WHAT IS A PA SYSTEM?

A PA is a **Public Address system**. There are a wide variety of PA systems in existence, from small one speaker setups to 80 speaker flown systems as used at festivals such as Glastonbury.

PA systems are in use in venues, pubs, clubs, shopping centres, shops, restaurants, railway stations, stadiums and many other places. They were originally devised to enable announcers or public speakers to be heard – hence the name public address.

For the purposes of this chapter, we will be concentrating on the sorts of systems you would expect to use for small to medium size pubs and venues, from 10 to 2000 people.

PA systems are generally used for amplifying voices, as guitarists have loud guitar amps, bassists have bass amps and drums are just loud. However, as the gigs get bigger more and more gets put through the PA system, and hence the PA system grows in size. The largest PA's and situations require that all the instruments go into the PA, and that the PA also provides different on stage sound for each performer.

For the purposes of this chapter, PA systems will be split into mobile (or touring) systems, and installed systems. Some venues have their own systems installed, and others require that you bring your own or hire one.

WHAT ARE THE COMPONENT PARTS OF A PA SYSTEM?

A basic PA system consists of a microphone or some other source of sound (CD player etc), an amplifier and a loudspeaker.

At their most extreme, PA systems consist of racks of amplifiers, huge arrays of different types of loudspeakers, mixing desks, effects, microphones and lots of cable.

When PA systems are used for gigs, they often feature two sets of PA system in one – 'Front of house' sound, and Monitors (or 'on stage' sound). This is so that the audience can hear the music, and the band can hear each other. Most of this section will be about 'front of house' systems, but monitoring will be covered.

Now lets look at mobile and installed systems.

A lot of live music venues have an installed PA system with the cabling connected from the stage to the mixing desk. They often have their own engineer to operate the PA, and just require a spec sheet (specification sheet) or technical rider. This is simply a sheet of paper specifying what instruments will be played and what microphones will be required, so the engineer can sort out their connections and signal routing.

Mobile systems can be further divided into two categories – **ACTIVE** and **PASSIVE**.

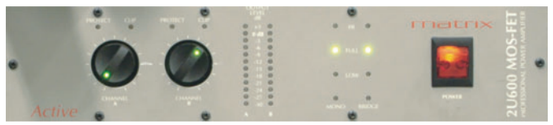
ACTIVE SYSTEMS have the amplifiers built into the loudspeaker cabinets (such as the Mackie SRM450). There are good reasons for this; amplifiers are matched to the loudspeakers by the manufacturer and there is less to carry around and set up. You need to provide mains power for each loudspeaker this way, which often involves having long mains extension leads all over the place. It also can make upgrading or changing the system more difficult.

PASSIVE SYSTEMS are when the amplifier and loudspeaker are separate. You therefore have more to carry around and set up, but it gives more flexibility. They also allow for active equalisation and bi-amping which is when the signal is split into frequency bands and each band has its own amplifier and speakers. Most large systems are constructed in this way.

Passive systems can be further divided into systems that make use of a powered mixer, or systems that use a power amp and a mixer.

Amplifier Rack

TOP : Matrix 2U600 MOS-FET professional power amplifier



MIDDLE : C-Audio stereo power amplifier

BOTTOM : CREST AUDIO CA12 power amplifier

Mackie active speaker

Passive speaker and power amplifier

MIXING DESKS are necessary as they enable you to plug several inputs into your PA, set different levels for each, adjust the tone (equaliser) and add effects.

Mixing desks and effects units are generally positioned at the back of the venue, facing the stage, in the 'front of house' position, enabling the engineer to hear all the sound from the stage and the PA.

POWERED MIXERS are mixing desks with built in amplifiers to power the speakers, thereby removing the need for any other amplification. Powered mixers tend to be used at the smaller end of the PA market, as the built in amplifiers aren't particularly powerful.

Master section from MIDAS Mixiing desk

Phonic Power Pod 615 Powered Mixer

MIDAS Mixing desk

INPUT SOURCES

Once you have chosen your mixer, you need to get sound into it. This will be either from a microphone or a connection to some other source such as a DJ mixer or keyboard. Connections to sources such as this are generally made through Direct Inject boxes (DI Box), which are designed to match the level of a range of inputs to the level required by a mixing desk.

