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MICROPHONES
NEWSLETTER

September 2009

Microphone Specs Explained

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 Updated 8-2-2011

What microphone is best for recording an orchestra? What's a good snare mic? Should the microphone be a condenser or dynamic, omni or cardioid?

You can answer these questions more easily once you know the types of microphones and understand their specs. First, it always pays to get a high-quality microphone. The mic is a source of your recorded signal. If that signal is noisy, distorted, or tonally colored, you'll be stuck with those flaws through the whole recording process. Better get it right up front.

Even if you have a MIDI studio and get your sounds from samples or synthesizers, you still might need a good microphone for sampling, or to record vocals, sax, acoustic guitar, and so on.

This article is in two parts. **Part 1** is short and simple; **Part 2** goes into more detail.

Part 1: Mic Specs in Plain English

Here's a highly simplified explanation of mic specs in plain English. It may help you evaluate microphones based on their specifications.

TYPE: Condenser, dynamic or ribbon.

These terms refer to the way the microphone converts sound into an electrical signal. Each type has its own "sound" and application.

Condenser: High-fidelity, detailed sound with lots of clean high frequencies. Popular for studio vocals, stage vocals, acoustic instruments and cymbals. Requires "phantom power" from a mixer to operate. Can be miniaturized.

Dynamic: Good sound quality, rugged. Popular for guitar amps and drums. Does not require phantom power.

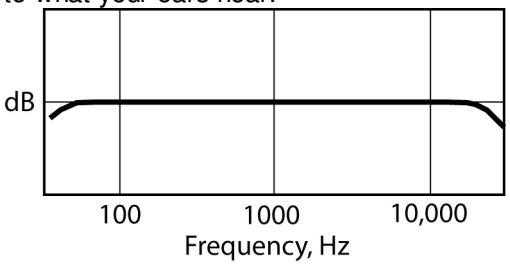
~~Ribbon~~: Warm, smooth sound quality. Delicate. Popular for horns and guitar amps. Does not require phantom power.

FREQUENCY RESPONSE: The lowest and highest frequencies that the mic can pick up well.

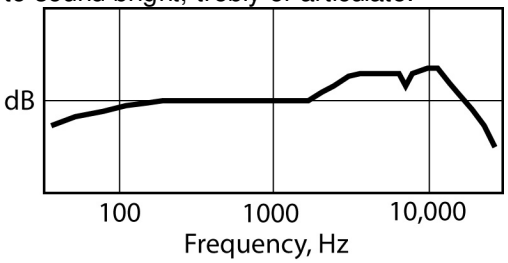
A frequency response from 20 Hz to 20,000 Hz covers all the frequencies we can hear. 80 Hz to 15,000 Hz is adequate for most instruments and vocals. 40 Hz to 10 kHz is adequate for bass instruments.

If the mic's data sheet shows a frequency response graph, the shape of the dark line or "curve" on the graph indicates how the mic responds to bass, midrange and treble frequencies. The right area of the graph is treble; the left area is bass, and the middle area is the midrange.

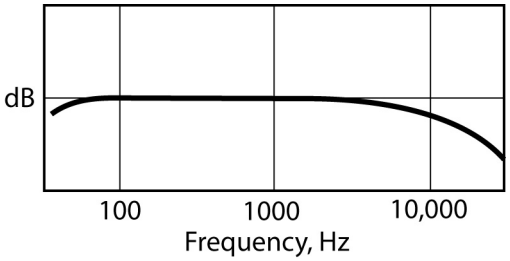
A curve that is mostly a horizontal line is called "flat". It tends to sound accurate, natural or similar to what your ears hear.



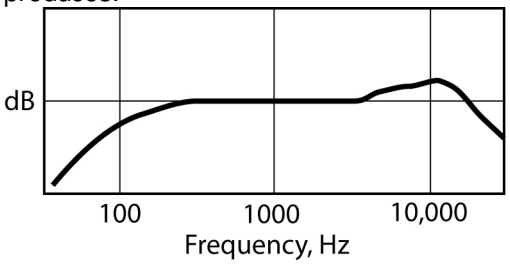
A curve that rises above "0 dB" toward the right side of the graph has a "presence peak". It tends to sound bright, trebly or articulate.



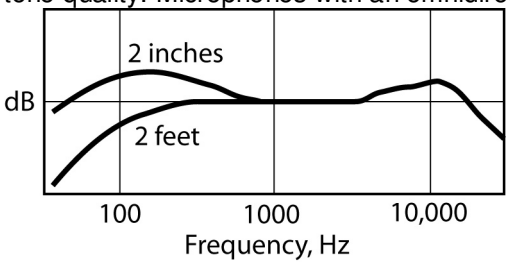
A curve that falls below "0 dB" toward the right side of the graph tends to sound mellow.



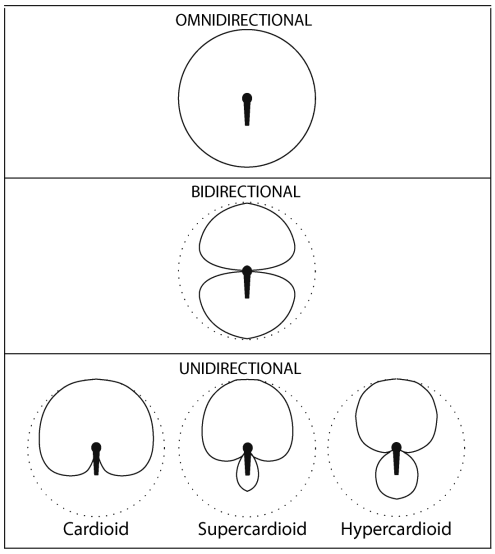
A curve that falls below "0 dB" toward the left side of the graph is called a low-frequency rolloff. It's desirable to roll off the low frequencies below the lowest note that the instrument or vocal produces.



Proximity effect: Most microphones boost the bass when used up close. That adds a warm, full tone quality. Microphones with an omnidirectional polar pattern do not have proximity effect.



POLAR PATTERN:
Also called directional pickup pattern. It's a graph of how the mic picks up sounds coming from different directions.



