



## REVEL CONCERTA2 A TECHNOLOGY WHITE PAPER

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# INTRODUCTION

Revel was launched in 1996 with one goal, to create the world's finest loudspeakers. To accomplish such a goal, the resources and expertise of Harman International were put to the task. Parameters such as cost and off-the-shelf parts were eliminated from the equation. Left were world-leading research and the freedom to craft loudspeakers utilizing science while maintaining sonic integrity.

Revel's flagship line, the Ultima2, debuted much to the applause of critical audiophiles and discerning reviewers and set the standard for state-of-the-art speaker design. This noteworthy line was hailed for its sonic purity and the ability to capture the magic and raw emotion of a live performance.

The Performa3 series, introduced in 2012, set a new standard for loudspeakers in that price point. The series is noted for its unmatched performance and striking construction utilizing features not commonly seen on loudspeakers at that price range.

The original Concerta series, introduced in 2005, proved that Revel offered outstanding performance for popularly priced speakers. Utilizing proprietary components and advanced system designs, the Concerta series quickly became a favorite among reviewers and listeners alike.

When the time approached to revamp the Concerta line and develop the Concerta2 series, there were several challenges to overcome. The series had to be a distinct sonic improvement over the previous Concerta series, it had to be visually stunning with a more modern design and finally, it had to maintain a popular price point. These challenges were faced head-on and subsequently overcome by the Revel development team.

Significant advancements in loudspeaker measuring and optimization, cabinet construction, crossover techniques, port technology, along with the resources and support from HARMAN allowed these goals to be met. Over two years of uncompromising development has produced the Concerta2 series: the F36 and

F35 floor standing loudspeakers, the M16 bookshelf loudspeaker, the C25 center channel loudspeaker, the S15 surround speaker and the B10 subwoofer.

The following White Paper describes some of the fascinating technologies behind this impressive series.

## DESIGN GOALS

One primary design goal was to increase sensitivity for the towers, useful for the expected match to lower powered multi-channel receivers and amplifiers. To achieve enhancements in this price point, a 3<sup>rd</sup> woofer was used instead of a separate midrange. A novel crossover (patent pending) divides the two lower woofers with the upper woofer/midrange. Taking advantage of each high impedance woofer driver, the upper woofer midrange crossover was designed to deliver the required current at mid frequencies (red curve, Figure 1)

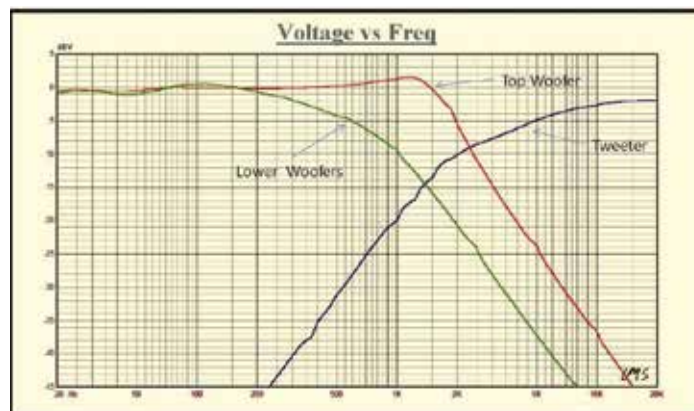


Figure 1: Voltage response of dividing network for F35 Tower.

Examining the acoustic responses of the 3 drivers with crossovers demonstrates how well they sum. (Figure 2)

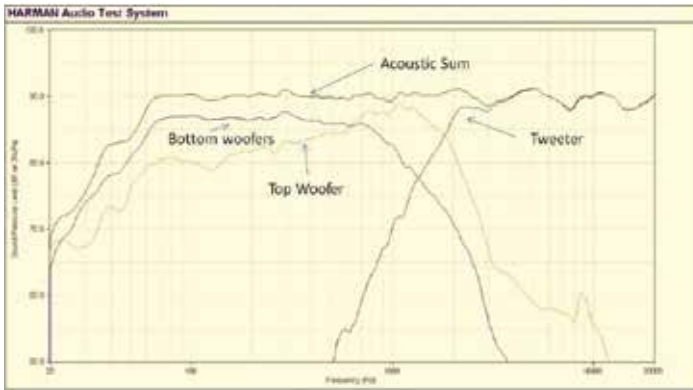


Figure 2: Acoustic Response of each driver, F35.

