Tannoy S8LR

By Joseph D'Appolito and Dennis Colin

This speaker is a bit different than other two-way speakers I have tested. First, the S8LR uses Tannoy's trademark "Dual Concentric" driver. The tweeter diaphragm and motor are mounted directly behind the woofer magnetic circuit. The high frequencies are emitted via an acoustic wave-guide passing through the woofer's pole piece. Second, Tannoy supplies a cylindrical foam plug that you can use to close the speaker's port, thereby converting the S8LR from a vented to a closed box system.

I ran a series of impedance, frequency response, and distortion tests on the S8LR loudspeaker under both configurations. *Figure 1A* is a plot of system impedance magnitude with the port open. At low frequencies the plot displays the double-peaked curve of a vented system. The impedance minimum of 5.8Ω at 33.6Hz indicates the vented-box tuning frequency. There is a second local impedance minimum of 4.6Ω at 165Hz.

Impedance phase lies between +59° and −56° over the full audio range. Fortunately, these rather large phase angles occur at relatively high impedance values. With minima in the range of 5Ω, Tannoy's 6Ω rating is appropriate.

The impedance peak of 53Ω at 2600Hz (*Fig. 1A*) is probably caused by the interaction of the woofer and tweeter crossover networks forming a parallel resonance at that frequency. We have seen this phenomenon several times before, but the value of the peak is quite a bit higher than values obtained in previous reports.

Figure 1B is the S8LR impedance with the port plugged. This plot shows a single low-frequency peak characteristic of a closed box speaker. The peak value of 42.1Ω occurs at 60Hz. Above 120Hz the closed port impedance curve is identical to the open port plot.

FREQUENCY RESPONSE

Figure 2 shows the S8LR's full-range frequency response for both open and closed port conditions. This response is obtained as a combination of the far-field quasi-anechoic response and properly summed near-field woofer and, for the open port case, the near-field port responses. I placed the microphone along the common centerline at a distance of 1.25m to produce the far-field response, and then spliced the near- and far-field responses together at 200Hz to produce the full-range response^1.

The response shown in *Fig. 2* has been normalized to 1m to obtain system sensitivity. Sensitivity averages 87.2dB in the four octaves between 250Hz and 4kHz. This is almost 3dB less than the figure quoted in Tannoy's specs. Relative to this level the low-frequency −3dB open port point is 43Hz. With the port closed the corresponding figure is 56Hz.

Response is relatively smooth between 2 and 15kHz. There is a broad response dip between 300Hz and 1.6kHz. This may give the S8LR a somewhat recessed character. Response dips 2.4dB just

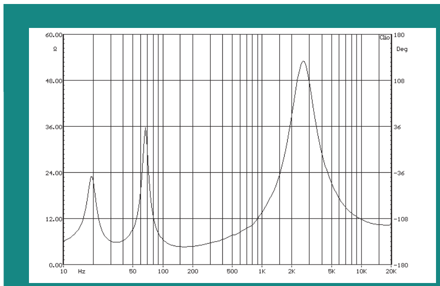

FIGURE 1A: S8LR impedance response with port open.

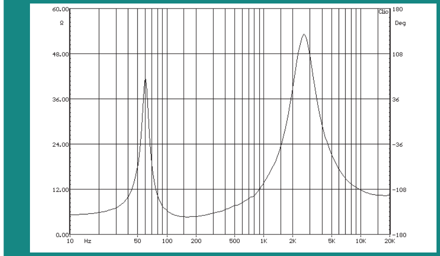

FIGURE 1B: S8LR impedance with plugged port.

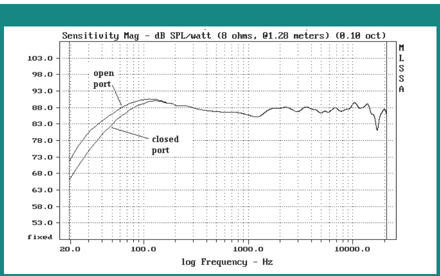

FIGURE 2: S8LR response with open and closed port.

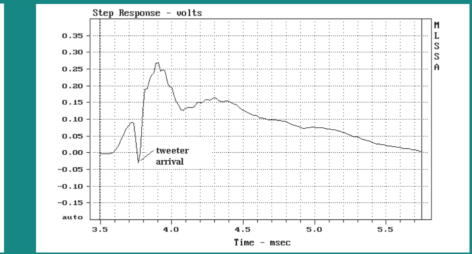

FIGURE 3: Step response with closed port.

