Another Look at Scan-Speak's 12MU/473100

by Vance Dickason

I had begun testing the Scan-Speak 12MU/4731T00 (see **Photo 1**), when I recalled that this driver had been tested previously. Looking through the *Voice Coil* archives, I found that I had characterized the Scan 12MU in the July 2009 issue. Rather than put this back on the shelf, I thought that readers might find it interesting to not only take another look at this very good sounding high-end midrange again, but to also compare current production with the data taken nearly two years ago. Knowing the emphasis on quality and quality control that Scan puts into its production, I expected the data to turn out very close, which indeed it did.

As part of Scan-Speak's Illuminator series of the drivers, the 12MU is built on the same great looking frame as the other Illuminator woofers, with the same, but scaled down, underhung (gap height is 13 mm, with a 6-mm voice coil height) neodymium ring magnet motor structure (see **Photo 2**). Like the woofer motor, the front plate is shaped to "guide" the backside airflow around the motor. In terms of features, the 12MU uses a single layer uncoated curvilinear embossed paper cone as opposed to the two-layer embossed cone employed for the 15WU and 18WU woofers. I am going to assume that the embossing on the 12MU cone is more cosmetic than functional and is intended to match the "look" of the Illuminator woofers. The uncoated paper dust cap is also embossed to complete the cosmetic appearance of the 12MU. Other features include a flat-cloth spider and a coated-foam surround (Mmd for this driver is only 5.2 grams), copper shorting ring, and lead wires that are terminated to gold-plated terminals.

Testing commenced with the driver clamped to a rigid test fixture in free-air, with voltage and current sweeps taken at 0.3 V, 1 V, 3 V, 6 V, and 10 V. The 10 V proved to be somewhat non-linear and was not used, but it was close, which is amazing for a 4" driver. The remaining eight 550-point stepped sine wave sweeps for each 12MU midrange sample were post-processed. The voltage curves were divided by the current curves (admittance) to create impedance curves, phase added using LMS calculation method, and along with the accompanying voltage curves, saved to the LEAP 5 Enclosure Shop software. In addition to the LEAP 5 LTD model results, I also created a LEAP 4 TSL model set of parameters using just the 1-V free-air curves. The final data set, which includes the multiple voltage impedance curves for the LTD model and the 1-V impedance curve for the TSL model (see **Figure 1** for the 1-V free-air impedance curve), 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 of Scan-Speak 4" samples measured for this issue. **Table 2** gives the data for the pair measured in July 2009.

As I expected, the Scan data was very consistent from 2009 and 2012, with about the same variation between LEAP parameter calculation results for the Scan 12MU mid and the factory data. As before, the Fs/Qt ratios are reasonably close to the Scan-Speak factory data. Given this, I set up computer enclosure simulations using the LEAP LTD parameters for Sample 1, the same sealed box volumes used in the July 2009 report. For the first closed box simulation I used a 38ci enclosure with 50% fiberglass fill material, and for the second sealed box, a larger volume of 62ci Qb3 also with 50% fiberglass fill material.

