MICROPHONE DESIGNS

Microphones are transducers
Any device which converts energy from one form to another.

<table>
<thead>
<tr>
<th>Energy</th>
<th>In</th>
<th>Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microphone</td>
<td>acoustic</td>
<td>electric</td>
</tr>
<tr>
<td>Loudspeaker</td>
<td>electric</td>
<td>acoustic</td>
</tr>
<tr>
<td>Tape Play head</td>
<td>magnetic</td>
<td>electric</td>
</tr>
<tr>
<td>Phono cartridge</td>
<td>mechanical</td>
<td>electric</td>
</tr>
</tbody>
</table>
MICROPHONE SPECIFICATIONS

A short List

- **Frequency response**: the range of sound wave frequencies a microphone can transduce effectively.

- **Sensitivity**: how much signal level is produced for a given SPL.

- **Directional characteristics**: the direction(s) in space that a microphone is most sensitive.

- **Signal to Noise Ratio**: How much greater the audio signals is compared to the noise inherent in the microphone system. (larger numbers are better)
MICROPHONE PREAMPLIFIERS

A microphone's output level is usually too low to feed directly to a “line level” input, such as a tape recorder.

A microphone pre-amp is used to increase the output to line level.
MICROPHONE DESIGN TYPES

1. Dynamic
   a. Moving coil
   b. Ribbon

2. Condenser or Capacitor
A. Diaphragm
B. Coil
C. Magnet
DYNAMIC-MOVING COIL

DIAPHRAGM

VOICE COIL

MAGNET
DYNAMIC-MOVING COIL
ADVANTAGES

• Rugged
• No need for power to operate
• Generally less expensive
• Difficult to overload (distort)
DYNAMIC MOVING COIL

DISADVANTAGES

❖ Lower sensitivity than condenser
❖ Frequency & transient response not as good
❖ Most don’t have switchable polar (directional) patterns
Basic Ribbon Construction

- Magnet
- Ribbon
- Output Leads

0.25" Wide
2.0" Long
0.0001" Thick
DYNAMIC-RIBBON

[Diagram of a dynamic-ribbon component with labels such as 'Impedance Matching Transformer', 'Nested Shield Case', 'Insulated Ribbon Support', 'Opening to Reduce Travel of Wave at the Higher Frequencies', 'Ribbon Tension Adjustment', 'Clamping Bar', 'Permanent Magnet', 'Side View of Ribbon and Blocks'].

[Image of the diagram with labels for each part of the dynamic-ribbon mechanism.]
HOW A RIBBON MICROPHONE TRANSDUCES
Dynamic-Ribbon Advantages

- Many have unique “smooth” sound quality
- Good Bi-directional response
- Good transient response
- Older ones have a cool retro look
RIBBON MICROPHONES

DISADVANTAGES

- Most fragile
- Lowest output/sensitivity (highest noise)
- Loud SPL can cause damage
CONDENSER MIC DESIGNS

Front Diaphragm
Fixed Back Plate

Photo of Actual Condenser Capsule
Electrec microphones are condensers with a pre-polarized diaphragm.
CONDENSER & ELECTRET ADVANTAGES

❖ Very sensitive (low noise)
❖ Widest frequency response
❖ Some have switchable polar patterns
❖ Most accurately represents short duration signals (transient response).
CONDENSER & ELECTRET DISADVANTAGES

- Fragile (more than moving coil)
- Require power (phantom or batteries)
- Sensitive to humidity
- Can be internally overloaded
MICROPHONE DIRECTIONAL PATTERNS

Microphones can be made to be more sensitive in a particular direction.

Uni-directional = sensitive in one direction (cardioid patterns)

Bi-directional = sensitive in two directions (figure of eight pattern)

Omni = equally sensitive in all directions (spherical(omni) pattern)

0 degrees on the polar plot below corresponds to the front of the microphone
MICROPHONE DIRECTIONAL PATTERNS

Omni:

- 0°
- 90°
- 270°
- 180°

Bi or Figure of eight:

- 0°
- 90°
- 270°
- 180°

Cardioid

Super Cardioid

Hyper Cardioid
SIDE PORTS ON UNI MICS

• An opening on the side of a uni-directional microphone.

• This opening allows some slightly delay sound energy into the rear of the capsule, creating the cardioid pattern.

• Never cover the ports or the directional characteristics will be lost!
SIDE EFFECTS OF DIRECTIONAL MICROPHONES

• Proximity effect: An increase in bass frequencies as the source moves closer to the microphone and a decrease as the source moves away.

• Off-axis coloration: Changes in frequency response as the source move away from directly on axis. See how patterns change with frequency.
WHY HAVE DIRECTIONAL MICROPHONES?

- Reduce leakage (unwanted sound from other sources)
- Reduce room acoustic leakage (room reflections)
- Greater “reach” to pick up sounds further away.
• Neumann TLM-1 70r

Internal Mic Capsule
RIBBON MICROPHONE

• AEA R84
SHOTGUN CONDENSER

- Neumann KMR 81
BOUNDARY LAYER
CONDENSER

- GFM 132
STEREO MICROPHONE

- Neumann USM 69

- Right Mic (rotates)
- Left Mic
- Directional Pattern Switches
BINAURAL DUMMY HEAD

- Neumann KU100

 Omni Microphone
• Condensers & Electrec Microphones can be powered through the 3 wire balanced microphone cable by phantom power.

• Phantom power is a D.C. (direct current) sent by the mixing console or microphone preamp through the microphone cable.
SWITCHES FOUND ON SOME MICROPHONES

Microphone Pad: A switch on the mic used to attenuate (reduce) loud sounds that may distort the internal electronics of a condenser microphone.

Low frequency roll off filter: Reduces low frequency pick up below a set frequency.
ACCESSORIES & SWITCHES

Wind screen / Pop filter: reduces “popping” caused by low frequencies overloading the mic.

Breath or wind may cause noise and/or pops.

Types: Foam cover or Screen

For Vocals

For Vocals & Wind
Shock Mount- Reduces unwanted mechanical vibrations from the mic stand into the microphone body.
CABLES & IMPEDANCE

- Professional quality studio microphones use a low impedance design and a balanced (3 wire) cable to reduce high frequency loss with long cable lengths and unwanted external noise from stray magnetic fields & radio signals.
BALANCED 3 PIN XLR CABLE

1. Male 3 pin XLR
2. Female 3 pin XLR

- Ground
- Audio (1 and 3)
- + Audio (2 and 3)

Male 3 pin XLR
Female 3 pin XLR
Hot & Cold Wire carry the same audio signal, the cold with reversed polarity. At the input of the mic preamp the polarity of the cold is reversed again so that it adds with the hot signal. Any noise induced by magnetic induction is cancelled because it is the same polarity on both hot & cold.
ASSIGNMENTS

❖ If you own microphones identify design types and there sonic differences.

❖ Locate and identify the microphones in your phone, laptop etc.

❖ See if you can produce the proximity effect, if not why?

❖ See if you can measure the frequency response of a mic.
LEARN MORE

- Video on how a Neumann U87 microphone is made.
- Video on microphone design types
- Microphone buying guide
- Understanding Microphone specifications video