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on **Voice Coil Test Bench (/categories/vc-testbench)**
Article

Test Bench: Scan-Speak 32W/4878T00 Subwoofer

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This month, I examined the 32W/4878T00, a new 12” subwoofer from high-end driver manufacturer Scan-Speak (see Photo 1). Over the years, Scan-Speak has become known for its midwoofers and tweeters, which is to say that its products can be found in a large percentage of the high-end loudspeakers on the market in the last 40 years. Having used Scan-Speak’s drivers in designs for some of my consulting business customers, I found it also makes some excellent subwoofers.

Photo 1: Scan-Speak recently released the 32W/4878T00, a new 12” subwoofer.

At the moment of writing, Scan-Speak has two Discovery line subwoofers, the 10” 26W/4558T00 and the 12” 30W/4558T00, plus a 10” Revelator subwoofer, the 23W/4557T00/02. The new 32W/4558T00 represents its second addition to the Revelator subwoofer line, and from what I was told, the first production run was entirely sold out! The 32W/4878T00 has a generous feature set that includes a proprietary nine-spoke cast aluminum frame that is completely open below the spider-mounting shelf. Other features include the incorporation of a stiff flat 12” cone that uses a paper sandwich formulation with a unique, patented foam fill technology that is stiff and light, an 85-mm hard paper dust cap, nitrile butadiene rubber (NBR) surround, and a 7”-diameter flat cloth spider that has the lead wires woven into the body of the spider (damper).

The 32W/4878T00 is driven by a 75-mm diameter (3”) voice coil wound with round wire on a paper-reinforced vented titanium former. The motor system powering the cone assembly utilizes a 25-mm thick, 175-mm diameter ferrite magnet sandwiched between a polished 8-mm thick front plate and a polished and shaped T-yoke that incorporates a 36-mm diameter pole vent. This motor incorporates the Scan-Speak patented symmetrical drive (SD) — which was originally patented in 1973 — motor system that uses shaped gap parts and copper shorting rings. Additional cooling is provided by the nine large 50-mm × 33 mm “window” vents formed by the frame spokes and located below the spider mounting shelf enabling air to flow across the front plate and exposed voice coil. Last, the braided voice coil lead wires terminate to a pair of gold terminals.

I began characterizing the new 32W/4878T00 12” with the LinearX LMS analyzer and VIBox. I generated both voltage and admittance (current) measurements in free-air at 1, 3, 6, 10, 15, 20, and 25 V. I used the measured Mmd provided by Scan-Speak (an actual physical cone assembly measurement with 50% of the surround and spider removed) rather than a single 1-V added (delta) mass measurement. Note that this multi-voltage parameter test procedure includes heating the voice coil between sweeps for progressively longer periods to simulate operating temperatures at that voltage level (raising the temperature to the third-time constant). I further processed each woofer’s 14 sine wave sweeps with the voltage curves divided by the current curves to produce impedance curves.

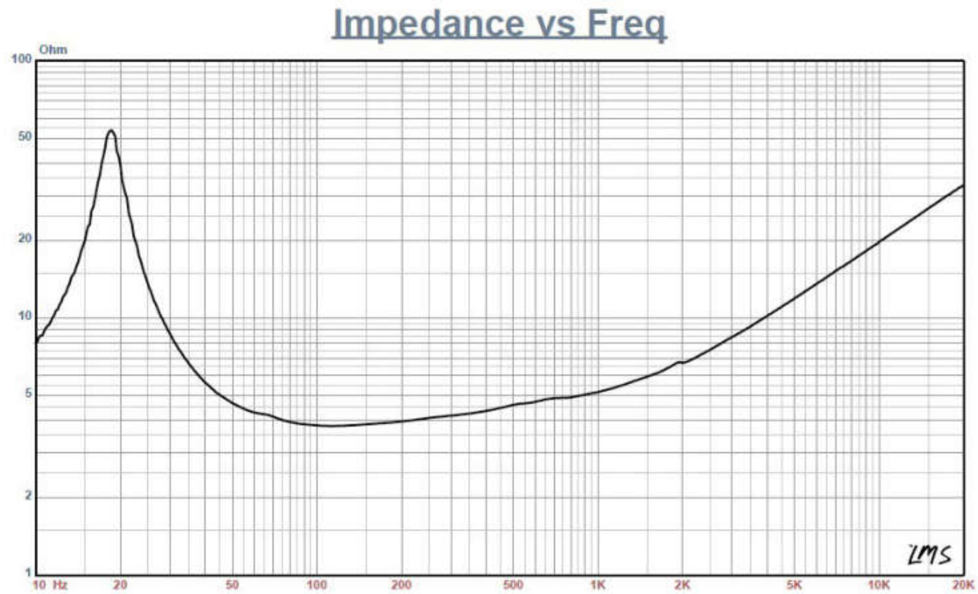

Figure 1: Scan-Speak 32W/4878T00 subwoofer 1-V free-air impedance plot.

