



Monitoring

✝ Church Audio ✝

Loudspeakers



Loudspeaker cones can reproduce some frequencies easily, but not others.

The actual frequency zone that a loudspeaker is capable of reproducing depends on the diameter of the cone.



Think about a Bass Guitar Loudspeaker Cabinet. Why has it got such a large cone?
Quite simply because smaller sized cones cannot reproduce really low frequencies.

Please do not be misguided by small loudspeaker cabinets with the phrase “Studio Monitor” or “Linear from 20Hz to 20kHz” written on them. They cannot defy the current physical laws of loudspeaker cones. A medium to small cone cannot reproduce bass frequencies properly. If they could, the Bass player wouldn’t be carrying around a big, very heavy box.



A proper “full-range” Loudspeaker cabinet is traditionally three cones of different size (called a 3-way cabinet):

*A small **Tweeter** that can shimmer very fast and reproduce the high frequencies. This has a diaphragm, not a cone.*

*A medium sized **Mid-Range** cone to handle the mid frequencies.*

*A sizeable **Woofer** cone that is built to move very slowly to reproduce the bass frequencies properly.*

The mechanical requirements of each of these is completely different, which is why a single cone hasn’t been invented to date.

It is physically impossible for a Tweeter to move really slowly and reproduce bass frequencies like a Woofer, and vice versa.

As loudspeaker technology improves we are seeing more 2-way cabinets, with just a large Mid-Range cone and a Tweeter.

Always look at a Cabinet and consider the biggest cone (Woofer). Is it honestly able to reproduce a Bass Guitar’s low notes?

*The hollow **tube** or **slot** resonators (bass reflex) you see in a cabinet are tuned to very low frequencies, and give a bigger bass sound to a cabinet. Unfortunately this bass sound is fake, generated by the cabinet and not from your audio. Study your cabinets!*

Without honest full-range Loudspeaker Cabinets delivering a complete audio soundscape, don’t expect a good sound.

Amplifiers

The job of an Amplifier (Amp) is to amplify the incoming audio signal (electrical signal voltage) and send it out loud enough (higher voltage) for the next stage. There are various levels of Amplifier used in the audio sector, each one is designed for a particular task.



Pre-Amplifier:

The task of this Amplifier is to boost the very tiny voltage generated by microphones, musical instrument pickups, etc. This signal is usually only thousandths of a volt. A Pre-Amplifier raises the tiny signal to what we call **Line Level**, which is around 1 volt. Most audio devices (including the Mixer) operate at this Line Level. A Pre-Amp can be found on each Input Channel of a Mixer, typically called a **Gain** knob.



Headphone-Amplifier:

If you plug a set of Headphones in to the output of a Mixer you will not hear anything. The reason for this is that “Line-Level” isn’t strong enough to power Headphones. A Headphone Amplifier amplifies Line Level up to around 1/8 watt or 1/4 watt which is the standard Headphone operating level. This amplifier will usually have the word ‘**Phones**’ with an associated Stereo Connector.



Power-Amplifier:

These Amplifiers take the Line-Level audio signal and raise it to a high voltage and amperage. This is needed to power large Loudspeaker Cabinets for public listening. eg 100w 500w 5000w. Power Amplifiers use a lot of energy and dispel it as heat. For this reason, it is important to keep Power Amps in an open space where air can circulate and keep their ventilators cool. Power Amps will usually have slotted vents on the sides, top, or back of their case. Be careful not to sit anything on these vents, or block their airspace, because if a Power Amplifier overheats and goes bang it is

expensive to repair. Some Amps have built-in protection against overheating (all of a sudden, they switch off until they cool down, which can be embarrassing). Because a high amperage comes out of a Power Amplifier it is important not to use normal audio cables such as microphone or guitar cable to connect to the Power Amp to the Loudspeakers. This can cause them to overheat and melt, which can a short-circuit and blow your Power Amp, or catch fire and burn the stage down ☹. While the sound system is running quite loud it is a good idea to grab hold of the Speaker cables going from the Power Amp to the Loudspeakers and feel if they are warm or worse... hot. Heat is a sign of loss of power caused by incorrect cable types.

Where does all the power go? 100w Power Amp with an 8 ohm Loudspeaker cabinet will produce 28 volts and have a current of 3.5 amps. Only the Woofer will be using all of this (you need a lot of energy to make a loudspeaker cone move slowly). The Tweeter, for example, only uses a small fraction of this energy.



Here is a graphic look at the various Audio Amplifiers.

