Chapter 13. Meeting 13, Microphones, Directionality, and Monophonic Microphone Techniques

13.1. Announcements

- Audio materials for Processing Report 2 (due Friday 23 March):

  audioProcReport02.zip

- Mix Report 1 Due Monday 9 April

13.2. Review Quiz 3

- ?

13.3. Mix Report 1

- Complete two mixes of two different multi-track studio recordings

  Only one mix can use extensive non-linear editing

- Perform channel strip processing on all channels using only filters and dynamic effects
- Automate only pan and levels
- Bounce a properly trimmed stereo file that has no clipping
- Report requires complete details on all tracks

13.4. Mix Materials for Mix Report 1

- C: Jazz quartet

  mix01-c-jazz.zip

- D: Trio of voice and two guitars

  mix01-d-28voxGtr.zip

- E: Duo of voice and percussion

  [file not available for OCW]

- F: Duo of voice and piano

  mix01-f-46voxPno.zip

- A: Shimauta

  [file not available for OCW]

- G: NIN

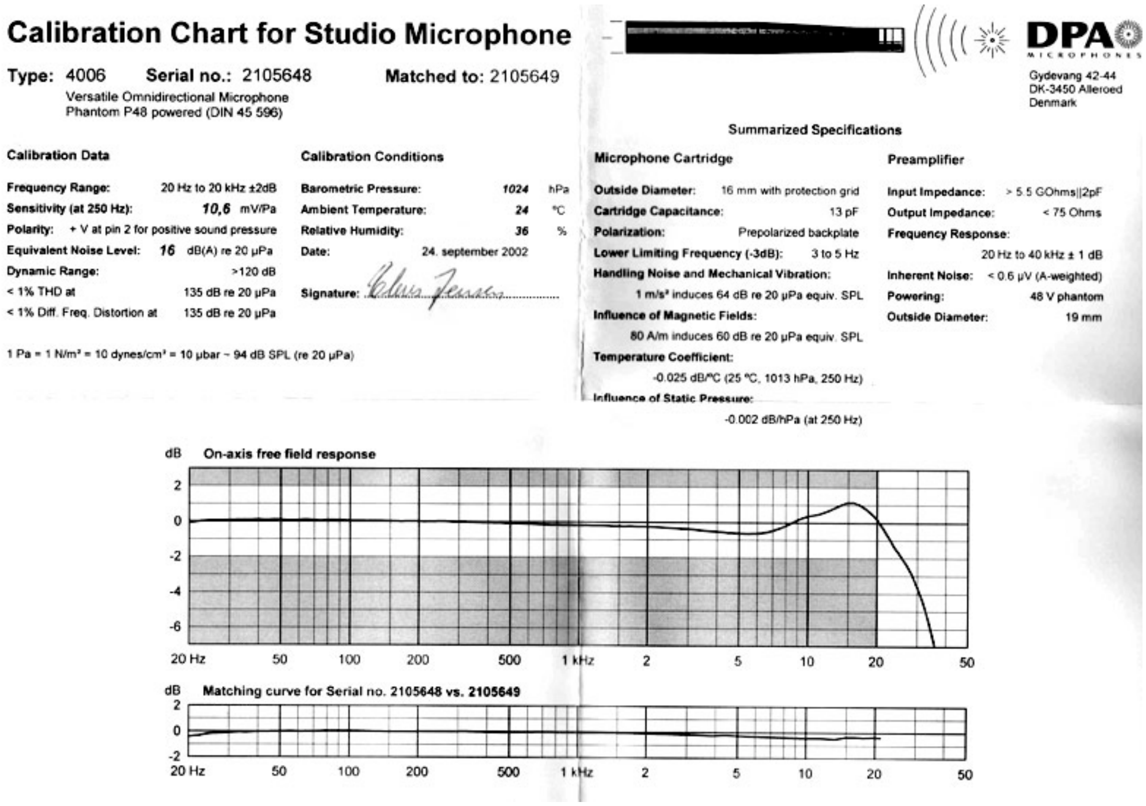
  [file not available for OCW]

13.5. Transducers and Transduction

- Transduction: conversion of one form of (sound) energy to another form
- Microphones and Speakers
- Transducers always act as a filter
- A frequency domain graph (frequency response curve) is used to show the effect of transduction

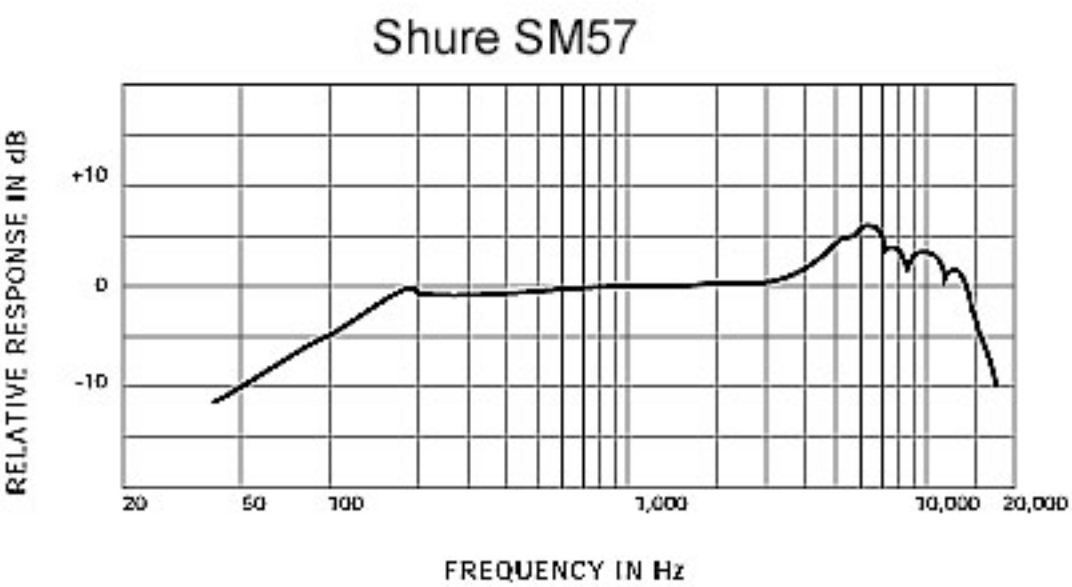
13.6. Microphones: Numerical Specifications

