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LEVEL 1 TECHNICAL TRAINING

Sound - Overview

- What is Sound ?
- Audio and Power connectors
- Audio signal flow
- PA systems and basic set up
- Tips & tricks

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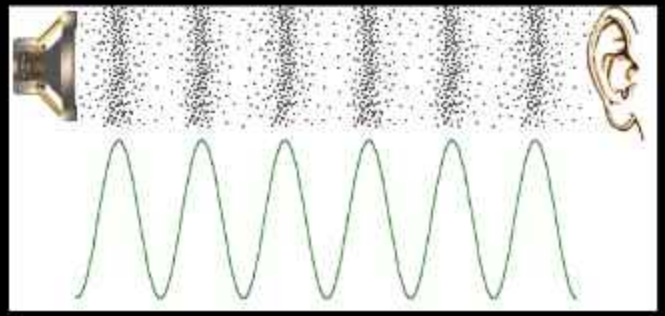
What is Sound ?

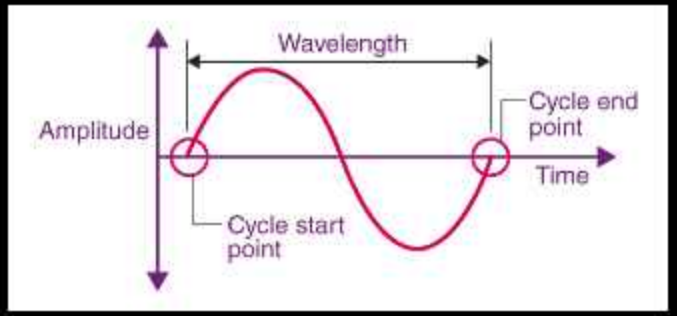
sound / noise - noun

1- the sensation produced by stimulation of the organs of hearing by vibrations transmitted through the air or other medium.

2- mechanical vibrations transmitted through an elastic medium, traveling in air at a speed of 343 m/s at sea levels.

3 - In physics, sound is a vibration that propagates as an acoustic wave, through a transmission medium such as a gas, liquid or solid. In human physiology and psychology, sound is the reception of such waves and their perception by the brain.





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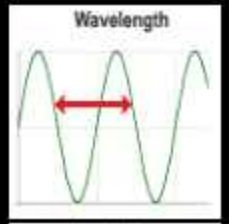
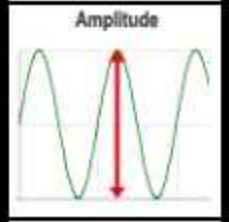
What is Sound ?

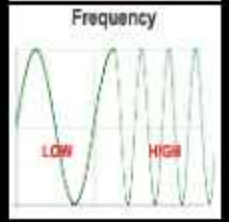
Sound waves properties



Wavelength
The distance between any point on a wave and the equivalent point on the next phase. Literally the length of the wave.



Amplitude
The strength or power of a wave signal. The "height" of a wave when viewed as a graph. Higher amplitudes are interpreted as a higher volume, hence the name "amplifier" for a device that increases amplitude.



Frequency
The number of times the wavelength occurs in one second. Measured in kilohertz (KHz), or cycles per second. The faster the sound source vibrates, the higher the frequency. Higher frequencies are interpreted as higher pitch, for example, when you sing in a high-pitched voice you are forcing your vocal chords to vibrate quickly.

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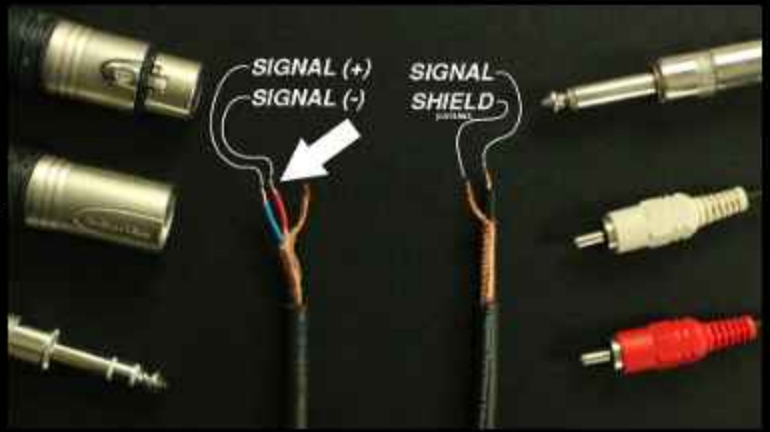
Audio connectors

Balanced VS unbalanced

One of the major differences between these cables is that balanced audio has less risk for unwanted noise, while unbalanced audio can pick up humming or buzzing sound in certain environments.
In general, balanced audio will give you a better, stronger audio signal without any extraneous noises. Unbalanced audio, on the other hand, is susceptible to picking up noise and interference over longer distances.
The ground wire in an unbalanced audio cable can pick up unwanted noise as the audio signal travels through it. This susceptibility to interference is due to how the cable is made.



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Audio connectors

TS 3.5mm (mini-jack) and 1/4 inch (jack)

Tip/Sleeve Cable or more popularly known as TS Cable is a common choice of instrument cable for guitars, keyboards etc. This is an unbalanced cable as it has just two conductors.
As a result, most TS cables are suitable only for short distances to connect to mono instruments. Some popular instruments that use TS cable are: guitars, drum machines, effects pedals, mono headphones and other unbalanced instruments.

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Audio connectors

TRS 3.5mm (mini-jack) and 1/4 inch (jack)

The TRS Cable is very similar to the TS Cable except that it has an additional Ring.
TRS is short for Tip, Ring, Sleeve Cable.
Depending on the application, we can use a TRS cable as a balanced cable or an unbalanced cable.
For balanced signals, we can use the tip, ring and sleeve to carry positive, negative and ground signals to use with a mono instrument/device. In case of unbalanced connection, we can configure it to carry 2-channel stereo audio for left and right channels.

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Audio connectors

XLR (3 pins)

Perhaps the most popular audio cable is the XLR Audio Cable. It has a bulky three pin connectors that is almost always used as a balanced cable. As a result, you can use XLR Cables for long distances without fear of distortion, noise or interference. In fact, most pro-grade microphones, speakers, instruments and PA Systems and Stage use XLR Connectors and cables. These cables are popular for stage shows, concerts and professional studios, whether you want a short cable (less than 6-feet) or a relatively large cable (over 50-feet) to connect to equipment.

