WIDE DISPERSION LOUDSPEAKERS

Their Characteristics and Measurement
Model WD-1

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October 2011

Summary

Modern research into psychoacoustics involving listener preferences has highlighted the need for loudspeaker dispersion to far exceed that available from traditional forward firing designs.

A modern design is presented, similar to ideas originating in the 1970's.

This work is intended to concentrate on normal stereo listening environments not used for monitoring purposes. It is now clear that professional listeners in monitoring environments have a consistent preference for loudspeakers with limited dispersion.

1. INTRODUCTION

Wide dispersion loudspeakers can be designed to cover a full 180 degree angle with an essentially flat response in the horizontal plane over their full range.

The initial product in this range, Model WD-1 is designed to be placed with its back against a wall either mounted on a rear plate or on a suitable stand.

This may be regarded as an extreme approach to improving stereo reproduction but the advantages are quite significant as follows:

1. Increased early reflections in the room, from appropriate directions, are known to enhance the feelings of spaciousness (envelopment) in the music.

2. Specially designed wall mounted loudspeakers help to eliminate damaging room effects in the bass and lower mid range region. Bass is gently enhanced, without boominess, and some dips and peaks due to room modes are reduced to tolerable levels.

3. As multiple drivers are used, performance is also enhanced in other areas i.e. lower distortion.

2. MEASUREMENT TECHNIQUES

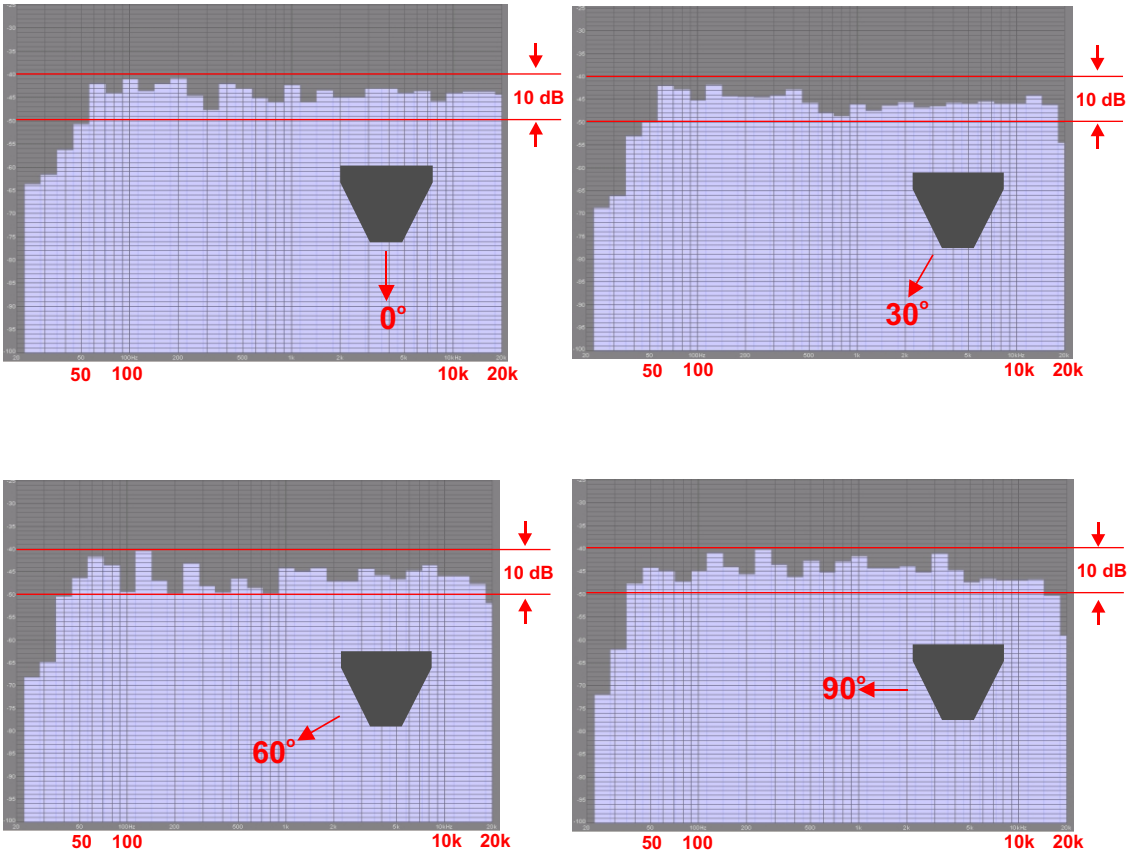
In room 1/3rd octave real time frequency response measurements are used initially.

