

To set up for the distortion measurement, I mounted the woofer rigidly in free-air and used a noise stimulus (SoundCheck has a software generator and SPL meter as two of its utilities) to set the SPL to 104 dB at 1 m. Then, I measured the distortion with the Listen microphone placed 10 cm from the dust cap. **Figure 11** shows the CF18VJS's distortion curves.

Celestion has delivered a well-designed and extremely robust 18" for pro-sound woofer for public address (PA) applications. The CF18VJD also has a number of fairly unique proprietary features. For more information on this and other pro sound products from Celestion, visit www.celestion.com.

The M0610

This next submission comes from a company new to Test Bench, MAG Professional Loudspeakers, which is located in Bila Tserkva, Ukraine. (Russian names are easy to pronounce in Russian, it's phonetic, but nearly impossible figure out in their anglicized incarnation.) MAG was founded in 1989 as a post-Perestroika cooperative venture, specializing in cone



Photo 2: MAG Company factory headquarters in the Ukraine



Photo 3: MAG's M0610 pro sound midrange driver

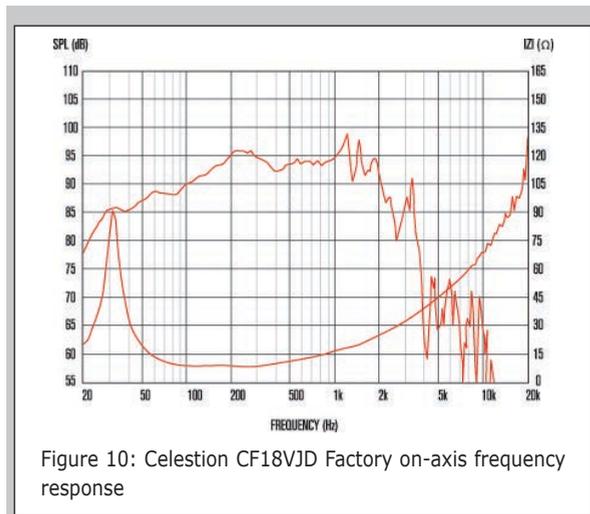


Figure 10: Celestion CF18VJD Factory on-axis frequency response

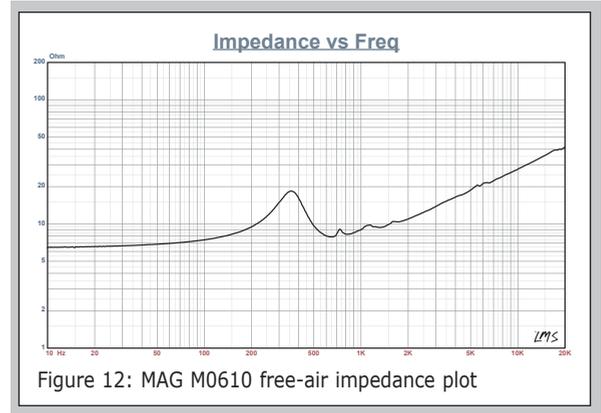


Figure 12: MAG M0610 free-air impedance plot

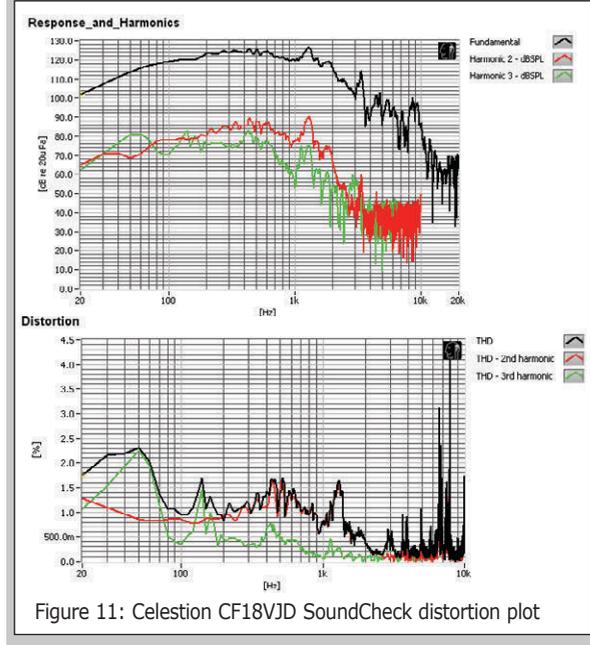


Figure 11: Celestion CF18VJD SoundCheck distortion plot

speaker production and repair. The main production facility was built a year later, in 1990 (see **Photo 2**).

