



DTS Clear Audio™: Better Listening Despite Background Noise

White Paper

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Executive Summary

Background noise interrupts audio listening, forcing consumers to frequently adjust the volume on their devices so they can hear the content clearly. DTS Clear Audio dynamically corrects loudness to compensate for noise, creating a more enjoyable experience. Music and voices can be heard clearly while listening to various forms of media (e.g., music, movies and radio) on devices with speakers, such as TVs, personal computers, and automotive audio systems.

Noise, Loudness Adaptation, and Psychoacoustics

Air conditioning in a home, road noise outside an automobile, or a fan used next to a laptop are just a few examples of noise sources that can disrupt a listener’s ability to adequately hear and enjoy music, movie and game soundtracks. When listeners are disturbed by noise, they often try to manually adjust the volume to compensate. Manual adjustment, however, has serious disadvantages. It is inaccurate, bothersome, causes the entertainment experience to be less immersive, and can even be dangerous when noise repeatedly distracts a driver.¹

By applying new psychoacoustic analysis and modeling techniques, audio frequencies masked by noise can now be automatically enhanced so listeners hear audio clearly.

Sometimes, listeners keep volume levels high because they either grow accustomed to them or they anticipate noise recurrence. This phenomenon, known as “loudness adaptation,” leads to unknowing tolerance of dangerously high sound pressure levels (SPL), even in the absence of the original background noise.

To illustrate the impact of loudness adaptation, consider the case where someone shuts down a vehicle with the audio on. The next morning, the driver returns to the vehicle and starts it, only to be jolted by extreme loudness. The driver may wonder how he or she could have tolerated such a high volume level. Such loudness adaptation can have a detrimental effect on hearing ability over time because it exposes listeners to chronically high SPLs. By employing an algorithm to automatically adjust SPLs down as background noise subsides, the impact of loudness adaptation can be minimized.

What is “Psychoacoustics?”

Human hearing is not a purely mechanical process. Our ears and brains work together, ignoring certain sounds and perceiving others in unique ways. Psychoacoustics is the scientific study of the human psychological and physiological response to sound. It recognizes human hearing as a sensory and perceptual event. Psychoacoustic modeling enables software developers to determine which parts of a digital audio signal can be removed without significant loss in perceived audio quality. Alternatively, it suggests what should be added or enhanced to improve the listening experience.

¹ Use of DTS Clear Audio will not prevent hearing loss or eliminate distractions while driving.

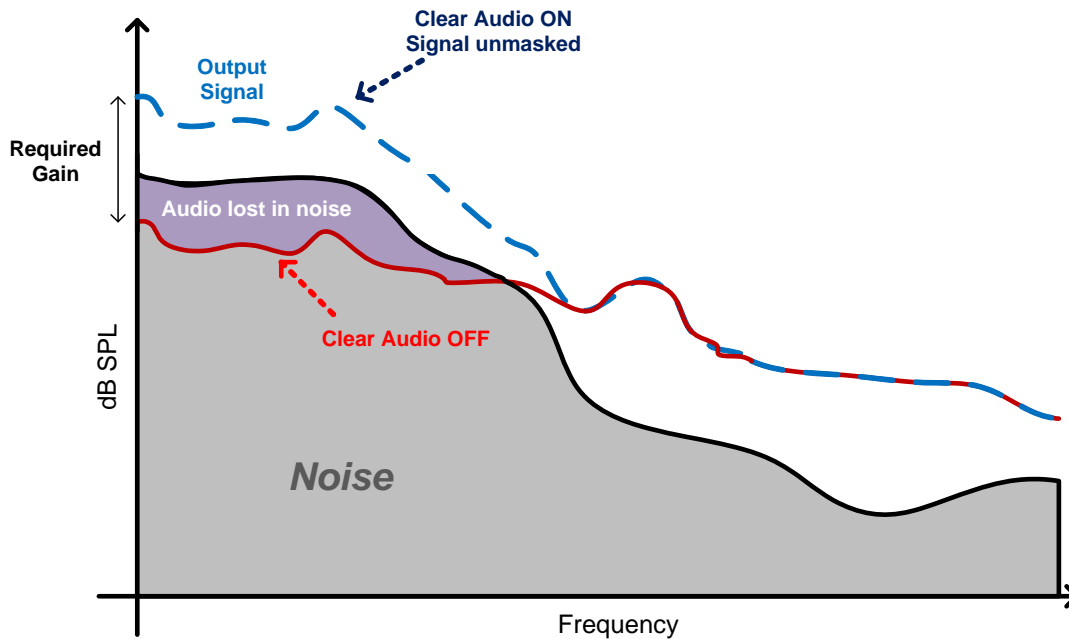


Figure 1: Noise Compensation by DTS Clear Audio

The DTS Clear Audio Solution

With DTS Clear Audio, listeners no longer need to manually adjust volume to overcome background noise. This innovative algorithm analyzes signal and noise components from a psychoacoustic perspective and then dynamically equalizes soundtracks so masked frequencies become clearly audible.

