MAJIK 112

KEY TECHNOLOGY

Single Bass Driver Design

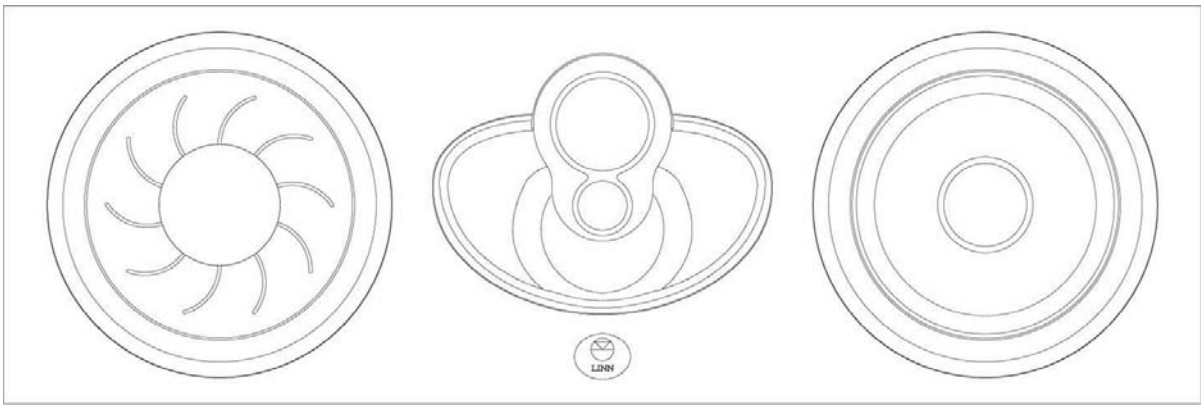

Figure 1

BACKGROUND

Most commercially available centre channel designs employ symmetrically loaded bass units. The main reason for this appears to be primarily cosmetic, as in many designs there is compelling acoustical evidence for deploying only one bass driver.

The ideal centre channel loudspeaker should provide a broad horizontal spread and narrow vertical dispersion to ensure a consistent listening experience from all positions. Column loudspeaker arrays used in public address systems achieve this 'ideal' dispersion using between 6 and 10 identical full range drivers in a single vertical enclosure. However, a vertical column represents the worst possible physical dimensions for a centre channel as it would obviously obscure the screen. Vertical columns may be good for churches, not so good for home theatre.

A typical centre channel employing two symmetrically positioned bass drivers can be considered as a small column array lying on its side. This would suggest that the loudspeaker will provide broad vertical dispersion with a narrow horizontal spread; exactly what you do not want from a centre channel.

Lower frequencies are generally less directional than higher frequencies, so the bandwidth over which the bass drivers are required to play must be considered. The higher the frequencies the bass driver is required to produce, the greater the likelihood of 'beaming' affecting the output. Beaming is commonly used to describe the effect of constructive and destructive interference caused by differences in path length between acoustic sources (drive units) and a receiver (your ears). When these path differences are similar in length to the wavelength of the sound being produced, the directivity pattern will exhibit lobes and nulls (peaks and dips), as shown in figure 3 on the next page. The strongest lobe will be directed forward with a null on each side. As frequency increases and the wavelength of sound gets shorter, more and more lobes and nulls will be produced, but always with the strongest lobe directed forward, thus the term beaming.

In addition, beaming occurs at lower frequencies the further apart identical drive units are placed. By using a single drive unit the distance between units is removed and the effects of beaming are eliminated over the bandwidth of the driver.

Figure 1 Majik 112 Front Elevation

TWIN VS SINGLE

Two models have been generated using acoustical simulation software to follow the topologies presented in figure 2 below. The simulation of each of the designs includes the crossover and relative dimensions and locations of the drive units. For use in the Majik 112 centre channel loudspeaker it is required that the bass / mid driver extends up to ~1.6 kHz in order to join correctly to the 30mm unit in the 2K array. For simplicity, the models consider only the response of the bass drivers.

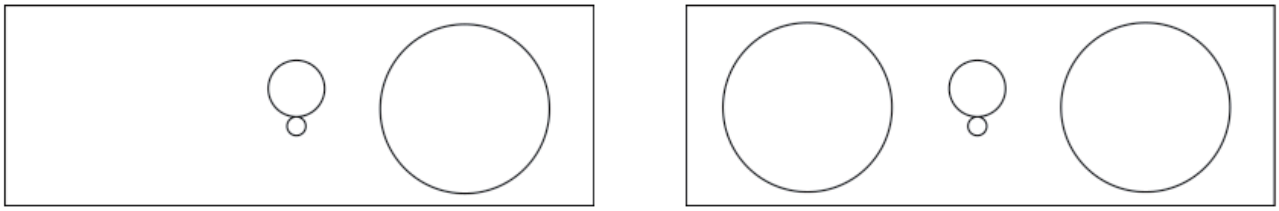

Figure 2

The model has been used to produce directivity plots for the simulated loudspeaker systems. Ideally, the response should be uniform across the usable range of the drive units in order to provide good horizontal coverage from the centre channel.

The first plot (figure 3) shows the horizontal radiation pattern for the twin bass driver model indicating the dispersion at 400 Hz, 800 Hz and 1.2 kHz.