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Audio connectors

RCA (Phono)

The Radio Corporation of America manufactured a low-cost consumer grade audio cable that is popularly by the initials of the company as RCA Cable. They produced both the male and female counterparts of the cable initially intended for phonograph (gramophone or a vinyl player).
Due to its simple design and relatively low-cost construction, the RCA Cable became the standard cable for home stereo equipment and AV Systems. RCA Cables are essentially unbalanced cables as they have only two conductors.
Hence, we often restrict them for a short distance. The red and white stereo cables are very popular even today for connecting analog audio devices and equipment.

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Audio connectors

MIDI

Technically speaking, MIDI cables don't send actual audio or sound but rather they send event information between MIDI compatible equipment and devices. They are one of the early digital audio cables that have a special 5-pin connector (looks similar to an XLR Connector).
They allow the sending and receiving of musical information in MIDI (Musical Instrument Digital Interface) format to allow digital devices to communicate with each other.
As they essentially carry messages in digital format than the actual audio signals, most modern MIDI communication has been replaced with USB Cables and connectors.

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Audio connectors

SpeakON (NL2 - NL4 - NL8)

Neutrik designed and developed a special type of connector known as SpeakON Connector for using in professional audio equipment, speakers, and amplifiers.
They are typically available as 2-conductors unbalanced cables but some cables come with 4 and 8 conductors for bi-amping.
Due to its design, Speakon cables are more rugged and durable and hence, they are often used as an alternative to standard 1/4-inch cables during stage shows, live performances and concerts.
Speakon cables also have higher current carrying capability than other cables and as a result we can use them for large loud speakers.

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Audio connectors

S/PDIF (optical cable)

Strictly speaking, S/PDIF (Sony/Philips Digital Audio Interface) is a standard to carry digital audio from one device to other.
We can use two types of cables for S/PDIF data.
One is the regular RCA Cables while the other is an optical fiber-based cable with a TOSLINK Connector (Toshiba Link).
The TOSLINK fiber-optic cable are very popular in home-audio setup to connect TV to surround sound system or a soundbar.
HDMI Cables largely replaced S/PDIF Cables in the consumer market.

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Audio connectors

USB

One of the simplest and extremely popular digital audio interfaces is the USB. First, USB replaced the MIDI Connector to transmit the event messages. Since USB can also carry power and data (digital), we are also using USB to transmit audio signals.
The latest USB Type-C has largely replaced the 3.5mm headphone jack in modern mobile phones. Apart from USB-C, USB cables are also available with other connectors with USB Type-A, Micro-USB and USB Type-B being the other popular options.

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Audio connectors

HDMI

With HDMI Revision 1.4, the HDMI Forum introduced ARC, which is short for Audio Return Channel. This feature enabled to reduce the number of wires between a TV and the other equipment such as Soundbar (or surround sound system) and an AV Receiver (or any other input device).
As a result, in the battle of HDMI ARC vs Optical Audio, HDMI came on top due to its significantly high bandwidth support to carry lossless audio and almost all modern audio formats.

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Audio connectors

EtherCON (RJ45 / Data cables)

The EtherCON is a ruggedized and lockable connector for Ethernet over twisted pair wiring. It is manufactured by Neutrik and is designed for professional audio and stage lighting network applications. The design is modelled after the XLR connector with a circular hard metal shell and a locking latch. The cable connector is always male and is designed to fit over a standard 8P8C modular connector. The chassis connector is always female and has the standard form factor of an XLR panel connector. The chassis connectors are rated for either Cat5, Cat6 or compatibles.

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LEVEL 1 TECHNICAL TRAINING

Audio connectors

TS 3.5mm & 1/4

TRS 3.5mm & 1/4

XLR

RCA

MIDI

SpeakON(NL2/4/8)

S/PDIF

USB

HDMI

EtherCON

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Power connectors

C5

C7

IEC 13A

16A 1p

16A 3p

32A 1p

32A 3p

PowerCon True1

PowerCon 16A

PowerCon 20A

Socapex

Powerlock

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Audio signal flow

Audio signal flow is the path of the audio signal from its source to its output. Sound comes in (input) one end, and is transformed into an electrical voltage, which travels through a cable and out (output) somewhere else, as sound.

In mixing, it's how the sound gets from an instrument or input to the audio console and what path the signal takes through the console before finally coming out of the speakers. Though there's nothing inherently all that complicated about signal flow, there are a whole lot of interesting twists and turns we can send that audio signal through on its path, and the choices we make around signal flow can have a huge impact on the sort of options we have for shaping sounds.

The most important skill you can have as a live sound engineer is a solid understanding of signal flow. Without it, there's no music, and you're not much of an engineer at all, actually. You need to know where the signal is coming from, where it needs to go and how to get it there at all times. In order to do that, you need to know how all the pieces of the PA system work together.

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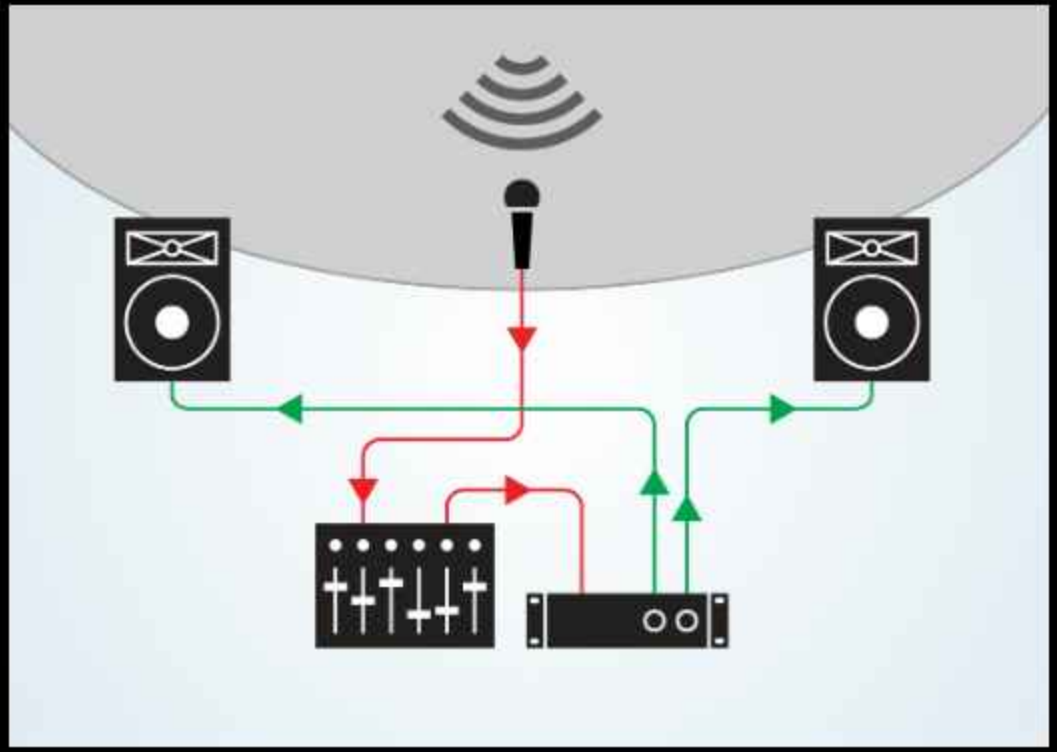
Audio signal flow