The company's primary products were ferrite magnets, which MAG continues to produce. In 1993, MAG exported its first batch of loudspeakers abroad. Since then, MAG has been shipping its products to Israel, Poland, Belarus, the Russian Federation, Moldova, Romania, and Germany. Since 1995, MAG transducers have been assembled exclusively using components from Dr. Kurt Mueller GmbH and U-Sonics in Malaysia.

In 2006, MAG began manufacturing speaker systems that range from small mobile sound systems and tiny PA speakers to large-scale touring front-of-house (FOH) speakers and line arrays. MAG professional transducers include a range of cone loudspeakers with sizes from 6" to 21", plus 1", 1.4", 1.5", and 2" high-frequency drivers and coaxial drivers. Besides manufacturing, MAG provides services in audio and lighting development, installation, and maintenance.

MAG currently has 120 employees and a 30,000 ft²

	TSL Model		LTD Model		Factory
	Sample 1	Sample 2	Sample 1	Sample 2	
F_s	352.3 Hz	333.9 Hz	333.9 Hz	317.9 Hz	255 Hz
R_{EVC} (series)	6.2	6.22	6.2	6.22	6.3
S_d	0.0139	0.0139	0.0139	0.0139	0.0143
Q_{MS}	2.23	2.44	3.78	2.79	2.17
Q_{ES}	1.26	0.83	1.7	1.23	0.96
Q_{TS}	0.81	0.83	1.14	0.85	0.67
V_{AS}	0.64 ltr	0.71 ltr	0.75 ltr	0.86 ltr	1.21 ltr
SPL 2.83 V	95.3 dB	95.1 dB	93.8 dB	94.9 dB	98 dB
X_{MAX}	1 mm	1 mm	1 mm	1 mm	2.6 mm

Table 2: MAG M0610 midrange comparison data

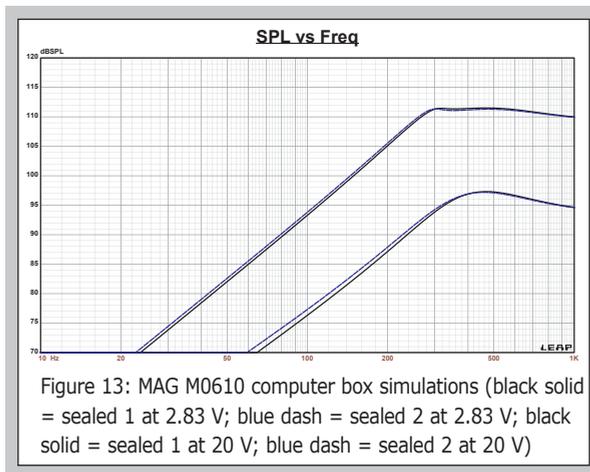


Figure 13: MAG M0610 computer box simulations (black solid = sealed 1 at 2.83 V; blue dash = sealed 2 at 2.83 V; black solid = sealed 1 at 20 V; blue dash = sealed 2 at 20 V)

production facility. About 60% of MAG's production is exported. Production includes more than 500 tons/year of ferrite magnets, 20,000 units/year spanning 50 models of transducers, and 6,000 speaker systems/year that includes more than 60 models.