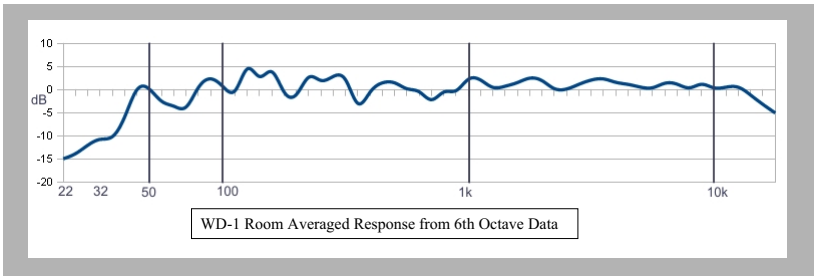
In addition, the analysis of impulse testing is used to verify whether or not a flat response is obtained as reflections buildup in the room.

This is because the main audible difference between wide dispersion loudspeakers and normal loudspeakers appears to be due to a different balance between direct and reverberant sound.

The room used was a normally furnished sitting room with a large window at one end, fitted with half drawn curtains. Approximate dimensions were 4 x 5 x 3 m, (width x length x height) and a mean path length of 2.25 m.

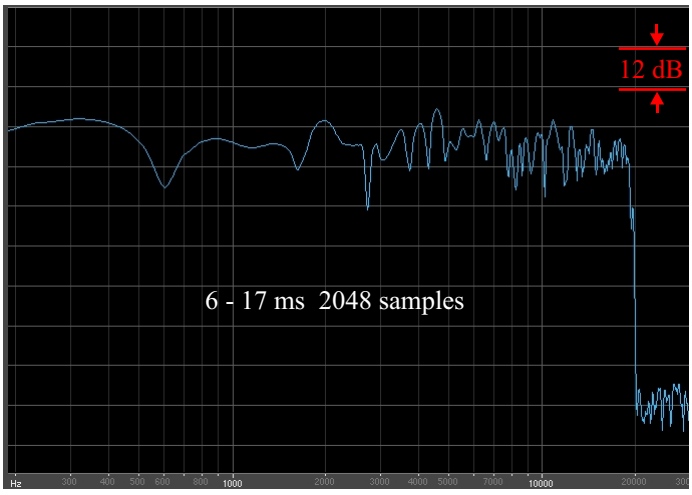
3. FREQUENCY RESPONSE MEASUREMENTS

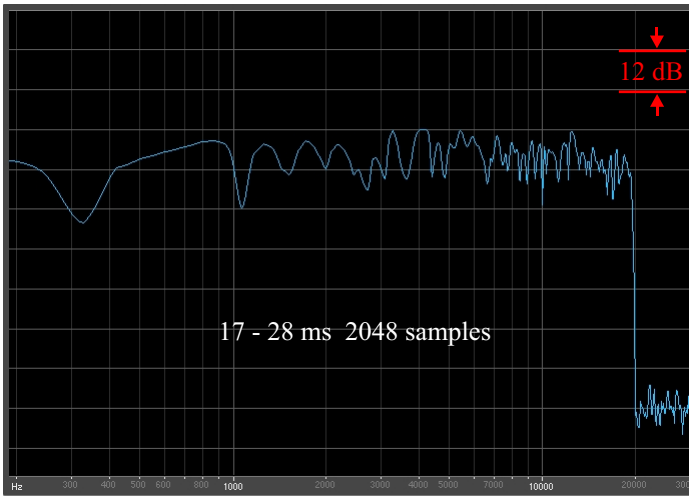


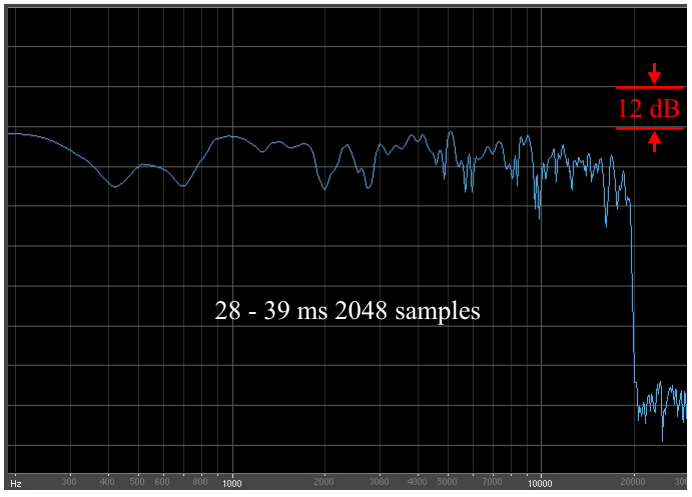


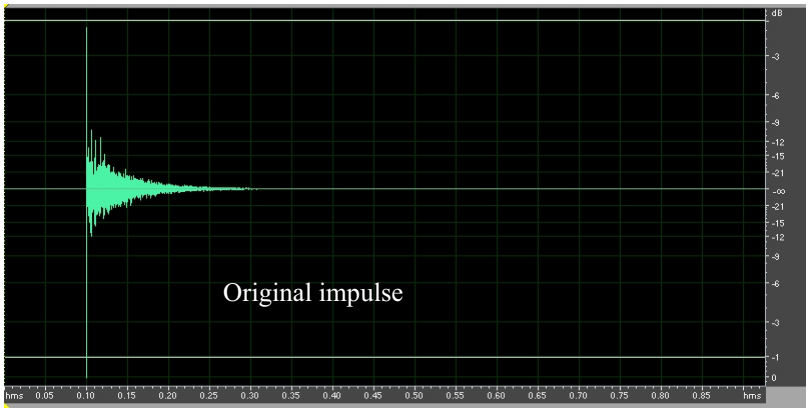
Response measurements on this page, except the room averaged plot, were made at a normal listening distance of 1.8 m with the loudspeaker wall mounted.

4. IMPULSE FREQUENCY RESPONSE ANALYSIS









Impulse response analysis for model WD-1.

These plots show the similarity of frequency response as reflections build up and decay away.

With most tone bursts, the steady state is reached to within 3 dB in 30 - 50 ms.

5. ESSENTIAL RELATED RESEARCH

A few definitions:

Spaciousness (= envelopment) is the perception of being surrounded by a large and enveloping space.

Apparent Source Width (= image broadening) is the perception that a sound source is wider than the imagined physical extent of the source. This often occurs with certain types of recording techniques using spaced microphones usually preferred for large orchestras.

Diffusion is the property of a physical sound field. Perfect diffusion in a room would require sound to arrive from all directions with equal probability. This is a concept required by mathematical models of room behaviour including reverberation time. It is poorly approximated using normal loudspeakers in listening rooms.

Listeners and their Preference for Reflections

Listening to recordings of music outdoors is not realistic and therefore not an enjoyable experience. Neither is listening to music in a room over treated with absorption.

We somehow need the reflective confines of a room to help return a feeling of spaciousness to an often dry stereo recording.

Ando (1977) has provided some information concerning how much lateral reflections are preferred by listeners using both speech and music. Figures 1 and 2 below show the results.