Cardioid: Picks up best in front of the mic. Partly rejects sounds approaching the sides or rear of the mic. Rejects sound best toward the rear.

Supercardioid: Picks up best in front of the mic. Partly rejects sounds approaching the sides or rear of the mic. "Tighter" or more narrow pickup than cardioid.

Hypercardioid: Picks up best in front of the mic. Partly rejects sounds approaching the sides or rear of the mic. "Tighter" or more narrow pickup than supercardioid.

Omnidirectional or omni: Picks up equally well in all directions. Unlike the other patterns, omni has no proximity effect (no up-close bass boost).

Bidirectional or figure-8: Picks up best in two directions -- in front of and behind the mic -- and rejects sounds to the sides.

Use cardioid, supercardioid, hypercardioid, bidirectional, or an instrument-mounted omni when you want to reject background noise, room acoustics and feedback. A mic with one of those patterns tends to pick up mostly what it is aiming at, and not so much of everything else.
Use omnidirectional when you want to pick up everything around the microphone.

IMPEDANCE: An electrical characteristic of a microphone. Use low-impedance microphones (under 300 ohms) to prevent hum pickup if you use mic cables over 10 feet long.

MAXIMUM SPL: The loudest sound that the mic can pick up without distorting. A maximum SPL spec of 120 dB SPL is good, 130 dB SPL is very good, and 140 dB SPL or higher is excellent. 120 dB SPL is painfully loud.

SELF-NOISE: A measure of how noisy the microphone is. A self-noise spec of 25 dBA is good, 20 dBA is very good, and 15 dBA or less is excellent. A self-noise spec of 30 dB is very good if the mic is mounted directly on an instrument because the instrument's signal is so much louder than the mic's noise.

SIGNAL-TO-NOISE RATIO: Another measure of how noisy the microphone is. A signal-to-noise spec of 69 dB is good, 74 dB is very good, and 79 or higher is excellent. A signal-to-noise spec of 64 dB is very good if the mic is mounted directly on an instrument because the instrument's signal is so much louder than the mic's noise.

POWERING: Condenser microphones require special power to operate, either a battery or phantom power. Phantom power is 12 to 48 volts DC, and is supplied by a mixer or by a phantom power supply. Phantom power is sent to the mic on its mic cable; no extra wiring is needed.

CONNECTOR: An XLR or 3-pin pro audio connector is recommended to prevent hum pickup with mic cables over 10 feet long.

SIDE-ADDRESS: The microphone picks up best from its side. You aim the side of the mic at the sound source.

END-ADDRESS: The microphone picks up best from its end. You aim the end of the mic at the sound source.

Part 2: Mic Specs Explained in Detail (next page)

Part 2: Mic Specs Explained in Detail

A microphone is a transducer—a device that changes one form of energy into another. Specifically, a mic changes sound into an electrical signal. Your mixer amplifies and modifies this signal.

TRANSDUCER TYPES

Mics for recording can be grouped into three types depending on how they convert sound to electricity: dynamic, ribbon, or condenser.

A dynamic mic capsule, or transducer, is shown in Figure 1 (next page). A coil of wire attached to a diaphragm is suspended in a magnetic field. When sound waves vibrate the diaphragm, the coil vibrates in the magnetic field and generates an electrical signal similar to the incoming sound wave. Another name for a dynamic mic is moving-coil mic, but this term is seldom used.

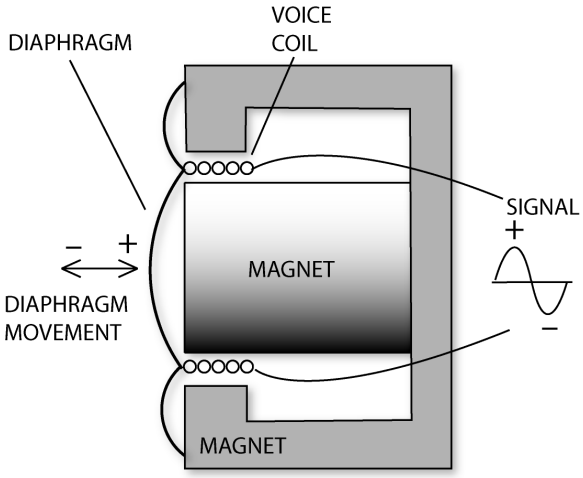


Fig. 1. A dynamic transducer.

In a ribbon mic capsule, a thin metal foil or ribbon is suspended in a magnetic field (Figure 2). Sound waves vibrate the ribbon in the field and generate an electrical signal.

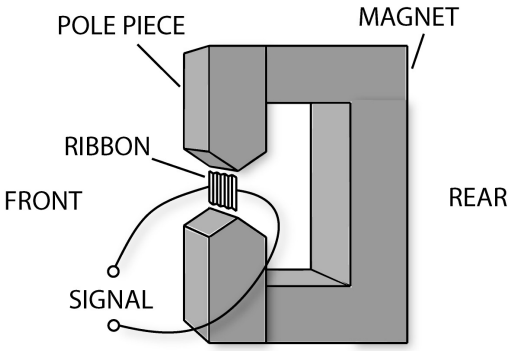


Fig.2. A ribbon transducer.

A condenser or capacitor mic capsule has a conductive diaphragm and a metal backplate placed very close together (Figure 3). They are charged with static electricity to form two plates of a capacitor. When sound waves strike the diaphragm, it vibrates. This varies the spacing between the plates. In turn, this varies the capacitance and generates a signal similar to the incoming sound wave. Because of its lower diaphragm mass and higher damping, a condenser mic responds faster than a dynamic mic to rapidly changing sound waves (transients).

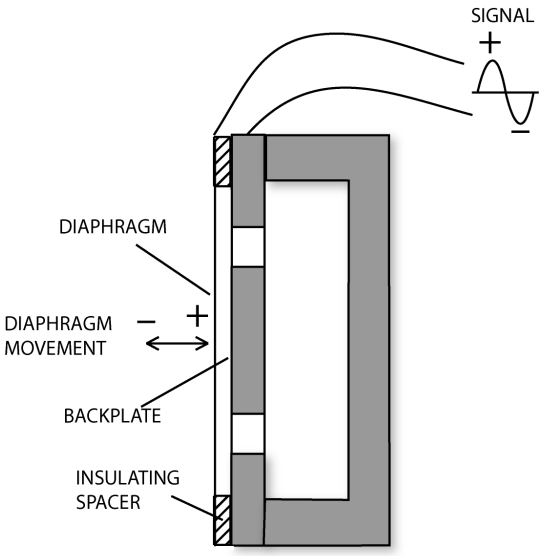


Fig. 3. A condenser transducer.

