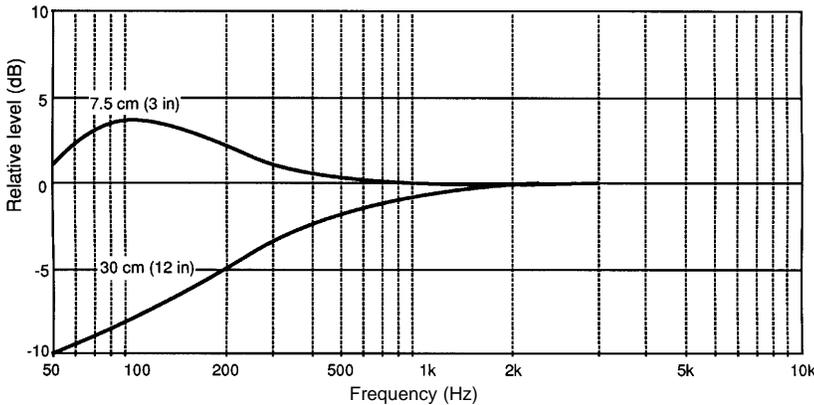
In terms of dB, when used at the same working distance the cardioid will reject randomly arriving sounds 4.8 dB more effectively than the omni, as is shown in Figure 8B. By comparison, the supercardioid would provide 5.8 dB more rejection, and the hypercardioid would provide 6 dB more rejection.

Figure 8



2. Proximity effect is a blessing and a bane. Many singers love the low frequency boost it gives their voices and would never think of using an omni microphone. On the other hand, proximity effect makes the cardioid microphone very sensitive to handling noises and to the effects of wind. Figure 9 shows typical proximity effect with a cardioid microphone. Low frequency response is shown for operating distances of 3 inches and one foot. This microphone has been designed with rolled-off low-frequency response at a distance, relying on proximity effect to restore the low frequencies when used close-in. Many so-called "vocal mikes" are designed in such a manner so that they may be used close-in with little trace of boominess.

Figure 9



3. In normal sound reinforcement applications, the cardioid pattern will offer extra immunity to system feedback, although perhaps not quite as much as the 4.8 dB mentioned in point 1.

4. As we have seen, the hypercardioid and supercardioid patterns offer slight improvement over the cardioid in terms of immunity to random sounds. While the studio engineer may prefer the

standard cardioid for its 180° null in output, the sound reinforcement engineer will often prefer the super and hypercardioid for their added reach. By opening up the rear (180°) lobe in the directional response (see views of these patterns in Figure 8B), the frontal pattern is actually "tighter" than that of the standard cardioid. This can also be useful on stage where two or more performers may be fairly close to each other. The data shown in Figure 8C shows the nominal acceptance angle (± 3 dB) that the microphones in the cardioid family provide.

1.3.0 Electrical Aspects of AKG Microphones:

In this section we will discuss five items that have to do with electrical aspects of the microphone: impedance, sensitivity, self noise level, overload point, and powering.

1.3.1 Impedance:

In keeping with modern engineering practice, AKG's condenser microphones have internal impedances in the range of 200 ohms, while the dynamics have impedances that vary from 200 to 800 ohms. Generally speaking, these values fall collectively under the designation "low impedance." All AKG microphones are designed to be loaded by modern consoles and speech input equipment with nominal impedances in the 3000-ohm and higher range.

The advantage of low impedance microphones is that they can be used over fairly long distances from the console with negligible losses. Distance up to 600 feet, while rarely encountered in normal applications, can be handled with no problem. Since all low impedance lines are balanced, they are virtually insensitive to normal external electrical disturbances.

High impedance microphones were once used in paging applications, where there was a short run between the microphone and the associated amplifier. Today there are no advantages for high impedance microphones, inasmuch as the costs of high quality low impedance preamplifiers has come down drastically.

1.3.2 Sensitivity:

In measuring microphone sensitivity the microphone is placed in a reference sound field in which a sound pressure level of 94 dB at 1000 Hz is maintained at the microphone. 94 dB is the sound pressure level equivalent to one pascal (Pa), the metric unit of pressure. The unloaded output voltage is measured and stated as the nominal sensitivity.

