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VOICE COIL

THE PERIODICAL FOR THE LOUDSPEAKER INDUSTRY

Test Bench

Scan-Speak Discovery Drivers

By Vance Dickason

This month Scan-Speak sent a couple of high-end home audio drivers from their relatively new Discovery lineup: a 1″ wide surround silk dome tweeter, the D2604/833000, and a 10″ aluminum cone subwoofer, the 26W/4558T00.

D2604/833000

Scan-Speak has been back on their own for a couple of years now and doing well as an independent business entity now that they are no longer a part of DST or Tymphany. Founded in 1970, Scan-Speak is still working out of the same address in Videbaek, Denmark, and with the same "no compromise" philosophy that was always a part of the company's mission. One of the latest efforts for Scan-Speak was to develop a new high-quality line of more competitively priced OEM product, dubbed Discovery. The D2604/833000 is the latest tweeter offering from the Discovery line and features a large surround 1″ diameter silk dome, a low 475Hz resonance, CRT shielding, a separate rear chamber, a ferrite magnet motor, an injection-molded faceplate with a five-point mounting configuration, voice coil wound with copper-clad aluminum wire, and gold-plated terminals.

I began testing the D2604/833000 silk dome (***Photo 1***) by generating a stepped sine wave impedance plot using the LinearX LMS analyzer. The result of the LMS 300-point impedance sine wave sweep is given in ***Fig. 1***. The tweeter resonance is 426Hz, somewhat lower than the factory spec. Minimum impedance for this tweeter is 3.2Ω at 2.4kHz with a measured Re= 3.0Ω.

After completing the impedance measurements, I recess-mounted the Scan-Speak tweeter in a small enclosure that had a baffle area of about 12″ × 7″ and measured the on- and off-axis frequency response at 2.83V/1m. ***Figure 2*** depicts the on-axis response. Frequency response for the D2604 dome is a very flat ±1.75 from 890Hz-16kHz with the response extending to 25kHz. ***Figure 3*** gives the on- and off-axis response for the Scan-Speak wide surround silk dome tweeter. Off-axis the device is -4.5dB down at 10kHz from

PHOTO 1: The D2604/833000 silk dome

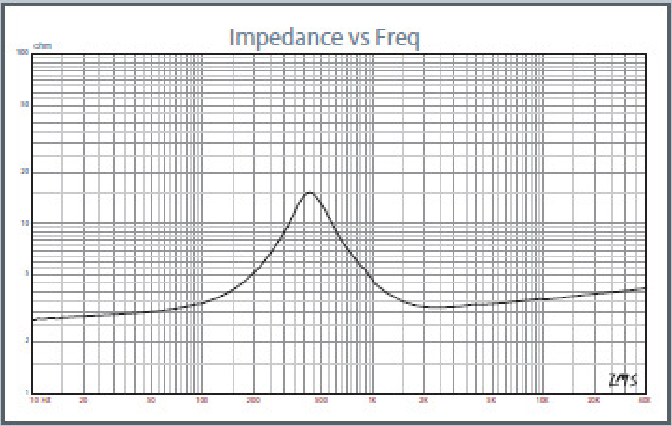

FIGURE 1: Scan-Speak D2604/833000 free-air impedance plot.

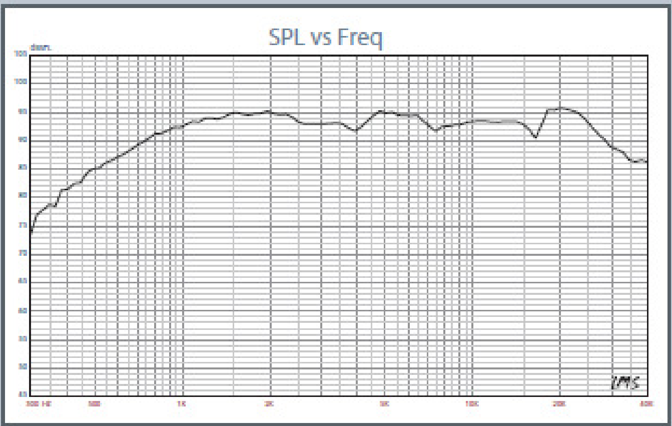

FIGURE 2: Scan-Speak D2604/833000 on-axis response.

