



PHANTOM

Ss3[®] TECHNICAL OVERVIEW

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www.phantomacoustics.com

Introduction

Phantom Acoustics has introduced the consumer electronics industry's most elegantly simple and affordable audio signal processing technologies—called the Ss3[®] processor—designed to provide a solution for the considerable loss in sound quality that occurs in digitally compressed music, movies, and video games. Ss3 processors do not recover information “lost” during the compression process, however, they reveal latent instruments, voices and spatial characteristics of audio and music. Whether or not recorded music, movies, or video games are transferred to a compressed format such as CD, DVD, or MP3, there is latent information the consumer cannot access without the Ss3 circuitry.

Phantom Acoustics provides CE manufacturers with the ability to combine mobility, convenience, and personalization with high fidelity for all portable and non-portable audio listening systems and devices to deliver an unparalleled listening experience.

With these technologies, OEM manufacturers will launch the smallest and least costly audio enhancement processors for listening to music on MP3/CD/DVD players, notebook computers, cell phones, videogame hardware, automobile systems, and other mobile and non-mobile devices. The net effect of Ss3 processors is that they allow the stereo image to become more distinct in width and breadth and improves the separation of instruments to enhance overall clarity. And it does so without expensive amplifiers and speakers. The Ss3 processor separates and re-processes the outgoing signal of audio thereby unleashing the trapped content, providing the listener with the rich three-dimensional sound of a live performance containing fantastic clarity, as all of the instruments and voices are separated and distinct.

The vast array of mobile devices flooding the market is creating built-in demand for the sound quality consumers already expect from their systems at home. In order for the portable audio market to maintain its rapid growth, it will be paramount that the audio quality improves as manufacturers add features and functionality.

While there have been many computer plug-ins, home stereo components, and automotive systems that provide “enhanced” sound, none of these technologies have been made portable and Phantom has the only technologies that re-process the original recording to bring out what is already present but unable to be heard. The Phantom Ss3 processors are designed from the ground up to be small, inexpensive, with low power consumption, allowing them to be attached to or embedded into portable audio devices, headphones, automotive systems, cell phones, PC speakers, PC sound cards, and other non-portable devices.

Motivation

In the digital audio world of CDs, DVDs, and MP3 recordings, the form factor and portability of audio has been greatly improved through these technologies, but it's well-known that these formats cause a severe loss in audio fidelity. Moreover, compression technologies like MP3 and audio streaming codecs have greatly reduced the audio quality in order to achieve mobility and convenience and it's a widely held sentiment that MP3 recordings sound “flat”. The Ss3 processor allows the consumer to enjoy the benefits of storing and transporting large libraries of music together with the sound quality of vinyl records and magnetic tape.

Vinyl albums and magnetic tape recordings are a superior sound quality to MP3 and CDs because the older analog formats provide a continuous range of frequencies—i.e. the entire sound wave is heard as opposed to bits of the wave as occurs in digital music, giving the listener the rich tones and spatial orientation found when listening to “live” music. In the production of digital music, audio tones are parsed to select frequencies, broken into bits, and digitally compressed for the final consumer product. There are many voices, instruments, and sound effects in all recorded music, movies, and video games that are not able to be heard because they are trapped below the sound floor of recorded music, video games, and movies.

The Sound Floor

The “Sound Floor” refers to the demarcation between the useful signal in an audio recording and the noise in the recording. This demarcation is also referred to as the “Noise Floor” in many texts; lowering the noise floor corresponds to raising the sound floor—i.e. bringing out critical information that is otherwise buried in the noise. This is precisely what the Ss3 processor does. It recovers latent information in the sound floor, allowing many aspects of the original recording to be revealed.

Historically, stereo audio recordings since the 1950’s possess significant fidelity buried in the sound floor. The original recording masters contain this information, and it has only been recoverable by re-mastering the originals. Today, with the high demand for portability, Phantom Acoustics has determined it’s mandatory to process and bring out the latent information in original music to restore 20-25% of the original audio envelope thereby assisting with the large fidelity losses that occur during the heavy compression process necessary to store large audio files on CDs and MP3 files.

Enhance Any Stereo System

Phantom Acoustics’ Ss3 audio processor can be applied, and is most effectively applied, to any playback device employing two channels—whether in the form of home audio speakers, PC speakers, automotive systems, portable stereo systems, or headphones. Ss3 processors can recover the latent information and raise the sound floor from both historical audio recordings as well as current generation digital audio, where it is particularly effective.

