"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them."

Co-funded by the European Union

Video Recording

Microphones Settings

Vladimir Maksimovic

University of Mitrovica (UPKM)

The role of microphones in audio systems

•A microphone is a basic device that converts **acoustic energy (sound)** into **an electrical signal**.
•The role of the microphone is to maintain the naturalness of the sound and the tonal balance of the source.
•The quality of the microphone directly affects the intelligibility, dynamics and character of the voice or instrument.
•Different constructions and characteristics give a specific tonal signature of each microphone.
•The microphone is the most sensitive part of the signal chain and the first step in the recording process.
•In studio and TV environments, several types of microphones are used for different tasks.

The principle of converting sound into an electrical signal

•Sound is **a mechanical wave** that moves a thin membrane in the microphone.

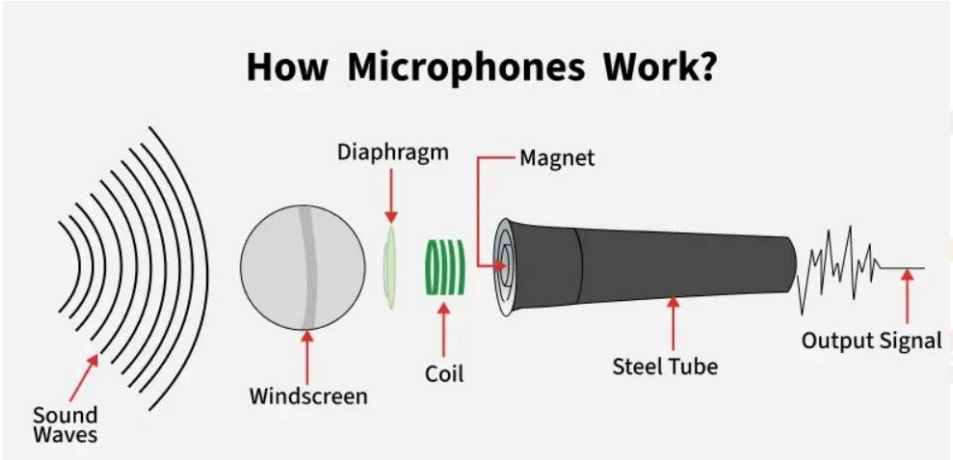
•The diaphragm changes the electrical value (voltage or current) according to the sound wave pressure.

•The signal obtained is **an analog** display of sound pressure.

•The sensitivity of the microphone is measured in mV/Pa and depends on the type of inverter.

•Dynamic and condenser microphones have different conversion mechanisms.

•Signal quality depends on conversion accuracy and low noise.



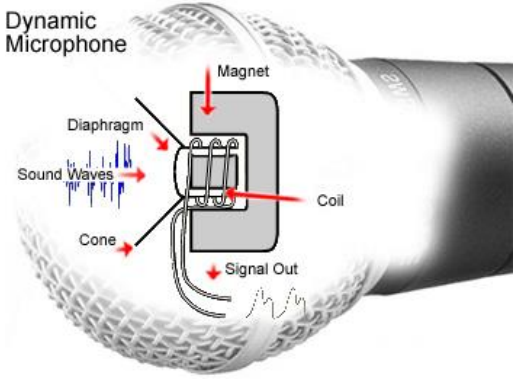
Co-funded by
the European Union

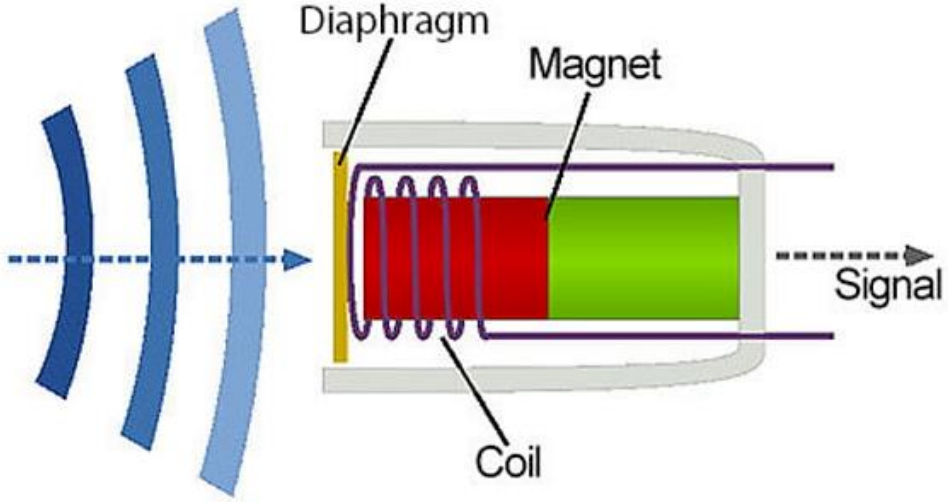
Microphone types by inverter

- **Dynamic microphones** use a magnet and coil, are robust and impact-resistant.
- **Condenser microphones** use a variable capacity between the membrane and the board.
- **The electret microphones** have a permanently polarized capacitor (in lavalier models).
- **Ribbon microphones** use a thin metal band – they give a natural, warm tone.
- **Digital microphones** have an integrated A/D converter and direct digital output.
- **USB microphones** dconnect directly to the computer via the USB port.
- The choice of type depends on **the application, sensitivity and acoustic character**.

Dynamic microphones: working principle

- The dynamic microphone operates on the principle of electromagnetic induction.
- Sound drives the diaphragm that is connected to the coil in the magnetic field.
- The movement of the coil generates an electrical signal proportional to the sound.
- They do not require power to operate.
- They are robust and resistant to physical shocks.
- They tolerate high sound levels (SPL) well.





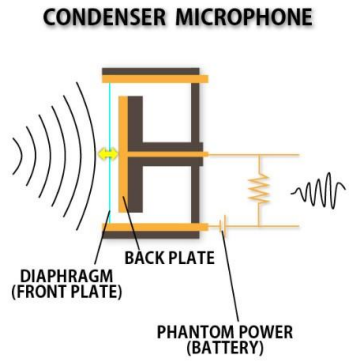
Co-funded by
the European Union

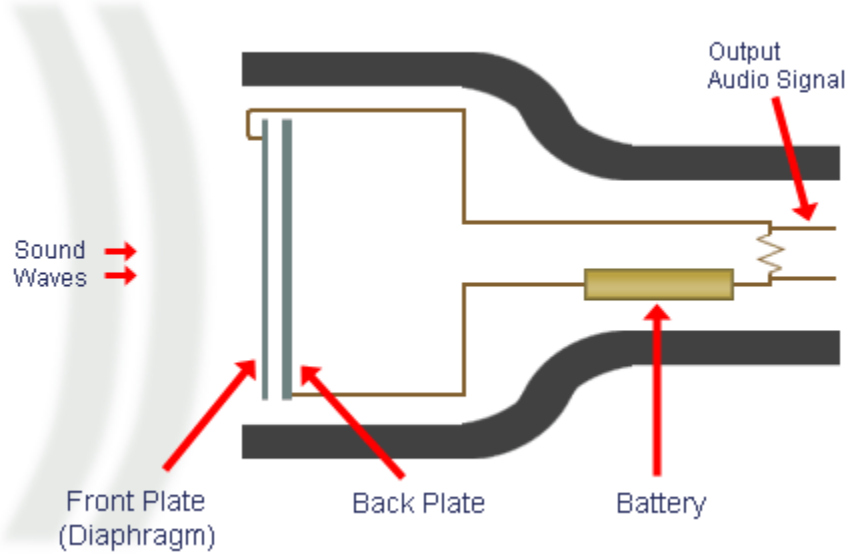
Dynamic microphones: application

- They are most commonly used at concerts and live events.
- Suitable for vocals in noisy environments.
- They have natural resistance to background noise.
- They reject microphone (feedback) well.
- They are long-lasting and cheaper than condenser microphon

Condenser microphones: working principle

- The condenser microphone operates on the principle of variable capacity.
- The diaphragm and back plate form a condenser.
- The sound moves the diaphragm, changing the capacity and creating a signal.
- They need a phantom power supply (+48V).
- They are more sensitive to detail and high frequencies.
- They have a wider frequency range than dynamic microphones.
- They are used where high audio fidelity is required.





