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Scan-Speak 12W/4524G00

Next I began collecting data on the Scan-Speak 4″ diameter 12W/4524G00 (***Photo 3***), the new midwoofer addition to the price-sensitive Scan-Speak Discovery line. Small diameter midwoofers used in mini bookshelf speakers have been an important product with Scan-Speak. The 12W is built on a six-spoke cast aluminum frame that has three 25mm × 6mm "windows" for enhanced voice coil cooling. Powering this 4″ device is a conventional 15mm thick 72mm diameter ferrite magnet sandwiched between the front and rear plates. Features include a fiberglass slightly curvilinear cone, fiberglass 1″ diameter dust cap, NBR rubber surround, 2.5″ diameter black flat cloth spider, 1″ (25mm) diameter voice coil (aluminum former wound with round copper wire), and gold-plated terminals.


PHOTO 3: Scan-Speak 12W/4524G00.

Table 2 Scan-Speak 12W/4524G00 Midwoofer

	TSL model		LTD model		Factory
	sample 1	sample 2	sample 1	sample 2	
F_S	51.2Hz	50.9Hz	52.3Hz	51.4Hz	56.0Hz
R_{EVC}	3.09	3.02	3.09	3.02	3.1
Sd	0.0059	0.0059	0.0059	0.0059	0.0058
Q_{MS}	3.32	3.50	4.18	3.66	3.12
Q_{ES}	0.35	0.32	0.41	0.37	0.35
Q_{TS}	0.35	0.29	0.38	0.33	0.31
V_{AS}	7.6 ltr	7.7 ltr	7.4 ltr	7.6 ltr	6.1 ltr
SPL 2.83V	86.6dB	86.9dB	85.9dB	86.4dB	88.5dB
X_{MAX}	3.0mm	3.0mm	3.0mm	3.0mm	3.0mm

Testing commenced with the driver clamped to a rigid test fixture in free-air and voltage and current sweeps taken at 0.3V, 1V, 3V, and 6V. Because this is a small diameter driver with only 3mm Xmax, the 6V data was too nonlinear for LEAP 5 to curve-fit, so I did not include it. I post-processed the six 550-point stepped sine wave sweeps for each 12W midwoofer sample and divided the voltage curves 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.

In addition to the LEAP 5 LTD model results, I also produced a LEAP 4 TSL model set of parameters using just the 1V free-air curves. I selected the final data set, which includes the multiple voltage impedance curves for the LTD model (see ***Fig. 16*** for the 1V free-air impedance curve) and the 1V impedance curve for the TSL model, and produced the parameters in order to perform the computer box simulations. ***Table 2*** compares the LEAP 5 LTD and TSL data and factory parameters for both Scan-Speak 4″ samples.

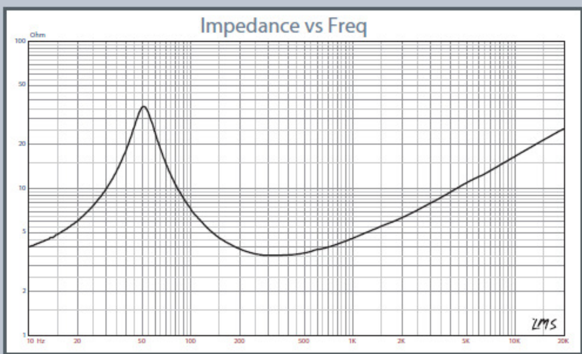

FIGURE 16: Scan-Speak 12W/4524G00 free-air impedance plot.

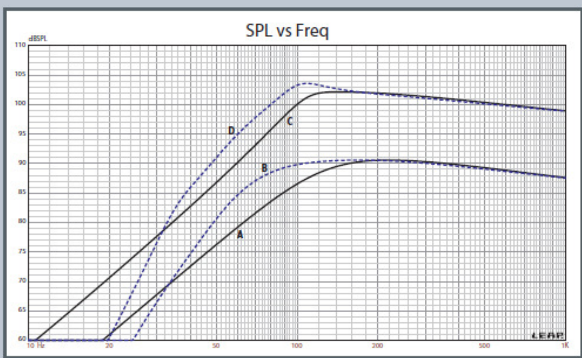

FIGURE 17: Scan-Speak 12W/4524G00 computer box simulations (A = sealed at 2.83V; B = vented at 2.83V; C = sealed at 12V; D = vented at 12V).