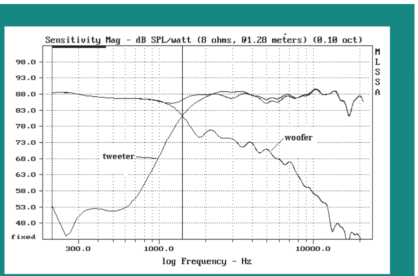

FIGURE 4: System and driver responses.

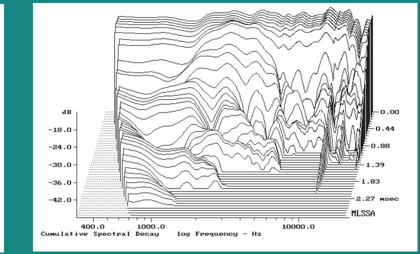

FIGURE 5: Cumulative spectral decay.

above 1kHz and then peaks 2.4dB at 130Hz for the closed port condition. A 3dB peak at 110Hz is obtained with the port open. These response peaks may give a sense of warmth to male voices. The overall closed port response is ±2.4dB from 60Hz to 15kHz.

With the port open I get +3/–2.4dB from 50Hz to 15kHz. The sharp response dip at 17kHz appears to be a diffraction-induced anomaly caused by interaction between the tweeter waveguide and the woofer cone. More on this later.

WOOFER/TWEETER TIMING

Figure 3 shows the S8LR step response. The rather amazing thing about this plot is that it shows the woofer response at the microphone rising before the tweeter arrives! This occurs because the tweeter diaphragm is at the rear of the woofer. In all of the test reports presented in this series, this is the first system to exhibit this behavior.

Tannoy claims in their literature that the S8LR phase response is linear in frequency, which implies that the speaker is time-coherent. In spite of the concentric mounting, however, the S8LR is not quite time-coherent.

Excess group delay is a very sensitive measure of inter-driver time-coherence. (See chapters 6 and 7 of reference 1 for a detailed discussion of the various properties of group delay.) Excess group delay is relatively constant and small below 1kHz and above 4kHz, indicating that the S8LR is time-coherent in those frequency ranges. However, between 1 and 4kHz, excess group delay changes rapidly, rising to 450ms at 2800Hz. This time offset of drivers appears to be caused by the crossover action discussed later. Notice also that tweeter polarity is reversed relative to the woofer so that the system cannot preserve waveform.

CROSSOVER ACTION

The S8LR has two pairs of binding posts for bi-wiring. This allowed me to measure the response of the individual drivers. The result is plotted in *Fig. 4*. The crossover frequency is seen to be 1410Hz.

In the octave below crossover, tweeter response falls 25dB. Above crossover, woofer response falls off at 6dB/octave out to 7kHz. Beyond this point, woofer response falls at 18dB/octave. The slow woofer rolloff causes some interaction between the woofer and tweeter in the 2–7kHz range.

CUMULATIVE SPECTRAL DECAY

The S8LR's cumulative spectral decay (CSD) response is presented in *Fig. 5*. This waterfall plot shows the frequency content of the system response following a sharp impulsive input at time zero. On the CSD plot, frequency increases from left to right and time moves forward from the rear. Each slice represents a 0.05ms increment of time. The total vertical scale covers a dynamic 35dB range.

Ideally, the response should decay to zero instantaneously. Inertia and stored energy that take a finite amount of time to die away, however, characterize real loudspeakers. A prominent ridge parallel to the time axis would indicate the presence of a strong system resonance.

The first time slice in *Fig. 4* (0.00ms) represents the system frequency response. Tweeter high-frequency decay is relatively good; the bulk of its response has decayed away in about 1ms. However, there is a step "glitch" of 2.6dB in tweeter response at 11.8kHz that does not show up in *Fig. 2* due to the 0.1 octave smoothing applied to the data, but it is there. It causes the sharp ridge seen in the tweeter decay beyond 1ms. It will be interesting to see whether this ridge has any sonic imprint. Low-frequency decay is typical for two-way systems, which is neither very good nor very bad.

POLAR RESPONSE

Polar response is examined in *Figs. 6–8*. *Figure 6* is a waterfall plot of horizontal polar response in 10° increments from 60° right (-60°) to 60° left (+60°) when facing the speaker. All off-axis plots are referenced to the on-axis response, which appears as a straight line at 0.00 degrees. Thus, the plotted curves show the change in response as you move off-axis.

