

AUDIO ENGINEERING

BEGINNER TO PRO

KUSHAL PATIL

Modules 1-6

<p><i>Understanding Sound</i></p> <p>Theoretical knowledge on sound and its characteristics, room acoustics, acoustic treatment, building DIY panels.</p>	<p><i>Audio Equipments</i></p> <p>Microphones, Audio interfaces, ADC and DAC, Cables and Connections, Input-output channels, Studio monitors, MIDI, Mixers, Analog gear, DAWs, etc.</p>	<p><i>Recording (Video lesson)</i></p> <p>Gain staging, Arranging, Sample-rate and Bit-depth, Vocal recording, Instrument recording, voice-over, recording audio for films, etc.</p>
<p><i>Mixing/Mastering (Video lesson)</i></p> <p>Setting up a mix session, Comping, EQ, Compression, Side-Chaining, De-essing, Pitch-correction, Automation, Panning, Saturation, Reverb and Delay, Buses, Artificial Harmonies, Dolby Atmos, etc.</p>	<p><i>Foley (Video lesson)</i></p> <p>Creating custom sound effects like rain, footsteps, fire, gunshots and more for films using simple tools in the studio.</p>	<p><i>Music Business (Video lesson)</i></p> <p>Releasing a song, Distribution, Streaming platforms, Record labels, Networking, Managing clients in the studio and more.</p>

Modules 1 and 2 are theoretical whereas modules 3 to 6 are video based*

Important Terms-

1. **Inverse square law-** When the distance to the sound source doubles, the level will decrease by 6dB.
2. **Sample rate-** The number of samples of audio recorded every second. Unit is kHz.
3. **Bit-depth-** the number of bits of information in each sample.
4. **Analog to Digital converter (ADC)-** takes an analog signal and converts it into a binary one.
5. **Digital to Analog converter (DAC)-** converts a binary signal into an analog value.
6. **Phantom Power-** process of delivering DC (Direct Current) to microphones requiring electric power to drive active circuitry. Usually 48V.
7. **Polar Pattern-** the sensitivity of any given microphone to sounds arriving from different angles.
8. **Proximity Effect-** leads to an increase in low frequency response as you move the mic closer to the source.
9. **Preamp-** an electronic amplifier that converts a weak electrical signal into an output signal strong enough to be noise-tolerant and strong enough for further processing.
10. **MIDI-** in full, Musical Instrument Digital Interface, technology standard allowing electronic musical instruments to

communicate with one another and with computers. The instruments may also be virtual software packages residing on a personal computer.

11. **Audio Interface-** An audio interface is a piece of computer hardware that allows the input and output of audio signals to and from a host computer or recording device.
12. **DAWs-** A digital audio workstation (DAW) is an **electronic device or application software used for recording, editing and producing audio files.** ... Regardless of configuration, modern DAWs have a central interface that allows the user to alter and mix multiple recordings and tracks into a final produced piece.
13. **Track-** A single stream of recorded sound.
14. **Mono-** Mono or monophonic audio describes a mix in which all sounds are mixed together into a single channel.
15. **Stereo-** Stereo (or Stereophonic sound) is **the reproduction of sound using two or more independent audio channels** in a way that creates the impression of sound heard from various directions, as in natural hearing.
16. **Tempo-** Tempo can be defined as the pace or speed at which a section of music is played.
17. **Longitudinal waves-** waves in which the vibration of the medium is parallel to the direction the wave travels and

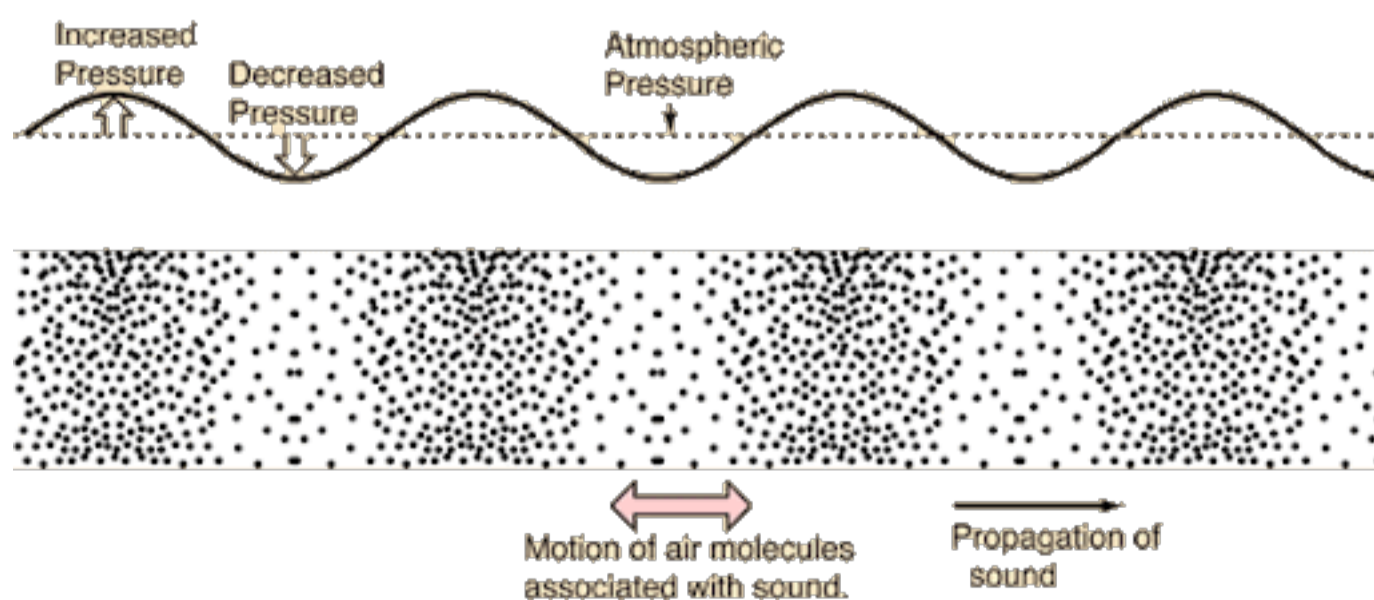
displacement of the medium is in the same (or opposite) direction of the wave propagation.

18. **Compression**- a region in a longitudinal (sound) wave where the particles are closest together.
19. **Rarefaction**- a region in a longitudinal (sound) wave where the particles are furthest apart.

MODULE 1 - UNDERSTANDING SOUND

What is Sound?- Sound is defined as vibrations that travel through the air or another medium as an audible mechanical wave. It is produced from a vibrating body. The vibrating body causes the medium (water, air, etc.) around it to vibrate thus producing sound. Sound waves are **Longitudinal Waves**.

Longitudinal waves- waves in which the vibration of the medium is parallel to the direction the wave travels and displacement of the medium is in the same (or opposite) direction of the wave propagation.