Figure 2 displays the results for the 12MU/4731T00 in the

Photo 1: The Scan-Speak 12MU/4731T00

Photo 2: The 12MU is built with a neodymium ring magnet motor structure

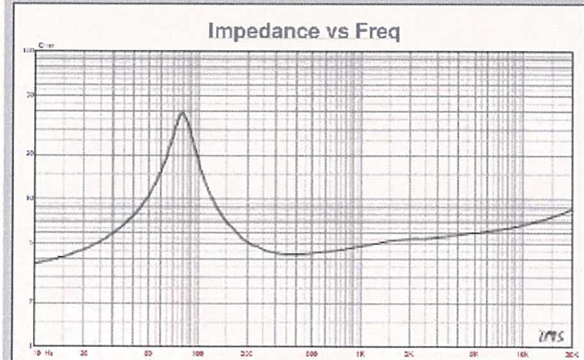

Figure 1: Scan-Speak 12MU/4731T00 free-air impedance plot

	TSL model		LTD model		Factory
	sample 1	sample 2	sample 1	sample 2	
Fs	79.4 Hz	66.2 Hz	74.5 Hz	62.5 Hz	64 Hz
Revc	3.11	3.03	3.11	3.03	3.1
Sd	0.0057	0.0057	0.0057	0.0057	0.0058
Qms	4.18	3.87	3.48	3.32	3.64
Qes	0.37	0.30	0.30	0.27	0.26
Qts	0.34	0.28	0.28	0.25	0.24
Vas	3.4 ltr	4.9 ltr	3.9 ltr	5.6 ltr	5.4 ltr
SPL 2.83 V	88.5 dB	88.6 dB	89.0 dB	88.9 dB	90 dB
Xmax	3.5 mm	3.5 mm	3.5 mm	3.5 mm	3.5 mm

Table 1: Scan-Speak 12MU/4731T00 midrange, tested March 2012

	TSL model		LTD model		Factory
	sample 1	sample 2	sample 1	sample 2	
Fs	75.3 Hz	76.5 Hz	73.2 Hz	74.7 Hz	64 Hz
Revc	3.04	2.91	3.04	2.91	3.1
Sd	0.0057	0.0057	0.0057	0.0057	0.0058
Qms	3.58	3.98	3.13	3.53	3.64
Qes	0.34	0.31	0.30	0.30	0.26
Qts	0.31	0.31	0.27	0.27	0.24
Vas	3.6 ltr	3.4 ltr	3.8 ltr	3.7 ltr	5.4 ltr
SPL 2.83 V	88.4 dB	88.6 dB	88.7 dB	88.9 dB	90 dB
Xmax	3.5 mm	3.5 mm	3.5 mm	3.5 mm	3.5 mm

Table 2: Scan-Speak 12MU/4731T00 midrange, tested July 2009

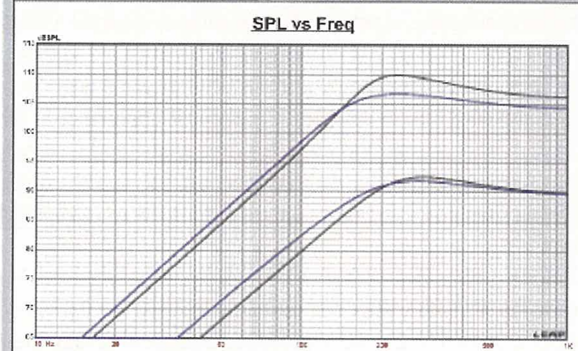

Figure 2: Scan-Speak 12MU/4731T00 computer box simulations (black solid = sealed 1 @ 2.83 V; blue dash = sealed 2 @ 2.83 V; black solid = sealed 1 @ 25 V, blue dash = sealed 2 @ 18 V)

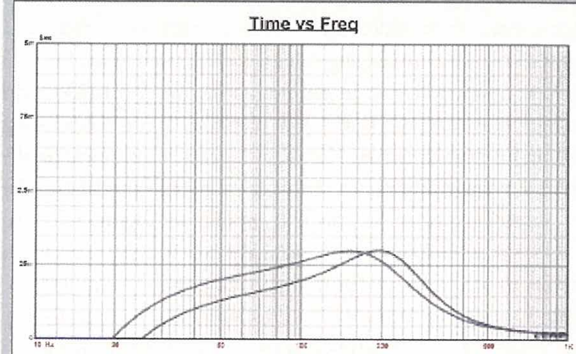

Figure 3: Group delay curves for the 2.83-V curves in Figure 2

two sealed boxes at 2.83 V and at a voltage level sufficiently high enough to increase cone excursion to Xmax + 15% (4 mm for the 12MU). This resulted in a F3 = 181 Hz with a box/driver Qtc of 0.67 for the 38 ci design and a –3 dB = 156 Hz with a Qtc = 0.57 for the 62 ci simulation. The July 2009 results were close to the same F3/Qtc with a F3 = 171 Hz with a box/driver Qtc of 0.70 for the 38-ci design and a –3 dB = 150 Hz with a Qtc = 0.60 for the 62-ci simulation.