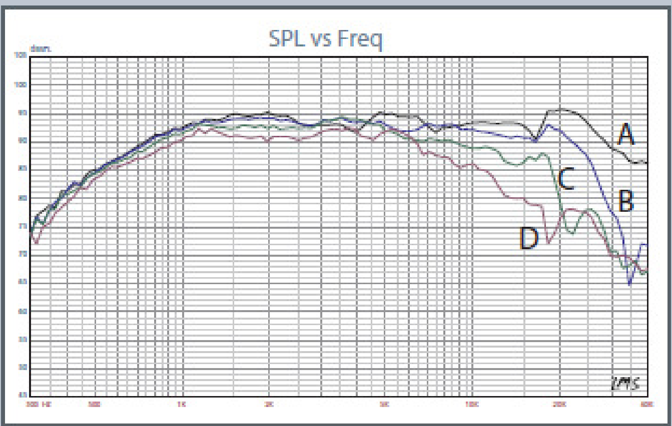

FIGURE 3: Scan-Speak D2604/833000 horizontal on- and off-axis frequency response (A = 0°; B = 15°; C = 30°; D = 45°).

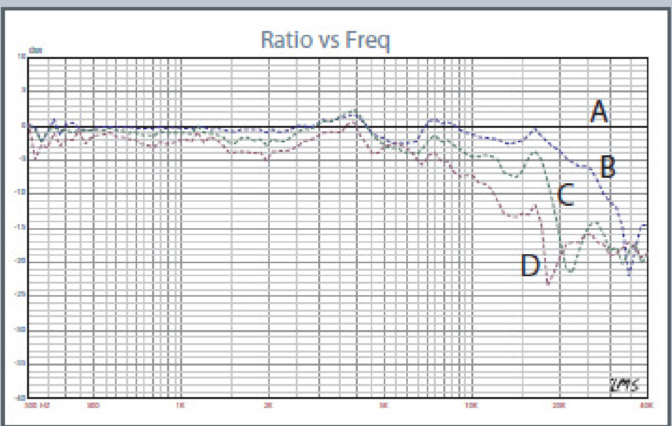

FIGURE 4: Scan-Speak D2604/833000 normalized on- and off-axis frequency response (A = 0°; B = 15°; C = 30°; D = 45°).

the on-axis response with respect to the 30° off-axis curve and -7.2dB at 45° off-axis, again with respect to the on-axis response. ***Figure 4*** illustrates the normalized version of ***Fig. 3***. In terms of production consistency, the two-sample SPL comparison is depicted in ***Fig. 5***, indicating the two samples were well matched with some minor variation in the 3-7.5kHz region.

Next, I used the Listen Inc. SoundCheck analyzer and SCM microphone to measure the impulse response with the tweeter recess-mounted. Importing this data in the Listen Inc. SoundMap software produced the cumulative spectral decay plot (waterfall) shown in ***Fig. 6***. While there are no major resonances indicated in this plot, it is very difficult to correlate long decay resonances with subjective performance. ***Figure 7*** gives the Short Time Fourier Transform (STFT) displayed as a surface plot. Last, I set the 1m SPL to 94dB (5.8V), and the sweep range to 2kHz-20kHz and measured the 2nd and 3rd harmonic distortion at 10cm, depicted in ***Fig. 8***. This shows the relationship between 2nd and 3rd harmonic distortion; however, correlation to subjective preference based on THD is not well established.

For those of you who have not used this format tweeter in a system, it's a great design and one of my favorites. All of the various incarnations I have designed into systems have sounded very good, and given the quality and craftsmanship always exhibited by Scan-Speak, this is a great addition to their new Discovery line.

26W/4558T00

The new Scan-Speak 26W/4558T00 subwoofer (***Photo 2***) is built on an eight-spoke proprietary cast aluminum frame, which includes eight 35mm × 20mm "windows" below the spider mounting shelf for cooling. Scan-Speak obviously spent a lot of time designing the cone for this woofer. The material used for this cone is a thick black flat profile anodized aluminum that has the outside perimeter of the cone turned down to strengthen the edge to prevent flexing. However, even more interesting is that the cone has a 5″ articulation that forms a 1/16″ rib that is in just about the same place that the dust cap attaches on the front side of the cone, which should add considerable stiffness. There are also eight slightly oblong ¼″ × 3/8″ holes intended to vent air out of the area beneath the dust cap. The dust cap is a 5″ diameter convex type made from a black coated fiberglass/paper sandwich.

