CHANNEL AUDIO

A Complete Beginner's Guide to

How Does a PA System Work?

www.channelaudiogroup.com

Table of Contents

CHANNEL AUDIO
Production | Audio Visual | Events

CONTACT INFO

(615) 669-2126

Contact@ChannelAudioGroup.com

OFFICE HOURS

Mon-Fri: 8:00 AM-5:00 PM
Sat-Sun: Closed

Delivery & Technicians are available 24/7.

www.channelaudiogroup.com

Introduction

Many people renting a PA system for their event may have little to no idea how the typical PA system actually works. In many cases, this leaves renters with a system that's too big or too small, and occasionally a system that's inadequate for the technical needs of the event. It's important to know that no two PA systems are alike. While many manufacturers might make every component that a system needs, it is common to mix and match components from different manufacturers, usually stemming from an engineer's personal preferences. This guide will explain the basic parts and functions of the most common type of PA system: a basic setup with ground supported speakers. We won't be getting into large-scale concert PA systems with line arrays; those systems deserve their own separate guide.

Let's dive in!

“

You're only as good as your weakest link in the ecosystem of sound, of audio.

– Jimmy Iovine

What is a PA System?

A PA system stands for "Public Address System." The origins of the PA system dates back to around 1910, when the Automatic Electric Company of Chicago, Illinois, announced it had developed a loudspeaker, which it marketed under the name of the Automatic Enunciator. By 1913, multiple units were installed throughout the Comiskey Park baseball stadium in Chicago, both to make announcements and to provide musical interludes. Charles A. Comiskey was quoted as saying: "The day of the megaphone man has passed."

PA systems don't just refer to the speaker cabinets prevalent at music venues and festivals. Any system of one or more speakers designed to replicate audio or speech to a group of people qualifies as a PA system. However, for the purpose of this guide, we're going to go over typical concert and event PA systems.

Basic PA System

MAIN COMPONENTS

Speakers

The first component that comes to mind when thinking about PA systems is the most important one, the speakers. PA speakers come in many different shapes and sizes. There are three main types of PA speakers:

- **Mains** (sometimes referred as "tops")
- **Subwoofers** (sometimes referred as "bottoms")
- **Stage monitors**

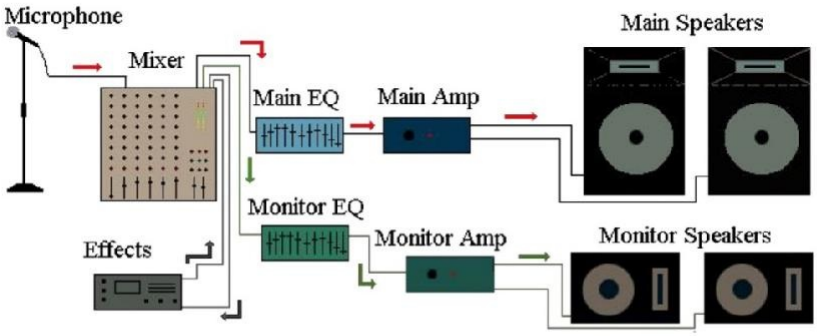
Each type of speaker serves a different function within the system, but each depend on each other.

Main Speakers

Mains function as the primary speakers in a PA system, producing most of the frequency range. In basic PA systems, the main speakers are either placed on speaker stands or mounted on top of subwoofers. Mains in a basic PA system are generally sized between 10"-15" with a smaller tweeter speaker above the woofer.

Subwoofers

Subwoofers—commonly referred to as subs—are larger than the main speakers and produce lower frequencies. This has the effect of "filling out" the audio and making it sound more powerful. Subwoofers are typically 15"-20" speakers, although dual 12" subs have become most common.



To separate the sound of the subwoofers and the mains, a crossover unit will almost always need to be employed. The crossover is usually rack mounted and separates the signal going through it by frequency, sending lower frequencies to the subwoofers and higher ones to the mains. An important part of tuning a PA system is selecting the correct crossover frequency for the room in which the PA is situated.

Stage Monitors

Stage monitors—also referred to as wedges—are speakers that face the opposite direction of the primary PA speakers. They provide sound for any performers or speakers on stage so that they can hear themselves. Stage monitors are usually on the ground tilted upward at an angle towards the performer. They are typically on a separate mix than the mains and subs.