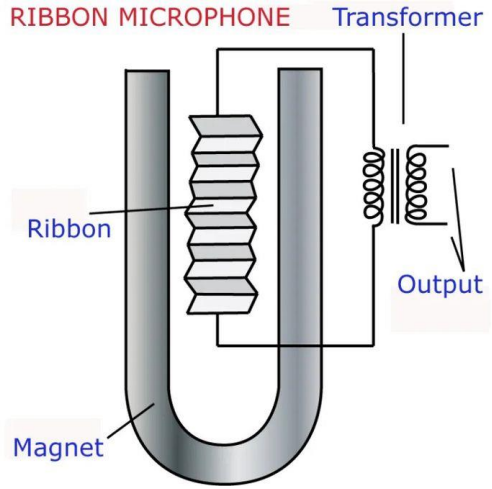
Co-funded by the European Union

Condenser microphones: application

- Standard in instrument recording studios.
- They are used in radio and TV studios.
- Suitable for recording acoustic instruments.
- They are often used as overhead drum mics.
- They convey the dynamics and details in the sound very accur
- They can be large diaphragm or small diaphragm.
- Directional microphones are often condenser
- Very sensitive to ambient noise and room.

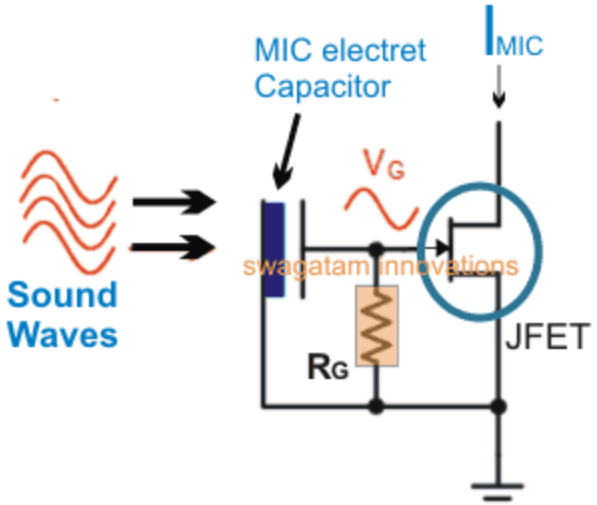
Ribbon microphones

- They use a thin metal strip placed in a magnetic field.
- The sound moves the tape and generates a signal
- They have a warm and natural sound.
- They most often have a figure-8 polar pattern.
- They are sensitive to mechanical damage.
- Not suitable for extremely high SPL levels.
- Popular in vocal and guitar amplifier studios.



Electret Condenser Microphones

- A special type of capacitor with a constantly charged membrane.
- They do not require a high phantom power supply.
- Small and compact, ideal for lavalier microphones.
- They are used in mobile devices and laptops.
- They have a good ration quality-price.
- Often integrated into wireless lapel systems.
- Sensitive to noise and RF interference.

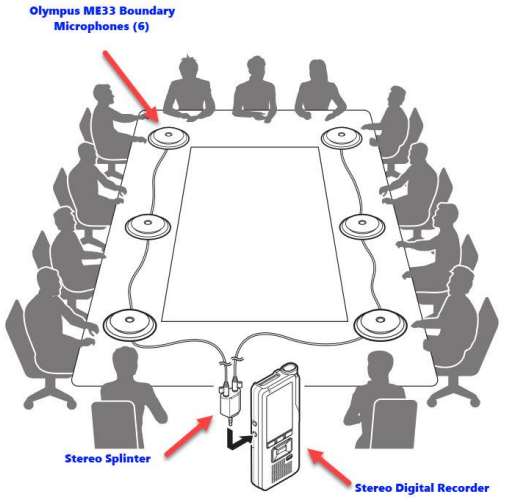


USB Microphones

- They connect directly to the computer via a USB port.
- They have a built-in digital audio interface solution.
- Popular for podcasting and streaming.
- Suitable for home studies and content creators.
- Cheaper than professional XLR microphones.
- Limited options in terms of quality and settings.

Boundary microphones

- Boundary microphones placed on the surface (table, floor).
- They use sound reflection for better response.
- They are used in conference rooms.
- Suitable for recording group conversations.
- Some models use cardioid capsules.
- They are also used in theatre to capture the ambience.
- Often connected via XLR or mini-jack.

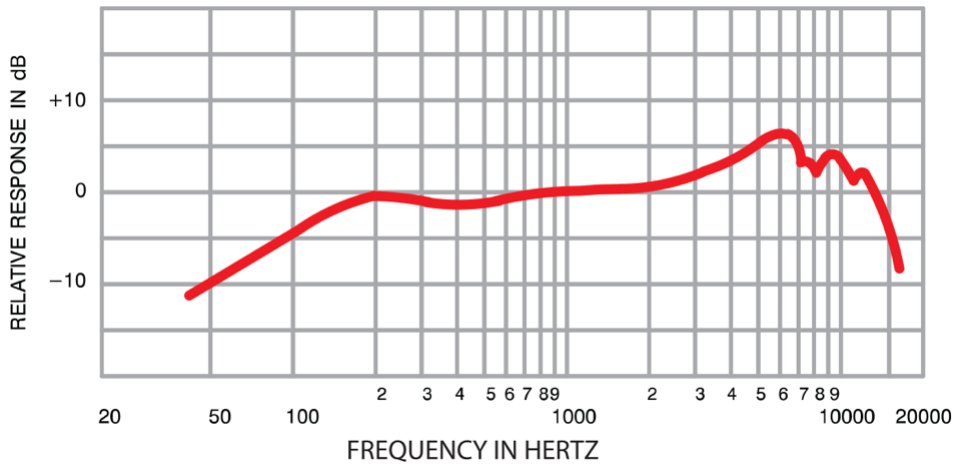


Specialized microphones

- Piezo microphones for instrument vibration capture.
- Binaural mics with ear mimics for 3D audio.
- Contact microphones for special effects and experimental music.
- Measurement microphones (flat response).
- Waterproof microphones for special applications.
- Sport microphones with directional capsules.
- Wireless clip-on microphones for small devices.

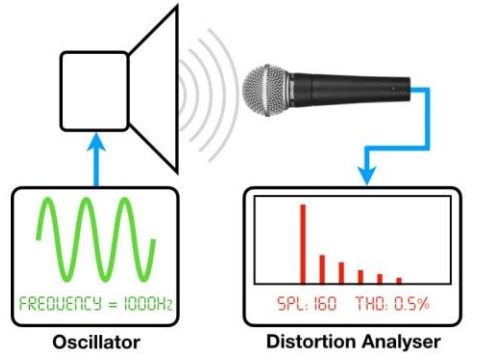
Frequency response and microphone behavior

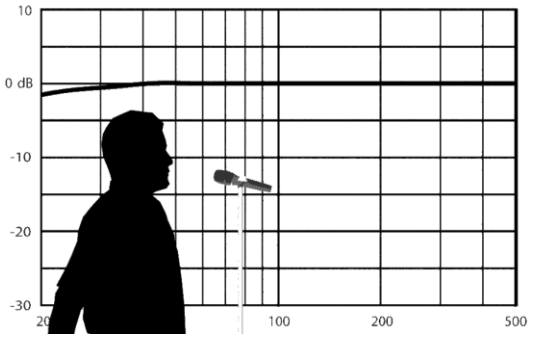
- The frequency response shows how the microphone responds to different tones.
- **The flat response** gives a natural and neutral sound – ideal for the voice.
- **The amplified response** in a certain range is used to colorize the sound.
- In a diffuse field, the microphone reacts differently than in free space.
- The size of the membrane affects the accuracy of high and low tone playback.
- The response is often displayed graphically (Hz to dB).