Increasing the voltage input to the simulations until the maximum linear cone excursion was reached generated 110 dB at 25 V for the sealed-enclosure simulation and 106 dB with an 18-V input level for the larger closed box (see **Figure 3** and **Figure 4** for the 2.83-V group delay curves and the 25/19-V excursion curves). Obviously, the 12MU, as with any midrange, will be used in conjunction with a band-pass filter network, but this information can help locate an appropriate crossover frequency. It is often difficult to locate the high-pass section of a band-pass filter within one octave or less of the resonance of a midrange device and sometimes requires and LCR conjugate circuit to prevent the circuit interaction.

Klippel analysis for the Scan 12MU midrange produced the Bl(X), Kms(X) and Bl and Kms Symmetry Range plots given in **Figures 5** to **8**. The Bl(X) curve for the 12MU (see **Figure 5**) is moderately broad and very symmetrical, which is more like a woofer than a midrange. Looking at the Bl symmetry range curve in **Figure 6**, there is a 0.5-mm rearward (coil-in) offset that goes to 0 mm at the physical Xmax position (3.5 mm for the 12MU). **Figure 7** and **Figure 8** give the Kms(X) and Kms symmetry range curves for the12MU. The Kms(X) curve also is very symmetrical. However since the application is as a midrange that will always have a band-pass filter, excursion will be limited, regardless of how good the Klippel data for this driver looks. Even considering this, the forward coil-out offset at rest is only 1.5 mm resolving to 0 mm at about 3 mm of travel. Displacement limiting numbers calculated by the Klippel analyzer for the Scan midrange were XBl @ 82% Bl = 6.1 mm and for XC @ 75% Cms minimum was 4.8 mm, which means that for this 4" mid, the compliance is the most limiting factor for prescribed distortion level of 10%. Regardless, it is still significant that both XBl and XC numbers occur beyond the physical Xmax. The 12MU may be offered as a midrange, but it's really not so bad as a woofer! **Figure 9** gives the inductance curves Le(X) for the 12MU/4731T00, which shows a very small 0.15-mH inductance change across the operating range, again due to the copper shorting ring and overall motor construction.

With the Klippel testing finalized, I mounted the 12MU driver in an enclosure which had a 15" × 5" baffle filled with foam damping material and proceeded to measure the driver frequency response both on- and off-axis from 300 Hz to 40 kHz at 2.83 V/1 m using a 100-point gated sine wave sweep. **Figure 10** depicts the 12MU's on-axis response displaying a smooth rising response to about 1 kHz, flattening out above that frequency. **Figure 11** compares the April 2012 on-axis curve to the July 2009 version. These two curves are very close, but if anything, Scan has improved the response by eliminating the 5.3-Hz peak that was in the previous test.

Figure 12 shows the on- and off-axis frequency response at 0°, 15°, 30°, and 45°. The –3 dB at 30°, with respect to the on-axis curve, occurs at 4 kHz, so a 4- to 5-kHz crossover frequency