Stereo means 'Two'



Power Amplifiers come in 'Stereo' boxes. Put more simply, they contain two completely independent Amplifiers. The two Amplifiers are intended to amplify the left and right channels coming from a Mixer and going to the Left and Right Loudspeakers. If a Stereo Power Amplifier says it is 200 watts, then check if it is 200 watts on each channel, or 100 watts on each channel (totalling 200 watts). 200 watts on each channel may be written 200+200.



You have two completely independent Amplifiers in a Stereo box. It is not obligatory to use them for the L-R Loudspeakers. You can use them for completely different jobs if you wish. Manufacturers know this, and have stopped labelling them L and R, and now call them Channel 1 and 2 instead. A common use is to power two different Floor Monitors. Mixer Send Aux 1 could be connected to Power Amp Chan 1 and power the Singer's floor monitor, while Mixer Send Aux 2 could be connected to Power Amp Chan 2 and power a Musician's floor monitor. *Remember always... **two completely independent Amplifiers!** In an emergency, if a Front-of-House power amp blows up, grab a floor monitor power amplifier. Leave one channel to run a floor monitor, and the other channel for a single Front-of-House loudspeaker for the congregation. It's a little rough but it saves the day!*

PASSIVE



Up to this point we have used the example of “Passive” Loudspeaker Cabinets that just have Loudspeaker Cones inside them. These need to be powered by an external Amplifier. For large live concerts this a necessary method, especially with large Power Amplifiers which are extremely heavy and need extensive cooling.

ACTIVE



Thanks to modern Loudspeaker Cabinets being made of light synthetic materials, and medium Power Amplifier circuits not needing special cooling, we can purchase “Active” Loudspeaker Cabinets which have the Power Amplifier already placed inside. This type is distinguishable by the addition of a power cable. There is no real advantage, but it is “convenient and tidy”.



GUITAR



KEYBOARD



BASS



Musical Instrument Amplifier Cabinets

Guitar Amplifier loudspeakers do not need to put out much bass power and only require low to medium power handling (50w to 200w). A 50w guitar amp goes a lot louder than a 100w home stereo because a guitar amp and loudspeaker package is more efficient.

Guitar Amplifiers are made for guitar frequencies, and Guitar power.

Keyboard Amplifiers are for keyboard frequencies, and Keyboard power.

Bass Guitar Amplifiers are made for bass frequencies, and Bass Guitar power.

More and more Bass Guitar musicians are preferring multiple speakers - 2 x 12", 4 x 10" etc rather than one big cone. These give a fuller, fatter sound than single speakers, but don't boom as much, suiting the modern electric bass sound.

Electric Guitar Amps are now preferring multiple speakers as well because even a 15" speaker cone is sounding a bit too heavy for a modern guitar sound.

If a musical instrument amp is very loud, and the musician won't turn it down because they "need" it that loud to play (professionals can play quietly, amateurs can't) then the cabinet needs to be turned around and faced up at the musician (like a floor monitor) so they can hear well without loud (*it's actually a great sound... better than any floor monitor*).



Some Amplifiers have a Direct Out (actually it's a D.I box). This is great to get a clean line out to the Mixer. The best-case scenario is to use this Direct line out from the Amp plus a Microphone picking up the loudspeaker cone. You will end up with two guitar channels at the Mixer which you blend to get a professional sound (the D.O. will be the clarity in your sound, and the microphone will give the body).

Floor Monitors (Stage Monitors) (Wedges)



Floor Monitors are wedge-shaped loudspeaker cabinets designed to sit on the floor in front of musicians and singers. It is called Fold-back (*folding sound back*). Floor monitors come with a large Woofer speaker. Try and get ones with additional Horn speakers (rectangular) or Tweeters to handle the mid to high range. Floor Monitor cabinets are specially designed to have around 40 degrees coverage to either side. Those with the additional Horn speaker will be mounted vertically to ensure a narrow dispersion horizontally and a wide dispersion vertically.

Floor Monitors are typically measured by their Woofers and may be called 15", 12", 10", 8" etc.

Single 12-inch diameter floor monitor cones have gained in popularity, especially for vocals, because of their smoother transition between cone and horn in the vocal range. For bigger stages more and more engineers are turning towards "dual" 12-inch Wedges for greater "punch" without the booming that comes from larger Loudspeaker cones. One 15-inch (38cm) Floor Monitor is still obligatory so that the Bass Player can hear a full bass sound.

As with all Loudspeaker cabinets the Floor monitor may require a separate Power Amplifier (Passive), or there may be a Power Amplifier inside (Active).