	TSL Model		LTD Model		Factory
	Sample 1	Sample 2	Sample 1	Sample 2	
F_S	18.3 Hz	17.1 Hz	17.6 Hz	16.4 Hz	18 Hz
R_{EVC}	3.05	3.06	3.05	3.06	3.1
Sd	0.0523	0.0523	0.0523	0.0523	0.0531
Q_{MS}	6.15	5.67	5.37	5.25	7
Q_{ES}	0.37	0.33	0.35	0.33	0.33
Q_{TS}	0.35	0.32	0.33	0.31	0.32
V_{AS}	196.4 ltr	223.5 ltr	214.34 ltr	244.8 ltr	207.5 ltr
SPL 2.83 V	87 dB	87.1 dB	87 dB	87 dB	90 dB
X_{MAX}	14 mm	14 mm	14 mm	14 mm	14 mm

Table 1: Scan-Speak 32W/4878T00 subwoofer.

I used the LEAP phase calculation routine to generate the phase curves. I then copied and pasted the impedance magnitude and phase curves plus the associated voltage curves into the LEAP 5 software's Guide Curve library. I used this data to calculate parameters using the LEAP 5 LTD transducer model. Because almost all manufacturing data is produced using either a standard transducer model or the LEAP 4 TSL model, I also generated LEAP 4 TSL model parameters using the 1-V free-air that can also be compared with the manufacturer's data. See Figure 1 for the 32W/4878T00 1-V free-air impedance plot. Table 1 compares the LEAP 5 LTD and LEAP 4 TSL T/S parameter sets for the 32W/4878T00 driver samples with the Scan-Speak factory data.

Using the Scan-Speak subwoofer's comparative data in Table 1, you can see that all four parameter sets for the two samples were reasonably similar and correlated with the factory data, with the exception that the Scan-Speak data quotes a somewhat larger SD and about 3-dB greater efficiency. Following my normal protocol for Test Bench testing, I used the sample 1 LEAP 5 LTD parameters and set up two computer box simulations, one in a 1.75-ft3 Butterworth-type sealed enclosure with 50% fill material (fiberglass) and a second vented box quasi third order Butterworth (QB3) alignment in a 2.91-ft3 box with 15% fill material and tuned to 21 Hz.

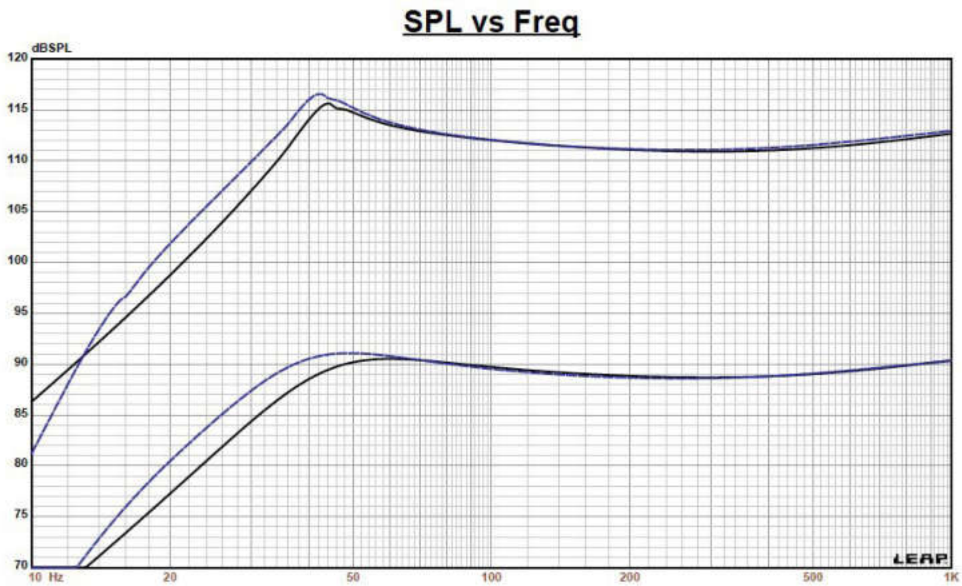

Figure 2: Scan-Speak 32W/4878T00 computer box simulations (black solid = sealed at 2.83 V; blue dash = vented at 2.83 V; black solid = sealed at 48 V; blue dash = vented at 50 V).

