OHM C2

DESIGN AIM

Several years ago, while perfecting the now-famed Walsh Transmission Line Loudspeaker, Ohm engineers initiated an intensive investigation into transducer behavior. By combining the results of this investigation with their study of the latest filter synthesis design techniques, they believed it possible to engineer a bookshelf loudspeaker of unprecedented performance. Specifically, their knowledge indicated that new standards for accurate, wide-range frequency response, efficiency, low distortion (including time-delay distortion) and high power handling ability were now feasible in a reasonably-priced loudspeaker.

FORMAT

The Ohm C2 is a three-way optimally vented loudspeaker of typical bookshelf dimensions. Drivers are of the moving coil principle and are mounted on the front panel. The decidedly unconventional design of the bass system and the complementary characteristics of the low and high tweeters combine to achieve an overall level of sonic accuracy beyond what was previously believed to be practically possible in a frequency-divided system employing piston-type drivers.

ABOUT OPTIMAL VENTING

Until recently, the serious speaker engineer designing a reasonably-sized system with extended, accurate bass response had no choice but to utilize the acoustic suspension (sealed system) approach. The mathematics for designing such systems were generally known and yielded predictable results. Any attempts to design an equally accurate, but more efficient vented system of similar proportions were doomed from the start. This is because the existing mathematics of vented systems were not wholly descriptive of the interaction between woofer, enclosure, and vent.

Then, in 1961, Australian electrical engineer A. N. Thiele recognized the similarities between the behavior of high pass filter circuits and that of vented loudspeakers. Using dynamical analogy techniques and network theory, Thiele derived a highly theoretical equation. From this equation, 28 sample "alignments" were discussed linking the various parameters of the vented system together. These alignments describe the precise qualities necessary to optimize woofer to enclosure and vent characteristics in order to achieve predictable bass response. Later, Thiele's 28 alignments were distilled into a more rigorous academic format by another Australian, Dr. Richard Small, professor of electrical engineering at the University of Sydney, Australia.

Thus, the tools for designing predictable, accurate vented loudspeakers have existed for some time, but because they were so difficult to grasp, they were largely ignored. The optimally-vented loudspeaker has significant advantages over an equivalent sealed system. These include:

- **A 10dB increase in output capability**
- **Lower harmonic distortion**

Plus:

- **A 4 dB improvement in efficiency, or**
- **A 2/3 decrease in enclosure size, or**
- **1/2 octave more bass.**

Partial combinations of the above are also possible.

These advantages are so compelling that the majority of new offerings from the more advanced loudspeaker manufacturers make some attempt to utilize filter theory. But designing an optimally-vented system correctly is more than a simple matter of adapting existing hardware to the new techniques. To design a vented system that performs in perfect accordance with theory requires experience in such fields as mathematics, electrical engineering, and applied filter theory. Very few speaker designers are so equipped. Fortunately, the Ohm Acoustics engineering staff has broad practical experience in these (and other) disciplines. It is no surprise then, that the bass performance of the Ohm C2 stands as singular confirmation of the applicability of filter theory as originally stated by A. N. Thiele.

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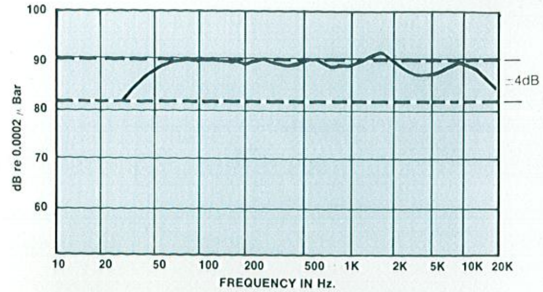