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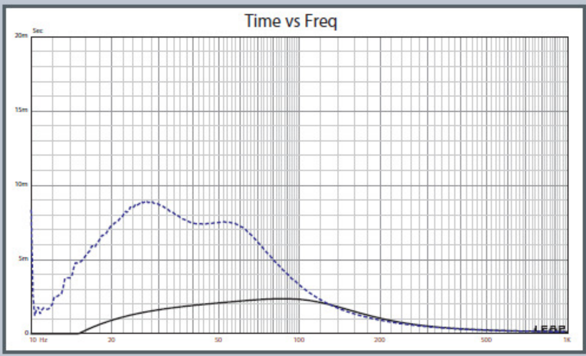

FIGURE 18: Group delay curves for the 2.83V curves in Fig. 17.

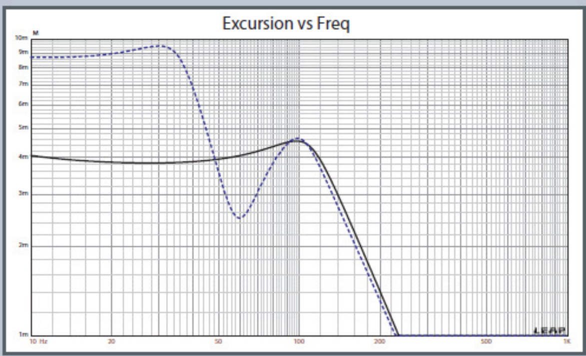

FIGURE 19: Cone excursion curves for the 12V curves in Fig. 17.

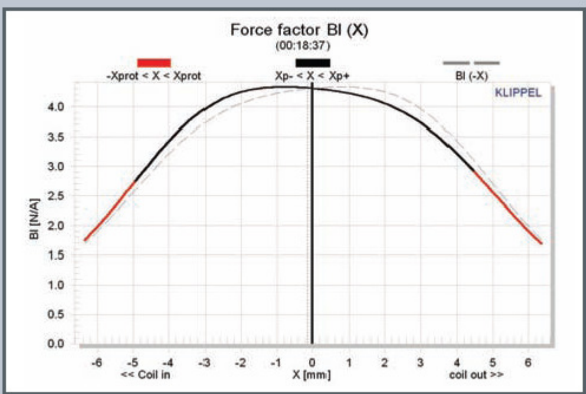

FIGURE 20: Klippel Analyzer Bl (X) curve for the 12W/4524G00.

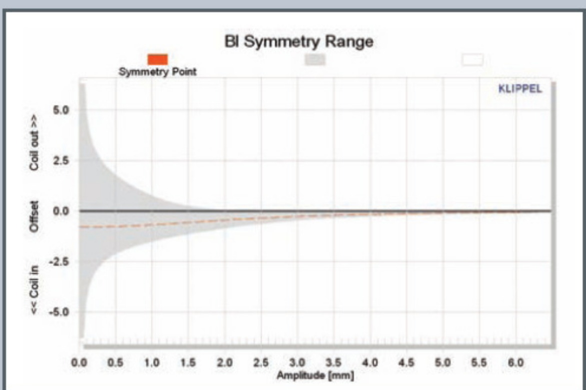

FIGURE 21: Klippel Analyzer Bl symmetry range curve.

LEAP parameter calculation results for the 12W midwoofer were close to the factory data, although the LEAP calculated sensitivity was about 2dB lower. Given this, I proceeded to set up computer enclosure simulations using the LEAP LTD parameters for Sample 1. I programmed in two enclosures, one sealed and the other vented. For the first closed box Butterworth simulation I used a 120 in^3 enclosure with 50% fiberglass fill material, and for the second vented box, a larger volume of 251 in^3 QB3 with 15% fiberglass fill material tuned to 55.4Hz.

