A Guide to Evaluating Any Speaker or Speaker System

By
Bill Agresta
Chief Engineer
KBRT – Avalon-Los Angeles, California

Abstract

You can find two nearly identical speaker cabinets with nearly identical components that have drastically different specifications and prices. There are many logical explanations for this. Before we go any further, let me make it clear that the following guide to speakers is "my opinion" based on 25 years in the pro-audio industry dealing with almost every major and minor brand of speakers.

1. Speaker Cables and ¼-Inch Plugs

Here's the most important note about speaker systems that I can pass on to you.

Never use ¼-inch phone plugs for speaker connections. That would be best compared to having a two-inch water pipe coming from your street to your house, having a 1 inch water pipe running to all the faucets in your house and connecting the two by reducing each of them to a half inch connector. When you use a ¼-inch plug and jack for speaker connections, you have less connection area than you would have if you touched the tip of one fingernail with another. This translates into heat at the connection and a loss of power at the speaker coil. I have tested two identical speaker cabinets powered by two channels of the same amp using a speaker cord with ¼-inch plugs on both ends for the left speaker and on the right speaker, a cord without any plugs (the wires were connected directly to the red and black binding posts on the amp and the speaker). Everyone in the room could hear the difference in volume between the two speakers.

2. Impedance

All speakers have an impedance measurement just as they have a diameter measurement. Not all speakers are 15 inches in diameter and not all speakers are 8 ohms. The most common 12, 15 and 18 inch woofer used in speaker cabinets by sound companies, studios, clubs and DJ's have an impedance of 8 ohms. If you have two of them in one cabinet you can wire the two woofers in parallel to create a 4-ohm cabinet, or you can wire them in series to create a 16-ohm cabinet. The parallel wired 4-ohm cabinet will produce much more volume, 6dB to be exact, and would be considered much more efficient. The series-wired 16-ohm cabinet will need much more power, four times as much, to produce the same volume as the 4-ohm cabinet, so it would not be a good choice for economic reasons. Since the 16-ohm cabinet will need more power to produce volume, many lower end companies mass produce these cabinets and heavily advertise the high power that they can handle, as if that makes it a better speaker than the more efficient and lower power speaker. This is the most misleading specification we see in advertising. One speaker company that advertises as much or more than anyone else makes a dual 15 cabinet with two 16-ohm woofers wired parallel to create an 8 ohm cabinet. They advertise it as having a huge power handling capability, but in reality it is much less efficient when used with the same amps that would easily power other cabinets loaded with two 8-ohm woofers wired in parallel. Another mass-advertised speaker has two 4-ohm woofers wired in series to create an 8-ohm cabinet. This is still not as efficient as the two 8 ohm woofers wired parallel. This is where you must make a choice. Do you want a good sounding, efficient speaker cabinet that you can power with a small affordable amp, or do you want a speaker that produces much less volume and you have to buy a larger amp, but which you have a little less chance of blowing?.

While on the subject of speaker impedance, we need to mention something about amplifier impedance. Most amps tell you the power output at 8 ohms, 4 ohms and 2 ohms (if the amp is capable of handling 2 ohms). An amp is most comfortable driving an 8 ohm load. That's why the 8 ohm rated power output is the lowest and the distortion level at 8 ohms is also the lowest. When you connect a 4-ohm speaker to the amp, it's a harder load for the amp to power, just like pulling a 5,000 pound trailer is harder on your car than pulling a 2,000 pound trailer. The power output rating is higher than at 8 ohms, but the distortion level is also greater. Many of the popular low-price amps today are not capable of powering a 2-ohm load. It would simply heat up the power transistors too much. For amps that can handle a 2-ohm load, it is the hardest load for the amp to handle and causes the most heat build up which leads to a higher level of distortion. If you have ever installed your own car audio system, you may have noticed that 4-ohm and 2-ohm loads on the amps are common. That's because there is so much road noise when driving your car that the higher distortion level of the amp usually goes unnoticed.