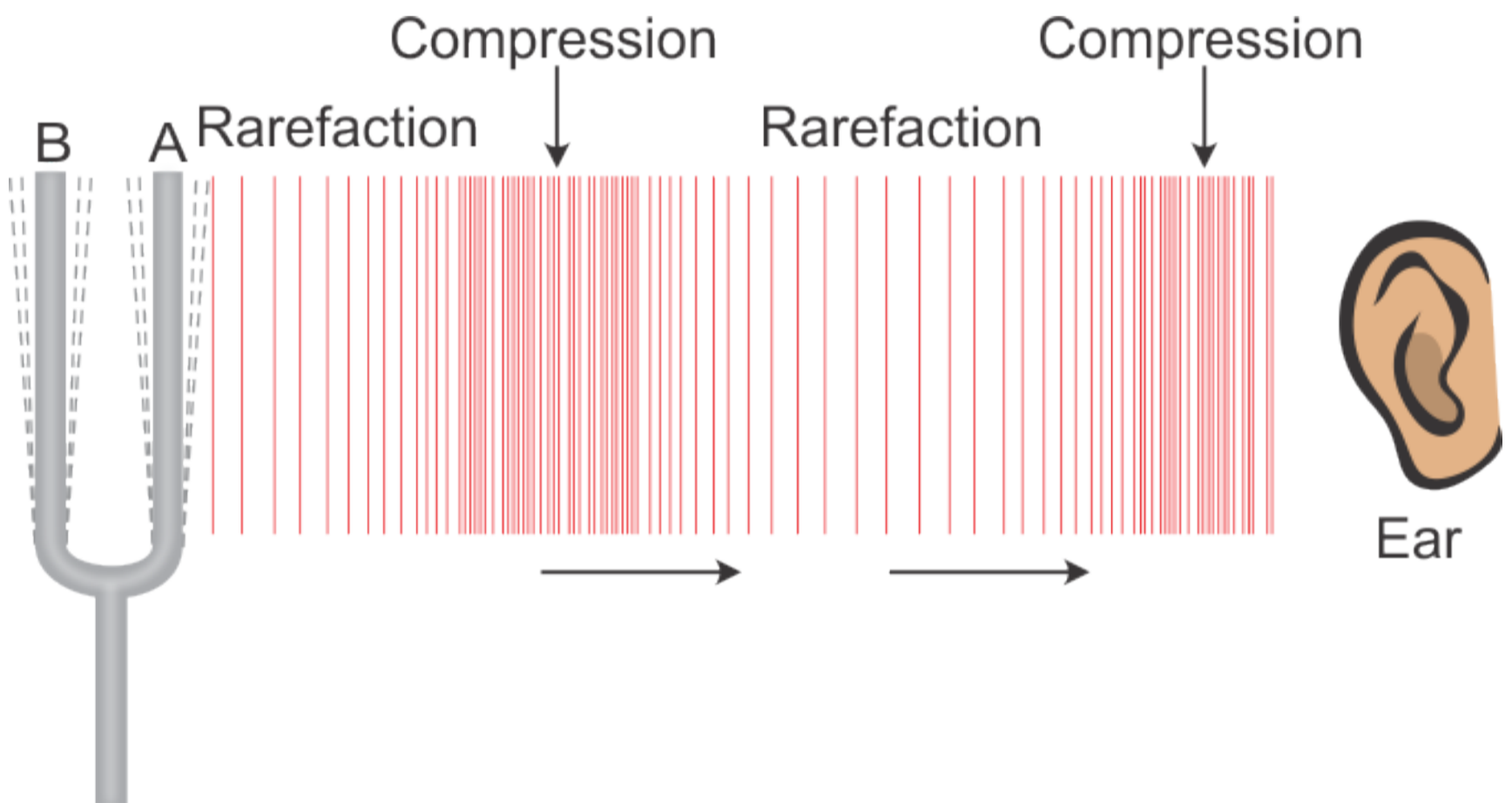


A diagram explaining a Longitudinal wave.

A wave is caused by,

Compression- a region in a longitudinal (sound) wave where the particles are closest together.

Rarefaction- a region in a longitudinal (sound) wave where the particles are furthest apart.



A diagram explaining how a longitudinal wave travels from the sound source to the human ear.

HOW DOES SOUND ACT IN A CLOSED ROOM/STUDIO SPACE?

Room Reflections-

Reflections from your room walls, ceiling, and floor will produce energy that moves around the room bouncing off every surface that it touches.

If a sound is not absorbed or transmitted when it strikes a surface, it will be reflected. Sound reflection gives rise to **Diffusion, Reverberation and Echo.**

Early Reflections-

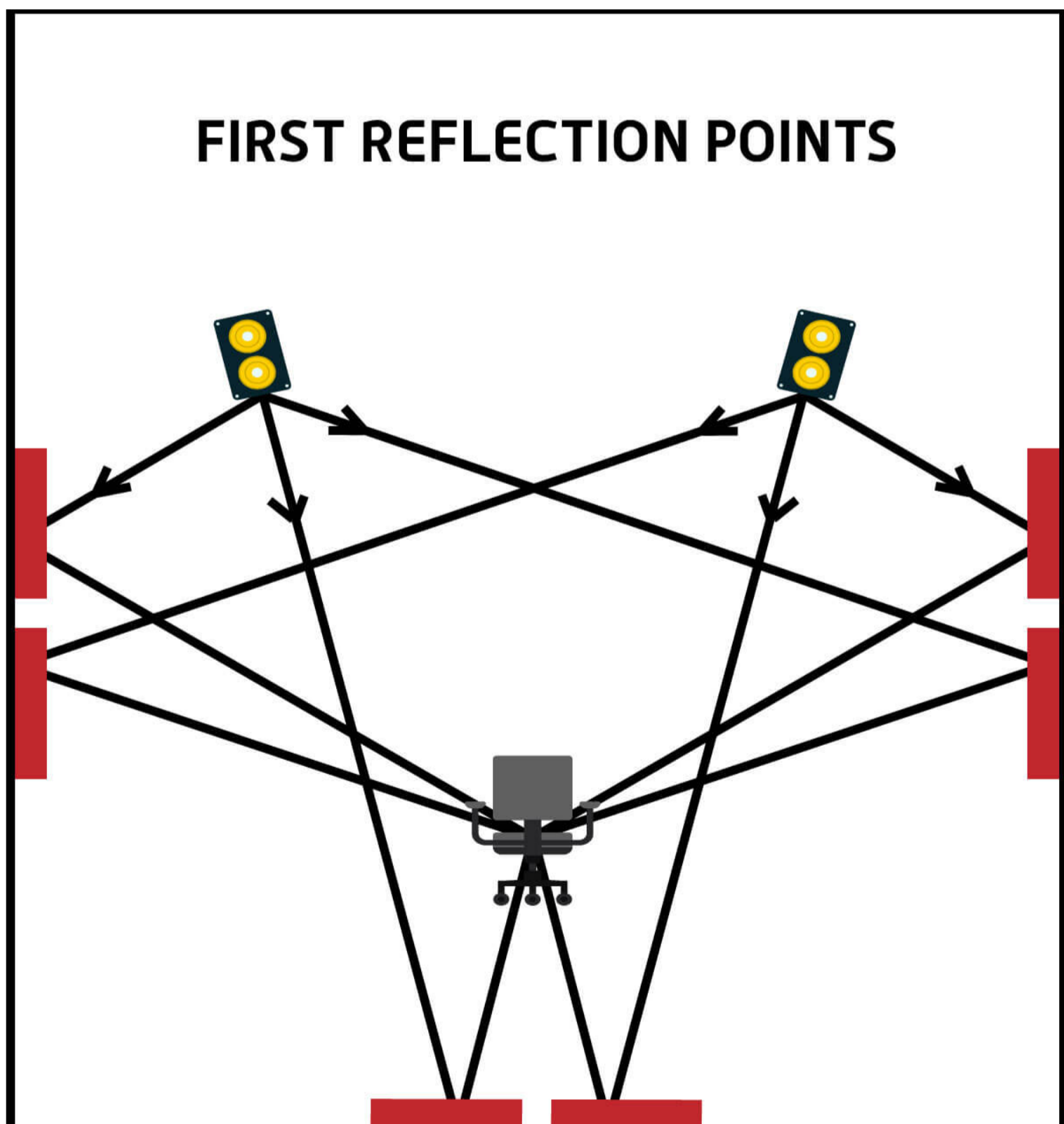
Early reflections are the echoes of a signal that arrive at the microphone within a stretch of about 30ms after the direct sound. Early reflections are direct copies of the direct sound source, rather than diffuse mixtures as are present in the late reflections, or reverberation, or a sound source.

