



The Venue Loudspeaker

The author maintains that, with this loudspeaker, you hear instruments as the solid 3D objects that they are, in precise focus, surrounded by a spherical “night sky” shell of natural venue ambience.

By Dennis Colin

Some of you might remember the so-called “3D” comic books of the 1950s, with red and blue stereo glasses. I say “so-called 3D” because the images weren’t rounded and solid, but rather like flat sheets of cardboard. The only thing 3D about these images was the depth separation between the “cardboard cutouts” and the equally flat background.

So it is with many conventional (forward-only radiating) speakers. They may have the flattest frequency response, lowest distortion, and most precise imaging this side of Mars; instrument sounds could be completely realistic. But those images still sound physically flat, like those “3D” comic book “cardboard sheets.” Like sitting inside giant headphones.



PHOTO 1: The Venue full-range bipolar speaker.

DESIGN PHILOSOPHY

The Venue (**Photos 1 and 2**) could be described as a coherent, full-range bipolar speaker. It is *not* (and not intended to be) an omnidirectional radiator; such units spread too much playback room acoustics.

But in a room with reasonably good and well-damped acoustics, of at least 2000ft³ volume, the Venue’s controlled upward-angled full-spectrum rear output stimulates an optimum amount of well-dispersed room ambience, which accomplishes two things:

1. Recorded venue ambience (concert hall long-delay reverberation or intimate nightclub ambience) is heard coming from all directions, because

(a) it is

(b) the time-blended lack of transients doesn’t allow Haas (precedence) effect localizing of this recorded ambience at the speaker positions or their



PHOTO 2: The Venue features upward-angle rear output.

horizontal stereo image plane, whereas the moderate amount of this room stimulation doesn’t interfere with the direct (forward) image precision. Rather, the latter is reinforced, making the direct soundstage images sound 3D solid, as the following shows:

2. Images sound like real sound sources because of “ray tracing”: Since the rear speaker output is spatially and (reasonably) time coherent with the front output, the arrival angles of ambience reflections are consistent with the locations of the direct image soundstage positions. This is analogous to reflections and shadowing of sunlight reinforcing the sun’s position in the sky.

ADDITIONAL DESIGN FEATURES

1. High quality drivers: 10” Scan-Speak woofer in sealed enclosure, 5” Focal midranges (front and back) in sealed compartment, and 1” Morel soft-dome tweeters (front and back).

2. Close spacing of all five drivers with tapered enclosure top, approximating a coherent spherical radiator, but with controlled (yet wide) dispersion.

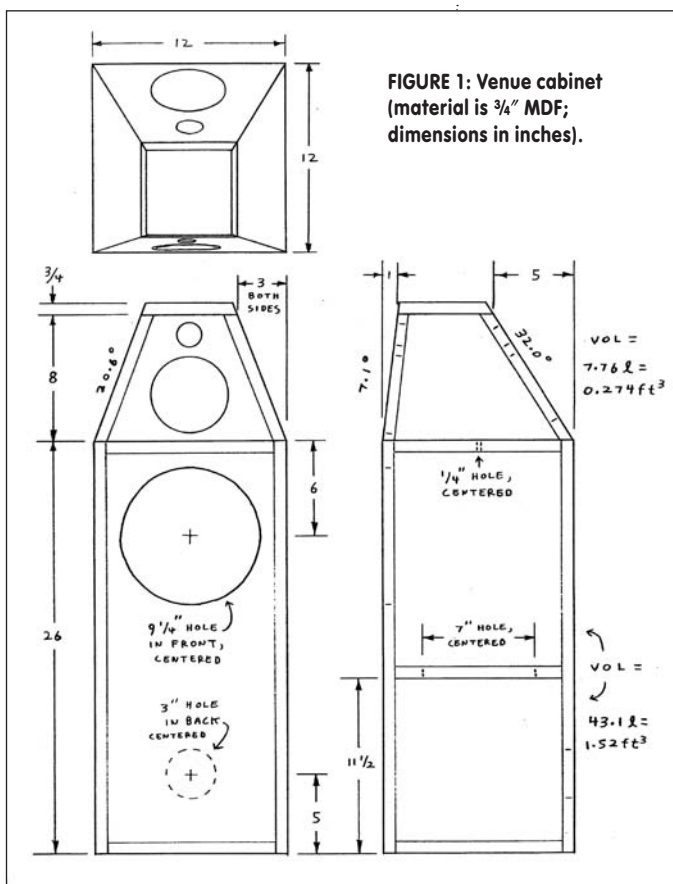
3. Angled and tapered cabinet top for smoothest dispersion and minimum diffraction.

