Xkitz Elect

quality, innovation, tech

Sign in or **Create ar**

Cart

Search all products...

- Home
- Products
- 45 Day No-Hassle Return
- Audiophile
- About Us
- Tools
- Blog

Cart

Your cart is empty.

Making the Case for Active Crossovers vs. Passive

Making the Case for Active Crossovers vs. Passive

Posted by **Mark Longley** on **Jul 24, 2018**

Have you ever wondered why high end speakers cost what they do?

And, more importantly, have you ever wondered if there is a way you can get the same high quality sound at a reasonable cost? (Hint: you can)

It’s not uncommon to pay thousands of dollars for a set of speakers. Some go for tens or even hundreds of thousands of dollars. It’s very likely that a big part of the high price is due to the name and reputation of the companies or individuals that produce these speakers. But the biggest reason that high end speakers cost what they do is the quality of the sound they produce.

So the next question to ask is how do these speakers produce such high quality sound?

The quality of the sound produced is the aggregate of thousands of design and build quality decisions made by the manufacturer. Every design element that

makes up the whole speaker must be carefully scrutinized and optimized to eliminate any distortion they may contribute to the sound produced.

The construction and tuning of the cabinet and porting are very important. The quality and stability of the speaker drivers is also very important. But by far the most important element contributing to the quality of the final sound is the *crossover*. An imperfectly designed passive crossover will ruin your sound, no matter how pristine the drivers and cabinets are.

Designing and building a passive crossover is easy. Designing and building a *good* passive crossover is really damn hard (and super expensive) for all the reasons laid out below. Top line speaker manufacturers put tremendous amounts of R&D into creating optimal and perfectly balanced passive crossovers for use in their speakers. They have the resources and equipment needed to design and build passive crossovers that are seamlessly matched to the speaker drivers and the cabinet's acoustic characteristics. This is a difficult and expensive process involving massive amounts of experimentation and testing. All of this work and expense is for the purpose of trying to overcome and/or mask the serious damage that the passive crossover can inflict on the quality of the sound produced. Any of the serious and difficult challenges listed below have the potential to destroy the sound of the speaker if not properly dealt with.

And that gets to the point of this paper: to outline how **all of the potential challenges related to the passive crossover are easily overcome: just eliminate it!** Remove the passive crossover from your system and you remove the majority of the sources of distortion.

Audiophiles with basic DIY inclinations have within their reach the ability to create the same high quality sound of a high end system on a much more reasonable budget through the magic of ***Bi-Amping***. In a nutshell, Bi-Amping simply is the replacement of the passive crossover in the speaker cabinet with an 'Electronic Active Crossover' placed inline between the preamp and the amplifier. This has some very significant advantages I'll talk about below.

We at Xkitz have long been sold on the virtues of active Bi-Amping. All of our audio products are geared around Bi-Amping or Tri-Amping. The improvement that can be gained in audio clarity, definition, and warmth is authentically nothing short of astounding. Many of our customers have commented that after converting from passive to active Bi-Amping, they now have sound quality comparable to a $25K+ system. One customer colorfully commented:

"Sound stage got huge in width, depth & height (stuff going on not only outside the room but in the side yards & backyard!!)"

I can personally attest to that. I'm constantly being surprised by some small detail, or subtle transient, or almost inaudibly whispered utterance that I've never heard before in music I've known by heart since the 70's. The stage becomes a giant, lush garden of sound. You can close your eyes and clearly picture every instrument on the stage. Piano solo so clear and real it sounds like the piano is right there in the room with you. If you're at all like me, once you've converted to bi-amp you'll get this uncontrollable urge to go back and re-listen to your whole record collection. I can assure you, you'll hear stuff you never knew was there!

The concept of active Bi-Amping has been around for decades. Active Bi-Amping is universally used in professional audio equipment. But it has yet to really penetrate the mainstream DIY audiophile community. It's quite baffling to me why that would be. Why do DIY speaker builders still subject themselves to the torture and great expense of designing and building passive crossovers? Especially when you consider the inevitably sub-optimum sound quality that will result, for any of the multiple reasons listed below.

Bi-Amping has historically been considered too expensive for the consumer audio market due to the high cost of electronic active crossovers and need for extra amplifier channels required. But that's rapidly changing due to the availability multi-channel amplifiers at reasonable prices and the introduction of lower cost, high quality Electronic Active Crossovers, such as our XOVER and XAMP series' of active crossover and Bi-Amplifier boards, or the fully integrated plug-n-play ***Sublime Acoustic K231 Stereo 3-Way Active Crossover*** unit.