Figure 3 shows an estimate of an "equal effect contour" relating to spaciousness and image broadening and the direction of 1st reflections. (Hikada, 1997)

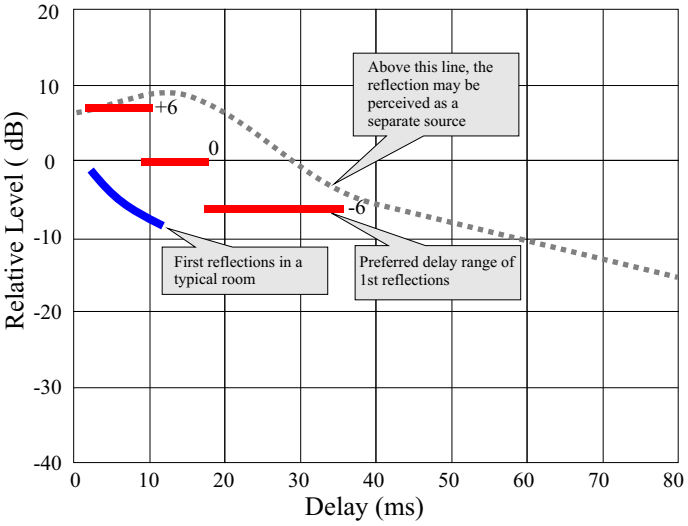


Figure 1

*Preferred levels of added first reflection with **speech** as the signal source. (Ando, 1977)*

Below the dotted line, all direct and reflected sounds are fused into one source (Barron, 1971).

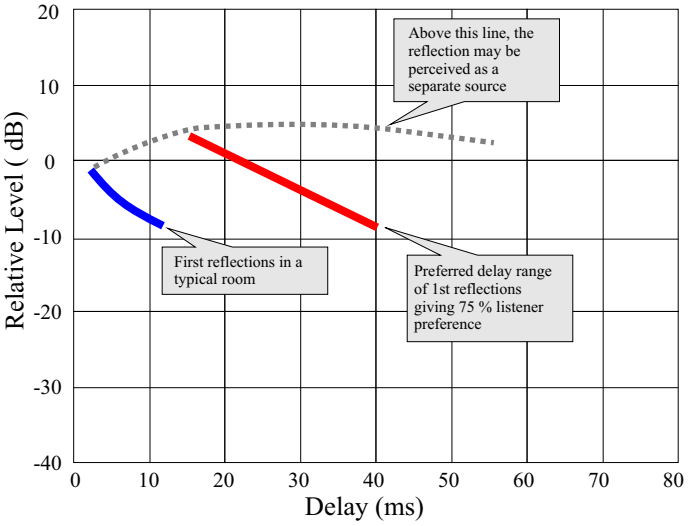


Figure 2

*Preferred levels of added first reflection with **music** as the signal source. (Ando, 1977, 1985)*

Below the dotted line, all direct and reflected sounds are fused into one source. (Barron, 1971)

Audible Effects of Loudspeaker Dispersion Patterns

Moulton (1986) performed listening evaluations of forward firing designs compared with wide dispersion designs.

It was concluded that "with stereophonic omnidirectional playback systems, the musical essence of the sound seems more palpable, more enduring, and more directly accessible than we have experienced with other loudspeaker systems."

