Dolby® Volume: An Innovative Solution to Inconsistent Volume Issues

As home entertainment options have increased—more channels, more media, more content—so have inconsistencies in perceived volume levels. Listeners must constantly readjust their volume controls to maintain consistent playback levels as they choose from among their many program options. Even content within the same program can vary in level, often dramatically, requiring even more volume control adjustments. And with content from the Internet and social media becoming part of the traditional home entertainment experience, volume inconsistencies are likely to increase further.

Dolby® Volume technology is a groundbreaking solution to this problem. More than 40 years of engineering experience in noise reduction, perceptual audio coding, and related psychoacoustic technologies have gone into its development. Incorporated into products such as A/V receivers, set-top boxes, and TV sets, Dolby Volume continuously monitors and adjusts the audio to maintain the listener's preferred perceived playback level—across all channels, all program sources, and all content. With Dolby Volume, the listener can select a preferred volume level for a more consistent and enjoyable listening experience—and never have to reach for the remote control again.

Dolby Volume also addresses the ear's changing sensitivity to different frequencies at different playback levels. At normal home listening levels—usually significantly lower than the reference levels used in the mixing studio—the listener does not hear the original tonal balance, or timbre, of the mix, and subtle surround effects intended to set the mood can actually disappear. Employing loudness domain signal processing and a highly sophisticated psychoacoustic model of human hearing, Dolby Volume monitors the difference between reference level and the listener's actual listening level, and dynamically fine-tunes the level in each channel to maintain all the characteristics originally intended by the content producers and mixers.

Volume Leveling: An Independent Approach

Unlike regular audio compressors and automatic gain controls, Dolby Volume measures, analyzes, and maintains consistent volume levels based on how people perceive sound. Moreover, it does so in a far more sophisticated way than other volume leveling technologies.

First, Dolby Volume features an innovative approach to volume leveling and modeling that is based on the science of psychoacoustics. This technique, loudness domain signal processing, takes into account differences in the ear's sensitivity to changes in perceived volume levels at different frequencies. Loudness domain signal

processing analyzes and processes all frequencies of the audio signal, enabling Dolby Volume to maintain the original timbre of the mix at all playback levels.

Moreover, Dolby Volume processes each channel independently, whereas other levelers process all channels at once based on what's happening in only one channel. The unique multichannel, multiband design of Dolby Volume prevents changes in one channel from forcing changes on the others, thereby maintaining the original channel balance under all conditions.

Second, Dolby Volume is based on a technique called auditory scene analysis, which addresses the central issue of how the brain comprehends individual sounds and mixtures of sounds. Dolby Volume was designed with the understanding that while some loud and soft sounds are perceived as distinct elements, at other times they are fused into single sound "events." For example, the initial loud sound of a piano chord is followed by a soft decay, and the sound of an approaching car starts soft and gets louder. Dolby Volume maintains the relationship between the loud and soft parts of events like these, unlike other systems that would boost the soft sounds arbitrarily and alter the intended effect. Together with loudness domain processing, auditory scene analysis prevents side effects, such as pumping and breathing, and changes in the artistic intent of the original mix.
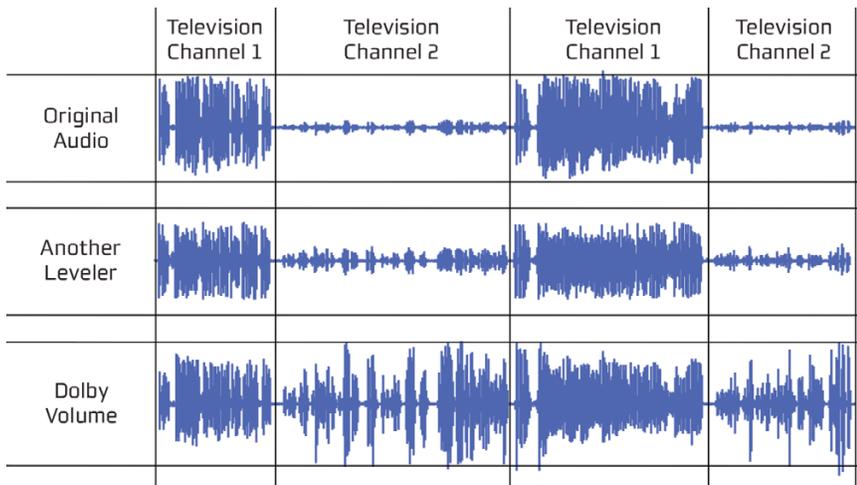