- Frequency response curves
- Transient response
- Self-noise
  1. Identify the microphones internal noise floor
- Sensitivity
  1. Given as negative dB: -57 dB
  2. Amount of boost required to raise input to 0 dBu
  3. A higher number means a more sensitive microphone
- Maximum SPL
- DPA 4006

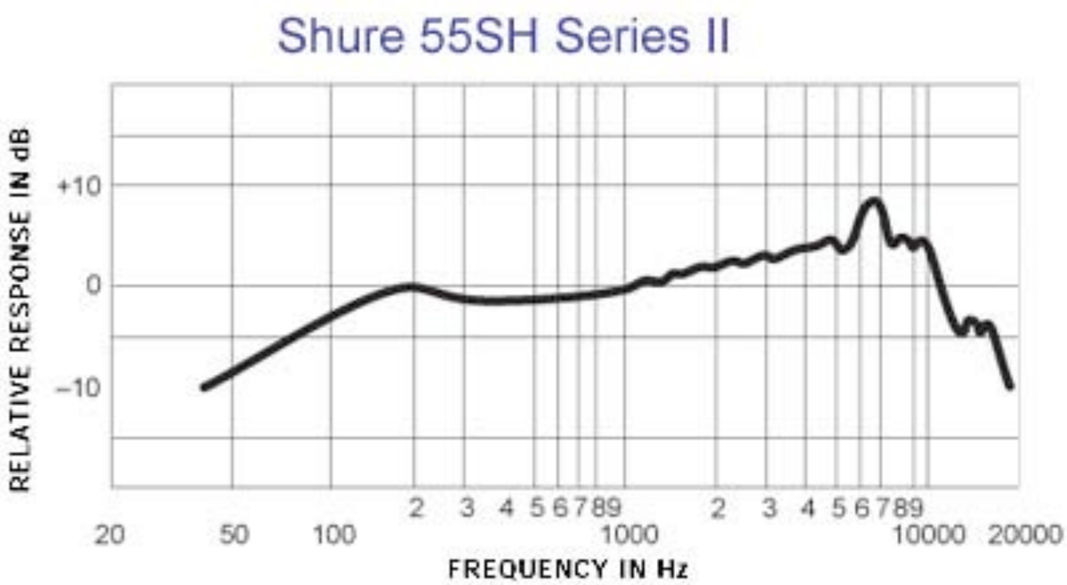


13.7. Visualizing the Affect of Transduction: Examples

- Shure SM-57


Shure SM57
RELATIVE RESPONSE IN dB
+10
0
-10
20
50
100
1,000
10,000
20,000
FREQUENCY IN Hz

- Shure 55SH



13.8. Microphones

- First stage of transduction
- Permanently alters the sound of the source
- Primary considerations: microphone type, microphone position, acoustical environment

13.9. Microphones: Directional Response

- Microphones pick up sound in various patterns (due to pressure or pressure gradient)
- Called polar pattern, pickup pattern, or directional response
- Microphones have a "front" or primary point of address, called on-axis
- Degrees are used to describe off-axis position (reverse is 180 degrees off-axis)
- Pickup patterns are in expanding three-dimensional spaces
- Different pickup patterns have different directional "pull" (sensitivity, or direcitional response)

13.10. Microphones: Directional Response Types

- Omnidirectional
    1. Gather sound from all around
    2. Called an "omni"
    3. Useful for gather reflections and space of a sound
    4. Not considered a "directional" microphone
    5. No proximity effect
- Bidirectional
    1. Gather sound from two sides
    2. Called a "figure-eight"
    3. Useful for complete side rejection and rejection
    4. Useful for capturing reverse reflections
    5. Useful for getting two sources into one channel
    6. Useful for the sides of a mid/side stereo recording
    7. Common polarity of ribbon microphones (pressure gradient)
    8. Proximity effect
- Unidirectional
    1. Gather sound from one primary direction

