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Tech Topic: Linking Loudspeakers - Properly

Series or parallel? Impedance is the thing

By Pat Brown

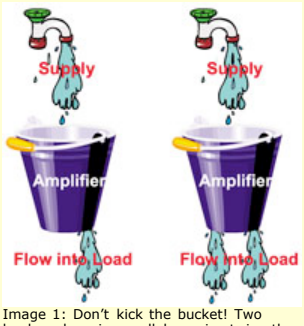


Image 1: Don't kick the bucket! Two loudspeakers in parallel require twice the current of a single one, just like two holes in a bucket offer one-half the opposition to water leaving the bucket as a single one.

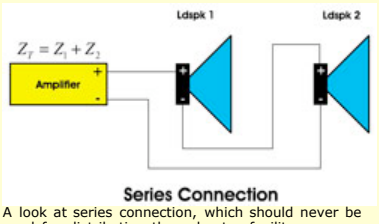
Multiple loudspeakers can be connected in series or parallel to the output of the amplifier. In either case, the current drawn from the amplifier is determined by the total impedance of the load as presented to the loudspeaker terminals.

Impedance is the opposition to the flow of current. As the load impedance is decreased, the load on the amplifier is increased, because it must work harder to supply the demand for current. In similar fashion, an automobile trying to maintain its speed uphill is under a greater load than on flat ground.

A "no load "condition means that nothing is hooked to the amplifier, so no current flows and no power is transferred. The opposite condition - a dead short between the amplifier "+" and "-" terminals, represents the maximum load possible, and current flow is limited only by the resistance of the wire making the connection. So, the lower the impedance the greater the load - a bit counter intuitive but nonetheless true.

HOLE IN THE BUCKET

An example will clarify this. Imagine a bucket full of water. Assuming watertight construction (a good thing for a bucket), there will be no water leaving the bucket (analogous to current flow), and the pressure against the sides of the bucket (analogous to electrical voltage) will be constant.



A look at series connection, which should never be used for distribution throughout a facility.

Now, let 's put a hole in the bucket. Water will now leave the bucket at a rate proportional to the size of the hole.

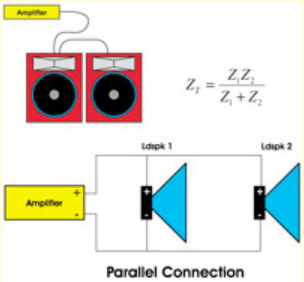
The hole represents the connection of a loudspeaker - current now flows from the bucket (amplifier) through the hole (load). If we keep the hole relatively small, the pressure will be similar to the water-tight condition. If we replenish the bucket continually, the flow can continue indefinitely.

Next, let 's put another hole in the bucket, identical to the first. Water is now exiting the bucket at twice the previous rate (more current is flowing), so the supply to the bucket would have to be increased to maintain the water level. The second hole is analogous to a second loudspeaker connected in parallel with the first to an amplifier. The load impedance (the total opposition to water leaving the bucket) is decreased, meaning that the replenishing supply must work harder to keep up.

The bucket represents the amplifier, the holes the load, and the replenishing supply is the AC cord that plugs into the wall. Since water is flowing in one direction only, the current is DC (direct current). The same principles hold true for AC (alternating current), which in this example would mean that water is alternately flowing in and out through the holes in the bucket.

GETTING THE FLOW

Series connection means that the current flows through one voice coil before it flows through the other. The applied voltage will divide between the two in proportion to the magnitude of their impedance. If their impedance is the same (the most common case), then the voltage will divide equally across the two. The same current will flow through both.



Parallel connection is the preferred method for multiple loudspeaker systems.

Series connection is usually accomplished by connecting the amplifier "+" to the "+" of the first loudspeaker, and the "-" of the first loudspeaker to the "+" of the second, and finally the "-" of the second to the "-" of the amplifier. The total impedance of loudspeakers in series will be the simple sum of their individual impedances, so adding more loudspeakers will decrease the load on the amplifier.

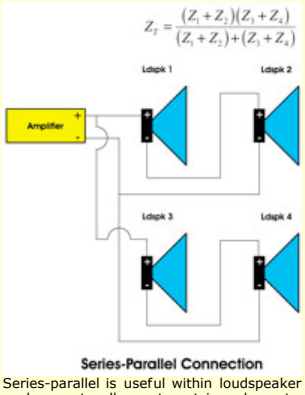
In other words, the higher the load impedance, the lower the current demand on the amplifier, and the less power delivered to the load. Series connection is rarely used in multiple loudspeaker systems since adding a loudspeaker will change the power flow (and loudness) through all of the loudspeakers. If one loudspeaker opens up, the feed to all of the loudspeakers is lost.

Also, if one of the voice coils shorts out, the other loudspeakers will get louder. If one of the voice coils opens up (more likely), all of the loudspeakers will quit working.

SAME ACROSS EACH

Parallel connection means that the amplifier output current flows through both of the voice coils simultaneously (a current divider), in proportion to their impedance. If they are the same impedance (the most common condition), the current through each will be the same.

The output voltage of the amplifier will be the same across each voice coil, since all "+" terminals are connected together and all "-" terminals are connected together. The load increases (the total impedance gets smaller) as more loudspeakers are connected in this fashion.



Series-parallel is useful within loudspeaker enclosures to allow a target impedance to be achieved with multiple devices.

Parallel connection is the preferred method for configuring a multiple loudspeaker system, because adding additional loudspeakers does not change the power flow (or loudness) through the existing loudspeakers. The sound level from existing loudspeakers remains the same as additional loudspeakers are added.

Care should be taken to avoid overloading the amplifier - a condition that occurs when too many loudspeakers are paralleled. This produces a total impedance that is too low and draws excessive current from the amplifier.

When loudspeakers are "daisy-chained" they are being connected in parallel.

The interconnecting cable busses all of the "+" loudspeaker terminals together and all of the "-" loudspeaker terminals together. This is often confused for series connection, but it is not since the current does not need to flow through one loudspeaker to get to the next. An open voice coil in one of the loudspeakers will not produce a level change in the remaining loudspeakers, making this configuration ideal for distributed ceiling loudspeaker systems.

Series-parallel connection combines both of the above and is useful within loudspeaker enclosures to allow a target impedance to be achieved with multiple devices (i.e., dodecahedron loudspeakers, guitar amplifier cabinets, etc.). It is sometimes employed to achieve an impedance value that would otherwise be too high if series connection alone were used, or too low if parallel connection alone were used.

This method works fine when used internally in a loudspeaker box (like a six 10-inch-loaded "guitar cabinet"), but should be avoided if the loudspeakers are to be distributed around a facility. Such a system would be difficult to expand and difficult to service due to the non-standard method of connection.

Pat and Brenda Brown own and operate Syn-Aud-Con, conducting audio training sessions around the world. For more info, go to ***www.synaudcon.com***

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