Figure 1:
⅓ octave band front hemisphere response

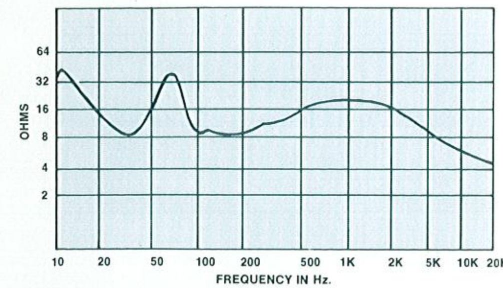


Figure 2:
Impedance vs. frequency

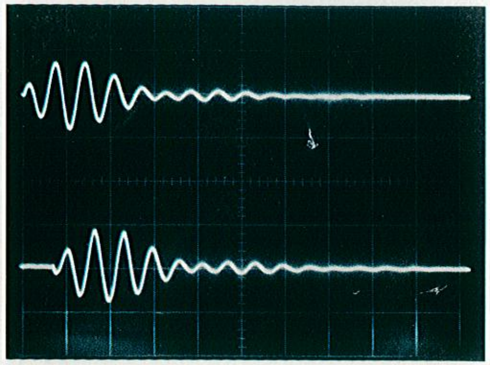


Figure 3:
300 Hz. pulse response, 1W. input. Top trace input, bottom trace C2 output.

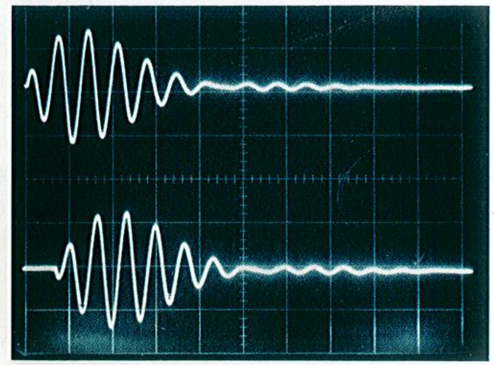


Figure 4:
300 Hz. pulse response, 250 W. input. Top trace input, bottom trace C2 output.

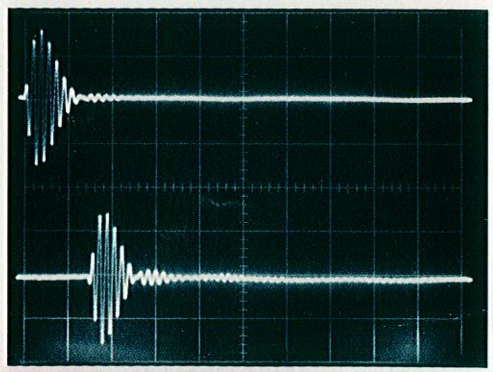


Figure 5:
3000 Hz. pulse response, 1W. input. Top trace input, bottom trace C2 output.

LEVEL (dB) RE 0.0002 MICROBAR	FREQUENCY			
	80 Hz.		300 Hz.	
	% 2nd	% 3rd	% 2nd	% 3rd
70	.09	.2	.01	.45
75	.1	.3	.02	.55
80	.25	.35	.09	.65
85	.3	.45	.16	.75
90	.5	.43	.35	.85
95	1.1	.55	.65	.95
100	3.3	.9	1.0	.85
105			1.4	1.1

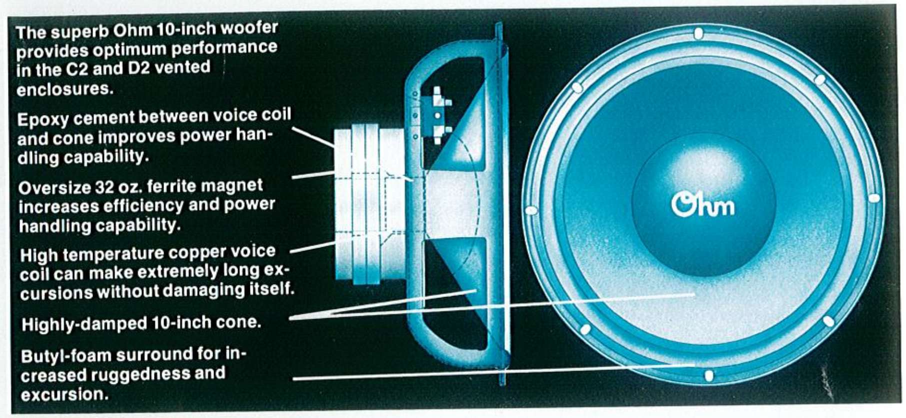
Figure 6:
Harmonic distortion vs. 1 meter sound level (90 dB equals 1 watt input).

