I am often asked "How do I connect multiple speakers to my amplifier?" Before I answer, let's define what we mean by the word "amplifier". In a stereo "amp" there are two amplifiers - one for the left, and one for the right channel. That is, in the one amplifier box, there are two different amplifiers. In a home theatre amplifier with surround sound, there may be 5, 6, 9 or 11 amplifiers in the one "amplifier" box. For the purposes of this article, we are talking about connecting multiple speakers to a single amplifier only, that is**, either** the left **or** the right, **or** any single amplifier. Of course you can connect multiple speakers to both the left and right amp of a stereo - you just need to follow the principles twice, once for each amp.

Multiple Speakers on One Amplifier

By adding an extra speaker to the output of an amplifier, you are adding to the load of the amplifier. That is, two speakers is double the load of one speaker. Most amplifiers can cope with a load of two speakers. Similar to a passenger on a small motor bike: add another passenger and the load the bike needs to carry is doubled, but most bikes will cope with two passengers.

However adding more than two speakers will normally overload the amplifier. Similar to the motor bike example: it can cope with two passengers, but starts to struggle with 3 or more passengers. Most modern amplifiers have some sort of limiting circuit to stop the amplifier working if it is overloaded. In some amplifiers, this involves blowing a fuse inside the amplifier. In other (more technical) amplifiers they will automatically turn off until you turn it back on with a load that is under its maximum safe load.

Amplifiers may cope with multiple speakers at low volumes, but will have issues when running at high volume levels. Similar to the motor bike illustration: it may cope with 3 or 4 passengers while going slowly on a flat road, but it will struggle when asked to work harder (like go up a hill or go faster). To be safe, never overload your amplifier.

To understand the technical reason for this, I strongly encourage you to read through the technical explanation on the next page.

If you just want to know how to wire two speakers to one amp, (4 speakers to a stereo) without switching or individual volume control, see the article on How to connect 2 speakers to 1 amplifier.

If you want speaker on/off or individual volume control, or you want more than two pair of speakers, (like three, four or more pairs) connected to your HiFi amplifier, see the article How to wire four speakers to one amplifier.

If you need to wire more than four pairs of speakers, particularly in a commercial installation, see the on Distributed Speaker Systems.

Technical Explanation

In the specifications for a hifi amplifier might say **Output: 100 watts @ 4 ohms**

This is normally specifying the maximum power output of the amplifier and the minimum resistance in the speaker circuit. So in this case, the amplifier will produce 100 watts of power when run at full volume connected to a speaker load of 4 ohms. The ohms bit is our main concern. Ohms is a measurement of resistance. In the case of speakers, it is the measurement of how much resistance the speaker has in the circuit connected to the amplifier. Technically speaking, the **resistance of speakers is called "impedance",** as the output of an amplifier is AC, and resistance in an AC circuit is called impedance.

To understand what all this means, we need to get technical and use some formulas. An explanation of these formulas can be found in the article The Dreaded Ohms Law. We will use the summary table from that article. You don't need to understand these formulas but we need to use them.

POWER IN WATTS P=			VOLTAGE IN VOLTS V=		
$V \times I$	$I^2 \times R$	$\frac{V^2}{R}$	$I \times R$	$\frac{P}{I}$	$\sqrt{P \times R}$
CURRENT IN AMPS I=			**RESISTANCE IN OHMS (Ω) R=**		
$\frac{V}{R}$	$\frac{P}{V}$	$\sqrt{\frac{P}{R}}$	$\frac{V}{I}$	$\frac{V^2}{P}$	$\frac{P}{I^2}$

In our example we know:

Power is 100 watts: P = 100

Impedance is 4 ohms: R = 4

So we can use the appropriate formulas to calculate the output voltage(V) and current(I) of the amplifier.

