Pro Tools 101

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Adapted from Frank Cook’s Training Manuals

What is Pro Tools?

Digital Audio Workstation

- Pro Tools Has Five Major Components
  - Audio Processing
  - MIDI Processing
  - Notation and Scores
  - Mixing and Automation
  - Audio for Video Post-Production

Pro Tools History and Evolution

- The reason we are going over this is because it would be on the final exam for PT 101.
- PT was designed by Digidesign and it's founders Peter Gotcher and Evan Brooks
- Early 1980's Gotcher and Brooks devised away to get drum samples on to EPROM computer chips.
- 1984 Digidrums was born and out of that company came a program called Sound Designer. Sound Designer was the first commercial product to combine waveform editing with a graphical display.

History Continued

- 1985: Digidrums became Digidesign. Digidesign began developing products for MIDI and synthesis on Macintosh computers.
- 1988: Digidesign began selling computer cards for playing back digital audio. The product was Sound Accelerator. It was CD quality 2-channel output card for the Mac II computer.
- 1989: Digidesign released the first “tapeless recording studio” called Sound Tools. This was Sound Designer II and a Sound Accelerator Card and a hardware box called AD that provided two analog-to-digital converters.

Pro Tools History Cont.

- 1991: Pro Tools was officially released. It only recorded four tracks but eventually software allowed for 16 tracks.
- 1992: Pro Tools Session 8 was released as the first Windows-based version of Pro Tools. Two years later Digidesign introduced Pro Tools TDM. This opened the door for real-time plug-ins.
- 1995: Digidesign merges with Avid Technology
- 1997: Pro Tools|24 came out with 24-bit recording technology.

- 1999: Pro Tools LE provided *host-based or native* audio processing. Also control surfaces were being introduced. This gave touch sensitive mixing control to the engineers
  - ProControl
  - Control|24
- 2002:
  - Pro Tools|HD Hardware Systems were released. These gave higher sample and bit rates to the systems.
  - Mbox was released.
- 2006: Sibelius was bought by Avid.

Pro Tools in This Decade

- April 2010
  - Avid Acuqired Euphonix a company who was known for high-end consoles and EUCON control surface technology. Out of this union cam the following consoles.
    - Artist Control
    - Artist Mix
    - Artist Transport
    - Pro Tools|S3 and S6 (Their flagship control surface)
  - New Mbox
  - New HD Interfaces
  - HD Native Platform

PT in this Decade Continued

- 2012: PT 10 released with new programming. AAX 64 bit audio engine
- 2013: PT 11: 64-bit architecture
- 2015: PT 12: Was released with new functions including
  - Input monitoring
  - VCA controls
  - Track Freeze and Track Bounce
  - Track Commit – This is HUGE. The processed track can be frozen with all the affected audio on it. This frees up a great amount of resources.
  - Cloud saving and Dolby ATMOS

Pro Tools Ultimate 2018 and First

- Ultimate 2018
  - Renaming of Pro Tools. Pro Tools is now on a subscription basis.
  - All new updates will be pushed out this method.
- First
  - Free Software similar to GarageBand, but allows more functionality that GB.
  - Three Projects saved in the cloud.
  - Subscription based at $5 a month with 10 Gb of space

Avid Based Systems

Software Options

- Pro Tools First
- Pro Tools Standard – What most of us will used until we hit the big time.
- Pro Tools HD: This can be stand-alone software or for use with the Pro Tools|HD Native or Pro Tools|HDX hardware.
  - This provides advanced automation, video editing, and surround mixing capabilities.

Host Based vs. DSP – Accelerated Systems

- Host Based is working solely on the systems in the computer.
- DSP – Digital Signal Processors work on hardware other than the system.

Audio Interface Options

Fast Track Family – Way of the Dodo

- Non HD
- USB

- Third Party Interfaces
    - UAD
    - Focusrite
    - and others….

Mbox Family – Discontinued as Well

- Mbox Family
- Firewire or USB
- Sample rates up to 192K

Eleven Rack

- Guitar Interface
- Non HD
- USB 2.0
- Standalone Amp
- 8 Channels of Recording
- 96K Highest Sample Rate

Duet and Quartet – Discontinued as Well

- Non HD
- Originally Apogee Interface
- Allowed for Multiple Inputs 192k

Pro Tools|HD Series Audio Interfaces: Omni

- Omni
  - 2 XLR Ins
  - 4 Line Ins
  - 8 Outputs
- HD

Pro Tools HD Interfaces: I/O

- Features
- 8x8x8
- 16x16x16 analog
- 16x16x16 digital

Pro Tools HD Interface: MADI

- Features
- Co-axial Cable
- 64 channels

Audio Basics

Sound Waves – How Do We Hear

- Sound
- Compression/Rarefaction: speaker cone
- Sound travels 1130 feet per second
- Sound waves hit receiver
- Sound waves tend to spread out as they travel away from source, getting weaker over distance (halves each time distance doubles: inverse square law)