Because DTS Clear Audio continuously adapts to changing background noise, the listener is not forced to adjust volume. When noise subsides, equalization is adjusted back to appropriate levels to protect the listener from unnecessarily high loudness. Since DTS Clear Audio adjusts to background noise automatically, the listener can sit back and enjoy the entertainment experience.

DTS Clear Audio provides the following features:

- Intelligent analysis of audio signal loudness relative to background noise
- Psychoacoustic modeling to equalize audio output so it can be heard and understood
- Avoids modifying the original signal unless background noise is significant

At the start of processing by DTS Clear Audio, the analysis filter-bank shown in Figure 2 divides the input signal into smaller frequency bands, so each band can be processed independently.

As the signal reaches the Environmental Noise Compensation (ENC) block, a single, omni-directional microphone monitors background noise relative to the main stereo input levels. The block then applies dynamic compensation, if required, to maintain perceived loudness at a higher level than the interfering noise. This is done by simulating the masking behavior of the human hearing system. Frequency dependent gain is applied to the input if masking of the desired soundtrack becomes likely.

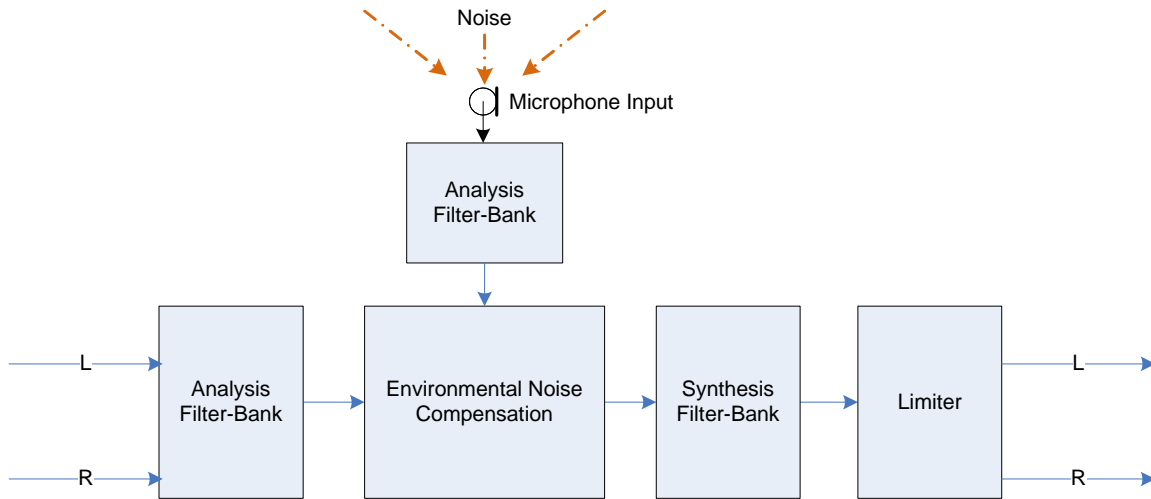


Figure 2: DTS Clear Audio Block Diagram

In order to separate soundtracks from noise, DTS Clear Audio is calibrated to approximate what the listener would hear without noise. To achieve this, a signal path is measured between the microphone and the speakers. Since the direction of interfering noise is unknown, an omnidirectional microphone is recommended to pick up noise equally from all directions.

The ENC block is an intelligent algorithm that analyzes the noise and uses psychoacoustics to model excitation patterns that occur within the listener’s inner ear. It also models the way background noise partially masks the loudness of foreground audio. The level of the desired foreground audio is then increased just enough to enable it to be heard, once again, above the interfering noise.

Next, the synthesis filter-bank converts the signals and prevents any aliasing artifacts. The final protection limiter manages the peak levels of audio output, prevents clipping and delivers additional gain compensation.



Conclusion

DTS Clear Audio enables audio to be clearly heard and better enjoyed across a variety of listening devices despite background noise. As the levels of noise in the surrounding environment change, the algorithm applies psychoacoustic modeling and dynamically compensates in real time.

With DTS Clear Audio, background noise is automatically counterbalanced so the listener does not need to frequently adjust the volume. It minimizes the detrimental effects of long term exposure to high loudness levels due to loudness adaptation. And the system avoids modifying the original signal unless background noise is significant. As a result, listening to audio from various media through TVs, personal computers, and car audio systems that use speakers becomes much more immersive.

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