Providing compliance for this woofer is a fairly wide (30mm) black NBR surround and a black 6″ diameter flat

PHOTO 2: The Scan-Speak 26W/4558T00 subwoofer

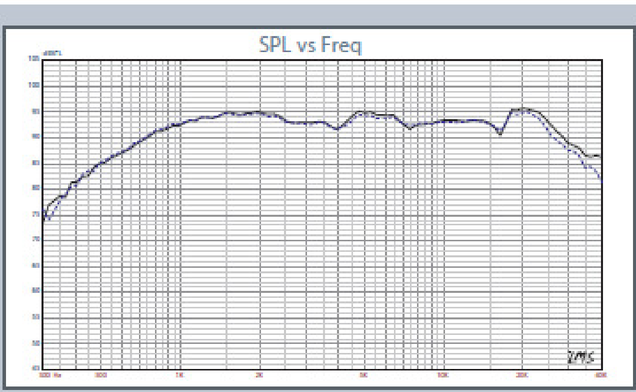

FIGURE 5: Scan-Speak D2604/833000 two-sample SPL comparison.

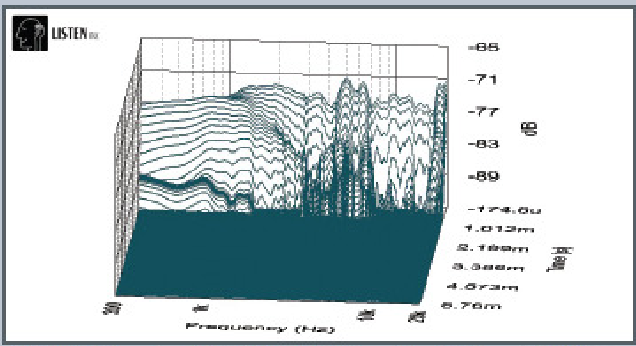

FIGURE 6: Scan-Speak D2604/833000 SoundCheck CSD waterfall plot.

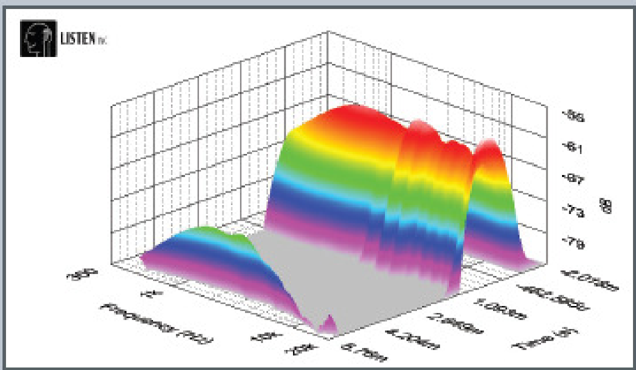

FIGURE 7: Scan-Speak D2604/833000 SoundCheck STFT surface intensity plot.

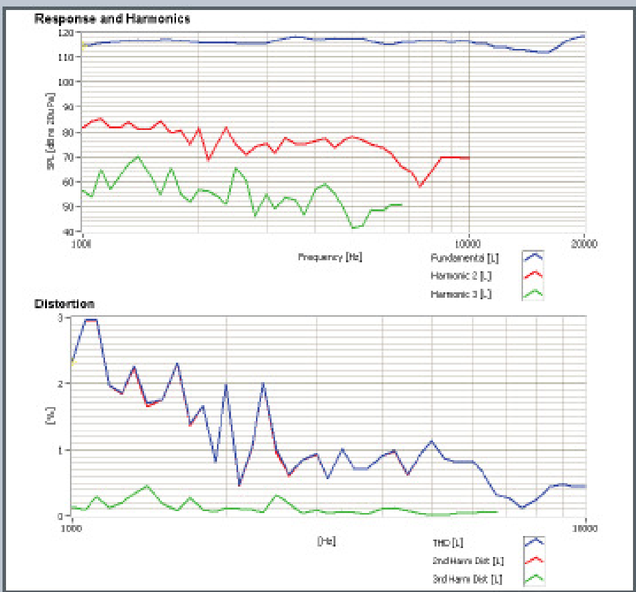

FIGURE 8: Scan-Speak D2604/833000 SoundCheck distortion plots.

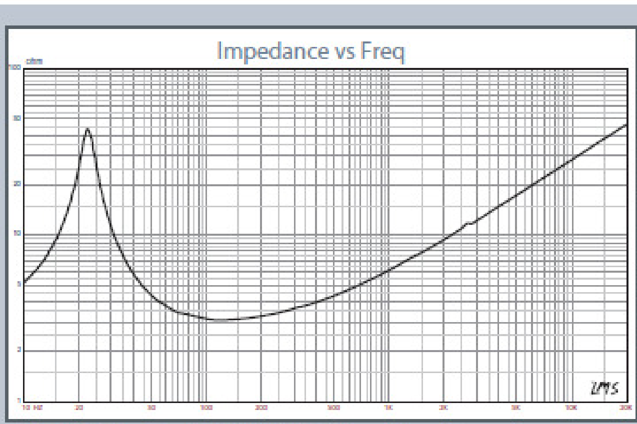

FIGURE 9: Scan-Speak 26W/4558T00 free-air impedance plot.