Drawbacks of Traditional Acoustics

Traditional sound processing technologies have been the de-facto solution for high-end audio in the home and in theaters. However, there are several drawbacks to these technologies that prohibit them from applications in the mobile arena or small two-speaker systems:

- **Complexity:** these systems employ very complex circuitry with significant power and space requirements. Portability is not an option.
- **Encoding:** these systems mainly operate on surround-encoded audio sources, and for normal stereo sources (including any analog format audio, CDs, or MP3s), they merely split the signal into multiple speaker channels. They do nothing to enhance the image field or improve the sound floor of un-encoded sources.
- **Multiple Speaker Requirements:** these systems typically produce a benefit when played back through a suitable amplifier supporting one or two rear channels, and optional sub-woofer and center channels. This requires not only additional speaker hardware, but also introduces annoying issues relating to routing speaker wires throughout the listening environment.
- **Cost:** due to the complexity of the circuits themselves, and the need for power and multiple output channels, the cost increment for adding these technologies in a system far exceeds the nominal price points for audio enhancement in the mobile markets.

In contrast, Ss3 processors have none of these drawbacks. The technology greatly increases the audio envelope to the end listener thereby providing a full 3D spatial experience from any source, creating a wide sound field from headphones or just two speakers without the need for expensive amplifiers and speakers. Not only are the circuit designs elegantly simple but they have minimal power consumption requirements and can be miniaturized to a level that makes them viable for devices as small as cell phones and compact MP3 players.

Ss3 Benefits

The Ss3 processor provides a number of important benefits for listeners and manufacturers:

- Restores the Image Field by exploiting the Difference Channel (discussed in more detail later). An expanded Image Field produces more high and mid-range frequencies by turning up the audio envelope—not just the treble—without the need for expensive amplifiers and speakers.
- Supports multiple headphone jacks and users, ideal for many applications such as gaming or portable DVD viewing.
- The Ss3 circuits use no delays, filters, or multi-stage processing. As a one-stage system, it produces less processing noise.
- Produces better frequency response due to increased spatial information. By bringing “up” the less-dominant signals, the Ss3 restores the spatial qualities of the audio.
- Slightly increases gain, which is particularly helpful for headphone applications with mobile devices that generally suffer from insufficient output power.
- Adds tone control (equalization) and therefore greatly improves the sound quality of low-end systems.
- Allows the listener to experience the clarity and time-lasting quality of digital recordings with the warmth of vinyl, but without the “needle talk” always present on vinyl.
- Produces a higher-quality symmetry mix for spatial information.
- The circuit designs can support an Image Field indicator that shows the listener how much of the original audio image is present. When the Ss3 brings in a brighter signal, the listener is closer to the original, intended experience. The Image Field can be measured with an audio sensitive LED meter that can show how much of the Image Field is being restored.

Ss3 Processor Technologies

The principle design innovation of the Ss3 circuitry is that it restores the latent audio content by cross-feeding information from each channel into the opposite channel, thus reinforcing and revealing information contained in the sound floor.

Channel Manipulation

The Sum Channel is a mono signal containing vocal information, and is formed by taking the common in-phase signals from the left and right and combining them into a common signal which is spatially oriented in the center, thus not interfering with other information in the side channels.

The Difference Channels are left and right out-of-phase channels formed by taking the difference between the incoming left and right channels. The result is 180 degrees out of phase from the Sum Channel, and represents negative-going sound waves that cannot be heard with standard equipment. Ss3 allows this audio information to be heard by giving the listener a left and right in-phase signal that incorporates the Difference Channel information.

More specifically, the Ss3’s patent-pending circuit symmetry takes the out-of-phase information from the left and cross-feeds it to the negative input of the right channel. Similarly, it takes the out-of-phase information from the right and cross-feeds it to the negative input of the left channel. The result is both left and right in-phase signals (which are the dominant signal) as well as a left minus right and a right minus left out-of-phase signals. Standard equipment does not allow the listener to hear the negative out-of-phase

signals because it is designed to only enhance the left and right in-phase signals. The out-of-phase signals, while present, are masked by the dominant in-phase signals.

