

# The Altisonus Loudspeaker Design Hierarchy

BY KERMIT GRAY

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## 1. Driver Breakup Modes

Determine whether the driver behaves as a well-controlled piston throughout its intended operating range. If not, you may have to operate the driver over a narrower frequency range. This is not an uncommon decision in loudspeaker design. Random vibrations of the driver are referred to as “breakup modes” and are the most harsh sounding of quality losses in loudspeaker. If severe breakup modes occur within the driver’s frequency range, no subsequent design decision can eliminate its influence.

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## 2. Resonances

Identify and control mechanical, acoustical, electrical, and structural resonances. Stored energy always degrades musical realism and must be addressed before finer refinements become meaningful.

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## 3. Driver Overlap

Select drivers whose natural operating ranges complement one another. Ideally that means that one driver’s frequency range ends where the next one begins. The most successful crossover design begins with compatible drivers instead of electrical compensation.

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## 4. Frequency Response

Establish smooth, natural spectral balance only after the driver’s fundamental behavior has been understood. Frequency response is an important result of good engineering, not a substitute for it.

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## 5. Off-Axis Response

Ensure that the loudspeaker disperses sound evenly and smoothly into the listening room. The room’s reflected sound field contributes substantially to the listener’s perception of tonal balance and spatial realism.

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## 6. Crossover Summation

Develop crossover networks that allow adjacent drivers to combine seamlessly into a single acoustic source. The listener should never become aware that multiple drivers are reproducing the music.

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## 7. Lobing

Minimize interference between drivers by considering physical spacing, crossover frequency, and acoustic geometry. Stable imaging depends upon controlled dispersion of sound.

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## 8. Power Handling

Determine whether the loudspeaker can reproduce its intended musical program without introducing unacceptable distortion or risking damage.

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## 9. Xmax

Xmax is the measurement of how far a driver can move linearly. Nonlinear motion increases distortion, so maintain an adequate mechanical operating margin by ensuring the driver never exceeds Xmax. The objective is not merely avoiding failure but preserving low distortion throughout normal listening conditions.

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## 10. Thermal Compression

Evaluate the driver's ability to maintain consistent performance during sustained operation. As its voice coil heats up it will lose efficiency, creating an unwanted form of compression. Dynamic realism, which is the ability to reproduce subtle peaks and transient details, depends upon the driver's behavior remaining unimpaired as its voice-coil temperature increases.

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## 11. Group Delay

In a perfect speaker, every frequency will be produced by the speaker at the same time and we'll arrive at the listener at the same time. How far this deviates from ideal is expressed by the term group delay or time domain behavior. Less than perfect time domain behavior, alters the harmonic balance of the music and well obscure subtle details and transients. Examine the time-domain behavior of the complete system. Transient accuracy contributes as much to realism as frequency response.

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## 12. Time Alignment

Related to phenomenon of group delay, time alignment is a measure of when the sound produced from the speaker arrives after the listener. Again, the sounds should all arrive at the same time. Think of a horse race where every horse crosses the finish line at the same time. That would be a speaker with perfect time alignment. So in contrast think about a typical horse race or each horse crosses the finish line at a different time. That's analogous to a speaker without accurate time alignment.

Ensure that the outputs of individual drivers arrive together as closely as practical, preserving coherence throughout the crossover region.

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## 13. Acoustic Center Alignment

Optimize the physical and acoustical relationship between drivers so that the loudspeaker behaves as a unified acoustic source instead of a collection of individual sources. Otherwise, you do not have that tangible, vividly realistic sound that the speaker is striving for.

- The order of these priorities is not arbitrary. Each step depends on those preceding it. If diaphragm breakup modes have not been controlled, crossover refinement becomes less effective. If resonances remain excessive, improvements in frequency response produce only limited benefit. If driver integration has not been achieved, precise time alignment cannot fully maintain coherence.