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Guides: Amplifiers

Concert Loudspeaker Processors

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Due to the ever-increasing public awareness of sound system fidelity, the pro-user's desire for dependable and "idiot-proof" audio equipment, and the loudspeaker manufacturer's constant battle to be one step ahead of the competition, the age of the concert loudspeaker processor has arrived.

Apogee Sound, Community Light and Sound, Eastern Acoustic Works, Electro-Voice, Meyer Sound Laboratories, Professional Audio Systems, and Renkus-Heinz are but a few of the companies presently manufacturing processor-based concert loudspeaker systems. Each company has their own design philosophies and individual product features, but as a whole, processor-based concert loudspeaker systems share the same general objectives. This article will attempt to explicate the most common design objectives and lightly touch upon the methodology in which the manufacturers are attempting to achieve the desired results.

The concert loudspeaker processor, in many instances, is nothing more than a combined electronic cross-over, signal delay, speaker protector, and response corrector packaged together for a particular loudspeaker and placed inside a single rack-mountable box. The objective of the loudspeaker processor is to optimize the acoustic output of the loudspeaker while protecting the loudspeaker componentry, all the while trying to remain as transparent as possible throughout the dynamic range of the loudspeaker. It seems simple enough, but applying this philosophy is extremely difficult. However, aside from the difficulties in design, the manufacturers are developing loudspeaker systems with definite advantages directly resulting from the loudspeaker processing.

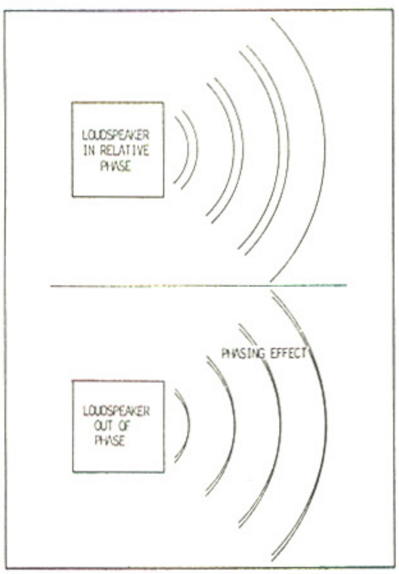
Aside from the obvious size and convenience qualities of the processor, there are a couple of other benefits as well. For example, by placing all of the working components in one box, and applying the same design philosophy throughout the entire unit, the processor is apt to be much quieter than individual components strapped together. As an aside, the technician's time can be spent in other places rather than patching together outboard components while trying to figure out input and output impedances. An additional benefit is the manufacturer's ability to customize the processor to a particular loudspeaker. Herein lies the real power of the concert loudspeaker processor.

By designing a loudspeaker processor for a specific loudspeaker, the manufacturer is able to incorporate circuitry for a known sound source to achieve optimal performance from that sound source as well as protect the sound source with the use of protective circuitry. The net effect is a seemingly more efficient loudspeaker system than traditional loudspeaker systems. As mentioned previously, the majority of the processed loudspeaker systems perform these optimizational functions with the use of electronic cross-overs, signal delays, speaker protection circuits, and equalization or speaker response correction circuits. The next four sections will touch upon these four functions of the loudspeaker processor.

ELECTRONIC CROSS-OVERS

The electronic cross-over in loudspeaker processors is much the same as other electronic cross-overs. The difference lies in the manufacturer's ability to design cross-over frequencies, slopes, and phase to meet the needs of the loudspeaker in order to create the optimum performance. This obviously cannot be accurately achieved with off-the-shelf cross-overs since the manufacturer has no way of knowing with what sound sources the cross-over will be in line.

Figure 1. A loudspeaker in or out of phase.



The loudspeaker processor facilitates precise tailoring of the adjoining cross-over frequencies to the specific sound sources they are serving, thus creating a smoother transition from sound source to sound source assuming the speaker components are chosen properly. The smoother transition gives the loudspeaker the illusion of being only one sound source rather than multiple sound sources working together, again assuming the speaker components are chosen correctly.

Cross-over slopes can be designed to make the transition from sound source to sound source longer or shorter, depending on the response output of the loudspeaker as a whole. Combinations of different cross-over slopes are also used to generate the desired results from the loudspeaker components.

Finally, phase can be adjusted for each cross-over frequency in order to align the acoustic wavefronts of the transitional sound sources. Alignment is achieved by matching the acoustic phase of the first sound source with the acoustic phase of the second sound source at the cross-over point, thereby putting the two sound sources in the same relative phase (*Figure 1*). Acoustic wavefront alignment is important in order to reduce the cancellation and summation of the acoustic energy being emitted from the loudspeaker. It is important to note that two sound sources with different coverage patterns, although in relative phase on-axis, will not remain in relative phase throughout their off-axis coverage pattern due to the difference in flare rate between the two sound sources. The proper choice of loudspeaker components is imperative for a successful loudspeaker, even with a loudspeaker processor.

