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VOICE COIL

THE PERIODICAL FOR THE LOUDSPEAKER INDUSTRY

IN THIS ISSUE

Industry News & Developments

By Vance Dickason

CES 2018

CES, formerly The International Consumer Electronics Show (International CES) will be held from January 9–12, 2018 in Las Vegas, NV, at the Las Vegas Convention Center. The show now in its 51st year, first launched in June 1967 in New York, NY, with 200 exhibitors and 17,500 attendess.

This year's CES will feature product debuts from more than 3,200 exhibitors, covering more than 30 product areas, including the latest in content, wireless, digital imaging, mobile electronics, home theater, and audio, including a continued focus on electric vehicles and in-vehicle technology.

Building upon last year's CES, this year's show will feature 24 Marketplaces (formerly called TechZones). This includes 3D Printing, Augmented Reality, Accessibility, Baby Tech, Sleep Tech, Smart Cities, eCommerce & Enterprise Solutions, Education & Technology, Eureka Park (a unique exhibiting opportunity to launch a new product, service or idea), Family & Technology, Fitness & Technology, Gaming & Virtual Reality, Artificial Intelligence, Self-Driving Technology, High-End Audio, Health & Wellness, iProducts, Kids & Technology, Robotics, Smart Home, Wearables, CES Sports Zone, Design & Source, University Innovations, and Drones. (Drones, UAVs, and other unmanned systems have taken off as a unique tool for everyday life, regardless of whether flight is controlled by onboard computers or remotely from the ground.)

CES 2018 will feature more than 200 conference sessions and more than 500 speakers to help educate attendees on the latest consumer electronic trends. It is expected to be about the same size as last year, which had 4,000 exhibitors and 184,279 visitors.

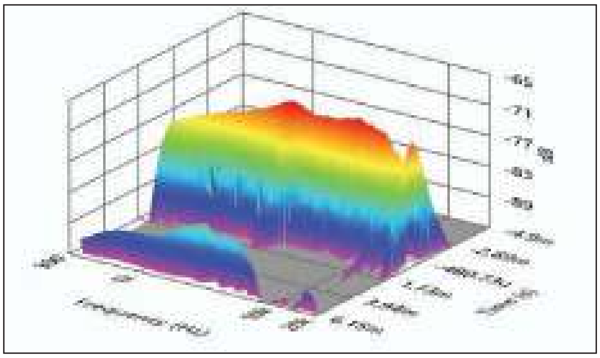

Figure 17: Eton 4-512/C8/25 RP SoundCheck Wigner-Ville plot

were closely matched within less than 1 dB in the normal operating range of the transducer.

Next, I employed the Listen, Inc. SoundCheck V15 software, along with the AmpConnect analyzer with the Listen 0.25″ SCM microphone and power supply (courtesy of Listen, Inc.) to measure distortion and generate time-frequency plots. For the distortion measurement, I mounted the Eton 4-512/C8/25 RP rigidly in free air. I used a noise stimulus to set the SPL to 94 dB at 1 m (6.79 V) and measured the distortion with the microphone placed 10 cm from the dust cap. This produced the distortion curves shown in **Figure 15**. I used SoundCheck to get a 2.83 V/1 m impulse response and imported the data into Listen's SoundMap Time/Frequency software. **Figure 16** shows the resulting CSD waterfall plot. **Figure 17** shows the Wigner-Ville plot (for its better low-frequency performance).

Overall, the Eton 4-512 is a nicely executed midrange driver with the excellent build quality you expect from a high-end OEM like Eton. For more information, visit www.eton-gmbh.com.

The Volt RV3143

The second driver I characterized this month is from UK OEM manufacturer Volt. Thus far, I have covered two other Volt products in Test Bench— the VM752, a 3″ dome midrange, which was discussed in the September 2017 issue, and the VM527, a 2″ dome midrange, which was characterized in *Voice Coil*'s August 2017 issue. While we are on the subject of the VM752 and VM527 dome mids, Volt asked me to add the following feature clarification for the two dome midrange drivers that did not make it into the original reviews:

The VM752 uses a single layer, round wire copper coil slightly longer than the focused magnet gap to allow for high excursions at the lower end of its operating range. This mid dome also uses a single piece dome with two surrounds for high power handling and stability along with a Kapton/Kraft sleeve voice coil, while the 2″ VM527 mid dome uses a single-piece dome/surround along with a Nomex/Kapton voice coil.