2. Useful for focusing in on a singular sound source

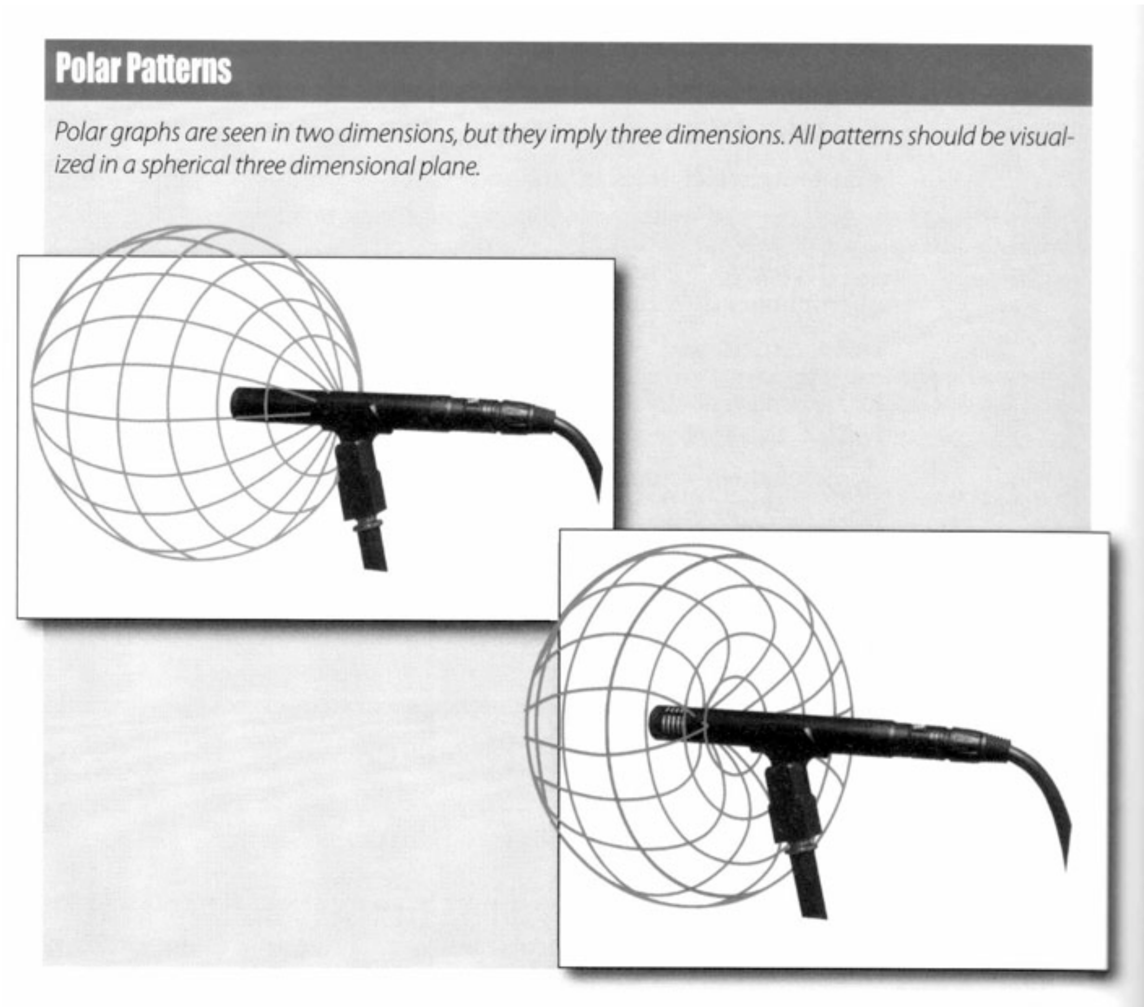
3. Various types of cardiods: reject sound form the rear

4. Proximity effect

- Some microphones have variable patterns with switches or interchangeable capsules

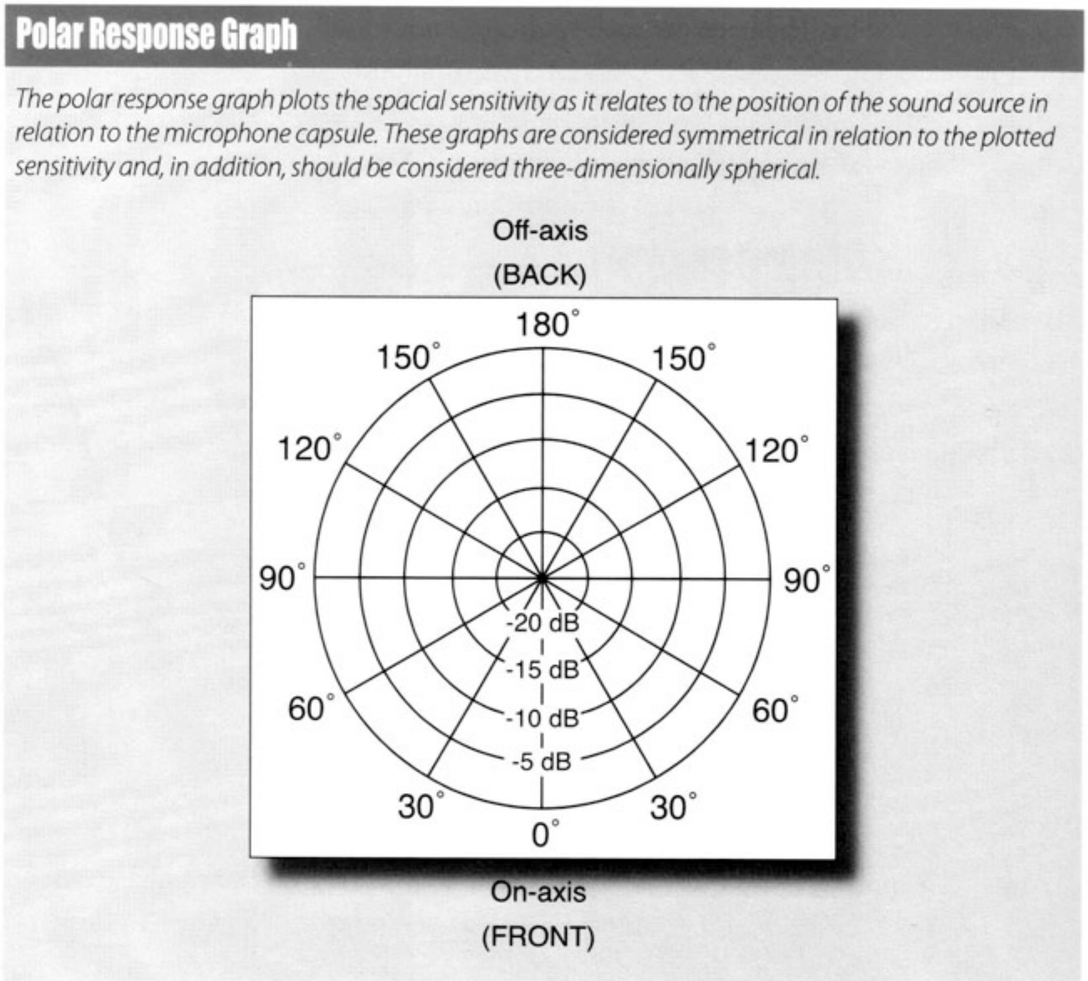
13.11. Directional Response in 2D and 3D

- Three dimensional presentation



Source: Gibson, B. *Microphones & Mixers*. 2007.