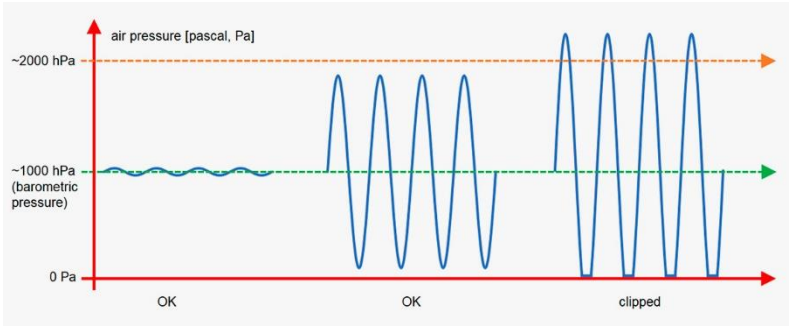


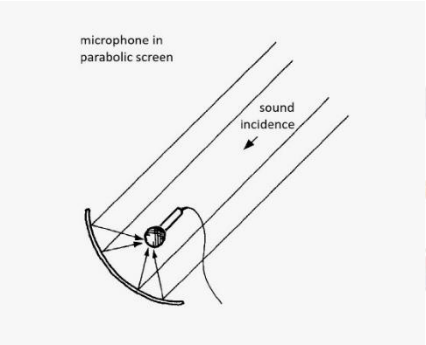
Effects and phenomena in microphones

- **Proximity effect:** bass amplification at a short distance.
- **Diffraction:** bending of the waves around the body of the microphone, changes the tonality.
- **Reflections:** affect the phase shift and the creation of sound color.
- **Pressure build-up:** acoustic pressure at closed surfaces (e.g. piano, drum).
- **Distortion:** occurs when the SPL exceeds the dynamic range of the microphone.
- Quality microphones have built-in **mechanical filters** to mitigate these effects.









Co-funded by
the European Union

What determines the character of the microphone

•The character of the microphone depends on the **directionality**, **frequency response** and **capsule**.

•Each combination gives a specific tonal balance and sensitivity to surrounding sounds.

•Directional microphones reduce ambient noise, while omni capture all sounds evenly.

•It is important to match the character of the microphone with the acoustics of the space and the type of voice.

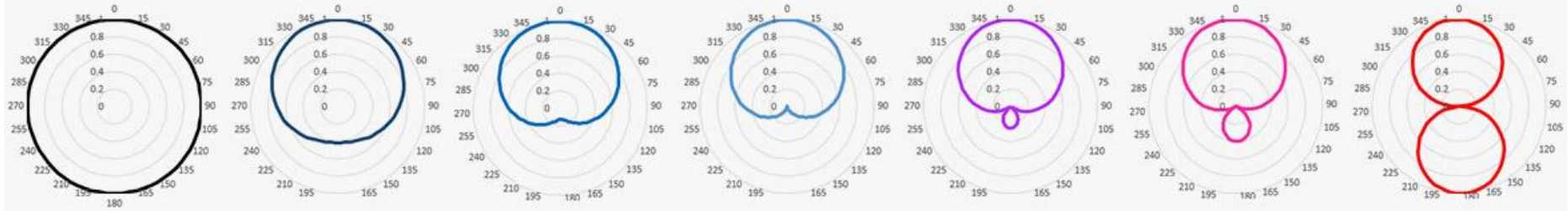
•The polar diagram helps to select the microphone for specific conditions.

•Professional systems combine multiple microphones of different character.

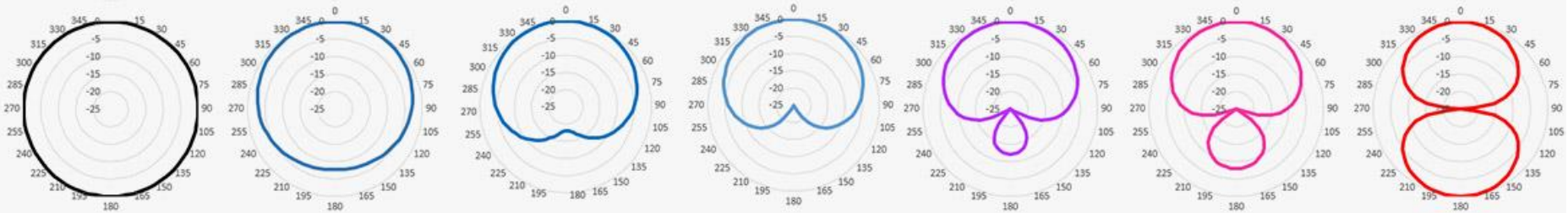
Co-funded by
the European Union

Polar pattern

Linear scale



Omni Wide Open Cardioid Super Hyper Fig. 8



Log scale (dB)

Basics of Audio Signal Lines

•The microphone generates a voltage that is transmitted to the mixer or recorder.

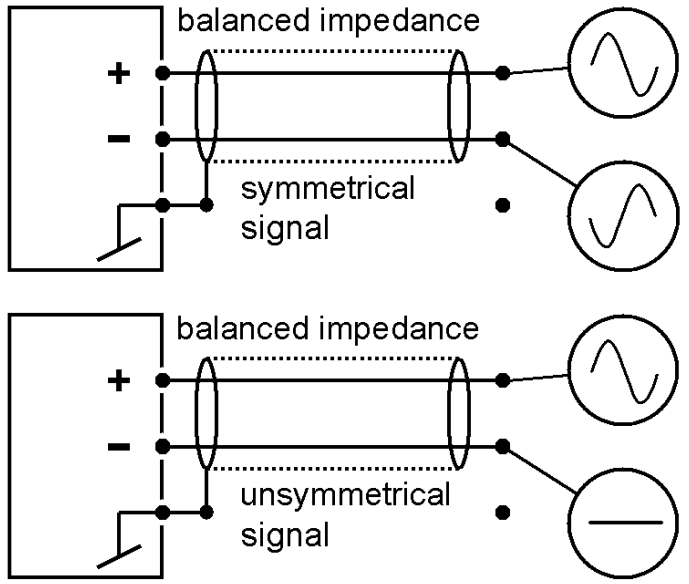
•This signal may be **balanced** or **unbalanced**, depending on the transmission mode.

•Transmission quality is determined by cable resistance, length, and electromagnetic interference.

•Balanced systems use **two conductors and a ground**, while unbalanced systems use only one and a ground.

•Professional audio systems always prefer balanced connections to reduce noise.

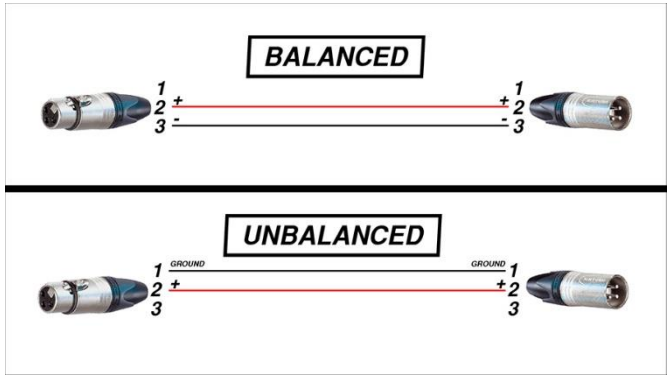
•Cables may terminate with **XLR, TRS or RCA** connectors.



Balanced signal

- It transmits the signal using **two opposite phase conductors** and a common ground.
- Interference affecting both conductors is cancelled in the mixer (common mode rejection).
- Provides **clean and stable transmission** over long distances.
- The standard microphone signal level is about **–60 to –40 dBu**, line level about **+4 dBu**.
- It is used in professional audio systems, TV and theaters.
- The most common connector is **XLR (3 pins)**.