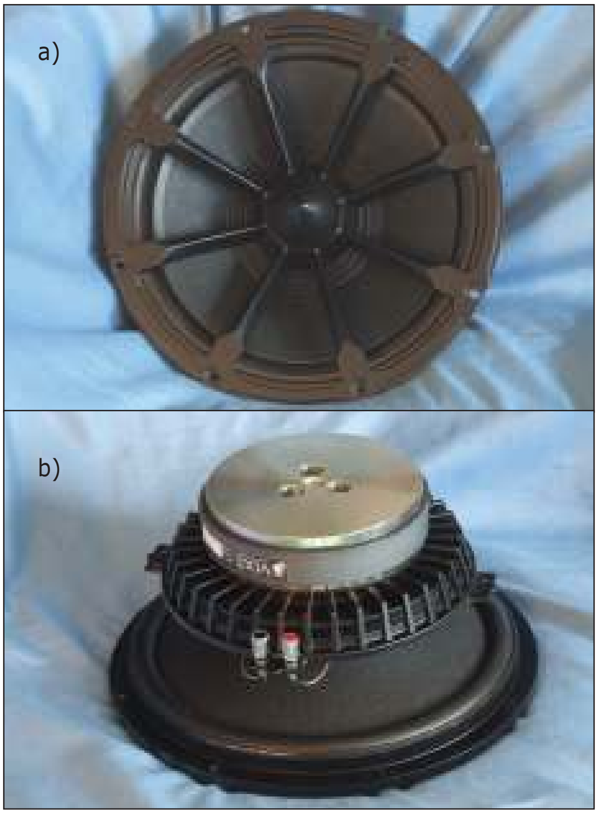

Photo 3: The Volt RV3143 studio woofer is shown from the front (a) and from the back (b). There is no frame on the back side of the driver!

As for the subject of this explication, the Volt RV3143 12″ studio monitor woofer is probably the most uniquely designed woofer to come across my desk in a while. Looking at **Photo 3**, it is obvious there is something different about the Volt RV3143—there is no frame on the back side of the driver!

Volt's patented Radial Technology is the brain child of the company's founder, David Lyth. Lyth has had a fascinating career in the development of British loudspeakers. After graduating with a degree in electronics, he received an MSc in Applied Acoustics from London University specializing in servo-controlled loudspeaker systems. Lyth then worked at Jordan Watts of Hayes, Middlesex, which manufactured full-range

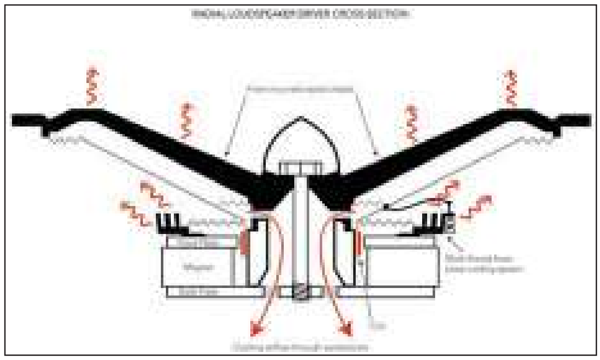

Figure 18: The Volt Radial Technology consists of a front-mounted eight-spoke proprietary cast aluminum frame.

aluminum cone loudspeaker units and systems. He was also employed by Gale Electronics as QC manager and lead production for its well-known black and chrome loudspeaker system. Still overseeing production, Lyth moved to Martin Audio where he worked closely with Dave Martin in a technical capacity. Before starting Volt, Lyth completed six months with Sanyo designing domestic systems and advising on its UK manufacture.

Now with a wealth of commercial experience, Lyth leased a small space from his first employer, Jordan Watts, and Volt Loudspeakers was born—the rest is history. A highly respected figure in the audio industry, Lyth now focuses on providing design assistance to existing customers and using his extensive knowledge and expertise to complete bespoke systems.