For good stereo imaging the off-axis curves should be smooth replicas of the on-axis response with the possible exception of some tweeter rolloff at higher frequencies and larger off-axis angles. For home theater applications a more restricted high-frequency response is desirable.

In *Fig. 6*, frequency response is limited to 15kHz. Otherwise, the sharp response dip at 17kHz produces a very confusing waterfall display. Notice that response falls off rapidly with increasing angle above 5kHz. At 10kHz the –3dB beam width is only ±10°. Contrast this with a typical 28mm dome tweeter that will have a –3dB beam width of ±25° at 15kHz.

It appears that the woofer cone limits off-axis response at higher frequencies. The restricted high-frequency coverage may limit the sweet spot in stereo listening. It will be interesting to see what the listening tests reveal.

The average response over a 60° horizontal window (±30°) in the forward direction is shown in *Fig. 7*. Average response falls rapidly above 10kHz and is down about 6dB rela-

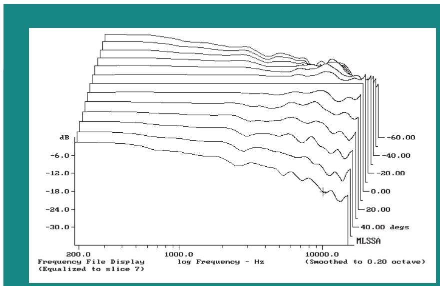

FIGURE 6: Horizontal polar response.

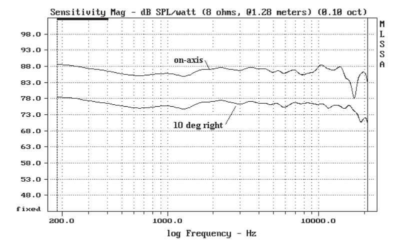

FIGURE 8: Response on-axis and at 10° right.

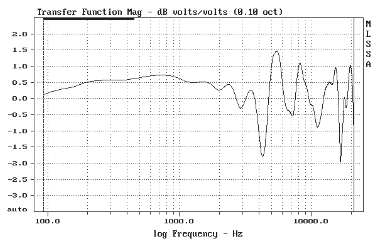

FIGURE 10: Effect of grille on frequency response.

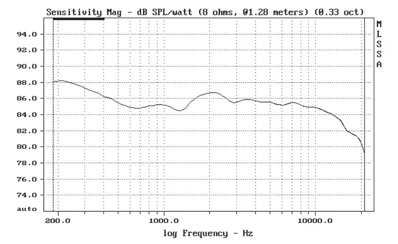

FIGURE 7: Average response over 60° horizontal window.

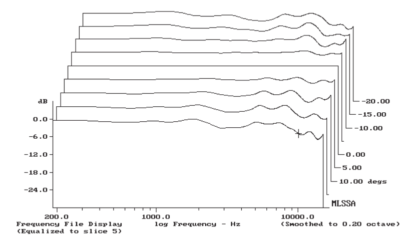

FIGURE 9: Vertical polar response.

Reviewed by Dennis Colin

With the grilles off and vent damping plugs not used, I first played music from “Carmen” (unknown recording from an FM station). I was immediately impressed with a dramatically natural sense of 3-D spaciousness, with solid image coherence even 45° off the central listening axis. The flute, with its pyrotechnic melody embellishment, sounded extremely natural, as did the piano. (I grew up hearing my father play flute and I played piano.) This recording lacked for nothing.

Next, I tried the *Hi-Fi News and Record Review* Test Disc III CD. In Track 2, the chorus sounded naturally spacious and detailed. I thought the voice timbre was somewhat “midrangey,” but this track sounds that way on every system I’ve played it on. On track 4, the trumpets sounded good, but a little bright.

Tracks 5 and 6—All the “Peter and the Wolf” instruments sounded very natural. Of particular “note” were the horns (lush and spacious) and the drums (very solid and real-sounding). The narrator remained faithful to my impressions on other speakers—that he used a garbage can with a voice coil for a microphone! (I can understand not wanting to rent a forest, but couldn’t they afford a better reverb?) I was surprised at the bass clarity and extension (I would guess to 40Hz).

At this point I tried the supplied foam vent plugs, which reduced the bass extension and provided no benefit in my well-damped room, so I took them out. (They could be of use in a room with excessive bass “boom.”)