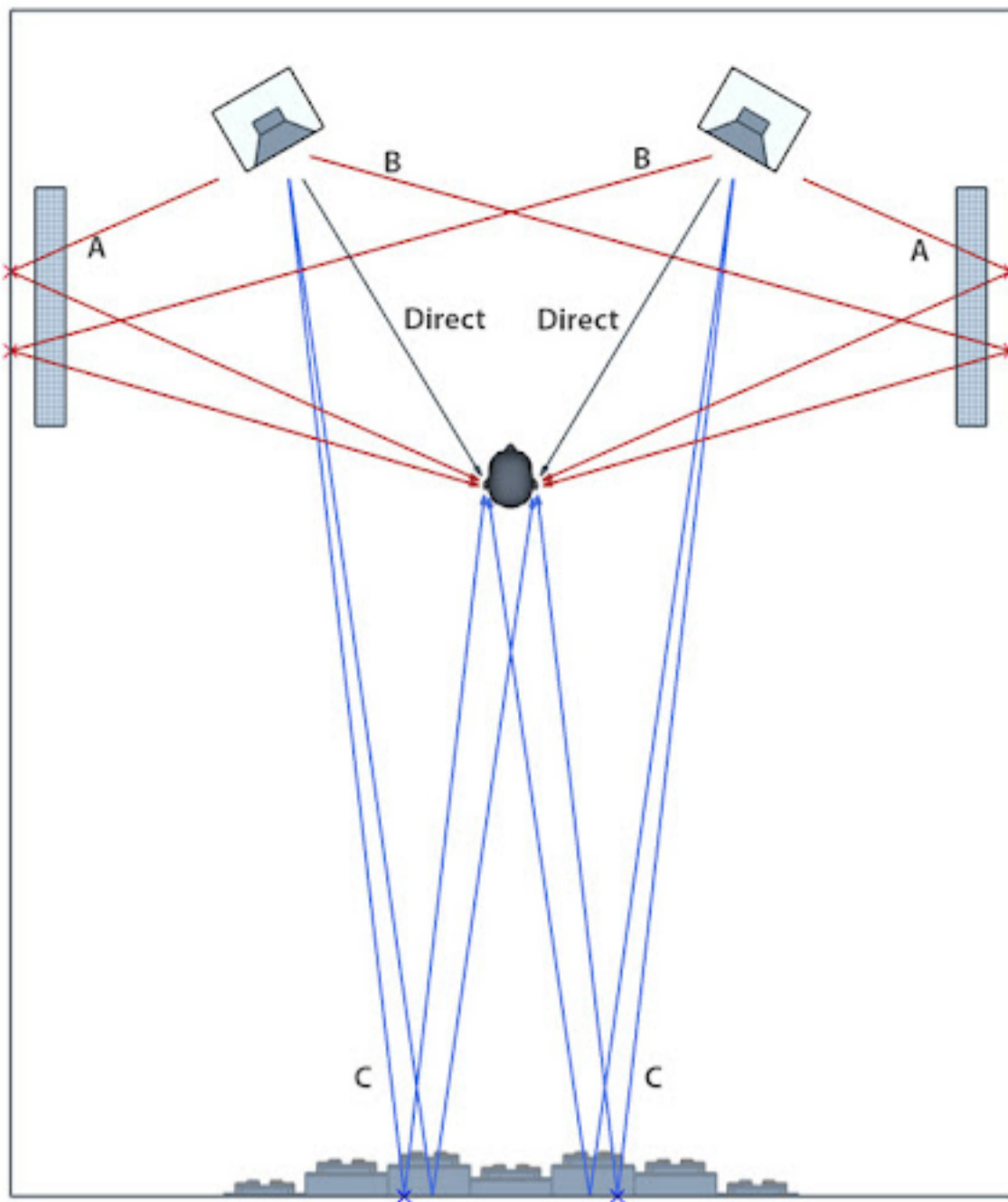
Late Reflections-

Every reflection that we hear later than ~ 50 ms after the direct signal is added to what we typically call reverberation (also known as decay, diffuse sound or reverb tail).

HOW TO GET RID OF THESE REFLECTIONS?

You can get rid of the room echos by acoustically treating your room. A room can be treated by placing high sound absorption panels or diffusers which are made up of foam, rock wool, wood and other materials at the first reflection points of the room.





A diagram showing a reflection free zone treating both early and late reflections coming from the source.

ACOUSTIC PANELS

Rock wool Panels- Rock wool Sound Insulation is made from stone, with a non-directional fibre orientation and a higher density, which means it traps sound waves and dampens vibration.

Foam Panels- Acoustic foams are cut in tiles with different profiles such as egg, pyramid, wedge, and square shapes depending on the application. They work not only to absorb sounds, but also to enhance the quality of sound and speech in a room.

Diffusers- These devices reduce the intensity of sound by scattering it over an expanded area, rather than eliminating the sound reflections as an absorber would.



An example of how ROCK WOOL panels are used to treat a room.



An example of how FOAM panels are used to treat a room.



A wooden DIFFUSER used to treat the rear walls.