4. First-order phase-preserving woofer/mid crossover (co) and quasi-third-order mid/tweeter co. Speaker transient response is time-coherent to within 200μs (**Fig. 18**).

5. Frequency response both anechoically and in a good room is smooth and with good bass extension (**Figs. 8 and 9**).

6. Power handling is high (about 200W typical music) and distortion is low even with deep bass.

7. Overall coherence: The woofer/mid co frequency is about 220Hz, meaning that the rear mid/tweeter combination rolls off (smooth first order) below

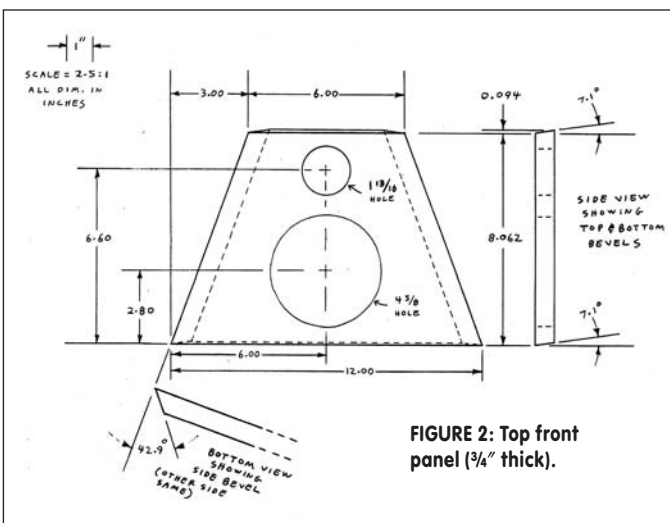


that frequency. However, below about 220Hz the woofer's output becomes nearly omnidirectional, reaching behind the enclosure to fill in where the rear midrange starts to roll off.

Thus, both the direct and rear outputs are full spectrum.

THE SOUND (IN A GOOD ROOM)

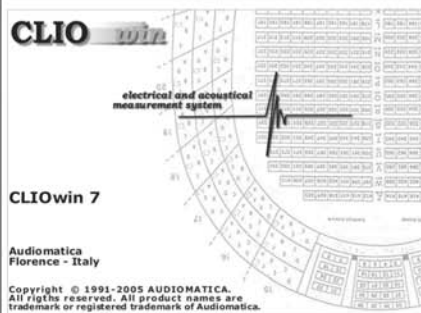
You hear images that not only have excellent tonal accuracy (my personally most important speaker criterion), but also sound very much like real musical instruments and voices—solid sound sources precisely located in their original ambient venue—hence the name.



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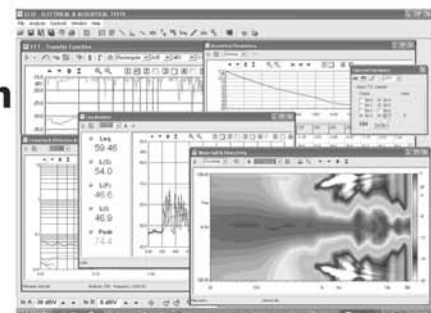


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ENCLOSURE DESIGN

I first built a full-size cardboard model, cutting the tapered pyramid top pieces by trial and error. The top angles are different—front, side, and rear; so I had hoped the cabinetmaker could figure out the bevel angles by experiment.

Wrong—he asked me to precisely calculate them! [expletive deleted], I thought!

So I spent a full day resurrecting my high school trigonometry memories, finally arriving at all the angles and dimensions. Some notes:

1. I recommend sealing all internal

wood joints with silicone rubber—particularly the top of the woofer enclosure, to prevent woofer back pressure from leaking into the midrange/tweeter compartment. You should test this by driving the woofer with about 30W at 20Hz (13.4V RMS across its $\approx 6\Omega$); feel the midrange cones to make sure they're barely (at most) moving.

2. Use 1 lb. of

Acousta-Stuf damping in the woofer compartment; pack as much as possible into the upper chamber.

3. When performing step 1's leakage test, also check for any signs of leakage to the outside—listen for any “puffing” sounds and feel around the entire enclosure for any air leakage.

4. For those who prefer flush-mounting the drivers, the countersink depths are 3mm (tweeter), 5mm (midrange), and 6mm (woofer).

Figures 1-5 show the detailed cabinet construction. **Figure 6** is a mounting template for the midrange and tweeter. Note: The scale values shown in **Figs. 1-6** are not correct; my original drawings have been reduced for publication.

