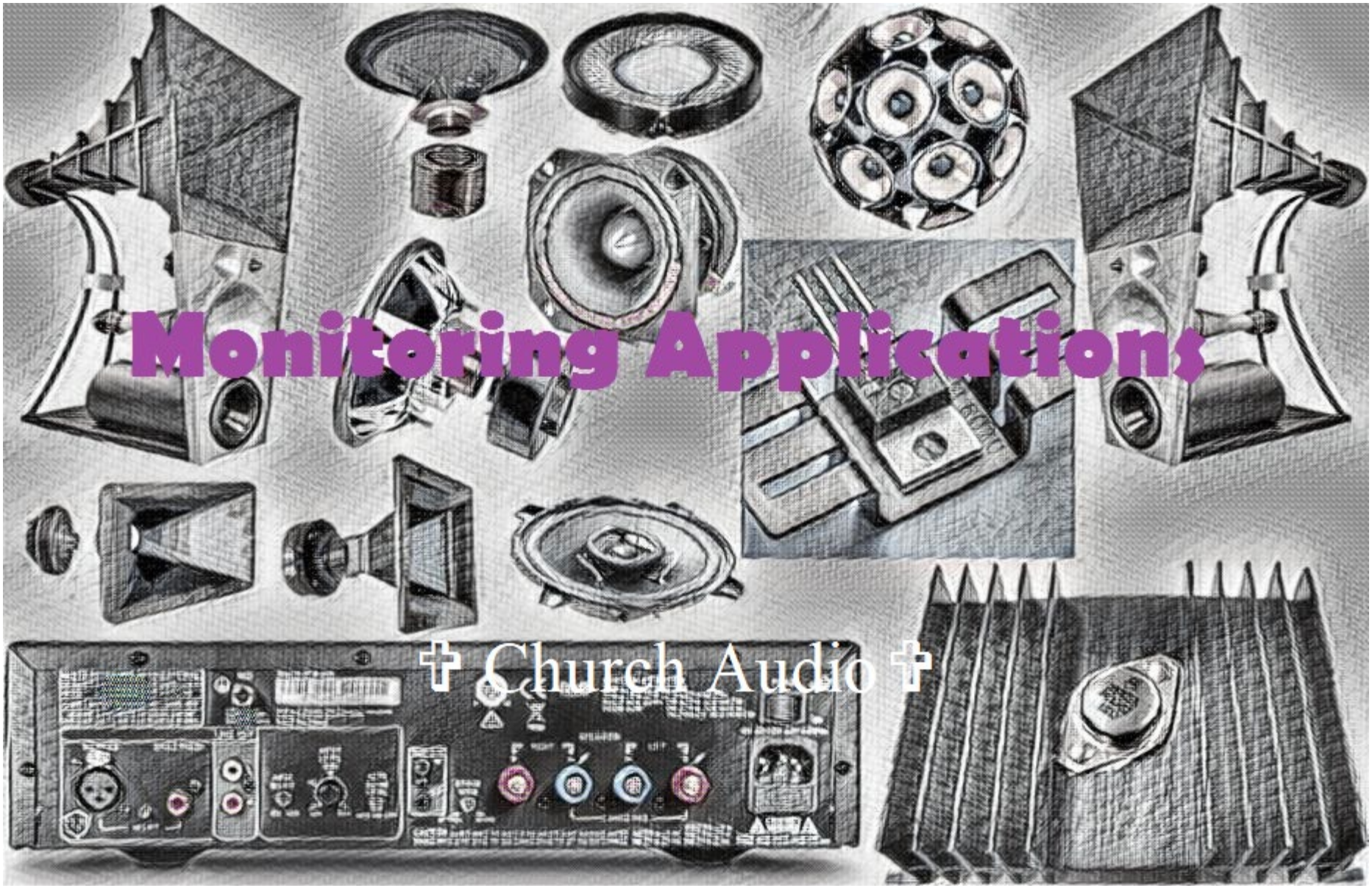
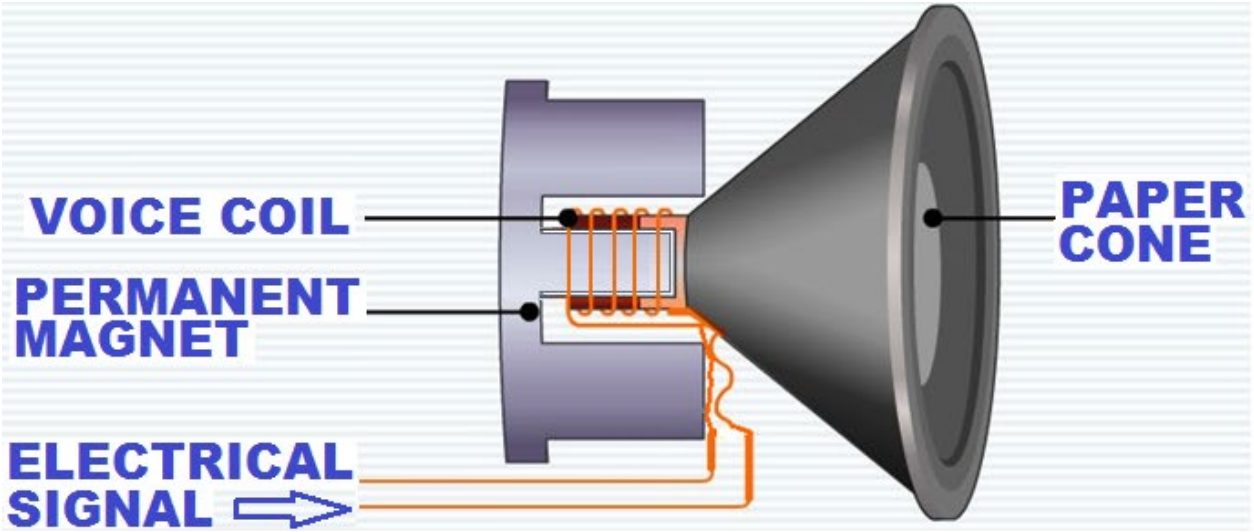
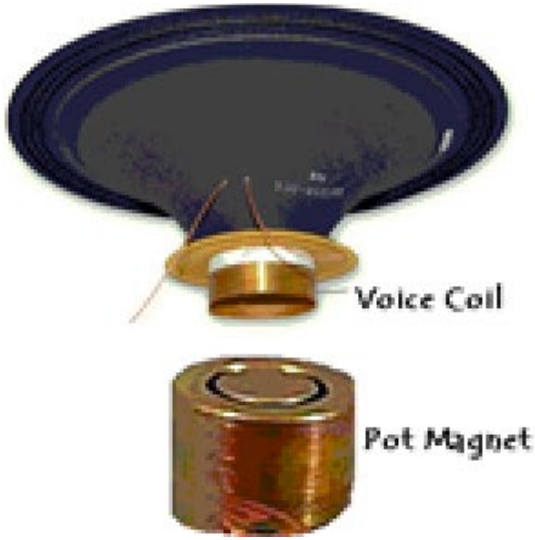