3. Magnet Weight

Magnet weight is another very misleading specification. Most people think that a woofer with a 90-ounce magnet has to be better than a woofer with a 50-ounce magnet. Simple logic tells you that this should be true, but it is not. We have seen many woofers with larger magnets not perform as well as woofers with smaller magnets and we have also seen many companies rate their magnet weights wrong. This would be like thinking that all cars with larger engines outperform cars with smaller engines. There are too many other factors involved for that statement to be true. Voice coil diameter, number of windings, size and type of winding wire and cone material are all just as important, but you almost never see these items listed in advertising.

4. Power: RMS, Continuous and Peak

How is a true “continuous power rating” be established? We do this first by sending a sweeping signal of all frequencies to the speaker and slowly increasing the power. When the tester feels like he is getting near the maximum power that the speaker can handle, he extends the time before raising the level again. When he hears the slightest distortion or observes the coil getting hot, he backs it off by five watts and lets it run for a few hours. If it endures that test, it gets a "continuous power rating" of the power it handled for those hours.

RMS is, by definition, an average and it would rarely ever be the same as the continuous power level measured manually. In our industry the two terms are often mistakenly used to describe the same thing. I would rather have an honest manual measurement than a computed average.

Peak power usually means the highest amount of power that the speaker can handle for less than a second at a time. Although you can test a speaker for this measurement using the same method above, it is more common today to see speaker manufacturers double the continuous power measurement and call that the peak power even though it may not be technically accurate.

Just like the other measurements of speakers we mentioned above, power handling specifications are very misleading. I tested a pair of speakers that were rated at 320 watts from one of the biggest-advertising speaker companies. When they arrived, they had a spec sheet that showed the peak power handling at 320 watts but the continuous power handling capability was rated at 160 watts. During the test, the horn driver began distorting at around 100 watts when the music had heavy bass playing. You might wonder how a speaker that starts distorting at 100 watts can be advertised as a 320-watt speaker.

There is no standardized method of measuring these speaker specifications. Each manufacturer does it however it pleases. Some companies choose to rate conservatively, which is better for you but doesn't look so good on paper, while other companies grossly exaggerate their specifications to look great in advertising, but it's not so good for the customer. The best way to measure the power handling capabilities of a speaker is to play the same type of music or program material through it that the user will be playing through it and try to figure and match the decibel levels that the user might need to achieve to sufficiently accommodate their use of the speaker system. Since that is not always possible, most companies send computer generated signals to the speaker and see how many watts it can handle before it distorts. (That would be the point at which the voice coil has been thrown past the edge of the upper magnet plate). If that signal is full range and not just one frequency, and played for four hours, you will get a close idea of how much power the speaker can really handle.

Unfortunately, many budget speaker companies will send a signal that is just one frequency (usually 1 kHz) and crank up the power for 30 seconds to get a high power handling reading that is not an accurate representation of what the speaker will do with full range music playing through it. This type of reading may be technically correct, but it is not representative of what you and I would consider "true". Another method we have seen used by many budget speaker companies is to take the power handling capabilities of each individual component in the cabinet and add them up. If they were each measured conservatively and you made a great crossover to protect each one, this would be a better method than the single frequency signal method, but still not as accurate as a full range signal played for four hours.

5. Crossovers: Electronic and Passive

A crossover network limits the frequency range that reaches a speaker. Almost everyone will say too much power blows speakers. It would be more accurate to say that too much of the wrong frequency blows speakers.

An important note: I have never found anyone that disputes the opinion that an electronic crossover is better than a passive crossover. Here's why: an electronic crossover selects the frequencies to be passed to the speakers at a low line level before the amplifier. At this low level, there is no distortion and absolutely no loss of signal. A passive crossover is usually mounted inside the speaker cabinet and selects the frequencies to be passed to the speakers at a very high level after the amplifier. The main problem we have seen with these passive crossovers in budget speakers is the design of the crossover itself. To save money, they usually scrimp on this component a little too much. We have seen many crossovers that were designed to handle only 50 watts installed in a cabinet that was rated at 120 watts. This is the main reason we see so many budget speakers distort earlier than their more expensive counterparts.