Sensitivity is also stated in decibels relative to one volt, a designation known as dBV. The following table gives the sensitivity range of typical AKG microphones:

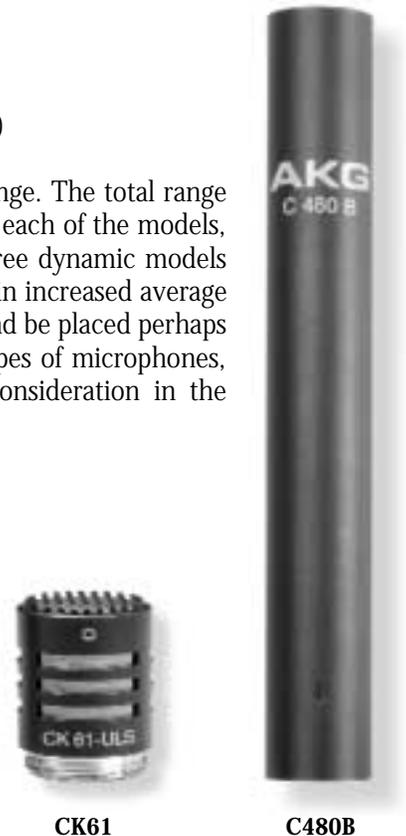
Model:	Type:	Sensitivity:	dBV:
C414B/ULS	Condenser (multi-pattern)	12.5 mV/Pa	-38
C480 CK61	Condenser (multi-capsule)	20 mV/Pa	-34
C535EB	Condenser (vocal/instrument)	7 mV/Pa	-43
C3000B	Electret Condenser (two pattern)	25 mV/Pa	-32
D3800	Dynamic (vocal)	2.8 mV/Pa	-51
D770	Dynamic (vocal/instrument)	2.5 mV/Pa	-52
D58	Dynamic (noise-cancelling)	0.72 mV/Pa	-63

(Note: The equation for converting from mV/Pa to dBV is: $dBV = 20 \log (mV/Pa) - 60$)

Note that all sensitivities are in the low millivolt (mV), or one-thousandth of a volt, range. The total range shown here is about 25 dB. However, taking into account the recommended usage for each of the models, the average output voltage probably will not vary all that much. For example, the three dynamic models listed here are intended to be used fairly close-in to sound sources, and that will result in increased average output. Likewise, the four condenser models listed may be used in classical recording and be placed perhaps 15 feet away from sound sources in the studio, so actual operating voltages, for all types of microphones, will tend to average out to about the same value. In fact, this is an important consideration in the engineering of a particular microphone model.

1.3.3 Self Noise Level:

The self noise of a condenser microphone is the audible noise level the microphone produces when it is placed in isolation from outside sound sources. As an example, a microphone that has a self noise level of 15 dBA produces roughly the same output as a "perfect" microphone placed in a room with a measured noise floor of 15 dBA. AKG's new condenser microphone-preamp combinations using the model C480 preamp-powering module have noise floors in the range of 10 dBA. This is as low as any studio condenser microphone in the industry, and such microphones are targeted for digital recording in the studio.



Dynamic microphones do not carry a self noise rating, inasmuch as their effective noise floor depends on their sensitivity and the electronics they are loaded with.

For many applications we can safely ignore the self noise level of microphones, since the acoustical noise in the operating environment is normally far greater than that of the microphone itself.

1.3.4 Overload Point:

The useful effective upper limit in sound pressure level that a microphone can handle is that value at which the microphone's output exhibits a stated amount of harmonic distortion. General industry standards set a value of 0.5% or 1% for this, and the distortion value is always stated in any listing of specifications. For most AKG studio condenser microphones we are looking at levels in the range of 130 to 140 dB SPL for distortion values of 0.5% or 1%.

Dynamic microphones are often rated by stating the acoustical level which will produce harmonic distortion values of 1% and 3%. Many of the models can be used in sound fields up to 156 dB, producing output with no more than 3% distortion.

For most purposes involving speech communication and reinforcement we can ignore these limitations, but in the recording studio and in music reinforcement, with microphones placed very close to loud instruments, we can easily reach levels in the range of 130 dB.

1.3.5 Handling Noise:

Many older microphones intended for hand-held operation were very susceptible to handling noise. Today, most manufacturers have solved this problem through careful shock mounting of the capsule within the microphone case and through electrical roll-off of low frequencies of those microphones intended for close-in operation. There are no standards for measuring handling noise, and its relative absence is simply a mark of the manufacturer's attention to design details. AKG microphones are noted for their low handling noise.