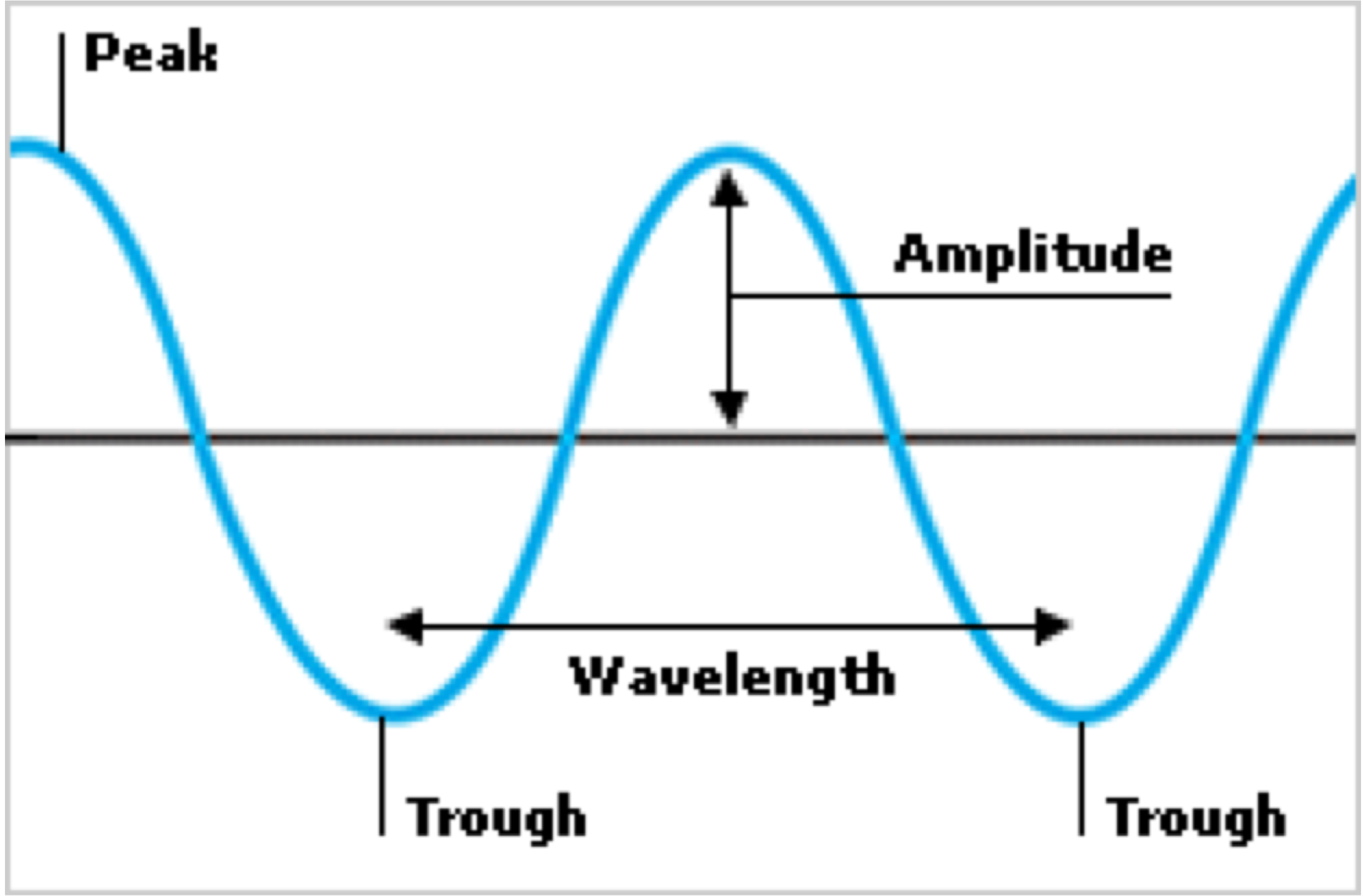
Oscilloscope

- Let’s look at some sound waves.
  - The form that is on the screen is called the wave form.
  - This form can be manipulated depending on the overtone series it produces.
  - The oscilloscope I have is not very good.

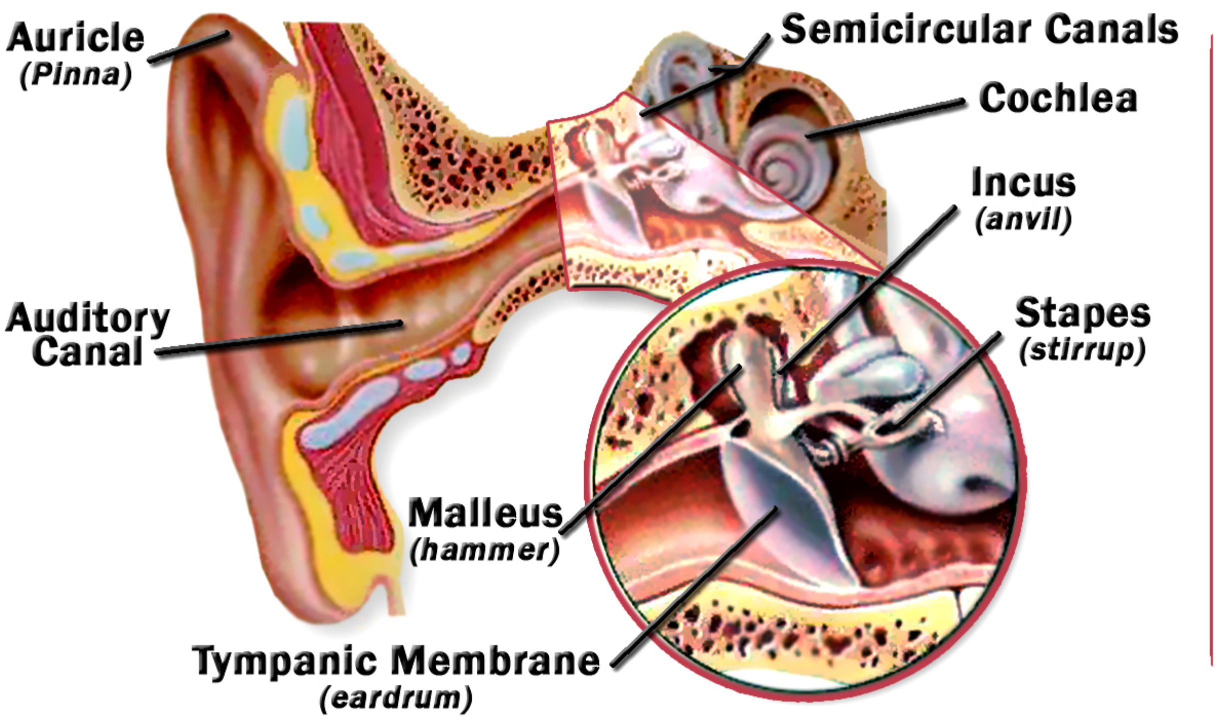
Waveform

- Waveform is the “shape” of sound – or more accurately, the shape of the vibration that produced the sound. This shaped can be influenced by a number of different factors.
  - Size
  - Shape (String, Vocal Chord, Brass, Woodwind, Percussion)
  - Everything Vibrates Differently – Timbre and the Overtone Series