Figure 2. Signal synchronization.

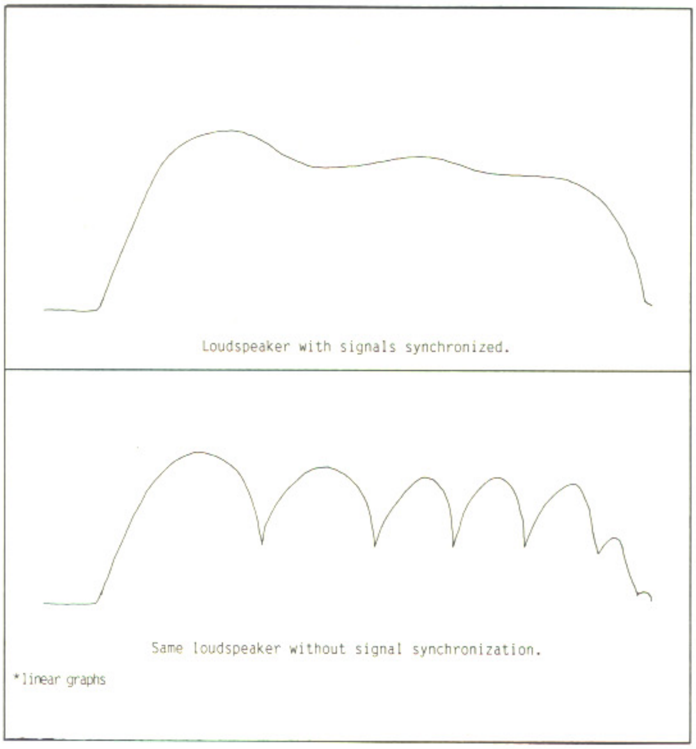
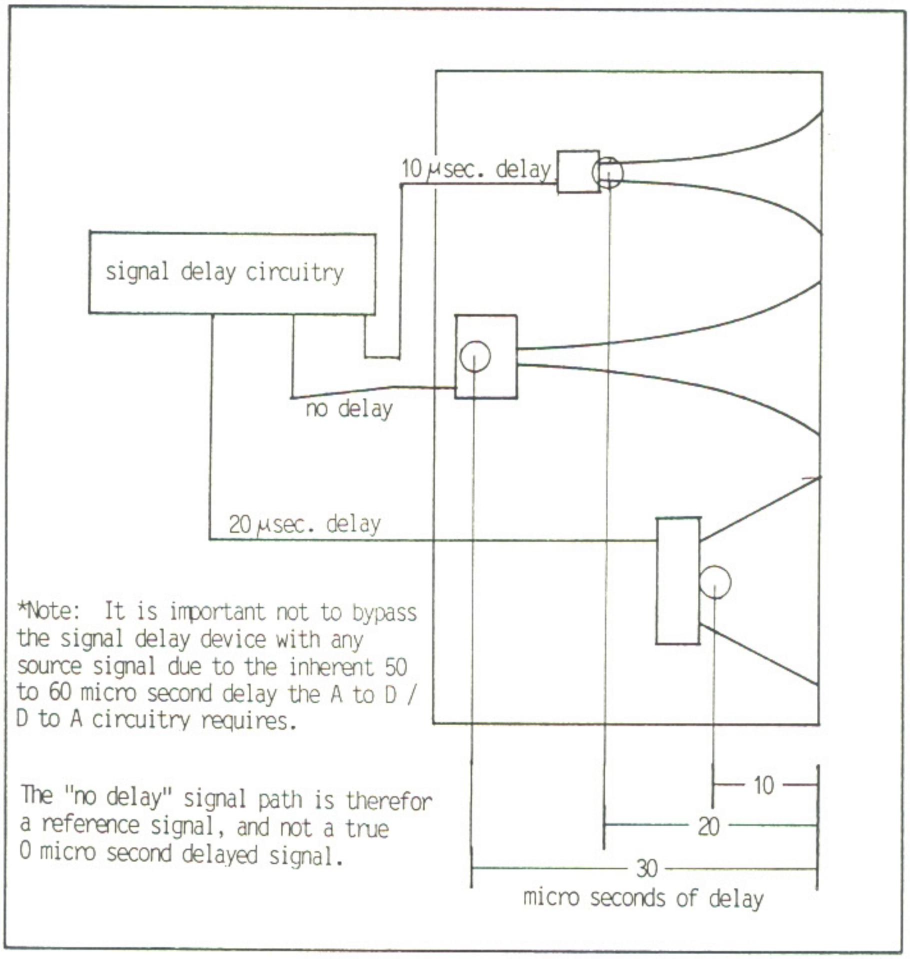


Figure 3. Signal delay.



Signal delays are utilized for sound source signal synchronization, a vital function in processors if the processor is servicing a loudspeaker with non-aligned sound source acoustic centers.