Subsequently, the ‘spin-o-rama’ response shows the success of the design goals (Figure 3).

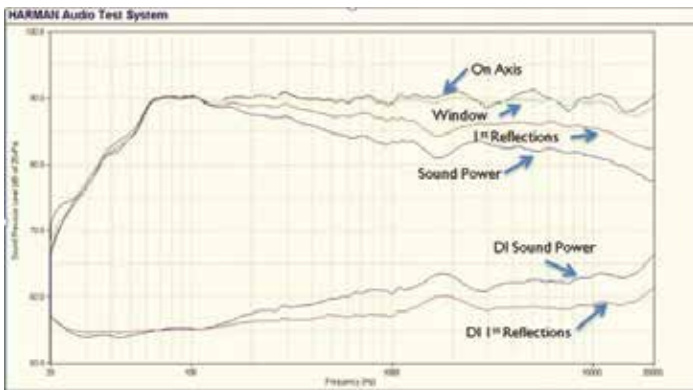


Figure 3: The F35 spin curve.

## DRIVE UNITS

### Tweeter

The 3 main sections of the Concerta2 tweeter are; tweeter assembly, wave guide, and acoustic lens. A cross sectional view of the tweeter assembly is shown in Figure 4. Typical tweeter magnetic assemblies have minute space behind the dome causing a high mechanical resonance. The tweeter mechanical resonance rise should be well below the operating band to assure linearity and consistency at the crossover frequency. In order to achieve a low mechanical resonance with the Concerta2, a large cavity behind the magnetic assembly is vented around the perimeter. Along with a compliant diaphragm surround, this sets the mechanical resonance frequency to a low 800 Hz

compared to typical 1.5 kHz found in similar priced speakers. Now the tweeter/midrange crossover can be set lower improving the system directivity.

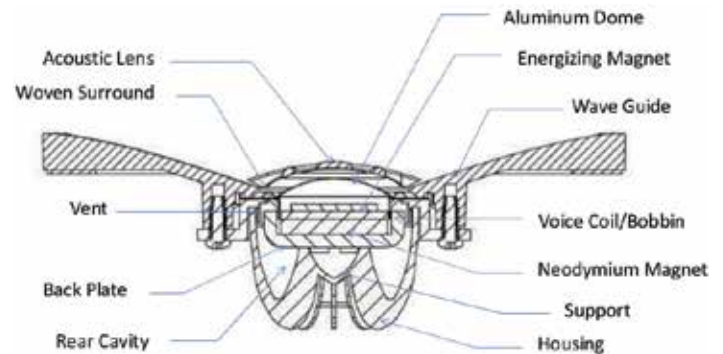


Figure 4: Cross sectional view of the Concerta2 tweeter/waveguide assembly.



Figure 5: Concerta2 tweeter, exploded view.

### Tweeter Wave Guide and Acoustic Lens

There is a substantial directivity discontinuity between a midrange driver and a tweeter due to the vast difference in driver diameters. The solution is to use a tweeter wave guide.

Tweeter waveguides have the following advantages:

- More closely matches the directivity of the woofer/midrange driver at crossover, blending the sound of the midrange and tweeter to virtually one source.
- Increase in gain, typically in the range of 3-7dB around and above the crossover region.

- Improved power handling and lower compression from the gain increase.

Conventional waveguide theory states that broadband pattern control (i.e. directivity control) is best achieved by a large straight (conical) section in the waveguide, and that transition design at the entrance and exit of the waveguide are critical to prevent high frequency narrow-band directivity and frequency response problems. Finally, the size of the waveguide determines how low in frequency the waveguide can control pattern.

With previous generation waveguides, although the directivity was well matched at the crossover frequencies, they tended to have excess directivity and lower output above 9kHz.

A new generation slender wave guide along with an acoustic lens was developed for the Concerta2. The wave guide uses a large gentle blend radius at the exit of the waveguide. The directivity is now well matched to the midrange drivers of the Concerta2. The output is improved above 9kHz by adding an acoustic lens in front of the dome (Figure 7).