Sound Waves

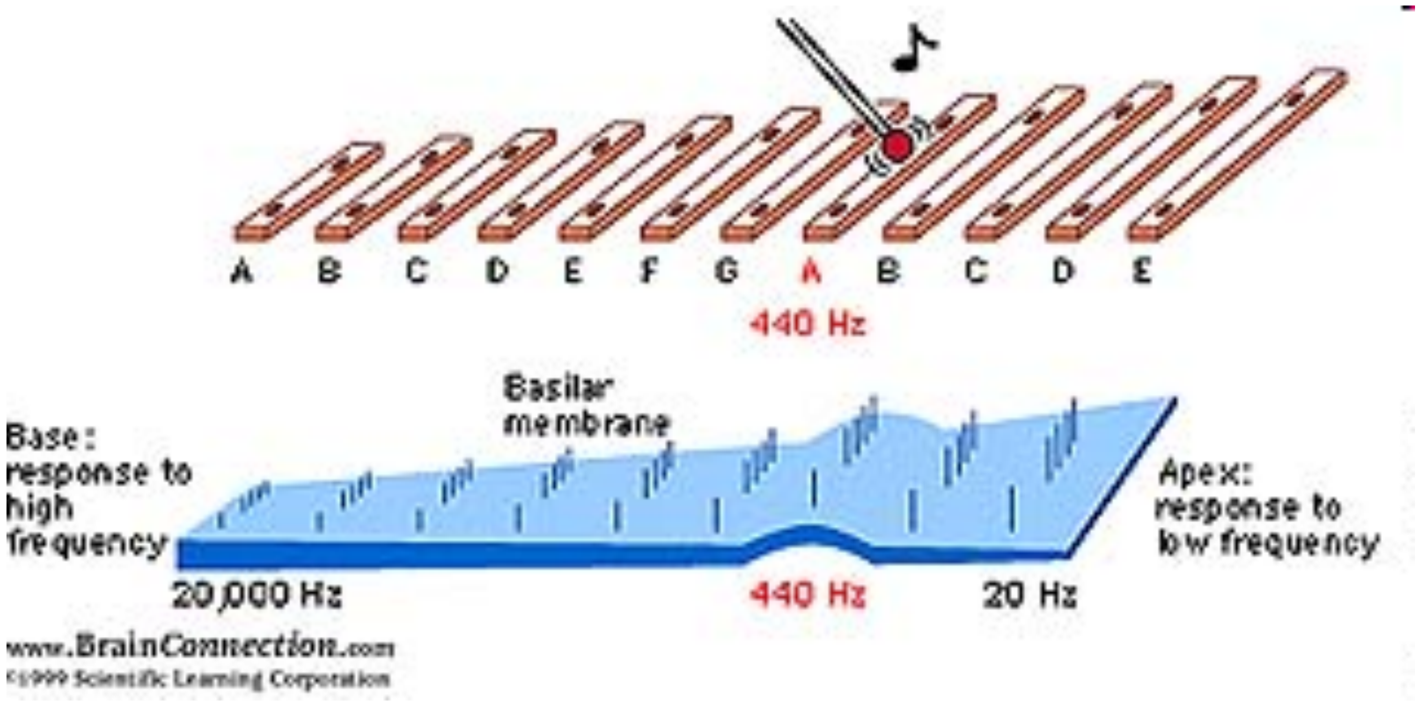


Inner Ear

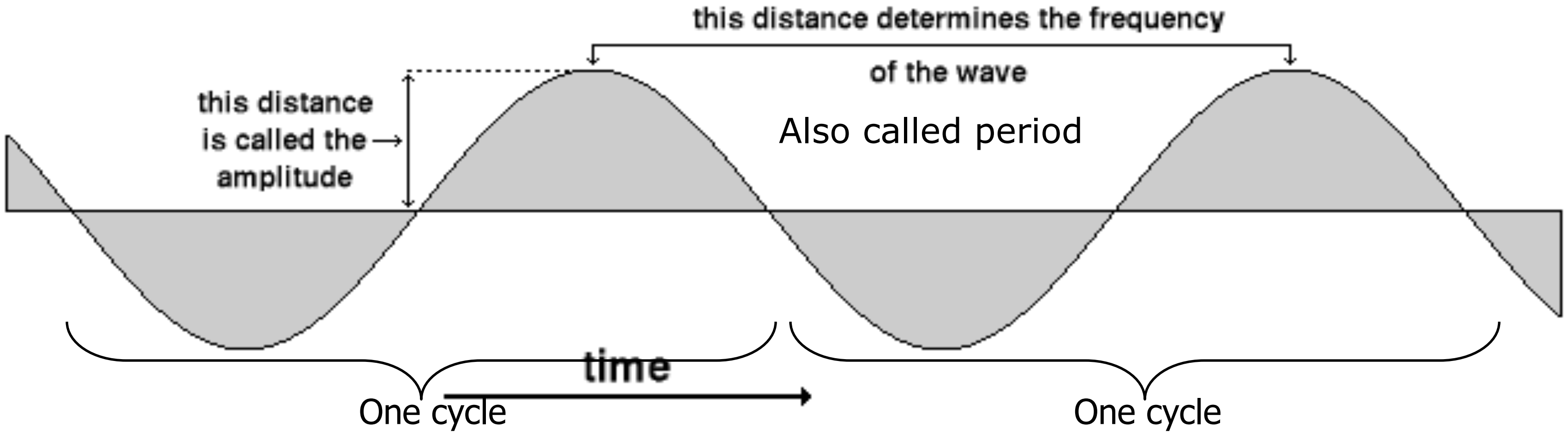


Auricle
(Pinna)
Semicircular Canals
Cochlea
Incus
(anvil)
Auditory
Canal
Stapes
(stirrup)
Malleus
(hammer)
Tympanic Membrane
(eardrum)

Basilar Membrane



Sound Waves: Frequency



- Frequency (Hz or kHz) number of cycles per second. Named for Henrich Hertz. The scientist who theorized that sound traveled in waves
- Frequency: highness or lowness of sound
- Human hearing range: 20 Hz – 20kHz (20,000 Hz)
- Doubling Frequency raises the pitch one octave
- [Instrument Frequency Chart]

Audio Basics: Amplitude

- The intensity or of the sound pressure variations that reaches our ears creates our perception of the loudness of the sound.
- Measured in Decibels: dB
- Logarithmic unit that used to describe a ratio of sound pressure. It is not linear.
- As the amplitude increases the sound becomes louder.
  - Doubling intensity of the sound pressure variations produces a 3dB gain.
  - Doubling a sounds loudness results in a 10dB gain.

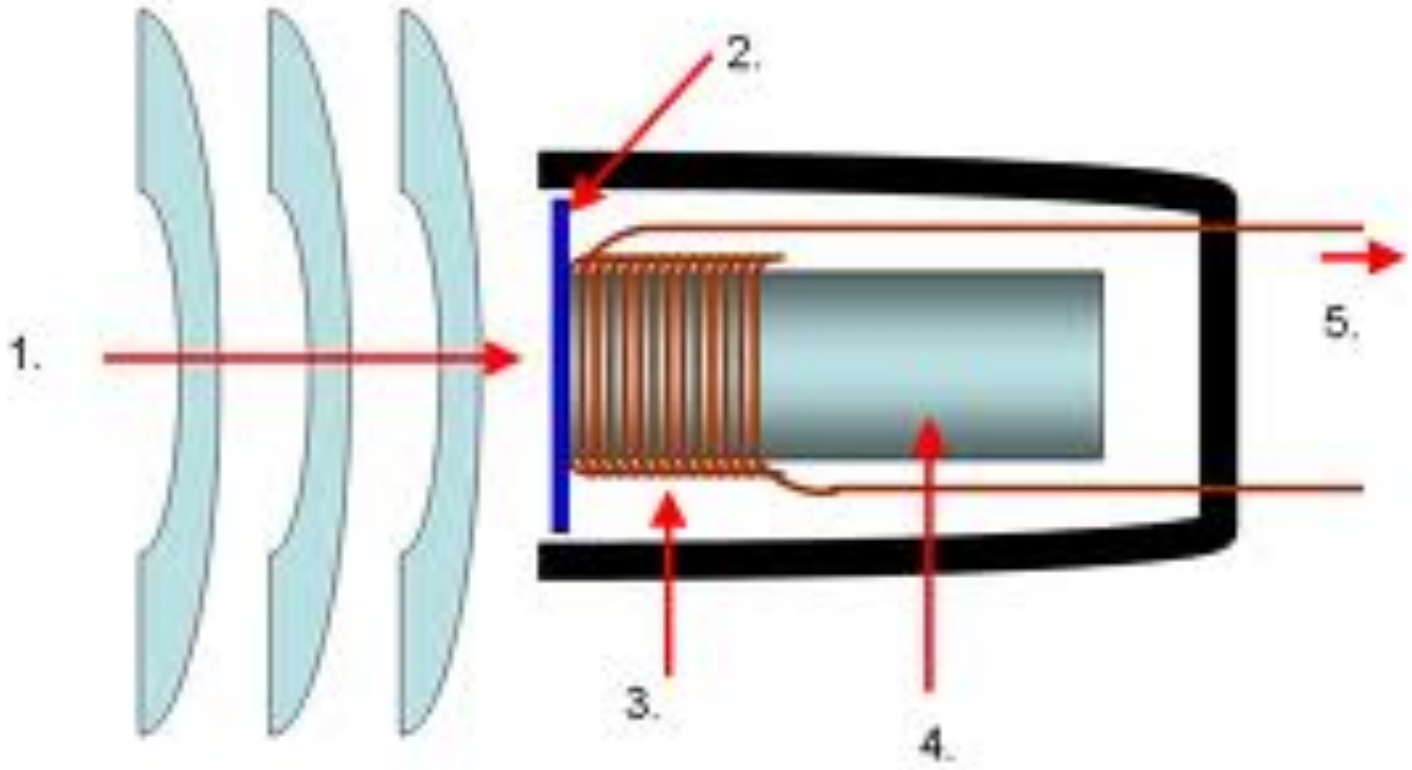
Microphones

- Transducer: device that changes one form of energy into another
- Mics and speakers: sound to electrical signal

Microphones: types

- Dynamic: a coil of wire attached to a diaphragm suspended in a magnetic field.
- Sound waves vibrate diaphragm, coil vibrates in magnetic field and generates an electrical signal similar to a sound wave.