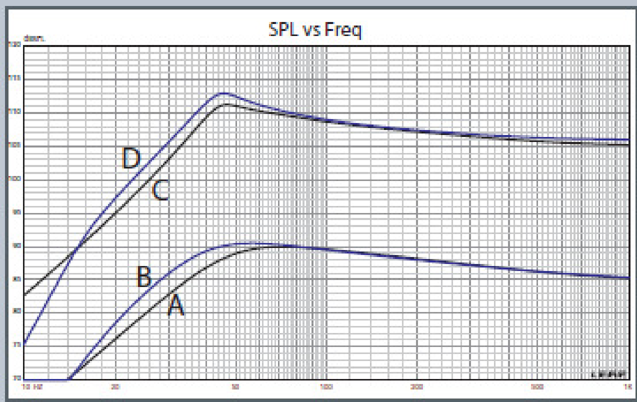

FIGURE 10: Scan-Speak 26W/4558T00 computer box simulations (A = sealed at 2.83V; B = vented at 2.83V; C = sealed at 36V; D = vented at 40V).

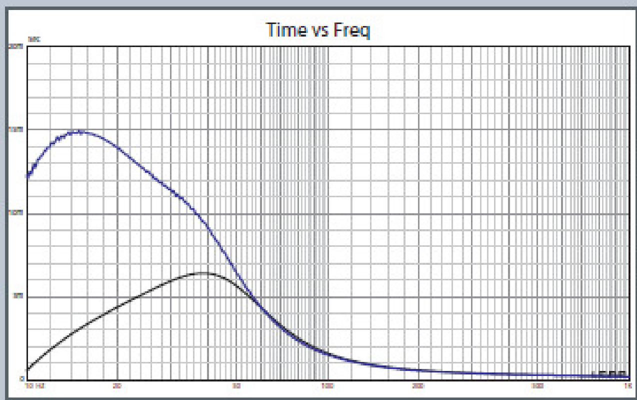

FIGURE 11: Group delay curves for the 2.83V curves in Fig. 10.

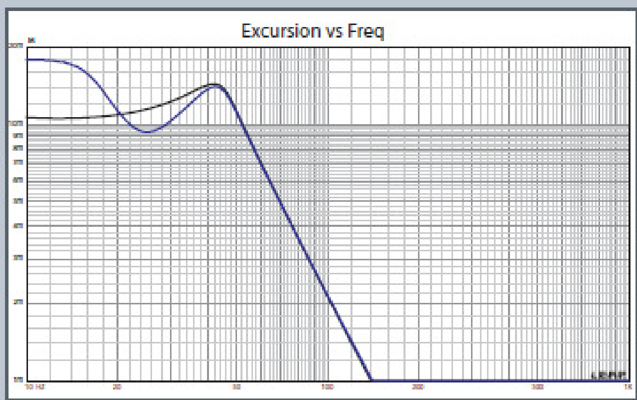

FIGURE 12: Cone excursion curves for the 36/40V curves in Fig. 10.

TABLE 1: Scan-Speak 26W/4558T00 Subwoofer					
	TSL model		LTD model		Factory
	sample 1	sample 2	sample 1	sample 2	
F_S	22.1Hz	21.9Hz	21.2Hz	21.1Hz	20Hz
R_{EVC}	2.51	2.51	2.51	2.51	2.5
Sd	0.0340	0.0340	0.0340	0.0340	0.0352
Q_{MS}	6.17	5.99	5.95	6.13	5.59
Q_{ES}	0.38	0.38	0.35	0.38	0.29
Q_{TS}	0.36	0.36	0.35	0.36	0.28
V_{AS}	83.3 ltr	85.2 ltr	94.7 ltr	92.2 ltr	104 ltr
SPL 2.83V	85.7dB	85.6dB	85.3dB	85.4dB	89dB
X_{MAX}	12.5mm	12.5mm	12.5mm	12.5m	12.5mm