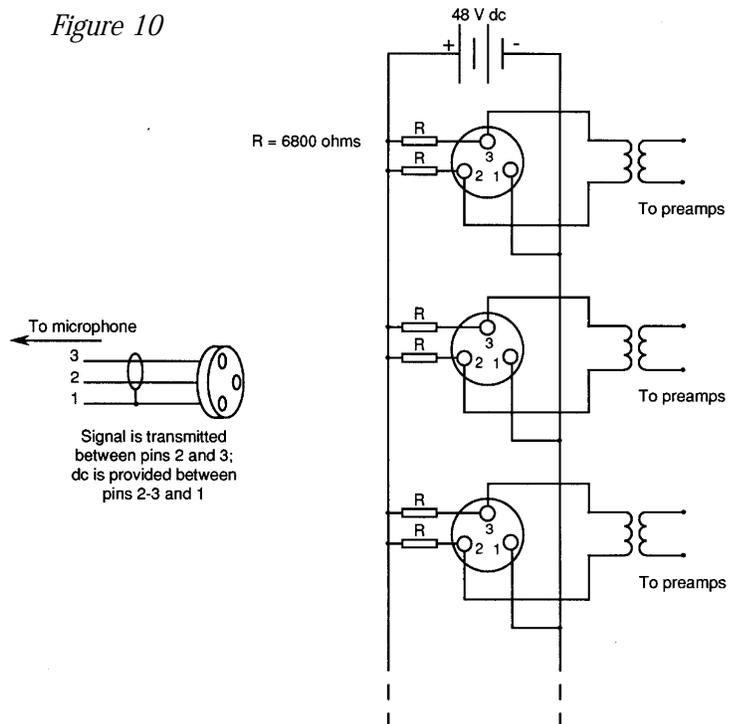
1.3.6 Powering:

All condenser microphones need some kind of power, since they all contain a preamplifier section. Some tie-tack and many electret microphones are powered by a self-contained 9 volt battery. When the microphone is not in use it should be turned off in order to conserve battery power. Virtually all of the non-electret condensers are powered via universal phantom powering, as shown in Figure 10. The phantom powering standard covers nominal values of 12, 24, and 48 volts dc. The tolerance on the values is broad enough so that many AKG condenser microphones can be powered anywhere from 9 volts to 52 volts, making them adaptable to a wide range of operating conditions. Some of the studio models such as the older C414EB/P48 will work only on 48 volt powering.



C414EB/P48

Figure 10



2.0.0 "B" BASIC PRINCIPLES OF MICROPHONE USAGE:

2.1.0 Multiple Microphone Interference:

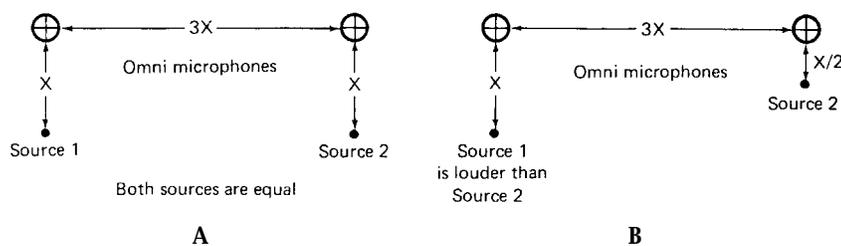
Most people tend to use too many microphones. The simple rule is that less is very often more in terms of performance. Multiple open microphones not only cause coloration due to peaks and dips in response, they also make the system more feedback prone. Let's illustrate a few of the more common problems.

2.1.1 The Three-to-One Rule:

Figure 11A shows the proper way to cover two closely spaced performers, each with a microphone. If the distance between microphones is at least three times the distance from each microphone to its associated performer, then the leakage signal from the distant performer into the nearer performer's microphone will be about 10 dB lower -- low enough not to be a problem.

If however source 1 is louder than source 2, as shown in Figure 11B, then the softer source will have to move in on the microphone, as needed.