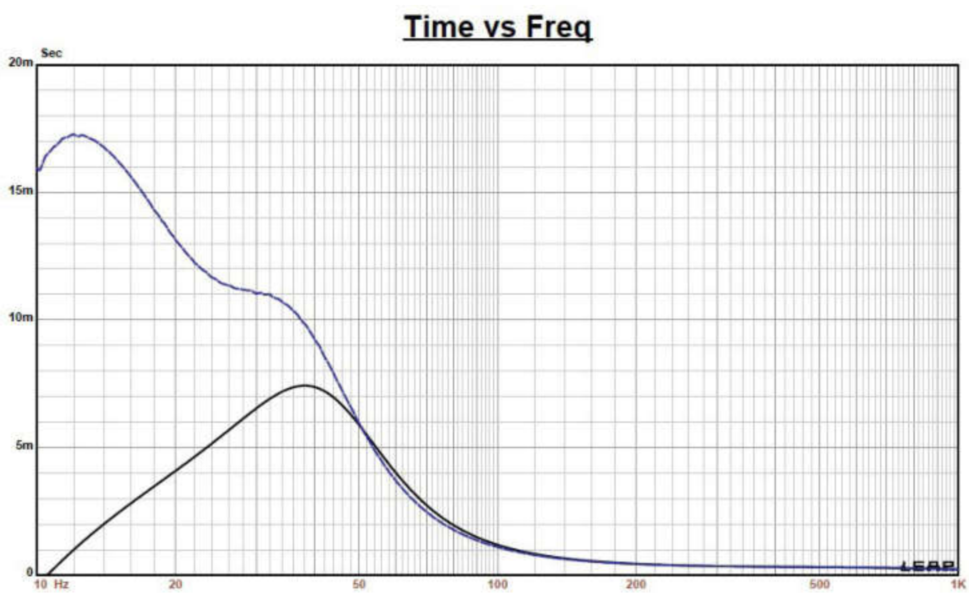

Figure 3: Scan-Speak 32W/4878T00 group delay curves for the 2.83-V curves in Figure 2.

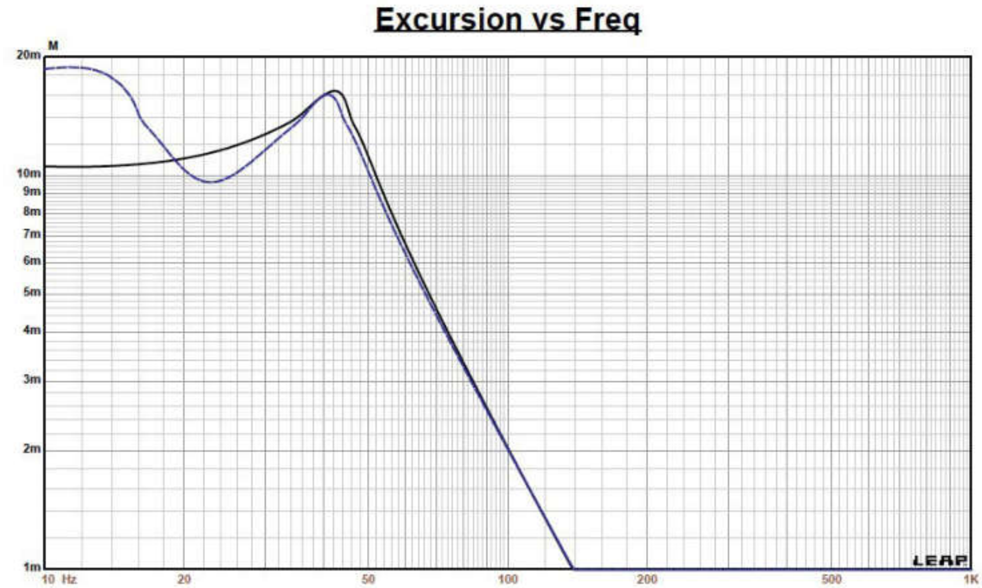

Figure 4: Scan-Speak cone excursion curves for the 48-V and 50-V curves in Figure 2.

Figure 2 shows the results for the Scan-Speak 32W/4878T00 in the sealed and vented enclosures at 2.83 V and at a voltage level sufficiently high enough to increase cone excursion to XMAX + 15% (16.1 mm for 32W/4878T00). This resulted in a F3 of 37 Hz (–6 dB = 30.3 Hz) with a QTC = 0.67 for the 1.75-ft3 closed box and a –3 dB for the 32 Hz (–6 dB = 30 Hz) QB3 vented simulation. A larger extended bass shelf (EBS), a 4.9-ft3 enclosure tuned to 18.5 Hz would have produced an F3 of 26 Hz and F6 of 21.5 Hz. Increasing the voltage input to the simulations until the approximate XMAX + 15% maximum linear cone excursion point was reached resulted in 115.5 dB at 48 V for the sealed enclosure simulation and 116.5 dB with a 50-V input level for the larger vented box. See Figure 3 and Figure 4 for the 2.83-V group delay curves and the 48 V/50-V excursion curves.