Dynamic Microphone

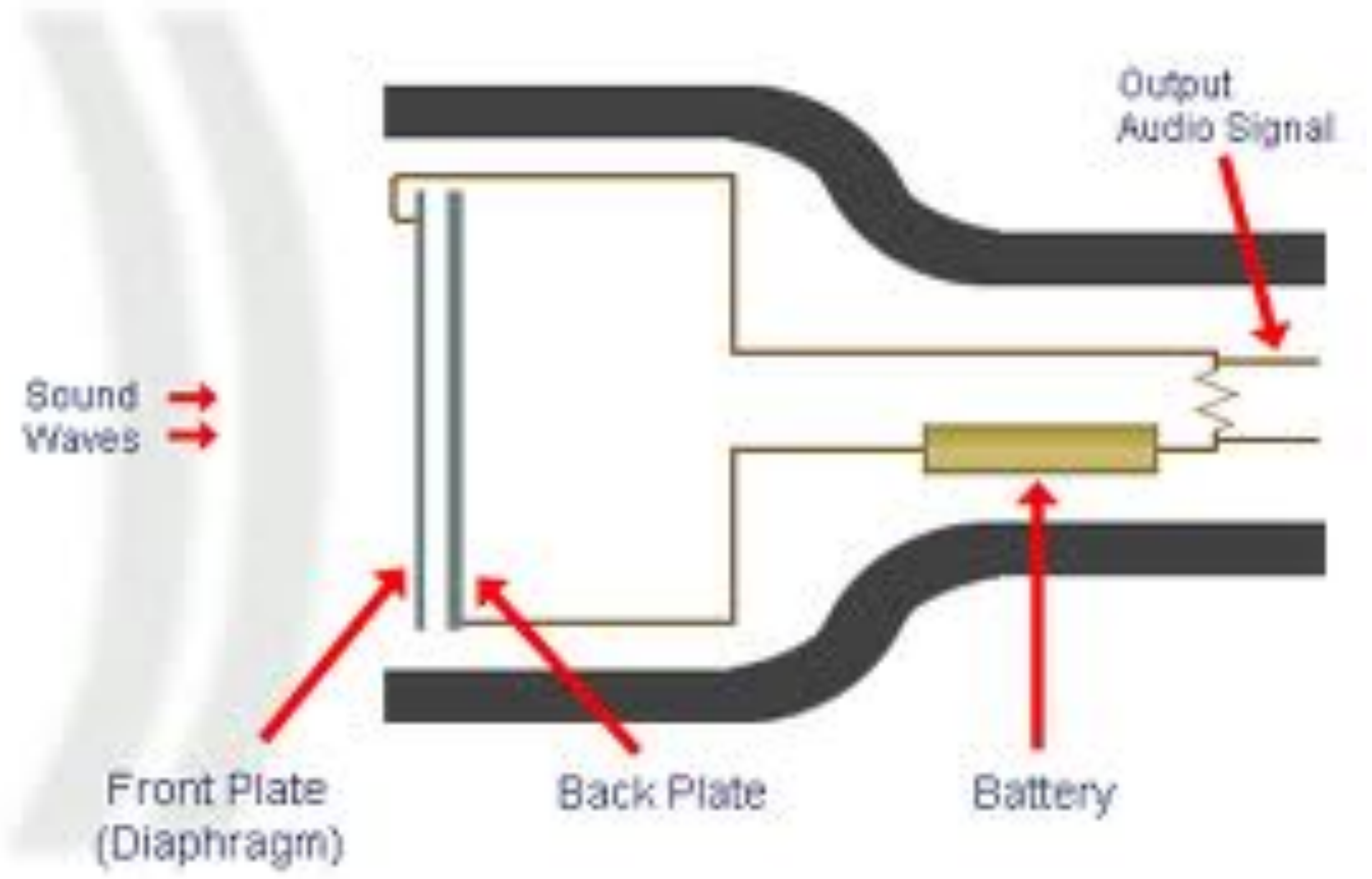


Microphones: Dynamic

- Tends to have rougher response
- Rugged and reliable
- Handles heat, cold, and high humidity
- Preferred for high SPL: guitar amps, drums
- If flat response, can take the “edge” off sounds (woodwinds, brass)

Microphones: Condenser

- Sometimes called capacitor mic
- 2 parts: conductive diaphragm and metal backplate, spaced very close together
- Both charged with static electricity
- When sound waves strike diaphragm, it vibrates, varying the spacing between the plates
- This variation generates a similar signal to incoming sound wave
- Diaphragm mass is lower, responds faster to rapidly changing sound waves (transients)


Output
Audio Signal
Sound
Waves
Front Plate
(Diaphragm)
Back Plate
Battery

Microphones: Condensers

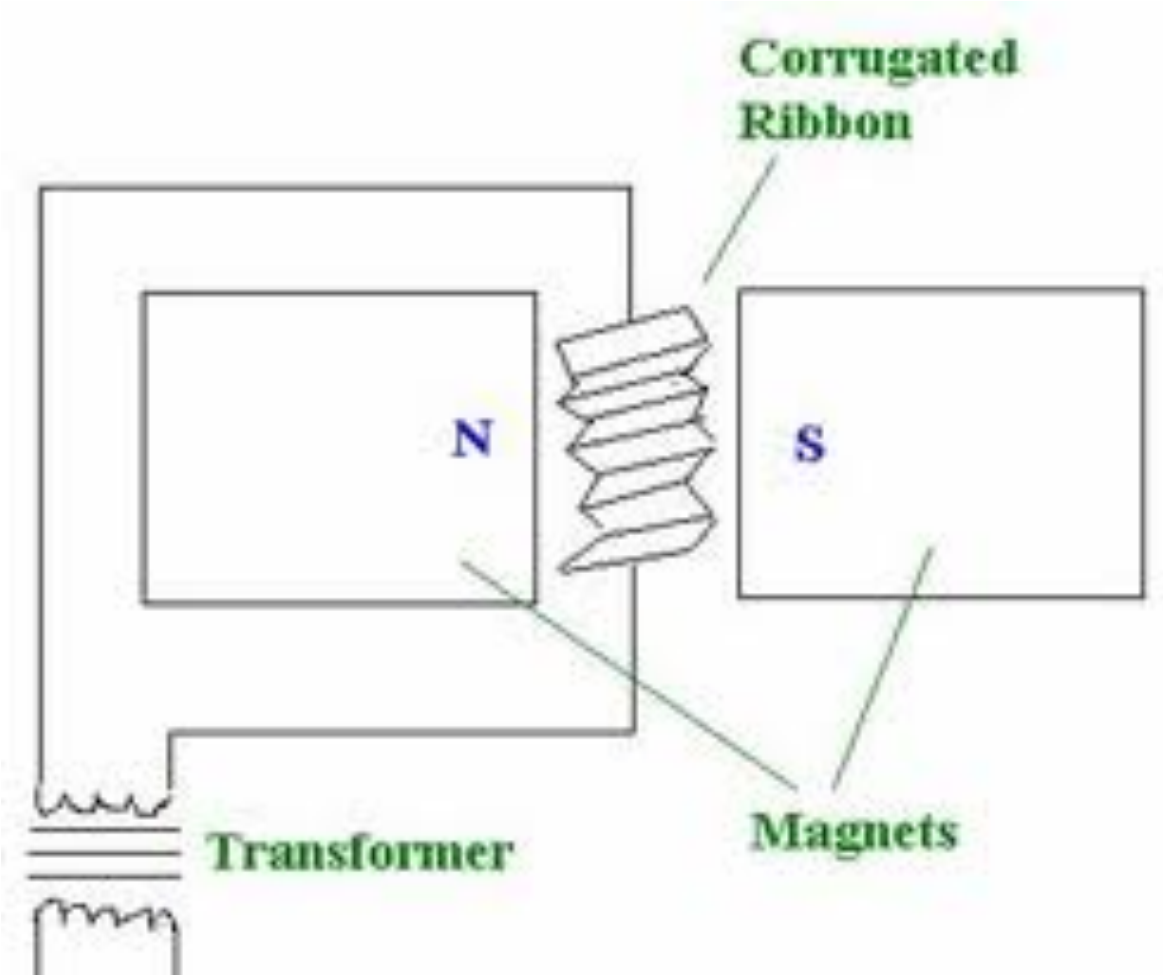
- Condenser mics need external power supply (battery or phantom power)
- Phantom power: 12 to 48 volts supplied through XLR cable
- Most mixers have a switch to turn on phantom power