Figure 11

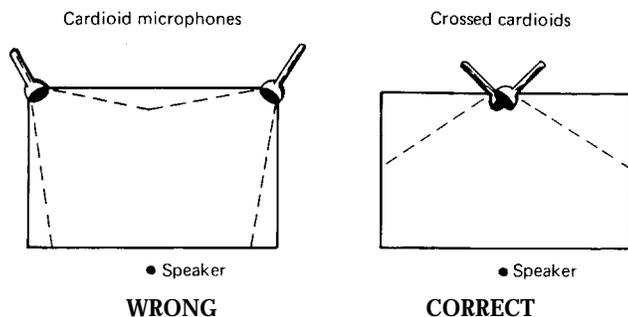


2.1.2 Multi-microphones on the Podium:

If there are two or more microphones on a podium, each going in a separate direction, never to be combined with each other, then the placement is of little concern, except to ensure that each microphone gets a clear shot at the voice and is not hidden behind other microphones. This situation is common in news gathering activities.

However, if two microphones are combined to keep a talker "on mike," then extra care must be taken. Figure 12A shows how this is often done by inexperienced persons. Here, two microphones are placed far apart, angled in so that they cover all of the performer's possible locations. This is the wrong way of doing it; the correct way is shown in Figure 12B. Both microphones should be placed in very close proximity to each other and splayed so that their common coverage angle will be large enough to capture the talker in any position.

Figure 12



What are the differences? In the case shown in Figure 12A, there is only one correct position for the talker, and that is in the center equidistant from both microphones. As the talker moves away from this position the relative signal delays from talker to microphone will shift values and their combination will show interference effects of cancellations and reinforcements. In fact, if you have never heard this effect, it is instructive to set it up and hear for yourself just how bad the combinations can be. Then move to the setup in figure 12b and hear how much more consistent the audio quality is for all positions of the talker.

2.1.3 Reflections from Nearby Surfaces and Boundary Effects:

Figure 13

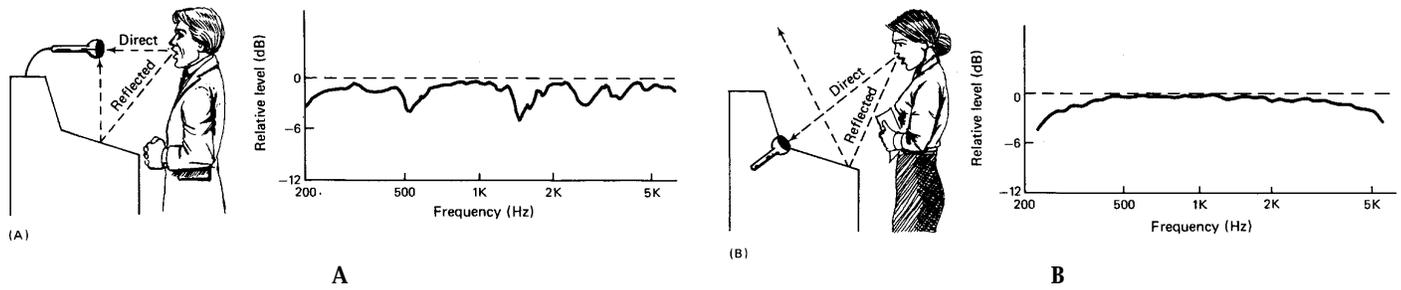


Figure 13A shows common problems encountered in sound reinforcement and recording. The reflecting surface can be a tabletop, a pulpit, a wall, or a floor. In the case shown here, there are effectively two sound sources, the direct one and the reflected one. These combine at the microphone with a delay between them, producing response that will look something like that shown in Figure 13A. The rule is to keep the microphone as far away from a reflecting boundary as possible -- or flush mount it directly on the surface, as shown in Figure 13B, effectively making the direct sound and its reflected image one and the same.

Also, remember that the effect is worst with omnidirectional microphones, inasmuch as that pattern has no off-axis discrimination. Cardioid microphones can minimize the effect through off-axis discrimination, but it is best to avoid the condition altogether.