Comparing the current cost of Bi-Amping to the cost of today's high end passive crossovers, where capacitors alone can run into the hundreds of dollars, Bi-Amping is actually now the ***lower cost*** and ***higher quality*** option today.

Passive Crossovers ~ Devils in the Details

So let's dive into the evils and complexities of the passive crossover. As most already know, a crossover is comprised of a low pass filter to drive the woofer and a high pass to drive the tweeter. How hard can that be?!? Well, as I already mentioned; *really damn hard (and super expensive)* if you want it to sound decent. Here are just a few of the many reasons:

Large and Pricey Components

The components required to build a really decent crossover are not small and not cheap! The choice of inductors and capacitors is critical to attaining a high quality sound from the crossover, and is indeed the *only* difference between a low end consumer crossover and one you'll find inside a $200K speaker.

Consumer grade crossovers may employ inductors with iron or ferrite cores because these types are smaller and cheaper to produce. But they are inherently non-linear, which means they act differently at different frequencies and power levels, which distorts the sound produced. High end crossovers generally use air core inductors, but these are much larger and more expensive to reach the required power and inductance levels.

Capacitors are another point of distinction. Low end crossovers may opt to use lower cost electrolytic capacitors. But many people agree that these don't create a very high quality sound. High end crossovers generally use metalized poly film capacitors, which are larger and MUCH more expensive (some in the multi $100's range!). This is an area where there is much mythology and mysticism perpetrated by people who want to separate you from as much money as possible. Are these magical caps really THAT MUCH better? I'm skeptical. But, no matter; you won't need any of these once you go Bi-Amp!

Component Tolerances

Tight component value tolerances are difficult to attain on these large inductors and capacitors. All but the most expensive parts have 10% or even 20% tolerance ratings. This can lead to wildly varying performance levels from one crossover to another, and of course, leads to behavior of the crossover that may fall well outside of the designer's intentions.

Crossover Characteristics Change with Temperature

The capacitor and inductor values drift with temperature. When you turn up the volume the crossover components will begin to heat up. And when they heat up their values begin to drift, which causes the effective crossover frequency and other characteristics to drift, which can lead to distortion of the sound.

Active crossovers operate in the low voltage, high impedance signal domain, which means they don't heat up when you turn up the volume. And they employ much smaller and low power components that can be economically obtained in tolerance levels as low as 0.1%. Active crossovers have a rock solid performance consistency that does not drift with temperature, and does not vary from one unit to another.

Amplifier Power Wasted

Passive crossovers waste a huge amount of your amplifier's power. In some cases up half of the available power from your amplifier is lost to heat dissipation in the crossover components.

The insertion loss of a passive crossover can be as high as 3dB. This means that to achieve a given Sound Pressure Level (SPL) in your sound system you need an amplifier with twice the wattage as would be necessary in a bi-amp system. The presence of the passive crossover in the speaker forces you to pay more for the amplifier than you would otherwise have to.

Active bi-amp systems have zero insertion loss and do not require twice the amplifier wattage to reach the same SPL level.

Tricky Load

The complex electrical interactions between the caps and inductors and the speaker driver itself create a very difficult load for the amplifier to handle. The load impedance that the amplifier sees varies with the frequency its trying to produce, and exhibits a steep dip at the crossover frequency. In other words, the speaker/crossover may present an 8 ohm load at most frequencies, but when that one note hits close to the crossover frequency, the load may suddenly dip to 2 or 3 ohms. This impedance dip presents a real challenge to the amplifier. Few modern amplifiers would fail outright under these conditions, but these load peaks can lead the amplifier to briefly go into clipping, and in many cases will cause a greater distortion of the audio in this frequency range.

These impedance dips require a higher wattage amplifier than would otherwise be needed in order to be sure it can handle the load peaks and still perform reasonably well when these impedance dips occur. The presence of the passive crossover, again, forces you to pay more for the amplifier than you would otherwise need to achieve a decent level of sound quality.

Active bi-amp systems do not suffer from this affliction. Since the amplifier is connected straight to the speaker driver posts, the amplifier sees just a simple inductive load that does not vary by frequency.