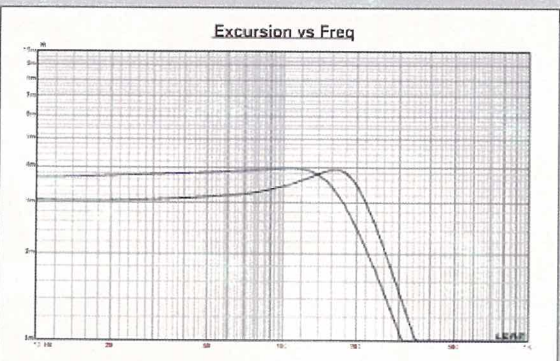

Figure 4: Cone excursion curves for the 25/18-V curves in Figure 2

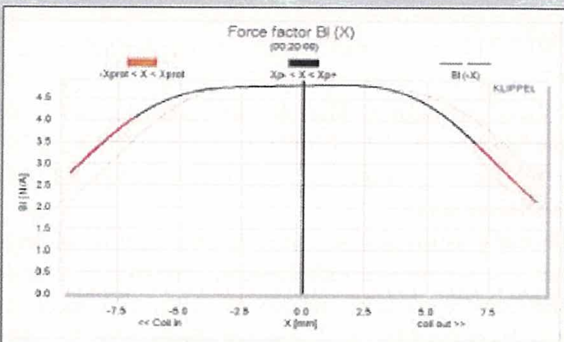

Figure 5: Klippel Analyzer Bl (X) curve for the Scan-Speak 12MU/4731T00

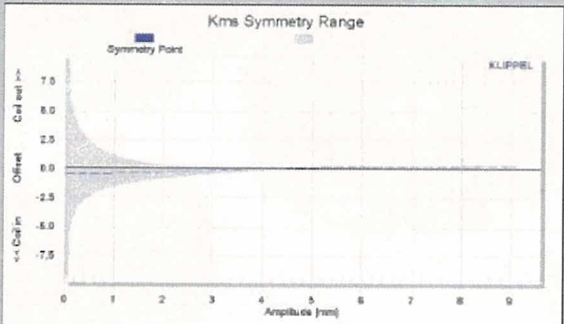

Figure 6: Klippel Analyzer Bl symmetry range curve for the Scan-Speak 12MU/4731T00

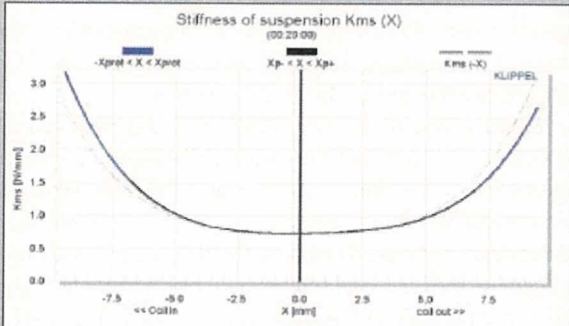

Figure 7: Klippel Analyzer mechanical stiffness of suspension Kms (X) curve for the Scan-Speak 12MU/4731T00