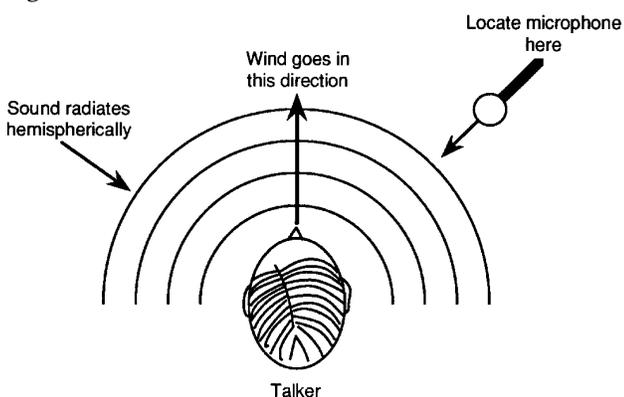
The long standing problem with wall and floor reflections has, over the last two decades, given rise to what is generally called boundary layer microphones. These are microphones whose profile is that of a flange. They are made to be mounted flush on a plane boundary surface, and in that position the microphone will pick up both direct sound and its reflected image virtually in phase. As a result of this, the output of the boundary layer microphone will be twice (+ 6 dB) that of a single microphone located away from the wall. Early versions of boundary layer microphones were usually omnidirectional; today there are a number of cardioid family pickup patterns available. AKG makes both types.

2.2.0 Wind and Microphones Don't Mix:

Whether outdoors or indoors, it is imperative to keep wind away from microphones, especially directional ones. Never blow on a microphone to find out if it is working! This is an imposition on the audience, and it also runs a risk of getting moisture on the microphone screen. It is surprising how many people who regularly do public speaking have never been taught the rudiments of microphone usage.

The rule for avoiding wind noise and "popping" is to hold the microphone toward one side, pointing it at the talker's mouth, but not allowing the person to talk directly into the microphone. This will prevent puffs of wind that are so annoying to the listener. The real key here is in positioning the microphone on the podium in the first place so that the "popping" of air blasts against the microphone will not happen.

Figure 14



Basic rule: point microphone at talker's mouth -- but do not point talker toward the microphone!

For handheld microphones, performers simply have to learn to hold it off to one side while pointing it directly at the mouth. Here, a foam windscreen will be useful, just as a safeguard. Figure 14 shows how and how not to position the microphone.

3.0.0 “C” CASE STUDIES:

3.1.0 Miking Talkers, Vocalists, and Instruments in Houses of Worship:

With the groundwork that has gone before we are now ready to examine in detail specific miking problems. Since the vast majority of microphone applications have to do with the spoken voice, let's start there.

The typical worship space of today requires speech amplification from all possible speaking positions, including pulpit, lectern, altar, and free-standing locations. We will discuss these in order.

3.1.1 Pulpit and Lectern Microphones:

Figure 15 shows a pulpit in top view (A) and in front view (B). There is normally a reading desk in the center, and the ideal microphone position is to the right or left of it, depending on the preference of the principal talker. An excellent microphone choice here would be AKG's Discreet Acoustics modular series GN30E gooseneck with a CK80 or CK47 condenser capsule. These capsules' narrow profile designs have integral rifle sections for increased directivity (hypercardioid) along their primary axis. The bass is slightly rolled off (CK80) to compensate for proximity effect, and the dark matte finish makes them invisible at normal viewing distances. An integral gooseneck section simplifies adjustment of the microphone's position.

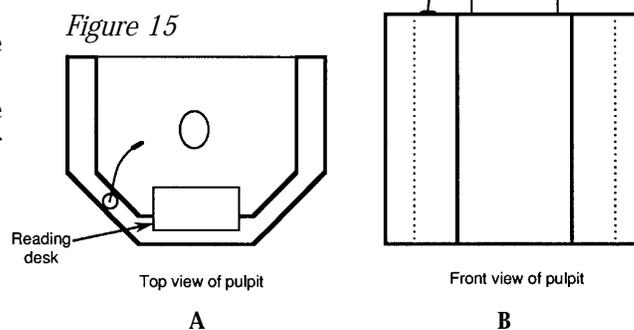


We are assuming here that the talker will occupy basically a single position, facing forward, and that the microphone can be positioned so that normal movements of the talker's arms, or vestments, do not interfere with the microphone. Another choice might be AKG's Discreet Acoustics modular series GN30E gooseneck with a CK31 condenser capsule. The CK31 capsule is a cardioid microphone that is less obtrusive than the CK80 or CK47.

Most of what has been said about the pulpit applies to the lectern. However, the lectern is often smaller than the pulpit, thus offering fewer options for microphone location.