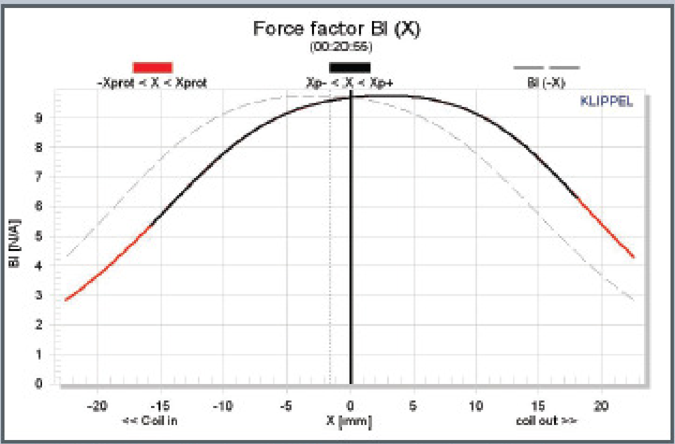

FIGURE 13: Klippel Analyzer Bl (X) curve for the Scan-Speak 26W/4558T00.

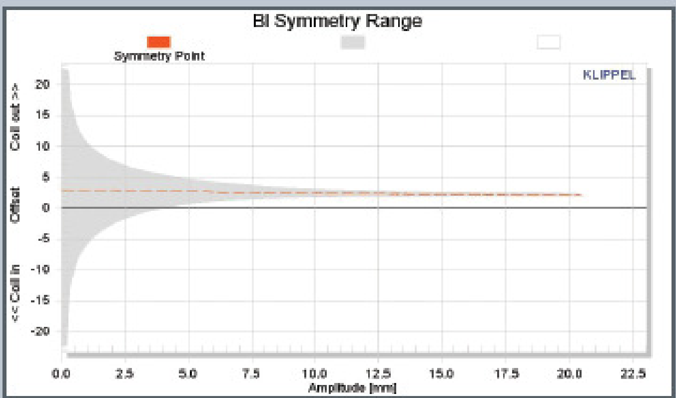

FIGURE 14: Klippel Analyzer Bl symmetry range curve for the Scan-Speak 26W/4558T00.

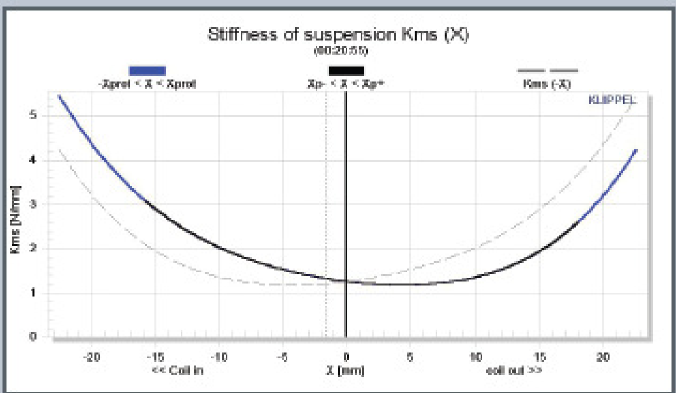

FIGURE 15: Klippel Analyzer mechanical stiffness of suspension Kms (X) curve for the Scan-Speak 26W/4558T00.

Nomex spider. It also includes flat Litz wire sewn into the spider and terminates to a pair of gold-plated terminals. While not connected to a terminal (this is a single voice coil subwoofer), there is another pair of Litz wires sewn into the opposite side of the spider.

The motor system for the 26W is composed of a stacked pair of 147mm diameter and 18mm thick ferrite magnets. These are sandwiched between an 8mm front plate and a 9mm back plate with a 10mm bump out.

I commenced testing the Scan-Speak 10″ 26W subwoofer using the LinearX LMS analyzer and VIBox to produce both voltage and admittance (current) curves with the driver clamped to a rigid test fixture in free-air at 1V, 3V, 6V, 10V, 15V, and 20V. The twelve 550-point stepped sine wave sweeps for each 26W sample were post-processed and the voltage curves divided by the current curves (admittance) to produce impedance curves, phase added using LMS calculation method, and, along with the accompanying voltage curves, uploaded to the LEAP 5 Enclosure Shop software. Besides the LEAP 5 LTD model results, I additionally produced a LEAP 4 TSL model set of parameters using just the 1V free-air curves. The final data, which includes the multiple voltage impedance curves for the LTD model (see ***Fig. 9*** for the 1V free-air impedance curve) and the 1V impedance curve for the TSL model, were selected and the parameters created in order to perform the computer box simulations. ***Table 1*** compares the LEAP 5 LTD and TSL data and factory parameters for both 26W samples.