Calculation of output voltage (V):

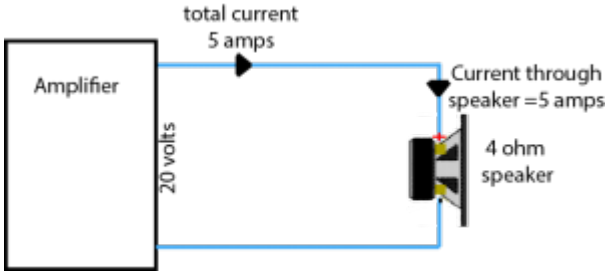
$$V = \sqrt{P \times R} = \sqrt{100 \times 4} = \sqrt{400} = 20 \text{ volts}$$

Calculation of output current (I):

$$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{100}{4}} = \sqrt{25} = 5 \text{ amps}$$

So, from the specifications and a couple of calculations, we now know the following:
Power=100 watts, Impedance (resistance) = 4 ohms, Voltage = 20 volts, Current = 5 amps

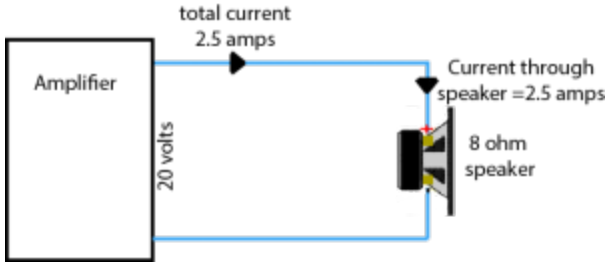
An equivalent circuit will help us visualise what is happening.



This illustrates the maximum capacities of the amplifier. With a load impedance (speaker) of 4 ohms, the amplifier needs to deliver 5 amps to produce the 100 watts of power. This amplifier will normally have some sort of limiting circuitry to limit the current output to no more than 5 amps. The reason being, all the electronics will be designed to deliver 5 amps. Therefore to avoid "blowing up" the output stage (and possibly the power supply), some form of current limiting is employed. The simplest form of a current limiting circuit is a fuse. If a 5 amp fuse is placed in series with the output, then it would supply the current until the total current exceeds the 5 amps at which point it would "blow".

Remember, these are the maximum ratings of the amplifier. In practice, many speakers are made to have an impedance of 8 ohms. Therefore the equivalent circuit would be similar, but with a different impedance, therefore a different current as shown here:

$$I = \frac{V}{R} = \frac{20}{8} = 2.5 \text{ amps}$$



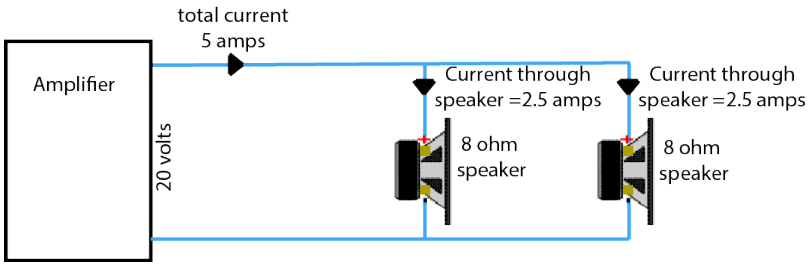
The power output of the amplifier is also reduced:

$$P = \frac{V^2}{R} = \frac{20^2}{8} = \frac{400}{8} = 50 \text{ watts}$$

In practice, because the speaker impedance is increased, the load is decreased and the amplifier is capable of outputting around 23 volts which gives a maximum power output of 70 watt @ 8 ohms.

The important principal is: **the higher the speaker impedance, the less current required** from the amplifier. Also, the **lower the speaker impedance, the more current** required from the amplifier.

OK, this is all very good, but what about connecting two or more speakers to the amplifier? Glad you ask, this is the fun bit. Let's connect two 8 ohm speakers to the one amplifier.

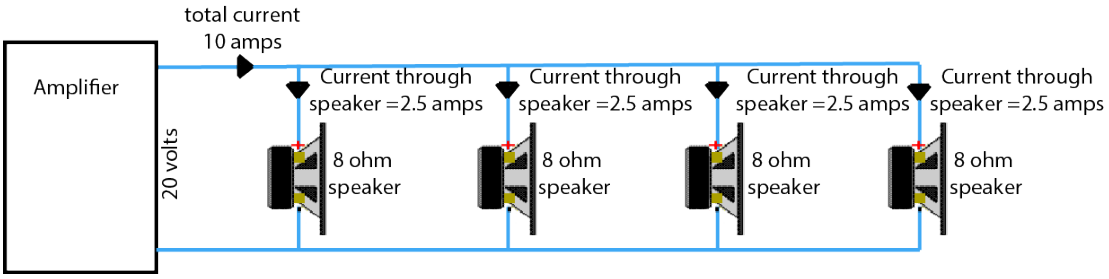


You will notice that each speaker still draws 2.5 amps from the amplifier. So the combined load on the amplifier is now drawing a total of 5 amps (2 x 2.5=5). You may have noticed that this is the same current (and therefore the same total load) as one 4 ohm speaker. That's right, two 8 ohm speakers in parallel is the same as one 4 ohm speaker. If you like, you can prove this using the formula for calculating resistances in parallel. If you've had enough formulas, just skip this and go to the next paragraph.