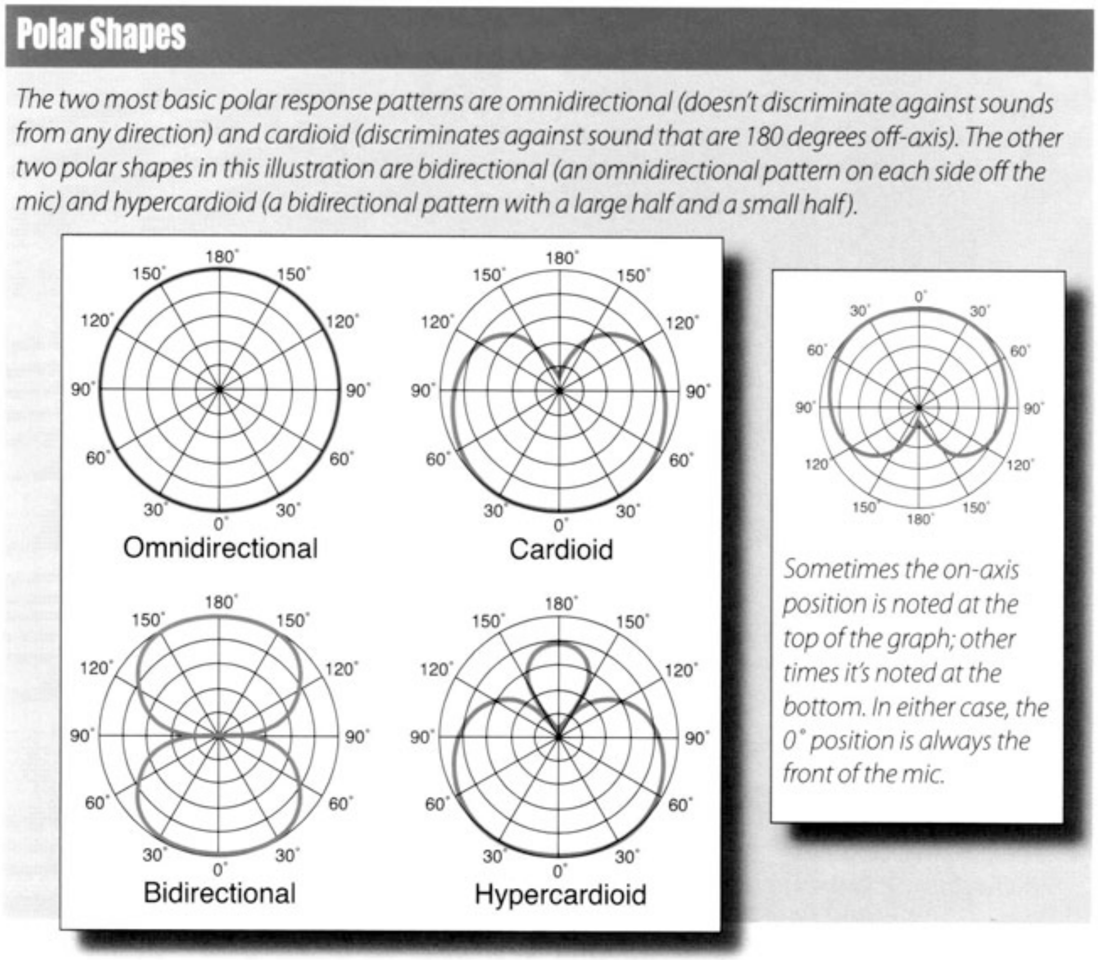
- Two dimensional presentation


Polar Response Graph

The polar response graph plots the spacial sensitivity as it relates to the position of the sound source in relation to the microphone capsule. These graphs are considered symmetrical in relation to the plotted sensitivity and, in addition, should be considered three-dimensionally spherical.

Source: Gibson, B. *Microphones & Mixers*. 2007.

- Cardiods in two dimensions



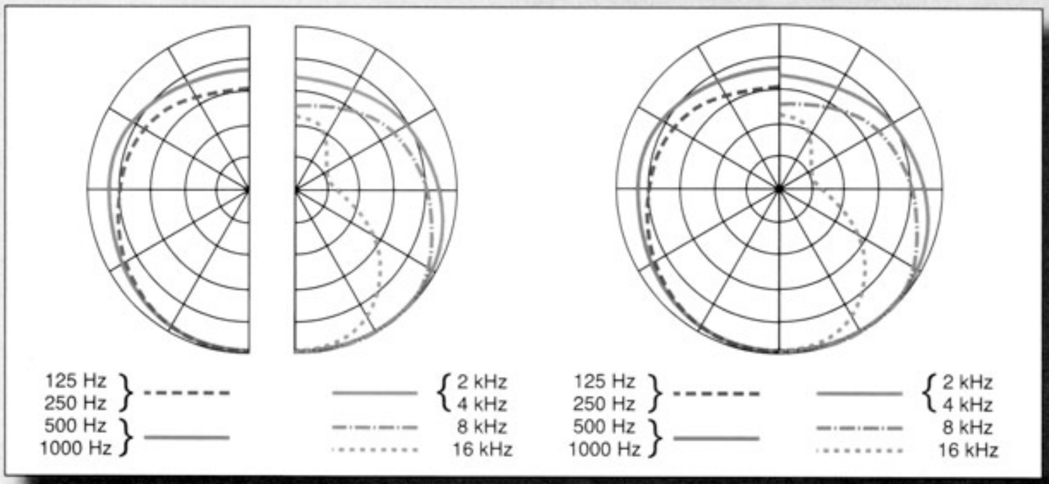
Source: Gibson, B. *Microphones & Mixers*. 2007.