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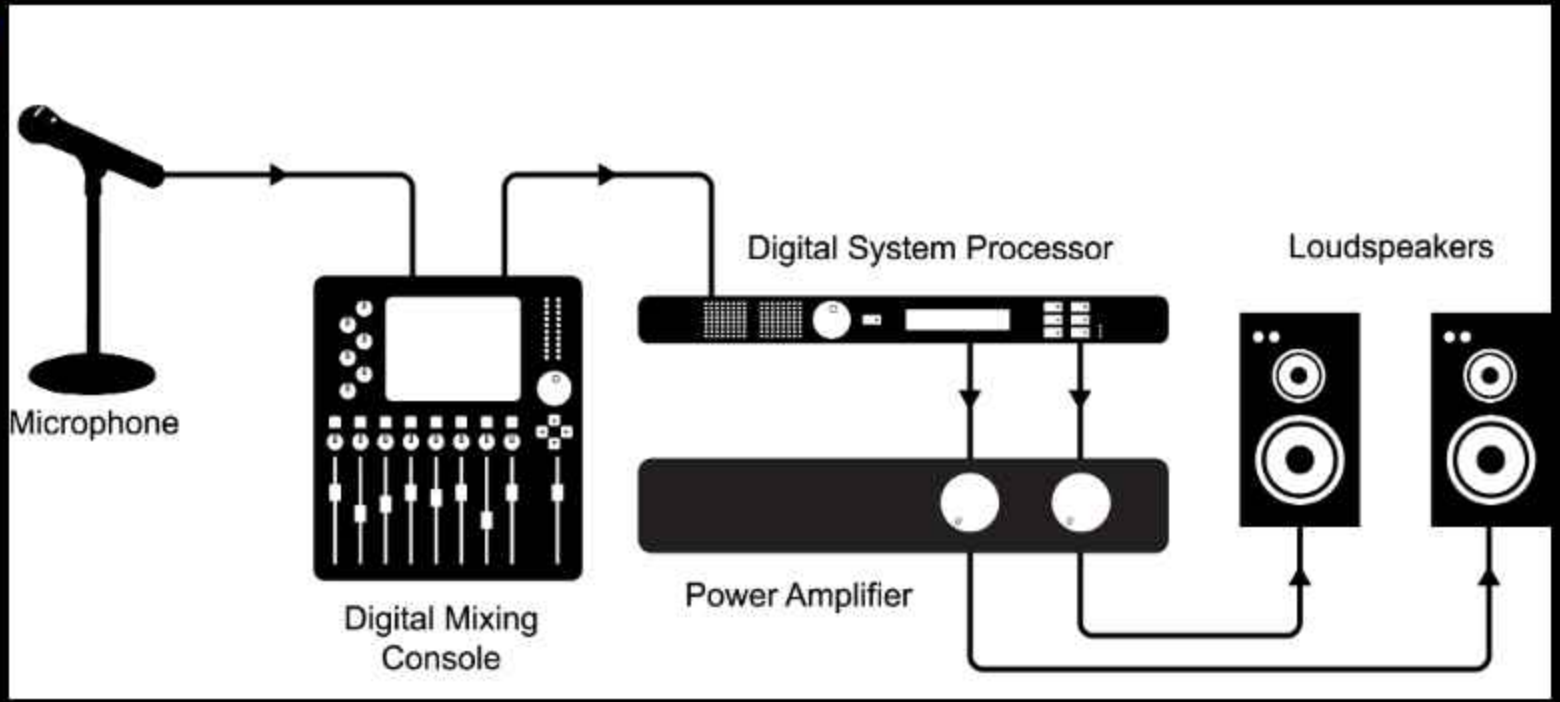
Audio signal flow



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PA systems and basic set up

What is a PA?

PA stands for public address ,i.e projecting sound to a large group of people louder than you could by talking or playing an acoustic instrument. Your first thought of PA speakers could be of those used at concerts or sports stadiums.

Here's a brief rundown of what a PA system is:

- A public address system used to project sounds from instruments, voices and other acoustic sources.
- Comprises of microphones, mixers, amplifiers and loudspeakers.
- Front of house (FOH) speakers point towards the audience, while monitors are directed to the performers.
- A mixer adjusts EQ and effects. Either on stage or controlled by an audio engineer at a mixing desk.
- Used everywhere from clubs and leisure centres to arenas and airports.

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PA systems and basic set up

Microphones

At their most basic, microphones are transducers.
A transducer is an electrical device that converts energy from one form to another. In this case, the transducer is turning sound — acoustical energy — into an audio signal — electrical energy.
Most of you would know that sound is essentially fluctuations in air pressure. The component all microphones have in common is called the diaphragm. When sound waves hit the diaphragm, it vibrates, and the vibrations (which represent the fluctuations in air pressure) are turned into electrical energy (current). At the other end of the mic lead, that current is turned into the audio signal.

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PA systems and basic set up

Microphones - The two main types of microphones

DYNAMIC MICS

Dynamic mics are the kind you see on stage most often, where the sound is aimed down the front of the mic. These can handle louder sounds since they're less sensitive, not only to volume but to damage in general.

The diaphragm is a part that vibrates due to sound pressures and in dynamic mics it moves a magnet through a wire coil's magnetic field. This makes electricity flow. This whole system is called a transducer, and it works differently in a condenser mic, which is what sets them apart.

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PA systems and basic set up

Microphones - The two main types of microphones

CONDENSER MICS

Condenser mics are the kind you usually see in recording studios.
The sound is aimed into the side of these mics, which is why you see some of them pointing to the ceiling and some hanging upside down, because it doesn't matter as long as the correct side is aimed at the sound source.
They are more sensitive to smaller changes in volume and can pick up tiny nuances, which is why they're preferred in the studio when the acoustic environment is tightly controlled.
But you can damage the larger diaphragm or tube (if it has one), by recording a source that's too loud or dropping it.
The transducer works by allowing the diaphragm to vibrate closer and further from a charged metal plate, and this plate is why condenser mics need Phantom power or some other power source like a battery or its own power supply.