The acoustic center of a sound source is the point at which the acoustic energy appears to originate, and this point does not have to be in the center of the magnet assembly or in the throat of a horn. If the acoustic center of one sound source is not in physical alignment with another sound source, unnatural filtering effects will occur between the acoustic outputs of the sound sources. The filtering is commonly known as comb filtering (*Figure 2*).

Comb filters, when sizeable, will cause an audible distortion to the program material, and can be easily detected. However, comb filtering often will not be heard directly from the loudspeaker. Instead, the resultant of comb filtering will be heard in the environment surrounding the loudspeaker due to the adverse comb filtering effects on a loudspeaker's coverage pattern. A loudspeaker with sound sources that are not signal synchronized can emit very concentrated lobes in odd directions. Not only does this make loudspeaker placement difficult, due to feedback control, but it will also cause an increase in the reverberant field resulting from unwanted room reflections—thereby decreasing the direct to reverberant sound and decreasing intelligibility.

Since, as mentioned earlier, the acoustic wavefronts of the sound sources must be in alignment, and now the acoustic centers of the sound sources must also be in alignment, the manufacturer of the loudspeaker system must make a few decisions. Most manufacturers will physically align the acoustic wavefronts, and then introduce signal delays in order to synchronize the signals of the loudspeaker sound sources (*Figure 3*). Other manufacturers will develop an integrated sound source array that physically aligns both the acoustic wavefronts and acoustic centers, thereby eliminating the need for signal delay circuits inside the loudspeaker processor.

SPEAKER PROTECTION

The most common form of speaker protection in loudspeaker processors is achieved with limiting. The limiter will "squash" the dynamics of the program material, through the use of a very high compression ratio, should the limiter be switched on. The manufacturer can design the limiter in such a way that the switching circuitry and compression ratio are suitable for the speaker components inside the loudspeaker, and the dynamic range of the loudspeaker is maintained with the highest level of processor transparency. The method of triggering the limiting circuitry varies from manufacturer to manufacturer.

Some of the loudspeaker processors contain "sensing circuitry" that will constantly monitor the output of the amplification device and begin limiting when the amplifier goes into clipping. A very high-quality amplifier with the manufacturer's suggested power rating is necessary for this type of protection system to be of benefit. Other loudspeaker processors will incorporate a threshold gate that triggers the limiter when the program material exceeds the pre-set threshold.

Another form of speaker protection commonly found in loudspeaker processors is thermal protection. Thermal protection circuits are usually a form of low to mid ratio compression. As with the limiting function, the thermal protection is triggered in much the same manner. Additionally, there are some manufacturers that use "sliding crossover" functions in their loudspeaker processors to protect against thermal overload. This function changes the cross-over frequency of the sound source in danger until it is able to safely operate in the wider bandwidth again.

SPEAKER RESPONSE CORRECTION

Speaker response correction, or equalization, is incorporated into most loudspeaker processors. The processor package gives the manufacturer the opportunity to fine tune the components of the loudspeaker with great accuracy to achieve the desired loudspeaker output response. Some loudspeaker processors offer switchable and/or adjustable equalization functions for use when the loudspeaker is arrayed or placed in acoustically coupling environments.

Additionally, some loudspeaker processor manufacturers include "feedback suppression" circuitry with their processors. When the processor senses a feedback loop, the proper attenuation is applied until the feedback loop is repressed.

The age of the loudspeaker processor has enabled the sound system engineer to purchase a loudspeaker system with good performance, compact dimensions, and consistent acoustical characteristics: the three ingredients needed for successful performance. The processor-based loudspeaker systems have made it possible to travel from venue to venue and have an excellent idea as to how the sound system will respond at each site, while the time needed for set-up is, in most instances, greatly reduced. The loudspeaker system's owner has the piece of mind that the loudspeakers have a high resistance to destruction due to misuse. However, there are certain drawbacks to the processor-based loudspeaker systems as well.

The loudspeaker processor must be used in conjunction with the specified loudspeaker. Hooking up a processor to the wrong loudspeaker would probably not sound very pleasant, and may destroy the loudspeaker, although there are some manufacturers with "generic" limiter-based processing units that are capable of operating with other manufacturer's products.

The loudspeaker processor also has a tendency to distort the tonal values of the program material when the protection circuitry is employed. However, the tonal variation due to the protection function is usually much less detectable and preferred over the harsh distortion of over-excursion.

And finally, the purchase price of processor-based loudspeaker systems is extremely high when compared to conventional loudspeaker systems. As for the value—that is for the individual to decide.

Manufacturers Mentioned:

Apogee Sound, Inc., CA (707) 778-8887, Community Light & Sound, Inc., PA (215) 876-3400, Eastern Acoustic Works, Inc., MA (617) 620-1478, Electro-Voice, Inc., MI (616) 695-6831, Meyer Sound Laboratories, Inc., CA (415) 486-1166, Professional Audio Systems, Inc., CA (213) 534-3570, Renkus-Heinz, Inc., CA (714) 250-1035

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