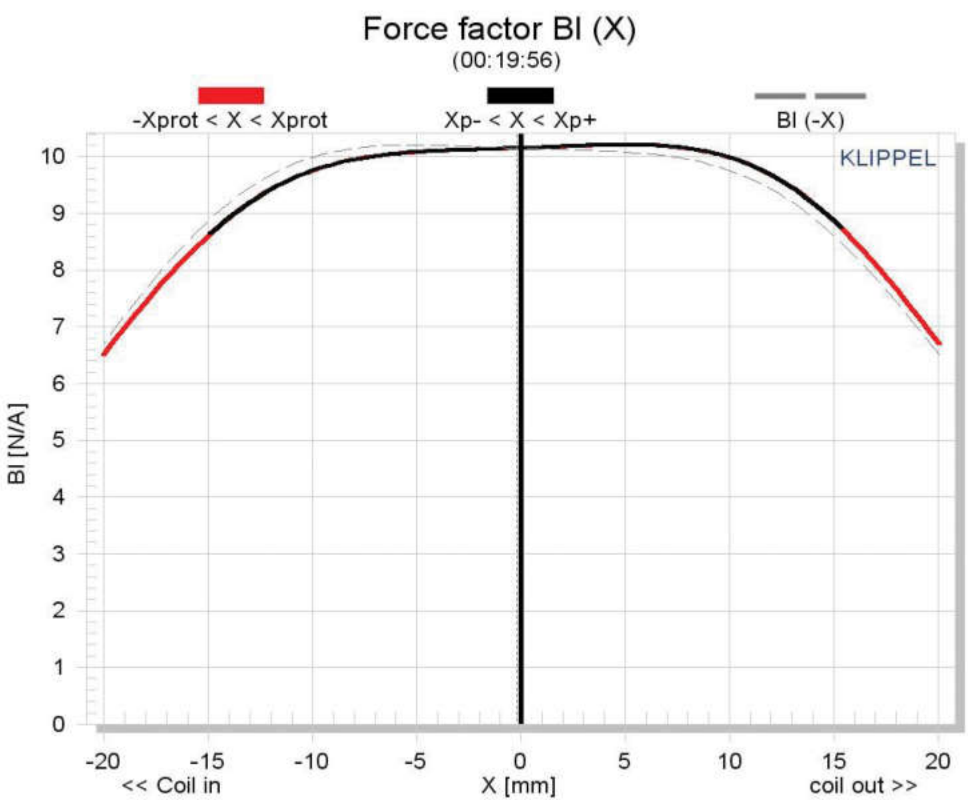

Figure 5: Klippel analyzer Bl (X) curve for the Scan-Speak 32W/4878T00.

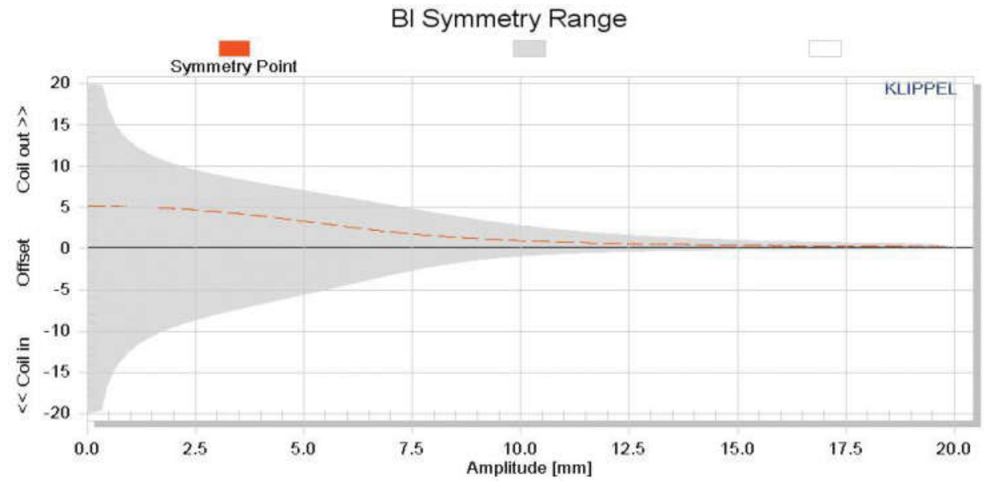

Figure 6: Klippel Analyzer Bl symmetry range curve for the Scan-Speak 32W/4878T00.