Figure 1 Changing Channels With and Without Dolby Volume

Figure 1 shows the effect of Dolby Volume (bottom) and another leveling technology (middle) when switching between two television channels that differ significantly in overall volume level (top). The other solution barely makes a difference, while with Dolby Volume, at whatever playback level the user selects, the two channels are heard at the same perceived level and otherwise exactly as broadcast.

In normal operation, Dolby Volume has no effect on the dynamic range of the original audio, only on its perceived level. However, Dolby Volume does enable the listener to reduce a program's dynamic range if desired. For example, with the volume turned down (such as when viewing at night), the dynamic range can be

reduced so that dialogue remains clear, surround ambience stays audible, and loud effects retain impact without waking up the family.
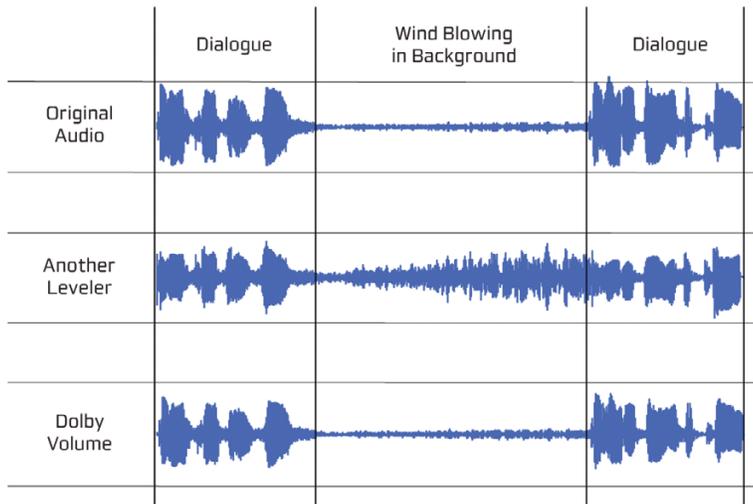

Figure 2 Effect of Dolby Volume on a Movie Soundtrack

Figure 2 compares the effect of Dolby Volume and that of another volume leveling solution on a movie soundtrack with dialogue and low-level wind in the background. Ideally, as a leveler adjusts perceived volume level, it should maintain the relationship between the dialogue and the quiet background sound. That is exactly what Dolby Volume does, thanks to auditory scene analysis. With other solutions, the loudness of the background sound increases when the actors aren't speaking and decreases when the actors are speaking, resulting in an annoying artifact called "breathing."

Volume Modeling: Accurate Sound at All Listening Levels

Dolby Volume also incorporates a unique solution designed to address the challenge of the ear's sensitivity changing with volume level. To bring the cinematic experience into the home requires high-volume playback (85 dB), which is not practical for the average home entertainment environment. Reducing system volume results in a loss of dynamic range and surround ambience, especially at low-volume listening levels.

Dolby Volume models the complex nonlinearities of loudness perception, compensating for the human ear's sensitivity changing as gain levels are increased or decreased. As with Dolby Volume's leveling function, loudness domain processing plays a key role, balancing all frequencies to maintain all the nuance and impact of the program material regardless of playback volume level.