The table below outlines what sorts of connection or microphone you would expect to use for each sound source.

A large cable called a multicore is used to carry the signals to and from the stage. A multicore has a stage box at one end, with sockets to plug microphones and DI boxes into, and plugs at the other end to connect to the mixing desk.

MULTICORE

Source	Type	Example
Vocals	Dynamic microphone	Shure SM58
Electro-acoustic Guitar	DI Box	Behringer Ultra-DI DI100
Electric Guitar	Dynamic microphone	Shure SM58 or SM57
Electric Bass	DI Box	Behringer Ultra-DI DI100
Keyboard	DI Box	Behringer Ultra-DI DI100
DJ	DI Box	Behringer Ultra-DI DI100
Kick Drum	Dynamic microphone	AKG D112
Snare Drum	Dynamic microphone	Shure SM57
Tom tom	Dynamic microphone	Sennheiser MD421 or Shure SM57
Drum Overhead	Condenser microphone	AKG C451 or AKG C1000s

TYPES OF SPEAKERS

The most basic PA speakers consist of two drivers (individual speakers within a speaker cabinet are called drivers) – one for low frequencies and one for high frequencies. The low frequency drivers are called woofers, and the high frequency drivers tweeters. Typically, woofers are 10", 12", 15" or 18" diameters, with larger sizes capable of higher volumes and lower frequencies. The tweeters come in a range of styles and sizes, and are matched to the woofers. The sound entering the cabinet is split into high and low frequencies by a crossover.

The cheapest passive speakers would have a 10" woofer and 1" tweeter. The other specifications to be aware of are the power handling, which shows how powerful an amp they can accommodate, the frequency response, which shows what range of frequencies the speakers can produce (e.g. the B1020 are 55Hz to 18KHz) and the Sound Pressure Level (SPL) which shows how loud the speakers are per watt of power from the amp (e.g. the B1020 produce 95dB for 1 Watt at 1m distance).

Speakers go up in size and price from around £110, some have more drivers and some separate the frequencies into 3 bands (low, mid and high frequencies) and have a driver for each band. Active speakers are based on the same principles but have one or more built in amplifiers.

PA's that will be used in larger rooms or to amplify an entire band or DJ usually have Subwoofer speakers as well. These speakers are capable of producing lower frequencies than the speakers described above, and at a louder level. They usually have one or more 15" or 18" drivers.

Typically one subwoofer and one normal PA speaker are used for each side of the stage, with the normal speaker often positioned on a pole or directly on top of the subwoofer.

TOP : Passive PA speakers example 1
BOTTOM : Subwoofers

Passive PA speakers example 2

MONITORING (ON STAGE SOUND)

Once the front of house sound has been arranged, the next step is the sound on stage, or monitoring. This is essential for all music related PA applications, as the performers need to be able to hear what they are doing. For the smallest PA applications, only the vocal needs to be put into the monitors. At the other end of the scale, all the instruments need to be in the monitors, and each performer will want a different mix in their monitors.

The most common form of monitor is the wedge monitor. This is an angled speaker cabinet that is placed on the floor in front of the performer. Wedge monitors also come in active and passive varieties, so active wedges have built in amplifiers, and passive wedges need a separate amplifier.

Another common form of monitor is called a sidefill. These are stacks of speakers that are similar or the same as normal PA speakers, positioned at the sides of the stage pointing in at the performers. Another variation on this is the drumfill, which is the same as a sidefill but positioned next to the drummer so they can hear the other instruments. These are often large speakers to enable them to be heard over the noise of the drum kit.

In-ear monitors are becoming more popular now. These are basically in-ear headphones that are moulded to fit the ears of each performer. They enable much more accurate monitoring for the performer and help eliminate feedback. However, some performers don't like them as it feels more like being in the studio than being on stage.
In-ear monitoring systems are usually wireless, and a set of one transmitter, one receiver and one set of headphones costs from £340.

FEEDBACK

Feedback is when a microphone picks up the sound from the PA or monitors, and the signal goes round in a circle, amplifying each time. The end result is a howl or squeal that sounds bad and is very loud. It is avoided by careful speaker placement and equalisation, as the feedback is often at a certain frequency that can be cut.