LEAP parameter calculation results for the 26W were reasonably close to the factory data, although my data showed a lower sensitivity. Following my usual protocol, I proceeded setting up computer enclosure simulations using the LEAP LTD parameters for Sample 1. I set up two box simulations, one sealed and one vented. For the closed box simulation I used a $1.0ft^3$ enclosure with 50% fiberglass fill material, and for the vented box, a $1.7ft^3$ QB3 type vented alignment with 15% fiberglass fill material and tuned to 24Hz.

Figure 10 illustrates the results for the Scan-Speak 26W subwoofer in the sealed and vented boxes at 2.83V and at a voltage level high enough to increase cone excursion to Xmax + 15% (14.4mm for the 26W). This yielded a F3 = 40Hz with a box/driver Qtc of 0.67 for the $1.0ft^3$ sealed enclosure and –3dB = 33.5Hz for the $1.7ft^3$ vented simulation. Increasing the voltage input to the simulations until the maximum linear cone excursion was reached resulted in 111.2dB at 40V for the sealed enclosure simulation and 106dB with an 16V input level for the larger vented box (see ***Figs. 11 and 12*** for the 2.83V group delay curves and the 36/40V excursion curves).

Klippel analysis for the Scan-Speak 10″ subwoofer produced the Bl(X), Kms(X) and Bl and Kms symmetry range plots given in ***Figs. 13-16***. The Bl(X) curve for the 26W (***Fig. 13***) is very broad and reasonably symmetrical, typical of high Xmax drivers. Looking at the Bl Symmetry plot (***Fig. 14***), this curve shows a coil forward (coil out) offset that goes from 2.8mm at rest to about 2.3mm of excursion at the physical Xmax position. Because it stays fairly constant throughout the operating range, this is likely a physical offset. ***Figures 15 and 16*** give the Kms(X) and Kms symmetry range curves for the Scan-Speak 26W. The Kms(X) curve (***Fig. 15***) is also as moderately symmetrical as the Bl curve, and likewise has a coil-out offset. In the Kms symmetry range curve in ***Fig. 16***, the coil-out offset is 4.4mm at rest decreasing to about 3mm at the physical Xmax position. From the displacement limiting numbers calculated by the Klippel analyzer for the 26W, the XBl @ 70% is Bl = 12.6mm and for XC @ 50% Cms the minimum was 13.2mm, which means that for the 26W woofer, Bl was the limiting factor for the prescribed 20% distortion limit. This occurs at just about the physical Xmax of the driver, so not bad.

Figure 17 gives the inductance curves L(X) for the 26W. The curve illustrates a decreasing inductance as the coil moves inward, the result of the aluminum shorting sleeve in this motor system. Voice coil inductance varies only about 0.16mH from Xmax in to Xmax out (0.43mH to 0.59mH), which is very good given the amount of wire in the voice coil.

Even though the 26W is a subwoofer and could likely be used with a plate amp limiting its upward extension to 100Hz, this 10″ driver could also find application in three-way designs. Given that, I mounted the 26W/4558T00 subwoofer in an enclosure which had a 17″ × 8″ baffle and was filled with damping material (foam) and then measured the DUT on- and off-axis from 300Hz to 20kHz frequency response at 2.83V/1m using a 100 point gated sine wave sweep. ***Figure 18*** gives the 26W's on-axis response displaying a very smooth rising response to about 600Hz, followed

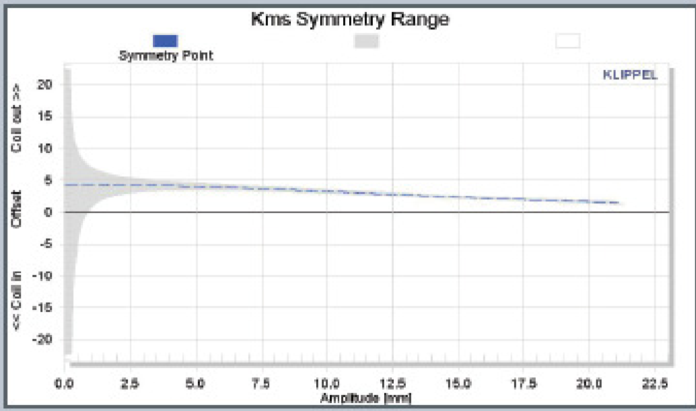

FIGURE 16: Klippel Analyzer Kms symmetry range curve for the Scan-Speak 26W/4558T00.