GN30 CK31



3.1.2 Altar Microphones:

Today we think entirely in terms of boundary layer (BL) microphones for this purpose. In most cases two or possibly three of the directional models (C547BL or C680BL) would work best on the modern style table altar shown in Figure 16A. Here, the pastor faces the congregation, and a directional BL microphone can be used to advantage in getting more gain before feedback. Use as many of these as there are principal positions behind the altar. Because the altar is invariably covered with a cloth, permanent mounting of the microphones is not possible, however, double-sided tape will keep them from slipping or moving during a service.

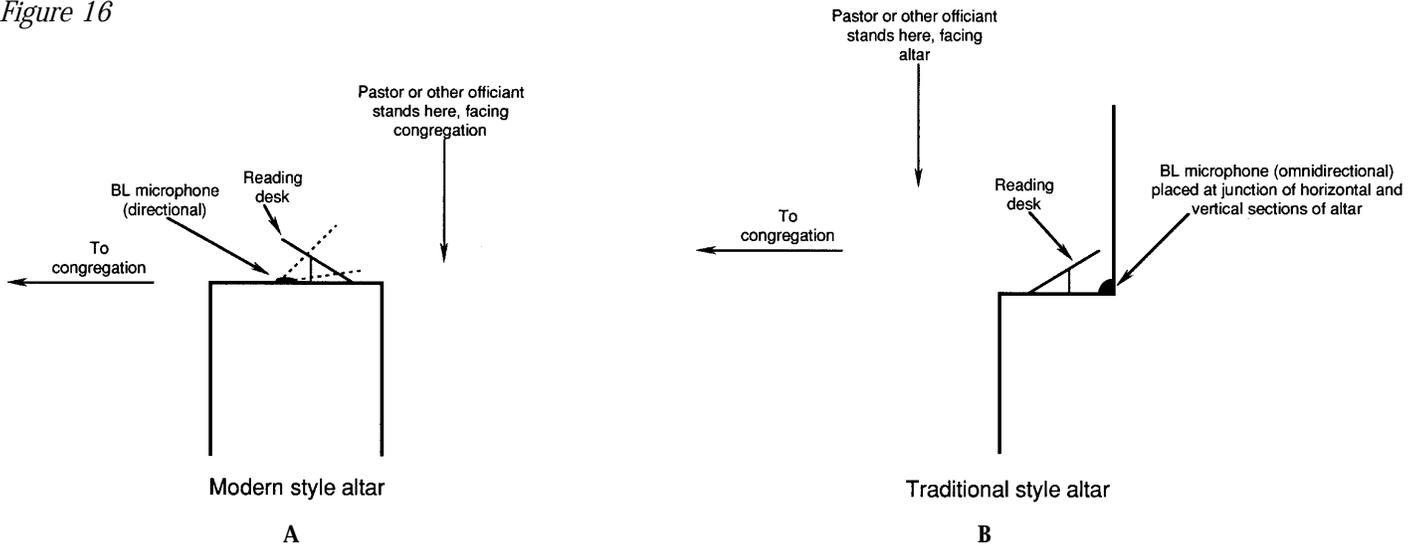


C547 BL

In the case of the traditional altar, shown in Figure 16B, it is best to use an omnidirectional BL microphone located as close as possible to the intersection of horizontal and vertical surfaces of the altar. Use as many as needed.

As a rule, no more than one speech pickup location should be switched on at a time in a worship space. This is especially true at the altar, where a multiplicity of microphones, if all were open at the same time, would create a very unnatural sound. We strongly recommend that some kind of automatic microphone mixing or gating be used in these applications.

Figure 16



3.1.3 The Roving Talker:

In some worship spaces the entire front platform is used for speaking, and a hand-held wireless is normally the microphone of choice. For this purpose a number of AKG wireless models should be auditioned and one chosen that best complements the talker's voice. It should be supplied with a foam windscreen to limit the breath effects of too-close use. It is also advisable for the operating engineer to use a program limiter so that the output capabilities of the entire system will not be stressed by overmodulation. The AKG wireless dynamic microphones WMS40/880, WMS81/880 and WMS81/3800 all provide a rise in the presence range that presenters will appreciate. The wireless condenser microphone C535WL/1 has a smoother high end, which will complement most voices.



SR81



HT 81 &
D880WL/1



SR40



HT40/880

3.1.4 Baptismal Fonts and Weddings:

For services at a baptismal font or for weddings, which are generally held in a free standing area at the head of the congregation, a tie clip-on or lapel wireless microphone, such as the C417, CK97, C477WR or C577WR, is probably the most unobtrusive.