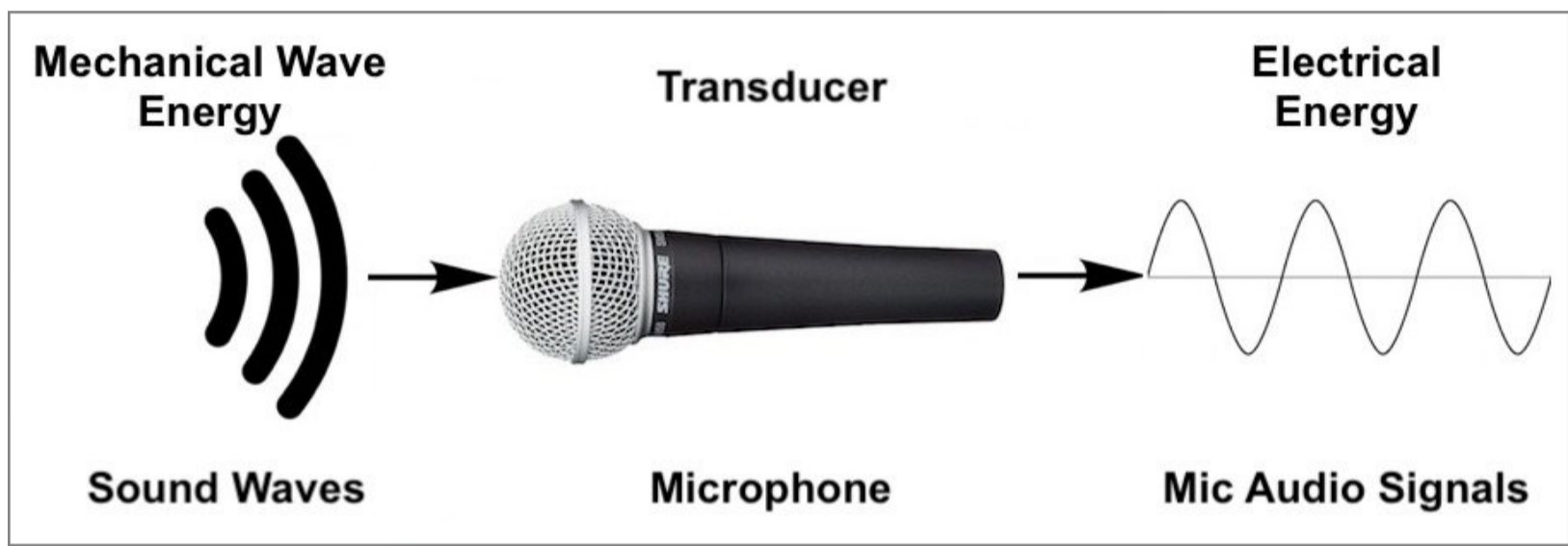
A studio with a combination of both diffusers and foam

A good recording studio always implements all kinds of acoustic treatment to enhance the audio quality in the room.

MODULE 2-AUDIO EQUIPMENT

THE MICROPHONE

A microphone is a device that captures audio by converting sound waves into an electrical signal.



An image describing the working of a microphone

There are 2 main categories in microphones.

1. **Condenser Microphones-** Condenser mics get their name from the “capacitor” inside that converts acoustic energy into an electrical signal (“condenser” is an old term for “capacitor”). The capacitor in a studio condenser microphone consists of two metal-surfaced plates suspended in very close proximity to each other with a voltage across them.

Characteristics of Condenser microphones-

1. Delicate and accurate
2. Often offers less coloration
3. Phantom power necessary (48V)
4. Do not have to be very close to get an intimate sound
5. Widely used in studios to record vocals



Large Diaphragm mic



Small Diaphragm mic

2. Dynamic Microphones- The microphones that convert sound into an electrical signal by means of electromagnetism. They fall into two categories, moving coil and ribbon microphones.

Characteristics of Dynamic Microphones-

1. Simple construction, economical
2. Rugged, resistant to hand noise
3. Require no batteries or power supply
4. Commonly used in performances