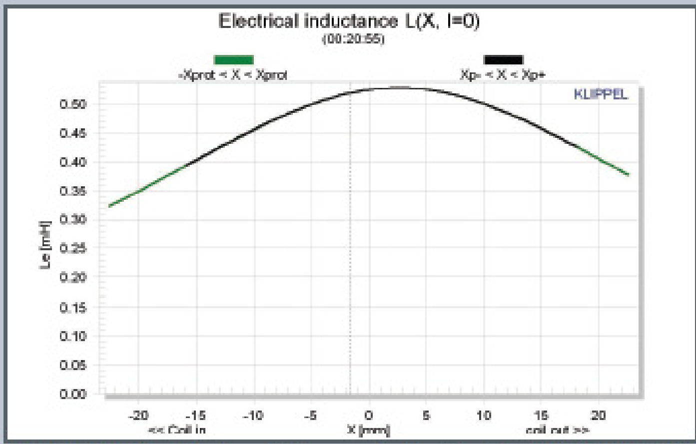

FIGURE 17: Klippel Analyzer L(X) curve for the Scan-Speak 26W/4558T00.

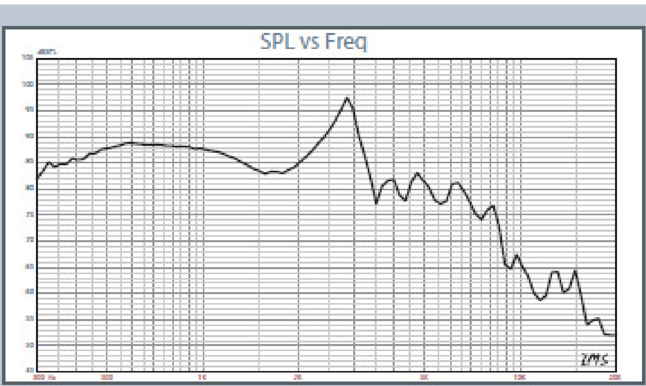

FIGURE 18: Scan-Speak 26W/4558T00 on-axis frequency response.

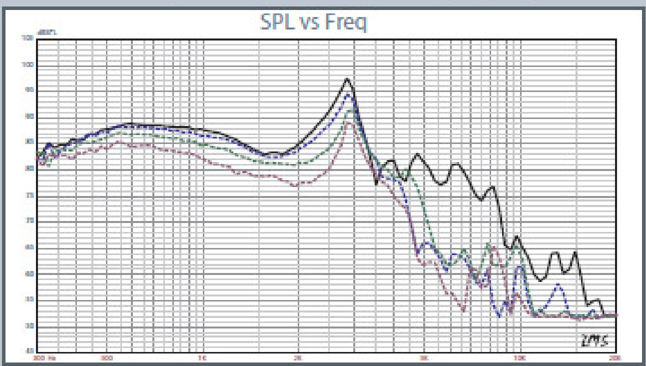

FIGURE 19: Scan-Speak 26W/4558T00 on- and off-axis frequency response.

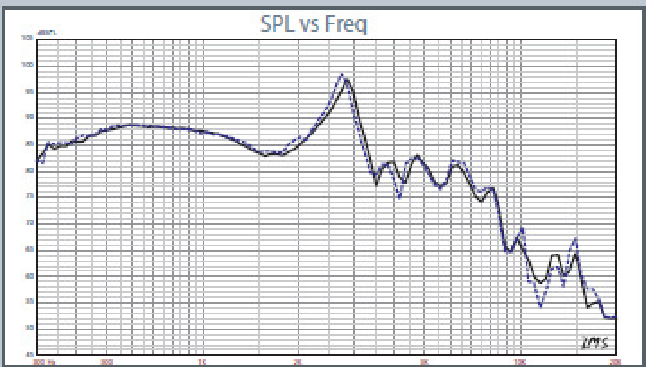

FIGURE 20: Scan-Speak 26W/4558T00 two-sample SPL comparison.