~~Two types of condenser mic are true condenser and electret condenser~~. In a true condenser mic (externally biased mic), the diaphragm and backplate are charged with a voltage from a circuit built into the mic. In an electret condenser mic, the diaphragm and backplate are charged by an electret material, which is in the diaphragm or on the backplate. Electrets and true condensers can sound equally good, although some engineers prefer true condensers, which tend to cost more.

A condenser mic needs a power supply to operate, such as a battery or phantom power supply. Phantom power is 12 to 48 volts DC applied to pins 2 and 3 of the mic connector through two equal resistors. The microphone receives phantom power and sends audio signals on the same two conductors. Ground for the phantom power supply is through the cable shield. Nearly all mixing consoles and audio interfaces supply phantom power at their mic input connectors. You simply plug the mic into the mixer to power it.

Dynamics and ribbons need no power supply. You can plug these types of mics into a phantom supply without damage because the voice coil or ribbon is not connected to ground (unless they are accidentally shorted to the mic housing). Some newer ribbon mics have a built-in preamp that is phantom powered.

Figure 4 shows a cutaway view of a typical dynamic vocal mic and condenser instrument mic.

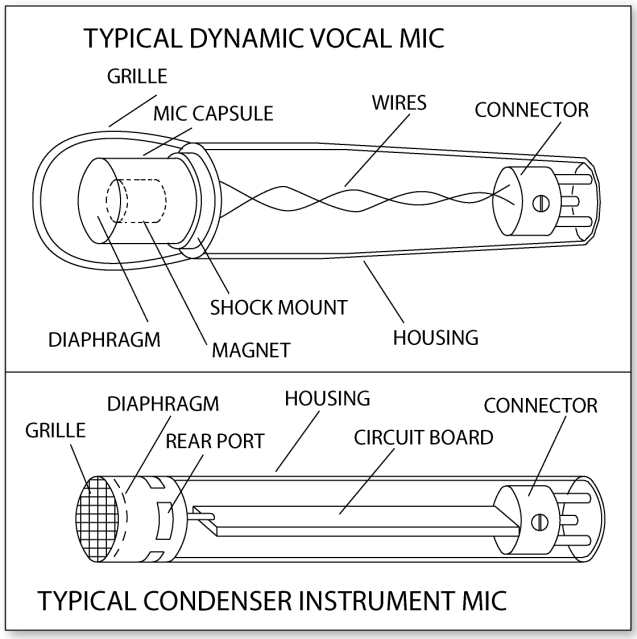


Fig. 4. Inside a typical dynamic vocal mic and condenser instrument mic.

General Traits of Each Transducer Type
Condenser

- Wide, smooth frequency response
- Detailed sound, extended highs
- Omni type has excellent low-frequency response
- Transient attacks sound sharp and clear
- Preferred for acoustic instruments, cymbals, studio vocals
- Can be miniaturized

Dynamic

- Tends to have rougher response, but still quite usable
- Rugged and reliable
- Handles heat, cold, and high humidity
- Handles high volume without distortion
- Preferred for guitar amps and drums
- If flat response, can take the “edge” off woodwinds and brass

Ribbon

- Prized for its warm, smooth tone quality
- Delicate
- Complements digital recording

There are exceptions to the tendencies listed above. Some dynamics have a smooth, wide-range frequency response. Some condensers are rugged and handle high SPLs. It depends on the specs of the particular mic.

POLAR PATTERN
Microphones also differ in the way they respond to sounds coming from different directions. An **omnidirectional** microphone is equally sensitive to sounds arriving from all directions. A **unidirectional mic** is most sensitive to sound arriving from one direction—in front of the mic—but softens sounds entering the sides or rear of the mic. A **bidirectional** mic is most sensitive to sounds arriving from two directions—in front of and behind the mic—but rejects sounds entering the sides.

There are three types of unidirectional patterns: cardioid, supercardioid, and hypercardioid. A mic with a **cardioid** pattern is sensitive to sounds arriving from a broad angle in front of the mic. It is about 6dB less sensitive at the sides, and about 15 to 25dB less sensitive in the rear. The **supercardioid** pattern is 8.7dB less sensitive at the sides and has two areas of least pickup at 125 degrees away from the front. The **hypercardioid** pattern is 12dB less sensitive at the sides and has two areas of least pickup at 110 degrees away from the front.

Figure 5 shows various polar patterns.

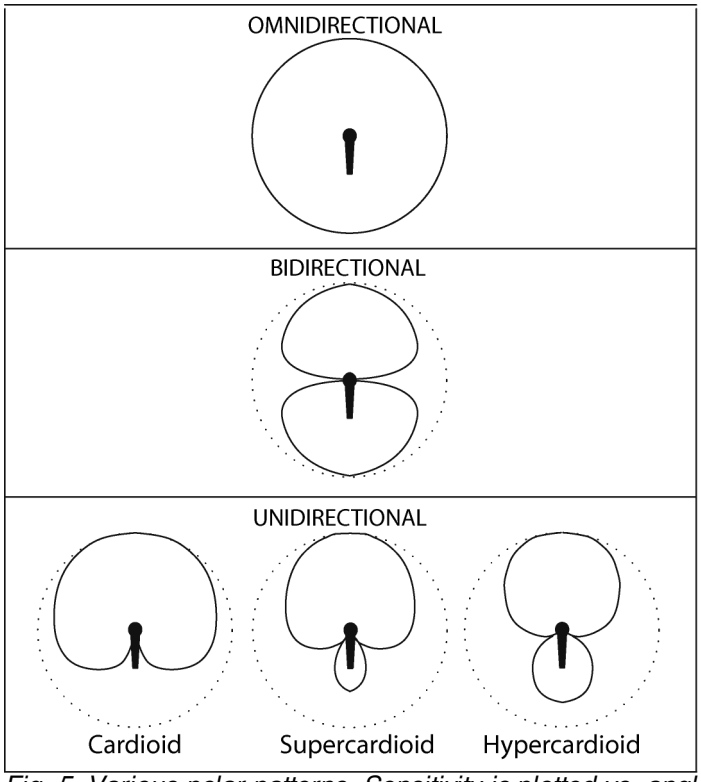


Fig. 5. Various polar patterns. Sensitivity is plotted vs. angle of sound incidence.