There are four types of passive crossovers: low-pass, high-pass, band-pass and narrow-band-pass.

Low-pass crossovers allow low frequencies to pass through to the speaker while gradually reducing the power of the higher frequencies and cutting them off. Coils are used in low pass crossovers because they attenuate the higher frequencies.

High-pass crossovers allow the high frequencies to pass through to the speaker while gradually reducing the power of the lower frequencies and cutting them off. The power reduction increases as the frequencies become lower. Capacitors are used in high pass crossovers because they attenuate low frequencies.

Band-pass crossovers are a combination of the two above. They only allow a certain band or range of frequencies to pass through to the speaker. This type of crossover is most often used on mid range speakers where the extreme highs and lows are cut off so they do not reach the speaker and cause it to distort.

Narrow-band-pass crossover must be used when the band of frequencies chosen to reach the speaker is less than a decade – that is, if the high crossover frequency is less than 10 times the low crossover frequency. A narrow-band-pass crossover has the same function as the normal band-pass network. However, it is wired very differently.

Crossover points or frequencies are achieved by using different values of coils and capacitors. There are different rates for the reduction of power, called *slopes*. The most common are 6dB, 12dB and 18dB slopes. A 6dB slope will reduce the power at a rate of 6dB per octave starting at the chosen crossover frequency, creating a gradual slope of power reduction. The 12dB and 18dB per octave slopes work the same way except that a 12dB slope has twice as much reduction per octave as the 6dB slope and an 18dB slope has three times the amount of reduction, thus cutting off those frequencies three times as fast.

If you are making your own crossovers, here are a few starting tips: Air core coils are best for higher frequencies; Iron core coils are more economical for lower frequencies if the power rating is not too high. Solid iron core coils are good economically for low frequencies at high power (over 300 watts). Air-core, flat-wound copper coils are always best and handle the most power without saturating (most-10 gauge coils handle about 800 watts) but are very hard to find and expensive. Polypropylenes are the best capacitors (you can find these in ±2% with a 600-volt rating). Mylar capacitors are next best. Non-polarized electrolytics are the most economical and commonly used.

6. SPL 1W/1m

This stands for Sound Pressure Level measured at one watt of power and at a distance of one meter from the speaker. This should be a great way to gauge the efficiency of all speakers and although there is a standard method of performing the test, many of the budget speakers we have tested don't come close to the manufacturer's specs. From what I have seen in speaker catalogs, I think most measurements have been copied from the specs of the individual horn or midrange components instead of an actual reading from all components operating together in the speaker cabinet.

7. Horn Drivers: Compression and Piezo

The least expensive of the two common types of horn drivers is the Piezo. Most people think of a small round tweeter when you say Piezo, but there are also larger, threaded horn drivers that have a Piezo element instead of a voice coil. Piezo drivers have a vibrating ceramic disk that is usually capable of producing only two or three frequencies

Because there is no voice coil in a Piezo driver, it is usually harder to blow than a compression driver with a voice coil. Most people don't even use a crossover with a Piezo driver. Right now most people would be wondering why anyone should use a compression driver if they cost more and can be blown more easily. The answer is simple: they sound better. The Piezo is most commonly referred to as being harsh sounding because of its three-frequency limit. Yes, it can produce highs and a lot of volume, but no Piezo driver has ever produced highs as smoothly as a good compression driver.