ABOUT TIME-DELAY DISTORTION

Time Delay Distortion occurs naturally in a standard frequency-divided system when the fundamental musical tones produced by the woofer reach the listener's ears slightly *later* than the upper harmonics produced by the mid-range (if present) and tweeter. The problem is compounded by typical crossover network design which actually puts the drivers *out of phase* at the crossover points. The result is vaguely "canned" sound and loss of precise imaging. It is interesting to note the recent proliferation of "time-aligned" loudspeakers, many using exotic staggered enclosures (in an attempt to get the woofer closer to the listener's ears) from manufacturers who've just "recognized" time-delay distortion. Ohm acoustics engineers were designing such systems nearly a decade ago. They were among the very first to identify and resolve the time-delay distortion problem and they've managed to achieve remarkably low time-delay distortion in the Ohm C2 *electrically,* without resorting to odd cabinet configurations.

THE WOOFER

Key to the performance of the Ohm C2 is a well-made, but rather ordinary appearing, 10″ woofer. Despite the conventional



appearance, its performance is extraordinary. The Ohm 10″ woofer covers a range which encompasses the fundamental frequencies of virtually *all* musical instruments—a full 5½ octaves from 37 to 1700 Hz.

Ohm engineers began with a Thiele alignment designated Quasi Third Order Butterworth and, drawing upon Walsh technology, designed a highly-refined 10″ piston woofer precisely optimized to enclosure and vent. This driver features a long-throw copper voice coil edge wound on an aluminum bobbin designed to operate at temperatures that would melt ordinary voice coils. Powered by a massive 2 lb. ferrite magnet, this 1½″ voice coil operates in an unusually narrow gap. The result is amplifier control over cone motion that is unexcelled by any other piston-type woofer known to Ohm Acoustics. Another benefit is the quick impulse response (acceleration) of the driver cone, so that musical attacks—from deepest bass to lower treble frequencies—are crisply and sharply delineated.

The typical woofer behaves not only as a piston, but also as a "bad" transmission line. This means sound waves produced at the apex of the cone by the voice coil flow along the surface of the cone. These waves hit the surround and rebound back up the cone towards the voice coil. This causes *standing waves* and other undesirable effects, including erratic dispersion. The audible result of standing waves is slightly ragged and smeared sound.

Another problem in conventional woofer design is caused by the concentric rings imprinted on the cone surface to increase stiffness. These rings can cause spurious resonances which add coloration and degrade transient response.

Standing waves are sharply reduced in the Ohm 10-inch woofer with techniques borrowed from the Walsh technology employed in the Ohm F. The cone of the Ohm 10-inch woofer is *properly terminated.* Upper frequencies are absorbed by the cone material itself before they reach the surround. The desired degree of cone stiffness is accomplished with a smooth cone material that is not segmented by concentric rings. Accurate frequency response throughout the upper midrange and lower treble frequencies is assured because the cone material rolls off smoothly and evenly at the point where the low tweeter is rolled on. These factors help explain why the performance of the Ohm 10-inch woofer equals or surpasses that of the most advanced midrange drivers.