Monitoring Applications
✝ Church Audio ✝

Cone Loudspeaker





A cone loudspeaker takes advantage of the Dynamo effect. It has a short paper cylinder with a paper cone connected to it. A coil of wire is wrapped around the short cylinder, which is then suspended inside a magnet. Whenever we send an electrical (audio) signal through the coil it will generate magnetic fields which conflict with the magnetic fields of the pot-magnet (the dynamo effect), causing the tube and cone to vibrate back and forth in a similar manner to the electrical audio signal.

The thin copper wire coil is called the **Voice-coil**. The pot magnet, tube and voice coil together are called a **Driver**.

Paper-cone Loudspeakers are able to move very slowly, without effort, and reproduces bass and mid frequencies easily.

This makes them suitable for Woofer and Mid Range loudspeakers.

Tweeter Loudspeaker

For high frequency work the Driver (voice coil and magnet) remains the same, but the Paper Cone part is either reduced dramatically to a small harder version, or the paper cone is removed altogether and replaced with a thin dome. This allows the Driver to vibrate very quickly (shimmer) and so it can reproduce high frequencies with ease. We use this method to make high frequency (Tweeter) loudspeakers. A tweeter is not designed to move slowly and is not able to reproduce mid or bass frequencies well.

Horn Loudspeaker

For outdoor work, where paper cones can get water and sun damage, we replace the cone with a plastic or metal Horn. The Driver is slightly modified to suit, and we call it a Compression Driver.

In the old days Horns were shaped exactly like the paper-cones were, and they sounded awful. In time it was discovered that you need to shape the throat of the Horn using an exponential curve. This took on the name of Compression Horn as it compresses the air in the throat which greatly improves the frequency response. As it must follow the exponential curve law the length of a Horn is determined by the width of the mouth. The bigger the mouth, the lower the lowest frequency will be.
If we want a Horn with a lowest note of 100Hz then it will be around 15 cm at the mouth, 4cm at the Driver end… and a whopping 95cm long neck.

A Horn produces ten times more power than a Paper Cone of the same wattage, unfortunately the sound quality is somewhat inferior.

Cone Damage

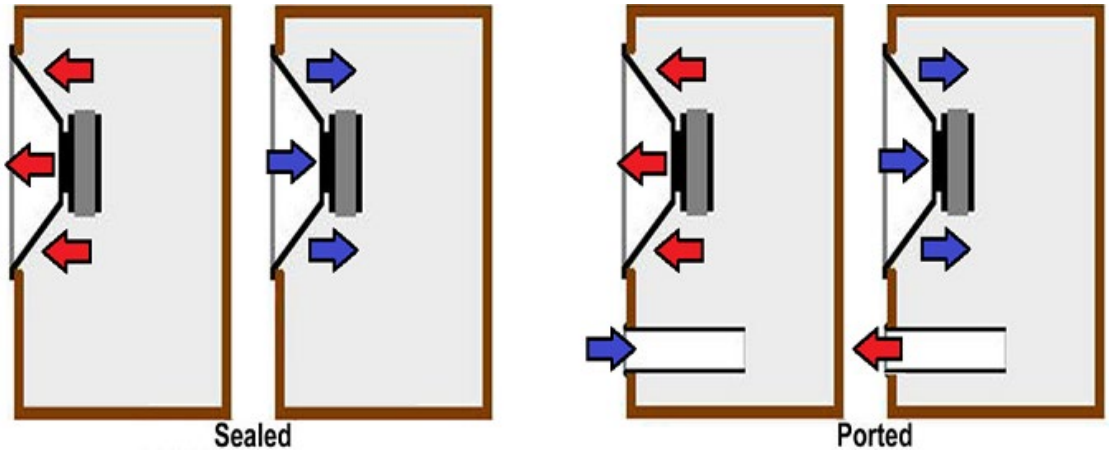

If a cone loudspeaker starts making a disgusting spluttering noise then you possibly have a tear in the paper cone, or a torn mount around the outer rim.
If a cone loudspeaker stops working altogether then the fine copper wire in the voice coil may have melted (too much current caused by continuous loud volume is often the reason).
High volume will cause the loudspeaker cone to move back and forth quite some distance (look closely, you can see the *travel*). Eventually, even the best cone will push out far enough, and tear. Cones that have paper on their outer rim will tear quicker. More professional cones have rubber on the outside edge, which will survive high volume (long travel) much better but will eventually consume and tear as well.
As well as the risk to the cones, there is the voice coil which will melt if the current (electrical volume) gets too high for too long. High volume can be expensive!



Simple tears on paper cones can be repaired with an appropriate rubber glue. Certain Loudspeaker Manufacturers sell replacement kits (a new paper cone and a new voice coil) but the kit needs to match the metal frame exactly.

To check if a loudspeaker cabinet has any blown cones just play some music through it and go up close. Some people listen with a cardboard tube held close to each individual cone, one at a time, like a stethoscope. You will hear the spluttering.