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PA systems and basic set up

Microphones - Pick up Patterns

A lot of mics are pretty simple to use. You point it at the sound you want to record or broadcast and that's it. But many also offer ways to change the sounds it picks up without changing the direction you point them. These 'ways' are settings called pickup patterns. You'll often see these pickup patterns referred to as polar patterns, polarity, and directionality. They all mean the same thing. Most mics that don't let you change the pickup pattern are set to cardioid.

This is the most common pattern, because it picks up a wide field in front of the microphone while blocking out noise coming in from behind.

Think about a singer on stage. You don't want the sound of the crowd cheering and singing along, coming from behind the mic, being played back out of the speakers. You only want the singer's voice being captured from in front. Most of the other pickup patterns are variants on the cardioid pattern, although there are other useful ones that you'll still rarely use.

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PA systems and basic set up

Microphones - Pick up Pattern

All of these patterns come in three basic flavours:

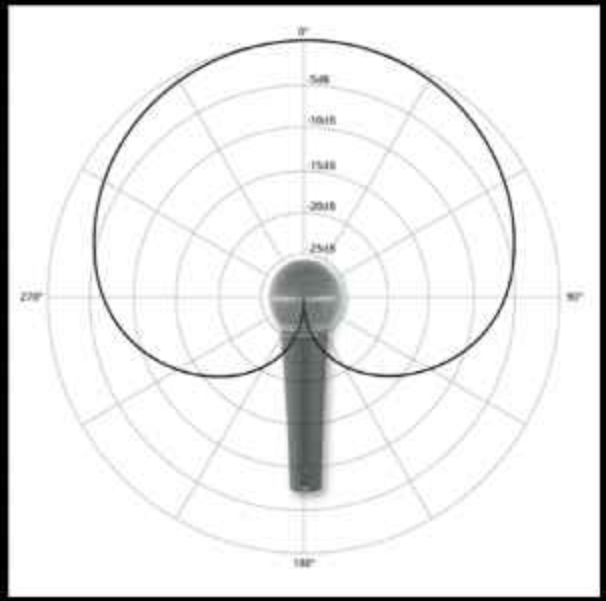
- Unidirectional
- Bidirectional
- Omnidirectional

In order, these mean that the mic will record sounds from only one direction (front), two directions (front & back), or a full 360 degrees.

You'll typically only ever use the cardioid pattern, which is unidirectional.

It largely only picks up sound from the front, but will still capture some sound from the sides (at a lesser volume).

That's because these patterns have a sensitivity to them as well, as seen in the image where the dark black lines extend further out in the circle, which corresponds to higher volumes (measured in decibels).



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PA systems and basic set up

Mixing Desk

A mixing console is the most critical equipment in live sound setups because it controls all the audio sources before they are sent to the loudspeakers. Knowing the ins and outs of a mixing board and how to use them will make the difference between a perfect mix and a mediocre one.
An audio mixer is a device used to combine multiple sound sources by manipulating the volume, frequency, and dynamics of the audio source. Audio Mixers are also called mixing console, mixing board, mixing desk, or soundboard.

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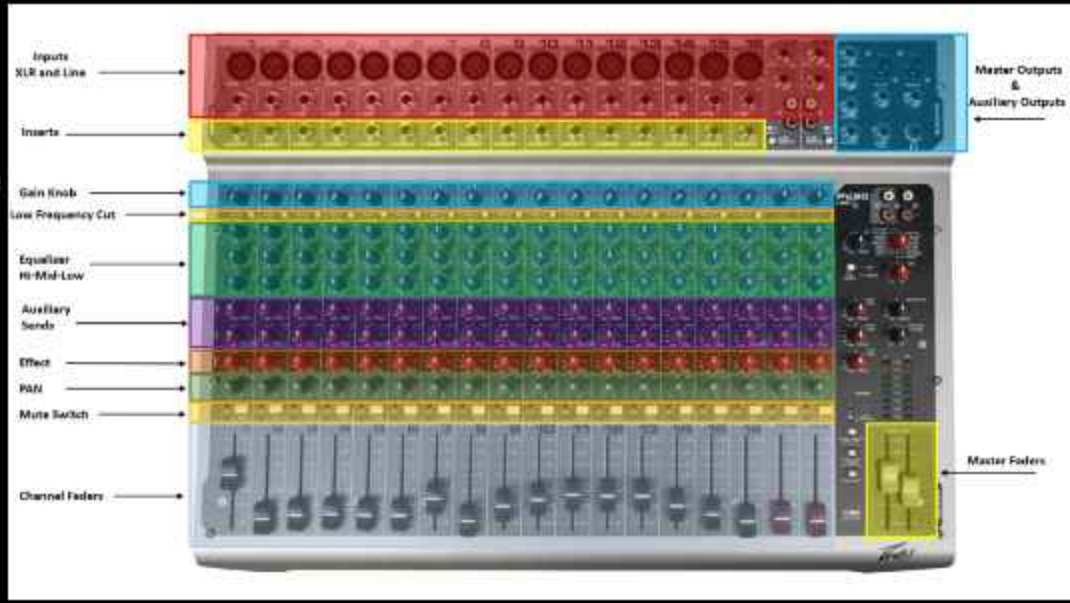
PA systems and basic set up

Mixing Desk - Part of a Mixing Desk

Depending on the size of the mixing console, it could have hundreds of knobs that are designed to do a specific task. All of the knobs on the surface of a mixing console make it look complicated, but the truth is that each channel strip has a few controls that repeat for the rest of the channels.
If you understand one channel, you would know how a mixer works.