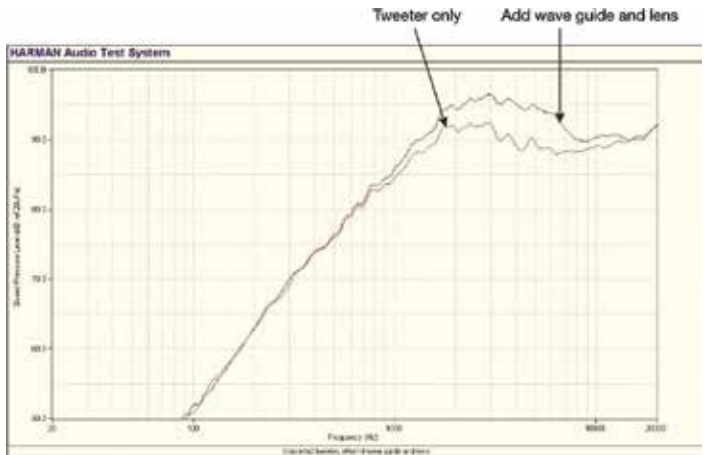


Figure 6: The gain advantage of the Concerta2 tweeter over no wave guide.

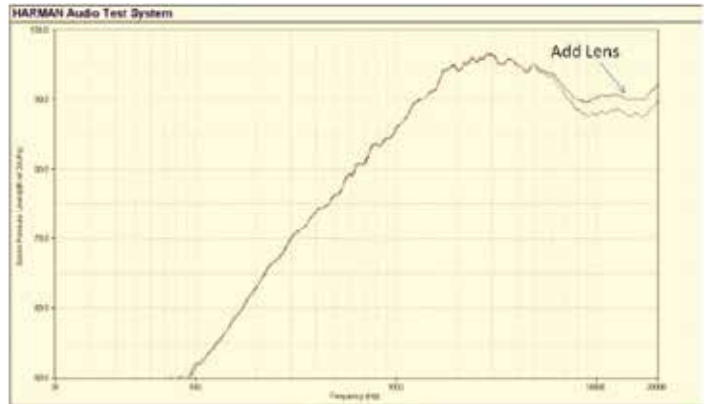


Figure 7: Effect of acoustic lens.

## Woofer

### Cone Material

A loudspeaker cone needs to operate as a piston, not only in its operating band, but well above to assure proper crossover response and low distortion. The cone material should be stiff and have internal damping. The Concerta2 woofer uses the cone material, Micro-Ceramic Composite (MCC) (Harman Patent 456404897B1). This patented process uses 2 layers of ceramic separated by aluminum. Ceramic which has an extraordinary high Young's Modulus (stiffness) is reinforced by the lower density aluminum center. Because the speed of sound through these 2 materials is different, there is added damping. The result is a composite cone material of superior performance to conventional metals, paper and aramid fibers.

### Improving Linearity using Klippel Analysis

Figure 10 illustrates the electromagnetic principal using the Concerta2 woofer as an example. The pole is saturated in order to attain a more constant field. In addition to the flux across the gap there is excess flux which 'fringes' across the field. The signal in the coil reacts to the flux in the gap causing the coil to move normal to the lines of flux in the gap. As the input signal is increased, and the coil moves further, the flux density is not constant, largely due



to asymmetrical fringing. This causes asymmetrical distortion. To improve this situation, the Concerta2 uses an extended pole piece to make the fringing symmetry more uniform.

The Klippel analyzer is an advanced powerful device that examines what happens when the loudspeaker departs from its rest position. A cone must move the same distance and manner in both directions of travel. Figure 11a illustrates an earlier iteration of the Concerta2 woofer voice coil moving from rest. The BL curve is not symmetrical. This shows a skewed B field. By simply re-positioning the coil slightly forward, improves the symmetry, thereby lowering distortion (Figure 11b). Figure 12a shows the stiffness of suspension in an earlier iteration of the driver. The asymmetry was attributed to spider non-linearity. Adjusting the spider progression improved the symmetry, and improves performance. (Figure 12b)

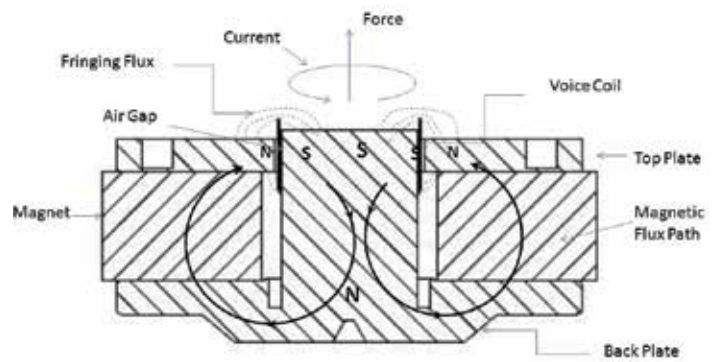


Figure 10: Electromagnetic principal.