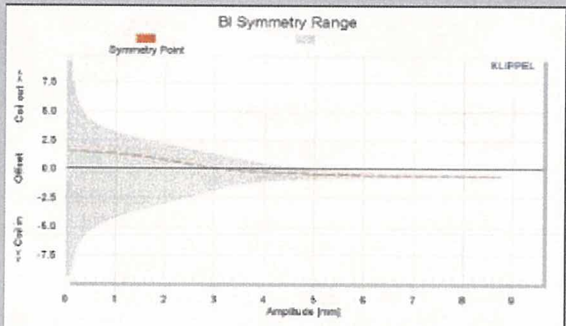

Figure 8: Klippel Analyzer symmetry range curve for the Scan-Speak 12MU/4731T00

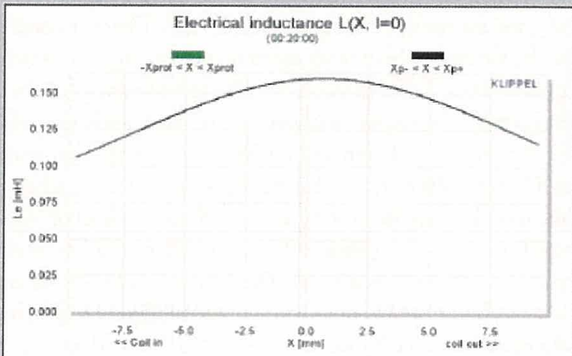

Figure 9: Klippel Analyzer Le (X) curve for the Scan-Speak 12MU/4731T00

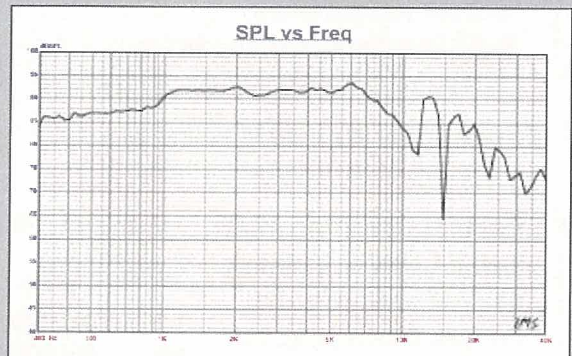

Figure 10: Scan-Speak 12MU/4731T00 on-axis frequency response

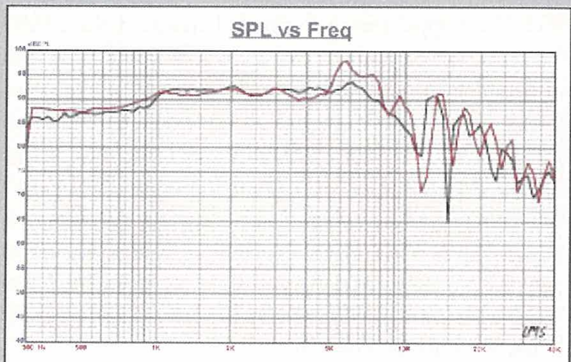

Figure 11: Scan-Speak 12MU/4731T00 on-axis frequency response comparison of February 2012 sample to July 2009 sample