Microphones: Condenser traits

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

Microphones: Ribbon

- Thin metal foil or ribbon is suspended in a magnetic field
- Sound waves vibrate the ribbon in the field and generate a electrical signal



Corrugated Ribbon
N
S
Transformer
Magnets

Microphones: Ribbon

- Prized for its warm, smooth tone quality
- Delicate, damaged by temperature and humidity changes
- Complements digital recording
- Expensive

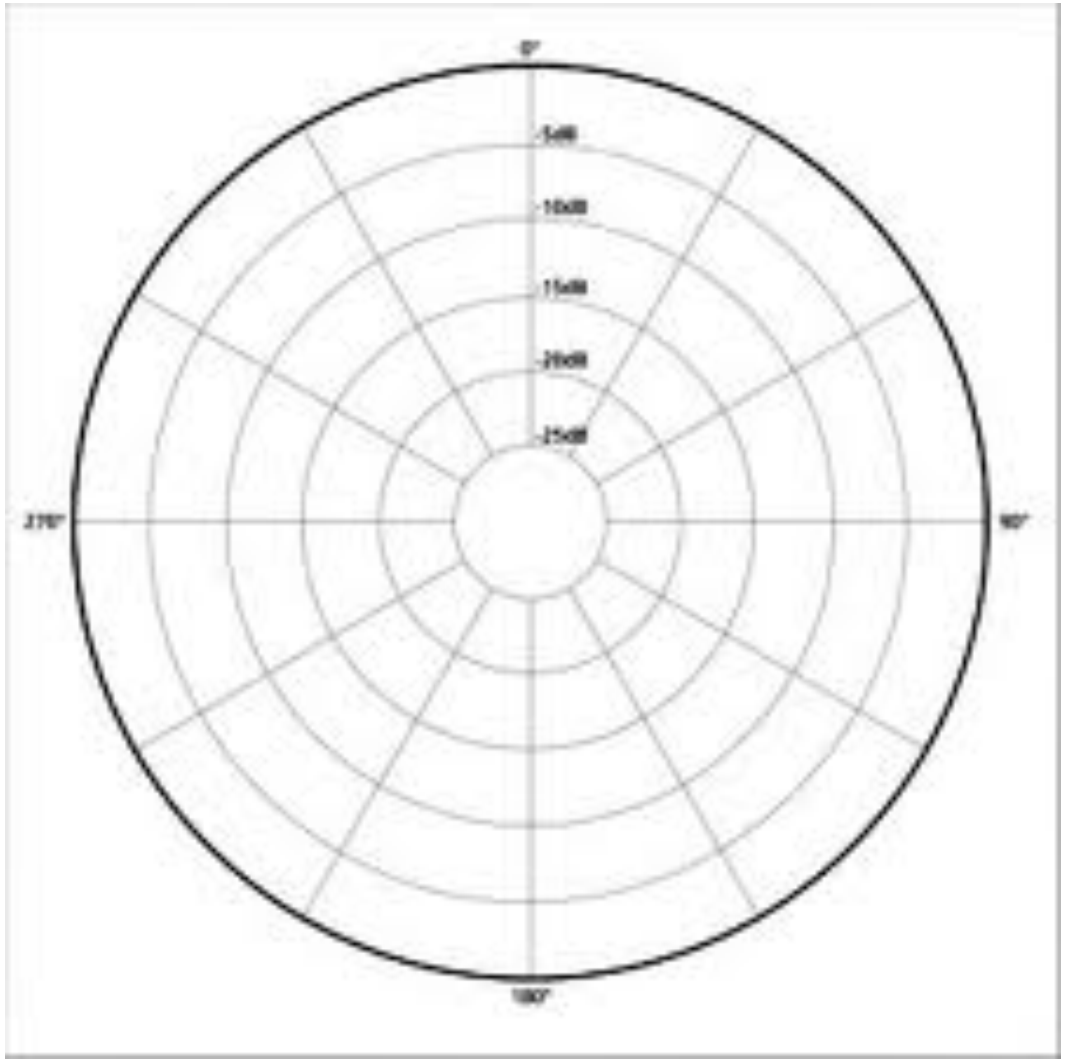
Microphones: Polar Patterns

- Polar pattern refers to the way a microphone responds from different directions
- Graph based on sensitivity measured in decibels.
- Uni-directional, Omni-directional, Bi-directional (figure-8)
- Three types of unidirectional patterns: cardioid, supercardioid, and hypercardioid

Microphones: Omni-directional

- All around pickup
- Picks up room reverb
- Not much isolation
- Low sensitivity to pops
- Low handling noise
- No up-close bass boost (proximity effect)
- Extended low frequency response (condensor) great for organ, orchestra, etc…
- Lower cost (in general)

Microphone: Omni Pattern



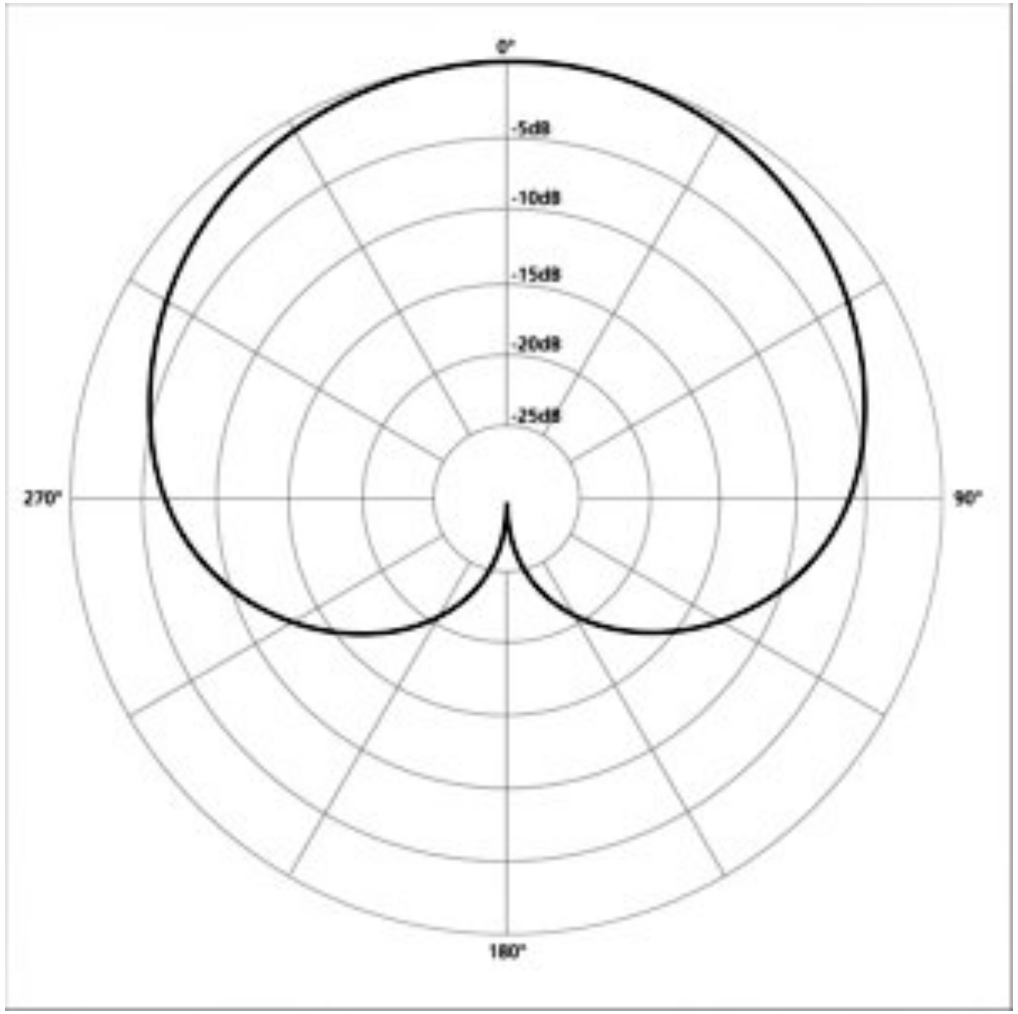
Microphones: Unidirectional (cardioid, supercardioid, hypercardioid)