CROSSOVER

Woofer = Scan-Speak 25W/8565-01,

43 ltr sealed

Midranges = 2—Focal 5W 4211,

7.7 ltr sealed

Tweeters = 2—Morel MDT40

Woofer: 1st order co (L1), zobel (C1, R1)

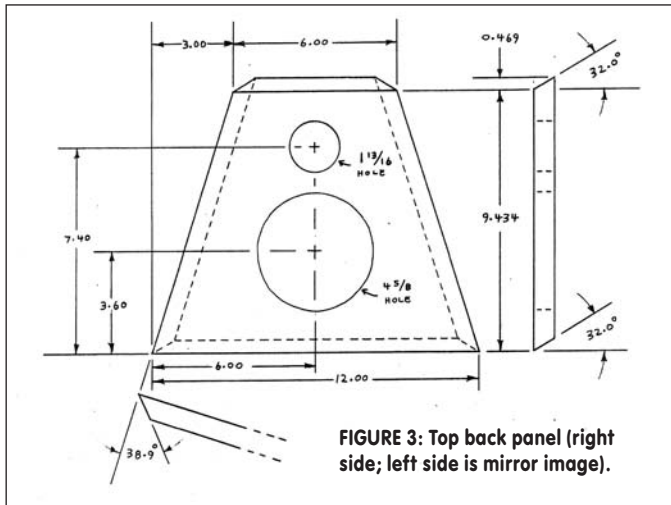


FIGURE 3: Top back panel (right side; left side is mirror image).

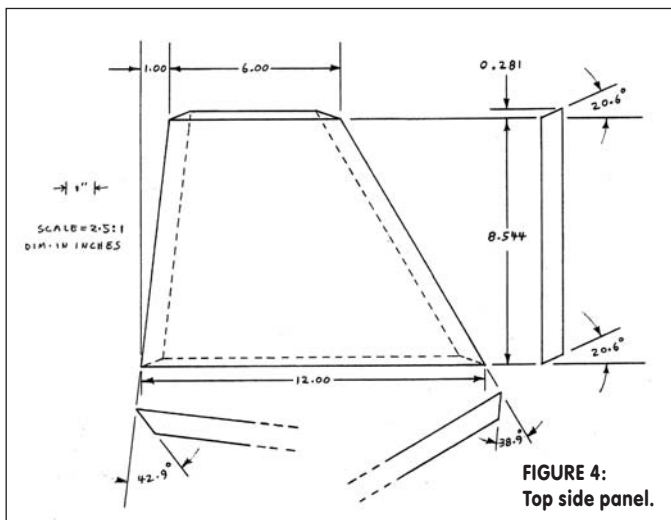


FIGURE 4: Top side panel.

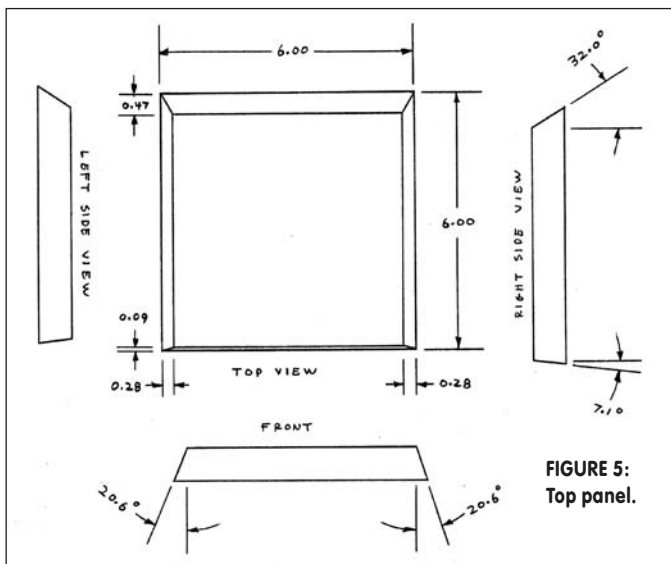
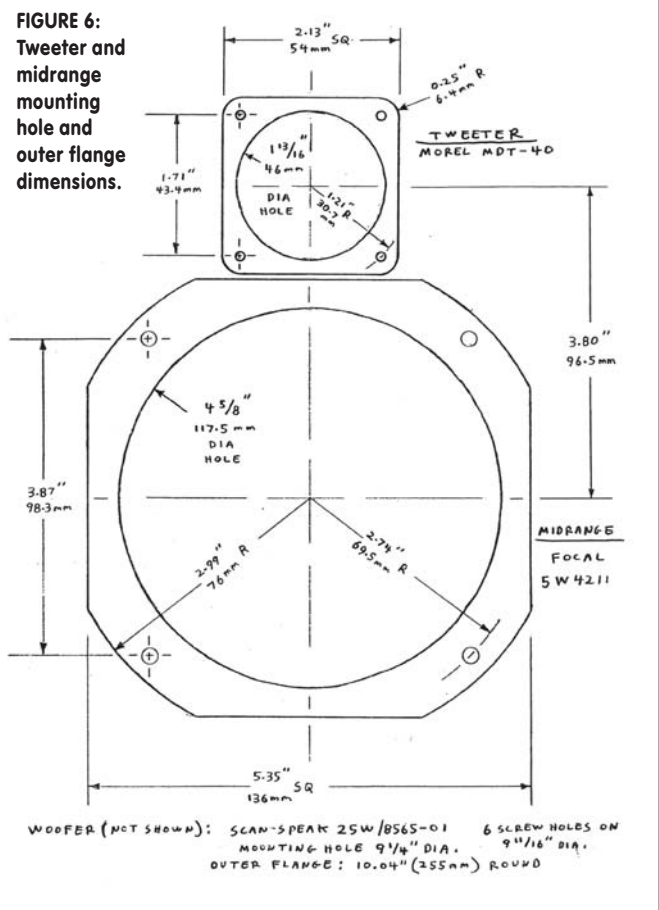