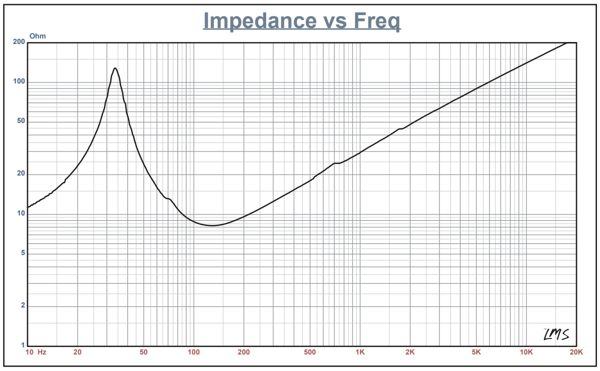

Figure 19: Volt RV3143 1 V free-air impedance plot

	TSL Model		LTD Model		Factory
	Sample 1	Sample 2	Sample 1	Sample 2	
F_S	33.4 Hz	34.9 Hz	32.1 Hz	30.6 Hz	35 Hz
R_{EVC}	6.26	6.1	6.26	6.1	6.1
Sd cm^2	483.1	483.1	483.1	483.1	479
Q_{MS}	6.10	6.10	5.53	5.13	5.35
Q_{ES}	0.31	0.32	0.31	0.28	0.32
Q_{TS}	0.29	0.3	0.29	0.27	0.3
V_{AS}	0.74 ltr	0.79 ltr	0.81 ltr	0.80 ltr	0.72 ltr
SPL 2.83 V	92.6 dB	92.7 dB	92.4 dB	92.7 dB	91.5 dB
X_{MAX}	5.2 mm	5.2 mm	5.2 mm	5.2 mm	5.2 mm

Table 2: Volt RV3143 studio woofer comparison data

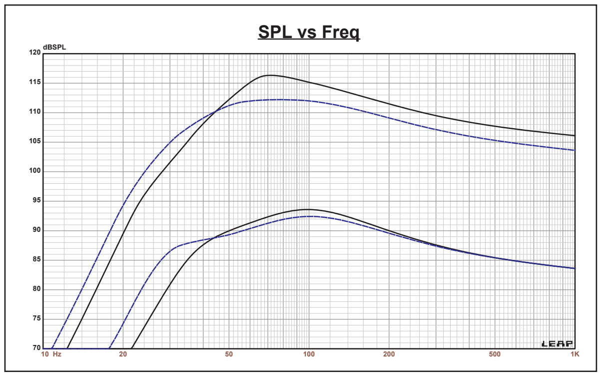

Figure 20: Volt RV3143 computer box simulations (black solid = vented 1 at 2.83 V; blue dash = vented 2 a 2.83 V; black solid = vented 1 at 44 V; blue dash = vented 2 at 32 V)

Looking **Figure 18**, you can observe that the Volt Radial Technology consists of a front-mounted eight-spoke proprietary cast aluminum frame that is mechanically coupled to both the back plate and to the top of the pole structure/phase plug, in contrast to a normal rear frame that is only coupled to the motor front plate. This not only has greater mechanical coupling to the major heat conducting elements of the motor structure, but much of the heat produced by the motor is being radiated to the air outside the enclosure rather than heating the air within the enclosure. Additional cooling to the front plate is provided by a rather substantial 72 fin heatsink that also includes 36 vents (5 mm × 9 mm) beneath the primary spider mounting shelf. As can also be seen, the Volt RV3143 has a dual-spider suspension system, with a smaller diameter spider attached from the cone to the front located frame, and a larger primary spider that is attached from the cone to the front plate heatsink system. Note that air from the top side of the pole piece is vented to the outside of the enclosure rather than venting into the enclosure as with most venting below the spider mounting shelf systems. The Volt Radial Technology provides a powerful heatsink to the outside of the enclosure and a convection cooling system that is coupled to the outside of the enclosure. Heating of the air inside an enclosure contributes to power compression, and it would be incorrect to think