- Selective pickup
- Rejection of room acoustics, background noise, and leakage
- Up-close bass boost
- Better gain-before-feedback in live sound

Microphone: Cardioid

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

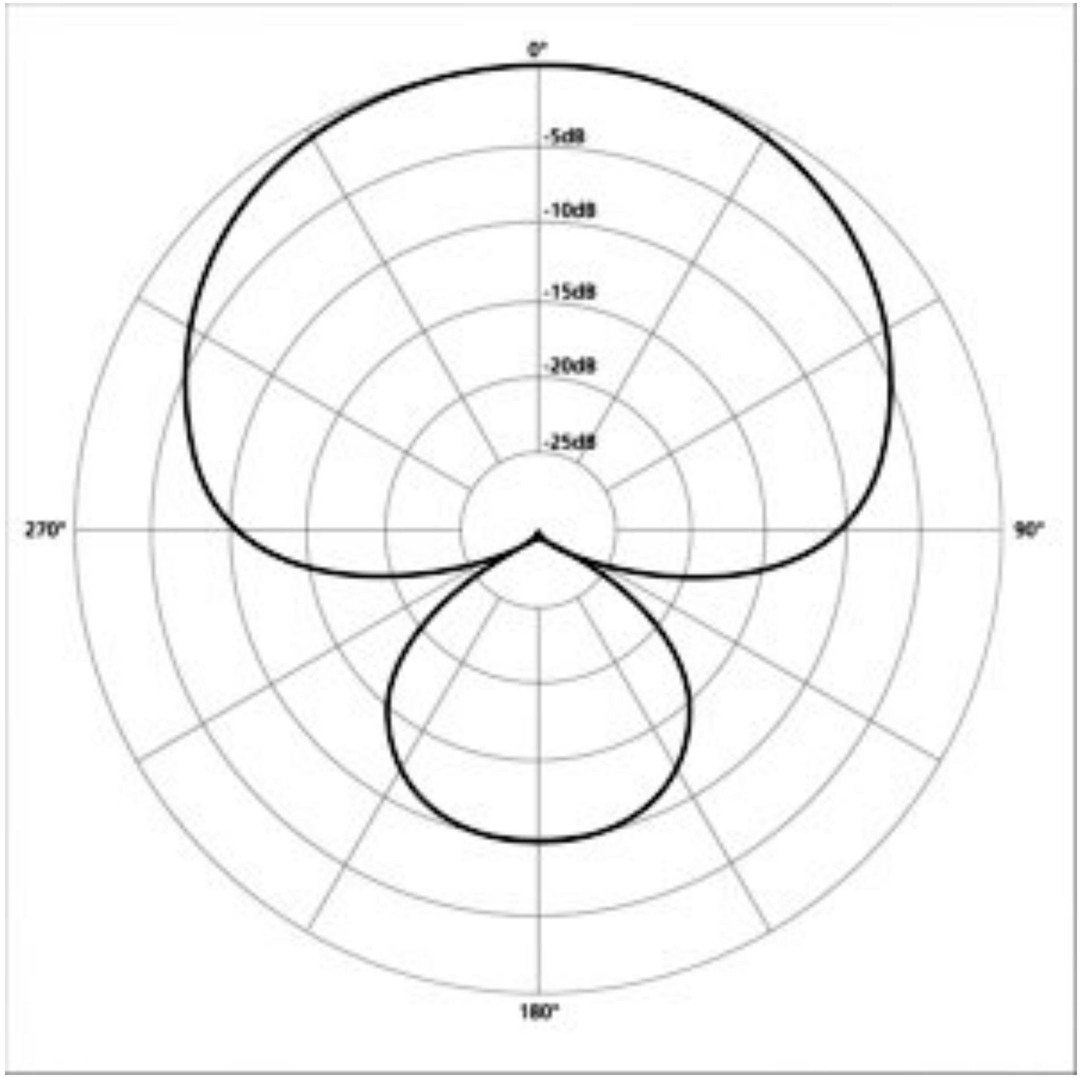
Microphone: Cardioid



Microphones: Supercardioid

- Maximum difference between front hemisphere and rear hemisphere
- More isolation than cardioid
- Less reverb than cardioid