13.12. Directional Response: Frequency Dependence

- Directional response is not the same for all frequencies

Multiple Frequencies and Symmetry on the Polar Graph

The polar graph often displays the directional characteristic for multiple frequencies. To accomplish this in the least cluttered manner, all patterns are assumed to be symmetrical across the Y axis. In addition, to help clarify the results, various line styles are incorporated on each frequency. Sometimes the polar graph is split, like the graph on the left, to highlight the variations in frequency response; other times the graph is whole, like the graph on the right, with the pattern variations simply changing between left and right.



Source: Gibson, B. *Microphones & Mixers*. 2007.

13.13. Directional Response: Characteristics of Cardiods

- Directional response summarized

  Key value is the distance factor

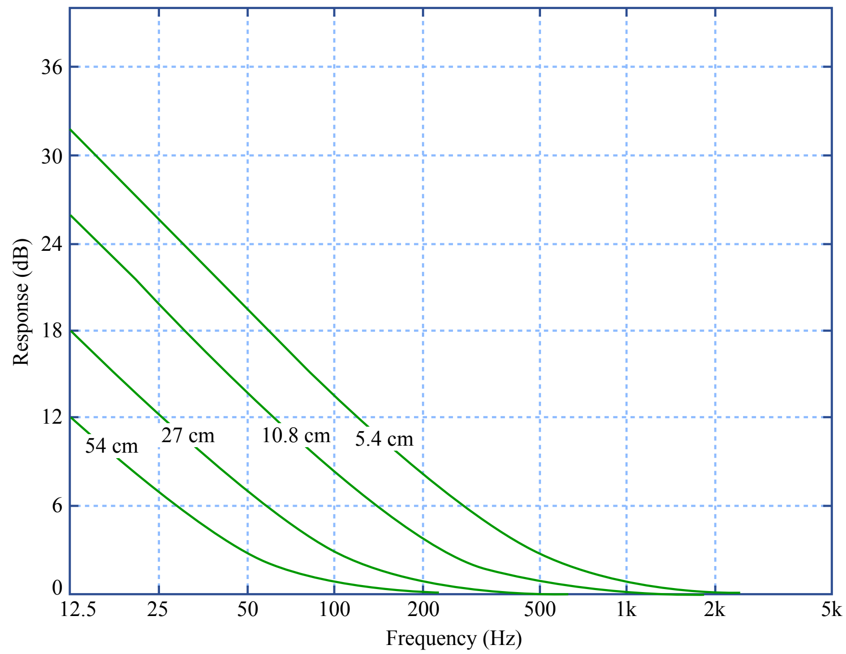
Image removed due to copyright restrictions.
Characteristics of first-order cardioid microphones, Figure 5-4, in
Eargle, J. *The Microphone Book*. 2nd ed. Focal Press, 2004.

- A greater distance factor means a greater directional pull
- Equal-amplitude distance chart

Image removed due to copyright restrictions.
Distance factor illustration for first-order cardioid microphones, Figure 5-5, in Eargle, J. *The Microphone Book*. 2nd ed. Focal Press, 2004.

13.14. Proximity Effect

- Bass frequencies are exagerated when very close to directional (cardiod or figure-eight) microphones
- Low cut filters are often provided on microphones to mitigate



Graph of the proximity effect vs. distance for a cardioid microphone, on axis.

Image by MIT OpenCourseWare.

13.15. Microphone Parts and Species

- Diaphragm
  - Large: greater than a few centimeters
  - Small
  - Smaller diaphragms have less off-axis coloration
- Capsule: contains diaphragm as well as mount and possibly a pre-amp
- Transduction Method
  - Magnetic Induction
  - Variable Capacitance
- Transducer Type
  - Condenser (Variable Capacitance)
  - Moving Coil or Dynamic (Magnetic Induction)
  - Ribbon (Magnetic Induction)

13.16. Transduction Methods: Magnetic Induction

- Electromagnetic force
- Moving metal in a magnetic field produces voltages
- Induce a voltage with a magnet
- Used in ribbon and dynamic mics
- Do not require power to operate

13.17. Transduction Methods: Variable Capacitance

- Electrostatic force
- Two closely-spaced, parallel plates: one fixed, one acts as a diaphragm
- Stored charge, between plates, varies due to acoustical pressure
- Requires power to charge plates (usuall 48 V phantom power)
- Output is very small small; must be amplified in microphone