Wedge monitor example

BUYING SECOND HAND

It is quite common to buy PA equipment second hand.

There are many places to obtain second hand music equipment, from local papers, to websites, magazines to auctions. One of the most popular places now is ebay, the online auction site. It is possible to pick up some bargains, but when buying any music equipment second hand ensure you can test it before you pay. PA equipment can get quite battered and bruised and may require some maintenance.

There are some weblinks in the Want to know more? section that lead to second hand PA equipment listings.

SETTING IT ALL UP

SMALL (PUB) GIG

This section will describe a typical PA setup for a band in a small venue such as a pub. Let's assume a typical band line up;

Lead vocal, 2 x backing vocal, Drums, Electric guitar, Electric bass, Keyboard

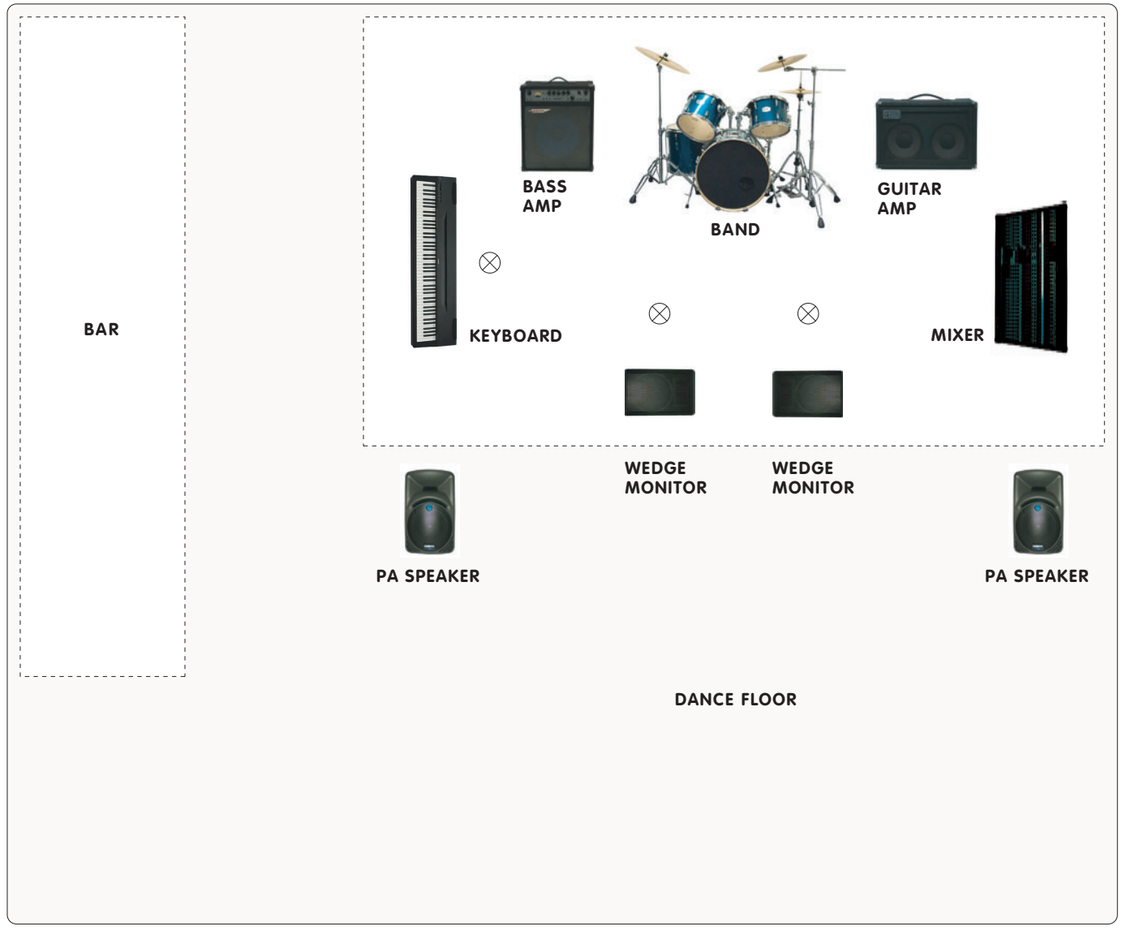
The PA would normally provide amplification for the keyboards and the vocal, as the drums would be loud enough by themselves, and the guitarist and bassist's amplifiers would be loud enough on their own.

