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BI-AMPLIFICATION

To bi or not to bi

BY

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In recent years the technique known as bi-amplification has received quite a bit of attention. Conventional two-way speakers are "two wire" speaker systems fed by one amplifier. The two wires are connected from the amplifier to a crossover circuit or frequency splitter, that sends the low frequencies to the bass drivers and the high frequencies to the tweeters. These conventional crossovers are passive. In other words, they operate without the need for external power. Since the electrical signals that pass through passive crossovers are at amplifier output (or speaker) level, the components used are rather hefty, though not too expensive.

In a bi-amplified system, an active crossover requiring external power and operating at amplifier input or line level, is placed before the amplifiers. This means that a two-way speaker system now needs two amplifiers; one for the woofer and one for the tweeter.

There is a misunderstanding spreading around some in this industry that there is one truth in audio and it is that there is a clear and irrefutable benefit in bi-amping every loudspeaker in every sound system. However, the issue isn't quite that simple. Why, for instance, should one spend the extra money and incur the added complexity of a bi-amplified system if, because of other design choices, there results no audible improvement in the sound quality?

Basically, there are two valid reasons for bi-amplification. If the sound system designer is in a situation where it is the most efficient way to deal with multiple speaker sections and to overcome an audible weakness of some part of the reproducing chain (speakers, amplifiers, passive crossovers etc.). You bi-amplify if it really helps. Otherwise, one should avoid it if possible because it's more expensive and more likely to drift.

To design and build a loudspeaker cluster that will cover a stadium from a point high above the center of the building, one uses a multitude of woofer sections and high frequency horns. There are often several high frequency horns of progressively longer throw coverage patterns stacked one above the other designed to evenly cover a large area.

In installations such as these, it is far more convenient to use separate amplifiers for not only the woofers and tweeters, but for the different tweeter horns as well. Sometimes bi-

amping is the easiest way to match the impedances presented to the amplifiers by a large number of drivers. In addition, it can aid the installers by allowing individual level adjustments for the different horns to be done with the simple input level controls on the amplifiers. The horns that are covering the most distant seats may very well need to play louder than those covering the nearer seats. Should there be additional high frequency horns underneath a grandstand or balcony, fed by delayed signals, a bi-amplified approach is the easiest way to go. Expensive yes, but much less tedious to set up.

If a designer wished to use passive crossovers in such systems, the level adjustments for the various speakers would need to be done with transformers. Once set, of course, such a system would presumably maintain its calibration for years without drifting. But a technician would have a more difficult task should he be required to later change the level of a particular speaker section by just 2 dB.

Other situations that benefit from bi-amplification are cases of mismatched speaker systems, poor performance from the available passive crossover, portable road systems or custom speaker assemblies for which no passive network is available. A mismatched speaker system is one where there is a significant difference in sensitivity between the low frequency sections and the high frequency sections. Such a difference is typical of speaker systems that use a direct radiator woofer and a large horn loaded tweeter, for instance. Systems such as these can exhibit as much as an 11 dB (12 1/2 times power) difference in sensitivity between the two sections. Using a single amplifier with these speaker systems means that not only do you need a much more powerful amplifier to drive the relatively insensitive woofer, but the amplifier may produce greater intermodulation distortion of the high frequencies when asked to push the bass so hard. Bi-amplification would avoid this problem.

There is another factor in favor of bi-amping speakers with horn tweeters and direct radiator woofers. The woofer drivers in such systems are usually mounted in vented boxes. This is to say that the air behind the drivers inside the cabinet, is vented to the outside through one or more holes or ports. Also, the less sensitive a speaker, the greater the driver excursion required to deliver a given sound level in the room. With diaphragms needing to move so much farther and the use of vented boxes, the electrical damping factor of the amplifier becomes more important for controlling the driver's motion and minimizing overshoot. The insertion of anything into the speaker line that adds resistance, such as a passive crossover, reduces the damping factor. Therefore, I recommend that anyone considering the use of a passive crossover should determine its insertion loss. Some crossover designs are reputed to lose as much as 3 dB or more. A 3 dB loss means that 1/2 of the amplifier power is wasted (heating the crossover). An ideal

crossover will have no more than a 1/2 to 1 dB loss which is acceptable in many situations.