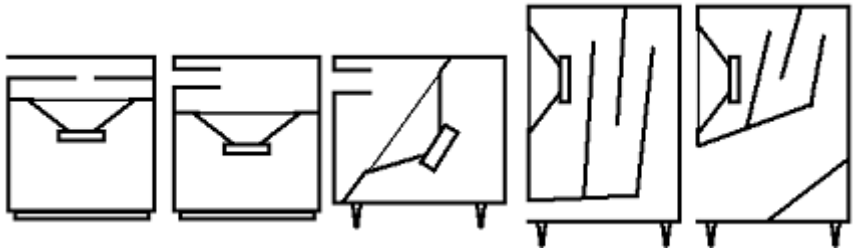
Loudspeaker Enclosures (Cabinets)



Infinite Loudspeaker Cabinets are completely sealed, so the air inside is trapped. As the cone moves back and forth it has to fight the internal air pressure, and energy is lost. Apart from that, this type of cabinet does have a particular type of compact punchy sound to it, and can be ideal for certain applications.

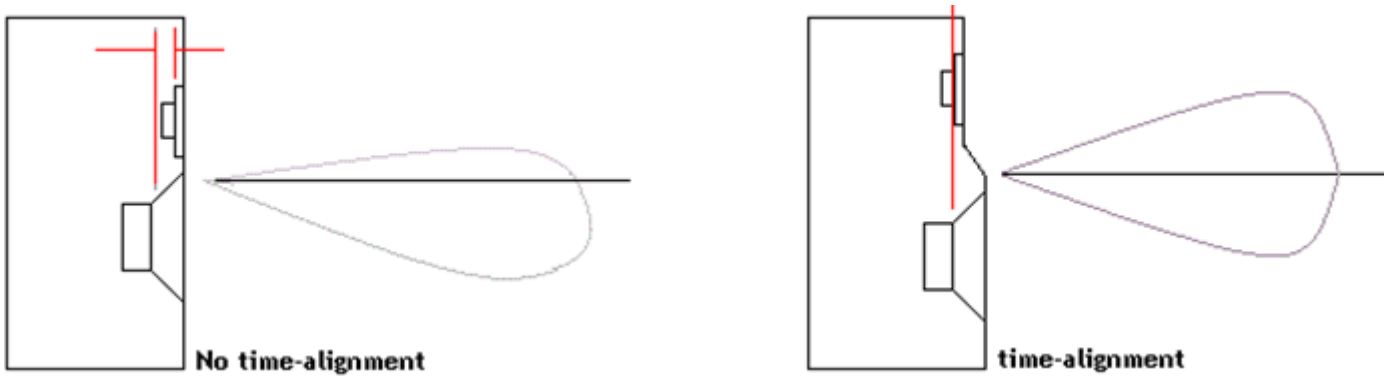
Finite Loudspeaker Cabinets have a hole in the enclosure so there is no internal air resistance. It is more power efficient, and has become the model of choice.

The “hole in the cabinet” developed over time, and a tube was added to the hole to make a resonant “Port”. This tube resonates at a precise resonant frequency, which the manufacturer will choose to suit the cabinet.
We call a cabinet with a resonant port a **Bass Reflex** cabinet. It has a noticeably improved bass frequency response.



The **Labyrinth**, or Passive Radiator Cabinet, has extra internal passages for the sound to bounce off before it comes out of a hole (Port). This construction has a little more internal air resistance than a Bass Reflex enclosure and the frequency response is smoother. **Bass Bins** (**Subs**) are usually Labyrinth cabinets.

Time-Aligned

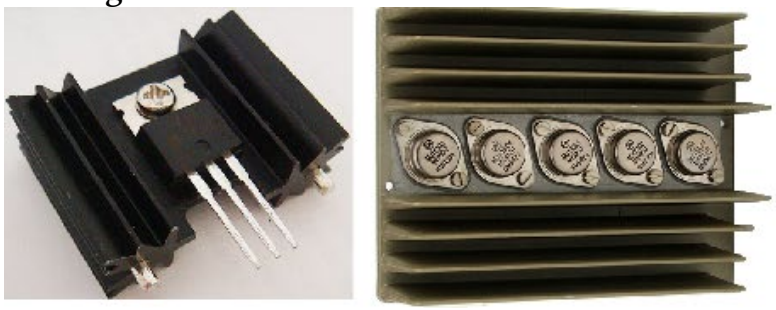


A Loudspeaker Cabinet has different sized cones moving at different speeds. The combined sound that results from this is slightly distorted. This is not a giant concern to people working in live environments, but for elite listening requirements there are cabinets constructed with the smaller cones further back.