As the PA wouldn't be handling any bass or kick drum, a simple PA system consisting of 2 speakers each side, with 12" or 15" woofers and a tweeter would be sufficient. These would normally be placed on stands so that they are above the heads of people standing at the front.
Monitoring would be necessary so that the performers can hear the vocal and keyboards, but as small venues tend to have small stages there would probably only be room for 2 wedge monitors.

For a gig such as this, a powered mixer, passive speakers, and a powered wedge monitor and a passive slave wedge would be ideal. You would need a mixer with a minimum of 4 channels, and it would need to have an aux send to be used to send a mix to the monitors.

The following is a list of equipment that would be ideal for this sort of live sound situation. The price is only an indication, and if equipment was bought second hand it would be cheaper.

Component	No.	Manufacturer	Price	Why
Powered mixer	1	Behringer	£250	250w per speaker output, 10 input channels
PA speaker	2	Behringer	£140 each	12" woofer, tweeter, 200w power handling
Active monitor	1	Carlsbro	£255	12" woofer, tweeter, 100w amplifier
Passive monitor	1	Carlsbro	N/A	Comes with active wedge
Microphones	3	Shure	£69 each	Industry standard live vocal mic
DI box	1	Behringer	£39	Robust build, good quality
			£1031	



NOTE : ⊗ MICROPHONE PLACEMENTS

KARAOKE

Karaoke or singers who perform with a backing track need a slightly different design of PA system. The PA would amplify everything, including the backing track (from a CD player or similar) and one or more microphones.

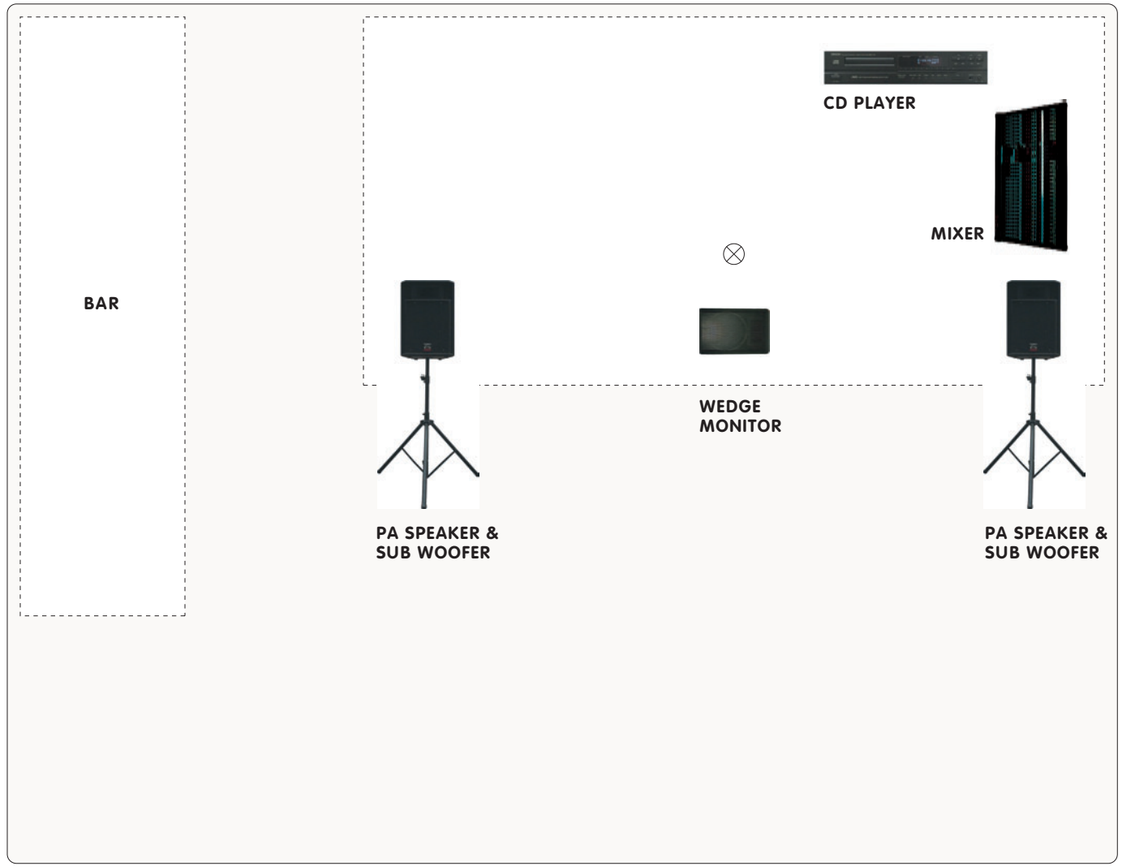
There would be a need for subwoofers, as the PA would be handling bass from the backing track.

