ACOUSTIC ACCURACY IN AUDIO REPRODUCTION - AN INNOVATIVE APPROACH TO AUDIO SYSTEM DESIGN

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1 INTRODUCTION

This paper describes the considerations that were used in the designing and construction of an audio system to meet the most discriminating requirements of the audio professional / enthusiast. The considerations were bold and sometimes over-designed only to be refined after realization of the prototyped system.

Based on the following definitions, the design criterion* was established:

Distortion – falsified reproduction of an audio or video signal caused by change in the waveform of the original signal [1]

Fidelity – the degree to which an electronic device (as a record player, radio or television) accurately reproduces its effect (as sound or picture) [2]

* "To eliminate or minimize distortion from any circuit or system thus providing the highest level of fidelity."

Note: A high level of acoustic accuracy is Inherent in this approach and the resultant system, by design, provides an unencumbered, full frequency, live stage quality sound.

2 SPEAKER SYSTEM

A speaker system is a complex electro-mechanical system, the following steps were taken to meet the design criterion*

2.1 Drivers

A 4-way system was decided on to allow dividing the audio spectrum up into four frequency bands and directing each range of frequencies to a driver specified to give the flattest response to that range. The drivers are; a titanium dome tweeter, horn high-mid, 10" low-mid and a 12" woofer. No one driver is asked to reproduce too broad a frequency range, minimizing **Inter-Modulation Distortion**. The large radiating surface area of the low-mid and woofer allowed for appropriate sound power levels at low drive power.

2.2 Enclosures

A study of speaker enclosure designs was undertaken to determine the best fit for the criteria. Styles such as open backed, tuned, ducted, ported, acoustic suspension, tactrix horn, folded horns

such as the Jordan Horn[3] and others were built and evaluated. As a result of these evaluated enclosures the decision was made to adopt a design providing each open frame driver with its own large volume sealed enclosure. The large volume minimized **compression distortion**, separate enclosures eliminated the **interaction** between the open frame drivers and sealing the enclosures eliminated any sound emanating from the enclosure that was **out of phase** with the sound waves coming from the front of the driver.

The speaker enclosures were constructed of ¾" plywood. All joints were mitered and glued to provide structural integrity, a solid joint seal and internal bracing was applied to provide wall stiffening. Initially an enclosure, approximately 8 cubic feet in volume, was constructed for the 12" driver and a similar sized enclosure was constructed for the 3 higher frequency drivers. This over-designed approach with respect to enclosure volume was later revised to a more user friendly size.

2.3 Crossover Network

Considering the reactance of the drivers, the potentiometers used to adjust the SPL of the drivers and the crossover network reactance, The power amplifier is presented with a extremely complex, **non-linear**, load to not to mention the fact that typically crossover networks have a **low quality factor** and are **passive** therefore consuming a portion of the amplifiers power.

To meet our design criteria the crossover networks were eliminated and each driver was powered by its own amplifier.

3 FILTERS / PREAMP

In that the crossover networks were eliminated from the speaker systems and the drivers were separately amplified, a way of filtering the four frequency bands and routing that information to the respective amplifier needed. The logical choice was active filtering at line level and inputting that information to its respective amplifier. An operational amplifier, specifically designed for audio applications, was chosen for this task. The features of this operational amplifier were low noise, low total harmonic distortion and low offset voltage. Four pole, 26db / octave roll off, maximally flat, Low pass and high pass filters were designed [3] for the specific frequency bands specified to match the drivers. A voltage follower preceded the filters to effectively isolate the input source and drive the four filters sections. Due to the extremely low offset voltage all circuitry to the amplifiers was D.C. coupled.

4 AMPLIFIER

For the purpose of testing the prototyped speaker systems and filters a very low distortion commercial amplifier set was chosen for the prototype.

To continue the innovative approach to the system design integrator circuitry has been designed to allow D.C. coupling of all circuitry from the line input through the speaker system. the D.C. coupled servo technology will eliminate loss of low end frequency response due to the R-C network effect on the sub-audible frequencies.

5 REFERENCES

1. Webster's Ninth New Collegiate Dictionary, Merriam-Webster, 368. U.S.A. (1987)
2. Webster's Ninth New Collegiate Dictionary, Merriam-Webster, 460. U.S.A. (1987)