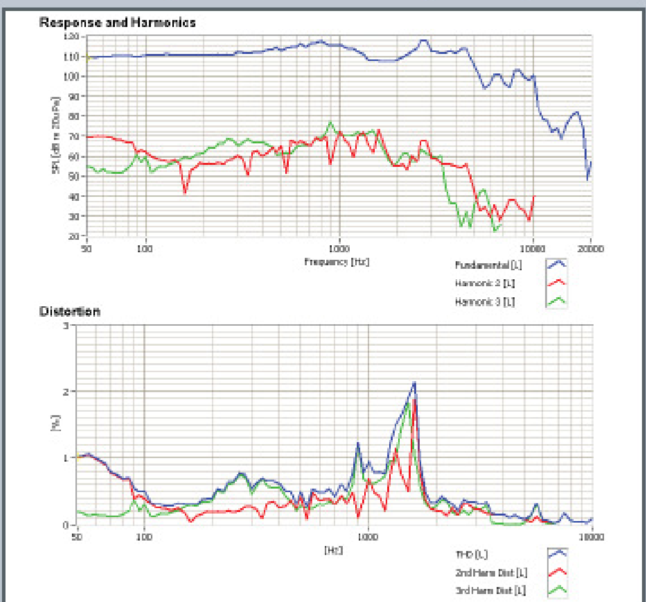

FIGURE 21: Scan-Speak 26W/4558T00 SoundCheck distortion plots.

by a 6dB drop in SPL to about 1.8kHz, followed by the start of the aluminum breakup mode centered on about 2.8kHz. ***Figure 19*** has the on- and off-axis frequency response at 0°, 15°, 30°, and 45°. With respect to the on-axis curve, -3dB at 30° occurs at 1.0kHz, so a cross point anywhere below that frequency should be fine. It certainly would be possible to match it to a ribbon driver in a two-way at that frequency, but a more likely configuration would be combining the 26W with a 5.25″ midrange and a 1″ dome. The last SPL measurement is shown in ***Fig. 20*** and gives the two-sample SPL comparisons for the 10″ Scan-Speak driver, showing a close matchup within the relevant operating range of the woofer.

For the last group of tests, I employed the Listen Inc. SoundCheck analyzer (courtesy of Listen Inc.) and SCM microphone to measure distortion and generate time frequency plots. Setting up for the distortion measurement consisted of mounting the woofer rigidly in free-air, setting the SPL set to 94dB at 1m using a noise stimulus (SoundCheck has a software generator and SPL meter as two of its utilities), and then measuring the distortion with the Listen Inc. SCM microphone placed 10cm from the dust cap. This produced the distortion curves shown in ***Fig. 21***. Last, I employed the SoundCheck analyzer to get a 2.83V/1m impulse response for this driver and imported the data into Listen Inc.'s SoundMap Time/Frequency software. The resulting CSD waterfall plot is given in ***Fig. 22*** and the Wigner-Ville logarithmic surface map (for its better low-frequency performance) plot in ***Fig. 23***. Looking over all the data presented, this is a very well designed driver, and another good one from Scan-Speak. For more information on these and the other new Scan-Speak drivers, visit the Scan-Speak website at www.scan-speak.dk. ***VC***

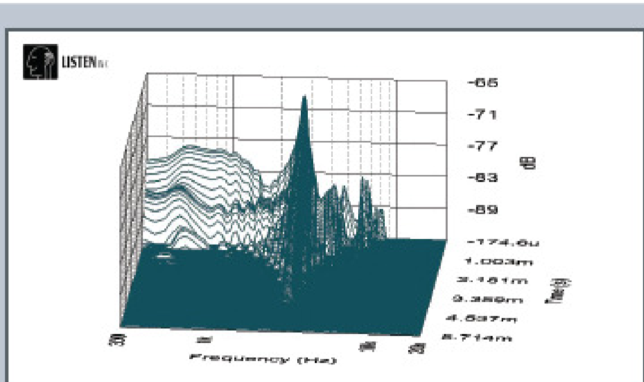

FIGURE 22: Scan-Speak 26W/4558T00 SoundCheck CSD waterfall plot.

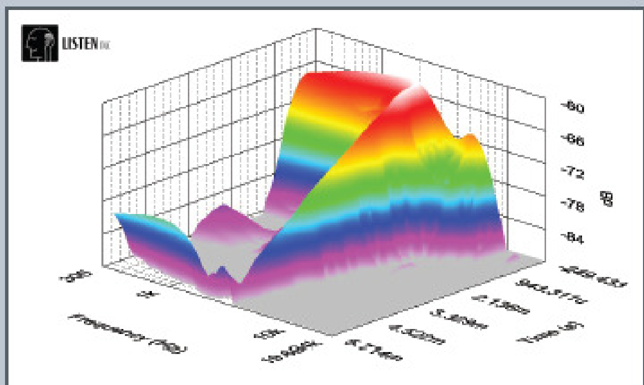

FIGURE 23: Scan-Speak 26W/4558T00 SoundCheck Wigner-Ville plot.