FIGURE 5: Top panel.



- Midrange: 1. 1st order LF co (C2)
 2. Damping of 85Hz Z peak (R2, L2; also R4)
 3. 1.1kHz dip (L3, R3, C3);
 -5dB, half octave at -2.5dB
 4. 2nd order (elect) HF co (L4, C4)
 with R4 damping
 Acoustical slope $\approx$ 16dB/octave
- Tweeter: 1. 2nd order (elect) co (C5, L5);
 acoustic $\approx$ -16dB/octave
 2. 5dB attenuator (R5) with
 20kHz boost (L6, C6)
 3. Zobel (R6, C7)
 4. 6kHz dip, -2dB (R7, L7, C8)

- Notes: 1. Woofer/mid co at 220Hz,
 -2.5dB re acoustic sum
 2. Mid/tweeter co at 2.5kHz,
 -5dB re acoustic sum

MEASUREMENTS

Quasi-anechoic on-axis response at 4', mike 37" high, performed by Joe D'Appolito. Anechoic $f_{-3} = 37\text{Hz}$ (Fig. 8).

RTA in 2000ft³ live room (Fig. 9). For room photo and dimensions, see "Stereo Subs for the Swans M1," *aX* Sept. '05, Photo 2 and Fig. 1 (pp. 6, 8). Note that f_{-3} is 27Hz; 20Hz is only 7dB down.

Composite of three in-room measurements (Fig. 10).

Acoustic co responses (Fig. 11).

Electrical co responses (Fig. 12).

Impedance magnitude and phase (Fig. 13), courtesy of Joe D'Appolito.

Note that the impedance reaches lows of 2.77Ω at 400Hz at 19kHz, and is around 3Ω from 4.5-20kHz. This is unfriendly to many tube amps. With my Mad Katy 250W stereo tube amp (*aX* June '06), Ed Dell, Joe D'Appolito, and I noticed a slight "softening" of the treble when using the amp's 4Ω output