To hear how a cardioid pickup pattern works, talk into a cardioid mic from all sides while listening to its output. Your reproduced voice is loudest when you talk into the front of the mic, and softest when you talk into the rear.

The super- and hypercardioid reject sound from the sides more than the cardioid. They are more directional, but they pick up more sound from the rear than the cardioid does.

A microphone's polar pattern is a graph of its sensitivity versus the angle at which sound approaches the mic. The polar pattern is plotted on polar graph paper. Sensitivity is plotted as distance from the origin.

Traits of Each Polar Pattern

Omnidirectional
- All-around pickup
- Most pickup of room reverberation
- Not much isolation unless you mike close
- Low sensitivity to pops (explosive breath sounds)
- Low handling noise
- No up-close bass boost (proximity effect)
- Extended low-frequency response in condenser mics—great for pipe organ or bass drum in an orchestra or symphonic band
- Lower cost in general

Unidirectional (cardioid, supercardioid, hypercardioid)
- Selective pickup
- Rejection of room acoustics, background noise, and leakage
- Good isolation—good separation between tracks
- Up-close bass boost (except in mics that have holes in the handle)
- Better gain-before-feedback in a sound-reinforcement system
- Coincident or near-coincident stereo miking

Cardioid
- Broad-angle pickup of sources in front of the mic
- Maximum rejection of sound approaching the rear of the mic
- Most popular pattern

Supercardioid
- Maximum difference between front hemisphere and rear hemisphere pickup (good for stage-floor miking)
- More isolation than a cardioid
- Less reverb pickup than a cardioid

Hypercardioid
- Maximum side rejection in a unidirectional mic
- Maximum isolation—maximum rejection of reverberation, leakage, feedback, and background noise

Bidirectional
- Front and rear pickup, with side sounds rejected (for across-table interviews or two-part vocal groups, for example)
- Maximum isolation of an orchestral section when miked overhead
- Blumlein stereo miking (two bidirectional mics crossed at 90 degrees)

In a good mic, the polar pattern should be about the same from 200Hz to 10kHz. If not, you'll hear off-axis coloration: the mic will have a different tone quality on and off axis. Small-diaphragm mics tend to have less off-axis coloration than large-diaphragm mics.

You can get either the condenser or dynamic type with any kind of polar pattern (except bidirectional dynamic). Ribbon mics are either bidirectional or hypercardioid. Some condenser mics come with switchable patterns. Note that the shape of a mic does not indicate its polar pattern.

If a mic is **end-addressed**, you aim the end of the mic at the sound source. If a mic is **side-addressed**, you aim the side of the mic at the sound source. Figure 6 shows a typical side-addressed condenser mic with switchable polar patterns.

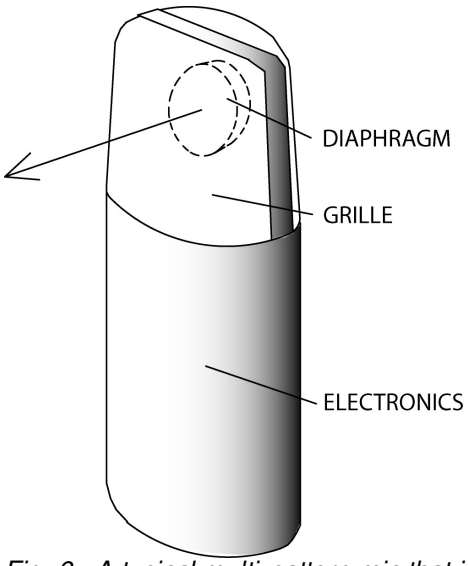


Fig. 6. A typical multi-pattern mic that is side-addressed.

Boundary mics that mount on a surface have a pattern that is half-omni (hemispherical), half-supercardioid, or half-cardioid (like an apple sliced in half through its stem). The boundary mounting makes the mic more directional so it picks up less room acoustics.

FREQUENCY RESPONSE

As with other audio components, a microphone's frequency response is the range of frequencies that it will reproduce at an equal level (within a tolerance, such as ±3dB).

The following is a list of sound sources and the microphone frequency response that is adequate to record the source with high fidelity. A wider range response works, too.

- Most instruments: 80Hz to 15kHz
- Bass instruments: 40Hz to 9kHz
- Brass and voice: 80Hz to 12kHz
- Piano: 40Hz to 12kHz
- Cymbals and some percussion: 300Hz to 15 or 20kHz
- Orchestra or symphonic band: 40Hz to 15kHz

If possible, use a mic with a response that rolls off below the lowest fundamental frequency of the instrument you're recording. For example, the frequency of the low-E string on an acoustic guitar is about 82Hz. A mic used on the acoustic guitar should roll off below that frequency to avoid picking up low-frequency noise such as rumble from trucks and air conditioning. Some mics have a built-in low-cut switch for this purpose. Or you can filter out the unneeded lows at your mixer.

A frequency-response curve is a graph of the mic's output level in dB at various frequencies. The output level at 1kHz is placed at the 0dB line on the graph, and the levels at other frequencies are so many decibels above or below that reference level.

The shape of the response curve suggests how the mic sounds at a certain distance from the sound source. (If the distance is not specified, it's probably 2 to 3 feet.) For example, a mic with a wide, flat response reproduces the fundamental frequencies and harmonics in the same

proportion as the sound source. So a flat-response mic tends to provide accurate, natural reproduction at that distance.