Many main speakers are purposely designed to also act as stage monitors if needed.

Amplifiers

PA speakers can either be passive or active. Active speakers have an internal amplifier of their own while passive speakers have no internal amplifier and require an external amp to convert the line level signal from the mixer to a louder signal that drives the speakers. Amplifiers can be an expensive item, but deservedly so. In a passive PA system, you are trusting the entirety of the system's sound to one component.

Tip: Always turn on your PA system's amps at least 15 minutes before playing audio through them. This allows the circuitry to warm up and stabilize.

Sound Board

A mixing console is one of the most essential parts of a PA system, and like other PA components, the options on the market are endless. Simply put, a sound board (also known as a mixing board or mixer) takes multiple input signals—such as microphones, instruments, iPods, DJ turntables, etc.—and merges them together so that they can be sent to speakers as one signal. A sound board will have a set number of channels and is also responsible for routing sound, changing the volume level, timbre (tone color) or dynamics of many different audio signals. A mixer can provide phantom power for capacitor/condenser microphones, pan control on each channel, and monitoring mixes, for the stage monitors. Most mixing consoles will have left and right main outputs and individual outputs known as auxiliary sends, most commonly used for stage monitors or effects.

An audio engineer's job is to ensure each input channel blends harmoniously to produce a well-balanced sound. They use a sound board to optimize the combined sounds by adjusting input levels, applying effects, equalization and dynamic processing.

Sound Board Components

Inputs: These are jacks/plug-ins where all the sound sources plug into. Audio signals typically enter the board through an XLR, 1/4" TRS, or RCA jack - the most common/standard audio inputs.

Channel EQ's: Every input sound source corresponds to a channel, and each channel typically has EQ potentiometers. These allow an audio engineer to control the sound source's frequency balance individually.

Auxiliary Channels: Commonly referred to as "aux channels," these enable you to send a duplicate feed of a channel/input signal to additional devices. The aux channels output the duplicate feeds through a jack on the top or back of the sound board. These are most commonly used during performances; a band member may want to hear the audio back with certain elements adjusted to their preference through their own dedicated monitor wedge or IEM (in-ear monitors).

Faders: These are the sliders on a sound board that enable an engineer to adjust the volume/presence of each channel within the final output or mix. All channels should start at 0dB (referred to as unity) and be adjusted accordingly from there. This is why an experienced audio engineer running the board is key, as their ears are trained to recognize precisely what is needed to create a quality listening experience.

Cables

To connect the components of a PA system and carry audio signal, various cabling is required. PA speakers most commonly take one of three forms of cable: XLR, TRS, or Speakon. Mixers and amplifiers usually have main outputs and inputs of both XLR and TRS. Some amplifiers can have a form of RCA outputs called banana plugs.

XLR

TRS

SPEAKON

Many times, you can obtain a higher quality cable at a cheaper price by making it yourself! Simply buy some high-quality 3-pin cable wire and connectors and get to soldering.

Using the correct cabling when setting up a PA is vitally important. If wrong cables and/or connectors are used, equipment may not operate correctly. In the worst case, using the wrong cables or connectors can be dangerous.

Effects

An optional, yet common component of a typical PA system is effects. Many modern mixers will have onboard effects; however, effects paired with a PA system are usually outboard, meaning they are stand-alone units. Common effects paired with a PA system are reverb, compression, delay, gates, and equalizers.

Sound Sources

PA systems have various applications; thus there are a variety of common sound sources for PA systems. For example, music can be played through a PA system by feeding the sound through one or more channels on the mixer. However, the most common source is the sound from a **microphone.**

Microphones

There are a wide variety of microphones, all with differing shapes, sizes, pickup patterns, and applications. While your AV company should be expected to recommend the best microphones for your event, it is good to know some basic information about them.

Wired vs. Wireless Mics

When deciding between wired or wireless microphones the manner in which they will be used is crucial. If the performer needs to have a wide range of movement, a wireless microphone is the best option. Wireless microphones have become the standard for professionals, offering performers, interviewers, and speakers the flexibility to freely navigate the stage and focus on the task at hand.

What's the Difference Between Wireless and Cable Mics?