Monitors would also be necessary as the performer would need to hear themselves and the backing track.

The ideal choice here would be an active PA – active speakers and subwoofers, an active monitor and a small mixing desk. This is because it is easier to set up and move around, and provides a good quality of sound.

The list in the table below is an indication of what you could use for this sort of situation. As before, this is not the only way that this job can be done.

Component	No.	Manufacturer	Price	Why
Mixer	1	Behringer	£120	4 mic inputs, CD player input, built in effects
Active PA speaker	2	Mackie	£1300 for 2	High quality bi-amped 400w speaker
Active monitor	1	Carlsbro	£175	12" active monitor
Microphones	1	Shure	£69	Industry standard live vocal mic
CD Player	1	Denon	£100	Rack mountable
			£3064	



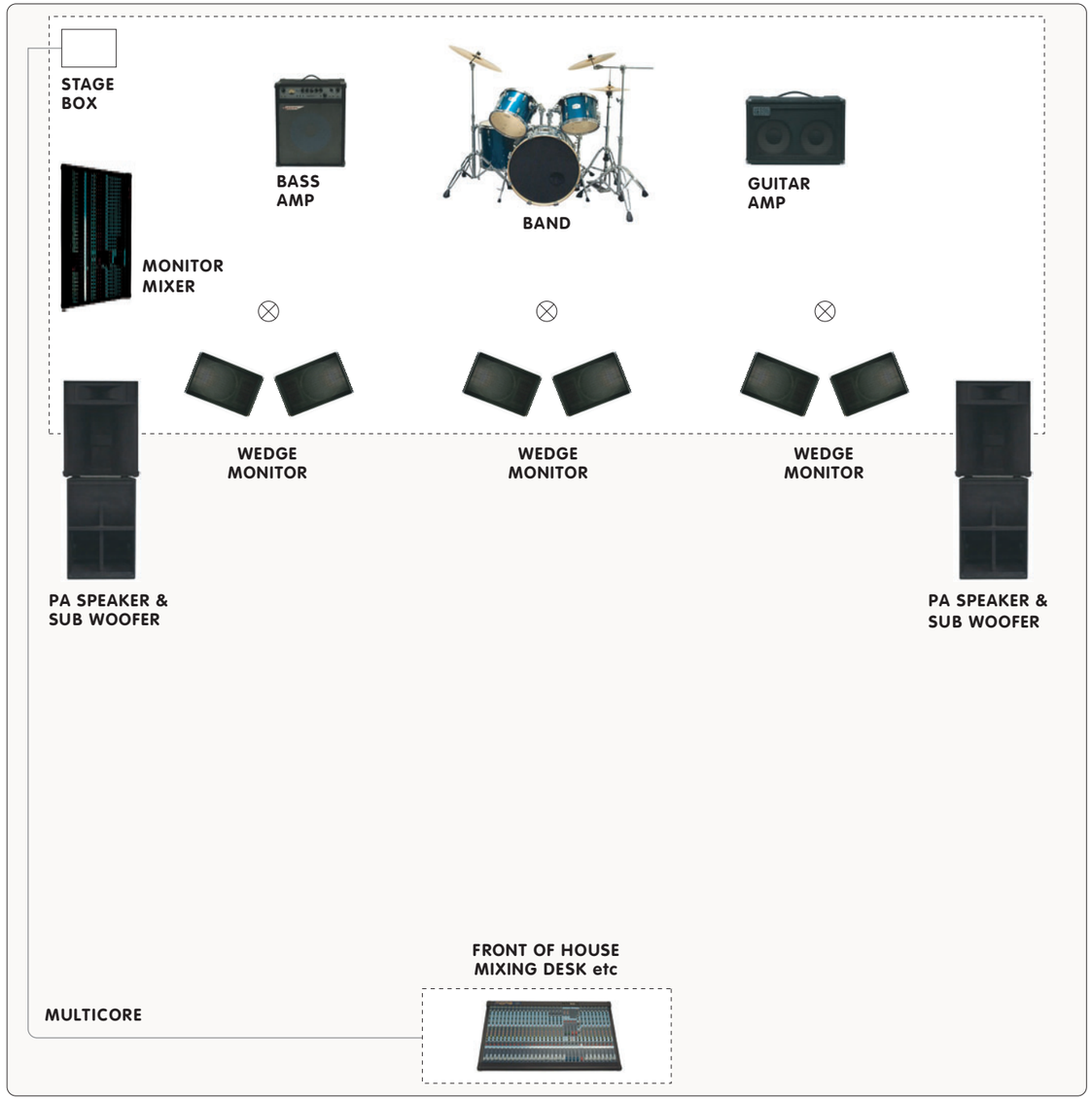
NOTE : ⊗ MICROPHONE PLACEMENTS

PERMANENT VENUE PA

The diagram represents the sort of equipment used in a permanent venue PA. In this situation, the front of house engineer would use one or more aux sends to send a feed to the monitors from each channel. In this way, different mixes for different monitors can be provided.

The front of house mixing desk would generally be set up in a convenient position, and would be accompanied by effects units, compressors, noise gates and graphic equalizers.

The stage box and multicore would normally be positioned at the back or side of the stage, ready to plug the microphones and DI boxes into.



NOTE : ⊗ MICROPHONE PLACEMENTS

GETTING THE RIGHT MIX

There are some basic principles for getting a good live sound.

Set up the PA and get the vocal as loud as you comfortably can without feedback. Then match the other instruments to this vocal level.

If you are putting the whole band through the PA, ensure that the amps on stage are not too loud, as this will make getting the sound right through the PA difficult.