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} \text{ so } \frac{1}{R_{total}} = \frac{1}{8} + \frac{1}{8} = \frac{1}{4} \text{ therefore R (total) = 4 ohms}$$

The good news is, this is within the specifications of the amplifier as we saw earlier. So, as long as the speakers both have an impedance of 8 ohms (or more), and the amplifier is rated for 4 ohms, then you can safely run the amplifier with two speakers.

Now what do think is going to happen if we are having a party in several rooms and need multiple speakers (like four speakers) connected to one amplifier on the stereo? The circuit would look like this:



If the poor old amplifier can still hold the 20 volts, each speaker is still trying to draw 2.5 amps, meaning the total current draw from the amplifier is 10 amps - way above its specified capabilities. At this point, we hope it has a limit/protection circuit and has turned itself off, or at the very least the 5 amp protection fuse inside has blown. If there is no current limiting circuitry, then quickly turn the power off when you see the smoke rising from the amplifier.

For those who like the mathematical evidence rather than just the pictorial reasoning, the calculation of the total resistance looks like this:

$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$ so $\frac{1}{R_{total}} = \frac{1}{8} + \frac{1}{8} + \frac{1}{8} + \frac{1}{8} = \frac{1}{2}$ therefore R (total) = 2 ohms

Then calculate the current: $I = \frac{V}{R} = \frac{20}{2} = 10$ amps = smoke.

For an easy way to calculate the total impedance of speakers in parallel, try my simple Speakers in Parallel Calculator.

Multiple Speaker Selector Switches

There are ways of connecting multiple speakers to one HiFi amplifier without causing damage, but not by simply connecting one speaker onto the other. For a detailed and practical outline of how to connect four or more pairs of speakers to a HiFi amplifier, see this article. The simple method (with the limitations listed in the other article) is to use a speaker selector switch. A 4 zone switch will allow up to 4 pairs of speakers to be connected to the one amplifier.

Speaker selector switches can use various techniques to allow multiple speakers to be connected to the one amplifier, namely:

- a series resistor (around 5-6 ohms) to restrict the minimum impedance of the speakers circuit to this value. This simple series resistor is often marketed as "manual impedance protection" or simply "Protection". They are normally good for lower powered speakers, and the resistor can get hot at high volume levels.
- combining the different speakers in series and/or parallel to keep the overall impedance above 4 ohms.
- matching impedance transformers - this is normally the best, but it is also the most expensive.

All these methods allow multiple speakers, but at a lower volume than using just one speaker. This is logical as the signal is being shared by more than just the one speaker.

For a more detailed explanation and summary of the features of speaker selectors, see the article on Speaker Selector Switch Summary.

If you are interested in purchasing a multiple speaker selector, here is a link to Amazon's range of speaker selectors in USA, Canada, UK, Germany, Spain and France.

Instead of using a speaker selector switch to connect multiple speakers to your hifi amplifier you can use impedance matching volume controls, as outlined in the article on connecting four speakers.

Conclusion

Depending on the impedance of your speakers and the rating of your amplifier, you should be able to use two pairs of speakers connected to a HiFi amplifier. However, it is wise to use the example given above as a guide and use the figures in the specifications of your amplifier and speakers to calculate and know for sure what the outcome will be. Otherwise use a multiple speaker selector switch and/or impedance matching volume controls.

For a practical discussion on how to simply wire just 2 pair of speakers to a stereo amplifier (4 speakers to a stereo amp), see my article on How to connect 2 speakers to 1 amplifier.

For more practical information of how to wire two, three, four or more speakers to one amplifier using speaker selector switches and volume controls see this article.

Thanks to James from Sydney, Australia who suggested this topic.