Speaker Cable IR Drop

Another problem that the frequency specific impedance dip causes is related to the IR drop of the speaker cable. IR drop is defined as the voltage drop due to energy losses in a resistor. All speaker cables have a measurable resistance. Thinner cables will have a higher resistance than fat cables. This means that you will see a signal voltage drop at and around the crossover frequency, which distorts the audio. Fatter cables will have less IR drop because they have lower resistance. This is why expensive monster cables make your speakers sound better. Again, you’re forced to pay more for fatter speaker cables because of what the passive crossover does to the audio signal.

Active bi-amp systems do not require expensive monster cables because there

are no frequency dependent impedance dips.

Back EMF Distortion

Back EMF, or back electro-motive force, is the voltage created by the speaker winding when the momentum of the cone causes the winding to continue moving relative to the speaker magnet. This voltage, particularly from the woofer, flows backward through the crossover toward the amplifier and into the tweeter channel. The massively chaotic interactions these voltages can cause are far too complicated to even begin to calculate. But it’s ok, you don’t need to calculate them, just dump the passive crossover!

Active bi-amp systems are not in any way susceptible to back EMF distortion.

Intermodulation Distortion

The combination of the speaker drivers and the caps and inductors of the passive crossover all form a single circuit that is charged with producing sound over the entire audible range. As mentioned there are massively chaotic and complex electrical interactions between all of these parts as it endeavors to reproduce the required sounds. Intermodulation distortion is a type of distortion that occurs when this circuit is tasked with producing two or more frequencies at the same time. The intermodulation between each frequency will produce additional frequencies at the harmonics and at the sums of the original frequencies that are not part of the original signal. This is most pronounced when simultaneously reproducing very low and very high frequencies. This type of distortion leads to a muddying of the sound created, making it harder to distinguish the individual instruments across the sound stage.

Active bi-amp systems are much less susceptible to intermodulation distortion because the woofer and tweeter channels are electrically isolated from each other.

Loss of Damping

The caps and inductors placed in the circuit between the amplifier and the speaker coil cause a loss of damping, meaning that the amplifier is more

isolated from the driver and has weaker control over the motion of the loudspeaker cones. The result is a muddier, less precise sound.

In a bi-amp system the amplifiers are connected directly to the speaker coils with no capacitors or inductors to get in the way of the amplifier's ability to precisely position the cones, which gives you dramatically higher sound definition and vibrancy.

Driver Sensitivity Matching

All speaker drivers have different levels of sensitivity, meaning that a given signal voltage applied to the terminals will produce a different Sound Pressure Level, or SPL.

These specs are rated as a dB level with a 1 watt signal applied and measured at 1 meter distance from the driver. To obtain a clean, natural sound any mismatch in driver sensitivity of the woofer and tweeter must be corrected by adding a padding resistor in series with the driver with the highest sensitivity to reduce it to match the other driver.

As an example, if your speaker design includes a tweeter with sensitivity rated at 92dB and a woofer at 90dB. If left uncorrected, this mismatch would give an overly bright sound with the highs sounding too loud. The crossover designer must add a padding resistor of some value in series with the tweeter to bring the level down by 2dB. This resistor robs even more power from your amplifier, and choosing its value can be difficult. Theoretically, the value can be calculated. But in reality, manufacturers' specs can vary widely from real life sensitivities, so experimentation is almost always required to arrive at the appropriate value of the padding resistors.

Active bi-amp systems solve this problem easily by allowing you to adjust the gains of the woofer and tweeter channel by simply adjusting a couple of potentiometers.

Crossover Frequency Baked Into the Design

The selection of the crossover frequency is one of the most important elements

in the design of the speaker system. Frequencies below this number are sent to the woofer and those above this are sent to the tweeter. There will always be an overlap in the frequency response curves of the woofer and tweeter, meaning that frequencies in this range could just as well be sent to either the woofer or tweeter with presumably equal results. The crossover frequency could theoretically be placed anywhere in this range. But in reality, there is always one sweet spot within that frequency range, and if you place the crossover frequency there you will have the most natural sound. How do you find that sweet spot? You have to experiment. You have to try different crossover frequencies and compare the sound. But, of course, that's much easier said than done. The crossover frequency is baked deep into the crossover design. To change the frequency you'd need to change the values of the inductors and capacitors (which, as discussed, are quite costly). So in reality, unless you're recently won the lotto, experimenting with different frequencies in a passive crossover is not really feasible.

As you might guess by now, this is not a problem in active bi-amp systems! The crossover frequency of an active crossover is set by the values a handful of precision resistors which are generally mounted on a low cost and easily swappable module. To change the crossover frequency, you only need to pull out the XO module and replace it with one set for the new frequency.