Ensure that the monitors are not too loud as this sound will interfere with the front of house sound.

Use this table to work out what types of effects or processing you need.

Instrument	Processing	Why	Effect	Why
Vocal	Compression	Keeps the level consistent and makes it easier to hear over other instruments	Reverb	Gives a sense of space to the mix, but use with care – not too long a reverb time
Bass guitar	Compression	Keeps the level consistent	None	Bass players can add their own effects on stage if they want them
Electric guitar	Maybe compression	Keeps the level consistent	None	Guitarists can add their own effects on stage if they want them
Acoustic guitar	Compression	Keeps the level consistent	Reverb	Gives a sense of space to the mix, but use with care
Keyboards	None		None	
Kick drum	Noise gate	Removes unwanted sound from the mic	None	
Snare drum	Noise gate	Removes unwanted sound from the mic	Reverb	Gives more depth to the snare, but use with care
Tom toms	Noise gate	Removes unwanted sound from the mic	Reverb	Gives more depth to the snare, but use with care
Drum overheads	None		None	
DJ	Limiting	Limiting is hard Compression which ensures that the PA isn't overloaded	None	

HEALTH & SAFETY

When performing live or running a PA in a venue there are many health and safety issues to be aware of. These include:

CROWD SAFETY
First Aid
Security
Capacity
Disabled Access
Ventilation
Slips and Trips
Fire Exits
The Door
Staff Safety

For more information on health and safety
» WORKBOOK 4 – PERFORMING – CHAPTER 4

ELECTRICAL SAFETY
PAT - Has equipment been tested?
RCDs - Residual Current Devices
Ventilation

FIRE SAFETY
Fire Exits
Fire Extinguishers
Fire Proofing – need to ensure any sets are fire proof

NOISE POLLUTION
Time curfew – some venues have a time limit on how late they can make noise
Volume (Decibel) limit – some venues have a maximum volume limit, and sometimes this is linked to the mains power to the stage, so that if the volume gets too loud the power is cut