At relatively low frequencies the radiation pattern is quite uniform, suggesting the two bass driver system will provide good horizontal dispersion at or below 400 Hz. At frequencies above this the model demonstrates that the system will exhibit a comb filter effect with obvious peaks and dips (lobes and nulls) in the response depending on the listening angle. Listener 2) is positioned in the 'sweetspot' and receives all frequencies at the same amplitude; listeners 1) and 3) do not. In fact, at these positions there is a -6 dB difference for the 800 Hz and 1.2 kHz frequencies.

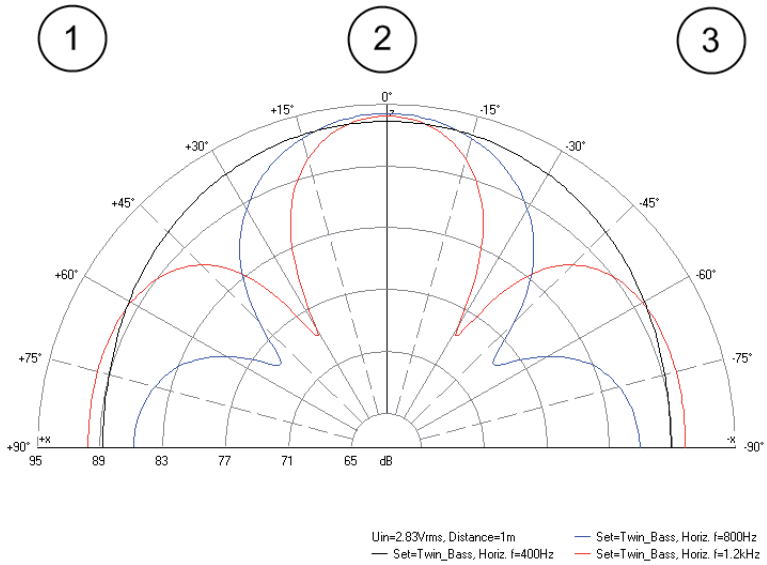

Figure 3

The second plot, figure 4, shows the horizontal radiation pattern of the single bass system design.

It is clear that the effects of constructive and destructive interference are no longer present and a uniform horizontal coverage will be achieved with this design. All three listeners receive all frequencies at the same amplitude.

Two points of interest in figure 4 (in comparison to figure 3) are the lower maximum output amplitude and the left-hand bias to the radiation pattern. These are of little concern to the final design for the following reasons:

The overall output level has been reduced in line with the reduction in radiating surface area (one driver instead of two). For a centre channel loudspeaker employing two bass drivers it is likely that the input signal to the two bass units would need to be reduced to better match the efficiency of the

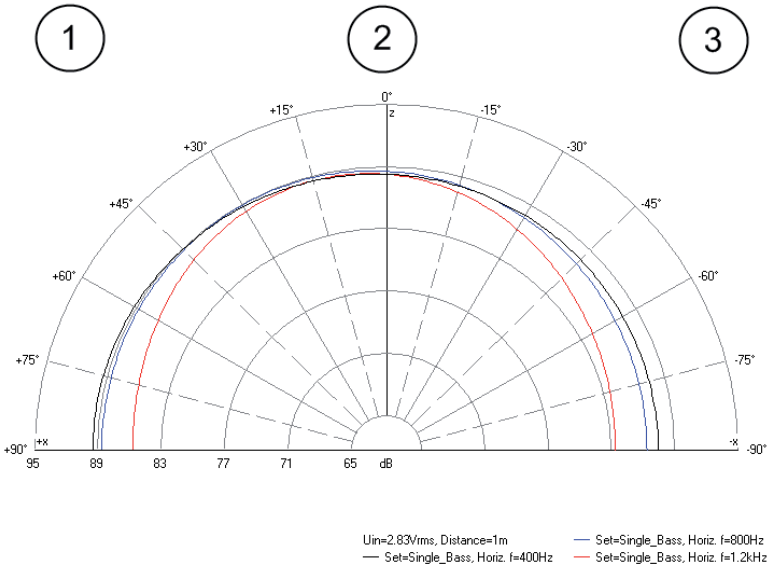

Figure 4

Figure 2 Acoustic Models - Single vs. Twin
Figure 3 Twin Bass Driver Radiation Pattern
Figure 4 Single Bass Driver Radiation Pattern

tweeter(s). This is usually achieved by inserting resistors into the passive crossover, adding noise to the signal and reducing playback quality.

The output is indeed shifted slightly to the left, due to the bass driver being located nearer to one end of the cabinet. However, most localisation cues are derived from high frequencies; provided the tweeter(s) is centrally located, it is highly unlikely that the perceived acoustic centre will drift. This is further reinforced by the likely inclusion of visual cues supplied by a screen, which tend to overwhelm most auditory cues in human perception.

CONCLUSION

There is compelling evidence in favour of the single bass/mid driver design where the bass drivers are required to present the audible signal above 400 Hz. Majik 112 is a practical application of this technology which produces exceptional dispersion characteristics and is balanced aesthetically by a front-firing bass reflex port (both concealed by grilles).

Figure 5

Appendix: Akurate 225 and Klimax 320 centre channel loudspeakers

Both the Akurate and Klimax centre channel loudspeakers employ symmetrically loaded bass systems. In these systems there is no issue with constructive and destructive interference between the two bass drivers due to the low crossover frequency to the 3K array. In both systems the bass drivers deliver content up to a crossover frequency of approximately 360 Hz. It is clear from the plot presented in figure 3 that dispersion below this frequency will not be influenced by mutual interference of the bass units.

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