In really noisy stage environments you won't hear any better by simply raising the floor monitor volumes. You will need to push for clarity of sound to cut through the stage noise. Equalising the floor monitors, compressing them, or choosing a smaller diameter speaker will give you clarity, which is better than volume. Resist making floor monitors overly loud as it will cause excessive off-stage noise, and you will never make a good Front-of-House sound.

There will commonly be two connectors on a Floor Monitor; one to connect your audio from the Mixer or Power Amp, and a second connector in parallel in case you want to pass it on to another Floor Monitor. You can "link" multiple floor monitors using the parallel connectors. *Attention... when using the parallel link connectors remember that two speakers in parallel will electronically halve the load on the power amp. 2x 8 ohm floor monitors in parallel will become 4 ohms. 3x 8 ohm floor monitors in parallel will become 2.6 ohms. So be sure to check how low (ohms) the Power Amp you are using can go.*

Personal Monitors - Spot Monitors



Instead of classic Floor Monitors, these small powered-monitors attach to a microphone stand and are surprisingly effective. A 5" speaker will give a decent midrange and have more than sufficient power for most musicians needs. The advantage is that it is really close to their face and doesn't need to be so loud and so it doesn't induce feedback squealing.



The above example is the "Flea" (made in New Zealand). It mounts on any stand, and powers itself off the main Loudspeaker line. It gives the musician a crystal-clear mix of the main loudspeakers, right in their face! Obviously, using the main loudspeaker line it is not a personal mix and they will hear what the congregation hear, but many musicians quickly discover they prefer this once they experience it. You can put up to 32 Fleas on 1 stereo power amp.

Personal Monitors – In Ear



In-ear personal monitoring requires the musician or singer to carry a radio-receiver pack, which is connected to earplugs. This method eliminates squealing (feedback) and eliminates the floor monitor noise (spillage) that always dirties the front-of-House sound.

The musician doesn't have to keep saying 'turn me up' as they have the volume control on their receiver pack.

With floor monitors the musician can only move a metre or so either side before they can't hear themselves, while in-ear monitoring allows complete independence of movement.

Because in-ear monitors allow stereo, some companies have started offering a little trick they call dual-mono. This enables the sound technician to send different sounds to the left and right channel, and the musician can adjust the balance of the two (Pan) if they wish, slightly modifying their mix to suit themselves.

Personal Monitors – Headphones



OPEN BACK



CLOSED BACK

With the need to press PFL and listen intently to specific singers and instruments in the midst of a congregation singing loud, and a band playing louder, you need to use large headphones that completely enclose your ears and cut off, as best they can, the racket in the room. Closed-back Phones are designed for working in high background noise environments, and this is what you use for 'live' sound work.

Open-backed Phones are designed for situations where you need a really natural sound such as mixing music via headphones in a quiet ambient. It has a wide stereo image.

Headphones are really just two midrange loudspeakers of around 1/8 Watt to a 1/4 Watt.

Because headphones are small midranges they are not able to produce the bass frequencies faithfully (even if the manufacturer says they can).

Ear-plugs are even tinier loudspeakers. These can't even reproduce a healthy mid-range, and you can definitely forget hearing any fidelity in the basses.

You can't honestly filter sounds using headphones (*though you may have to if you are in the middle of a Service*). If you filter a sound according to what you hear in the headphones, it will have little relevance to what people are hearing in the big Front-of-House Loudspeakers. *You absolutely mustn't filter using earplugs.*



Should you find yourself needing multiple Headphones consider a Headphone Distribution Amplifier, as shown were, each person can set their own volume.

CREDITS

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Text: *Original, by the Author, a Christian Recording Engineer.*

Images: *Designed by the Author. Some photographs were sourced from the Internet, then re-worked.*

Ever since the creation of the world, God's invisible attributes and divine nature have been evident. They are clearly understood through his workmanship, and all the wonderful things that he has made. Therefore, those who fail to believe and trust in him are without excuse, or defence. **Romans 1:20**

All of us have sinned and fallen short of God's glory, but God treats us much better than we deserve.

Because of Christ Jesus, he freely accepts us and sets us free from our sins. God sent Christ to be our sacrifice. Christ offered his life's blood, so that by faith in him we could come to God. **Romans 3:23**

If you declare with your mouth, "Jesus is lord," and believe in your heart that God raised him from the dead, you will be saved. For it is with your heart that you believe and are justified, and it is with your mouth that you profess your faith and are saved. **Romans 10:9**

For the Scripture (*Isaiah 28:16*) says, "Whoever believes in Him will not be disappointed." **Romans 10:11**

These things have been written so that you may believe that Jesus is the Christ, the son of God; and that by believing, and relying on him, you may have new life in his name. **John 20:31**