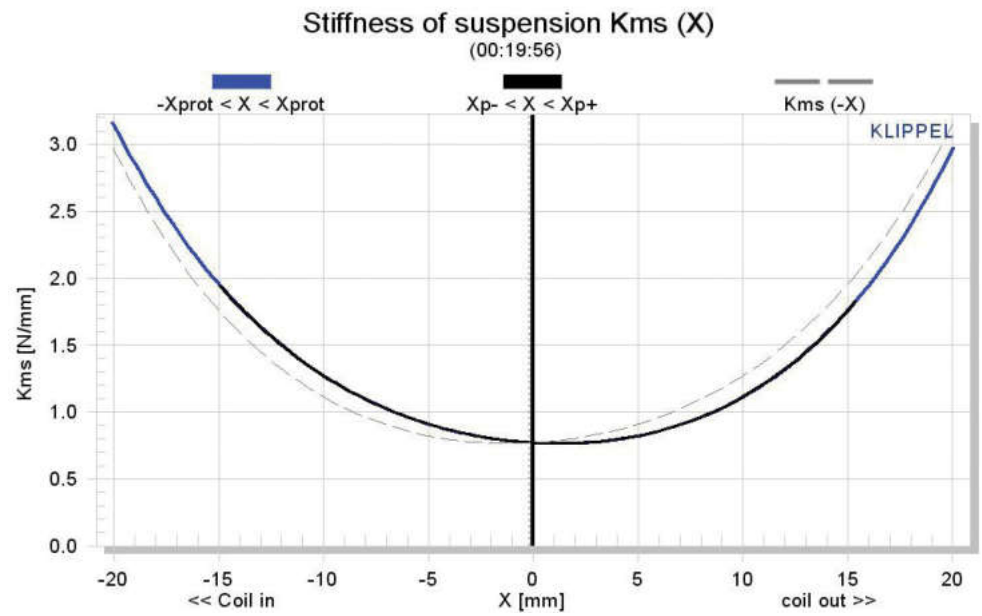

Figure 7: Klippel analyzer mechanical stiffness of suspension Kms (X) curve for the Scan-Speak 32W/4878T00.

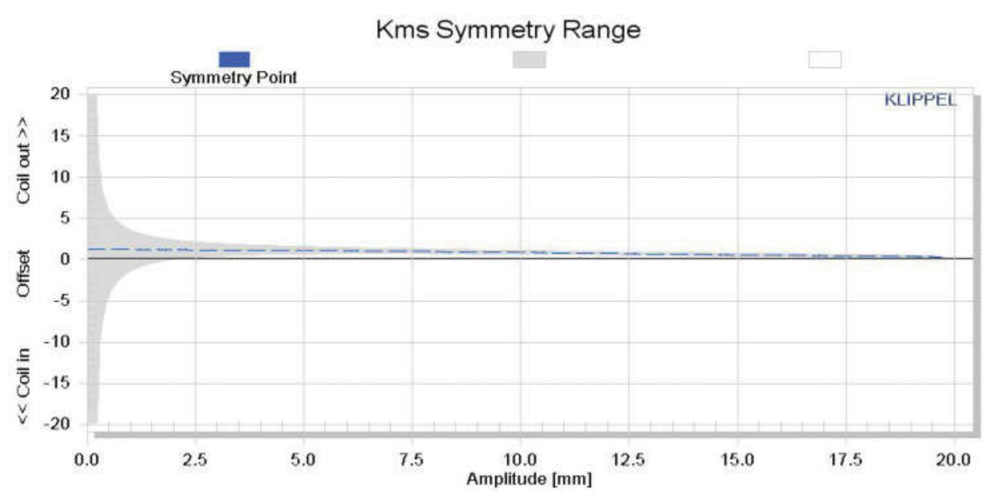

Figure 8: Klippel analyzer Kms symmetry range curve for the Scan-Speak 32W/4878T00.

Klippel analysis for the Scan-Speak 32W/4878T00 12" woofer produced the Klippel data graphs shown in Figures 5–8. Klippel provided the analyzer, and Patrick Turnmire of Red Rock Acoustics performed the analysis. Please note, if you do not own a Klippel analyzer and would like this type of data on any transducer, Red Rock Acoustics can provide Klippel analysis. Visit **www.redrockacoustics.com (http://www.redrockacoustics.com)** for more information.

The Bl(X) curve for Scan-Speak 32W/4878T00 shown in Figure 5 is very broad and symmetrical (with a slight tilt) typical of a driver with substantial XMAX. The Bl symmetry curve in Figure 6 shows 5-mm Bl coil out (forward) offset at rest, which transitions to a near-zero offset at the 10 to 12 mm of excursion; however, you want to ignore this. Because Bl curve has almost no offset at all, the analyzer has difficulty resolving this at small amounts of excursion (0 to 8 mm). The gray area represents the degree of uncertainty in the measurement.