Unlike processors that treat bass frequencies only, Dolby Volume does not audibly emphasize any part of the spectrum at any playback level. Equally as important, Dolby Volume applies independent loudness adjustments to different frequency bands and channels only when needed, rather than applying rigidly fixed compensation that ignores the input signal's changing complexities. As a result, the overall mix is not compromised, reference-level spatial and spectral balance (timbre)

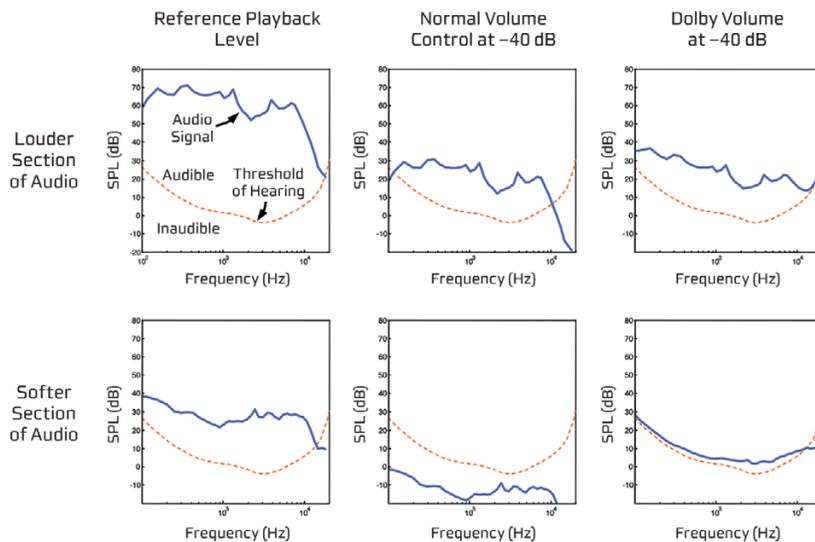are fully maintained, and surrounds are never artificially boosted, as is the case with other processors.

Figure 3 Sound Quality at Low and High Volume

As shown at the top left of Figure 3, nearly all frequencies are audible on a loud passage heard at reference level. However, if the listener turns down the volume by 40 dB (top center), extreme low and high frequencies fall below the threshold of hearing, thereby significantly changing the listening experience. Dolby Volume (top right) restores the audibility of all frequencies at the lower playback level so that characteristics like tonal balance (timbre) are unchanged.

Shown at the lower left of Figure 3 is a soft section, such as low-level ambience on a movie soundtrack, at reference level. When the volume is turned down (center), everything falls below the threshold of hearing, so the ambience is completely lost. With Dolby Volume, all frequencies, and thus the ambience itself, are still audible, even at the reduced playback level. This feature is especially valuable in surround sound systems, where ambience in the surround speakers can be lost altogether at reduced playback levels. Dolby Volume restores the ambience when the system volume is turned down, as for late-night viewing.

Compatible and Robust

Dolby Volume can be easily integrated into products such as A/V receivers that feature DSP technologies such as room equalization or feature enhancements to the audio signal that are delivered downstream for processing by hardware players. Room equalization, for example, can actually enhance the performance of Dolby Volume, making it even more efficient. Integrating room equalization with Dolby Volume provides the listener with the very best experience possible— an environment where the room is properly balanced and equalized, and where the listener receives a consistent reference-quality listening experience at any volume level. In addition, Dolby Volume complements the dialogue normalization

used in broadcast, DVD-Video, and Blu-ray Disc™ to provide consistent dialogue levels across programming and content, resulting in the most consistent playback quality possible.

Manufacturers implementing Dolby Volume also have the option to include any of a number of powerful Dolby signal processing enhancements. These are offered as part of the Dolby Volume suite and improve overall audio performance of a product, complementing the benefits provided by Dolby Volume loudness processing. Manufacturers choose which, if any, of the following technologies to add based on their specific product application.

Audio Optimization

Natural Bass applies a clean, powerful bass extension, increasing bass response by up to an octave. Its multistage filtering removes subsonic frequencies that can't be reproduced effectively on small speakers and frees the power amplifier to work on frequencies that can be heard. The result is increased headroom and reduced clipping distortion.

Speaker EQ provides a beginning-to-end solution for quickly maximizing speaker performance. It analyzes up to 20 frequency bands and employs perceptual loudness techniques with the goal of achieving flat frequency performance from the on-board speaker system. Implementing up to seven biquad filters—the exact number of filters is determined by the MIPS budget and required frequency control needed for tuning—this holistic approach to efficiently optimizing speaker performance offers great flexibility in terms of filter shapes while requiring a low MIPS investment.