Track 7—Voices were realistic. The harpsichord had very fast, clean, natural transient “bite.” I think the Tannoy “Dual Concentric” system (tweeter center coincident with woofer apex) is well-designed: high-frequency transients maintained solid coherence at any position in the room. Absolutely no “phasiness” or image-smearing on- and off-axis.

Track 10—The percussion array (drums and tympani) sounded very real and solid, with no sense of time or space blurring sometimes heard on non-coincident multi-way speakers.

Track 14—While not my kind of music (“space-age”?), I was impressed by the ability of the speakers to keep up with these sonic fireworks. In particular, the bass drum sounded like a bass drum, rather than a pair of small speaker boxes.

I also tried a variety of other music, which sounded very natural in tone and space, with surprisingly deep, clean bass. The only coloration I heard was a slight brightness on some vocals (Barbra Streisand and Linda Ronstadt). It sounded like a mild rise (my guess is 1dB) of the 2kHz area regarding that at 1kHz on down. Similar to the Purcell trumpet on the *HFN* Track 4, the effect was not at all ragged-sounding, but rather like a very small amount of a single gentle resonance. Small enough not to hear on 90% of the selections.

ABOUT THE AUTHOR

Dennis P. Colin graduated with a BSEE from the University of Lowell (MA) and is currently an Analog Circuit Design Consultant for microwave radios. Previously a keyboardist and a recording engineer, he has been published in the *Journal* of the Audio Engineering Society. He has demonstrated the audibility of phase distortion at Boston Audio Society, and has designed the “Omni-Focus” speaker (bipolar coincidental with phase-linear first-order crossover), ARP 2600 analog music synthesizer, 1kW bi-amp and PWM supply at A/D/S, and Class D amps.

Bass was very natural and deeply extended. Power handling was very good; I could drive the 100W/ch amp to clipping without noticeable speaker distortion. All music—whether classical, jazz, rock, blues, or other—was reproduced with excellent clarity, imaging, ambience, and power.

HIGH-FREQUENCY SMOOTHNESS

Violins are my favorite test. The bow drags the string until it slips, and the cycle repeats, producing a sawtooth waveform. This contains a uniform series of all harmonics to beyond 20kHz, which although shaped by the sound board resonance, also reaches the ear directly from the strings. In addition, the harmonics are sufficiently phase-coherent and evenly distributed to convey the “pulsiness” of the sawtooth waveform, responsible for the rich but velvety “bite.”

The Tannoys are one of the very few speakers I’ve heard that preserve violin tone and detail satisfactorily. Another is the Swans M1 with superb ribbon tweeter (*SB* 3/99). This is still my favorite, but not by much. Both are good enough to allow you to “hear into” the actual instrument; that is, to effortlessly and without distraction picture the original as close enough to touch.

SPACIOUSNESS AND IMAGE COHERENCE

These two characteristics are often assumed to be mutually exclusive. Not so here! Nowhere in the room did the images become de-focused, yet this precision was accompanied by lush spaciousness that sounded “coherent with” the direct sound. That is, the hall ambience sounded seamlessly connected to the direct sounds stimulating it. So much so that when I momentarily switched on some surround speakers, the spatial envelopment naturalness actually decreased!

I’m sure that’s because this concentric design radiates as an effective point source with waveform coherence across the whole audio range. Thus all room reflections can be acoustically “ray traced” back to the same source point, maintaining a believable image of both sound sources and 3-D space. You simply must hear a good coincident-driver design such as this Tannoy to realize how solid a reproduced image can be.

COMMENTS ON MEASUREMENT

Frequency response (Joe’s *Fig. 2*)—I’m not surprised by the smoothness; that’s how they sounded. I didn’t hear the elevation around 100Hz—probably because I’ve measured a mild depression at 100Hz in this room with drivers at ≈3′ off the floor (near the ¼ wave floor-bounce cancelling distance at 100Hz). The rise within 1–2kHz is probably the occasional brightness I heard on the trumpets and some voices.

CSD (*Fig. 5*)—The transparency and detail I heard agree with the good HF decay. The 11.8kHz step glitch and ridge may explain the slight brightness heard on some vocals, and why I rated violin reproduction second to the superb Swan’s ribbon tweeter.

Horizontal and vertical dispersion (*Figs. 6* and *9*)—While rolloff is rapid off-axis, it maintains a very smooth, virtually monotonic response (also similar in all directions, due to the concentric symmetry). I think this agrees very well with the superbly solid imaging and maintenance of tonal neutrality regardless of listening position.