Figure 7 and Figure 8 show the KMS(X) and KMS symmetry curves for the Scan-Speak subwoofer. Like the Bl curve, the KMS stiffness of compliance curve is very symmetrical, with only a minor offset (see Figure 7). The KMS symmetry range curve has a minor 1-mm offset at rest decreasing to 0.3 mm at the driver's physical XMAX. The Klippel analyzer calculated the 32W/4878T00's displacement-limiting numbers using the woofer criteria for Bl (XBl at 70%). The Bl dropping to 70% of its maximum value is equal to 14.9 mm. This number is somewhat greater than the physical 14-mm Xmax for this driver for the prescribed 20% distortion level, which is the criterion for subwoofers. For the compliance, XC at 50% Cms minimum was 12.3 mm (1.7 mm less than this driver's physical Xmax), which means that for the 32W/4878T00 subwoofer, the compliance is the more limiting factor for achieving the 20% distortion level.

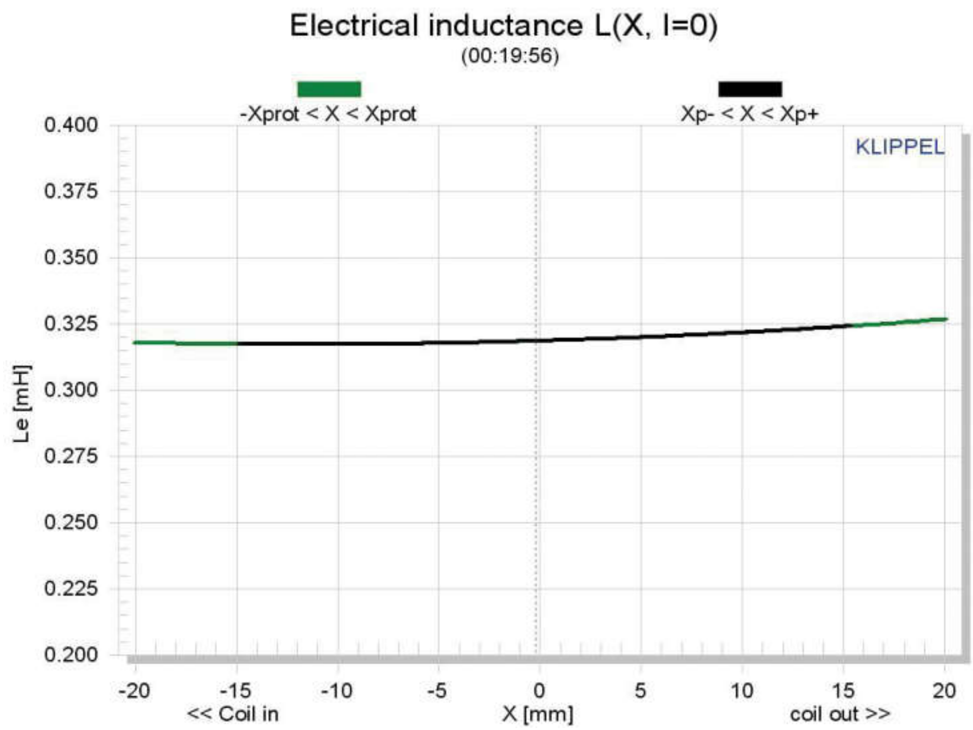

Figure 9: Klippel analyzer Le(X) curve for the Scan-Speak 32W/4878T00.

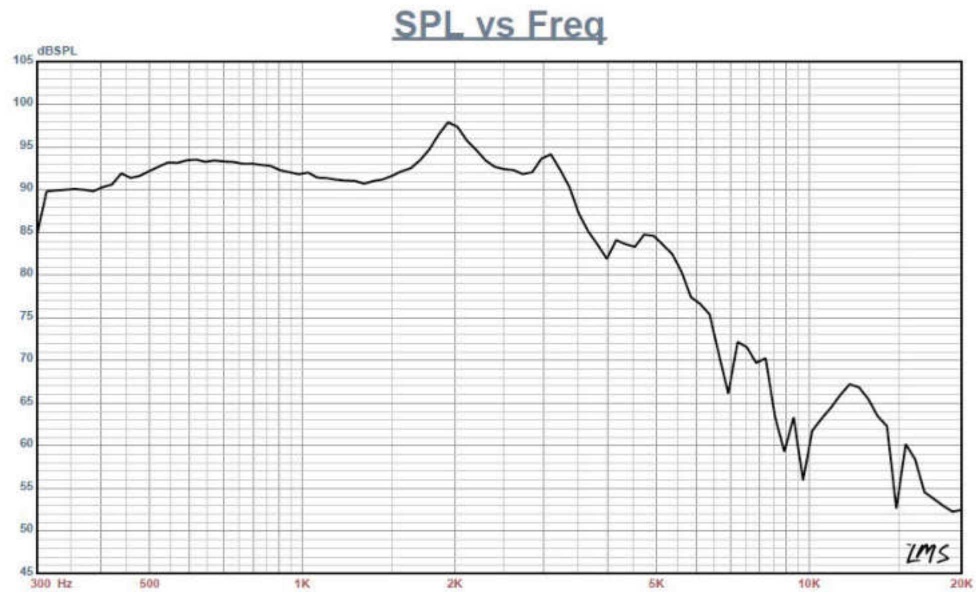

Figure 10: Scan-Speak 32W/4878T00 on-axis frequency response.