A rising high end or a “presence peak” around 5 to 10kHz sounds more crisp and articulate because it emphasizes the higher harmonics (Figure 7). Sometimes this type of response is called tailored or contoured. It’s popular for guitar amps and drums because it adds punch and emphasizes attack. Some microphones have switches that alter the frequency response.

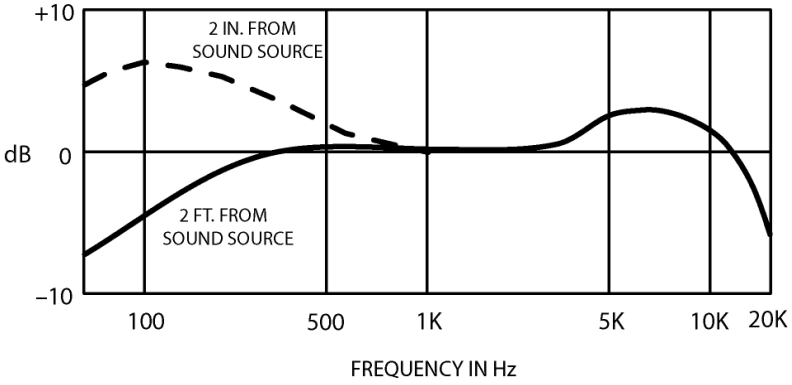


Fig. 7. An example of the frequency response of a microphone with proximity effect and a presence peak around 6kHz.

Most uni- and bidirectional mics boost the bass when used within a few inches of a sound source. You’ve heard how the sound gets bassy when a vocalist sings right into the mic. This low-frequency boost related to close mic placement is called the proximity effect, and it’s often plotted on the frequency-response graph. Omni mics have no proximity effect; they sound tonally the same at any distance.

The warmth created by proximity effect adds a pleasing fullness to drums. In most recording situations, though, the proximity effect lends an unnatural boomy or bassy sound to the instrument or voice picked up by the mic. Some mics—multiple-D or variable-D types—are designed to reduce it. These types have holes or slots in the mic handle. Some mics have a bass-rolloff switch to compensate for the bass boost. Or you can roll off the excess bass with your mixer’s equalizer until the sound is natural. By doing so, you also reduce low-frequency leakage picked up by the microphone.

Note that mic placement can greatly affect the recorded tone quality. A flat-response mic does not always guarantee a natural sound because mic placement has such a strong influence.

IMPEDANCE(Z)
This spec is the mic’s effective output resistance at 1kHz. A mic impedance between 150 and 600ohms is low; 1000 to 4000ohms is medium; and above 25 kilohms is high.

Always use low-impedance mics. If you do, you can run long mic cables without picking up hum or losing high frequencies. The input impedance of a mixer mic input is about 1500 ohms. If it were the same impedance as the mic, about 250 ohms, the mic would “load down” when you plug it in. Loading down a mic makes it lose level, distort, or sound thin. To prevent this, a mic input has an impedance much higher than that of the microphone. But it’s still called a low-Z input.

MAXIMUM SPL

To understand this spec, first we need to understand sound pressure level (SPL). It is a measure of the intensity of a sound. The quietest sound we can hear, the threshold of hearing, is 0 dBSPL. Normal conversation at 1 foot measures about 70 dBSPL; painfully loud sound is above 120 dBSPL.

If the maximum SPL spec is 125 dBSPL, the mic starts to distort when the instrument being miked is putting out 125 dBSPL at the mic. A maximum SPL spec of 120 dB is good, 135 dB is very good, and 150 dB is excellent.

Dynamic and ribbon mics tend not to distort, even with very loud sounds. Some condensers are just as good. Some have a pad you can switch in to prevent distortion in the mic circuitry. Because a mic pad reduces signal-to-noise ratio (S/N), use it only if the mic distorts.

SENSITIVITY

This spec tells how much output voltage a mic produces when driven by a certain SPL. A high-sensitivity mic puts out a stronger signal (higher voltage) than a low-sensitivity mic when both are exposed to an equally loud sound.

A low-sensitivity mic needs more mixer gain than a high-sensitivity mic. More gain usually results in more noise. When you record quiet music at a distance (classical guitar, string quartet), use a mic of high sensitivity to override mixer noise. When you record loud music or mike close, sensitivity matters little because the mic signal level is well above the mixer noise floor. That is, the S/N is high. Listed below are typical sensitivity specs for three transducer types:

- Condenser: 5.6mV/Pa (high sensitivity)
- Dynamic: 1.8mV/Pa (medium sensitivity)
- Ribbon or small dynamic: 1.1mV/Pa (low sensitivity)

The louder the sound source, the higher the signal voltage the mic puts out. A very loud instrument, such as a kick drum or guitar amp, can cause a microphone to generate a signal strong enough to overload the mic preamp in your mixer. That's why most mixers have pads or input-gain controls—to prevent preamp overload from hot mic signals.

SELF-NOISE

Self-noise or equivalent noise level is the electrical noise or hiss a mic produces. It's the dBSPL of a sound source that would produce the same output voltage that the noise does.
Usually the self-noise spec is A-weighted. That means the noise was measured through a filter that makes the measurement correlate more closely with the annoyance value. The filter rolls off low and high frequencies to simulate the frequency response of the ear.

An A-weighted self-noise spec of 14dBSPL or less is excellent (quiet); 21dB is very good, 28dB is good; and 35dB is fair—not good enough for quality recording.

Because a dynamic mic has no active electronics to generate noise, it has very low self-noise (hiss). So most spec sheets for dynamic mics do not specify self-noise.

SIGNAL-TO-NOISE RATIO

This is the difference in decibels between 94 dB and the mic's self-noise. The higher the SPL of the sound source at the mic, the higher the S/N. Given an SPL of 94dB, an S/N spec of 74dB is excellent; 64dB is good. The higher the S/N ratio, the cleaner (more noise-free) the signal, and the greater the "reach" of the microphone.

Reach is the clear pickup of quiet, distant sounds due to high S/N. Reach is not specified in data sheets because any mic can pick up a source at any distance if the source is loud enough. For example, even a cheap mic can reach several miles if the sound source is a thunderclap

POLARITY only if you're making cables

The polarity spec relates the polarity of the electrical output signal to the acoustic input signal. The standard is "pin 2 hot." That is, the mic produces a positive voltage at pin 2 with respect to pin 3 when the sound pressure pushes the diaphragm in (positive pressure).

