



A Complete Beginner's Guide to
**How Does a
PA System Work?**

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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.

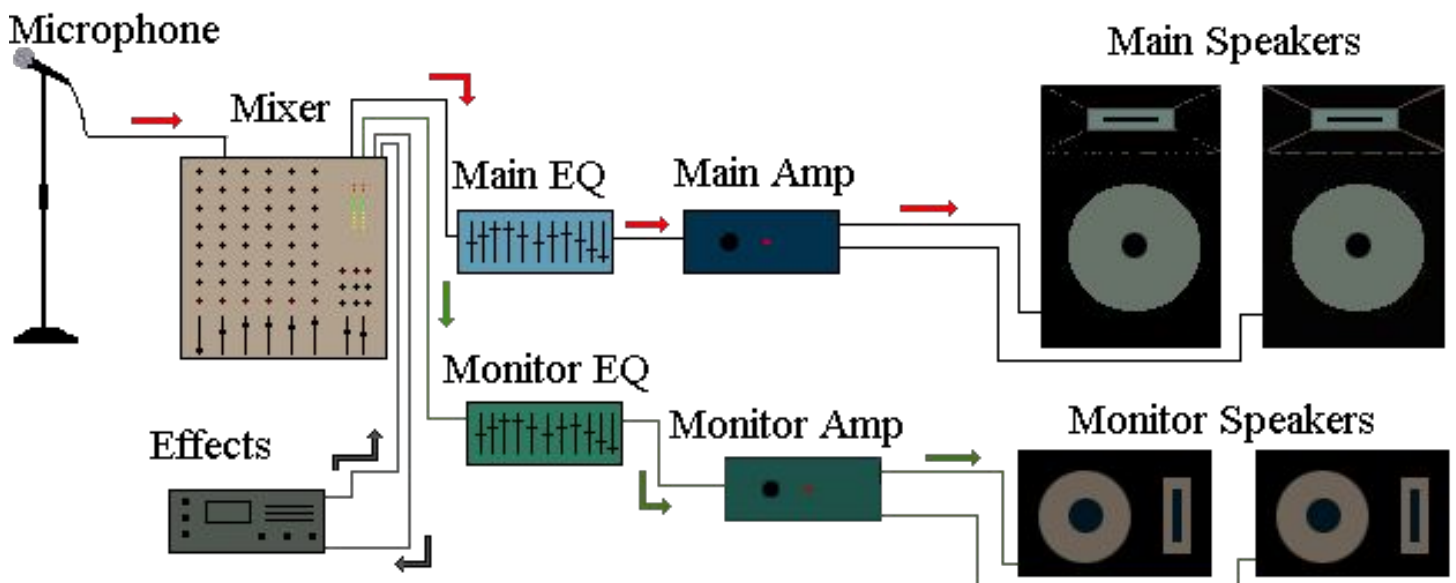


Main Speakers

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.

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