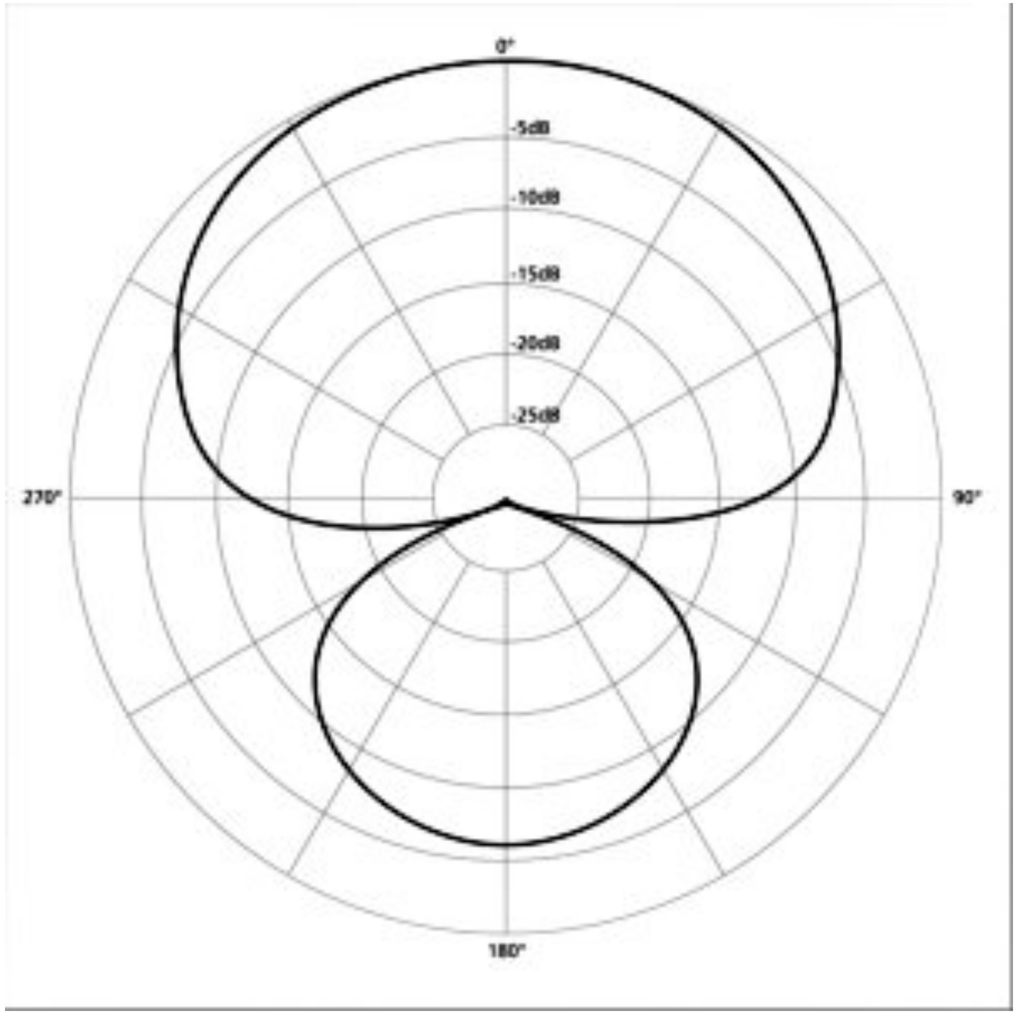
Microphone: Supercardioid



Microphone: Hyper-cardioid

- Maximum side rejection
- Maximum isolation – maximum rejection of reverb, leakage, and background noise

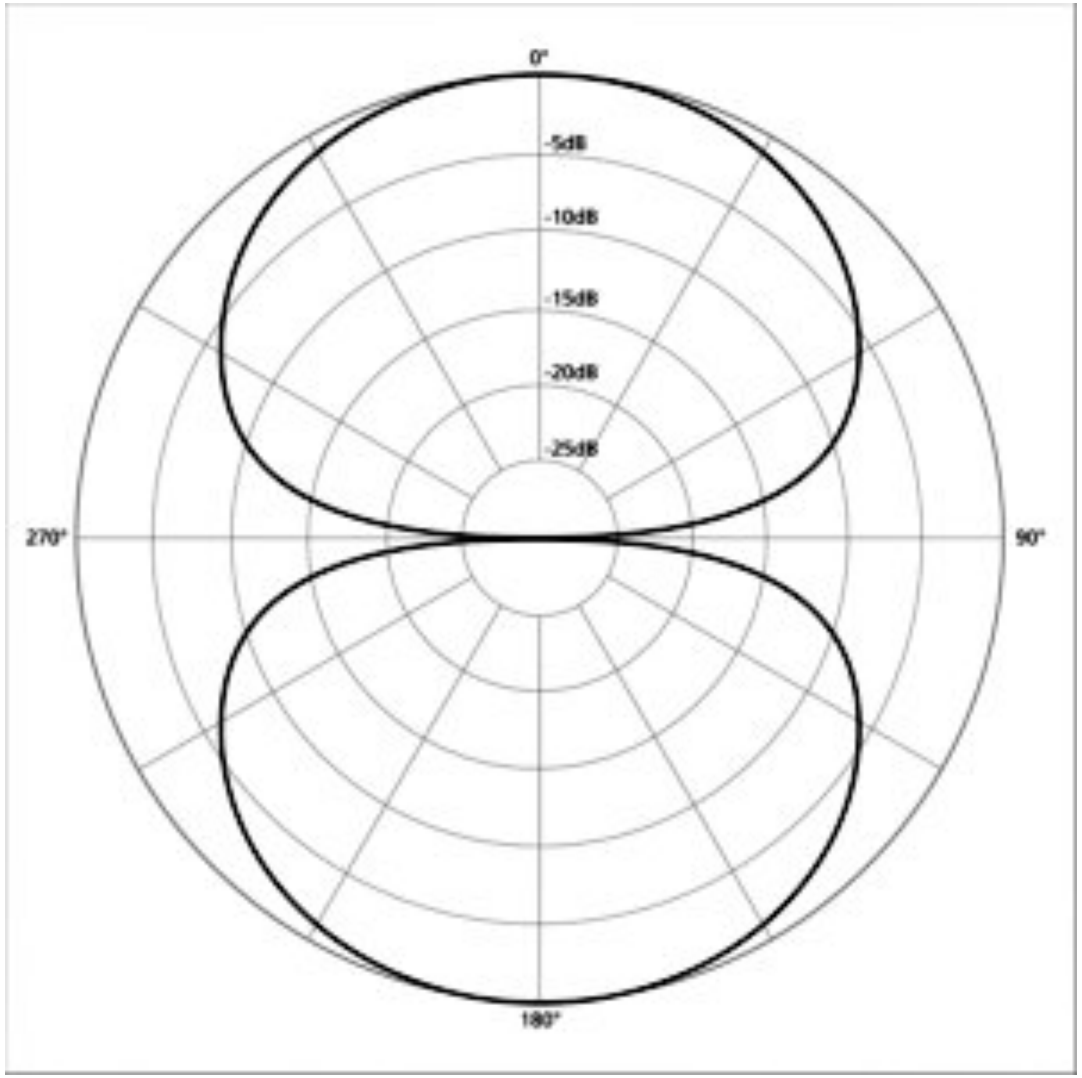
Microphone: Hypercardioid



Microphone: Bi-directional

- Also called figure-8
- Front and rear pickup, with sides rejected
- Across table interviews, two-part vocals/instrumentals

Microphone: Bi-directional



Microphones

- Frequency response varies from proximity: off axis coloration
- Off axis coloration: mic will have a different tone quality on and off axis

Microphones:

- Condensers or Dynamics come in all polar patterns (except bi-directional dynamic)
- End-addressed or side addressed
- Switchable polar patterns common with side addressed mics
- Boundary mics: half pattern (usually omni); rejects room acoustics

Boundary Microphone

Mic Accessories

- Pop Filter: breath pops “p”, “b”, or “t” sounds
- Stands and booms
- Shock Mount
- Snake

Microphones: Frequency Response

- Range of frequencies a mic will reproduce at an equal level (within a tolerance like ±3db)
  - Most instruments: 80Hz – 15kHz
  - Bass instruments: 40Hz - 9kHz
  - Brass and voice: 80 Hz – 12kHz
  - Piano: 40 Hz – 12 kHz
  - Cymbals and some percussion: 300 Hz – 15 or 20 kHz
  - Orchestra or symphonic band: 40 Hz – 15kHz

Microphones: Frequency Response

- Roll-off switches: attenuates frequencies below a point below fundamental frequency of instrument you're recording (guitar does not play below 80 Hz)
- Frequency response curve
- Presence peak: rising high end around 5 – 10kHz makes sounds more crisp and articulate (crunchy)
- Proximity effect: a bass boost tendency of a mic when placed too close.