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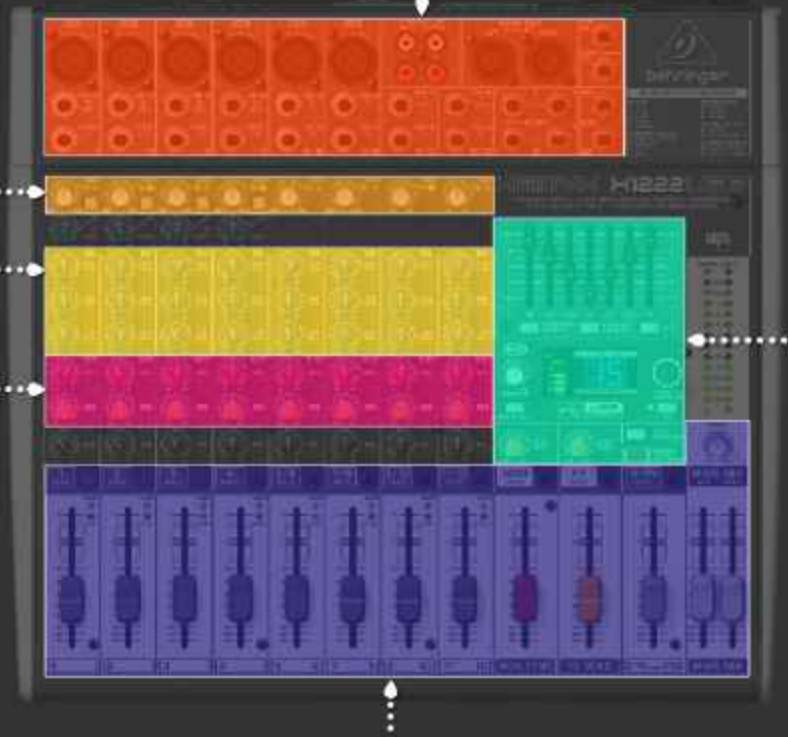
MIXER SECTIONS

INPUTS AND OUTPUTS
MICROPHONES, INSTRUMENTS, DEVICES, AND SPEAKERS



PREAMPLIFER GAIN
BOOST SIGNAL TO LINE LEVEL

EQUALIZATION
ADJUST HIGH, MID, AND LOW FREQUENCY LEVELS

AUXILIARY SENDS
CONTROL THE LEVEL SENT TO MONITOR AND FX BUSSES

EFFECTS
REVERB, DELAY, AND MORE

LEVEL FADERS
CONTROL THE LEVEL OF EACH CHANNEL, BUS, AND OUTPUT

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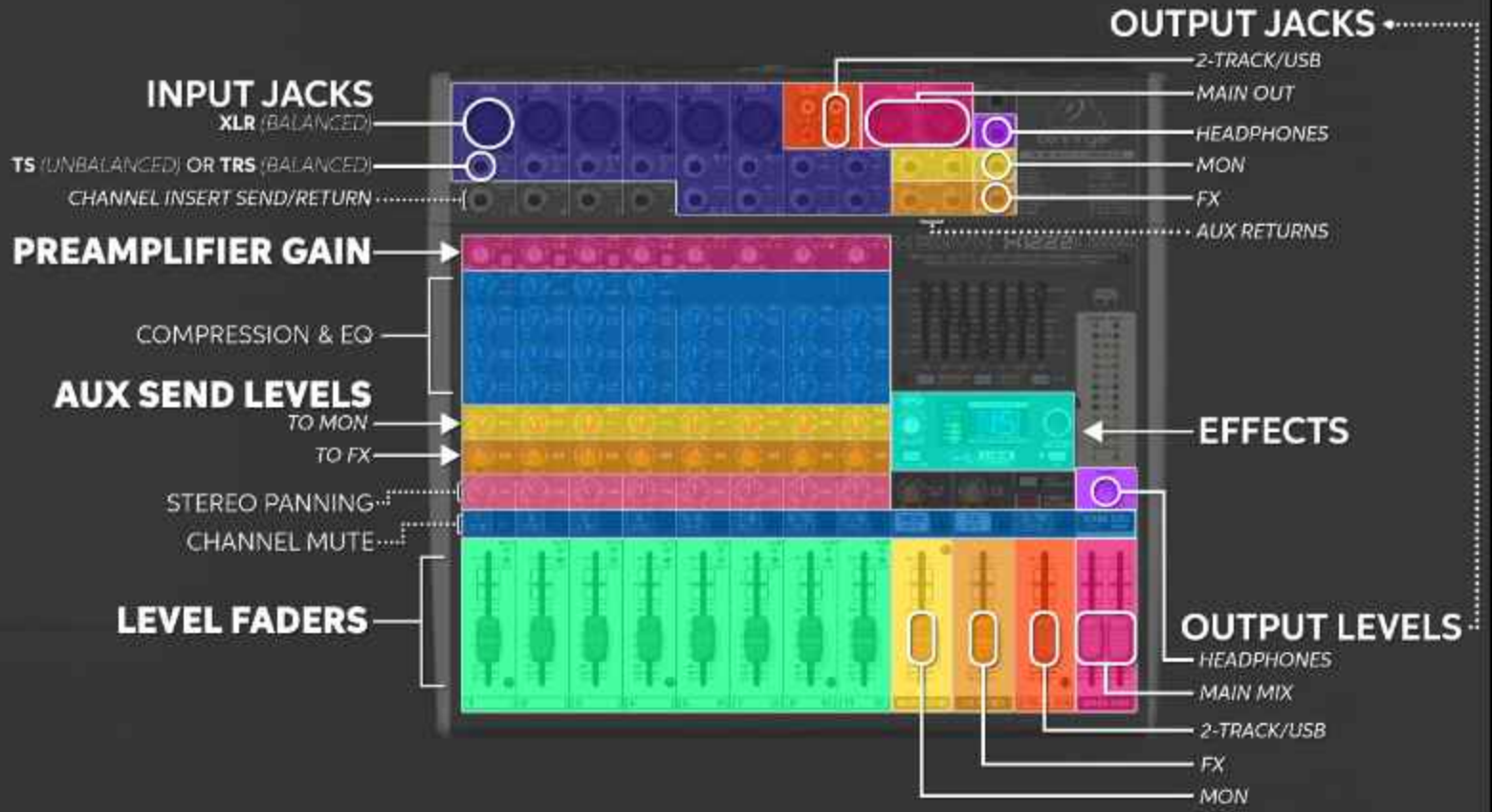
PARTS OF A MIXER



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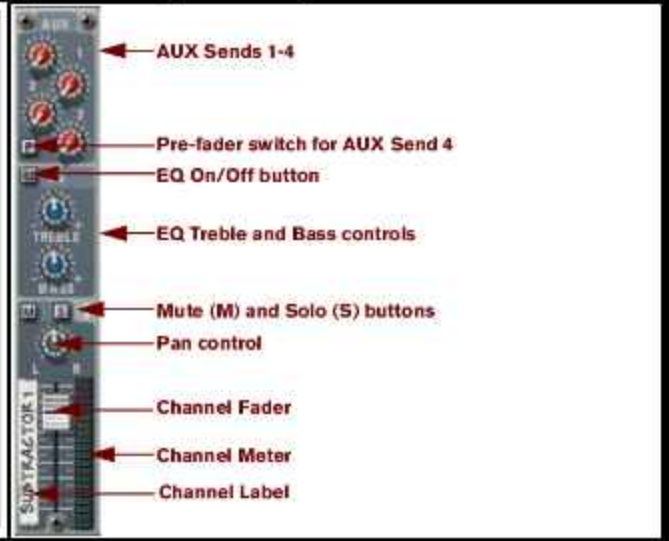
PA systems and basic set up

Mixing Desk - The Channel Stripe

A single channel on a mixing board is also known as a channel strip, and it's configured from top to bottom. All channels are arranged in columns that go across the board. Each channel strip has inputs, inserts, gain, equalization, auxiliary sends, and volume faders.