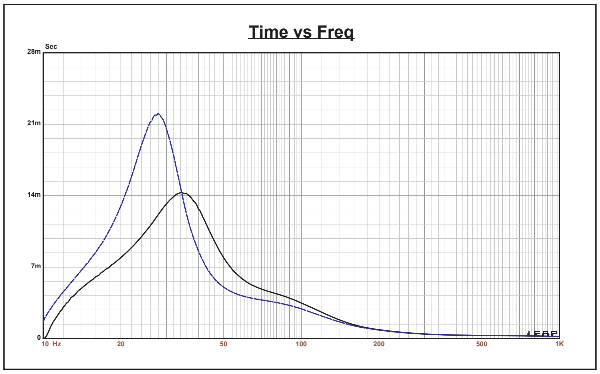

Figure 21: Group delay curves for the 2.83 V curves shown in Figure 20

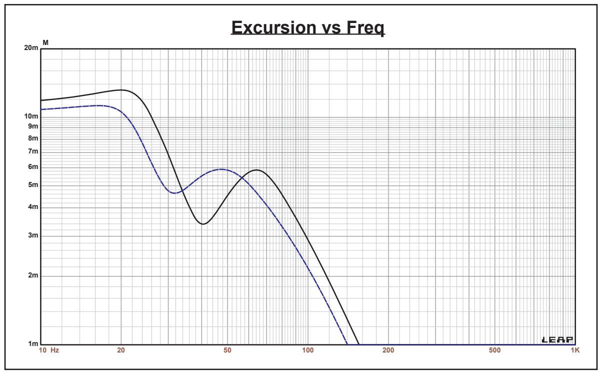

Figure 22: Cone excursion curves for the 44 V/32 V curves shown in Figure 20

there is a lot of thermal communication through a port tube, as that is not the case. In fact, Patrick Turnmire who does the Klippel testing for Test Bench, and his partner Enrique Stiles (two of the best transducer engineers I know of in the industry) have a patent titled "Thermal Chimney Equipped Audio Speaker" (Patent US 7181039 still available for licensing), which uses a device to transmit heat away from a motor structure to the air outside the enclosure, again to decrease power compression at high thermal levels.

After reviewing countless driver cooling systems in *Voice Coil*, and not an inconsequential number of car audio subwoofers cooling structures in the now defunct *Car Audio and Electronics* magazine, this appears to me to be one of the best configured driver cooling systems I have examined to date. What this means is that a driver will stay cooler with less dynamic changes over time, an important aspect to recording studio monitors or to live sound PA speakers. For this reason, Volt Radial Technology is utilized in a number of highly respected UK studio monitors and high-end home speakers from companies such as PMC, Quested, and Robson Acoustics.

In terms of the rest of its features, the RV3143 has a stiff curvilinear paper cone suspended by an

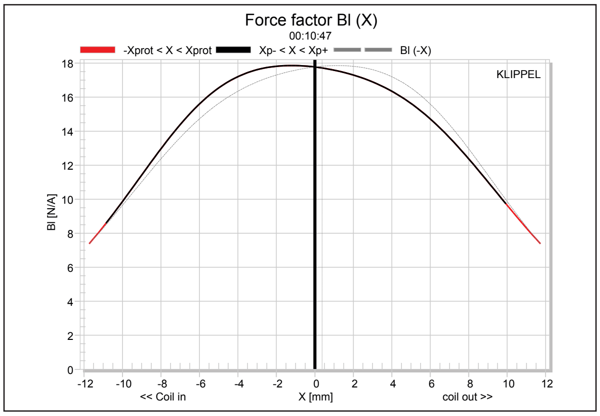

Figure 23: Klippel analyzer Bl(X) curve for the Volt RV3143

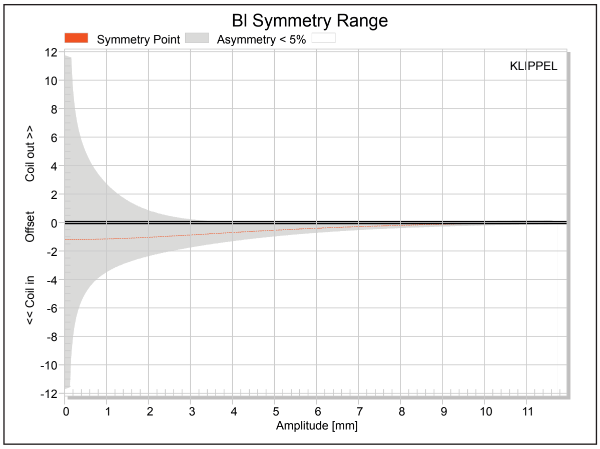

Figure 24: Klippel analyzer Bl symmetry range curve for the Volt RV3143

inverted NBR surround and a dual-spider system. The top spider is a 5″ diameter flat cloth spider and on the bottom spider is a 6″ diameter elevated cloth type. The assembled motor is driven by a 75 mm (3″) diameter four-layer voice coil wound with copper wire on a non-conduction Kapton former. The motor structure consists of a single 155 mm diameter × 25 mm high ferrite magnet sandwiched between milled and polished front and back plates. The plates are bolted together to the frame through the shaped pole piece by a large central bolt. Tinsel lead wires connect to color-coded push terminals on one side of the driver.