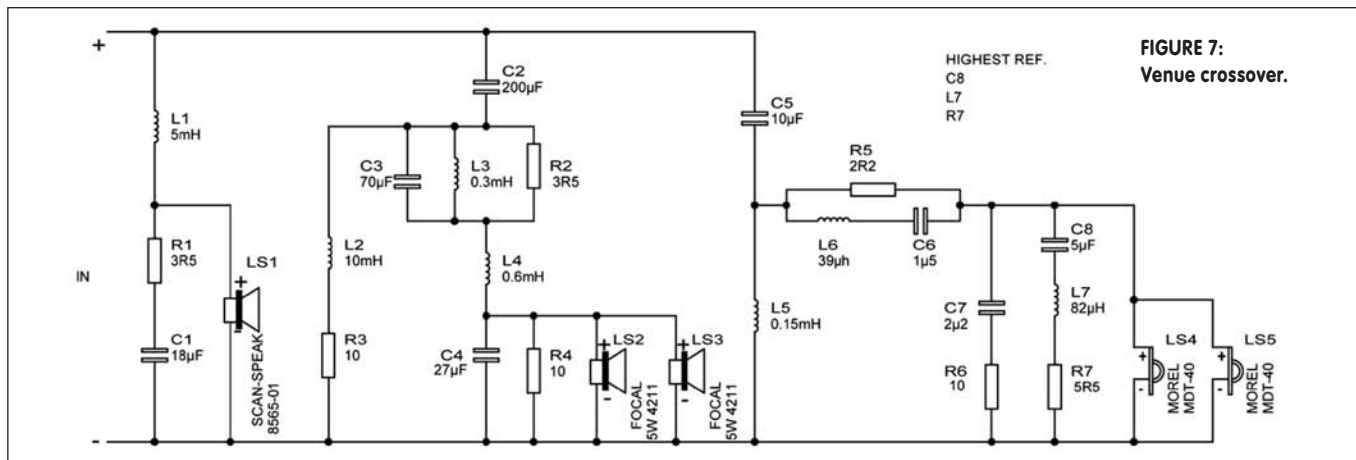


FIGURE 7:
Venue crossover.

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taps, when compared with a solid-state amp. When I later switched to the tube amp's 2Ω taps, I heard no such softening; everything sounded crystal clear,

including live-miked voices and a bell.

Excess group delay (Fig. 14), courtesy of Joe. Note that the peak is only 200μs, equivalent to a 2.7" acoustic path differential.

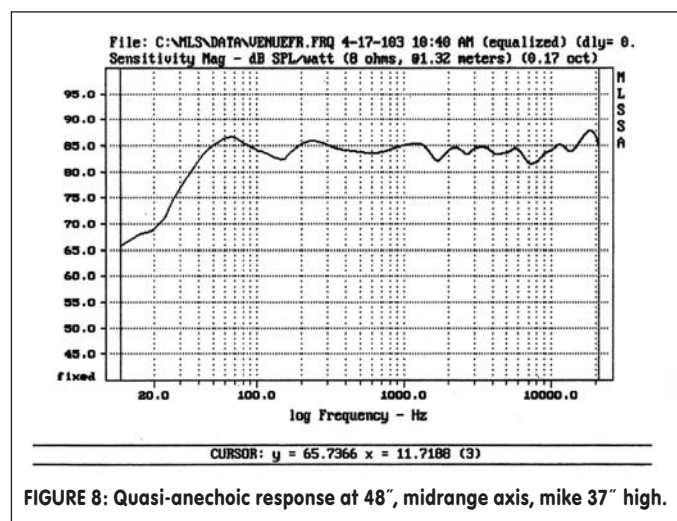


FIGURE 8: Quasi-anechoic response at 48", midrange axis, mike 37" high.

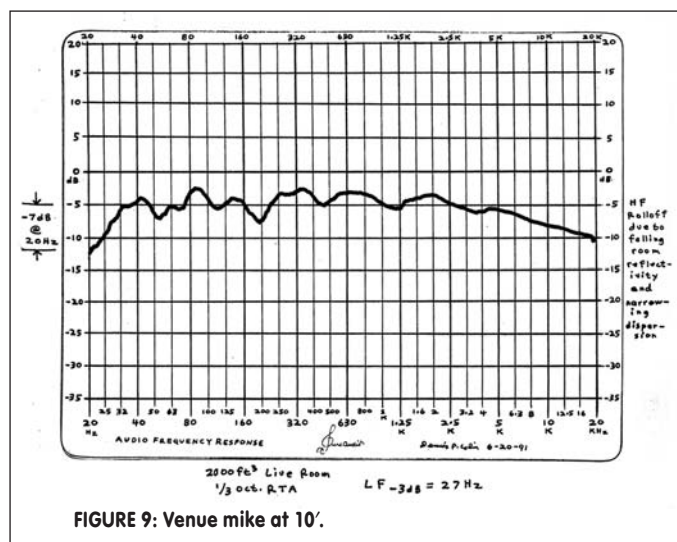


FIGURE 9: Venue mike at 10'.

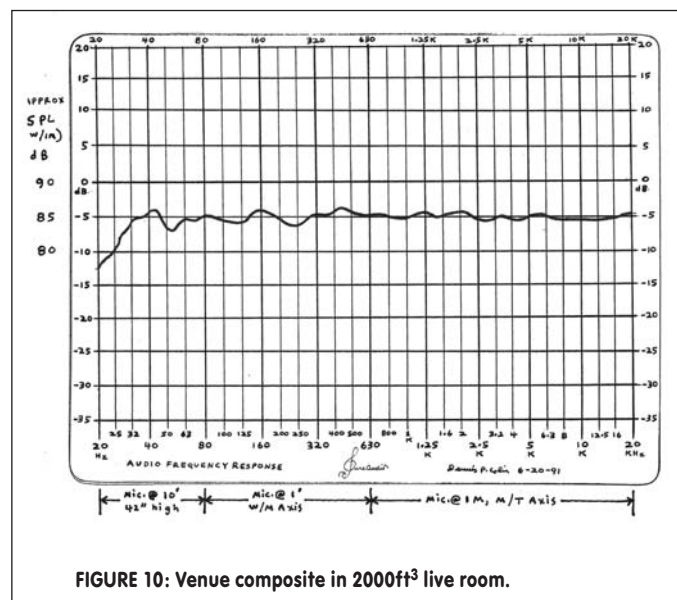


FIGURE 10: Venue composite in 2000ft³ live room.