13.18. Transducer Type: Dynamic

- Metal is a coil attached to a diaphragm that moves within a magnetic field

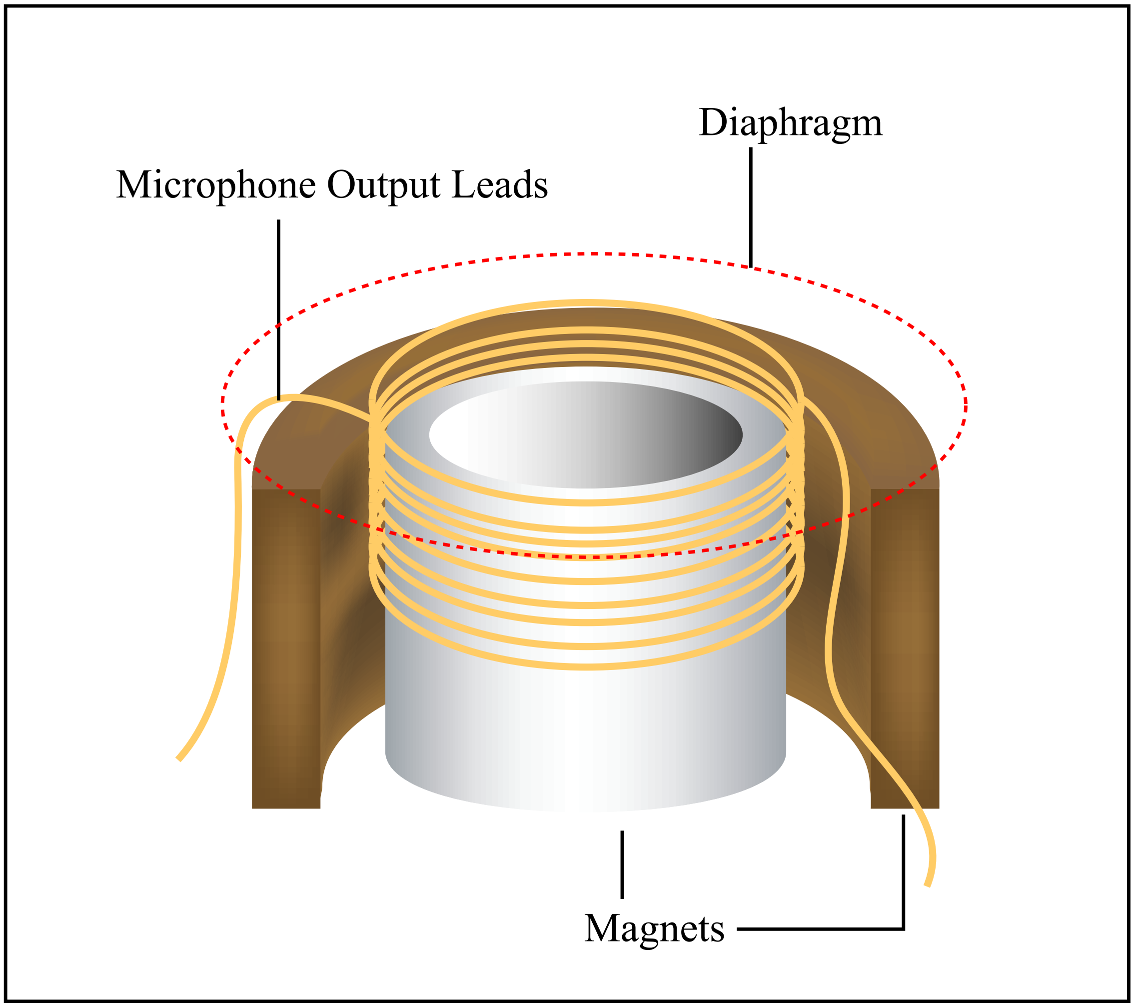


Image by MIT OpenCourseWare.

- Have big magnets: heavy
- Diaphragm must move relatively large distance: slower transient response

- Durable, can handle high SPLs
- May color sound between 5 and 10 kHz
- Often used in close-miking, within a foot of source; can be very close
- Phantom power not necessary, does not hinder performance

13.19. Transducer Type: Dynamic: Examples

- Shure SM-57

- Sennheiser MD-421

13.20. Transducer Type: Ribbon

- Metal is a thin ribbon

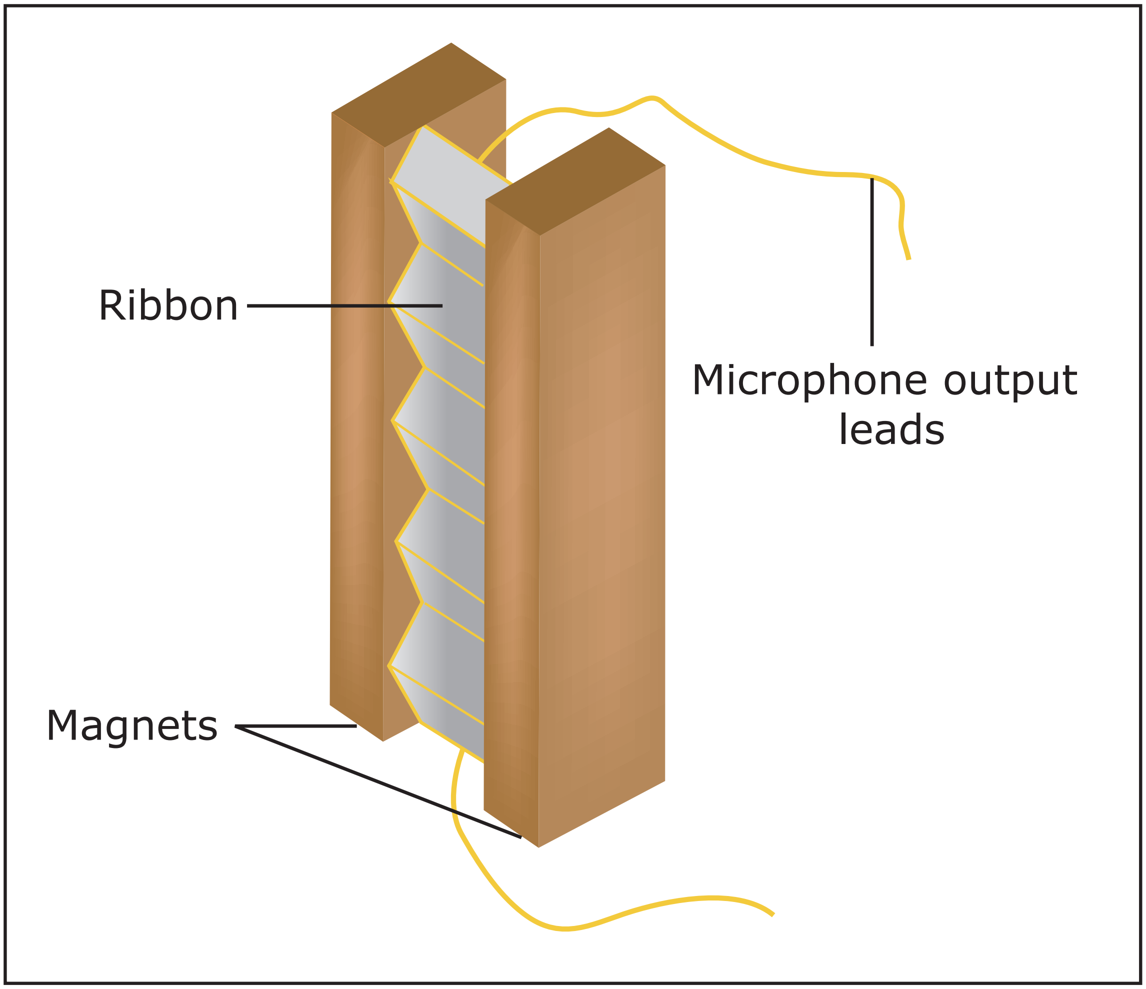


Image by MIT OpenCourseWare.