Be sure that your mic cables do not reverse polarity. On both ends of each cable, the wiring should be pin 1 shield, pin 2 red, pin 3 white or black. Or the wiring on both ends should be pin 1 shield, pin 2 white, pin 3 black. If some mic cables are correct polarity and some are reversed, and you mix their mics to mono, the bass may cancel.

MICROPHONE TYPES

The following sections describe several types of recording mics.

Large-Diaphragm Condenser Microphone (LDC)

This is a condenser microphone, usually side-addressed, with a diaphragm 1 inch or larger in diameter (Figure 6). It generally has very good low-frequency response and low self-noise. Common uses are studio vocals and acoustic instruments.

Examples: AKG C12VR, C414, Perception 100 and 200, C2000B and C3000B; Audio-Technica AT2020/3035/4040, Audix SCX25, Blue Blueberry, CAD Equitek Series and M177, DPA 4041, Lawson L47MP MKII and L251, Manley Gold Reference, Neumann U87, U47 and TLM 103; Soundelux Elux 251, Sterling Audio ST51. ADK various models, SE Electronics various models, Shure KSM Series, MXL V67G, V69, 900, 2001, 2003 and 2006; Rode NT1A, Studio Projects B and C Series, Samson CL7 and C01, Nady SCM 950 and 100, Violet Flamingo, M-Audio Solaris, Sputnik, Luna and Nova; and Behringer B1 and B2.

Small-Diaphragm Condenser Microphone (SDC)

This is a stick-shaped or "pencil" condenser microphone, usually cardioid and end-addressed, with a diaphragm under 1 inch in diameter (Figure 4). It generally has very good transient response and detail, making it a fine choice for close miking acoustic instruments—especially cymbals, acoustic guitar, and piano.

Examples: AKG C 451 B; Audio-Technica AT 3031 and AT 4051a; Audix SCX1, ADX50, and ADX51; Berliner CM-33, CAD Equitek e60; M-Audio Pulsar; Samson C02; Crown CM-700; DPA 4006; Mojave MA-100, Neumann KM 184; Sennheiser e614 and MKH50; Shure KSM109/SL, KSM137/Sl and SM81; MXL 600 and 603S; Behringer B5 with cardioid capsule; and Studio Projects C4.

Dynamic Instrument Microphone

This is a stick-shaped dynamic microphone, end-addressed (Figure 4). Although it may have a flat response, it generally has a presence peak and some low-frequency rolloff to prevent boominess when used up close. It's often used on drums and guitar amps.

Examples: Shure SM57, AKG D112 (kick drum), Audio-Technica AT AE2500 (kick), Electro-Voice N/D868 (kick), Heil PR40 (kick), Audix D1 through D6 and I-5, and Sennheiser MD421, e604 and e602 (kick).

Live-Vocal Microphone

This unidirectional mic is shaped like an ice-cream cone because of its large grille used to reduce breath pops. It can be a condenser, dynamic, or ribbon type, and it usually has a presence peak and some low-frequency rolloff.

Examples: Shure SM58, Beta 58A, SM85, SM86, SM87A and KSM9; AKG D3800, C 535 EB, C5, ELLE C, and D 5/D 5 S; Audix OM5 and OM7, Beyerdynamic M88 TG and TG V70d; EV N-Dym Series, Sennheiser e945; and Neumann KMS104 and KMS105.

Ribbon Microphone
This mic can be side- or end-addressed. It generally is used wherever you want a warm, smooth tone quality (sometimes with reduced highs). Examples: models by Beyerdynamic, Coles, Royer, Cascade, Blue and AEA.

Boundary Microphone
Boundary mics are designed to be used on surfaces. Tape them to the underside of a piano lid, or tape them to the wall for pickup of room ambience. They can be used on hard baffles between instruments, or on panels to make the mics directional.

A boundary mic uses a mini condenser mic capsule mounted very near a sound-reflecting plate or boundary (Figure 8). Because of this construction, the mic picks up direct sound and reflected sound at the same time, in-phase at all frequencies. So you get a smooth response free of phase cancellations. A conventional mic near a surface sounds colored; a boundary mic on a surface sounds natural. Other benefits are a wide, smooth frequency response free of phase cancellations, excellent clarity and reach, and the same tone quality anywhere around the mic.

Examples of half-omnidirectional or hemispherical boundary mics: AKG C 562 BL, Audio-Technica AT 841a, Beyerdynamic MPC 22, Crown PZM-30D and PZM-6D, and Shure Beta 91.

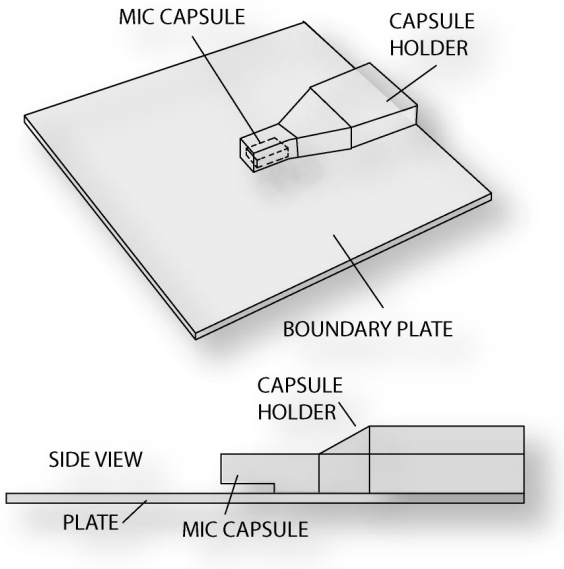


Fig. 8. Typical PZM construction.

Some boundary mics have a half-cardioid or half-supercardioid polar pattern. They work great on a conference table, or near the front edge of a stage floor to pick up drama or musicals. Examples: Crown PCC-170; Bartlett Microphones TM-125, TM-125C and TM-125HP.