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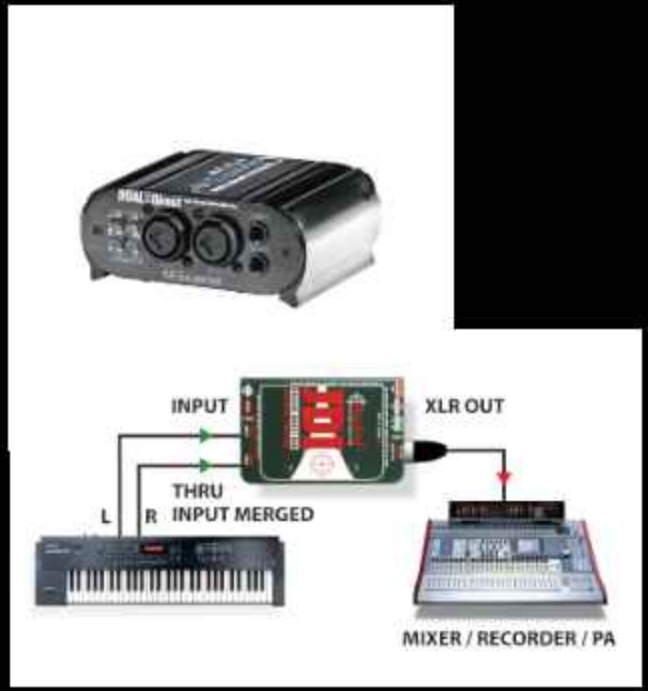
PA systems and basic set up

DI BOX (Direct Box)

A DI box, also called a direct box, converts the unbalanced, high impedance signal output of an instrument to a balanced low impedance mic-level signal.
This enables the signal to travel distances of 100 meters (300 feet) without adding appreciable noise.
The output of a DI box is mic level – thus the balanced output signal is treated just like a microphone.
When playing live, the mixing console is usually positioned in the house (front of house or FOH position) which is often 50 to 100 meters away.
Most instruments such as bass guitar, acoustic guitar and keyboards are connected to a DI box and mixed at FOH.
For the sound engineer, capturing the direct sound of the instrument separately from being processed by the artist on stage usually makes it easier to amplify the signal as it can be optimized for the room.



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PA systems and basic set up

LSM processor (speaker management)

LMS stands for Loudspeaker Management System (LMS) and is essentially a active digital crossover.
An active crossover is needed when using different cabinets. For instance, a system using a mid/top cabinet with a bass cabinets.
The active crossover splits the frequency and assures that each loudspeaker is just playing in its optimum frequency range.
The LMS also gives you digital control over the equalisation, delay and peak limiting.
The equaliser or EQ allows the sound system to have a flat frequency response in any venue.
The delays ensure that all the loudspeakers are working in time and phase with each other even if they are in different positions.
Finally the peak limiters help protect your sound system by stopping the amplifiers from clipping.

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PA systems and basic set up

Audio Power Amplifier

An audio power amplifier is an electronic amplifier that amplifies low-power audio signals to a level suitable for driving loudspeakers and is the final stage in a typical audio playback chain.

The preceding stages in such a chain are low power audio amplifiers which perform tasks like pre-amplification, equalization, tone control, mixing/effects, or audio sources like record players, CD players, and cassette players.

While the input signal to an audio power amplifier may measure only a few hundred microwatts, its output may be tens, hundreds, or thousands of watts.

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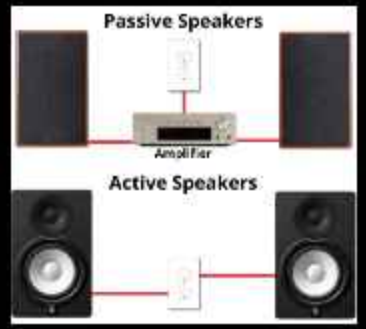
PA systems and basic set up

Loudspeakers

Loudspeakers produce sound waves by causing a thin diaphragm to vibrate and disrupt the air pressure around it in the form of the intended sound wave. An amplified audio signal (alternating current) that has the same waveform as the sound wave is responsible for vibrating the speaker diaphragm.

Active vs Passive

An active speaker has a built-in amplifier and gets its power from a power outlet. A passive speaker gets power from an external amplifier.
Active and passive speakers also vary in sound, flexibility, and signal path.



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PA systems and basic set up

Type of loudspeakers

Full range PA speakers

A full-range loudspeaker drive unit is defined as a driver which reproduces as much of the audible frequency range as possible, within the limitations imposed by the physical constraints of a specific design. The frequency range of these drivers is maximised through the use of a whizzer cone and other means. Most single driver systems, such as those in radios, or small computer speaker designs, cannot reproduce all of the audible frequencies or the entire audible audio range (i.e., sound within the range of human hearing 20Hz - 20 KHz).

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PA systems and basic set up

Type of loudspeakers

Column PA systems

Column speakers are designed for a much more focussed beam of sound than a standard wall speaker, being similar in design to the large line-array systems used at large concert venues and festivals. Rather than the usual larger woofer and small tweeter configuration found in most wall-mount speakers, a column speaker uses an inline row of smaller, identical sized drivers, working together to produce a full range output.

This feature makes a column speakers pa system especially effective for high ceiling environments, as the sound can be directed across an area in a torchlight type beam, helping greatly to limit the loss of a standard speaker output. This also helps with avoiding unwanted room echo and keeping the overall volume of the system lower.

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Type of loudspeakers

Stage monitors

A stage monitor system is a set of performer-facing loudspeakers called monitor speakers, stage monitors, floor monitors, wedges, or foldbacks on stage during live music performances in which a sound reinforcement system is used to amplify a performance for the audience. The monitor system allows musicians to hear themselves and fellow band members clearly.