Moving coil microphone

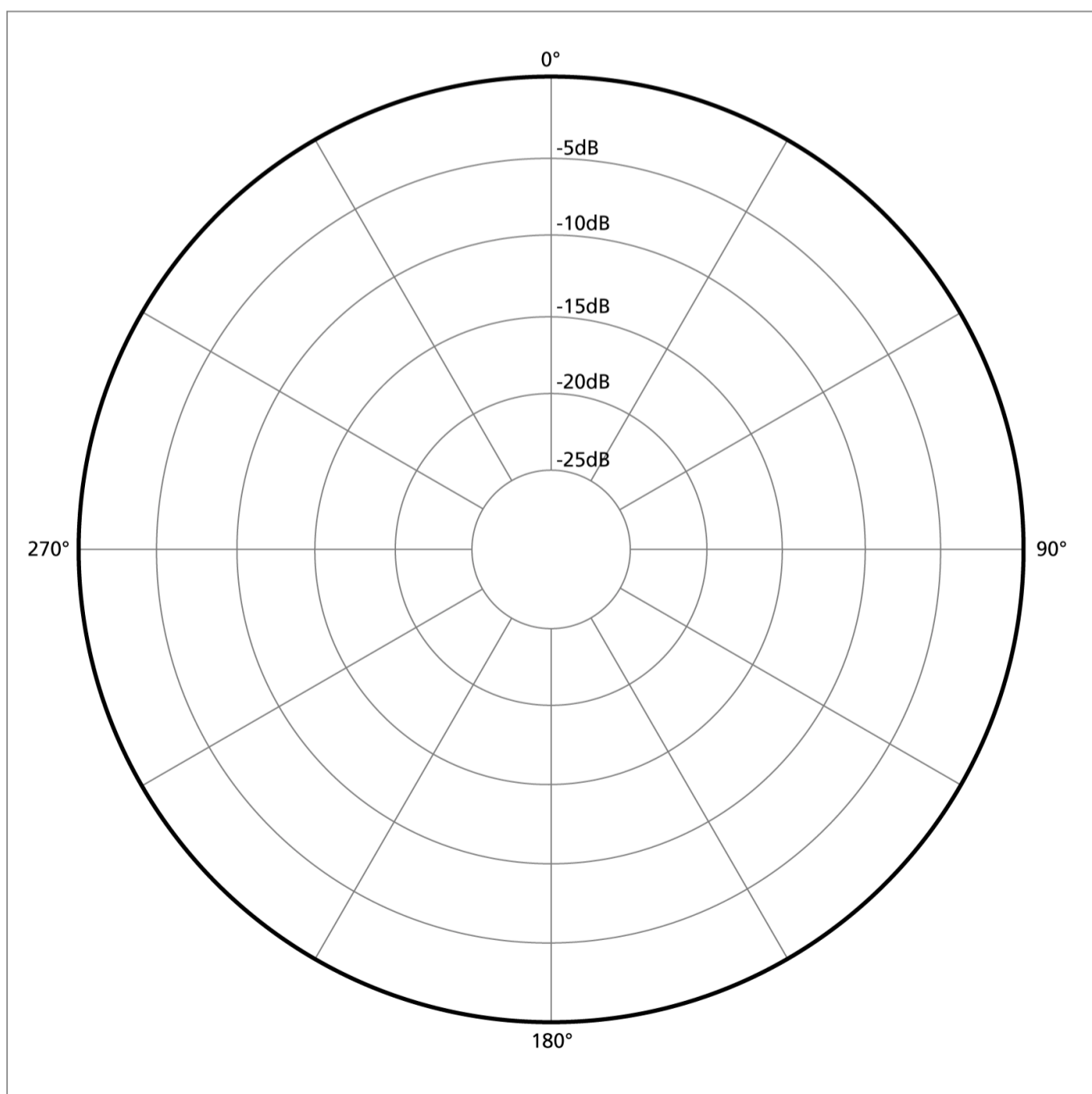


Ribbon microphone

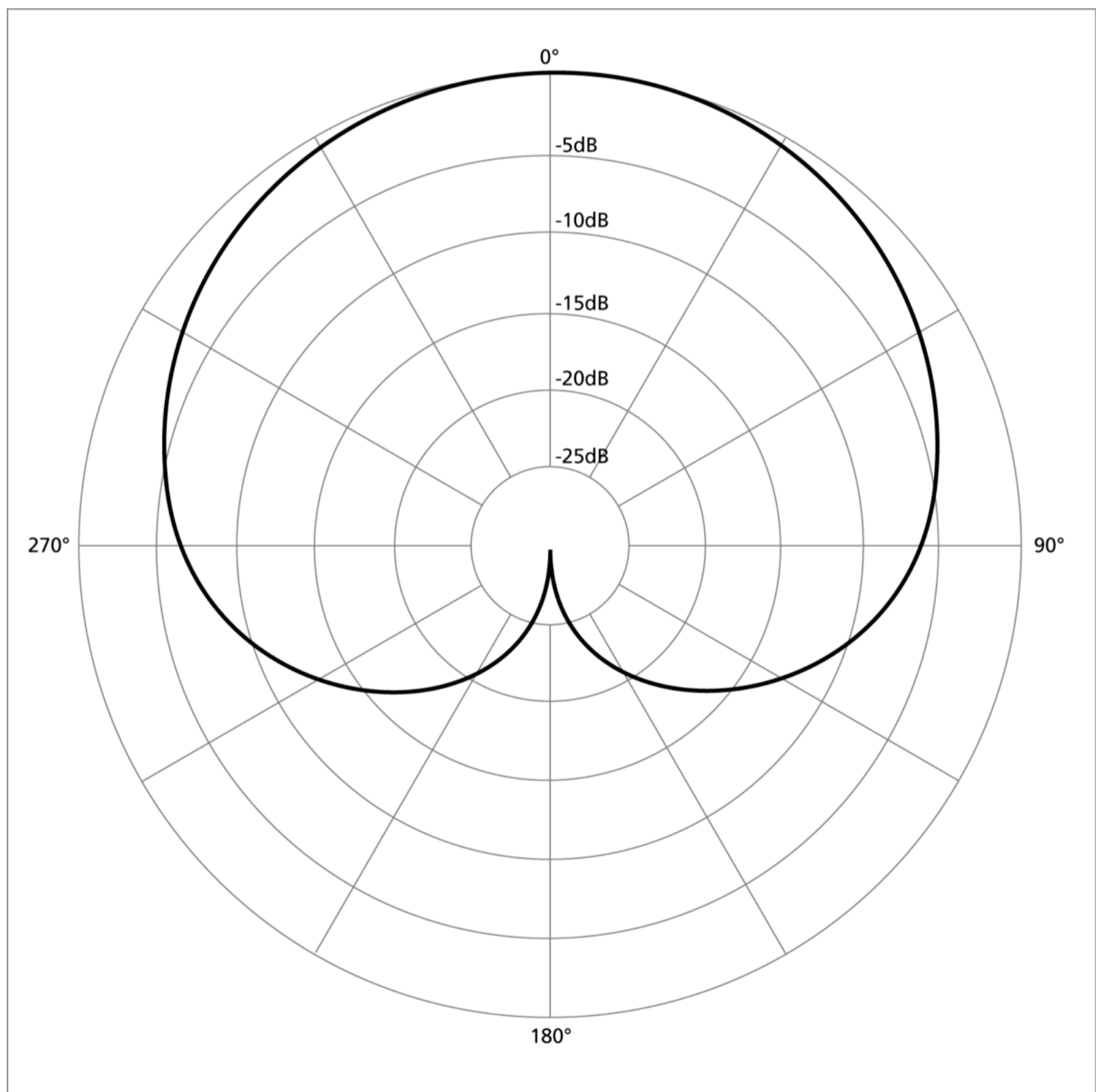
POLAR PATTERNS

Different microphones have different polar patterns. There are 6 main types of polar patterns.

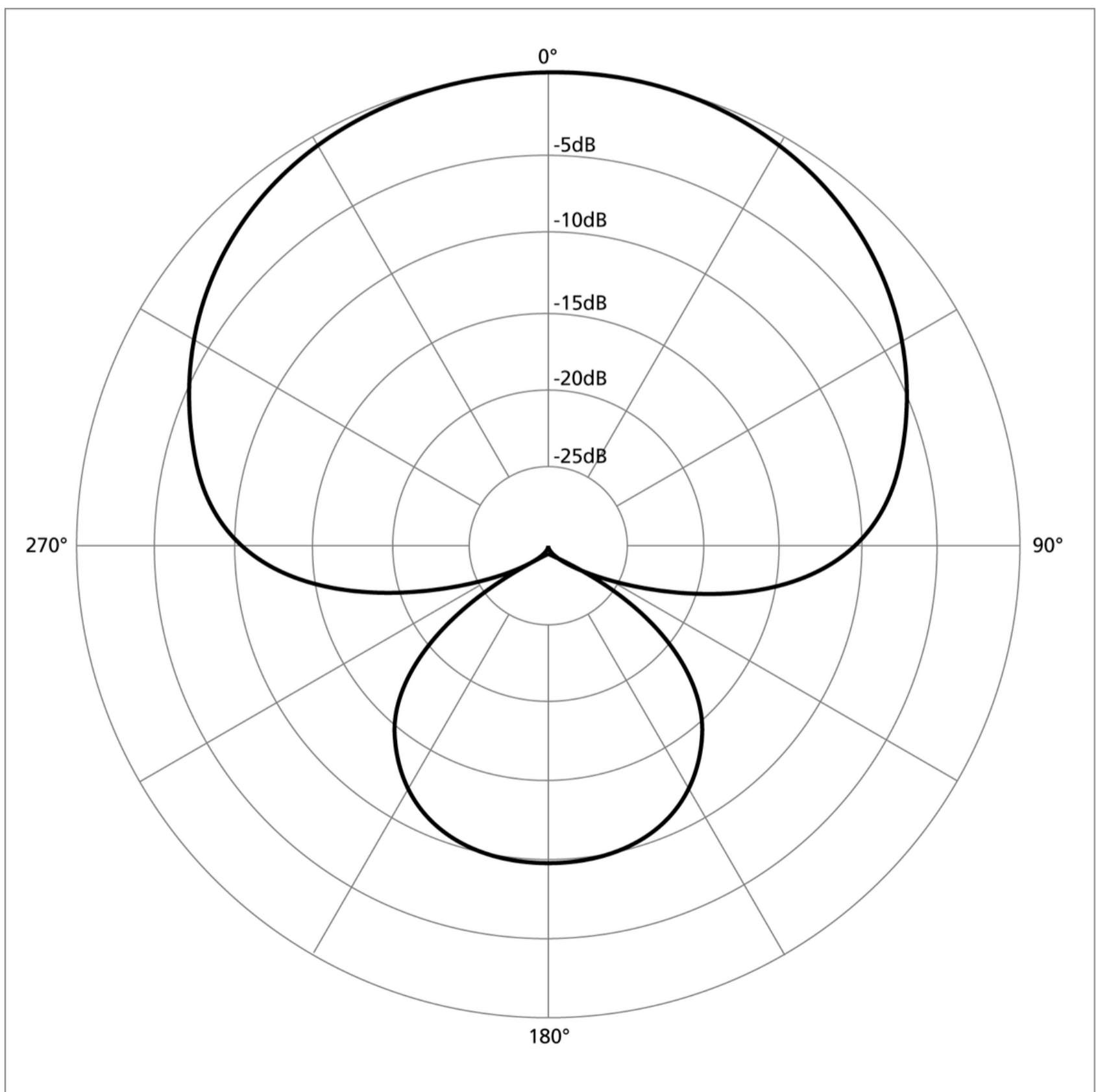
1. **Omnidirectional-** An omnidirectional polar pattern **picks up sound in a 360-degree radius** – it is equally sensitive to sound at all angles. These microphones are especially well-suited for recording acoustic instruments and when recording a wide sound source, such as an orchestra or choir.