There are two types of compression drivers used in our industry. In most cases, the less expensive of the two has a phenolic diaphragm, and the more expensive unit has a titanium diaphragm. The titanium diaphragm is much better for reproducing the extreme highs heard when a drummer crashes his cymbals, but some of the designs produce excessive harmonics making them sound harsh. Both units have a heavy magnet and a voice coil with wire windings just like any woofer. Both units need a good crossover to protect them from harmful low frequencies. There are also several other diaphragm materials available on the market today. Again, because there are so many other variables like the design of the phase plug etc., physically listening to the driver through a well-selected horn or coupled to a cabinet face in the case of a studio monitor device is the only way of really knowing how it sounds.

8. Stereo or Mono

While every sound company, sound engineer, church, club owner or DJ has their own opinion about running their system in stereo or mono mode, the most common method is to run the sub-woofers mono and the rest in stereo. Most people agree that sub-woofers running in a stereo mode tend to muddy up the low bass where a mono mode has all sub-woofers producing the same thump at the same time for a much more pronounced bass sound.

9. Sub-woofers: Front-Loaded, Horn-Loaded and Band-Pass

Front-loaded sub-woofers are cabinets that have the woofer facing the front just like a common full range speaker cabinet. These units usually produce more bass within the first 30 feet of the cabinet, but lose volume quickly as distance from the speaker increases.

Horn-loaded sub-woofers have the woofer mounted inside a large cabinet where you can't see it. The most well-known horn loaded sub cabinet is the Cerwin-Vega Earthquake. This cabinet is designed so the sound created by the woofer travels a precise distance through a precise opening before it is released from the cabinet. The distance and opening size are calculated based on the woofer’s specifications. These units usually produce less bass within the first 30 feet of the cabinet than a front loaded cabinet would, but the sound travels much further.

Band-pass sub woofers are designed with the woofer mounted inside and have two chambers of precise size with one chamber having one or more ports to release only a certain band of low frequencies. The size of the two chambers as well as the size and number of ports are the result of calculations based on the woofer’s specifications. These units work well for small systems that need a fairly large amount of bass, but like horn-loaded system, are not as smooth as the front loaded types.

10. Speaker Location

The best location for speakers in a night club or for a DJ is not always the same as for a studio or even a church for that matter. In a concert or club setting, you want the sub-woofers on or near the ground and close to the dance area if one exists. In a dance club you want the mids and highs about one foot above the crowd’s head level. This is because the mids and highs are directional and if they are aimed at the dancers body, the people farther back would hear less volume. Bass is not directional and therefore does not need to be raised. Sub-woofers usually do best on the floor and near a corner to help resonate the bass.

In a studio setting, you want monitor placement to be unobstructed by any objects that might reflect or block the direct sound of the monitors. If you are using a sub-bass system in your studio, you will need to experiment with your placement a little to accommodate your particular room design. Remember that unlike the use of a sub in a club or concert situation you do *not* want to over-emphasize the bass. You are simply trying to produce the natural sound as accurately as possible. Placing the sub in a corner of the room will in most cases amplify it. Always move around the room and listen for standing waves. If you have a problem with this you will have to deal with you room acoustics before going any further.

In church or speech reinforcement situations, the object is again to reproduce the speech accurately so it is not fatiguing to the listener. I have been involved in several studies on this, and you would be surprised what a subtle change in frequency equalization can do to the listener's ability to stay interested and recall the lecture. Also, some systems utilizing titanium diaphragms in their high frequency devices proved to cause the same fatiguing effects as over-emphasizing the highs because of their over-generated harmonics. In either case, the listener loses interest more quickly as he must strain to endure the acoustical mess being thrown at him. It is better to run this type of system quite flat and give it much more mid than systems for other uses.

11. Conclusion

Remember, there are as many if not more things to consider when purchasing a speaker than simply the speaker system itself. Since every environment is not the same acoustically there are many things to consider here so the system can translate well into its *real* environment. What sounds good in an acoustically over-dead environment will not usually serve well in a marble-walled cathedral, for example, and selecting the correct components in the first place is much better than trying to mask the problem with EQ.