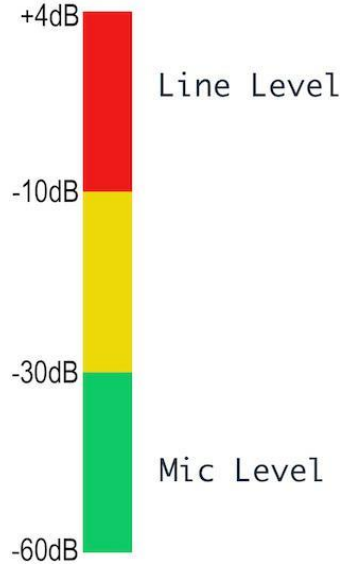
Unbalanced signal



- Transmits the signal using **a single conductor and ground**.
- Easily susceptible to electromagnetic interference and buzzing.
- Only suitable for **short cables** (up to 3 m).
- Used in **consumer audio equipment, cameras, instruments**.
- Typical connectors: **RCA (cinch)** or **mono 6.3 mm jack**.
- The difference in level between balanced and unbalanced can be up to **12 dB**.

Microphone and line signal level

- The microphone level is very low (**–60 dBu**), it needs a **preamp**.
- The line level is much stronger (**+4 dBu professional / –10 dBV consumer**).
- If the microphone signal is connected to the line input, it will be almost silent.
- Conversely, a line signal to the microphone input may cause **distortion and damage**.
- The preamplifiers in the mixers compensate for the difference between the levels.
- Wireless microphones often have an output level adjustment to accommodate input.



Phantom power supply (+48 V)

•the condenser microphones require **voltage to operate the capsule and electronics**.

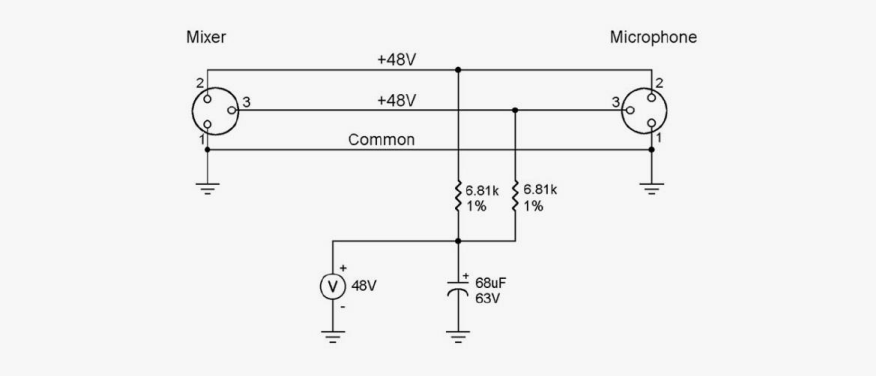
•The Phantom power supply is transmitted **through the same cables** as the audio signal.

•The standardized power supply is **+48 V DC** (IEC 61938).

•It is activated on the mixer, interface or preamp.

•Dynamic microphones ignore the phantom power supply and are not compromised.

•The phantom power supply should never be switched on if an unprotected **ribbon microphone** is connected.



Influence of volume and frequency on perception

•The human ear is not equally sensitive to all frequencies – it is most sensitive between 20 Hz – 20 kHz.

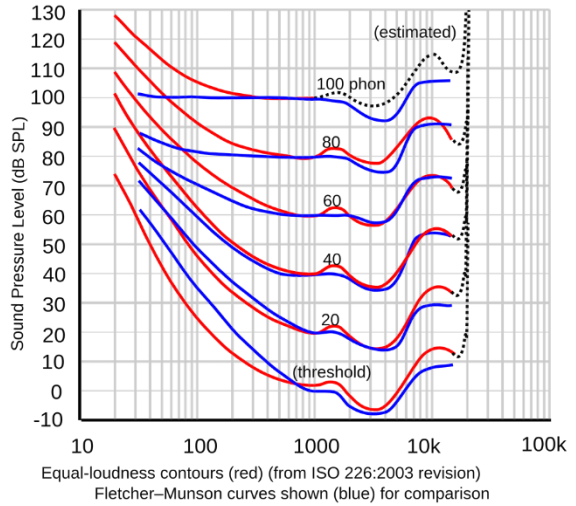
•Loud sounds seem more dominant even if they have a lower energy value.

•Nonlinear response microphones can distort tonal balance at higher volumes.

•The equal volume curves (Fletcher–Munson) explain the change in perception with intensity.

•In practice, **compression** is used to reduce the dynamic range and increase the subjective volume.

•For live broadcasts, monitoring must be set to avoid overgain.



Equal-loudness contours (red) (from ISO 226:2003 revision)
Fletcher–Munson curves shown (blue) for comparison

Handling Noise

•Vibrations and body movements are transmitted through the microphone structure to the capsule.

•Handling noise occurs when grasping the microphone, cable or stand.

•Cause: **mechanical resonances, connector friction, shocks**.

•Condenser microphones are more sensitive than dynamic microphones.

•Solution: **rubber brackets (shock mount), anti-vibration brackets, rigid cables**.

•Proper microphone holding (at the bottom of the body) reduces vibration transmission

•Quality microphones have internal damping elements (foam lining, elastomer).

•In boom settings, the cable must be loosened so that it does not transmit vibrations.

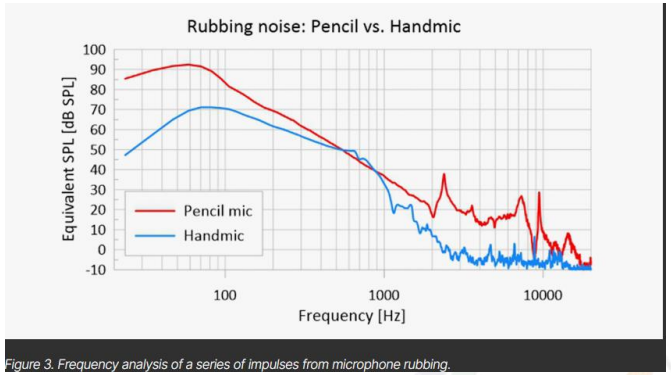


Figure 3. Frequency analysis of a series of impulses from microphone rubbing.

Basic principles of proper microphone positioning

•The position of the microphone relative to the source has a decisive impact on the quality of the recording.

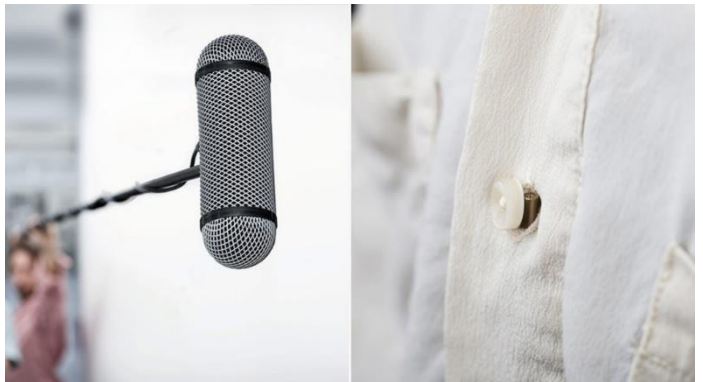
•Distance, angle and directionality change the tonal balance and clarity of voice.

•Proximity enhances the bass (proximity effect), while greater distance increases ambience.

•The angular position affects the sibilants and the “blowing”.

•The microphone should be positioned to retain the natural voice-to-space relationship.

•Professional records require testing multiple positions before final selection.



Microphone position relative to voice

•The microphone is usually placed at an angle of **30–45°** to the mouth.

•The position below the line of the mouth gives a warmer tone, while above it creates a brighter character.

•Lateral placement reduces explosive consonants (“p”, “b”).

•A distance of 15–20 cm is optimal for most vocal recordings.

•Proper setting reduces the need for post-processing (EQ, compression).

•In live production, the position is adjusted to the microphone type (dynamic or condenser).