I used the LinearX LMS analyzer and VIBox to create voltage and admittance (current) curves with the driver clamped to a rigid test fixture in free air at 0.3 V, 1 V, 3 V, 6 V, 10 V, 15 V, 20 V, and 30 V. It should also be noted 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 first and second time constants). Next, I post-processed the 16 550-point stepped sine wave sweeps for each of the RV3143 samples and divided the voltage curves by the current curves

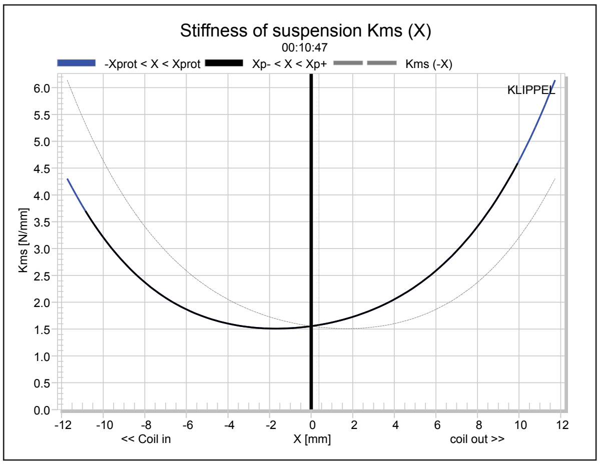

Figure 25: Klippel analyzer mechanical stiffness of suspension Kms(X) curve for the Volt RV3143

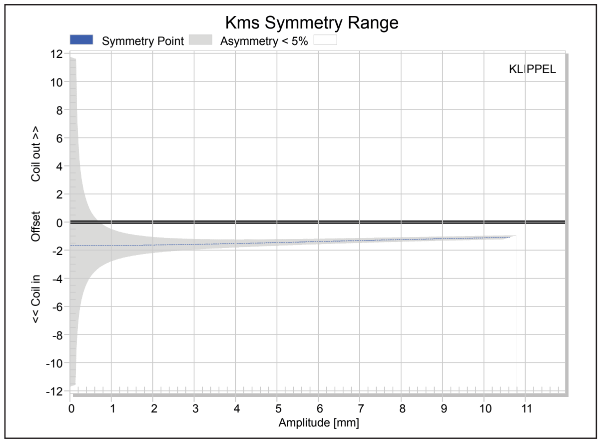

Figure 26: Klippel analyzer Kms symmetry range curve for the Volt RV3143

(admittance) to produce the impedance curves, phase-generated by the LMS calculation method. I imported them, along with the accompanying voltage curves, to the LEAP 5 Enclosure Shop software. Next, I selected the complete data set, the multiple voltage impedance curves for the LTD model, and the 1 V impedance curve for the TSL model in the LEAP 5's transducer derivation menu and created the parameters for the computer box simulations. **Figure 19** shows the 1 V free-air impedance curve. **Table 2** compares the LEAP 5 LTD and TSL data and factory parameters for both of the Volt RV3143 samples.

LEAP TSL parameter calculation results for the Volt RV3143 were reasonably close to the factory data. As always, I followed my usual protocol and set up computer enclosure simulations using the LEAP LTD parameters for Sample 1. The Volt literature for the RV3143 contains three recommended vented box volumes and tuning, so I set up the LEAP 5 computer enclosure simulation for two of them. The first was a 1.94 ft^3 vented box tuned to 39 Hz, and the second was a 3.9 ft^3 ported enclosure tuned to 30 Hz. Note that I use the simulated fiberglass (R19) selection in LEAP 5 primarily because it is an accurate and a known commodity in terms of damping. However, due to its carcinogenic nature, fiberglass is almost never used anymore (although I have seen it in the past few years in the pro market). Most damping material used today