If one is especially upset about a 1 dB loss in a theatre sound system, locating the amplifiers at the speakers would be as effective in reducing this loss as bi-amplification and less costly. However, it's better to design sound systems with enough headroom so that a 1 dB loss doesn't matter.

Headroom, or more precisely the lack of it, is one of the most common excuses that sales people use to sell bi-amping. The story goes that if an amplifier runs out of power and "clips" because of a large bass signal, the more fragile high frequency drivers may be damaged. All this is absolutely true until one asks why there isn't enough amplifier power and speaker sensitivity to avoid clipping in the first place.

Several people have asked why I do not bi-amplify our HPS-4000™ sound systems. The answer is that I have designed the systems using loudspeaker systems that are an order of magnitude more efficient than the direct radiator / horn combinations. The woofers, midranges and tweeters of these efficient systems all have the same sensitivity, as opposed to the 11 dB difference encountered with direct radiator / horn combinations. The passive crossovers I use have an insertion loss of about 1/2 dB and a 1000 Watt capacity. In addition, they are designed specifically for the speakers they are used with, which means they can have less circuitry. The design of these loudspeakers employs sealed back air chambers and no vents. This approach provides a high mechanical damping factor not available with vented boxes. This, and the lower driver excursion obtained with the more sensitive design, results in the electrical damping factor provided by the amplifier becoming less important.

In other words, the normally valid reasons for bi-amplification don't usually exist with the speaker designs I like to use. This is one of the many reasons I chose efficient loudspeakers. One last reason I don't bi-amp our sound systems is that, so far at least, I haven't been able to hear the difference between the systems where I have used multiple amplification and those where I have not.

A test was conducted by a designer of an electronic crossover. Using a 3-way fully horn loaded loudspeaker, a 12 pole switch was installed so that the system could be used with its own passive crossover or the electronic crossover and tri-amplification. After the levels were properly matched, none of the participants, including the designer of the electronic crossover, could tell which was which. The question remaining in this case is why one should go to the trouble and expense of three amplifiers per speaker when no

improvement is heard? The only reason to bi-amp or tri-amp in these situations would be the need for two to three times more amplifier power than is available from a (reliable) single amplifier. This can happen in very large theatres. (See BOXOFFICE October, 1982 page 32).

Recently a new development may add a new factor to the issue. BGW Systems, Inc. has introduced a signal Processing Amplifier called the SPA-3. Depending on the configuration ordered, the unit can be used to either bi or tri-amplify 2 or 3 way speaker systems. These SPA's contain their own electronic crossovers, independent high quality power amplifiers, time alignment delays, a parametric equalizer for the woofer to take care of any room peaks and an adjustable treble boost for the tweeters. This kind of device can be especially useful for theatre systems that use cinema processors that do not have 1/3rd octave equalization. One particularly nice feature is that BGW will supply these SPA's with crossover filters designed for the speaker systems you are using. Theatre sound system designers who are currently using stage speakers with the inefficient direct radiator type woofers and horn loaded tweeters, should investigate these new signal processing amplifiers.

We have seen that the issue of multiple amplification of loudspeakers is not always clear. Like many other things in audio, if we can cut through the religious fervor, we can see bi-amping as a tool that can be helpful in some circumstances, or unnecessary and wasteful in others.

John F. Allen is the founder and president of High Performance Stereo in Newton, Mass. He is also the inventor of the HPS-4000® cinema sound system and in 1984 was the first to bring digital sound to the cinema. John Allen can be reached by E-mail at JohnFAllen@aol.com.