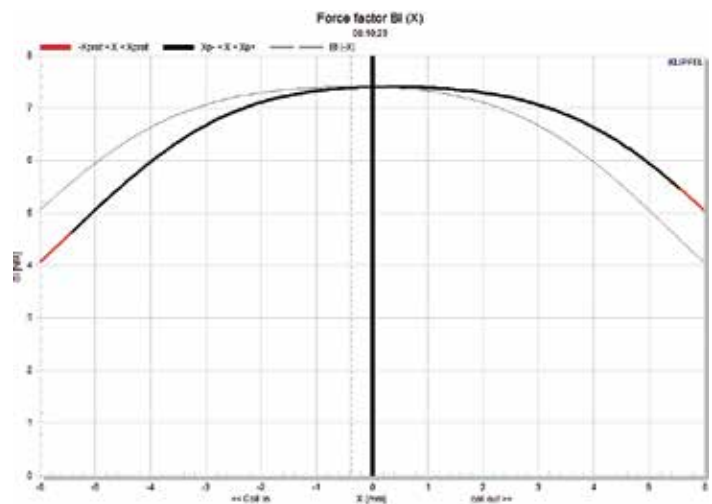


Figure 11a: BL before optimization.

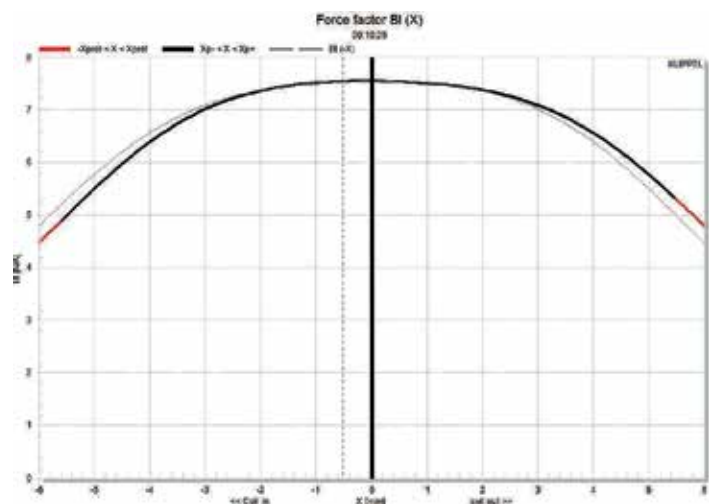


Figure 11b: BL after optimization.

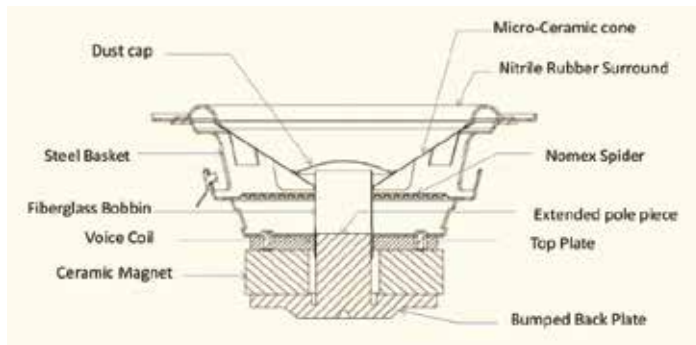


Figure 8: Cross sectional view of the Concerta2 woofer.



Figure 9: Concerta2 woofer, exploded view.

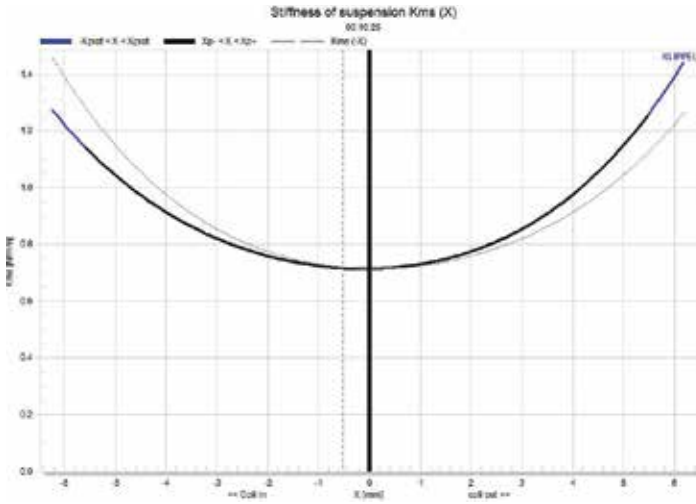


Figure 12a: Stiffness of suspension before optimization.