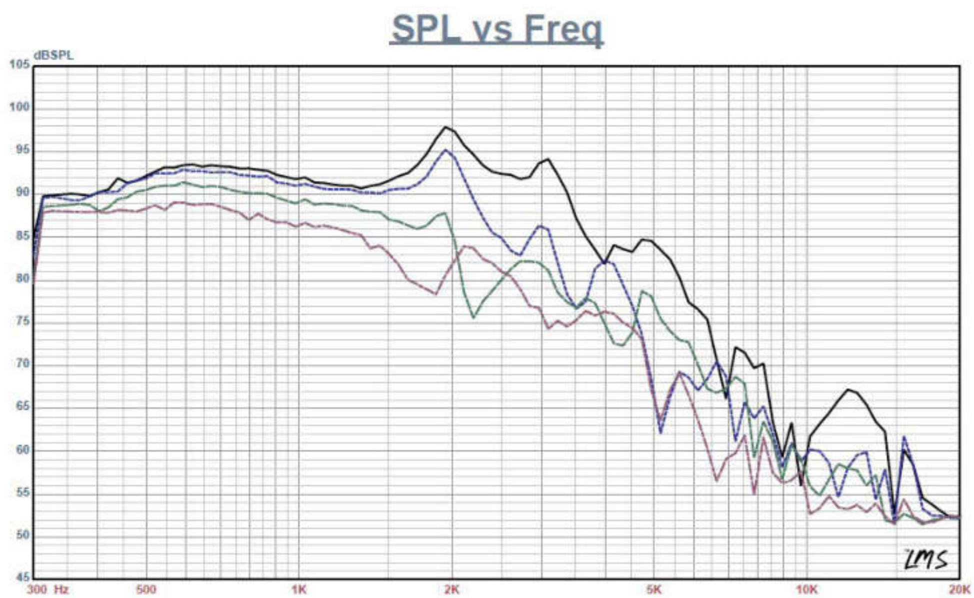

Figure 11: Scan-Speak 32W/4878T00 on- and off-axis frequency response.

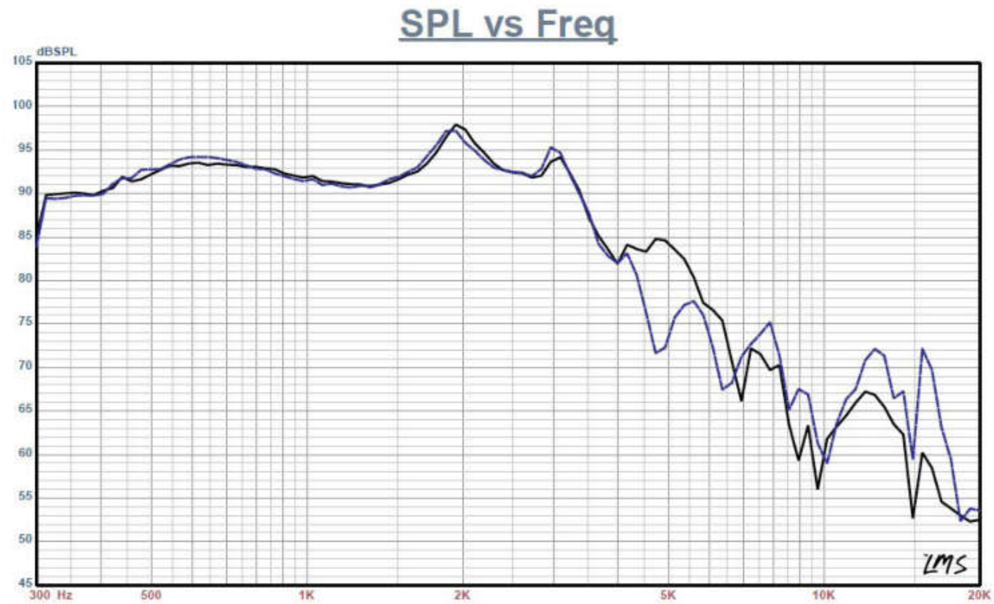

Figure 12: Scan-Speak 32W/4878T00 two-sample SPL comparison.