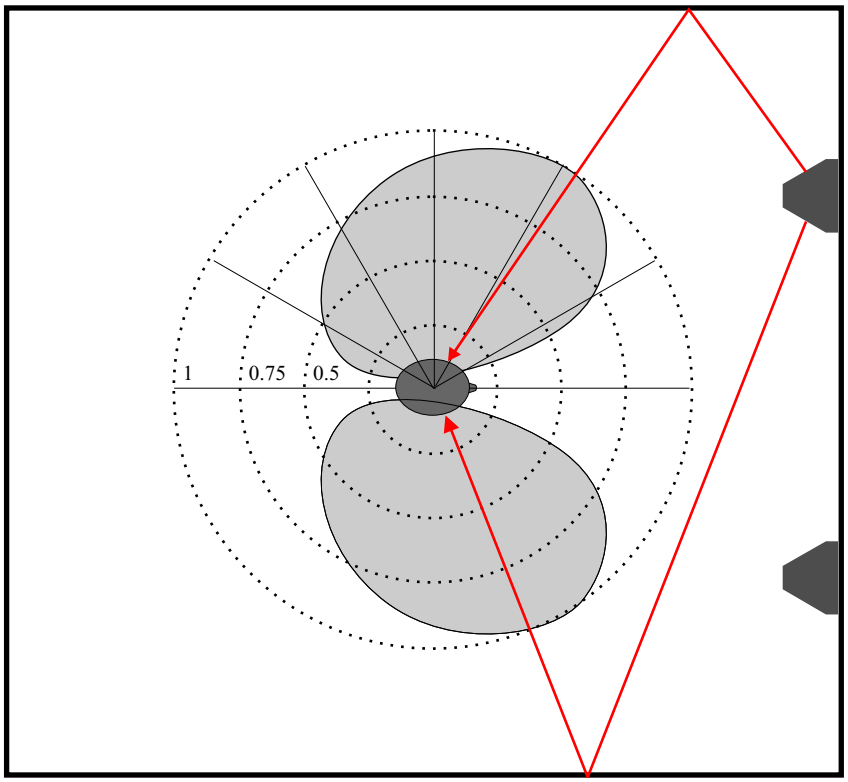


Figure 3

"Spaciousness / image broadening balloons" show the relative effectiveness of side reflections.

Note the wall mount WD-1 loudspeakers give optimum outputs for maximising reflections. (Hikada 1997)

Note that delays less than 80 ms with frequencies above 500 Hz cause image broadening, delays greater than 80 ms and frequencies from 100 to 1000 Hz give feelings of envelopment.

Moulton again (1995) stated "It appears that broad horizontal dispersion, with the engagement of a specularly responsive set of side walls, yields preferred sonic qualities for the stereophonic playback of music, both in terms of spectral accuracy and also in terms of stereophonic illusion, image and entertainment quality."

Toole quotes (ref. 1 page 139), "The results (from a wider discussion of similar evidence) discussed here all point in the same direction: that wide dispersion loudspeakers, used in rooms that allow for early lateral reflections, are preferred by listeners especially, but not exclusively, for recreational listening.
There appear to be no notable sacrifices in the "imaging" qualities of stereo reproduction."

These conclusions are based entirely on typical peer reviewed double blind psychoacoustic tests of the highest standard.

5. SUMMARY

The wall mounted model WD-1 is capable of truly omnidirectional dispersion as indicated by both room steady state measurements and the analysis of direct and early reflections.

Our own listening experiences indicates that there is an easily noticed change in the presentation of music when compared with forward firing loudspeaker designs.

This agrees with the evidence and arguments presented in the references and short extracts presented above.

Discerning audiophiles should set aside any previous concerns relating to reflections and combing effects and the degradation of imaging and seriously consider this different approach.

Finally, we will stress again that the above is unlikely to apply to professional monitoring situations and some listeners will always prefer monitor style loudspeakers in any situation.

Also, serious multichannel music reproduction will undoubtedly benefit from wide dispersion loudspeaker designs.

5. REFERENCES

Reference 1, Toole Floyd E., "Sound Reproduction, The Acoustics and Psychoacoustics of Loudspeakers and Rooms" *Focal Press (2008/9)* ISBN 978-0-240-520094

An excellent and comprehensive book of the state of the art. Should be on all audiophiles bookshelf.

Ando, Y (1977). "Subjective Preference in Relation to Objective Parameters of Music Sound Fields with a Single Echo" *J. Acoust. Soc. Am.*, pp. 1436 - 1441.

Ando, Y (1985). *Concert Hall Acoustics,* Springer Verlag, Berlin.

Barron, M (1971). "The Subjective Effects of First Reflections in Concert Halls - The Need for Lateral Reflections," *J. Sound Vib.,* 15, pp. 475 - 494.

Hikada, T., Beranek, L. L., and Okano, T. (1997) *Some Considerations of Interaural Correlation and Lateral Fraction as Measures of Spaciousness in Concert Halls.* Chapter 32 in *Music and Concert Hall Acoustics*, Ando, Y., and Noson, D. editors, Academic Press, London.

Moulton, D., Ferralli, M., Hebrock, S., and Pezzo, M., (1986) "The Localisation of Phantom Images in an Omnidirectional Stereophonic Loudspeaker System," 81st Convention, *Audio Eng. Soc.,* Preprint 2371.

Moulton, D., (1995) "The Significance of Early High Frequency Reflections from Loudspeakers in Listening Rooms," 99th Convention, *Audio Eng. Soc.,* Preprint 4094.