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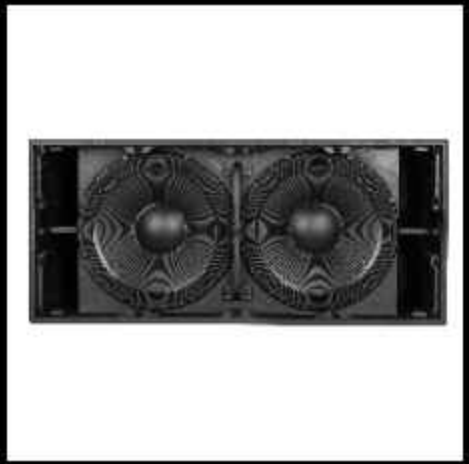
Type of loudspeakers

Subwoofers

A subwoofer (or sub) is a loudspeaker designed to reproduce low-pitched audio frequencies known as bass and sub-bass, lower in frequency than those which can be (optimally) generated by a woofer. The typical frequency range for a subwoofer is about 20–200 Hz for consumer products, below 100 Hz for professional live sound. Subwoofers are never used alone, as they are intended to augment the low-frequency range of loudspeakers that cover the higher frequency bands. While the term "subwoofer" technically only refers to the speaker driver, in common parlance, the term often refers to a subwoofer driver mounted in a speaker enclosure (cabinet).



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Type of loudspeakers

Line Arrays

Line Array Speakers focus the sound into a very narrow pattern to avoid the wasted sound energy that comes from using standard speakers. Array speakers are constructed of identical loudspeaker units mounted in a line and fed in-phase to create a singular source. Used vertically, Line Array Modules give a narrow and defined vertical output with a wide horizontal spread, which is perfect for arenas as it gets the sound across the audience rather than up into the ceiling or the open air.

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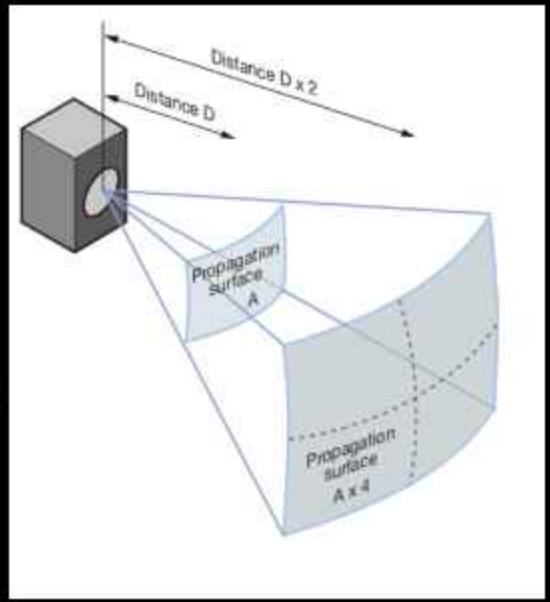
Point source VS Line source

Point source

Sound waves propagate in the shape of a sphere, spreading out horizontally and vertically. With every doubling of distance, the surface area of the propagation front increases by a factor of four. In other words, the sound intensity per unit area drops by a factor of four, and the sound pressure level attenuates by 6 dB.



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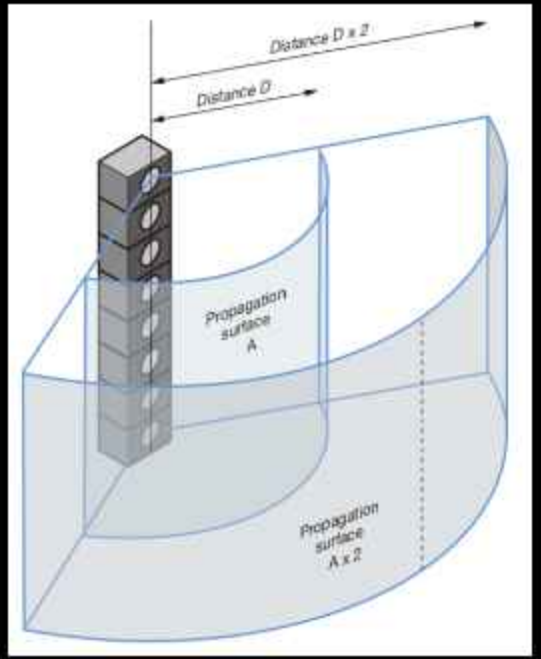
Point source VS Line source

Line source

Sound waves propagate in the shape of a cylinder, spreading out horizontally but not vertically. With every doubling of distance, the surface area of the propagation front increases by a factor of two. In other words, the sound intensity per unit area drops by a factor of two, and the sound pressure level attenuates by 3 dB.



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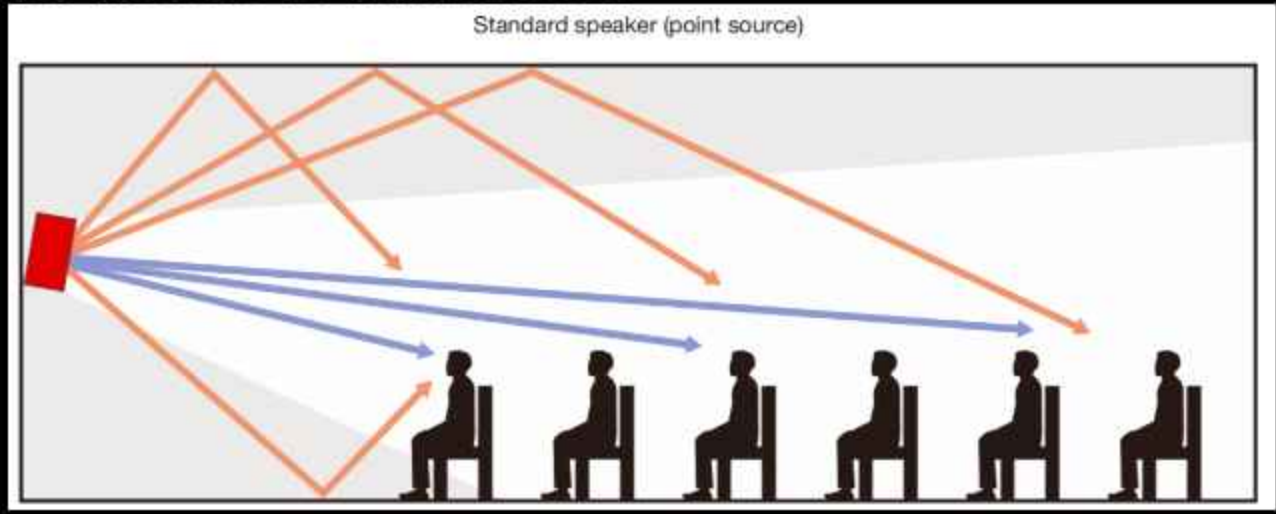
PA systems and basic set up