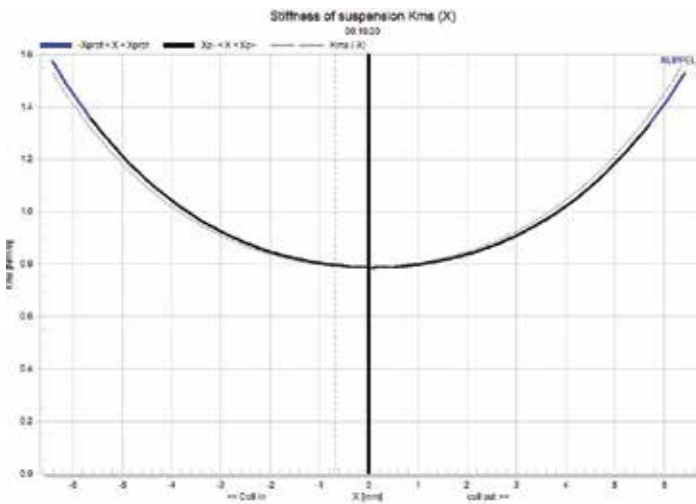


Figure 12b: Stiffness of suspension after optimization.

## ENCLOSURE DESIGN

The loudspeaker cabinet consists of a front baffle and enclosure. The cabinet is a complex device that has numerous functions. The baffle (front of enclosure) must rigidly hold the drivers in place. The enclosure must fulfill the role of controlling the back wave pressures. The enclosure must also be very inert in order to eliminate any unwanted sounds that could be transmitted from the enclosure.

Traditional enclosure construction is to use flat panels of MDF (medium density fiberboard) with V-grooved joints.

The Concerta2 line consists of a technique that adds both the beauty of curved side walls plus rigid enclosure strength. The curved walls are based on the Kerf technique of cutting multiple perpendicular slots, then bending the wood. The inside wall is reinforced with a layer of fiberboard. Along with strategic bracing this results in a rigid and inert enclosure.



Figure 13: Cross section of Concerta2 F36 baffle showing the Kerf technique.

## PORT DESIGN

### Constant Pressure Gradient Port

Loudspeaker ports are used to augment the low frequency acoustic output by creating a Helmholtz resonator by using the cabinet volume in conjunction with a port. At resonance, the inertance of the port resonates with the compliance of the air in the cabinet

and the system acts as an acoustic impedance transformer presenting high impedance to the rear of the loudspeaker cone and a low impedance to the air. This increases acoustic output over a portion of the low frequency range compared to a sealed box design.

Several complications occur in ported designs as output is increased beyond the point where the air in the port is not able to respond in a linear fashion. These include undesirable extraneous noises generated within the port as well as acoustic compression and distortion.

Earlier ported designs used a simple straight edge termination. This generated noise due to boundary layer separation, which means the flow of air breaks or separates from the wall. This causes, distortion or 'chuffing' which was audible even at moderate levels. Not surprisingly, these vented systems were frowned upon by audiophiles.

These generally broadband "chuffing" noises due to fast moving air have been addressed in recent years by rounding the port ends with various radii which leads to the now common flared port.

The pressure gradient of a conventional flared port design may become great enough that the momentum of the sound wave is greater than the pressure holding the sound wave to the wall or contour. If so the sound separates from the wall thus generating unwanted noise.

The latest generation of ports used in the Concerta2 line is 'Constant Pressure Gradient Design' (Harman Patent). This means that the inner wall of the port is contoured so that the pressure gradient or change in pressure along the longitudinal axis of the port from its inlet duct to outlet duct is substantially constant. They were developed after much research and produce the highest output, minimal compression and lowest distortion. Figure 14 shows the appearance of a Concerta2 Constant Pressure Gradient port.



Figure 14: F35 Constant Pressure Gradient port.

## CONCLUSION

A lot of the engineering technology featured in this White Paper came from our much more expensive lines. In addition, the Revel Concerta2 series contains the most up to date quality, manufacturing process, and attention to detail in the industry. The Revel engineering department invites you to audition the Concerta2.



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