Photo 3 shows the sample pro sound midrange driver MAG submitted. This is one of my favorite pro sound midrange formats.

My first experience with a short X_{MAX} curvilinear paper cone and flat surround pro midrange was the Audax Professional Midrange available in the 1980–1990 era. I reviewed this midrange in an early issue of *Voice Coil* and later incorporated them into a three-way keyboard monitor I built for my studio. I still have these speakers, but the foam surrounds disintegrated several years ago. Fortunately, Philippe Lesage, Audax's former chief engineer designed these drivers. He left Audax to form PHL Audio, which still makes almost the same driver. So, I was able to change the drivers without making any crossover changes. The MAG's M0610 has a similar format, which is exciting.

The M0610's features include a cast-aluminum frame, a light-weight curved profile uncoated paper cone, a 2" diameter uncoated paper dust cap, and a 1.5" (38-mm) diameter voice coil wound on a Kapton former with edge wound copper-clad aluminum ribbon wire. Compliance is provided by a flat foam surround (similar to the Audax and PHL models) and a 4.5" diameter flat cloth spider. A 110-mm × 15-mm detachable self-centering strontium ferrite magnet with a black coated back plate powers the unit. Last, the voice coil tinsel lead wires terminate to a standard pair of

solderable terminals.

I clamped the driver to a rigid test fixture in free air and used a LinearX LMS analyzer and VIBox to produce voltage and admittance (current) curves at 0.3, 1, 3, and 6 V. I post-processed all eight 10-Hz-to-20-kHz 550-point stepped sine wave curve pairs for each sample and divided the voltage curves by the current curves, which created the five impedance curves. I applied the LMS phase calculation procedure to each impedance curve and imported the data along with the voltage curve for each sweep into the LEAP 5 Enclosure Shop CAD program. I used 1-V free-air curves to create the LEAP 4 TSL model. I selected the complete curve set, the multiple voltage impedance curves for the LTD model, and the TSL model's 1-V impedance curves in LEAP 5's transducer derivation menu and created the parameters for the computer box simulations. **Figure 12** shows the 1-V free-air impedance curve. **Table 2** compares the LEAP 5 LTD and TSL data and factory parameters for both M0610 samples.

The M0610 6.5" midrange's T-S parameter results had some variations worth noting. First, the X_{MAX} quoted by MAG includes a large portion of the fringe field. (The Klippel data confirmed this information.)

I also used the physical X_{MAX} numbers derived from the published gap and voice coil height numbers. While there are variations in the V_{AS} and Q_{TS} , this driver is not intended to be operated in the piston range, and the consequence of these variations is rather minimal. The reason I publish T-S data and box simulations on a driver like this is mostly to establish the enclosure resonance and Q_{TC} to help make

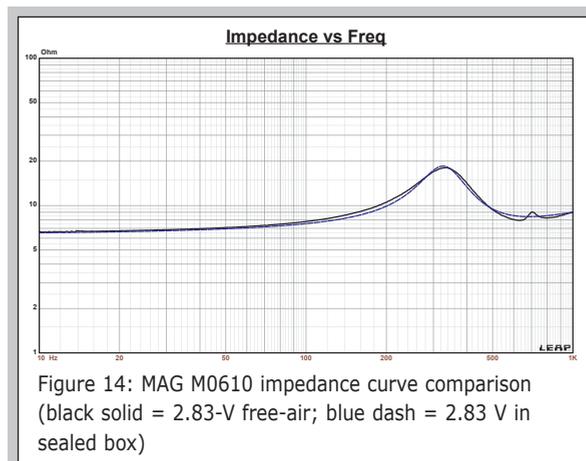


Figure 14: MAG M0610 impedance curve comparison (black solid = 2.83-V free-air; blue dash = 2.83 V in sealed box)