Proper posture of the vocal microphone

- On laboratory measurements, the microphone is positioned away from obstacles — in real conditions, the hand and head affect the sound field.
- Holding the microphone at the end of the handle gives minimal deviations in frequency response (a slight “ripple” above ~3 kHz).
- If the microphone is held closer to the head, under the reticle, major deviations occur — resonance in the range of ~ 1.8-2.2 kHz and above 10 kHz.
- "Cupping" (placing fingers/close to the grid) causes pronounced resonances and sound distortions.
- The hand covering the half grid causes resonance in the frequency range of about 2 kHz and above 6 kHz.
- The largest deviation occurs if the arm encompasses the entire mesh – multi-band resonance gain.

Proper posture of the vocal microphone

•A certain measure of resonance resulting from handling can be quite unpleasant and audible in live systems.

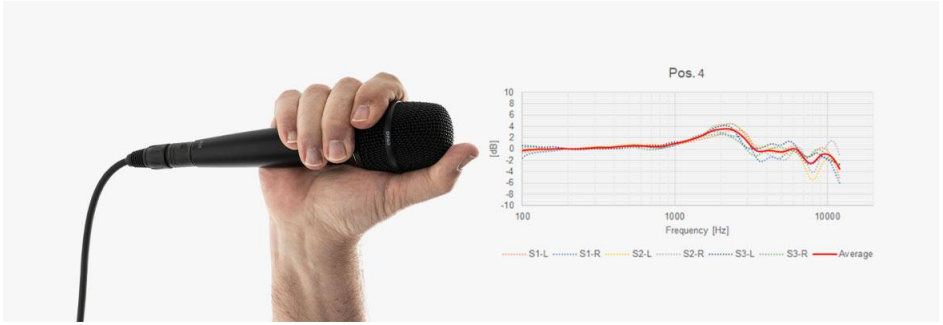
•Proper posture – with the handle (without cupping) – results in minimal changes in frequency response.

•Some microphones and some positions experience a drop in directives (the microphone becomes less directional).

•\Holding part closer to the mesh or partially covering causes measurements of resonant peaks and color in the sound.

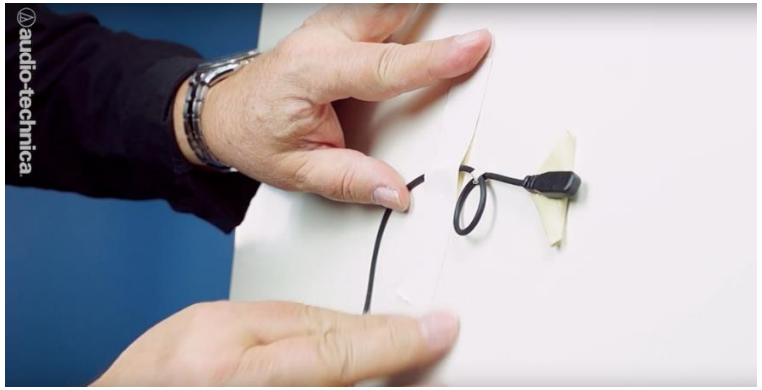
•In PA systems, unpleasant resonances can cause feedback and unwanted sound artifacts.

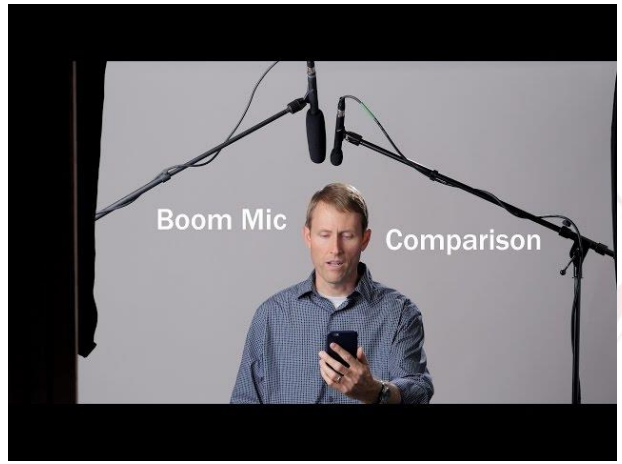
•**Conclusion: it is best to hold the microphone on the lower part of the handle, which is recommended by DPA experts**.



Dialogue microphone setting and multiple interlocutors

- In dialogue, the goal is to make the tone of both interlocutors sound **uniform and natural**.
- Lavalier microphones are placed in the middle of the chest, in line with the mouth.
- In the boom setting, the microphone is held above the heads, in the axis with the speaker.
- Deviations in height and angle give differences in tone and volume.
- Microphones should be paired by model and characteristic (if the two are identical channels).
- Differences in space acoustics may require additional EQ balance.



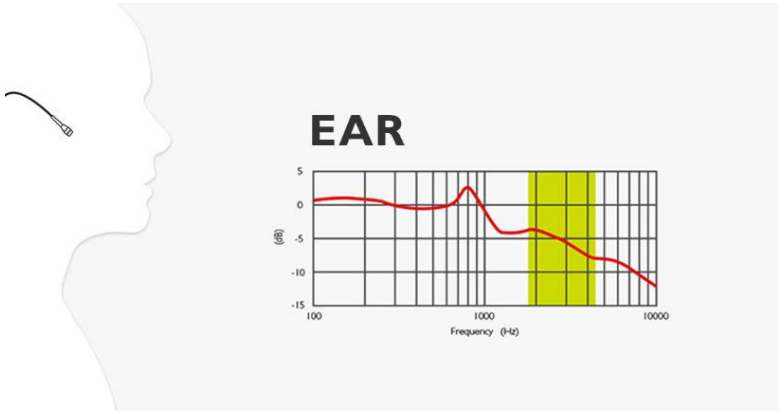


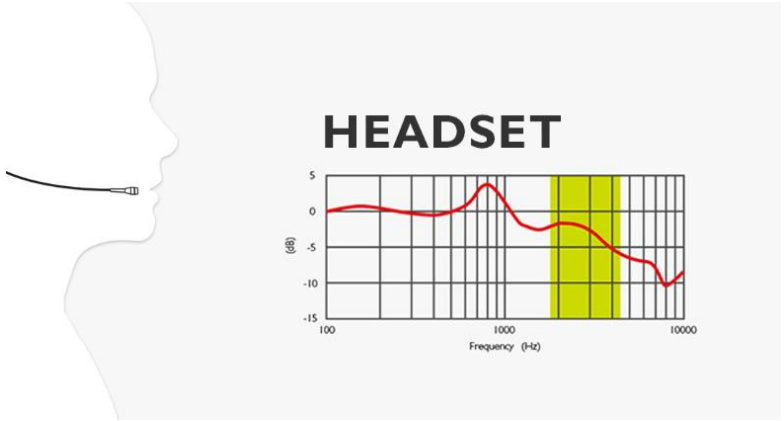
Effect of microphone position on voice sound

•**Reference microphone 1 m in front of the speaker**.

•The forehead-placement microphone gives a tone almost identical to the reference one – with a slight peak of about 800 Hz and a dip of about 1.5 kHz. **Over-ear placement** degrades higher frequencies and loses consonant bands above ~1 kHz.

•The **Lavalier position (lateral, end of smile)** retains the range from 1 to 2 kHz better – better intelligence than the position behind the ear.