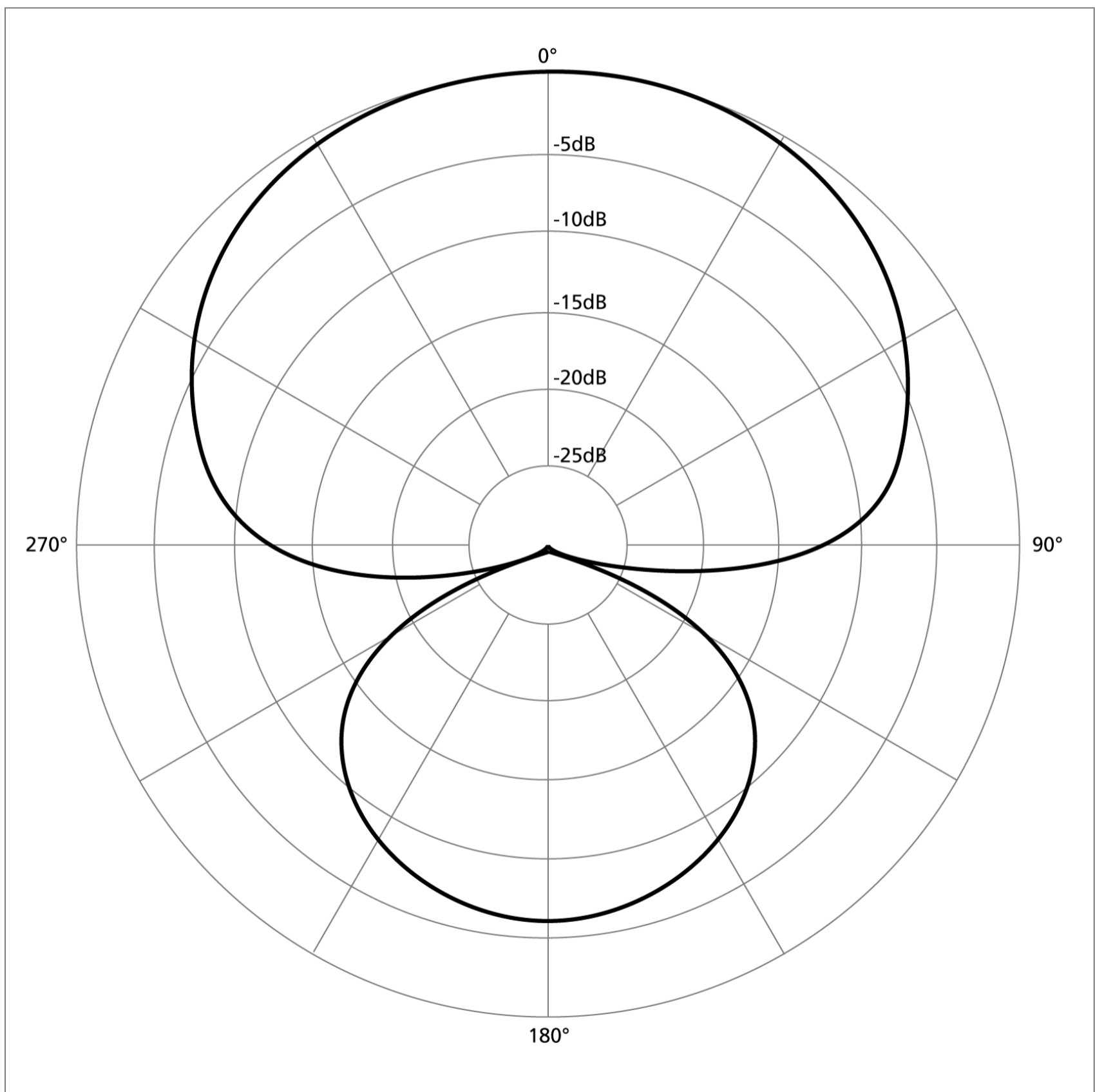
2. **Cardioid-** Cardioid is the most common directional polar pattern, with the highest sensitivity to sound coming in from directly in front of the microphone capsule (0°), practically no sensitivity to sound coming directly from behind (180°), and a reduced sensitivity to sound coming in from the sides ($90^\circ/270^\circ$).