- Ribbon suspended between poles of a magnet
- Old ribbon mics were very fragile and unreliable
- Newer models are better
- Known for warm sound when used in close proximity
- Phantom power can cause old models to fry

13.21. Transducer Type: Ribbon: Examples

- AEA R92

• Royer R-122

13.22. Transducer Type: Condenser

• Delicate and accurate

• Diaphragm must move relatively small distance: fast transient response


AT4050

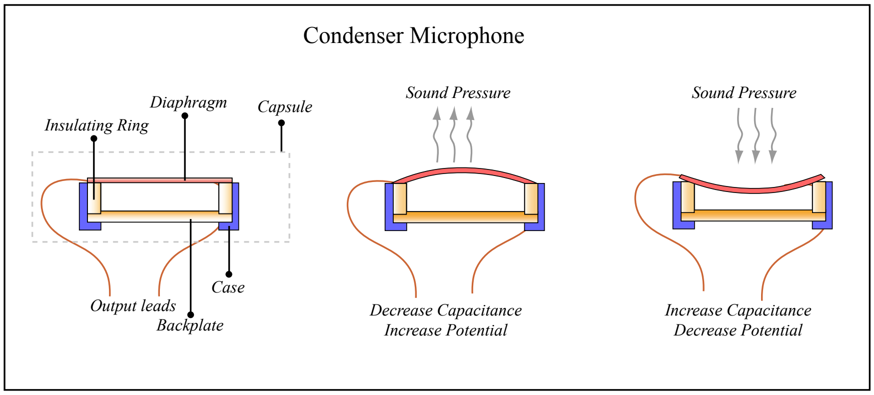


Image by MIT OpenCourseWare.

- Often offers less coloration
- Do not have to be very close to get an intimate sound
- Phantom power necessary
- Internal pre-amp may be transistor- or tube-based

