



Delivering Rich Media Content from Small Format Audio Speaker White Paper

Delivering Premium Audio in a High Definition World

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Delivering Rich Digital Media Content with Small Format Audio Speakers *Delivering Premium Audio in a High Definition World*

The recent explosive growth of digital media content has permeated an incredible range of media types and genres with greatly enhanced audio content. The new audio content now includes a broader range of frequencies and effects that combine to create a more realistic audio experience for the listener. Producers, whether they are focused on movies, music, or television, have placed audio at the forefront along with video in delivering a truly integrated user experience. The new audio content places an additional demand on the audio system to achieve adequate fidelity and realism. This paper describes the nature of this extended audio content and its implications upon consumer electronics equipment makers to recreate that user experience.

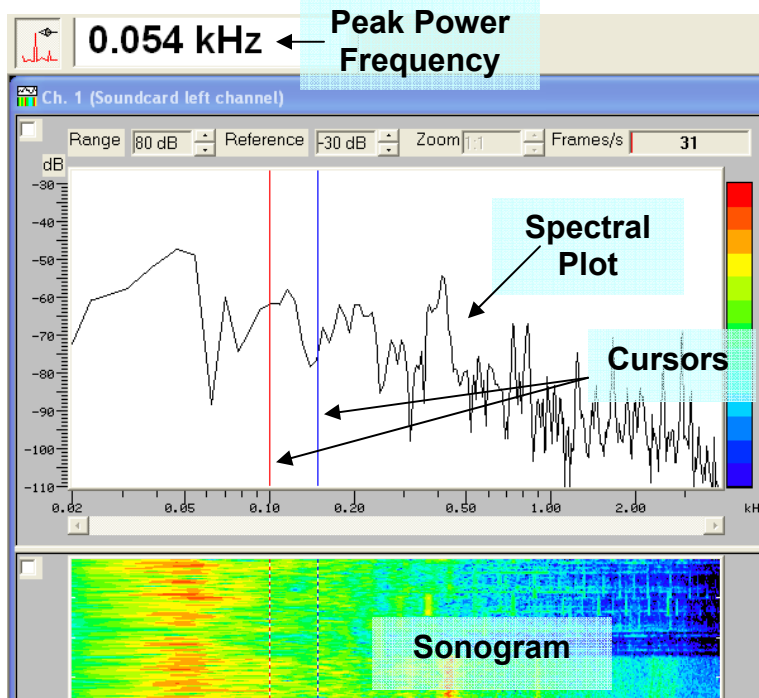
Modern Audio Content

Level analysis of modern audio content is relatively straightforward. The content itself (the digital data) is analyzed to determine what frequencies are present, how powerful they are, and generally, what type of effect was intended by the original material. The second step in the analysis is to review the general capabilities of a typical audio playback system. For understanding these capabilities and their limitations, we focus on standard Digital TV speakers. Lastly, by comparing the original content against the capabilities of the playback system, performance deficiencies due to small format speaker limitations can be identified and solutions suggested.

The Audio Analysis Package

There are a number of methods and software programs available to analyze digital audio content such as that present on movie or concert DVDs. For the analysis in this paper, the Analyzer2000 software was used. (www.brownbear.de) This program shows the instantaneous frequency energy during playback, as well as a historical display to show the repetitions and changes of audio that are representative of the content producer's intended listening experience. The screen display of this Analyzer2000 audio analysis package, shown on the right,

iRobot (20th Century Fox) Sonogram Illustrates the Essential Nature of Sub-100 Hz Content



incorporates three primary measurements. The instantaneous frequency spectrum of the audio is located in the larger middle display window, containing the “Spectral Plot” comment, and showing cursors of measurement points. The frequency of the peak power level is shown at the top left of the display. The sonogram portion towards the bottom shows the recent history as the audio is played, giving a “flowing” indication of periodic or transient shifts of frequency energy. The frequency spectrum (FFT window) measures signal strength for individual frequencies. The lowest frequencies are shown on the left side of the graph, and the highest frequencies are shown on the right side of the graph. The rainbow legend on the far right of the frequency spectrum plot is a reference used in the sonogram graph at the bottom. The sonogram window illustrates the recent audio power with low frequencies shown on the left and high frequencies shown on the right of the output. The strong signals (loud) representative of the rumbling sound within the audio segment are colored red or orange, while weak signals (quiet) are colored blue. As the movie scene changes, the different approaches to audio can be seen in the sonogram chart as well, and the flowing sonogram display while the audio plays provides a graphic historical representation of that audio. The frequency with the maximum audio power is displayed at the top left. Also noteworthy are cursor bars. In this example, the red vertical bar is located at 100Hz and the blue vertical bar is located at 150Hz, points chosen in this example to view and compare the content to the typical playback system.