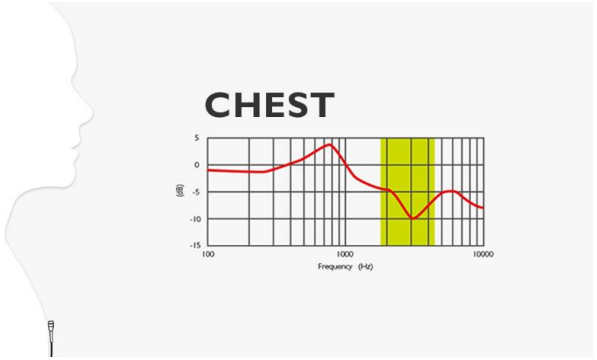
Effect of microphone position on voice sound

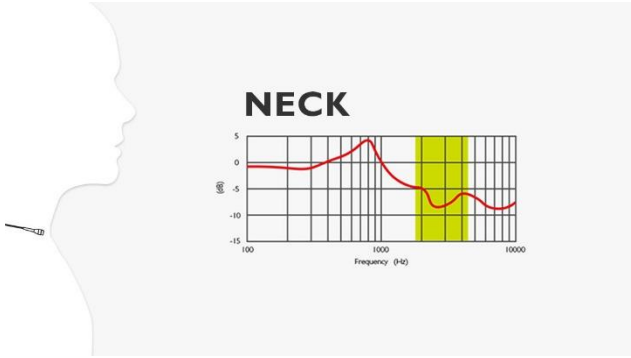
•Placing the microphone on the **chest or neck (under the chin)** gives the worst result — loss of frequencies between 2-4 kHz and poor speech intelligibility.

•The worst position is directly below the chin, as it is furthest behind the sound source.

•Conclusion of the article: position below or behind requires EQ correction to compensate for tonal differences — because the speech signal loses an important spectrum.

•Ideal tonality and the least need for correction is achieved using **the forehead position**, according to the experiment.



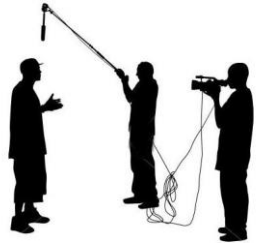


Co-funded by
the European Union

Matching tones between different microphones

- When using different microphones, **tonal matching** should be done.
- Differences in frequency response create unevenness between scenes.
- Solution: using the same microphone model or calibration via EQ.
- In film production, "room tone" helps to harmonize the color of the space.
- recommends avoiding combining the lavalier and shotgun microphones in the same scene.
- Digital processing (EQ matching) can compensate for differences, but with a loss of naturalness.

Co-funded by
the European Union



Microphones in video and TV production

•Recording for video requires **realistic and clean sound**, as the microphone "sees" differently from the camera.

•The microphone must record **what the camera sees**, not what happens outside the frame.

•The best position is as close to the source as possible, but **invisible in the frame** – often lavalier or shotgun.

•**Lavalier microphones** hide under clothing, but require an acoustic opening so they don't sound muffled.

•**Shotgun microphones** are used out of frame, mounted on boom sticks or rigs.

•It is important to harmonize the perspective of the image and sound – the distant frame must have a "further" sound.

Co-funded by the European Union

Microphones in video and TV production

•The most common mistake in video production is relying on top microphones on camera– they give a flat, distant sound.

•It is recommended to use **an external microphone**, even with DSLR and mirrorless cameras.

•When multiple cameras **are** used, all microphones must be phase-coordinated to avoid mounting problems.

•For multi-channel recording (e.g. talk show), each speaker must have a separate microphone.

•Monitoring with neutral reference speakers is used in control rooms and overhead.

•The goal is to perceive sound and image as a unique space.

Co-funded by
the European Union

Sound work in the film industry

•Cinematic sound has the task of retaining the **emotional context of the scene** and natural dialogue.

•Sound technicians use **boom microphones** for the main dialogue and **lavalier** for backup.

•The microphone must follow the **movement of the actor**, but without appearing in the frame.

•In a film set, the environment is often noisy – a **directional shotgun microphone** is used.

•Lavalier microphones must be properly hidden (under the collar, in the wardrobe).

•Precommends using **windjammer** protections for outdoor scenes.

•In post-production, ADR (Automatic Dialogue Replacement) is used for insufficiently clean replicas.

•The main goal of the recording is to make the dialogue natural and without the need for excessive cleaning.

•Proper positioning saves hours of correction in post-production.

Co-funded by the European Union

Sound work in the film industry

•The microphone placement must be in harmony with the movement of the actors — it is difficult to operate the microphone while the performers are moving.

•Cables and connectors break – quick repair and replacement is necessary to avoid extended recording.

•Cost issue: Sound equipment is often rented, and the director doesn't always understand the value of an expensive microphone.

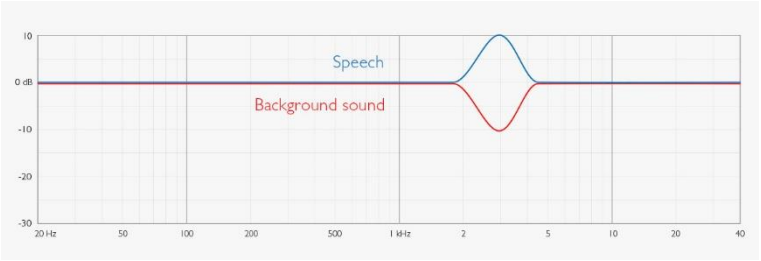
•With good preparation, cooperation with costume designers, directors and crew, it is possible to achieve high sound quality on the set.

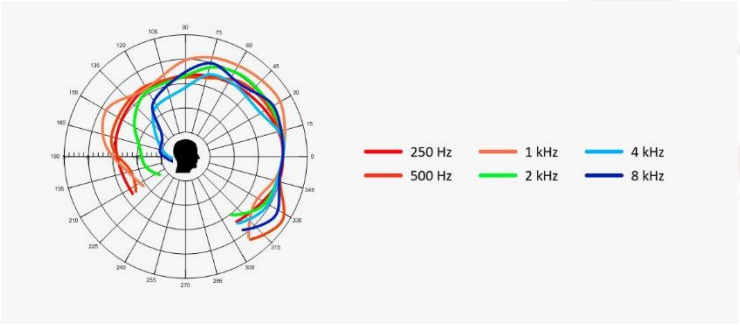
Microphones for live streaming and online streaming

- Live streaming requires **clean, understandable and balanced** sound without additional processing.
- Headset **microphones are most commonly** used due to their stable position and constant level.
- Lavalier microphones give a professional look and freedom of movement.
- Dynamic microphones are more resistant to background noise and reflections in the room.
- Condenser microphones give more clarity but require a quieter environment.
- The camera's proximity to the microphone helps synchronize the image and sound.

Microphones for live streaming and online streaming

- The choice of microphone depends on the acoustics of the space and the desired tone.
- The microphone should be **at a constant distance** from the source (2–10 cm).
- If a USB microphone is used, it is important to place it outside the breath axis.
- Using pop filters eliminates “p”, “b” and “f” sounds.
- When streaming, headphone monitoring helps to spot problems in real time.
- Stable microphone position and constant gain are the key to professional sound.





Stereo recording

•Stereo recording is a technique that simulates the **spatial perception of the listener**, creating an experience of the width and depth of the sound.

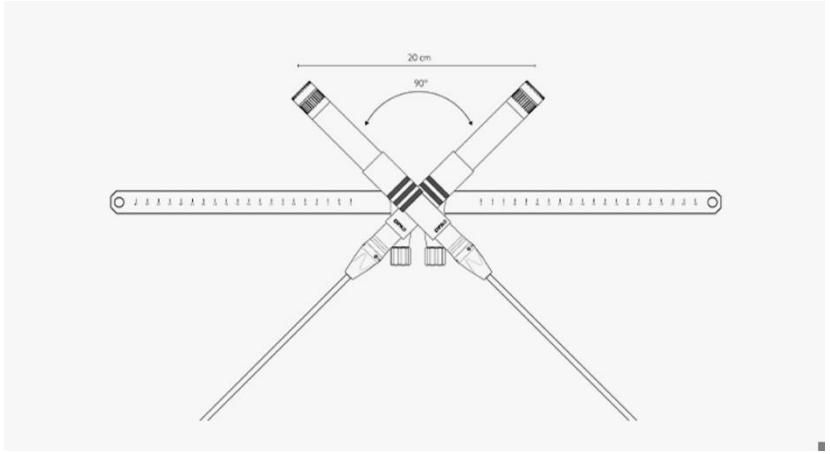
•The goal is to accurately reproduce the **localization of the sound source** between the left and right channels.