OSCILLOSCOPE WAVEFORM PHOTOS

80Hz square-wave response at 1' on mid/tweeter axis; 2ms/div (Fig. 15). This shows the first-order woofer/midrange co's transient-preserving ability. You hear, for example, the sudden impact of a drum,

and a bass string's "pulsiness" and harmonic structure with precise timing.

3.1kHz linear triangle wave (Fig. 16). Admittedly, this frequency was "hand-picked" because the mid/tweeter co is not time-coherent to less than 200μs. But the linear response demonstrates the drivers' capacities for clean, linear response. 1' mid/tweeter axis, 0.1ms/div.

10Hz step response in room (Fig. 17). 1' on midrange axis, 2ms/div.

Expanded (0.2ms/div) step response (Fig. 18); 24" on mid/tweeter axis, 200μs/div.

The first impulse is the tweeter response. Its 10-90% rise time (not discernible on this figure) is 15μs, corresponding to a BW-3 of approximately 0.34g/15μs ≈ 23kHz. The time from

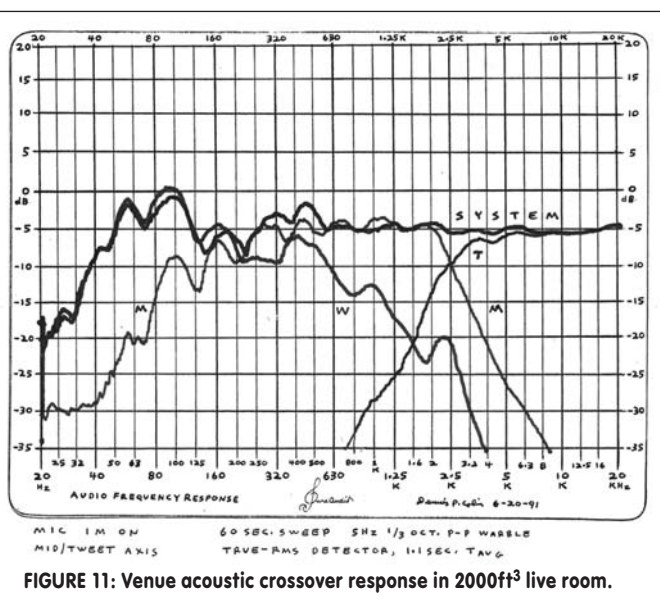


FIGURE 11: Venue acoustic crossover response in 2000ft³ live room.

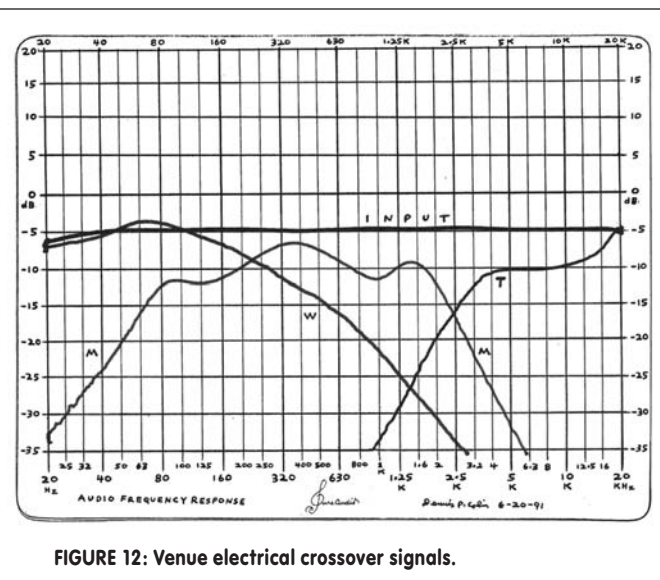


FIGURE 12: Venue electrical crossover signals.

this impulse peak to when the mike voltage again reaches that peak is about 200 μ s, agreeing with Joe's excess group delay measurement in **Fig. 14**.

After this first 200 μ s (typical third order co time response), the waveform reasonably (considering an in-room response) follows the exponential decay seen in **Fig. 17**, expected from the low frequency rolloff (second order at about 40Hz).