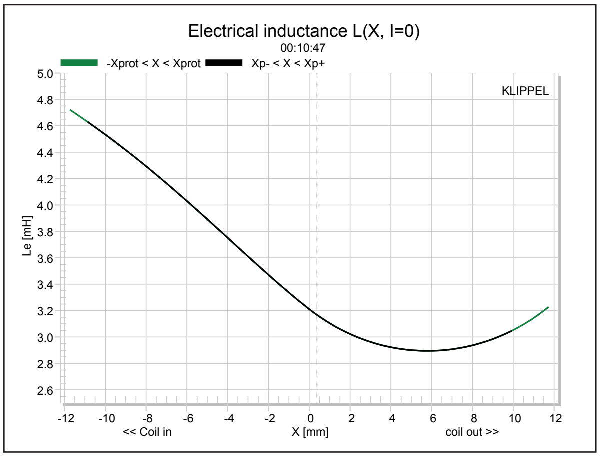

Figure 27: Klippel analyzer L(X) curve for the Volt RV3143

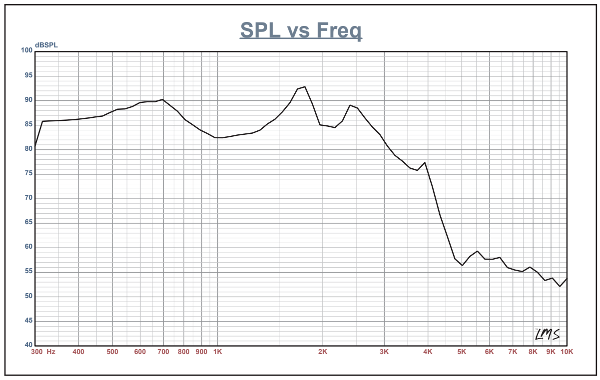

Figure 28: Volt RV3143 on-axis frequency response

is either foam or some form of Dacron batting. While LEAP does model polyester, the density is not as well established as fiberglass.

Figure 20 displays the results for the Volt 3143 with 1.94 ft^3 and 3.9 ft^3 vented box simulations at 2.83 V and at a voltage level sufficiently high enough to increase cone excursion to Xmax + 15% (5.9 mm for the RV3143). This produced a F3 frequency of 37 Hz (F6 = 32 Hz) for the 1.94 ft^3 vented enclosure and −3 dB = 27 Hz (-6 dB = 25 Hz) for the 3.9 ft^3 vented simulation. The factory numbers for the two enclosures were 40 Hz and 29 Hz, respectively. My numbers were calculated from the knee of the high-pass roll-off.

Increasing the voltage input to the simulations until the maximum linear cone excursion was reached resulted in 116 dB at 44 V for the 1.94 ft^3 enclosure simulation and 112 dB with a 32 V input level for the 3.9 ft^3 vented enclosure. **Figure 21** shows the 2.83 V group delay curves. **Figure 22** shows the 44 V/32 V excursion curves.

Klippel analysis for Volt RV3143 produced the Bl(X), Kms(X) and Bl and Kms symmetry range plots given in **Figures 23–26**. The Bl(X) curve (see Figure 23) is mostly symmetrical with some tilt, and is typical of a moderate Xmax driver. As you can see, there is a small amount of coil-in rearward offset. Looking at the Bl symmetry plot (see Figure 24), this curve shows a

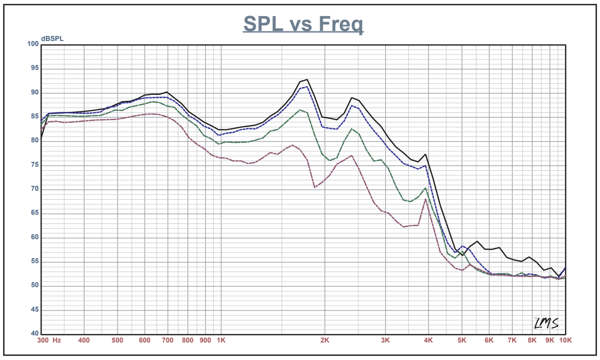

Figure 29: Volt RV3143 on- and off-axis frequency response (black solid = 0°, blue dot = 15°, green dash = 30°, purple dash/dot=45°

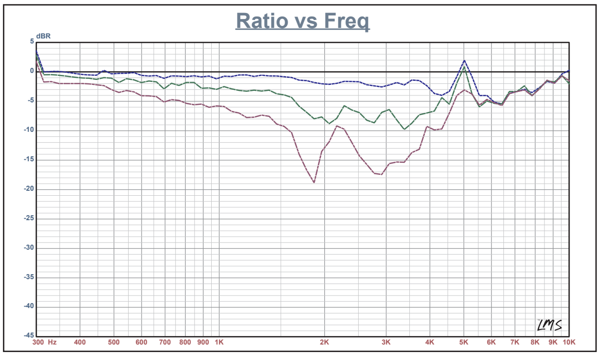

Figure 30: Volt RV3143 normalized on- and off-axis frequency response (0° = solid; 15° = dot; 30° = dash; 45° = dash/dot)

very minor coil-in (rearward) offset of 0.06 mm at the physical 5.2 mm Xmax of the driver (an area of high certainty for this Klippel measurement).