Microphones: Other ratings

- Impedance
- Maximum SPL: the point at which a mic starts to distort – 125db good, 135db better, 150db excellent
- Sensitivity: how much output voltage a mic produces when driven by a certain SPL
- Self-noise: noise level or hiss a mic produces
- Signal to Noise Ratio: the difference in decibels between mic's sensitivity and it's self noise

Microphone types

- Large-Diaphragm Condenser
  - Good low frequency response and low self-noise
- Small-Diaphragm Condenser
  - Stick shaped or pencil, usually cardioid and end addressed, good transient response and detail, good for acoustic instruments
- Dynamic Instrument
  - Stick shaped, end addressed, be careful of presence peak, used on drums and guitar amps

Microphone types

- Live-Vocal
  - Ice cream cone shaped large grill to reduce breath pops, can be condenser, ribbon, or dynamic, usually has presence peak and low frequency roll-off
- Boundary Mic
  - Used on surfaces like piano lid, wall, picks up direct and reflected sound at the same time for smooth response

Microphone types

- Miniature Mic
- Stereo Mic: combines two directional mic capsules in a single housing
- Digital (USB) Mic – built-in a/d converter

Microphone Selection

Natural, smooth tone quality	Flat frequency response
Bright, present tone quality	Presence peak (5kHz)
Extended lows	Omni condenser dynamic with extended low frequency response
Extended highs	condenser

Choosing a Microphone

Boosted bass up close	Directional mic
Reduced leakage, reduced room acoustics	Directional
Enhanced acoustic	Omni
Miking close to a surface	Boundry (TMZ)

Choosing a Mic

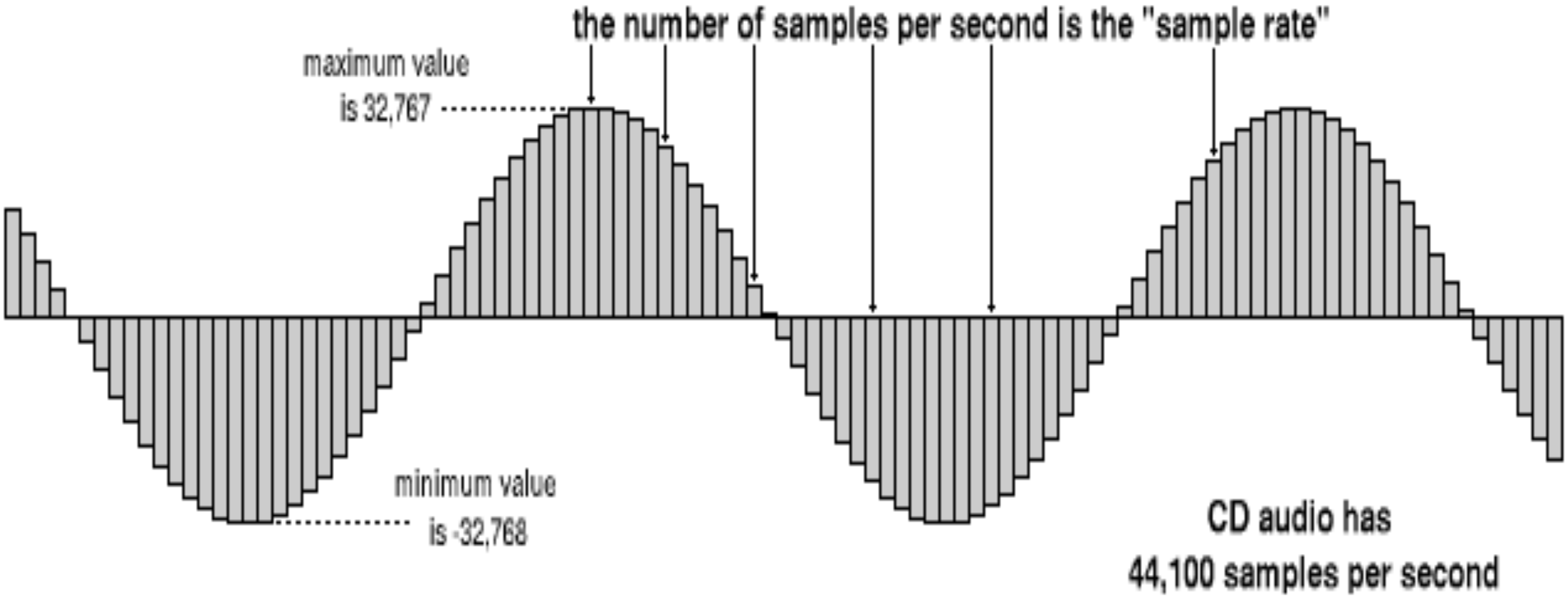
Coincident or near-coincident	Stereo mic
Extra ruggedness	Dynamic
Distortion-free pick-up of loud sounds	Condenser with high SPL spec or dynamic
Low self-noise, high sensitivity, noise-free pickup of quiet sounds	Large-diaphragm condenser mic

Converting Audio to Digital

What is a Sample?

- Sampling (in this case) is the process of taking discrete measurements of an electrical signal at various moments in time.
- Each measurement, or sample, is a digital representation of the signal voltage at that instant. Played back in succession, these samples approximate the original signal like a flip photobook or a film.

Sample Rate



the number of samples per second is the "sample rate"
maximum value
is 32,767
minimum value
is -32,768
CD audio has
44,100 samples per second

Nyquist Theorem or Sampling Theorem

- In order to produce an accurate representation of a given frequency of sound, each cycle of the sound’s vibration must be sampled a minimum of two times.
- If this does not happen alias tones or wrong tones will be produced.

Standard Sampling Rate

- As stated earlier, humans hear from 20Hz – 20kHz.
- We could in theory record at 40k Sampling Rate and be okay. There are people who hear beyond this.
- So we record at 22.05 Samples per second.
  - If we double that we get 44.1 K as a sample rate. This is the standard sample rate for a CD
  - 48K is used for video
  - 88.2 doubles the original.
  - 96K doubles for video.

Welcome to Binary

- Computers use binary digits called bits (0’s and 1’s) to represent data collected. The number of of bits used for each sample is called a *binary word length* or bit depth.
- The more digits the better the accuracy of each sample measurement.
- The relative loudness is rounded is quantized or rounded to the closest available whole-number value within the word length.

Example

- The range of numeric values available for each sample at a given bit depth is equal to 2 to the nth power (2^n), where n is the number of bits in the binary word.
- A 4-bit word can only represent 16 distinct amplitude levels.
- A 16-bit word can represent 65,536 discrete amplitude levels.
- A 24-bit word cam represent 16,777,216 discrete amplitude levels.

Importance of Bit-Depth

- The main thing that you need to know about bit depth is that is related to volume.
  - 8 bit: 48dB
  - 16 bit: 96dB
  - 24 bit: 144dB
  - 32 bit floating point: 32-bit floating point files represent discrete amplitude levels in the same way a 24-bit file does. The extra 8 bits provide exponent biasing and allow for headroom above full-scale 24-bit audio.

Minimum Bit-Depth

- The music we generally listen to is from 40-105dB. This would require 11 bits in the binary word.
- Pro Tools starts off at a minimum of 16-bits as a minimum bit depth. Plus math really gets funky when one uses odd bit depths.

Calculating Dynamic Range

- 8-Bit x 6 = 48dB
- 16-Bit x 6 = 96dB
- 24-Bit x 6 = 144dB

Recording in a Digital Format

Digital Transfers

- If it is digital already, just bring in the file. Converting it to convert it back would only degrade the file.
- Digital to Audio Connections
  - S/PDIF – Sony Phillips Digital Interface.
    - Looks like RCA or Optical Cable.
  - AES/EBU – Looks like an XLR cable
    - Audio Engineering Society or European Broadcast Union
- AES/EBU is more preferred.