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RECORDING engineer/producer

relating recording science • to recording art • to recording equipment

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—the magazine to exclusively serve the recording studio market . . . all those whose work involves the recording of commercially marketable sound.

—the magazine produced to relate . . . RECORDING ART to RECORDING SCIENCE . . . to RECORDING EQUIPMENT.

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BI and TRI AMPLIFICATION

by ALBERT SINISCAL
SPECTRA SONICS

One of the major goals in a sound reproduction system is the precision division/conversion of the full audio spectrum, at line power levels, into partial audio spectrum segments at the high power levels required to drive partial range acoustic transducers.

Both amplification and division must occur but, no longer necessarily in that order.

Amplification/frequency division has most commonly been accomplished by using one high power amplifier and channeling its full force first to a passive crossover network, usually mounted in the speaker enclosure, and finally to the individual acoustic transducers.

Conversely, frequency division/amplification is accomplished by first dividing the audio signal at a lower, non-critical level, with an electronic or passive crossover, after which separate power amplifiers for each frequency range are coupled directly to each individual acoustic transducer. Depending on the number of frequency divisions selected for separate amplification, two or three ranges, this latter method is commonly called bi- or tri-amplification.

Figure 1, illustrates the typical amplification/frequency division arrangement.

Figure 2, illustrates a frequency division/bi-amplification configuration similar to that being used in many top quality professional recording studio monitoring systems and broadcast studios such as Motown Records and Larrabee Sound in Hollywood and National Public Radio in Washington, D.C. Performing arts applications include such users as the Denver Symphony. Figure 3 illustrates an electronic crossover/tri-amplification configuration.

Figure 4. illustrates a high power/intensity electronic crossover/tri-amplification variation. Either system is extremely flexible and can be utilized to drive a number of different speaker systems with different purposes. For example, the system in Figure 4 is being used for fine quality recording by LONDON DECCA in Vienna, Austria. On the other hand, it is also being used for the performing arts sound reinforcement as typified by the TORONTO PAVILION, Toronto, Canada. And finally, because of the tremendous increase in effective power, it has been used often to drive very high intensity sound systems required at outdoor rock concerts and other permanent outdoor systems such as those at the HOLLYWOOD BOWL, Hollywood, California.

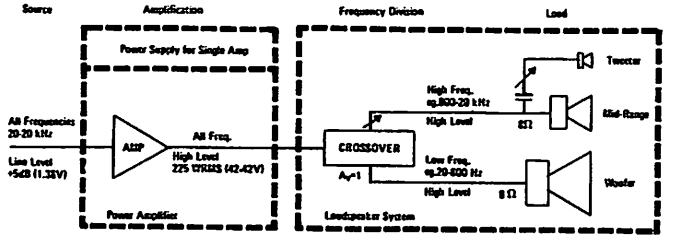

Figure 1 Single Amplification

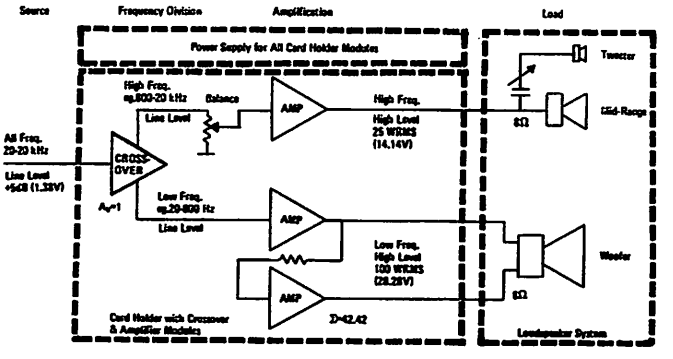

Figure 2 Bi-Amplification. The peak power available with a 25 WRMS and a 100 WRMS amplifier in the bi-amp configuration 2, is equivalent to a 225 WRMS amplifier in the single amplification configuration 1. —Approx. a 2 to 1 available peak power increase for the bi-amp

The amplifiers utilized in the installations are solid state, modular, plug-in units. A single amplifier will deliver 25 WRMS or greater to an 8 ohm load. For complete flexibility, two of these modular plug-in power amplifiers used together in a bridged (push-pull) configuration will deliver greater than 100 WRMS to an 8 ohm load. Therefore, all amplifiers are the same, whether used: 1.) singly for low power; 2.) in bridged pairs for high power; and/or 3.) in bi- or tri-amplification configurations for very high power. In addition each plug-in power amplifier module is individually fused on the output. This provides maximum safety for each individual loudspeaker component plus the amplifier module.

Power and Dynamic Range Advantages

The effective power increase offered by bi- and tri-amplification is much more than just a marginal improvement that only a select few can hear.

Referring to Figure 2), let us assume that the demand on the amplifier system simultaneously required both the full 100 watts RMS for the low frequency section and the full 25 watts RMS for the more efficient mid/high frequency section. Since:

$$P = \frac{E^2}{R}$$ where P = Power, watts RMS, E = Amplifier output, volts RMS, R = Load Resistance, ohms

we develop the following:

For figure 1.

$$\frac{(14.14 + 28.28)^2}{8 \text{ ohms}} = \frac{(42.42)^2}{8} = 225 \text{ WRMS}$$

For figure 2.

$$25 \text{ WRMS} = \frac{(14.14 \text{ volts})^2}{8 \text{ ohms}}$$

$$100 \text{ WRMS} = \frac{(28.28 \text{ volts})^2}{8 \text{ ohms}}$$

$$125 \text{ WRMS}$$

Therefore, a 25 WRMS and a 100 WRMS amplifier in the bi-amplification configuration can provide the equivalent peak power of a 225 WRMS amplifier being utilized in the single amplifier configuration! This is a startling increase in available power and dynamic range of approximately 2 to 1! In many cases the cost of a single 225 WRMS amplifier (at 8 ohms) will be more expensive than the 25 and 100 WRMS amplifiers (at 8 ohms). Adding another amplifier for tri-amplification as shown in Figure 3 increases the available power ratio to approximately 2.5 to 1!