Figure 17 displays the results for the 12W/4524G00 in the sealed and vented boxes at 2.83V and at a voltage level high enough to increase cone excursion to Xmax + 15% (4.5mm). This resulted in a F3 = 109Hz with a box/driver Qtc of 0.69 for the 120 in^3 closed box design and a -3dB = 72Hz for the 251 in^3 vented simulation. Increasing the voltage input to the simulations until the maximum linear cone excursion was reached generated 102dB at 12V for the sealed enclosure simulation and 103.5dB with same 12V input level for the larger ported enclosure (see ***Figs. 18 and 19*** for the 2.83V group delay curves and the 12V excursion curves). Very reasonable performance for a 4″ woofer.

Klippel analysis for the 12W midwoofer produced the Bl(X), Kms(X), and Bl and Kms symmetry range plots given in ***Figs. 20-23***. The Bl(X) curve (***Fig. 20***) is moderately broad and symmetrical, with a coil-in (rearward) offset. In the Bl symmetry range curve in ***Fig. 21***, there is a 0.8mm coil-in (rearward) offset that goes to 0.3mm at the physical Xmax position (3mm), so not too bad.

Figures 22 and 23 give the Kms(X) and Kms symmetry range curves for the 4″ midwoofer. The Kms(X) curve is even more symmetrical. ***Figure 23***, the Kms symmetry range plot, shows a 0.35mm coil-in offset at the rest position that increases somewhat to 0.5mm at the physical Xmax of the driver. Displacement limiting numbers calculated by the Klippel analyzer for the midrange were XBl at 82% Bl = 3.4mm and for XC at 75% Cms minimum was 2.4mm, which means that for this 4″ midwoofer, the suspension offset is the most limiting factor for prescribed distortion level of 10%.

Figure 24 gives the inductance curves L(X) for the 12W/4524G00, which shows a typical situation where the inductance increases and the voice coil travels inward covering more of the pole piece. Inductance swing from Xmax forward to Xmax rearward is about 0.21mH inductance. Having Scan-Speak add a copper cap to the pole will decrease the inductive swing, plus you could incorporate the copper cap along with a non-conducting former and get some reasonable subjective improvement, but, of course, you just increased the cost of a cost-effective product!

With the Klippel testing finalized, I mounted the 12W midwoofer in an enclosure which had a 15″ × 5″ baffle and filled with foam damping material and proceeded to measure the driver frequency response both on- and off-axis from 300Hz to 40kHz at 2.83V/1m using a 100-point gated sine wave sweep. ***Figure 25*** depicts the

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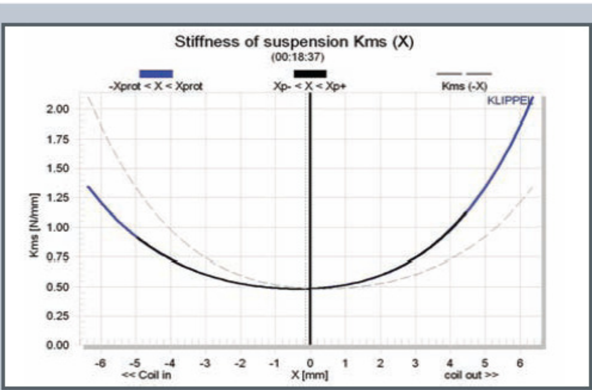

FIGURE 22: Klippel Analyzer mechanical stiffness of suspension Kms (X) curve for the Scan-Speak 12W/4524G00.