The Ss3 changes the ratio of the out-of-phase sound waves, moving them closer to the dominant signal, and then cross-mixing them. This approach restores the phase relationship in the listener's head, allowing the out-of-phase information to be heard. The Ss3 processor changes the ratio by bringing the negative out-of-phase waves that are hidden or not reachable, and makes them louder and in-phase with the other sound waves—thus Ss3 produces 20-25% more music envelope by manipulating the differences of the phase relationships within the channels.

Software Ss3

Phantom Acoustics pure digital software embodiment of the Ss3 circuit is ideal for a number of application areas:

- Incorporation into PC software-based media players
- Embedding in DSPs for mobile MP3 players, sound cards, and cell phones
- Embedding in DSPs for various digital systems, including CD/MP3 players in portable stereos, as well as gaming systems

Product Concepts

Due to the small size, minimal power requirements, and potential for miniaturization, the Ss3 processor has a wealth of possible applications in audio devices and accessories. Some of these product concepts include the following:

Headphones

An ideal application area for the Ss3 processor is to embed it in headphones. The circuit can be easily designed to accommodate a form factor suitable for incorporation into the headband of the headphones, with low-profile batteries for power

Portable/Personal Applications

The miniaturized Ss3 circuit can be embedded into typical portable CD, DVD, and MP3 players with minimal disruption to the design of the player. Alternatively, a stand-alone "tootsie roll" design can plug in-line between any existing portable music device and the listener's headphones. An independent unit also can be utilized with any system, including game devices, PCs and laptops, cell phones, etc.

PC Speaker Systems

Another ideal application area for Ss3 processors are the external, add-on PC speaker. These units are independently powered (with AC), and have ample room to embed the Ss3 circuit. Suddenly, a typical two- or three-speaker add-on system will have the full richness of a much more complex and costly multiple-speaker surround-sound system, at a fraction of the cost.

Gaming

While there have been many improvements to 3D graphics in video game hardware, little attention has been paid to providing gamers an enhanced and immersive 3D audio experience without a significant investment in audio equipment. Phantom Acoustics has developed a product concept specifically to be connected to any console video game hardware including: Sony Playstation/PS2, Microsoft Xbox, and Nintendo GameCube. When plugged in-line with either a TV or stereo system, players are provided a truly immersive game experience. The product also allows the users to plug in multiple sets of headphones with independent volume controls for each player to give a completely immersive gaming experience and/or to keep from disturbing others present.

PC Sound Cards

The PC sound card add-in market is particularly attractive for a number of reasons. Embedding Ss3 directly on the sound card will automatically improve the sound experience for all modes of listening, including external speakers and headphones. Additionally, sound card circuits already have op amps on board to drive the outputs. All that is needed is appropriate design changes to the output circuit to incorporate the Ss3 design, and perhaps additional elements to allow software control of the image field and equalizer settings.

Home Stereo

Any low-to-mid range two-speaker stereo system is an ideal candidate for the audio enhancement provided by Ss3. The Ss3 chip can easily be embedded into any CD/DVD player or the power amplifier to provide the illusion of listening to a vinyl album. For integrated stereo systems, the addition of Ss3 in the unit would add negligible cost to the design, have no impact on space or power consumption, and would bring tremendous benefits to the overall sound quality.

Phantom Acoustics has also patented and developed a product concept for a wireless surround-sound processor with an embedded Ss3 circuit that can bring greatly enhanced surround-sound to any home system. By employing wireless rear-channel speakers, the product eliminates the problems of routing long wires around the home. The product is significantly less complicated and costly than traditional surround-sound processors, and is easily added to any existing system. The technology for this design is covered under an issued United States Patent.

Car Stereo and Auto Entertainment

Phantom Acoustics has also patented and developed a car stereo surround sound system. Typical car stereos offer an ideal audio environment to experience the live soundstage enhanced sound quality. Additionally, as minivans and SUVs increasingly incorporate DVD entertainment systems, there exists an ideal opportunity to enhance the audio playback, either through speakers or through headphones.

Conclusion

Phantom Acoustics' Ss3 circuitry restores the original audio envelope content to all recorded and copied audio thereby greatly enhancing and providing high-quality sound from virtually any sound source. It brings "virtual vinyl" to all forms of digital recordings, and particularly improves the sound fidelity of digital music such as CDs and MP3s which suffer from heavy compression.

Ss3's small size, simple, low-cost design, and minimal power requirements make it the perfect and necessary solution for listening to all forms of digital and compressed audio on mobile devices, automotive systems, home stereo systems, and headphone-based systems.