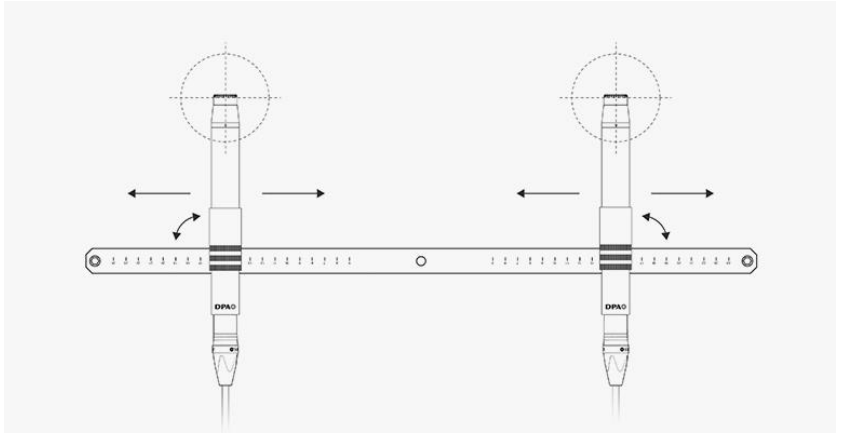
•The stereophonic signal consists of **channels L (Left)** and **R (Right)** that together form an acoustic space.

•The balance between the channels depends on the position of the microphone, the directive and the acoustics of the space.

•Stereo is used in music production, film, TV shows, and even in ambient recordings.

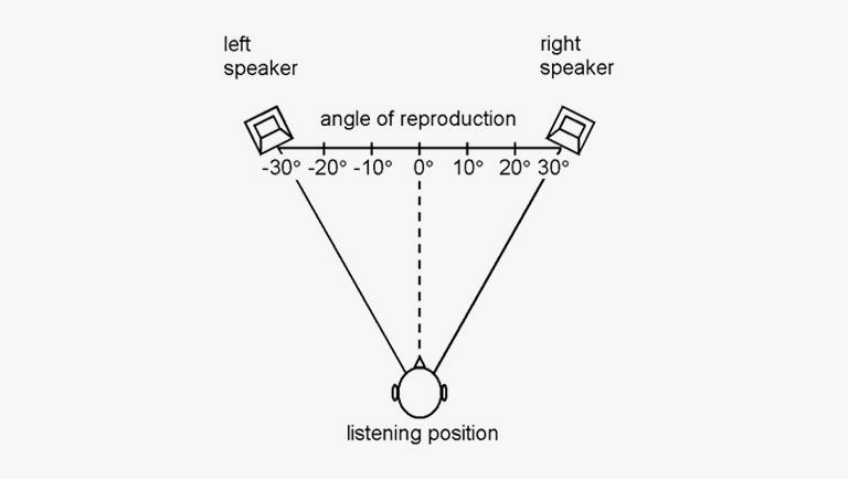
•stereo is not just "two microphones", but **an acoustic architecture of space**.





Basic principles of stereo recording

- The human ear **uses interactional differences** in time (ETC) and level (ILD) to localize sound.
- Stereo systems mimic these differences using **spacing and angles between microphones**.
- Stereo image quality depends on:
  - Microphone distances,
  - Their directives,
  - Acoustic reflections in space.
- Too far apart microphones give a wider but imprecise picture; too close – clustered picture.
- The ideal position depends on the acoustics and the number of instruments/sources.



Role and types of audio mixers

•Audio mixers are used to **receive, process and distribute audio signals** from microphones, instruments or devices.

•Basic functions: **gain, equalization (EQ), balancing (pan), mixing and master out**.

•**Analog mixers** offer immediate control and high reliability.

•**Digital mixers** have scene storage, internal processing (DSP), effects and network connectivity.

•Digital consoles are used in TV studios for **automation and precise level control**.

•**Compact digital mixers** with network controls (e.g. iPad remote) are preferred in portable systems.

Digital Mixers vs. Analog Mixers

Monitoring systems in production

•Monitoring allows the engineer to **control the quality and balance of the sound** in real time.

• Divide:

  •**Control monitoring** – in the direction or studio (reference speakers).

  •**Personal monitoring** – for contractors and managers (headphones, in-ear systems).

•Active monitors have a built-in amplifier, while passive monitors require external power supply.

•**Reference monitors** calibrated to 83–85 dB SPL are used in television.

•Monitoring must be linear – without too much bass or treble.

Behringer X32 – features and capabilities

•**Behringer X32** is a **digital mixer** with 32 channels and 16 mix buses, intended for studio and live applications.

•Each channel has **a complete DSP chain**: gate, compressor, EQ and insert effects.

•Enables **recording and playback** via USB and SD interface.

•Supports **AES50 and Dante network protocols** (via card) for digital audio transport.

•It has **16 preamps (MIDAS design)** with high dynamics and low noise.

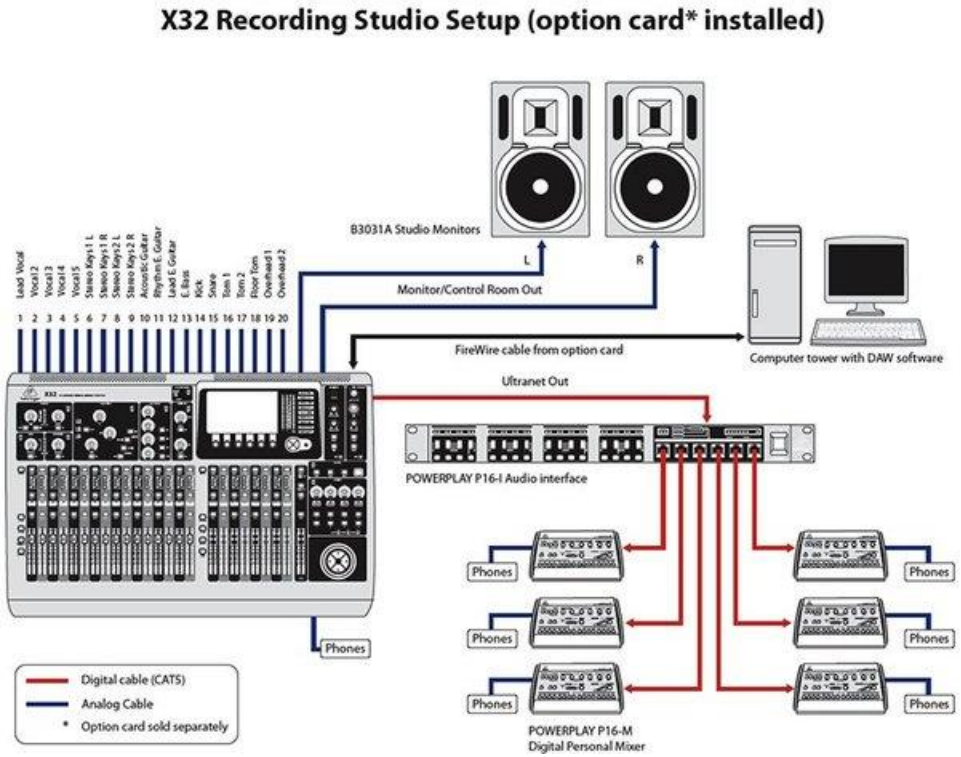
•Software control via **X32-Edit** allows management from a computer or tablet.