Weddings being the momentous events that they are, it is customary today to document them via recording, video taping and photography. Do not be surprised at requests from both bride and groom for personal microphones so that their vows can be recorded loud and clear.



C577WR

3.1.5 How to Position the Clip-on Microphone:

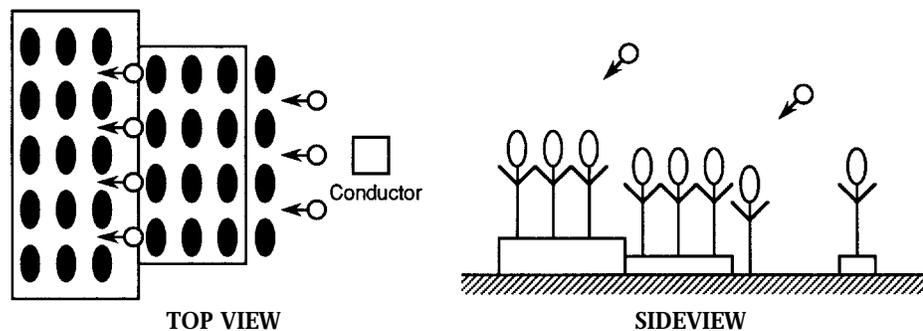
It is often appalling how ineptly tie-tack microphones are applied. Usually, they are positioned on the tie or lapel at too great a distance from the talker's mouth to work well. The tie position is best, inasmuch as it centers the microphone. However, do not place it so high that the talker's chin gets in the way when he or she refers to written notes. A microphone such as the CK 97 has the right degree of rolled-off bass response (to compensate for boom from the talker's chest cavity) and the right degree of high frequency boost (to compensate for the off-axis location of the microphone). It is also important to make sure that normal movements of the talker will not result in any stress or rubbing on the microphone's cable, which could cause extraneous noises.

3.1.6 The Music Service:

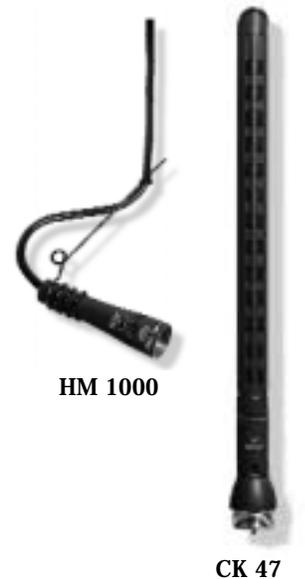
In many traditional religious denominations, the music, consisting primarily of organ and choir, may need no amplification as such, but there is certainly a move these days to record the music as part of the overall service. The comments we will make here are general and apply to both recording and feeds for sound reinforcement.

The choir is best picked up by way of a number of microphones of the integral hanging type such as AKG's Discreet Acoustics modular series HM1000 with a CK31 or CK47 condenser capsules. Of these, the CK47 capsule is best since it has a tighter pattern and more extended low frequency response. Figure 17 shows details on choir pickup. In general, four to seven microphones would be sufficient. For a divided choir, a symmetrical array of microphones would be desirable. For a larger group than shown here, the microphones may be flown somewhat higher, generally keeping the same scale as shown here.

Figure 17



CK97C



HM 1000

CK 47

The organ itself would rarely if ever be reinforced, but of course would be picked up by dedicated microphones for the recording the service. There may be some cases when a very slight amount of choral amplification might be necessary. Ordinarily, a vocal soloist, singing with the choir, would not be picked up separately, but from his or her position in the choir by means of the overhead microphones.

CONCLUSIONS:

This manual has given you the fundamentals of microphone selection and basic application in speech and vocal work. By now you should have a pretty good idea of why there are all those microphones in the AKG catalog. They exist to make your job of specifying the right microphone a little easier.

Special thanks to John Eargle for the use of his graphics and his contribution to this project. John Eargle is a consultant to AKG, Harman International and is Director of Recording for Delos Records.

NOTES:

AKG MICROPHONES: BASIC SPECIFICATIONS BY USAGE CATEGORY:

The accompanying chart details the principal specifications of microphone types discussed in The ABC's of AKG: Microphone Basics and Fundamentals of Usage.