Miniature Microphone
Mini condenser mics can be attached to drum rims, flutes, horns, acoustic guitars, fiddles, and so on. Their tone quality is about as good as larger studio microphones and the price is relatively low. With these tiny units you can mike a band in concert without cluttering the stage with boom stands (Figure 9), and the performers have freedom of movement on stage. Compared to large mics, mini mics tend to have more noise (hiss) in distant-miking applications, but noise is not a problem when close miking. A lavalier mic is a mini mic worn on the chest to pick up speech from a newscaster or a wandering lecturer.

Examples: AKG Micro Mic Series; Bartlett Spark Mini Mic, Guitar Mic and Fiddle Mic; Shure Beta 98S, Audix M1245 and Micro-D, Countryman Isomax B6, DPA 4060, and Sennheiser e608.

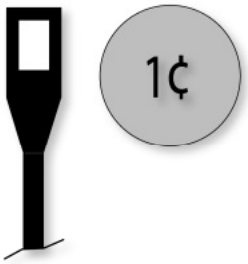


Fig. 9. A mini mic is the size of a penny.

Stereo Microphone

A stereo microphone combines two directional mic capsules in a single housing for convenient stereo recording (Figure 10). Simply place the mic a suitable distance and height from the sound source, and you'll get a stereo recording with little fuss. Examples: AKG C426 B Comb, Audio-Technica AT825 and AT822, Neumann SM69, Shure VP88, Nady RSM-2, AEA R88, and Royer SF-12.

Fig. 10. Audio-Technica AT825, an example of a stereo microphone.

Because there is no spacing between the mic capsules, there also is no delay or phase shift between their signals. Coincident stereo microphones are mono-compatible—the frequency response is the same in mono and stereo—because there are no phase cancellations if the two channels are combined.

Digital Microphone

This condenser microphone has a built-in analog-to-digital converter. It is usually side-addressed, has a large diaphragm, has a flat response, and very low self-noise. Its output is a digital signal, which is immune to picking up hum. Examples: Beyerdynamic MCD 100 and Neumann Solution-D.

Headworn Microphone

This microphone is used for a live performance which might be recorded. It is a small condenser mic worn on the head, either omni- or unidirectional. The headworn mic allows the performer freedom of movement on stage. Some models provide excellent gain before feedback and

isolation. Examples: AKG C 420, Audio-Technica BP892 MicroSet, Samson SE50, AKG C 520, Sennheiser ME 3-EW, Shure WBH53, Rode HS1-P, Countryman Isomax E6, Crown CM-311A, and DPA 4066F/4088F.

MICROPHONE SELECTION

Table 1 is a guide to choosing a mic based on your requirements.

TABLE 1 Mic Application Guide

Requirement	Characteristic
Natural, smooth tone quality	Flat frequency response
Bright, present tone quality	Presence peak (emphasis around 5 kHz)
Extended lows	Omni condenser or dynamic with good low-frequency response
Extended highs (detailed sound)	Condenser
Reduced "edge" or detail	Dynamic or ribbon
Boosted bass up close	Directional mic
Flat bass response up close	Omni mic, or directional mic with sound holes in the handle
Reduced pickup of leakage, feedback, and room acoustics	Directional mics
Enhanced pickup of room acoustics	Omni mics
Miking close to a surface, or uniform coverage of moving sources or large sources, or inconspicuous mic	Boundary mic
Coincident or near-coincident stereo miking	Stereo mic or matched pair of directional mics
Extra ruggedness	Dynamic mic
Reduced handling noise	Omni mic, or unidirectional mic with shock mount
Reduced breath popping	Omni mic, or unidirectional mic with pop filter
Distortion-free pickup of very loud sounds	Condenser with high maximum SPL spec, or dynamic or ribbon
Low self-noise, high sensitivity, noise-free pickup of quiet sounds	Large-diaphragm condenser mic

Suppose you want to record a grand piano playing with several other instruments. You need the microphone to reduce leakage. Table 1 recommends a unidirectional mic or an omni mic up close. For this particular piano, you also want a natural sound, for which the table suggests a mic with a flat response. You want a detailed sound, so a condenser mic is the choice. A microphone with all these characteristics is a flat-response, unidirectional condenser mic. If you're miking close to a surface (the piano lid), a boundary mic is recommended.

Now suppose you're recording an acoustic guitar on stage, and the guitarist roams around. This is a moving sound source, for which the table recommends a mini mic attached to the guitar. Feedback and leakage might not be a problem because you're miking close, so you can use an omni mic. Thus, an omni condenser mic is a good choice for this application.

For a home studio, a suggested first choice is a cardioid condenser mic with a flat frequency response. This type of mic is especially good for studio vocals, cymbals, percussion, and acoustic instruments. Remember that the mic needs a power supply to operate, such as a battery or phantom power supply.

Your second choice of microphone for a home studio is a cardioid dynamic microphone with a presence peak in the frequency response. This type is good for drums and guitar amps. I recommend cardioid over omni for a home studio. The cardioid pattern rejects the leakage, background noise, and room reverb often found in home studios. An omni mic, however, can do that, too, if you mike close enough. Also, omni mics tend to provide a more natural sound at lower cost, and they have no proximity effect.

MIC ACCESSORIES

There are many devices used with microphones to route their signals or to make them more useful. These include pop filters, stands and booms, shock mounts, cables and connectors, stage boxes and snakes, and splitters.

Pop Filter

A much needed accessory for a vocalist's microphone is a pop filter or windscreen. It usually is a foam "sock" that you put over the mic. Some microphones have pop filters or ball-shaped grilles built in.

Why is it needed? When a vocalist sings a word starting with "p," "b," or "t" sounds, a turbulent puff of air is forced from the mouth. A microphone placed close to the mouth is hit by this air puff, resulting in a thump or little explosion called a pop. The windscreen reduces this problem.

The best type of pop filter is a nylon screen in a hoop, or a perforated-metal disk, placed a few inches from the mic.

You can also reduce pop by placing the mic above or to the side of the mouth, or by using an omni mic.