Summing Up

Any one of the above evils should be enough to convince anyone to dump their passive crossovers. But all of these evils taken together make an overwhelming case against passive crossovers and in favor of active Bi-Amping.

To sum up the many advantages of active Bi-Amping over the lowly passive crossover:

- Elimination of the bulky, lossy, inaccurate, and over-priced caps and inductors that that distort your sound and change characteristics when they heat up
- No power is wasted to inductor and resistor heat dissipation

- Twice the efficiency. Twice the effective SPL per watt of amplifier power. Put another way, you can use smaller, lower cost amplifiers to reach the same SPL
- The amplifiers see a simple inductive load with impedance that doesn't change with frequency
- Lower distortion at and around the crossover frequency
- Speaker cable IR drop is constant, not frequency dependant. Put another way, you can use cheaper speaker cables and still get excellent results
- No back EMF distortion
- Greatly reduced intermodulation distortion (IMD)
- Greatly improved speaker damping
- Simple matching of driver sensitivities by simply adjusting potentiometers
- Ease and low cost of changing the crossover frequency
- Greatly improved clarity, definition and warmth of the audio produced

And There's More...

Active Bi-Amping gives you other advantages that are not in any way available with the old style passive crossovers.

The components used to build an active crossover can be of the utmost precision and quality, optimized to produce the cleanest possible audio. Audiophile grade op amps can be used that have THD+N specs as low as 0.00005%. The highest quality 0.1% tolerance metalized resistors and metal film poly caps can be employed to produce the best possible sound. These components don't need to handle huge amounts of power because they're on the low signal front end of the power amp, not on the back end of the amp.

Active Bi-Amping also gives you the flexibility to select the most optimum power amplifiers for the low, mid and high channels. For example, some people advocate using high wattage solid state amplifiers to drive the woofer channels, and a cleaner valve amp for the tweeter channels. There is much room for experimentation here. Bi-Amping gives you this flexibility to find the

best configuration to obtain the best possible sound.

The End (of passive the crossover)

Active Bi-Amping is simple, low cost, and gives you a vastly higher quality sound compared to the old passive crossovers. I'm hoping I've succeeded in making the case that there is no longer any good reason not to go Bi-Amp. But I know there will be skeptics. Comments welcome!

References:

- https://en.wikipedia.org/wiki/Audio_crossover
- https://en.wikipedia.org/wiki/Powered_speakers
- http://sound.whsites.net/bi-amp.htm
- http://sound.whsites.net/biamp-vs-passive.htm
- http://www.bigfootmusic.com/blog/archives/2014/06/13/bi-amping_for_dummiesand_smarties

2 comments

2 comments

Leave a comment ›

I must wholeheartedly concur with all of the above. Having purchased two Xkitz , K-231 active crossovers which took the place of passive x-over system. In my quad amped system. The detail I am receiving now simply wasn't available with the passive system. And the control I have now is also a great improvement. I had experimented with some other active crossovers like the DBX, Behringer and offerings from Peavey but the K-231 offers the best sound AND value, if your after silent control, optimal sound and not useless, "Bells and Whistles".

Scott Orlowe *on* ***Dec 06, 2017***

I absolutely agree with everything said. One thing not mentioned is about the speed of the transient responce, wich is much different than freequency responce, it is also greatly improved. The speed that the freequency can change is a much more smoother, and faster transition also. Thank you for your great insight on this, as I have been wondering why people dont bi, tri, or quad amp their systems, this is what I have done, so that I can use class D amplification at high levels for sub freequencies below 32Hz because it is only vibration at that point the earth to ground movment sets in, and stereo does not even appear at that level, also tbe amplifiers dont have to go through all the audio freequencies, making a higher power, using less, and then you can experiment wit different type amplifiers, at different freequency ranges, or a nice mixture of single ended triode, for mid freequencies, being the most tough to reproduce. Thankyou for this, as it is verry i formative, there is more I would like to say but may get too complicated, and that is a problem I have. Sincerely Eric Mootz ericarlenmootz@gmail.com

Eric mootz *on* ***Nov 10, 2017***

Leave a comment

Name

Email

Message

Please note, comments must be approved before they are published.

Post comment

Recent Articles

Making the Case for Active Crossovers vs. Passive
Jul 24, 2018

Quick Links

Search
45 Day No-Hassle Return
Warranty and Returns
Privacy Policy
Educational Discount

Terms of Use

Get In Touch

sales@xkitz.com

Newsletter

Email Address

Sign Up