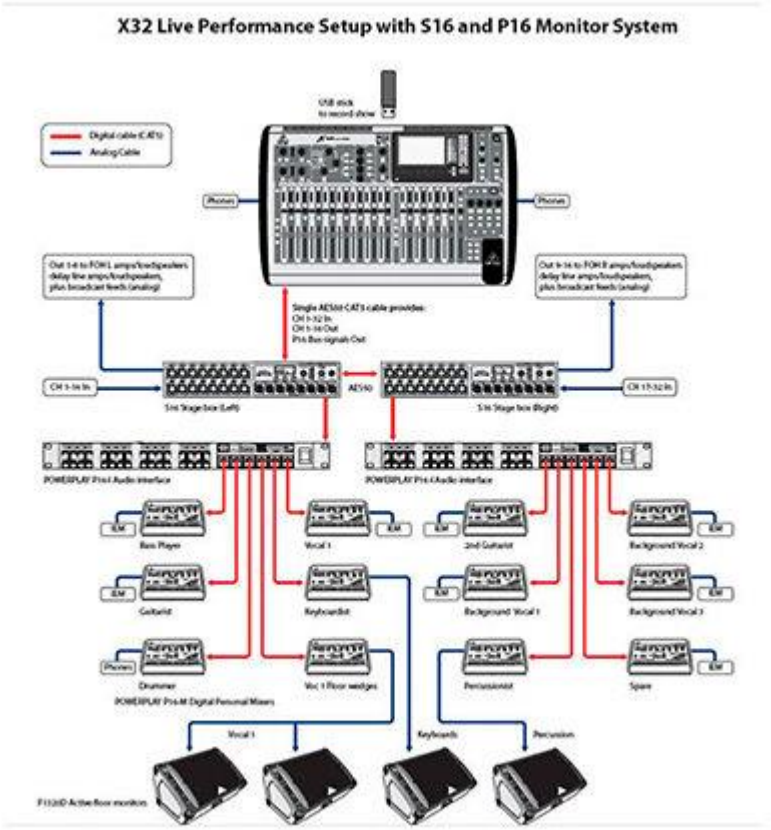
•Ideal for **TV studios, stages, churches and educational spaces**.

Behringer X32 functions and when used

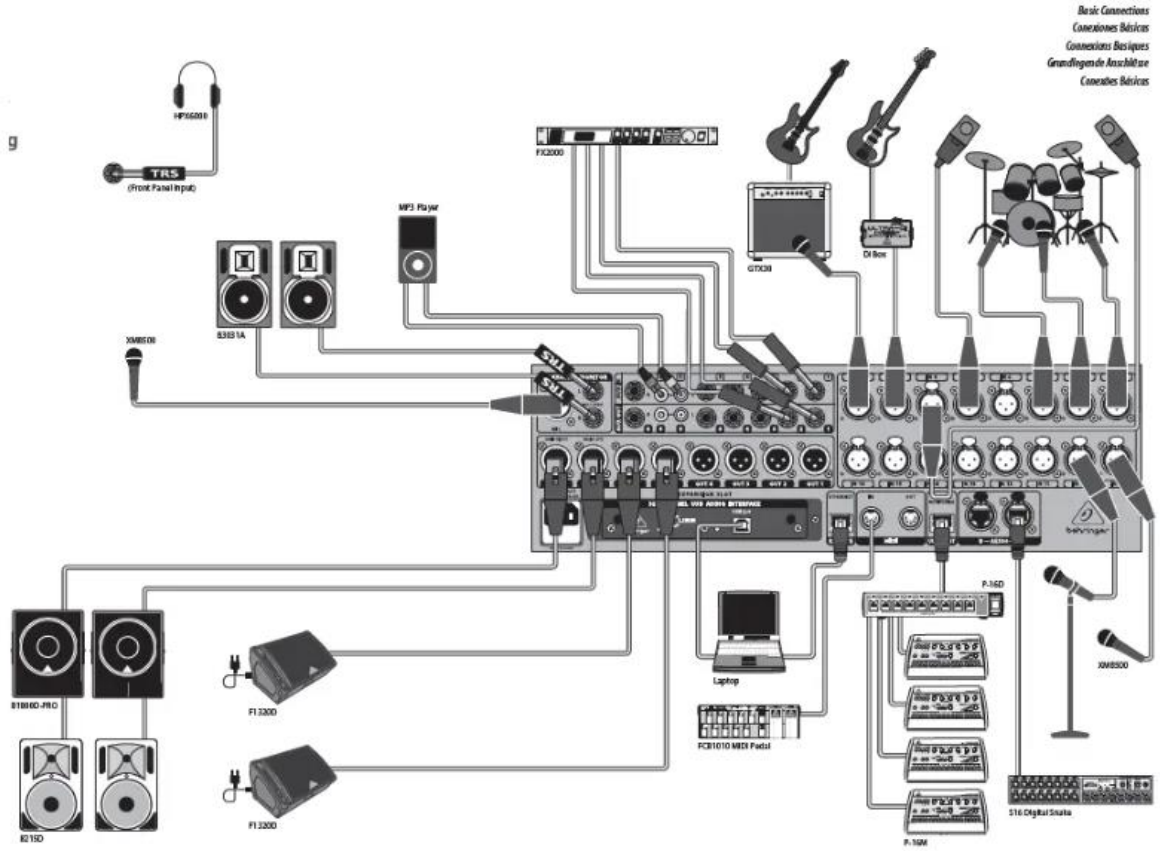
- **Gain trim** – adjustment of the input signal level (before EQ processing).
- **High-pass filter (HPF)** – removes low frequencies below 80–120 Hz (e.g. climate noise).
- **Gate** – used to suppress background noise in non-speaking microphones.
- **Compressor** – reduces dynamic range; used in voices and instruments.
- **EQ (4-band parametric)** – for precise tonal correction of each strip.
- **Pan** – determines the position of the sound in the stereo image.
- **Bus Send** – used to send signals to effects, monitors or streaming output.
- **Scene Save/Recall** – allows you to save a complete setup for different shows.

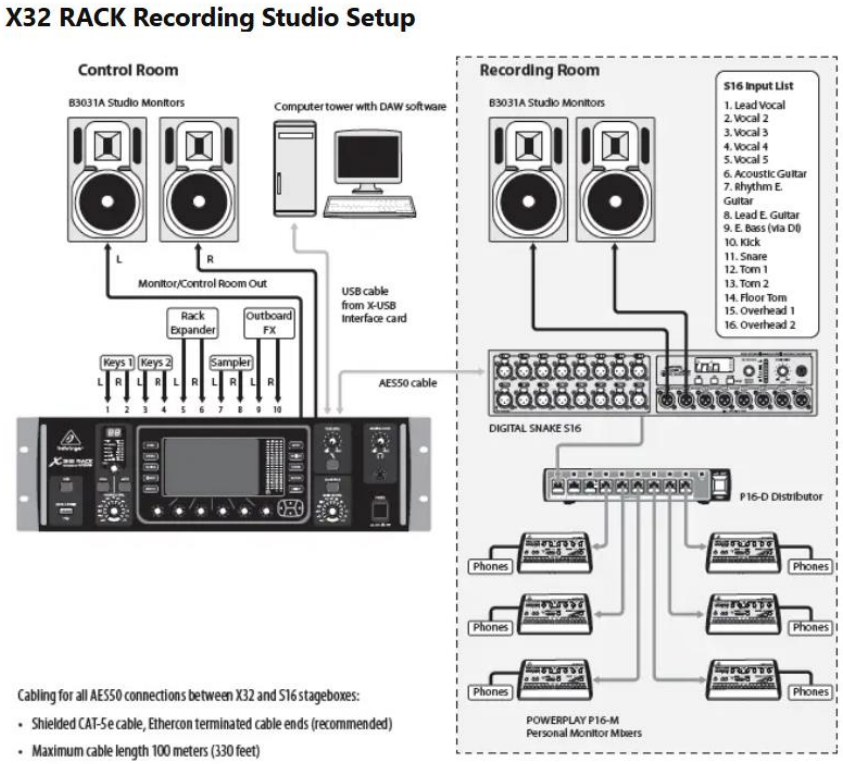
Behringer X32





Behringer X32





WBnet

Co-funded by the European Union

Questions & Answers

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them."

Network of centers for regional short study programs in the countries of the Western Balkans

Call: ERASMUS-EDU-2023-CBHE

Project number: 101128813

ATYCC

UNIVERSITY OF L]UBL]ANA
Faculty of Electrical Engineering

POLITÉCNICA

University of Pristina
Kosovska Mitrovica