Microphones with cables seem like a simple concept to most people. They take sound and convert it into an electrical audio signal, and it is sent through a cable to a mixer or sound system. Wireless microphones, however, send sound through thin air. They do this by converting the sound into radio-frequency (RF) energy and sending it from the microphone's transmitter to the microphone's receiver, which then converts the signal back into audio and routes it into a mixer. So technically, a wireless microphone (with a transmitter) is a small radio station, and the receiver is a radio that can be tuned to the specific frequency that matches the transmitter.

Transmitters

Ever see someone using a small wireless mic (such as a lapel mic) and notice the small box clipped to their belt or in their back pocket? That is a transmitter. Keep in mind that all wireless microphones require transmitters to send the signal to the receiver. So while the handheld mics have their transmitter built right into them, smaller microphones such as lapel mics that clip onto clothing or a Countryman that hangs on the ear, have their transmitter in the form of small boxes with antennas.

Receivers

The opposite of a transmitter is a receiver. Their function is to receive a radio signal from a transmitter and convert it into audio that you can hear from a sound system. Depending on how many microphones you are using, you can use single or multi-channel receivers, instead of having to get a separate unit for each microphone. Often, you can get a multi-channel receiver with either dual or quad capabilities.

Wireless Microphone Benefits

The most significant advantage with wireless microphones is the mobility that is gained. Performers, interviewers, and speakers are given the freedom to move around naturally, which can make both the person using the microphone, as well as the audience, more comfortable.

Four Main Types of

WIRELESS MICROPHONES

Handheld Microphones

As long as you do not need to use both hands extensively, you cannot go wrong with a good old-fashioned handheld mic. As far as wireless microphones go, they offer the best audio quality which can be attributed to the size of the diaphragm.

Considering they are also extremely versatile, sturdy, and dependable, it is no surprise that handheld mics are an excellent option for:

- Musicians and Performers
- Speeches
- Presentations
- Interviewers
- Any situation in which a microphone will need to be passed around (Q&A, Panels, etc.).

Lavalier, Lav, Lapel

Lavalier microphones (often called "lavs" or "lapels") are a great hands-free solution for your presenting needs. They have multiple mounting options, making them very easy to hide. They are most commonly mounted with small clips for attaching to collars, ties, or other clothing. The microphone is smaller, which means a slight downgrade in audio quality, but in most cases, the tradeoff is worth it considering the mobility gained. Not to mention, the fact that they remain so conspicuous often means that the person using it forgets it is even there, allowing them to feel much more comfortable during their presentation, speech, or performance.

The concealment and mobility gained with lavalier microphones make them a very popular choice for:

- Theatre
- Engaged public speaking
- Interviews
- Television
- Houses of worship

Countryman (Headset)

If you are in search of a wireless mic that is high-quality, lightweight, easily concealed, and comfortable, look no further than the Countryman - the industry standard. It is a smaller, more advanced lavalier microphone with an omnidirectional polar pattern, serving to minimize noise from handling, wind, and popping. They most commonly wrap around the head and position a mic in front of the performer or speaker's mouth. It also is great for placing on hair or skin, as its capsule is resistant to moisture.

All of these factors make the Countryman ideal for:

- Theatre
- Public Speaking
- Interviews
- Television
- Houses of worship

Fitness Headset

A fitness headset is perfect for the highest levels of physical activity. It has a moisture-repellent hydrophobic fabric that protects the microphone cartridge from corrosion that tends to occur in humid environments.

Additionally, fitness headsets have wireframes that fit comfortably and securely, making them perfect for:

- Exercise Videos
- Fitness Instructors & Entrepreneurs
- Aerobics Instructors (Spin classes, yoga, etc.)

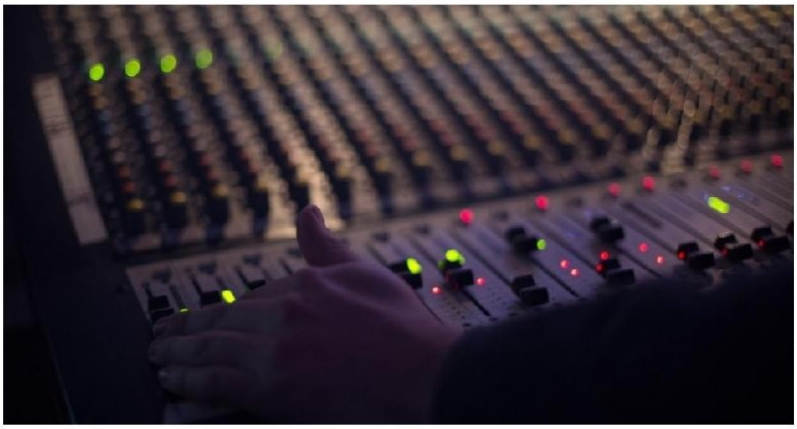
“

Mixing sound in the live realm
is not rocket science. In fact,
it’s probably closer to voodoo.