Figure 25 and Figure 26 show the Kms(X) and Kms symmetry range curves. The Kms(X) curve is likewise moderately symmetrical with a small amount of "tilt" along with some rearward (coil-in) offset at the 5.2 mm physical Xmax position. At this position, which shows a high degree of certainty, the offset is about 1.46 mm.

Displacement limiting numbers calculated by the Klippel analyzer for the Volt RV3143 were XBl at 70% Bl is 7.9 mm and for XC at 50% Cms minimum was 7.4 mm, which means that for this Volt Radial Technology woofer, compliance is the most limiting factor for prescribed distortion level of 20%. I chose 20% for the criteria given that this 12" plays fairly low and will likely be crossed over to a mid driver somewhere between 300 Hz to 500 Hz.

Figure 27 gives the inductance curve Le(X). Inductance will typically increase in the rear direction from the zero rest position as the voice coil covers more pole area, which is what happens here. The inductive swing from Xmax in to Xmax out is about 1.03 mH, typical for a four-layer voice coil of this diameter. You could probably decrease that by installing an aluminum shorting ring at the base of the motor, but it is hard to say if that would make any significant improvement to the overall subjective sound quality of this transducer.

Next, I mounted the RV3143 in an enclosure, which had a 15" × 15" baffle that was filled with damping material (foam) and then measured the transducer on

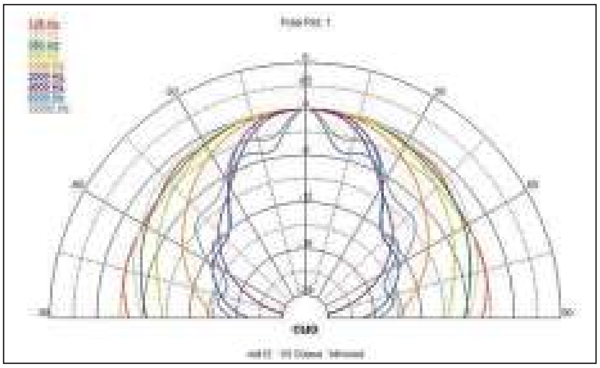

Figure 31: Volt RV3143 180° horizontal plane CLIO polar plot (in 10° increments)

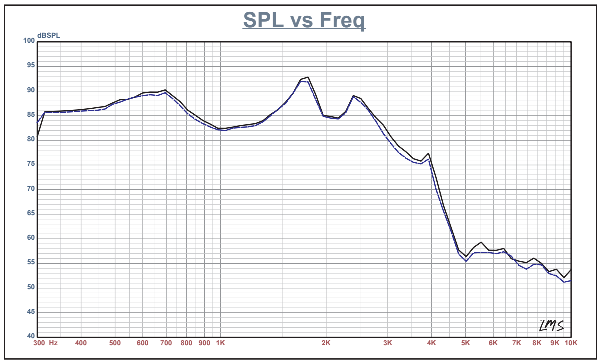

Figure 32: Volt RV3143 two-sample SPL comparison

and off axis from 300 Hz to 10 kHz frequency response at 2.83 V/1 m, using the Linear LMS analyzer set to a 100-point gated sine wave sweep. **Figure 28** gives the Volt RV3143 on-axis response, indicating a smoothly rising response to 1 kHz, followed by some surround breakup modes between 1.5 kHz to 3 kHz. As I already mentioned, the intended application for this driver was as a woofer in a three-way design that would transition to a midrange such as the Volt VM752 or the new Volt VM527 somewhere between 300 Hz to 500 Hz, although a cross point as high as 1 kHz to 1.5 kHz would certainly be possible.

Figure 29 displays the on- and off-axis frequency response at 0°, 15°, 30°, and 45°. **Figure 30** gives the off-axis curves normalized to the on-axis response, with the CLIO 180° polar plot (measured in 10° increments) depicted in **Figure 31**. The two-sample SPL comparison is illustrated in **Figure 32**, indicating the two samples were closely matched within less than 1 dB out to close to 3 kHz.