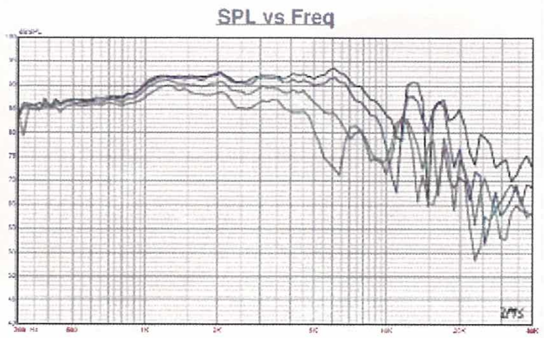

Figure 12: Scan-Speak 12MU/4731T00 on- and off-frequency response

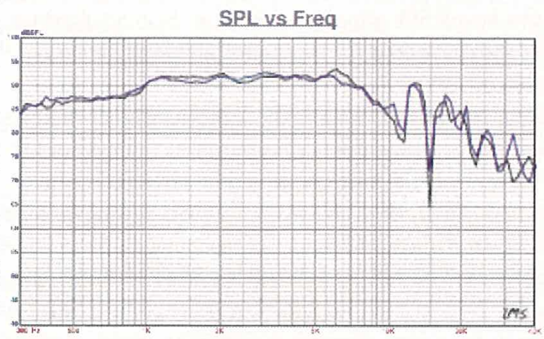

Figure 13: Scan-Speak 12MU/4731T00 two-sample comparison

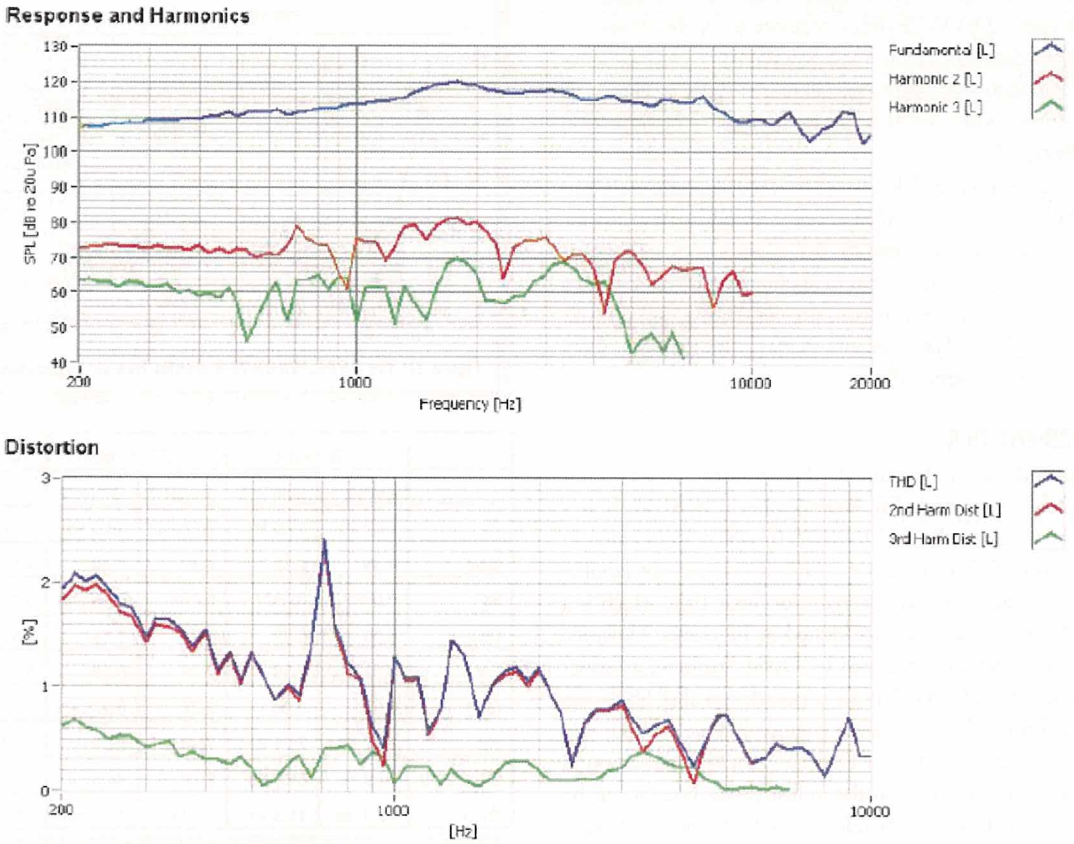

Figure 14: Scan-Speak 12MU/4731T00 SoundCheck distortion plot

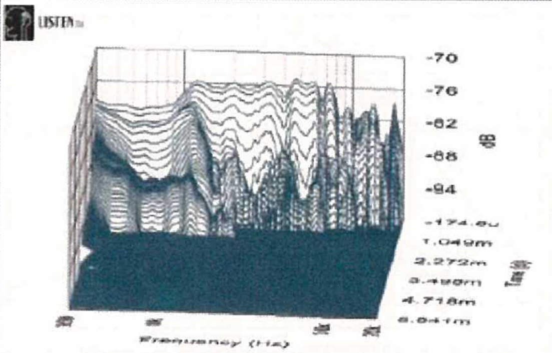

Figure 15: Scan-Speak 12MU/4731T00 SoundCheck CSD waterfall plot

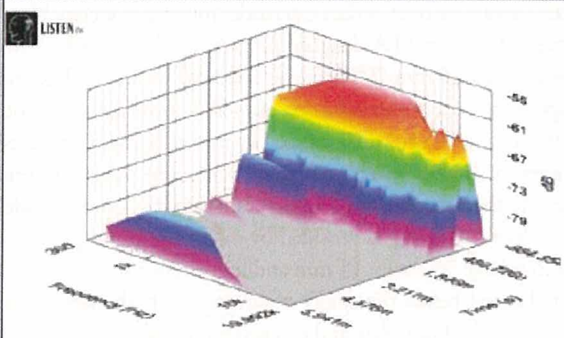

Figure 16: Scan-Speak 12MU/4731T00 SoundCheck Wigner-Ville plot

would be appropriate for this driver. And finally, **Figure 13** gives the two-sample SPL comparisons for the 4" Scan-Speak midrange driver, showing a good match within 1 dB or less throughout the operating range.

For the last body of testing on the Scan-Speak 12MU midrange, I used the Listen, Inc. SoundCheck analyzer (courtesy of Listen, Inc.) and the SCM microphone and power supply to measure distortion and generate time-frequency plots. Setting up for the distortion measurement consisted of mounting the woofer rigidly in free-air, and the SPL set to 94 dB at 1 m (4.8 V) 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 10 cm from the phase plug. This produced the distortion curves shown in **Figure 14.**

For the last test on the Scan 12MU, I used the SoundCheck analyzer to get a 2.83 V/1 m 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 **Figure 15** and the Wigner-Ville (for its better low-frequency performance) plot in **Figure 16**.

What attracts high-end loudspeaker manufacturers to Scan-Speak products is not only their musical sound quality, but the overall precision and consistency that goes along with Scan's manufacturing culture. It was fun to examine this driver, compare it with data I took nearly two years previously, and end up with the results I expected. For more information, visit the Scan-Speak website at www.scan-speak.dk.