– Dave Rat, FOH engineer

PA Operation

Operating even a simple PA system can be frustrating, although rewarding. For many small-scale events such as speeches and conferences, little to no tweaking of the settings on the mixer are required after soundcheck. However, for large-scale productions such as concerts, it is imperative that an engineer is present to mix the sound for the duration of the event. Due to the complex nature of music, vital changes to the PA systems sound are required constantly.



Mix to the Room

Every room or venue is different, and they all sound different when filled with people. Make sure you always adapt what you do to fit the space you are mixing in. This is one of the biggest mistakes beginners make. Always remember that the acoustical environment plays a big part in the way you tweak your mix; therefore, you cannot expect a setting that was perfect at another venue to be perfect every time.

Keep Your Head Up

Try not to bury your head into the console; look around the room and gauge the response and adjust accordingly. It is easy to get caught up in riding the faders and changing FX, but make sure to keep your head on a swivel.

Walk Around the Room

It would be great if every venue had ideal acoustic properties and every audience member could sit in the "sweet spot", but unfortunately, this is not the case. Because of this, it is essential to understand that how your mix sounds at your position at Front of House (FOH) is not necessarily how it sounds for every

seat in the house. Make sure to occasionally step away from the board during the show to take a stroll around the room and listen for any abnormalities. This is easy if you are mixing on a digital console with an iPad app. Zigzag your way around the venue floor as much as possible and make minor adjustments.

Make Space for Every Element

As engineers, it is our job to mix music in a way that every instrument, singer, and effect to have its own space in the mix. Accomplish this using subtle pan adjustments, EQ boosts and cuts, reverb, and volume. Focus on the frequencies of the inputs you are mixing and listen to how they interact with each other as well as the overall balance.

Keep Your Focus on the Big Picture

Because it is so easy to fixate on making that one pesky microphone sound better, sometimes you can miss making the other forty microphones work together. Try always to be attentive to the overall balance. You would not want to be tweaking a compression threshold when a guitar solo breaks out and gets drowned out by the rest of the band. As a FOH engineer, you will need to master multitasking and prioritizing.

Essential Mixing Tips

Connect Your Audience to the Mix

Mix in a way that doesn't just entertain your audience, but engages them as well. Every song builds and has peaks and valleys. Don't just set your levels and leave all the faders in the same spot. The mix should move as the song does. Follow the pace of the show and reflect it in your mix. Ride faders and keep things interesting. Furthermore, keep in mind the significance of your compression attack & release times and how they affect the 'feel' of each song. Adjusting those times can remarkably improve the flow of the show, especially on the lead vocal channel.

Use Your Ears, Not Your Eyes

Always remember to mix with your ears, not your eyes. Do whatever sounds the best. There is no formula, just listen critically. If a drastic EQ boost or cut is needed, do it. It does not matter what your EQ curves look like, as long as it sounds good. If the bassist is stealing the show with how dynamic he or she is playing, go ahead and slam the compressor down on their channel. At the end of the night, your only job is to make the performers sound the very best to the audience as you possibly can, there are no rules to how you can accomplish this.