For the remaining tests, I employed the Listen AmpConnect analyzer with SoundCheck V15 along with the Listen Inc. 0.25" SCM microphone and

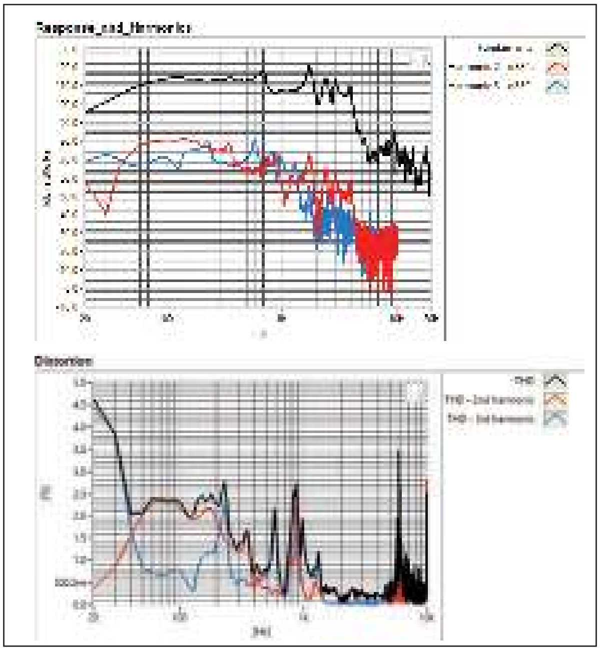

Figure 33: Volt RV3143 SoundCheck distortion plot

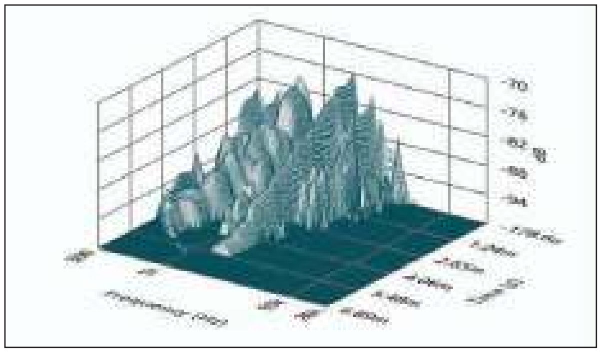

Figure 34: Volt RV3143 woofer SoundCheck CSD waterfall plot

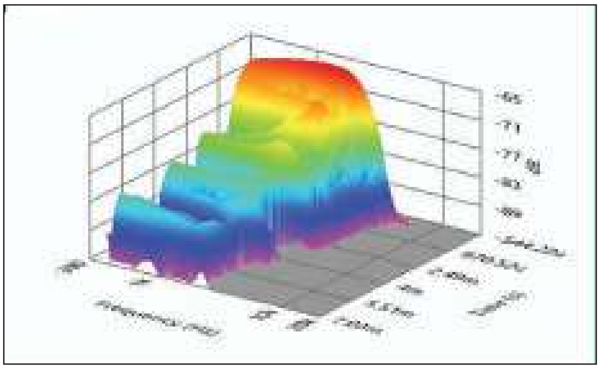

Figure 35: Volt RV3143 SoundCheck Wigner-Ville plot

power supply (courtesy of Listen, Inc.) to measure distortion and generate time-frequency plots. For the distortion measurement, I mounted the RV3143 rigidly in free air and used a noise stimulus to set the SPL to 94 dB at 1 m (6.74 V). Then, I measured the distortion with the microphone placed 10 cm from the dust cap. This produced the distortion curves shown in **Figure 33**. I used SoundCheck to get a 2.83 V/1 m impulse response and imported the data into Listen's SoundMap Time/Frequency software. **Figure 34** shows the resulting CSD waterfall plot. **Figure 35** shows the Wigner-Ville plot.

I am certainly impressed with Volt's Radial Technology, as it solves the problem of power compression that is exacerbated by the build up of heat in an enclosure, especially in pro sound PA and studio monitor applications. Regardless, the Volt RV3143 is a well-engineered woofer with some really unique features. For more information, visit www.voltloudspeakers.co.uk. ***VC***

Submit Samples to Test Bench

Test Bench is an open forum for OEM driver manufacturers in the loudspeaker industry. All OEMs are invited to submit samples to *Voice Coil* for inclusion in the monthly Test Bench column. Driver samples can include transducers for home audio, car audio, pro sound, multimedia, or musical instrument applications. While many of the drivers featured in *Voice Coil* come from OEMs that have a stable catalog of products, this is not a necessary criterion for submission. Any woofer, midrange, or tweeter an OEM manufacturer feels is representative of its work, is welcome to send samples. However, please contact *Voice Coil* Editor Vance Dickason, prior to submission to discuss which drivers are being submitted. Send samples in pairs and addressed to:

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

All samples must include any published data on the product, patent information, or any special information necessary to explain the functioning of the transducer. This should include details regarding the various materials used to construct the transducer (e.g., cone material, voice coil former material, and voice coil wire type). For woofers and midrange drivers, please 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).