Ten degrees off-axis (*Fig. 8*)—Other concentric systems I’ve measured also have a HF dip that disappears off-axis. The 17kHz dip here is above my hearing (≈15kHz), but those other systems had this waveguide dip around 12kHz. The audible effect, though, was very difficult to detect. At 17kHz, I doubt it will be noticed on the Tannoys.

Distortion—I needed to drive the 100W/channel amp near clipping to notice any distortion, and I can’t say it wasn’t the amp. Even at fairly loud levels, the speakers sounded unstrained and transparent. It is no surprise that Joe reported excellent low-distortion performance. These speakers can play “loud and clear.” I probably reached 107dB pushing the 2 × 100W

SONIC CHARACTERISTICS RATINGS

		1	2	3	4	5	6	7	8	9	10
Presence	DC	□	□	□	□	□	□	□	□	■	□
Freedom from Distortion	DC	□	□	□	□	□	□	□	□	□	■
Frequency Response Smoothness	DC	□	□	□	□	□	□	□	■	□	□
Low-Mid-High Balance	DC	□	□	□	□	□	□	□	□	■	□
Treble Quality	DC	□	□	□	□	□	□	□	□	■	□
Midrange Quality	DC	□	□	□	□	□	□	□	■	□	□
Bass Quality	DC	□	□	□	□	□	□	□	□	■	□
Bass Extension	DC	□	□	□	□	□	□	□	■	□	□
Immediacy and Transient Response	DC	□	□	□	□	□	□	□	□	■	□
Image Focus	DC	□	□	□	□	□	□	□	□	□	■
Stereo Soundstage Realism	DC	□	□	□	□	□	□	□	□	■	□
Ambience	DC	□	□	□	□	□	□	□	□	■	□

amp, and my ears probably distorted more than the speakers.

Crossover (*Fig. 4*)—Joe mentioned the slow 6dB/octave woofer rolloff up to 7kHz. Notice that the woofer bump at 2kHz is only 12dB below the summed response. I wonder whether this causes the mild step in *Fig. 2* that I may have been hearing on a few sources.

Joe also pointed out the unusual arrival of woofer before tweeter in *Fig. 3* step response. Well, let me tell you how useful this is in achieving full-band waveform coherence—all crossovers (except extremely complicated ones) delay bass more than treble (second- and higher-order low-pass and high-pass filters do this). So with the unusual greater tweeter delay in this speaker, it would be easy to add woofer delay so the driver arrivals are synchronous, resulting in a near-ideal transient response.

Actually, the Tannoy's inter-driver synchrony is within 0.2ms, which is probably inaudible. But my point is that I would steepen the woofer LP slope, uninvert the tweeter, and tweak for a month. I would hope to eliminate possibly audible woofer resonances and achieve perfectionistic time coherence as a side effect. I know, we *audioXpress* people always think we can improve anything!

CONCLUSION

This is a very good speaker—effortless, transparent, and very clear-sounding. Also very powerful for its size. And the imaging is, I would dare say, audibly perfect—this concentric design, superbly engineered, produces an acoustic image that has absolutely no, as in zero, smearing, wandering, de-focusing, or other spatial distortion. The Tannoy S8LR, with good source material, reproduces a sound field that is holographic in its 3-D lucidity.

EQUIPMENT AND SETUP

I used the same Nakamichi AV-1 receiver (100W/channel) and Yamaha CDC 755 CD changer (plus turntable and cassette player) that I've become very familiar with after three years, and on which I've heard many speakers—some very good and some not.

LISTENING ROOM

Approximately 20′ × 18′ × 8½′ (3000ft^3), the room is moderately damped with stuffed chairs, carpet, and drapes. It is well-dispersed by numerous openings and stepped walls. Room response is smooth (for a room) to below 16Hz. Many other speakers sound excellent in this room, including the Swans M1 (*SB* 3/99, p. 36).

I placed the speakers on stands with tweeters at seated ear height (≈36″), 3′ from the front wall and 4½′ from side walls (11′ apart); the distance to listeners was approximately 12′.

SOURCE MATERIAL

I used the *Hi-Fi News and Record Review* Test Disc III CD (tracks 2, 4, 5, 6, 7, 10, 14), and also played a variety of other material, including music from "Carmen" (flute and piano), Stevie Ray Vaughn, Julio Iglesias ("Tango"), Barbra Streisand, Linda Ronstadt, and "The Blue Danube" on LP (Ormandy/Phila. Orch.).