13.23. Transducer Type: Condenser: Examples

- AKG C 414 BXL II/ST

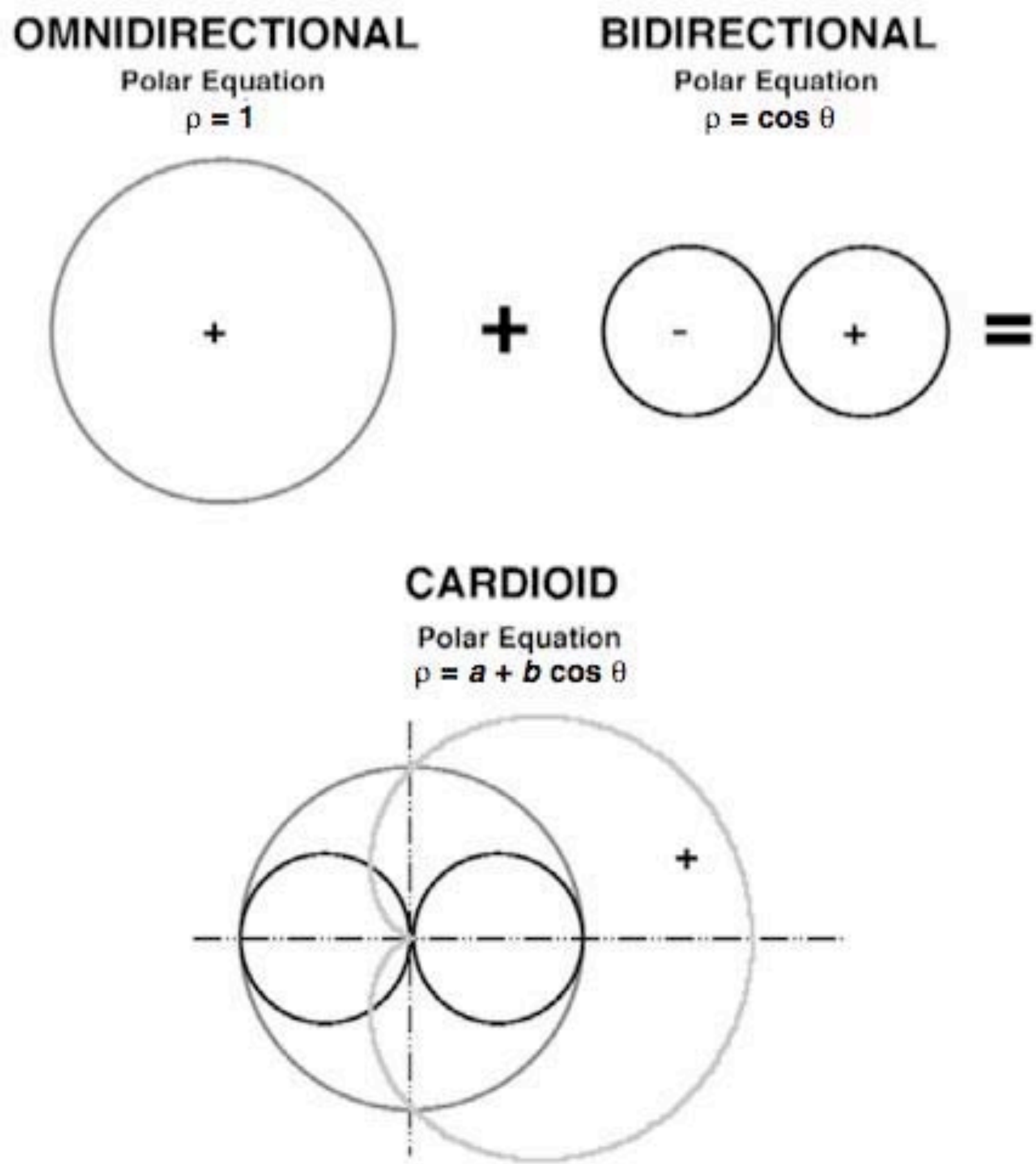
- AudioTechnica AT 4050

- Neumann M149

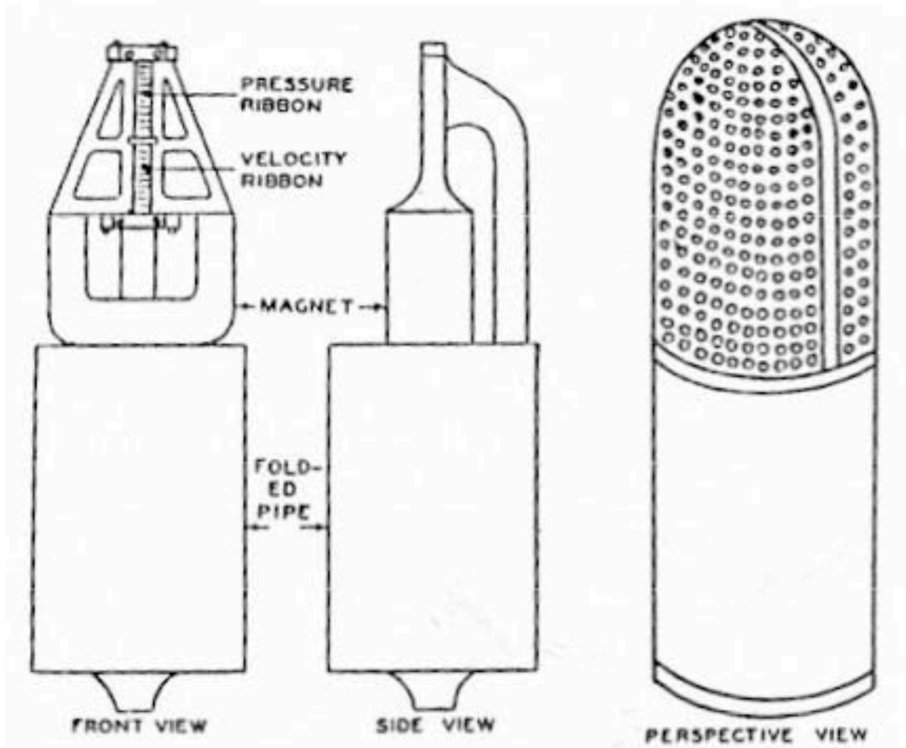
13.24. Reading: Streicher: The Bidirectional Microphone: A Forgotten Patriarch

- Omni-directional microphones are pressure microphones: respond only to pressure; diaphragm covers a sealed chamber

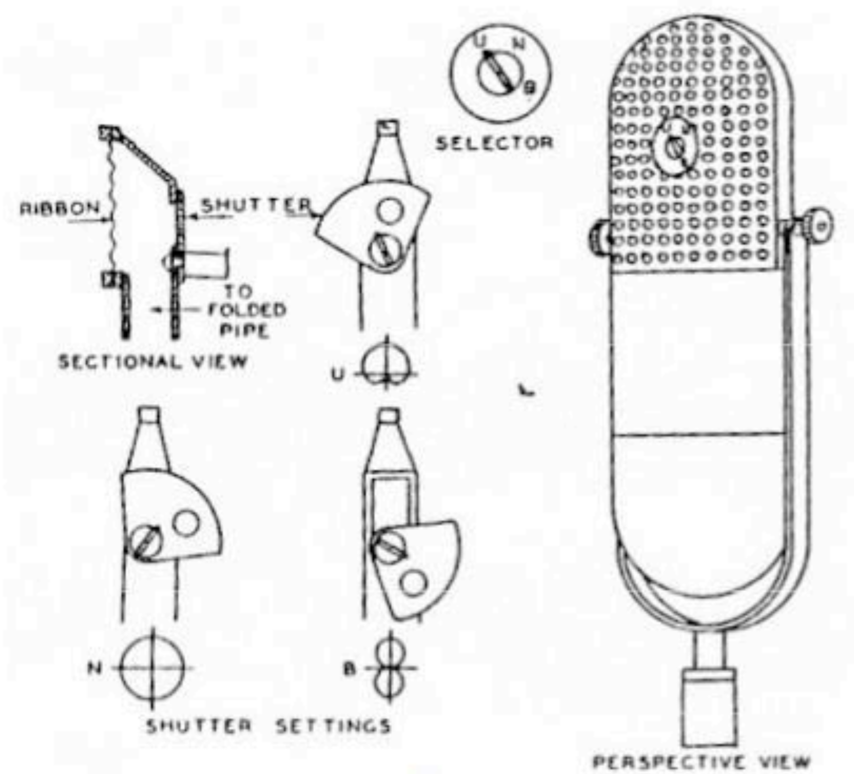
- Bi-directional microphones have a diaphragm exposed on both sides: responds to difference (or gradient) in pressure; sometimes called velocity
- A cardioid (directional) pattern can be created by combining omni and bidirectional patterns
- All polar patterns can be derived from combination of omni and bi-directional



- Earliest variable polar pattern microphone (RCA 77A) did this mechanically with a diaphragme divided into two parts



(a)



(b)

Source: Olson, H. F. "A History of High-Quality Studio Microphones." *55th Convention of the AES* 24 (1976): 862.

- Many modern capacitor mics that offer multiple patters used two cardioid diaphragms back to back and vary amplitude of components

13.25. Recording Instruments: Study, Experience, and Experimentation

- Conventional approaches based on practice and experience
- Creative approaches based on experimentation
- Walk around and listen
- Thinking of sound in three dimensions

    1. Three dimensional radiation
    2. Sound takes time to travel: 1.13 foot per millisecond (331 m/s)
    3. Sound travels in space: amplitudes diminish with distance
    4. Reflections matter: opportunities for comb filtering / phasing distortion