Figure 9 shows this transducer's inductance curve Le(X). Motor inductance will typically increase in the rear direction from the zero rest position and decrease in the forward direction as the voice coil moves out of the gap and has less pole coverage; however, that doesn't happen here. There is almost no inductance variation from full-in to full-out travel, which is the goal. It's easy to see the benefits of the Scan-Speak symmetrical drive motor. Delta inductance over the full range of motion is only 0.01 mH, which is outstanding.

After the Klippel analysis, I mounted the driver in a large enclosure filled with foam damping material with a 15″ × 15″ baffle area and used the LMS gated sine wave technique to measure the Scan-Speak 12″ SPL on- and off-axis. Figure 10 gives the on-axis response measured 300 Hz to 20 kHz at 2.83 V/1 m. The response is smooth out to the breakup mode at 2 kHz. Figure 11 shows the on- and off-axis to 45°. Although this is a subwoofer, it could be used in a three-way configuration with a low-pass crossover frequency as high as 1.2 kHz or so to a midrange driver. Finally, Figure 12 provides the two-sample SPL comparison showing, as expected from Scan-Speak, the drivers to be well matched.

Next, I used the Listen SoundCheck analyzer to perform distortion analysis. As usual, I dispensed with time-frequency analysis for subwoofers as the data is not really significant below 100 Hz. For distortion measurements, I set the voltage level with the driver mounted in an enclosure with a 14″ × 30″ baffle and increased it until it produced an 1-m SPL of 94 dB (1.4 V), which is my SPL standard for home audio drivers. I made the distortion measurement with the microphone placed near-field (10 cm) and the woofer mounted in the enclosure. Figure 13 shows the plot for the 12″ Scan-Speak subwoofer. There are actually two plots, the top graph is the standard fundamental SPL curve with the second- and third-harmonic curves, and the bottom graph shows the second- and third-harmonic curves, plus the THD curve with an appropriate x-axis scale.

Interpreting the subjective value of conventional distortion curves is almost impossible; however, looking at the relationship of the second- to third-harmonic distortion curves is of value. As can be inferred from the data, this is another well-crafted transducer from the group at Scan-Speak.
www.scan-speak.dk (http://www.scan-speak.dk)

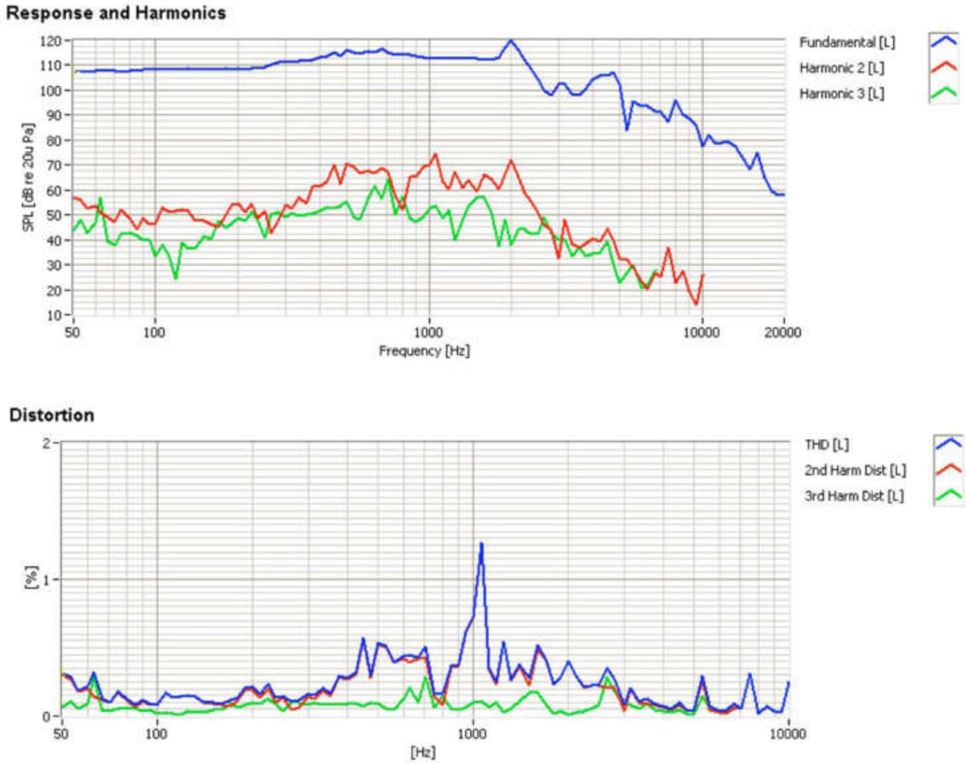

Figure 13: 32W/4878T00 SoundCheck distortion plots.

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