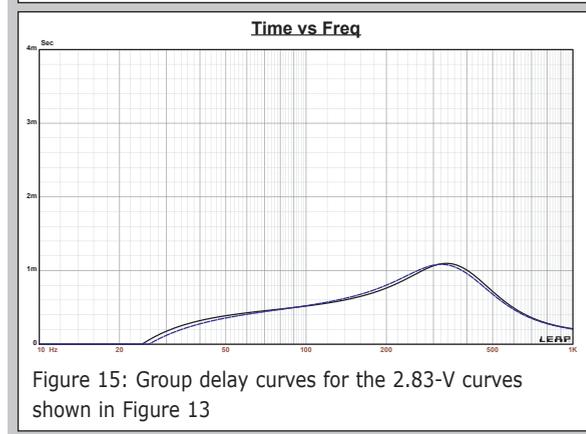


Figure 15: Group delay curves for the 2.83-V curves shown in Figure 13

passive crossover decisions. However, with this pro sound driver, it's more likely that the device will be used with an active crossover, making the data less important. That said, I used the LEAP LTD parameters for Sample 1 with two sealed enclosure sizes to program computer enclosure simulations. This included a 0.15-ft³ closed box with 50% fiberglass fill material and a larger 0.3-ft³ sealed box alignment also with 50% fiberglass fill material.

Figure 13 shows the M0610 midrange's results for the two sealed boxes at 2.83 V and at a voltage level sufficiently high enough to increase cone excursion to $X_{MAX} + 15\%$ (1.15 mm for the M0610). This calculation resulted in a 309-Hz F3 frequency with a 0.93 Q_{TC} for the 0.15-ft³ sealed enclosure and -3 dB = 297 Hz with a 0.86 Q_{TC} in

the 0.3-ft³ closed-box simulation. Again, the midrange's piston range is generally not particularly important. **Figure 14** shows the 2.83-V impedance in the 0.3-ft³ closed box compared to the free-air impedance and there is very little difference.

Increasing the voltage input to both simulations until the maximum linear cone excursion was reached resulted in 111.5 dB at 20 V for the smaller sealed enclosure and 111.2 dB with the same 20-V input level for the larger sealed box **Figure 15** and **Figure 16** show the 2.83-V group delay curves and the 20-V excursion curves.

The MAG M0610's Klippel analysis produced the BI(X), $K_{MS}(X)$ and BI and K_{MS} symmetry range plots shown in **Figures 17–20**. **Figure 17** shows the MAG M0610's BI(X)



Figure 16: Cone excursion curves for the 20-V curves shown in Figure 13



Figure 17: Klippel analyzer BI (X) curve for the MAG M0610

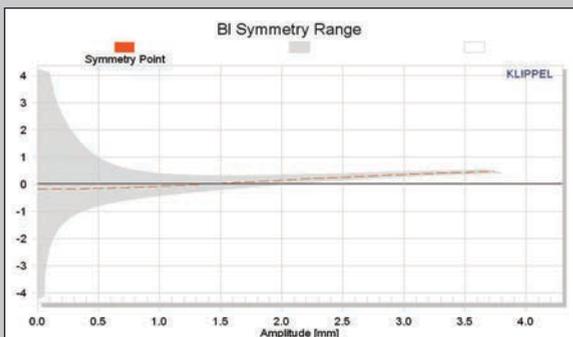


Figure 18: Klippel analyzer BI symmetry range curve for the MAG M0610

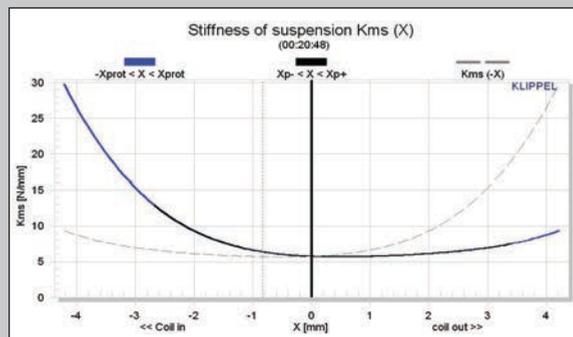


Figure 19: Klippel analyzer mechanical stiffness of suspension $K_{MS}(X)$ curve for the MAG M0610