Amplifier Components

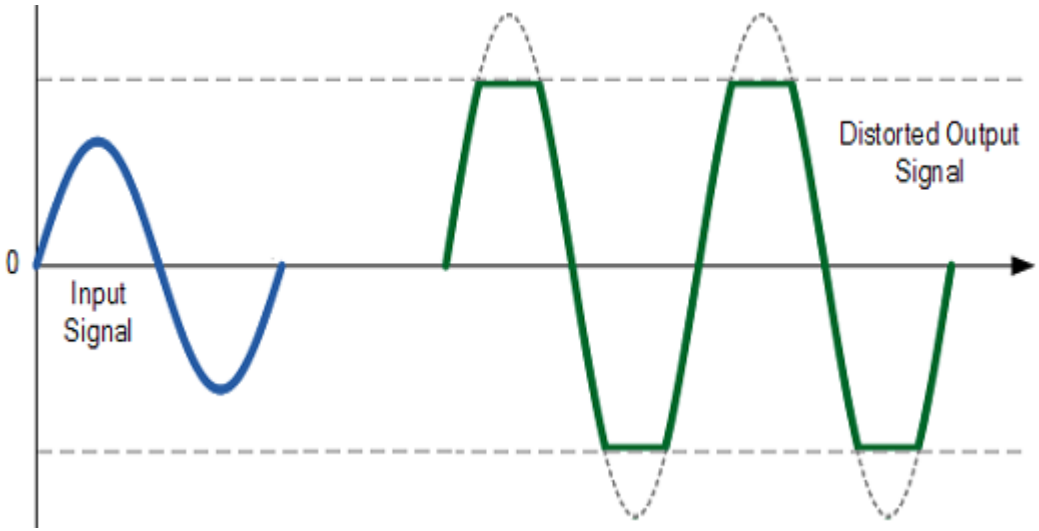
Audio Amplifiers are solid-state nowadays, guaranteeing high quality performance with all the added benefits of Integrated Circuits (I.C.'s).
Pre-Amplifier integrated circuits are designed for line-level work (a few volts and milliamps) and so they never heat up at all.
Power Amplifier integrated circuits operate at higher volts and amps, and get hot, and can even melt (high volume for a long period). For this reason, they are connected to metal fins that help dissipate the heat (Heat Sinks) and keep the component cool.

Cooling



We need ventilation around a Power Amplifier to ensure the hot air coming off the heat sinks is blown away. Small fans are often built in to help us. If you cover the vents, or keep the Power Amplifier in a closed cupboard, or you work in some absurd summer heat (especially if the sun is shining directly onto the Amp) the power components will over-heat.
At this point, if your Power Amplifier has protection (as all good ones do) then it will switch off to protect itself until it cools down… yes it will go silent, and the congregation will be looking at you and there is no way you can get any sound until it cools.
The other possibility when you overheat is quite straightforward, there will be a puff of smoke that should last about one second, then total silence followed by an acrid burning smell that should linger for over an hour. Power transistors and I.C.'s are the most expensive part, and these are the things that melt.

Distortion (Clipping) (Overloading an electrical signal)



An Amplifier always has a **maximum voltage** that it can deliver. *This is determined by its design and its own power supply.*
An Amplifier will also have a **maximum amplification** that it can deliver. *This is also determined by its design and its power supply.*

Example: Let's say an Amplifier has a maximum output voltage of 100 volts, and a maximum amplification of 50 times (50x).
Now... if we send a 2 volt audio signal to the input, it will amplify by 50x and give us 100 volts output, which our example can manage.
If we increase our input signal volume to 3 volts, the Amplifier will try to amplify the signal by 50x (as it is designed). However, the amplifier isn't capable of generating 150 volts (max 100v) and so the output signal voltage will sit at 100 volts until the input signal falls.
This causes flat tops on the electronic audio signal (**clipped peaks**).
This gives us the characteristic **distorted** sound.