BREAK-IN

I played the speakers loudly for one hour. I heard none of the sometimes referred-to "roughness" even out of the boxes, and no difference after the break-in hour.

tive to mid-frequencies at 20kHz. Most two-way systems I have tested in the past show fairly uniform average response out to 20kHz.

Figure 8 compares on-axis response with response at 10° off-axis to the right. Notice that the sharp dip at 17kHz is gone at 10°. This is further confirmation of a diffraction-induced interaction between the tweeter and the woofer cone.

Figure 9 presents a waterfall plot of vertical polar response over a range of ±20° in 5° increments. The concentric mounting of the woofer and tweeter produces a plot similar to that of *Fig. 8* over the same angular range.

HARMONIC DISTORTION

I ran harmonic distortion tests at an average level of 90dB SPL. Ideally, harmonic distortion tests should be run in an anechoic environment. In practice, it is important to minimize reflections at the microphone during these tests. Out-of-phase reflections can produce false readings by reducing the level of the fundamental while boosting the amplitude of a harmonic. In order to reduce the impact of reflections, I placed the microphone at 0.5m from the loudspeaker.

With the port open, second- and third-harmonic distortions at 50Hz were 1.8% and 2.4%, respectively—a rather good result. All HD distortion was below 1% above 110Hz, which is also a good result.

With the port closed, second-harmonic distortion at 50Hz doubled to 3.6%, and third-harmonic distortion was unchanged. The reflex action produced with the port reduces second-harmonic distortion, but has little effect on the third-harmonic. At 150Hz the port has little effect and the woofer behaves as though it is in a closed box.

INTERMODULATION DISTORTION

Next I measured intermodulation distortion. In this test two frequencies are input to the speaker. Intermodulation distortion produces output frequencies that are not harmonically related to the input. These frequencies are much more audible and annoying than harmonic distortion. Let the symbols f_1 and f_2 represent the two frequencies used in the test. Then a second-order nonlinearity will produce intermods at frequencies of $f_1 \pm f_2$. A third-order nonlinearity generates intermods at $2f_1 \pm f_2$ and $f_1 \pm 2f_2$.

I first examined woofer intermods by inputting 400Hz and 500Hz signals at equal levels. These frequencies should appear predominantly in the woofer output. I adjusted total SPL with the two signals to 87dB at 1m. Because steady tones are used in the IM test, I believed it was safer to use a lower power level to prevent possible tweeter damage. Principal woofer IM products occurred at 900, 1300, 1400Hz. However, the overall level was only 0.33%, which is an excellent result.

I measured tweeter intermods with a 10kHz and 11kHz input pair also adjusted to produce 87dB SPL at 1m. I observed IM products at 9 and 12kHz. Total distortion was 0.06%, which again, is a very low figure.

The last IM test examines cross-intermodulation distortion between the woofer and tweeter using frequencies of 400Hz and 10kHz. Ideally, the crossover should prevent high-frequency energy from entering the woofer and low-frequency energy from entering the tweeter. IM products appeared at 8.4, 9.2, 9.6, and 10.8kHz at a level of 0.03%, the lowest figure I have measured so far in this series of tests for *audioXpress*.

ADDITIONAL TESTS

I conducted all of the above tests with the grille off. *Figure 10* shows the S8LR's response with the grille on, but referenced to the response with grille off. That is, it plots the change in response under the two conditions.

The grille has little effect below 3kHz. Above 3kHz, however, the grille causes ragged response deviations of +1.5 to –2dB. Although the plot looks bad, this is still a factor of two better than most other speakers I have tested. The perfect grille is still the Holy Grail of speaker design!

Two samples of the S8LR system were available for testing. All of the tests described so far were conducted on one sample. Frequency response of the second sample matched the first to within ±0.2 below 2.5kHz. Above this frequency, matching degraded to ±2dB. Part of the problem here may be due to the difficulty in determining the on-axis position exactly coupled with the restricted high-frequency polar coverage of the S8LR.

A NOTE ON TESTING

The Tannoy S8LR was tested in the laboratories of Audio and Acoustics, Ltd. using the MLSSA and CLIO PC-based acoustic data acquisition and analysis systems. Acoustic data was measured with an ACO 7012 ½″ laboratory grade condenser microphone and a custom-designed wideband, low-noise preamp. Polar response tests were performed with a computer-controlled OUTLINE turntable on loan from the Old Colony Division of the Audio Amateur Corporation. ❖

REFERENCE

1. J. D'Appolito, *Testing Loudspeakers*, Audio Amateur Corporation, Peterborough, NH, 1998.