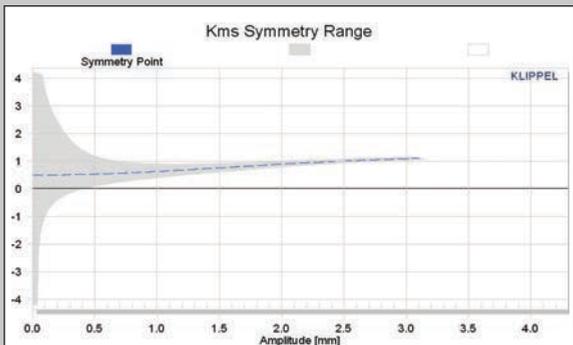


Figure 20: Klippel analyzer K_{MS} symmetry range curve for the MAG M0610

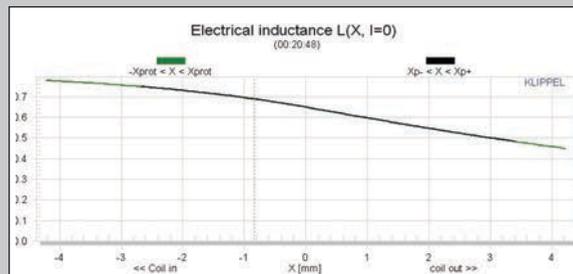
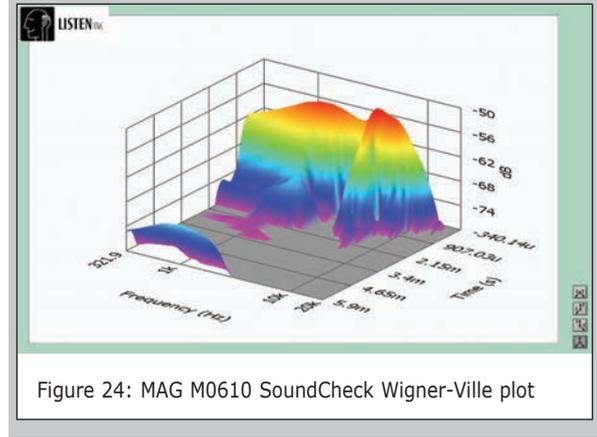
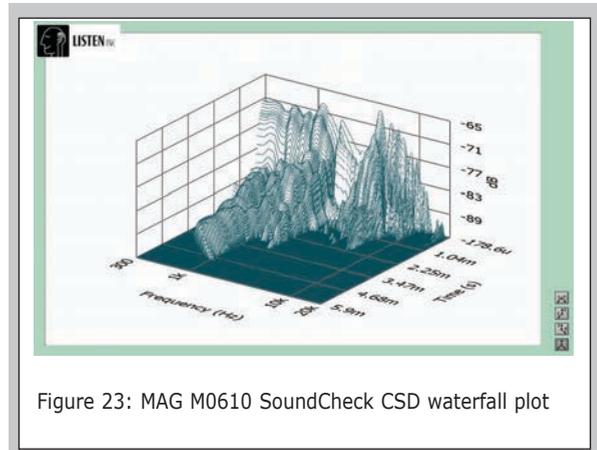
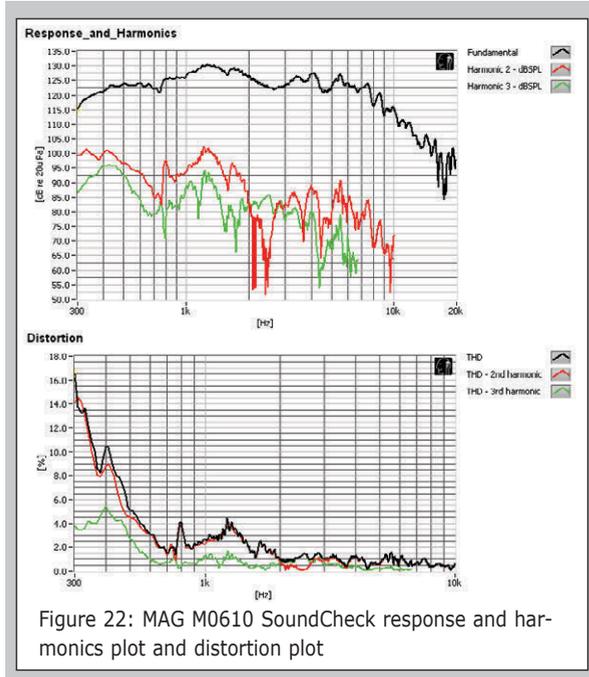