Referring to Figure 4 and making the same calculations the 25, 100, and dual 100 WRMS amplifiers in a high intensity tri-amplification configuration can provide greater peak power than that available in approx. a 1000 WRMS amplifier used in

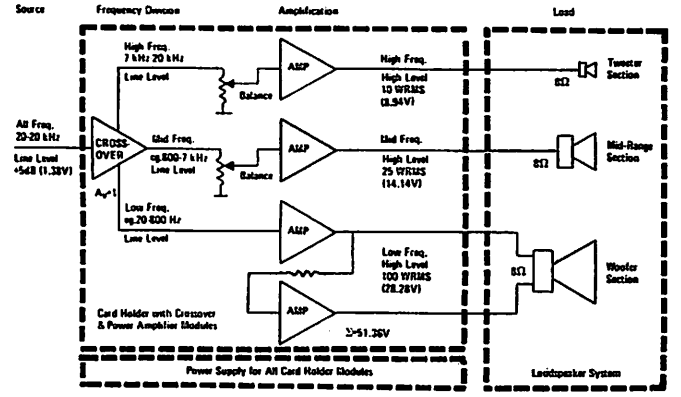

Figure 3. Tri-Amplification. The peak power available in this 135 WRMS tri-amp is equivalent to a 330 WRMS amplifier in the single amplification configuration - Approx. a 2.5 to 1 available peak power increase for the tri-amp!

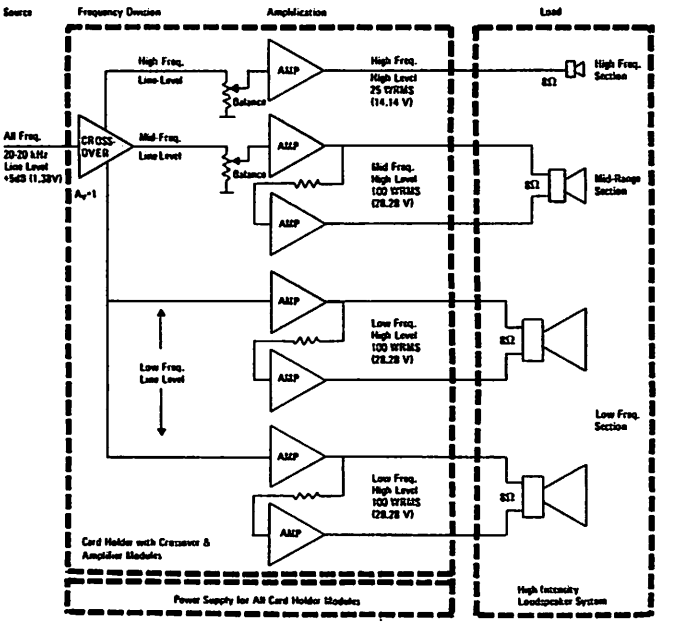

Figure 4. High Intensity Tri-Amplification. Available peak power in this 325 WRMS high intensity tri-amp is equivalent to approx. 1000 WRMS amplifier - Over a 3 to 1 available peak power increase!

the amplification before frequency division configuration. Now the increase in available power is well over 3 to 1! Thus via bi- and tri- amplification one may obtain greatly increased peak output listening levels not available using single large power amplifier methods. This increased peak output performance often may be obtained without a commensurate increase in power amplifier cost.

Lower Distortion, and Improved Transient Response

In the amplification/frequency division setup, when any one single frequency overloads the amplifier (eq. a drum beat, or cymbal transient) all frequencies passing through the one massive amplifier will be distorted until the amplifier recovers. When this occurs, the higher frequency distortion is most objectionable and results in listener fatigue within a very short period. In the case of the frequency division/amplification method (ie. bi- or tri-amplification) the frequency sections are amplified separately and thus overload is restricted to a smaller portion of the total program bandwidth.

Obviously, the transient response/rise time also is improved dramatically when the frequency division occurs at a lower non-critical level, and when the amplifiers are coupled *directly* to the individual acoustic transducers. Elimination of large passive crossover iron core inductors, resistive, and capacitor circuits from between the amplifier and individual loudspeakers greatly improves the rate at which the high level power amplifier energy can be transferred directly to each voice coil.

Similarly, as seen from the individual loudspeaker terminals, the physical removal of the high level crossover network improves the damping factor and eliminates inductive and capacitive reactance loading on the power amplifier.

Lower Signal-to-Noise

Rather than an in depth signal-to-noise discussion, it will perhaps, suffice to point out that in bi- or tri-amplification, each of the amplifier sections only need be of intermediate power and may operate over a restricted bandwidth. These two factors contribute to a better signal-to-noise ratio for the amplifier used in bi- or tri-amplified systems.

Summary

In summary, it apparent that frequent division before amplification (bi- or tri-) configurations offer significant advantages. Particularly in the areas of available peak power/dynamic range, distortion/transient response, damping factor, and signal-to-noise. The state of the art plug-in modular electronic crossover and amplifier format generally used in manufacture today lends itself to both electronic and functional flexibility.

Certainly, bi- and tri-amplification deserve a closer investigation when monitoring and sound reinforcement systems are either being planned or improved.

END