Typical Digital TV Speaker Performance

The typical frequency performance of a typical Digital TV speaker is shown in the following chart. In this display, we see that the frequency response is very limited. In this example frequency performance plot, the lower frequencies are to the left of the chart, and the higher frequencies are to the right of the chart. The preferred performance for a speaker would be to exhibit a very flat unchanging sound level regardless of frequency. As can be seen from the example spectral and sonogram plots

on the preceding page, the recorded sound level of that example’s audio varies significantly from one frequency to another. The widely varying performance of this typical speaker will significantly alter the listening sound from these varying and inconsistent playback sound levels of the audio, and will result in

unnatural and undesirable sound quality. Additionally the low frequency performance exhibits a marked drop off in sound levels for frequencies below 200Hz. This means that any audio content below 200Hz, and shown as dominant in sound energy in the spectral plot of the example, will not be audible to the listener using these speakers. Unfortunately, typical bass boosting and tone controls will not be able to correct for this type of physical limitation. The low-

Typical Premium Digital TV Speaker Frequency Performance with 3.0” Driver



frequency cut-off of a speaker is dominated by the size of the speaker driver itself and 2.5” to 3.0” drivers that are common in flat-panel TVs are simply not capable of delivering frequencies down below this range. Also noteworthy from this plot is the steep drop in output level at just over 3 kHz, as well as the generally reduced level of all outputs from 3 kHz to 20 kHz. This attenuation of high frequencies will rob the playback of much of its brightness and special effects content. The result will be a very dull type of playback that will not seem at all realistic.

Analyzing a Specific Example ...

The characteristics of modern audio content are clearly demonstrated in a typical scene from the movie *iRobot* (20th Century Fox). The scene conveys two perspectives by switching back and forth from a camera inside an automobile, to another camera outside of the automobile. As the scene switches, the audio dramatically changes character. The top portion of the sonogram corresponds to the calm audio heard when the scene is inside the car, while the bottom portion is a record of the audio heard when the scene is outside of the car where the audio contributes to a strong sense of foreboding. The contrast between the audio in these two environments is essential to conveying the mood as intended by the director.

**iRobot (20th Century Fox) Scene Analyzed Used in Analysis Window
Title #5; Chapter #1; 1:10 min.**

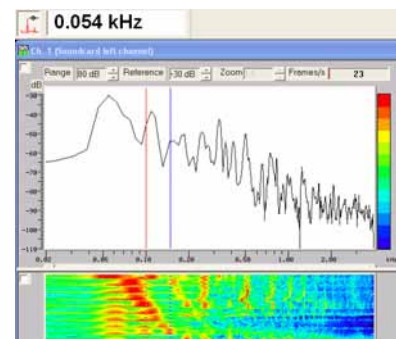


Inside the car (the top portion of the sonogram), soft music can be heard along with the deep tire rumble at roughly 54Hz conveying the movement of the car itself. Outside of the car (the bottom portion of the sonogram), there is a strong bass rumble at roughly 54Hz and extending up to 100Hz, along with a strong 500Hz tire rumble from the evil robot carriers. Recalling that the typical Digital TV speaker was only able to reproduce frequencies down to 200Hz, the majority of the audio content intended by the director will be completely lost at playback. This means that the viewer/listener will be missing much of the experience. Looking at the cursors in the analysis window, it is clear that the majority of audio power is below 150Hz and 100Hz in most modern content.

The content represented by the scene from *iRobot* (20th Century Fox) is by no means unique. The majority of modern content includes rich realistic sounding audio. Looking at an example from the music industry, we see a similar pattern where most of the audio energy is below the 150Hz frequency range.

The Diana Krall Live in Paris DVD (Eagle Eye Media and courtesy of The Verve Music Group): Video #1 “All or Nothing” – showcases large standing bass waves. The low frequency tones of the standing bass are not audible without the psycho-acoustic audio enhancements from D2Audio® DeepBASS™.

“Diana Krall Live In Paris” (Eagle Eye Media and courtesy of The Verve Music Group) Spectrum and Sonogram



The challenge is to play that content back using normal consumer electronics equipment. The playback issue can be avoided if a high-power AVR or stereo is available with large high-performance speakers, but this is often not possible. Increasingly, consumers are choosing sleek modern configurations, including flat-panel TVs with very small or even hidden internal speakers. Fortunately, D2Audio offers a solution.