Figure 21: Klippel analyzer $L_e(X)$ curve for the MAG M0610

curve is fairly narrow, but as you would expect for a short to moderate X_{MAX} (1-mm) pro driver and is moderately symmetrical with almost no offset. The BI symmetry plot in **Figure 18** shows no offset out to the M0610's physical X_{MAX} , which is not a problem since it is not really going to operate in the piston range. **Figure 19** and **Figure 20** show the



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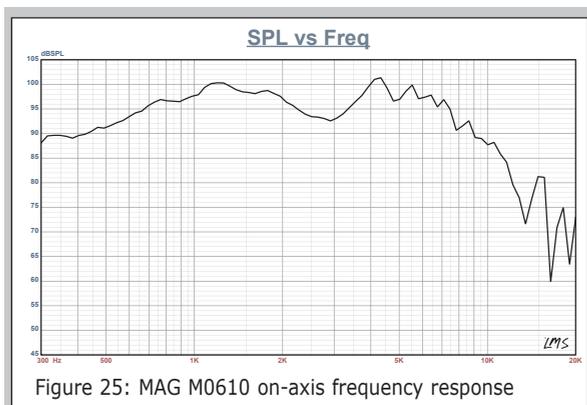


Figure 25: MAG M0610 on-axis frequency response

M0610's $K_{MS}(X)$ and K_{MS} symmetry range curves, respectively. The $K_{MS}(X)$ curve is rather asymmetrical. However, this is just an affectation of the unusual flat-foam surround used in this type of device.

Looking at the K_{MS} symmetry range curve, there is obviously a lot of forward coil-out offset, but for this to be relevant, the cone must be moving. With a fourth-order LR active high-pass at perhaps 500-Hz motion, this won't be an issue. Again, I am displaying this information to characterize the performance of a flat surround, which you will only see in the pro sound midrange category. The M0610's displacement-limiting numbers calculated by the Klippel analyzer showed the XBI at 82% ($Bl = 2.3$ mm) and the crossover at 75%, C_{MS} minimum was 1.5 mm, which means the compliance is the most limiting factor at the 10% prescribed distortion level, but even this is beyond the driver's physical X_{MAX} !

Figure 21 shows the M0610's inductance curves $L(X)$. Inductance will typically increase in the rear direction from the zero rest position as the voice coil covers more pole area, which is not what you see with this style of motor. From X_{MAXOUT} to X_{MAXIN} , the inductance range is only 0.7 to 0.6 mH, which is only a ± 0.06 -mH delta.

Submit Samples to Test Bench

Test Bench is an open forum for OEM driver manufacturers in the industry. All OEMs are invited to submit samples to *Voice Coil* for inclusion in the Test Bench column.

Driver samples can include any sector of the loudspeaker market, including transducers for home audio, car audio, pro sound, multimedia, or musical instrument applications. Contact *Voice Coil* Editor Vance Dickason to discuss which drivers are being submitted.