Point source VS Line source



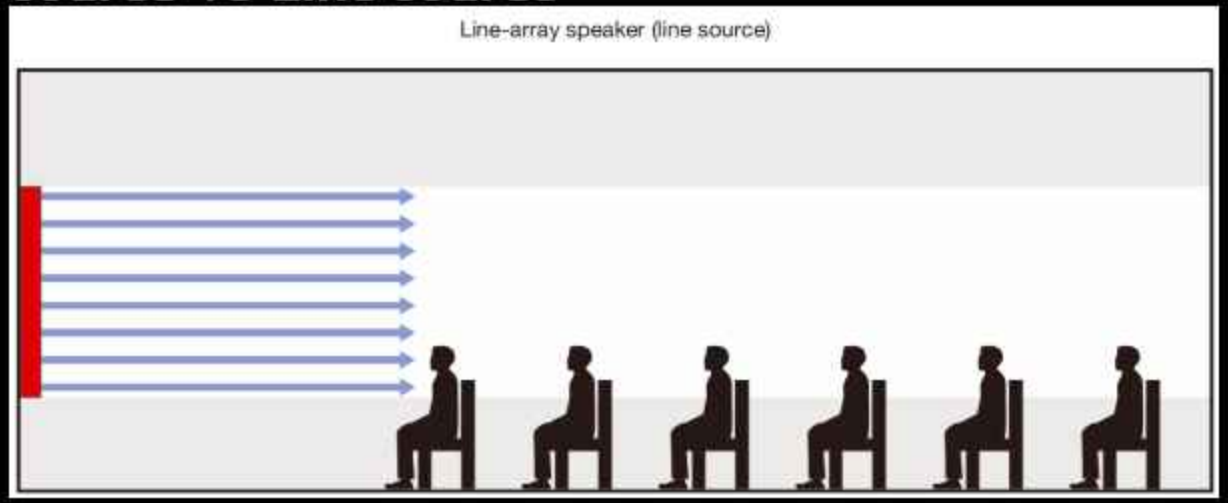
Because the sound also disperses widely in the vertical plane, a significant amount of reflection occurs at the roof and floor surfaces. These reflections are heard as reverberation and make the reinforced sound less clear.

ALPHA CREW

LEVEL 1 TECHNICAL TRAINING

PA systems and basic set up

Point source VS Line source



Sound waves disperse very little in the vertical plane, significantly reducing the amount of reflection at the roof and floor surfaces. Traveling directly from array to audience and free of reflections, the reinforced sound is clearer overall.

ALPHA CREW

LEVEL 1 TECHNICAL TRAINING

PA systems and basic set up

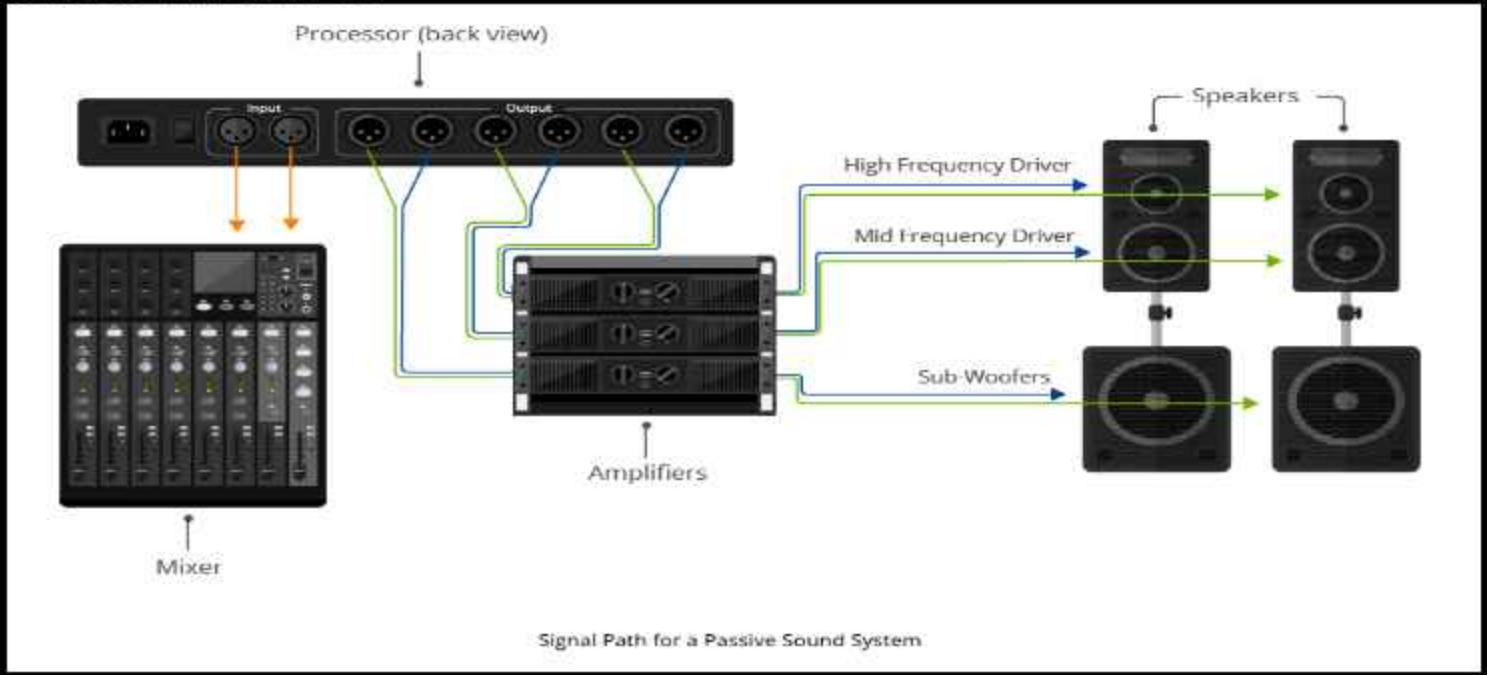
POINT SOURCE *vs* **LINE SOURCE**

ALPHA CREW

LEVEL 1 TECHNICAL TRAINING

PA systems and basic set up

BASIC PA SET UP



Signal Path for a Passive Sound System

ALPHA CREW

LEVEL 1 TECHNICAL TRAINING

PA systems and basic set up

BASIC PA SET UP