ROOM PLACEMENT

Note that the woofer center is 20" off the floor (for close woofer/midrange coherence). This causes a "floor dip" (from reflection cancelling) at about 169Hz. But you can avoid this by placing the speakers so that the woofer cone is twice that distance, or 40" from the room's front wall; position the enclosure back 28" from that wall. Then, at 169Hz the wall reflection will be a full wavelength

round trip, resulting in a reinforcement. In practice, this fairly well "cancels the cancellation" from the floor.

The speakers should be at least 28" from the side walls, and toed in to face a centered listener. However, with the Venue speakers' coherent wide-angle dispersion, the entire room (if good) is the "sweet spot."

In a five-channel surround (no ".1" sub needed), the sound is extremely lifelike,

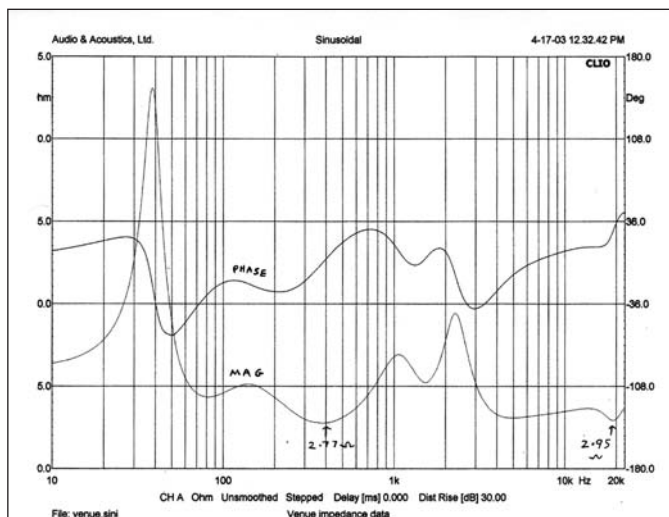


FIGURE 13: Impedance and magnitude phase.

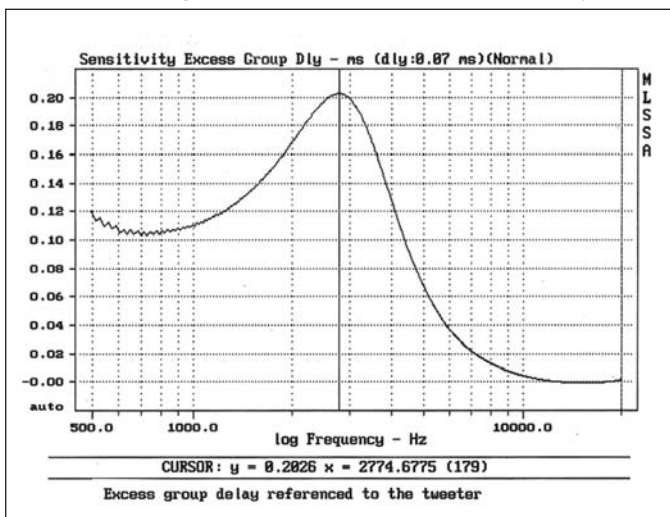


FIGURE 14: Excess group delay.

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SENSITIVITY AND POWER HANDLING

Figure 8 shows an average sensitivity of about 84dB at 2.83V, 48". Corrected for the standard 1m distance, this results in about 86dB.

Usually, the 2.83V (1W with 8 Ω) sensitivity is about what you would hear 2-3m away, because of room reinforcement and the contribution of both stereo speakers. But the full-range rear driver output adds about another 3dB in a room (a forward-only radiating speaker is omnidirectional in the bass only, resulting in a bass-heavy room reinforcement), but the Venue tends to maintain full spectrum reinforcement matching the direct output.

However, the Venue's average impedance is about 4 Ω , so 2.83V RMS produces 2W. The net result is this: In a good room, a power level of 1W per channel produces an SPL of about 86dB. A reasonable power-handling figure is about 200W peak sine-averaged (as power amps are specified). As my article "Musical Waveform Peak and Average Power Frequency Distributions" (*aX* Nov. '05) and letter from Robert Cordell ("Peak Audio Levels," *aX* Mar.