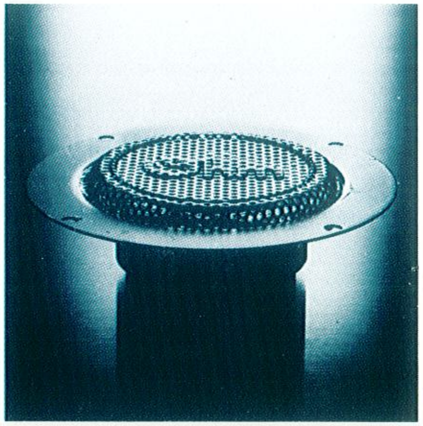
While the extremely tight coupling between the Ohm 10″ woofer and the amplifier results in undiminished clarity at very low volume levels, the ultimate power handling ability of the driver is prodigious. As employed in the C2, maximum woofer excursion occurs just below 70 Hz. Below that frequency, the output of the vent predominates to the 3 dB down point of 37 Hz., with harmonic distortion figures averaging half those obtainable in an equivalent sealed system.

THE CROSSOVER NETWORK

The drivers in the Ohm C2 are so well matched to each other that a typically complicated crossover network is not necessary. Instead, a very advanced, yet exceedingly simple, Phase Consistent crossover network is used. The Phase Consistent crossover network brings in the low tweeter at 1700 Hz. and the high tweeter at 5000 Hz. at the rate of 6 dB/octave. Since Ohm drivers do not have spurious output above their assigned frequency ranges, no electrical rolloff is used. The upper operating range of all drivers is unrestricted, thus insuring superior phase response. A three-position treble contour switch (labeled 0dB, −3dB, −6dB) of unusually precise response characteristics is provided to suit room acoustics and personal taste.

THE LOW TWEETER

The low tweeter employed in the Ohm C2 is the same resonance-free 2″ phenolic ring unit used in the more expensive Ohm H. Its impulse response characteristics are meticulously matched to those of the woofer and high tweeter to minimize time-delay distortion. It is characterized by excellent power handling capability and very linear on-axis response from



1700 Hz. to the limits of audibility. This tweeter has a 3-oz. ferrite magnet and 5/8″ voice coil.

THE HIGH TWEETER

The high tweeter is a refined 1″ polycarbonate dome, as used in Ohm's most expensive conventional loudspeakers. Its purpose in the C2 is to insure broad dispersion of the highest frequencies from 5000 Hz. to beyond the limits of audibility. Its large ferrite magnet and 1″ voice coil mean exceptional efficiency and power handling capability. It handles powerful bursts of high frequency material cleanly and effortlessly.

THE ENCLOSURE

A well-designed vented system requires an enclosure of uncommon structural integrity to avoid spurious resonances. The enclosure of the Ohm C2 is constructed of 3/4″ compressed flakeboard, a material inherently more resonance-free than ordinary plywood. Elaborate internal cross bracing further assures resonance-free performance. The enclosure, including baffle board, is hand finished in genuine oiled walnut veneer. Even the rear of the enclosure is finished in black formica, so the C2 presents a handsome appearance when viewed from any angle. And the grill cover is an attractive black double knit material, chosen both for its appearance and acoustic transparency. It is held in place with Velcro fasteners for easy removal.

PERFORMANCE

In actual home use, the Ohm C2 is compatible with amplifiers from 10-15 watts RMS in small to medium sized rooms where very high listening levels are not required. But thanks to its robust construction, the C2 also acquits itself well with "superamps". And because of the C2's very stable 8 ohm impedance, it is an excellent choice for multiple speaker installations.

The accompanying graphs indicate a loudspeaker of high performance capabilities, an impression that is certainly borne out in the listening. Because of *scientific design,* the Ohm C2 achieves a level of musical accuracy that simply defeats the most well-known loudspeakers within several hundred dollars of its price.

MAJOR SPECIFICATIONS

Size:
25" x 14" x 9¾" deep

Drivers:
10" woofer, 2" low tweeter, 1" dome high tweeter

Crossover frequencies:
1700 and 5000 Hz.

Enclosure:
Ducted port (Quasi-Third Order Butterworth filter)

Frequency response (minimum spec):
37-20,000 Hz. ±4dB on axis;

Impedance (IEEE):
40 to 8/6 ohms

Controls:
3-position tweeter attenuator, 3dB per step.

Approximate shipping weight:
45 lbs.

Due to possible design evolution, specifications are subject to change without notice.

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