Stands and Booms

Stands and booms hold the microphones and let you position them as desired. A mic stand has a heavy metal base that supports a vertical pipe. At the top of the pipe is a rotating clutch that lets you adjust the height of a smaller telescoping pipe inside the large one. The top of the small pipe has a standard 5/8-inch 27 thread, which screws into a mic stand adapter.

A boom is a long horizontal pipe that attaches to the vertical pipe. The angle and length of the boom are adjustable. The end of the boom is threaded to accept a mic stand adapter, and the opposite end is weighted to balance the weight of the microphone.

Shock Mount

A shock mount holds a mic in a resilient suspension to isolate the mic from mechanical vibrations, such as floor thumps and mic-stand bumps. Many mics have an internal shock mount which isolates the mic capsule from its housing; this reduces handling noise as well as stand thumps.

Cables and Connectors

Mic cables carry the electrical signal from the mic to the mixing console, mic preamp, or recorder. With low-impedance mics, you can use hundreds of feet of cable without hum pickup or high-frequency loss. Some mics have a permanently attached cable for convenience and low cost; others have a connector in the handle to accept a separate mic cable. The second method is preferred for serious recording because if the cable breaks, you have to repair or replace only the cable, not the whole microphone.

Mic cables are made of one or two insulated conductors surrounded by a fine-wire mesh shield to keep out electrostatic hum. If you hear a loud buzz when you plug in a microphone, check that the shield is securely soldered in place. A female XLR connector is on one end; a male XLR is on the other.

Here are the solder connections inside the XLR connector:
Pin 1: Shield
Pin 2: “Hot” or “in-polarity” lead (usually red or white)
Pin 3: “Cold” or “out-of-polarity” lead (usually black)

If the mic output is a 3-pin XLR, but your recorder or mixer mic input is an unbalanced phone jack, a different wiring is needed:
Phone-plug tip (the short terminal): Hot lead
Phone-plug sleeve (the long terminal): Shield and cold lead

Wind your mic cables onto a large spool, which can be found in the electrical section of hardware stores. Plug the cables together as you wind them.

Snake
It is messy and time-consuming to run mic cables from several mics all the way to a mixer. Instead, you can plug all your mics into a stage box with several connectors (Figure 11). The snake—a thick multi-conductor cable—carries the signals to the mixer. At the mixer end, the cable divides into several mic connectors that plug into the mixer.

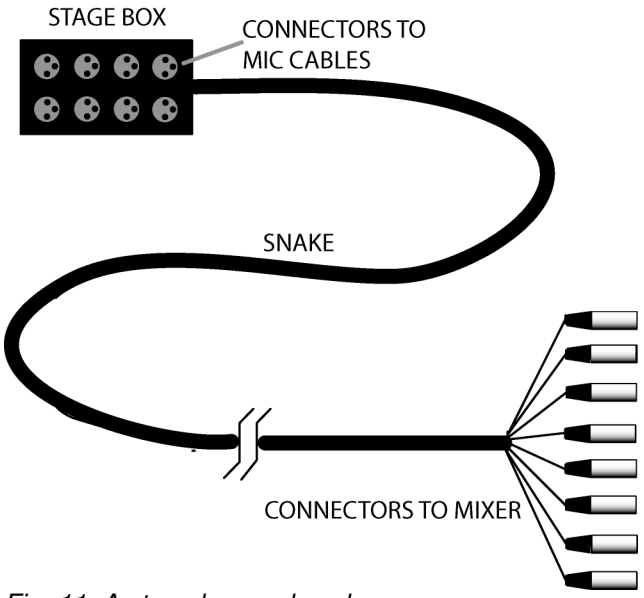


Fig. 11. A stage box and snake.

Splitter
When you record a band in concert, you might want to feed each mic’s signal to your recording mixer and to the band’s PA and monitor mixers. A mic splitter does the job. For each microphone channel, it has one XLR input for a microphone, a “direct” XLR output wired to the input, and one or more transformer-isolated XLR outputs with a ground-lift switch. The mixer that provides phantom power must be connected to the direct XLR output.

SUMMARY
We talked about some mic types, specs, and accessories. You should have a better idea about what kind of microphone to choose for your own applications.

Mic manufacturers are happy to send you free catalogs and application notes, which are also available on mic company websites. Mic dealers also may have this literature.

Remember, you can use any microphone on any instrument if it sounds good to you. Just try it and see if you like it. To make high-quality recordings, though, you need good mics with a smooth, wide-range frequency response, low noise, and low distortion.

# # #

Bartlett Microphones Stages Mic Shootout at Notre Dame's DeBartolo Center

Notre Dame, IN (Sept. 15, 2009): Engineers from Bartlett Microphones recently ran a live comparison between their TM-125 stage-floor microphone and the well-regarded PCC(R)-160, a mic they designed several years ago for Crown. The setting for the shootout was the DeBartolo Performing Arts Center at the University of Notre Dame.

Owner/engineer Bruce Bartlett said, "We chose the Center's concert hall for our tests because it has a state-of-the-art sound system and acoustics, and it's a very quiet venue."

With help from the Center's Audio Engineer Joshua Ingle, they listened to the sound of three variations of the TM-125 mic and a PCC-160 over the house sound system reproducing a person speaking. Tests were run for tonal balance, pickup angle, off-axis coloration and noise floor.

According to Ingle, the TM-125 matched the PCC-160 in gain-before-feedback. "The TM-125 also has a little more presence and more rear rejection", he noted.

Bartlett said, "It's essential to test mics in the real world. We learned a lot from this experiment. For example, the mic should be voiced to sound good when mixed with the live sound from the actors. A microphone with a flat response might look good on paper, but it sounds dull in this situation when combined with the actors' voices coming off the stage. It's better if the mic emphasizes the highs and rolls off the lows in this application."

All the mics picked up over a broad angle in front -- about +/- 50 degrees -- and dropped off rapidly beyond that. Bartlett demonstrated how lifting the mic off the stage floor made no change in pickup of floor thumps, proving that the mic is insensitive to mechanical vibrations. No hiss was audible from any of the microphones.

The company's web site, www.bartlettmics.com, offers free articles and a newsletter, plus detailed specifications of the TM-125 series of stage-floor microphones.

PCC is a registered trademark of Crown International.