This "distorted" element inside the wave is very damaging to electronic components. The flat-top voltages are D.C. (direct current) and cause over-heating.
But wait... there's more! On the diagram you can see dotted lines where the voltage "would have gone" if it was capable. When the Loudspeaker cone receives a distorted signal, it will be pushed out by the electrical signal as usual, except that if the signal suddenly stops, the loudspeaker cone (because it is mechanical) will take a moment to slow down and stop. This extra 'travel' strains the paper on the cone and causes tearing.

This is the same for Pre-Amplifiers and Headphone Amplifiers on your mixer, they distort if you send too much input to them.
*When you hear that crunchy "**distorted**" sound... think... is an input signal somewhere too loud for its amplifier?*

Many Amplifiers come with **Peak lights, Clipping or Overload lights** to warn you when the input voltage (volume) is too high. The manufacturers set the threshold down a bit, so you have a little space left (***Headroom***) before it distorts. A little flicker of a Peak light here and there is quite ok, but continuous flickering means you're in danger of distorting and you are starting to overheat the amplifier components and wreck the loudspeakers.

The principal purpose for a **Peak Limiter** is to ensure there is no surge of electrical peaks (spikes) of volume that would push your Power Amp over it's limit, and subsequently protect your loudspeaker cones as well. Many modern Power Amplifiers have built-in *Limiter* protection.

Bridge Mode

A Stereo Power Amplifier is really two independent amplifiers that you can use for two non-related jobs (other than Left/Right) if you choose.
One use (*if the Power Amplifier has the facility*) is to ***bridge*** the two channels together so they flip-flop against each other generating a greater wattage.

For example, 200w Left + 200w Right would become 500w if bridged. This is quite safe, and quite normal, just follow instructions provided by the manufacturer.

Because the two channels will be summed together, we lose the two independent inputs and outputs, and it just becomes one powerful input and output.

Distribution Line-Amp

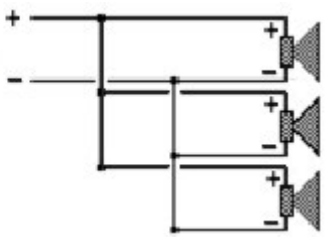
In a large church you may need to come out of your mixer with its two outputs and go to a multitude of Amplifiers and Loudspeakers.

It will be an electrical impedance disaster if you just connect everything directly, and you should consider a Distribution Amplifier.

The example shown is a device that has one single audio input to twelve single outputs, or one stereo (LR) input to six stereo outputs.

This keeps you electronics protected from impedance mis-matching.

Testing Loudspeaker Polarity



The voice coil on a loudspeaker may have a (+) sign to indicate which wire the signal should enter in to, and (-) to show the exit wire. The idea of this is to help you check that all cones in a cabinet are wired the same way (in-phase with each other). If one cone is pushing out while the other cones are pushing in (one is out-of-phase with the others) there will be a loss of power, and even a weird sound.

A loudspeaker cabinet that was purchased new, and never had any repairs done inside it, should be ok. If the cabinet has been repaired, or is home-made, or you have doubts, then you can test the cabinet relatively easily. A popular method is to press a 1.5 volt battery against the input connector wires. All the cones should push in the same direction (meaning they are all in–phase with each other). If not. Reverse the wiring on the cone that is being contrary, and check again.

Testing Loudspeaker Impedance

To measure the value of a Loudspeaker, you need to disconnect it first. Use a Tester (Multi-meter) set to read "*Resistance"* in ohms (Ω).
An 8-ohm (8Ω) Speaker (meaning 8 ohms is its impedance) will measure around 6 ohms (6Ω) ***Resistance*** on your Tester.
When an audio signal starts to run through this loudspeaker there will be an increase in resistance by a couple of ohms, caused by the signal itself. The increased resistance is called ***Reactance*** (2Ω). So… Resistance (6Ω) + Reactance (2Ω) = **Impedance** (8Ω).
The *Resistance of a Loudspeaker, measured on a Multimeter,* will be approximately 75% of the *Impedance*.

CREDITS

This material is offered freely to the Christian Churches; downloadable at Pietango.com

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**