Pertinent models are listed by usage category, model number and description of transduction type. The frequency response limits will give the user an indication of microphone choice for the fidelity requirements for a project at hand. At the same time, the sensitivity and impedance data will dictate the electrical input conditions that will be required. Final comments underscore the specific uses of a model within a given category.

	MODEL:	DESCRIPTION:	FREQUENCY RESPONSE:	SENSITIVITY:	IMPEDANCE:	COMMENTS:
Pulpit/ Lectern/ Hanging	CK80	Modular condenser	60Hz-15kHz	30 mV/Pa	≤600 Ohms	High directivity hyper-cardioid; universal powering
	CK31	Modular Condenser	50Hz-20kHz	20 mV/Pa	≤600 Ohms	Extended frequency response cardioid; universal powering
	CK47	Modular condenser	20Hz-20kHz	16.5 mV/Pa	≤600 Ohms	High directivity hypercardioid; extended frequency response; universal powering
	GN30	Modular Gooseneck				30-cm (12 in.) gooseneck used with the CK Discreet Series modular capsules
	HM1000	Hanging Module				10-m (33 ft.) or 20-m (66 ft.) non twisting hanging module used with the CK Discreet Series modular capsules
	C477WR	Headworn condenser	20Hz-20kHz	8 mV/Pa	≤3500 Ohms	Extended frequency range; wireless applications; 1.5 -12 Volt powering.
Lapel/ clip-on	C577WR	Clip-on condenser	20Hz-20kHz	8 mV/Pa	≤400 Ohms	Extended frequency range; omnidirectional; universal powering
	CK77WR	Clip-on condenser	20Hz-20kHz	8 mV/Pa	≤3500 Ohms	Extended frequency range omnidirectional; wireless applications; 1.5 -12 Volt powering.
Boundary layer	C400BL	Boundary layer condenser	150Hz-15kHz	13 mV/Pa	≤200 Ohms	Small size hypercardioid; effective at large distances; universal powering
	C547BL	Boundary layer condenser	30Hz-18kHz	8.5 mV/Pa	≤200 Ohms	Extended frequency range; supercardioid; switchable bass cut; universal powering
	C680BL	Boundary layer condenser	60Hz-20kHz	30 mV/Pa	≤200 Ohms	Extended frequency range; supercardioid; universal powering

MODEL:	DESCRIPTION:	FREQUENCY RESPONSE:	SENSITIVITY:	IMPEDANCE:	COMMENTS:	
Vocal Microphones	C5900	Handheld condenser	20Hz-22kHz	6 mV/Pa	≤200 Ohms	Switchable bass roll-off and cut; low handling noise; universal powering
	C535EB	Handheld condenser	20Hz-20kHz	7 mV/Pa	≤200 Ohms	Switchable bass roll-off and cut; excellent for on-stage vocals, universal powering
	D660S	Handheld dynamic	70Hz-20kHz	2 mV/Pa	≤500 Ohms	Hypercardioid, on-off switch
	D770	Handheld dynamic	60Hz-20kHz	2.5 mV/Pa	≤600 Ohms	Cardioid pattern; metal windscreen and handle; ideal for on stage vocal or instrument
	D880	Handheld dynamic	60Hz-20kHz	2.5 mV/Pa	≤600 Ohms	Supercardioid pattern; metal windscreen and handle; ideal for on stage vocal
	D880S	Handheld	60Hz-20kHz	2.5 mV/Pa	≤600 Ohms	Supercardioid pattern; On/Off dynamic switch; metal windscreen and handle ideal for on stage vocal
	D3700	Handheld dynamic	50Hz-20kHz 20Hz-20kHz at 1/2"	2.5 mV/Pa	≤600 Ohms	Hypercardioid pattern; very durable, Ideal for on stage vocal or instrument
	D3700S	Handheld dynamic	50Hz-20kHz	2.5 mV/Pa	≤600 Ohms	Hypercardioid pattern; On/Off switch; very durable, Ideal for on stage vocal or instrument
	D3800	Handheld dynamic	40Hz-21kHz	2.8 mV/Pa	≤600 Ohms	Hypercardioid pattern; very durable, ideal for on stage vocals
	D230	Handheld dynamic	40Hz-20kHz	2.5 mV/Pa	≤230 Ohms	Omni pattern; ideal for close-in speech; hum compensation; low handling noise



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