Proper Planning Prevents Poor Performance

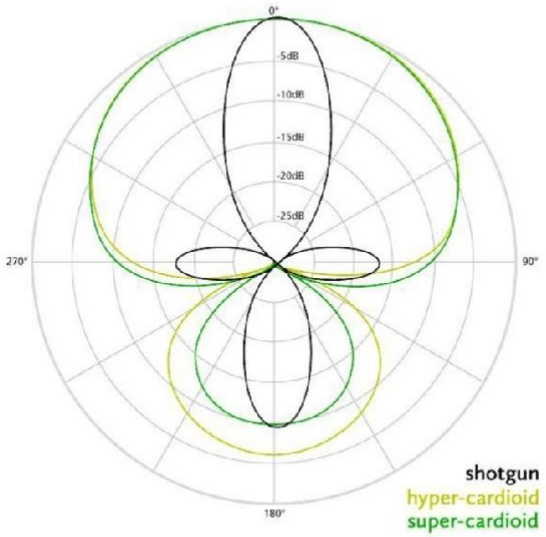
Many engineers chase their tails because they have not taken enough time to set up their console, label their inputs & outputs, route VCAs or create scenes. Often, they end up taking all the time just trying to make it all work rather than engaging in the creative process of mixing. It is crucial to take the time to prepare as much as you can before sound check so you can concentrate on the critical elements during sound check and more importantly, during the show.

Microphone Feedback

One of the most awful and embarrassing situations for an audio engineer is microphone feedback during an event. Not only is it painful for our ears, but it can interrupt the flow of an entire performance or event. Audience members may become skeptical of your abilities and event planners will look for someone to blame. Essentially, feedback is the last thing you want while running sound.

Microphone Position & Polar Pattern

Different microphones have differently shaped areas from which signal can be picked up. It is essential to know your microphone's specific polar pattern before you use them live. Knowing your microphone's polar pattern helps you to adjust where you will place stage monitors to avoid signal feedback into the microphone.



Know the "Point of Feedback"

Once you have adjusted and set your gain, slowly ride your mixer's fader up until you begin to hear feedback. Make a mental note or even use a piece of console tape to depict where feedback will ensue visually. If this level is too low, the microphone position or monitor position may need adjustment. This line is your limit and should only be crossed when required during certain moments when headroom has increased. Always make sure you bring it back below the line as soon as possible. Remember, feedback is acceptable during soundcheck. This is when you are feeling everything out and learning how the sound sources and stage configuration interact.

Use EQ

Using your ears or a real-time analyzer (RTA), determine which frequencies are spiking and feeding into each other. To do this, set all faders just below the point of feedback and raise the stage monitor levels up one at a time until they begin to feedback. When a frequency starts to spike, use a parametric or graphic eq to notch out the troublesome frequency pre-fader on the monitor output. Be careful not to tweak the EQ after this.

Preventing Feedback

Carefully Watch Your Stage Volume

The louder your stage volume is, the higher the chance for feedback gets. Try keeping your monitor levels as low as possible. Once a musician is happy with their mix and level, you can usually get away with turning the volume down slightly when they are not looking. Furthermore, consider using in-ear-monitors when possible. This reduces stage volume drastically which in turn reduces the chance for feedback.

Always Mute Unused Microphones

It is a good idea to mute microphones that are not in use at any given time. This helps to reduce the amount of pickup from the stage, which in turn allows you to push the unmuted microphones louder. Additionally, unused microphones pick up bleed which can only muddy up a mix.

Teach Performers Proper Mic Technique

It is often not the equipment but the performers that increase your chances of feedback. When an inexperienced performer does not have a proper projection technique, feedback can often leak in. Always remind them that it is ideal for them to be as close as possible to the microphone.

Use Direct Boxes Instead of Amps

Use a direct box instead of an amp as much as possible. Instruments like keyboards or bass guitars usually do not depend on an amplifier for their tone. Using a DI box eliminates having another microphone on stage. Going direct will also reduce stage volume, and you will have a cleaner signal.

Always Be Alert and Ready to Mute

Keep an eye on all live microphones at all times and their position on stage. A singer walking in front of a PA stack or an MC waiving a microphone near a stage monitor are all common causes of sudden feedback. If this happens always be ready mute the affected channel or quickly throw a fader down, your audience will thank you.

Conclusion

Now you've got all of the basics for PA systems, how they work, and mixing techniques. Whether you're looking to rent a system and hire an engineer, or try it out yourself, it's always important and beneficial to have some basic knowledge on the topic. We hope this guide can help you feel a little more at ease about your next event.

Of course, feel free to contact us at Channel Audio for a quote if you're in need of a PA system for your event. Our experienced engineers have handled everything from birthday and bachelorette parties to huge festivals, and they are always available to ensure smooth and clear audio throughout your entire event.

Thank you for reading. We look forward to hearing from you soon!