Virtual Speaker

Virtual Speaker creates a high-quality surround sound experience from only two speakers. Through the application of HRTF, decorrelation, and cross-talk cancellation technologies, Virtual Speaker achieves a wider sweet spot and a more intense virtual surround listening experience. Virtual Speaker is commonly used for the playback of native and upmixed 5.1-channel content via a device's built-in stereo speakers to simulate the experience of listening to a discrete multichannel speaker configuration.

Dialogue Enhancement

Dialogue Enhancement improves the audibility and the intelligibility of dialogue and vocals relative to the rest of audio content for stereo music and video. It detects and extracts the dialogue into a separate speech channel, applies dynamic equalization, and intelligently mixes the speech channel back into the audio stream. Dialogue Enhancement is particularly useful when the audio level is low, such as when watching TV late at night, and when the listening environment is particularly noisy.

Sound Space Expander

Sound Space Expander widens the perceived stereo field of closely placed speakers, creating a stable, solid stereo image that wraps around the listener. By preserving center channel integrity, dialogue remains clear and natural sounding. Ambience, individual musical instruments, and sound effects, meanwhile, spread across a much broader soundstage. A proprietary filter algorithm processes audio with minimal noise and distortion without resorting to processing-intensive double-precision calculations.

Graphic EQ

Graphic EQ integrates an audio equalizer of two to seven adjustable bands. The manufacturer has control over the number of equalization bands and the headroom requirements of the feature. The end user can be provided direct control over the gain in each band or be presented with equalization presets. All controls can be varied and adjusted in real time.

High-Frequency Enhancer

High-Frequency Enhancer restores the crispness and edge to audio content that has been digitally compressed. Designed to function with a range of audio material (music, speech, movie soundtracks, and more) compressed with different codecs (MP3, AAC, HE AAC) at different bit rates, it re-creates missing high frequencies by analyzing and extrapolating the lowest part of the signal spectrum still present after audio compression and applying nonlinear synthesis techniques to generate the upper frequencies.

Mono-to-Stereo Creator

Mono-to-Stereo Creator derives a convincing stereo effect from mono content to add depth to the playback experience. It works by creating a slightly delayed second channel, varying this delay in a frequency-dependent manner to avoid the "comb-like" filter effect evident when using a single delay.

Experience Makes the Difference

From the very beginning, Dolby technologies have been rooted in the science of psychoacoustics—that is, understanding how humans hear. As a result, we've been able to reduce background noise in analog media without introducing audible side effects (Dolby noise reduction), dramatically lessen the data rate necessary for high-quality multichannel digital audio (Dolby Digital), and deliver convincing surround sound over just two speakers (Dolby Virtual Speaker), among other achievements. Dolby Volume takes advantage of all the lessons learned in more than 40 years of researching the science of human hearing and creating audio technologies that have been accepted as standards throughout the world.

In addition to A/V receivers, stereo and home-theater-in-a-box systems, and sound-bar products, Dolby Volume can be integrated into TV sets and set-top boxes. It works with any input signal, analog or digital, with any service (cable, satellite,

terrestrial, and IPTV), and on any program source. This versatility is part of what sets Dolby Volume apart from other solutions. It works equally well with movies and music, and can handle any kind of content without difficulty.

Integrating Dolby Volume into hardware products can be as simple as employing a variety of preset user selections. A hardware manufacturer may choose to allow users to set their own preferred levels and control the overall EQ of their system. In addition, Dolby Volume signal processing may be assigned to individual inputs on an A/V receiver, based upon user preference. For example, a consumer may choose to apply the Dolby Volume solution to playback of CDs or MP3 files where dynamic range and gain levels may vary dramatically by program selection. Similarly, consumers may choose to leave Dolby Volume off when listening to reference-grade recordings or when they want to experience the full dynamics of a motion picture soundtrack.

Delivering a high level of listening consistency and listener satisfaction, Dolby Volume offers a unique way to differentiate and add value to home entertainment products. Dolby Volume is a technology solution demanded by enthusiast and mainstream consumers alike.