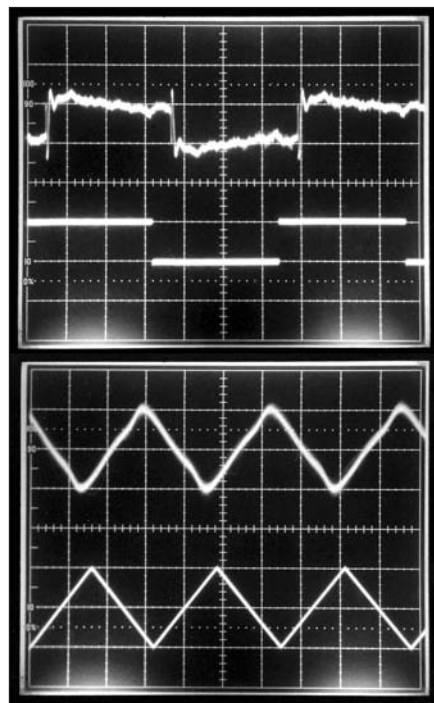


FIGURE 15 (top): 80Hz square-wave response.
FIGURE 16 (bottom): 1kHz linearm triangle wave.

TABLE 1.

Ref	Description	Size	Mfr	Mfr.PN	Dist	Dist. PN
	woofer	10"	Scan-Speak	25W/8565-01	Madisound	
	midrange (2)	5"	Focal	5W 4211	Zalytron	614211 5W4254
	tweeter (2)	1"	Morel	MDT-40?	Madisound	
	Acousta-Stuf (1.5 lb)					
C1	cap, 18 μ F, poly		Solen		Madisound	
C2	cap, 200 μ F, poly		Solen		Madisound	
C3	cap, 70 μ F, poly		Solen		Madisound	
C4	cap, 27 μ F, poly		Solen		Madisound	
C5	cap, 10 μ F, poly		Solen		Madisound	
C6	cap, 1.5 μ F, poly		Solen		Madisound	
C7	cap, 2.2 μ F, poly		Solen		Madisound	
C8	cap, 5 μ F, poly		Solen		Madisound	
L1	Ind, 5mH				Madisound	Sledgehammer
L2	Ind, 10mH				Madisound	Sledgehammer
L3	Ind, 0.3mH				Madisound	
L4	Ind, 0.6mH				Madisound	
L5	Ind, 0.15mH				Madisound	
L6	Ind, 39 μ H		Delevan	4590-393K	Digi-Key	DN4507
L7	Ind, 82 μ H		Delevan	4590-823K	Digi-Key	DN4511
R1, 3	Res, 3.5 Ω , 25W					
R2, 4, 6	Res, 10 Ω 25W					
R5	Res, 2.2 Ω , 15W					
R7	Res, 5.5 Ω , 15W					
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'06) show, the ratio of peak-to-average power on recorded music (if not clipped in playback) ranges from at least ten to over 20dB (a power ratio of 10:1 to

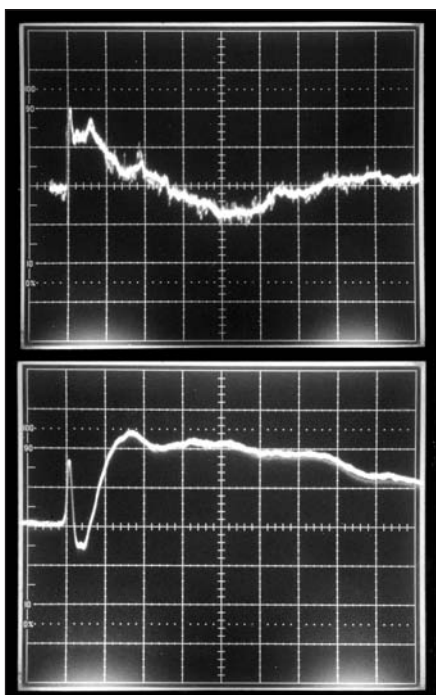


FIGURE 17 (top): 10Hz step response.
FIGURE 18 (bottom): Expanded step response.

over 100:1). Thus, the Venue speaker can comfortably handle the output of a 200W per channel amp if sensibly used.

The resulting peak SPL would then be about 109dB, with a maximum long-term average SPL of about 99dB. This is close to the maximum SPL generated by a large symphony orchestra.

One caution: while a pair of Venue speakers sounds very good and reasonably powerful with rock music, be careful with highly-compressed or synthesizer recordings; I wouldn't recommend using an amp of greater than 100W/channel, and that's assuming the amp isn't clipping.

But for most music listening, a pair (or four or five in multichannel) of these speakers will provide reasonably high SPL, powerful bass, very clear and natural tonality, precise imaging, and unusually deep and natural rendition of instrument and voice solidness and original venue ambience. *ax*

REFERENCE

1. "Loudspeaker Directionality and the Perception of Reality," by Bert Berlant, *Audio Eng. Society Journal*, May 1985.

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