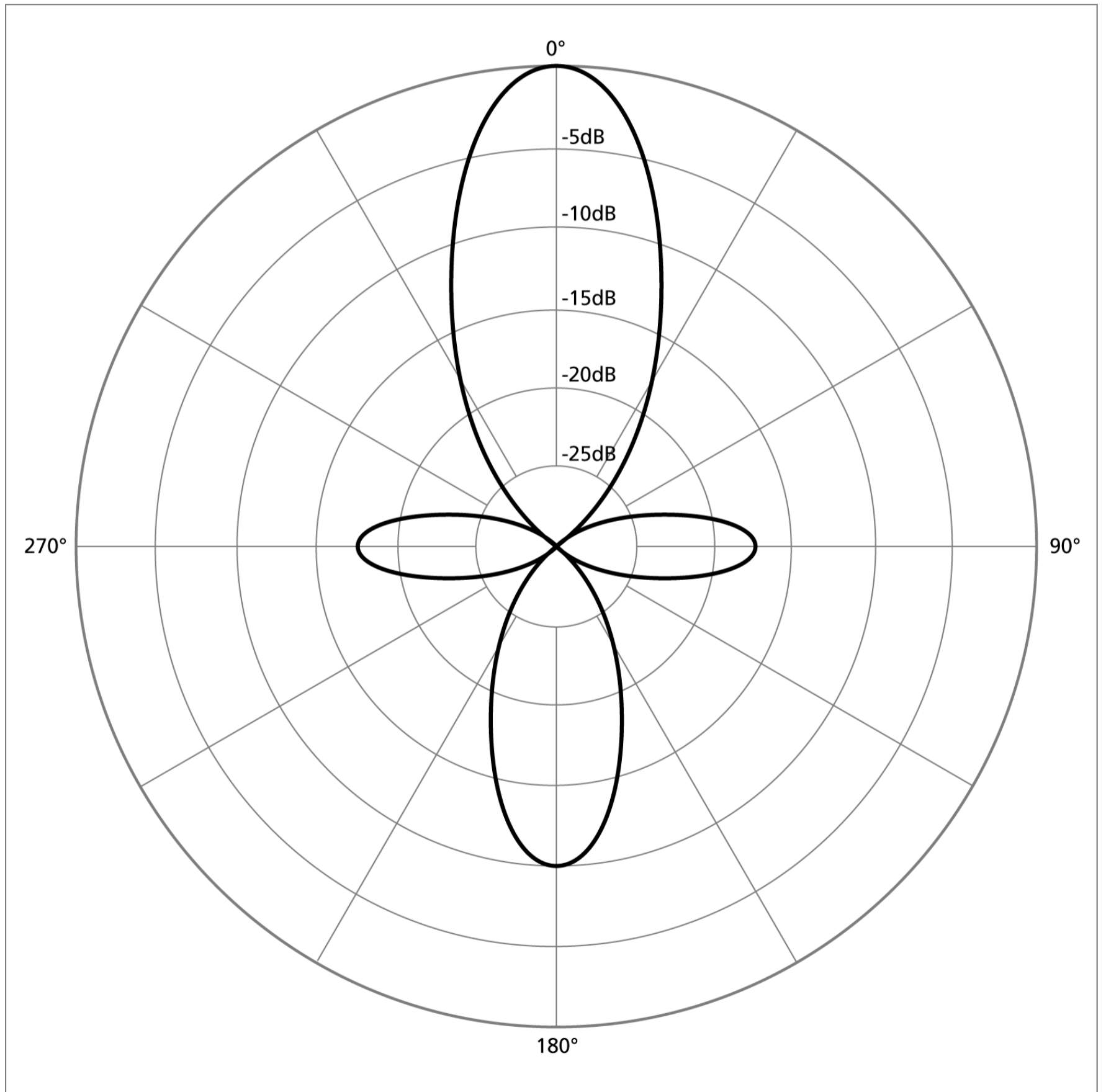
3. **Super-cardioid** - A super-cardioid microphone has a very directional super-cardioid polar/pickup pattern. It is most sensitive to on-axis sounds (where the mic “points”) with null points at 127° and 233° and a rear lobe of sensitivity. Super-cardioid mics are popular in film due to their high directionality.



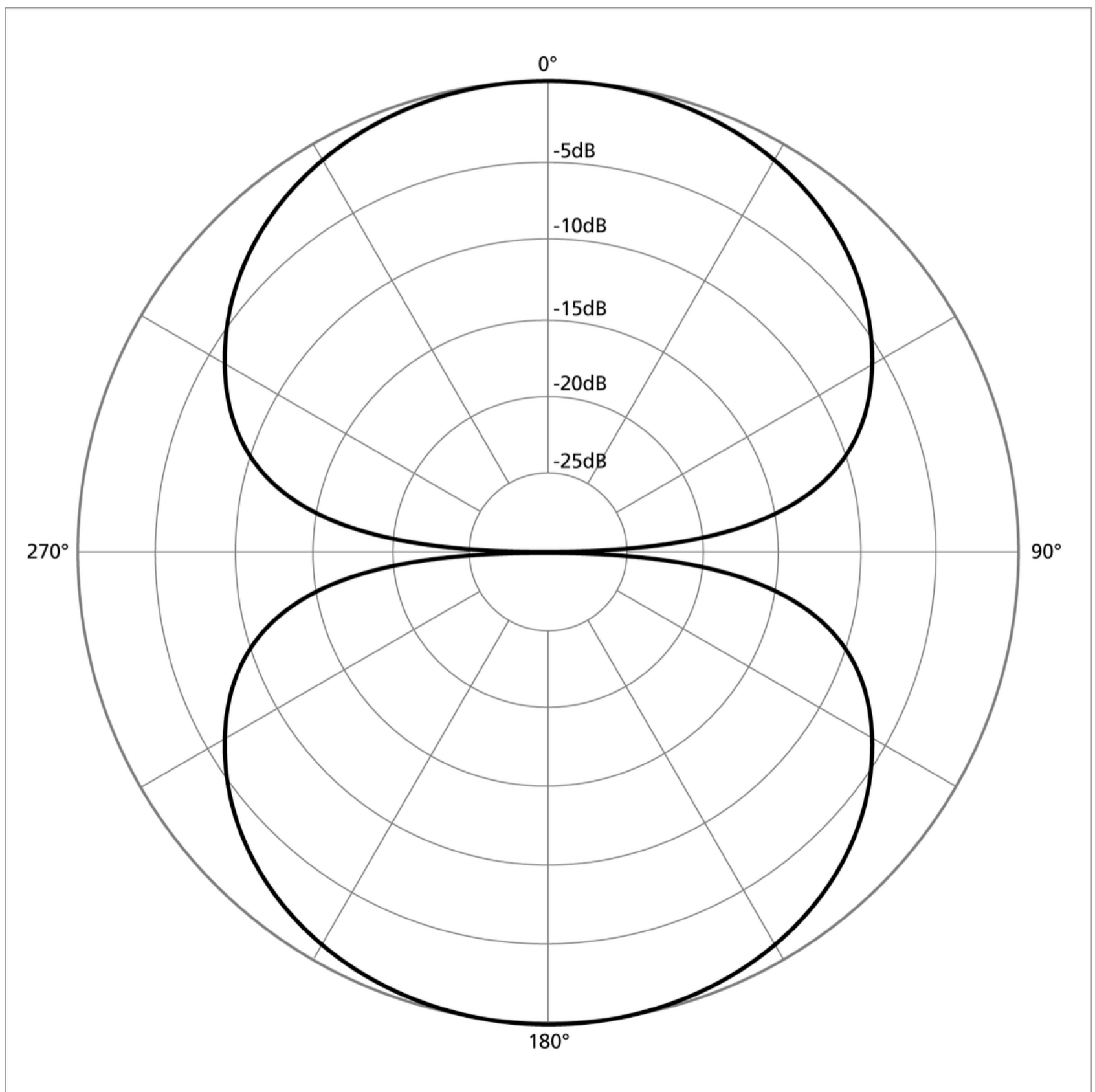
4. **Hyper-Cardioid** - A hyper-cardioid microphone has a very directional hyper-cardioid polar/pickup pattern. It is most sensitive to on-axis sounds (where the mic “points”) with null points at 110° and 250° and a rear lobe of sensitivity. Hyper-cardioid mics are popular in film due to their high directionality.