DSP Audio Processing Offers a Solution

The D2Audio SoundSuite group of psycho-acoustic and immersive processing algorithms has been specifically designed to address the inherent incompatibility between modern digital content and ever smaller speakers that are common in modern CE equipment. The key to closing the performance gap is to realize that speaker issues are dictated by their physical size, and that only DSP based pre-processing of the audio can effectively change the listening experience. One of the key components of D2Audio SoundSuite is the D2Audio® DeepBass™ low frequency extender. This psycho-acoustic algorithm works by exploiting a characteristic of the ear-brain interaction to make the brain think that it is hearing low frequency tones, when in fact the low frequency tones are not actually present. The algorithm is forced to mimic the nature of bass tones present in the original content, but it must do so within the available frequency range of the speakers used for playback. It does no good to try to play frequencies that the speakers are physically incapable of reproducing.

As was seen in the speaker performance plots, the overall sound reproduction across all frequencies was very inconsistent – strong at some frequencies and weak at other frequencies. The sophisticated speaker compensation and tuning employed by the D2Audio® DigitalEQ™ delivers unprecedented fidelity from small speakers. The several other components of D2Audio SoundSuite also contribute essential corrections and improvements for small speaker equipment. The power of DSP pre-processing of the audio is truly amazing. Experience the true sound of your entertainment with D2Audio SoundSuite powered components.

Appendix: Additional Content Analysis

- Lord of the Rings -The Return of The King (**New Line Home Video**): Rain effect is nearly lost while remaining audio reverts to a near mono format unless SoundSuite is active.



- Matrix Reloaded (**Warner Home Video**): Rain effects are lost due to lack of high frequency content unless SoundSuite is active.



- Pearl Harbor (Touchstone/Disney): Background music is almost completely removed from the scene as the torpedo is powering toward the ship; explosion is highly muted without SoundSuite.



- Ayumi Hamasaki (Avex Japan):
 - Track #1 “We Wish” has strong vocal harmony that is highly protected by D2Audio® SoundSuite™. The remaining music content and sound stage are greatly enhanced with D2Audio® WideSound™ and D2Audio® DeepBass™.

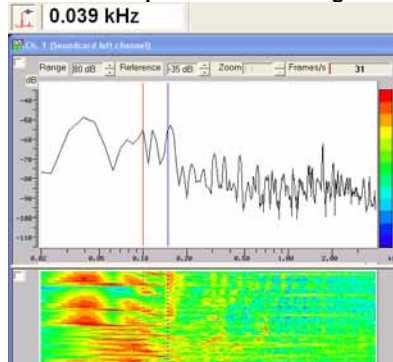


- Pussycat Dolls Live from London DVD (A&M Records):

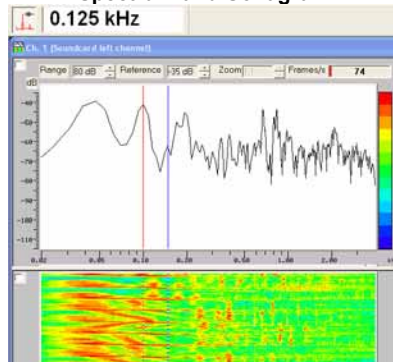
- Video #1 – “Don’t Cha” has deep rumbling bass that is highly accentuated with D2Audio® DeepBass™. Note that majority of content is below 100 Hz
- Video #5 – “I Don’t Need a Man” has significant voice content that is protected and enhanced with D2Audio® WideSound™ while the music content is expanded for a larger sound stage. Note that even though the sonogram illustrates significantly more content above 200 Hz, the dominant energy is located below 150 Hz.



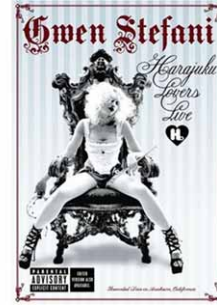
Don't Cha Spectrum and Sonogram



**“I Don’t Need a Man”
Spectrum and Sonogram**



- Gwen Stefani Harajuku Lovers Live DVD (Interscope Records):
 - Video #1 “Harajuku Girls”, Video #12 – “Serious” and video #13 “Bubble Pop Electric” all have prominent vocals that are maintained and protected by D2Audio SoundSuite. Live audience sound is highly muted without D2Audio® Widesound™ and D2Audio® AudioAlign™ functions.



Animusic 2 DVD (Distributed by www.Animusic.com):

- Chapter #2 employs a very consistent bass track. This is especially useful in allowing consumers to immediately hear the difference when the D2Audio® SoundSuite™ is cycled on and off. In other types of content, the audio material is not as consistent and consumers have some trouble determining if the music simply became louder, or if the immersive processing effects are the source of the change in sound quality. A consistent music track is very helpful in allowing a listener to quickly understand that the effect is from the audio processing and not the music content itself. Note the prolonged notes played in the 50Hz to 150 Hz range.