All samples must include any published data on the product, patent information, or any special information to explain the functioning of the transducer. Include details on the materials used to construct the transducer (e.g., cone material, voice coil former material, and voice coil wire type). For woofers and midrange drivers, include the voice coil height, gap height, RMS power handling, and physically measured Mmd (complete cone assembly, including the cone, surround, spider, and voice coil with 50% of the spider, surround, and lead wires removed). Samples should be sent in pairs to:

Vance Dickason Consulting
333 South State Street, #152
Lake Oswego, OR 97034
(503-557-0427)
vdconsult@comcast.net

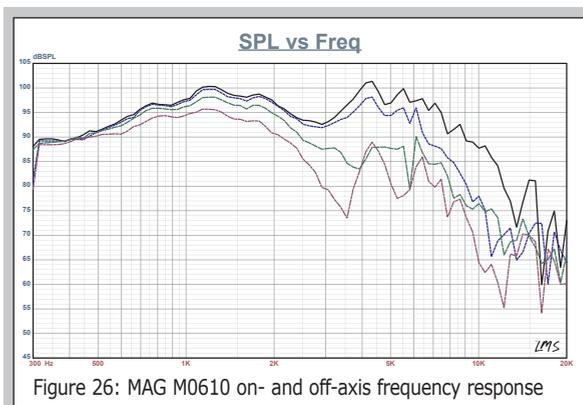


Figure 26: MAG M0610 on- and off-axis frequency response

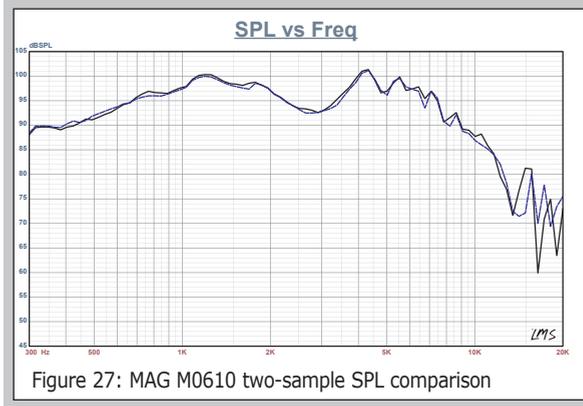


Figure 27: MAG M0610 two-sample SPL comparison

Next, I used the Listen SoundCheck AmpConnect analyzer for distortion measurements. I mounted the M0610 in an enclosure and used a noise stimulus to set the SPL to 104 dB (8.76 V) at 1 m, which is my standard for pro sound products. Then, I mounted the driver in free-air and placed the microphone at 10 cm. The M0610 produced the distortion curves shown in **Figure 22**. Following the distortion measurements, I again mounted the M0610 in an enclosure with a 8" x 12" baffle to take the impulse measurement. I imported the data into Listen's SoundMap software, windowed to remove the room reflections, and produced the cumulative spectral decay (CSD) waterfall plot shown **Figure 23**. **Figure 24** shows the Wigner-Ville plot.

For the remaining SPL measurements, I used the same enclosure used with the impulse response. Then, I used a gated sine wave method to measure the driver frequency response on- and off-axis from 300 Hz to 20 kHz with a 100-point resolution at 2.83 V/1 m. **Figure 25** shows the M0610's on-axis response, which yielded a smooth rising response out to 2 kHz followed by a 4-dB depression at 3 kHz peaking at 4.3 kHz just prior to the low-pass roll-off. **Figure 26** shows the on- and off-axis frequency response at 0°, 15°, 30°, and 45°. A -3 dB at 30° result with respect to the on-axis curve occurs at 2.2 kHz, which is a typical 2.5 to 3 Hz crossover for 6.5" drivers with 1" domes. When used with a horn, anywhere lower than that is appropriate. **Figure 27** shows the M0610's two-sample SPL comparisons, with both samples closely matched.

The M0610's fit, finish, and build quality is very nice, suggesting MAG should be a good contender in the pro sound driver arena. To learn more about the MAG M0610 and other pro sound drivers, visit <http://eng.magaudio.biz>. **VC**