5. **Uni-directional (Lobar)** - A microphone with a lobar polar pattern has the highest possible directivity. A type of polar, or pickup pattern found in many shotgun microphones.



6. **Bi-directional (Figure 8)**- A microphone with a Figure-8 or bidirectional pickup pattern is sensitive to sound coming from the front and coming from the rear, but has a **very high rejection** for **sound coming from the sides**.



HOW DO YOU RECORD SOUND TO YOUR COMPUTER?

Microphones convert mechanical energy to electrical energy. But this electric energy is into form of **Analog signal** which needs to be converted into **Digital signal** in order to perform a recording on your **DAW**.

We have devices which convert analog signals to digital signals and vice versa.

1. **Analog to Digital converter (ADC)**- takes an analog signal and converts it into a binary one.
2. **Digital to Analog converter (DAC)**- converts a binary signal into an analog value.

ADCs are used to record microphones, instruments and send analog data to the computer whereas DACs are used to send output to speakers, amps and digital data to analog devices.

Audio Interface - An audio interface is a piece of computer hardware that allows the input and output of audio signals to and from a host computer or recording device.

An audio interface has both ADC and DAC built into one single piece of hardware. It connects to the computer through a USB or thunderbolt cable.



All standard audio interfaces come with integrated gain controls for each channel, headphone jack, volume knob for the output and 48V phantom power.



Phantom power- process of delivering DC (Direct Current) to microphones requiring electric power to drive active circuitry. Usually 48V.

All **condenser** microphones need phantom power.

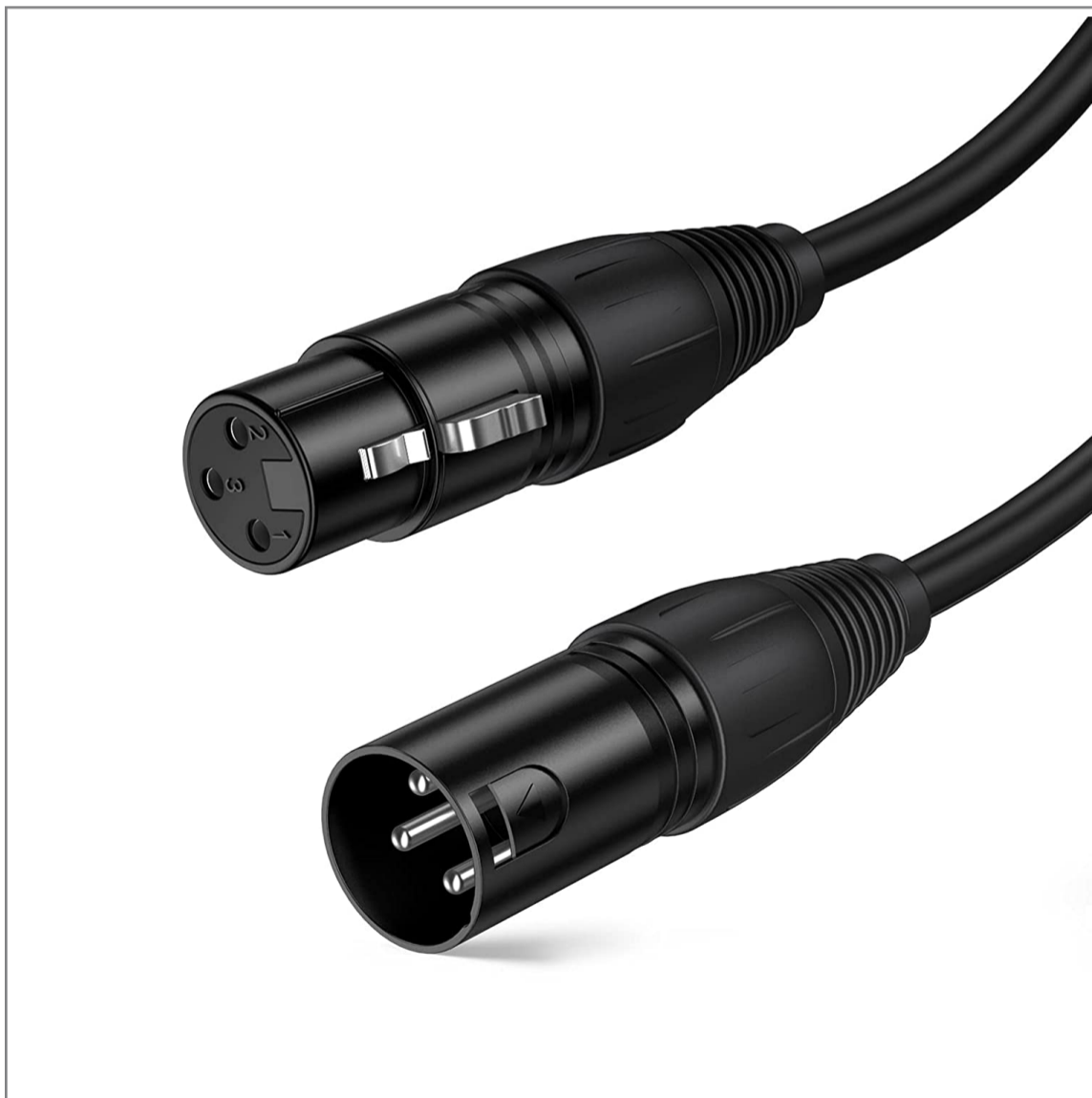
Cables- We need cables and connectors to connect all kinds of equipments to the Audio interface such as microphones, speakers, analog gear, etc.

Types of Analog Cables

1. **TRS (Tip-Ring Sleeve)**- connectors that have three wires inside (two conductors and one ground). Most common in headphone cables and headphone outputs on gear.
2. **TS (Tip Sleeve)**- they contain two wires: one conductor and one ground. TS cables are also mono. They're handy for gear that has a mono output: guitars, mono effects pedals, some synths and drum machines.
3. **XLR (External Line Return)**- XLR connector is a type of electrical connector primarily found on professional audio, video, and stage lighting equipment. They can be very long without noise interference. They are most commonly used to connect microphones.
4. **RCA (Radio Corporation of America)**- RCA connector is a type of electrical connector commonly used to carry audio and video signals. Most commonly used in DVDs and DJ gears.



TRS (left) and TS (right) cables/connectors



An XLR male (below) to XLR female (above) cable



RCA cables

Types of Digital Cables

1. **MIDI (Musical Instrument Digital Interface)**- technology standard allowing electronic musical instruments to communicate with one another and with computers. **MIDI does not make or transport sound. It transmits event messages.** The biggest benefit of MIDI is that you can easily edit performances note by note, change their articulation, or even alter or replace the sound that plays them.

2. **USB (Universal Serial Bus)**- USB cables have become super common in audio production. They're on MIDI keyboard controllers, audio interfaces, modern synths and drum machines.

Most of the USB A and B devices are now being replaced by USB type C (thunderbolt).



MIDI cables



USB type A and B (above) and USB C (below)