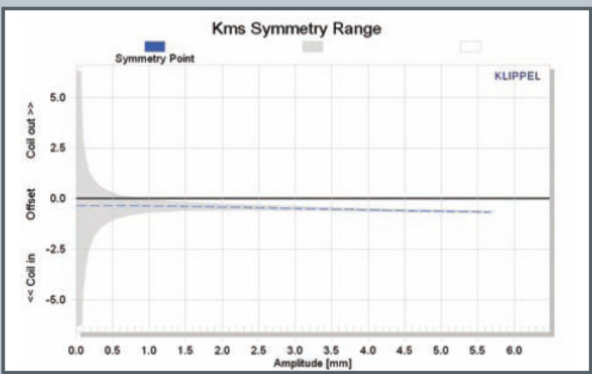

FIGURE 23: Klippel Analyzer Kms symmetry range curve.

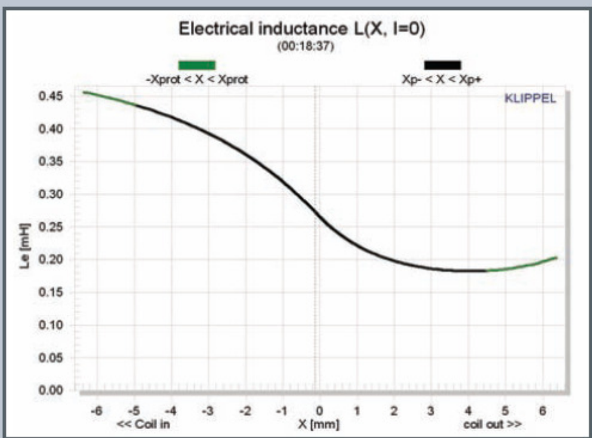

FIGURE 24: Klippel Analyzer L(X) curve for the Scan-Speak 12W/4524G00.

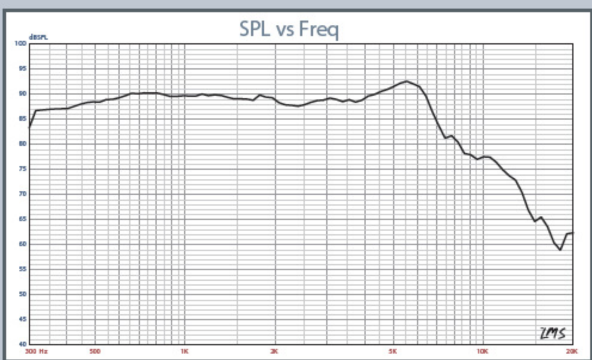

FIGURE 25: Scan-Speak 12W/4524G00 on-axis frequency response.

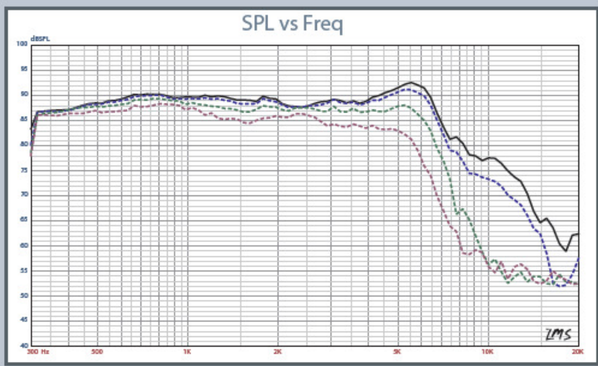

FIGURE 26: Scan-Speak 12W/4524G00 on- and off-axis frequency response.

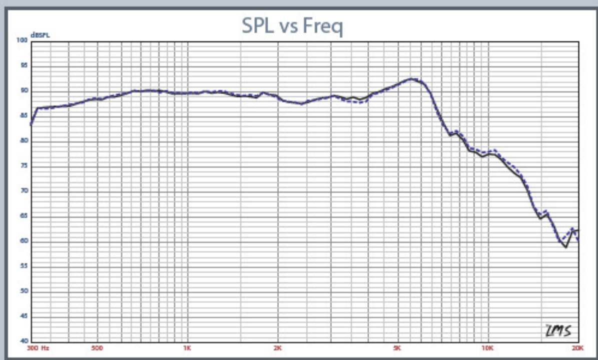

FIGURE 27: Scan-Speak 12W/4524G00 two-sample SPL comparison.

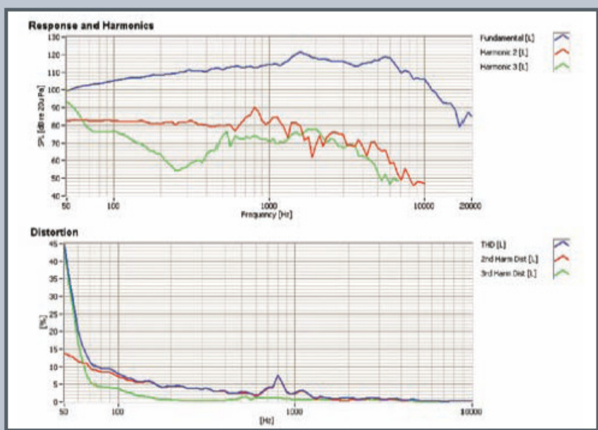

FIGURE 28: Scan-Speak 12W/4524G00 SoundCheck distortion plots.

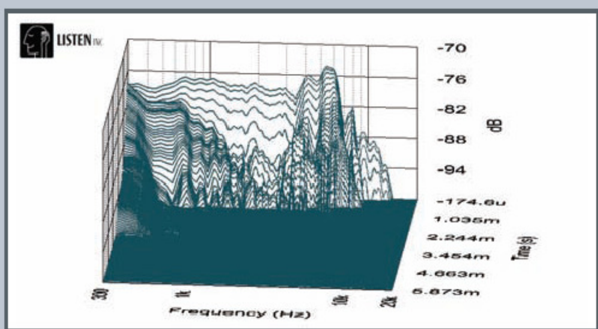

FIGURE 29: Scan-Speak 12W/4524G00 SoundCheck CSD waterfall plot.

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on-axis response resulting in a very flat rising response that is ±1.68dB from 300Hz to 4.5kHz with a small peak just before the low-pass rolloff. ***Figure 26*** has the on- and off-axis frequency response at 0, 15, 30, and 45°. -3dB at 30° with respect to the on-axis curve occurs at 4.5kHz, so a 3-4.5kHz crossover frequency would be appropriate for this Scan-Speak small woofer. And finally, ***Fig. 27*** gives the two-sample SPL comparisons for the 4″ 12W driver, showing a good match within the operating range.

For the last body of testing on the Scan-Speak 4″ midwoofer, I again fired up the SoundCheck analyzer and SCM microphone and power supply to measure distortion and generate time frequency plots. Setting up for the distortion measurement again consisted of mounting the woofer rigidly in free-air, and the SPL set to 94dB at 1m (5.8V) using a noise stimulus (SoundCheck has a software generator and SPL meter as two of its utilities), and then the distortion measured with the SCM microphone placed 10cm from the dust cap. This produced the distortion curves shown in ***Fig. 28***.

For the last test on the 12W, I used 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. 29*** and the Wigner-Ville (for its better low-frequency performance) plot in ***Fig. 30***. For more on this midrange and all the other great Scan-Speak drivers, visit www.scan-speak.dk. ***VC***

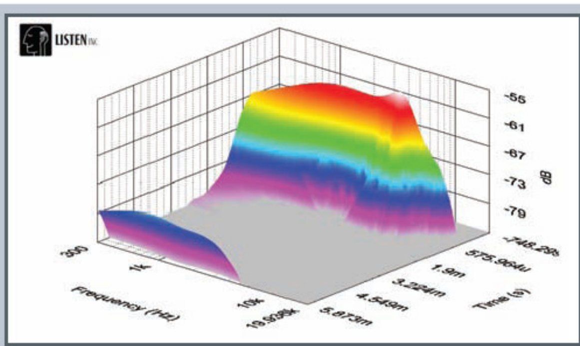

FIGURE 30: Scan-Speak 12W/4524G00 SoundCheck Wigner-Ville plot.