

Premium Sound for Handheld Entertainment



Overview

As the world's appetite for mobile entertainment continues to grow, consumers are demanding increasingly better audio and video performance from their mobile devices. But many challenges stand in the way of manufacturers being able to meet these expectations, especially the desire for improved audio quality. On the content side, mobile devices receive media from a wide range of sources, and the quality and production of this content varies dramatically. Also, headphone listening and small integrated speakers constrain audio quality. Battery life and processing power are not unlimited. Multiple applications and codecs in the same device mean that there is no simple audio fix. As a result, building mobile devices with good audio capabilities is a challenging and time-consuming task.

For this reason, many of today's leading mobile device manufacturers have chosen to implement Dolby® Mobile in their products and bring the renowned Dolby cinema experience to consumers on the go. The newest version of Dolby Mobile is a suite of integrated postprocessing technologies and audio codecs designed to work together as well as individually.

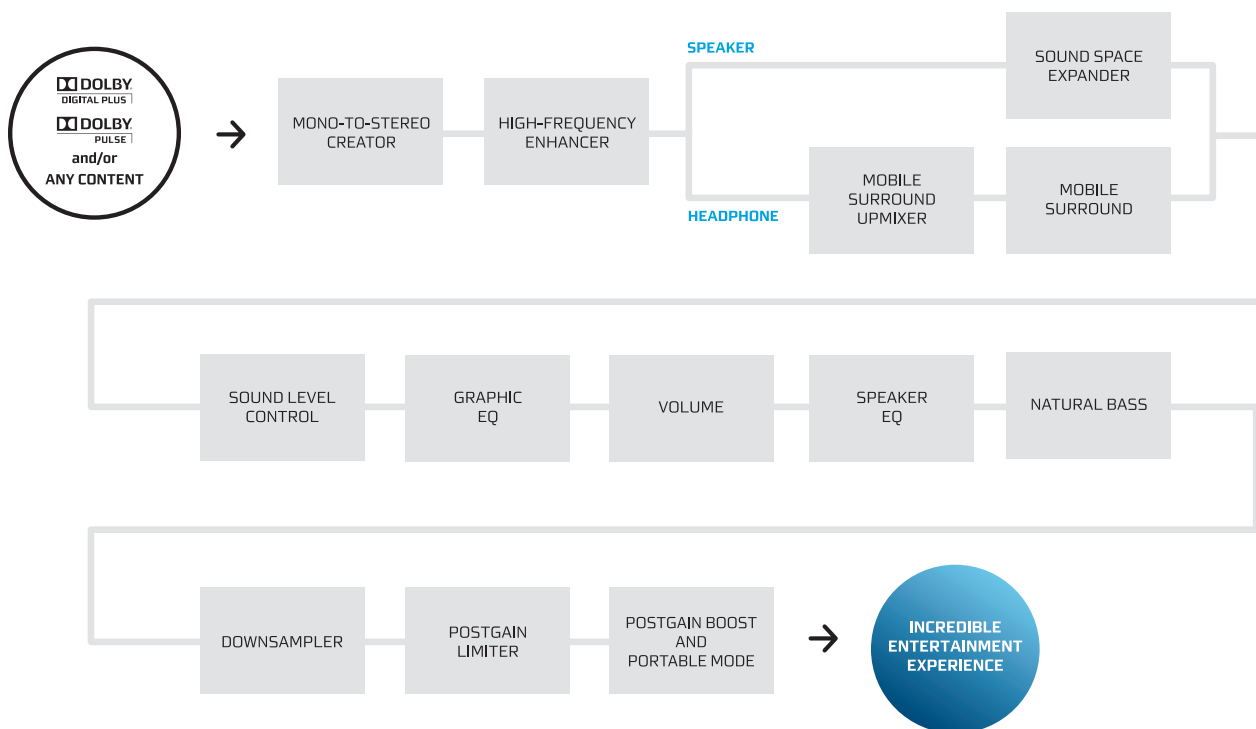
Careful design ensures that correct headroom and spectral balance are maintained at all times—a key feature given the widely varying content that mobile users encounter, as well as the abundant variations in handheld devices themselves. Careful design also makes it easy to enable a multitude of features without negative effects such as clipping or poor overall equalization. Likewise, Dolby Mobile consolidates postprocessing functions in one place with a single application programming interface (API), allowing all applications on a device to benefit from improved sound. And Dolby Mobile can be customized to fit a device's specific characteristics, accommodating everything from speaker size and positioning to audio path

headroom and placement in different sections within the device's media framework. In short, Dolby Mobile enables a premium listening experience from premium mobile devices without overtaxing the resources of either the devices or their makers.

For music playback, the Dolby Mobile postprocessing technologies provide compelling and natural audio. By restoring the bass, brightness, and clarity to compressed music, these technologies let mobile audiences experience all the energy and excitement of their favorite songs. Dolby Pulse is the bandwidth-optimized stereo audio codec for music content and short-form video. Its highly efficient design, based on HE AAC, makes it ideal for delivering content via bandwidth-constrained applications such as streaming.

For video playback, Dolby Mobile delivers superb surround sound by unlocking the surround information present in video soundtracks. In addition, the newest version of Dolby Mobile can decode Dolby Digital and Dolby Digital Plus content for HD-quality entertainment anywhere. When connected to a home theater system, a mobile device with Dolby Digital Plus can play a movie or video with up to 5.1 channels of surround sound.

Easy to integrate and available for many operating systems and hardware platforms, Dolby Mobile provides stunning audio for consumers right out of the box, and optimized audio when acquiring media encoded with Dolby technologies. This combination ensures the best possible sound experience from a mobile device.



Multiple Output Options

Dolby Mobile can provide improved listening through stereo headphones, through the mono or stereo speakers built into the device, or through the speakers in a connected docking station.

Audio processed by Dolby Mobile may also be transmitted for stereo Bluetooth® headset playback using the Bluetooth subband coding (SBC) audio codec with the Advanced Audio Distribution Profile (A2DP).

Home theater connectivity is another option. Whether through a physical HDMI® connection or a DLNA® home network, Dolby Digital Plus allows devices to deliver 5.1-channel audio for bigger screens.

Dolby Mobile Technologies in the Spotlight

Audio Codecs

Dolby Digital Plus

Dolby Digital Plus extends the capabilities of Dolby Digital, enabling an HD-quality audio experience on mobile devices. Efficient and flexible, it preserves bandwidth for uncompromised HD video and can support up to 5.1 channels of compelling, cinematic surround sound. Dolby Digital Plus also retains compatibility with existing home theater equipment and file-based Dolby Digital content.

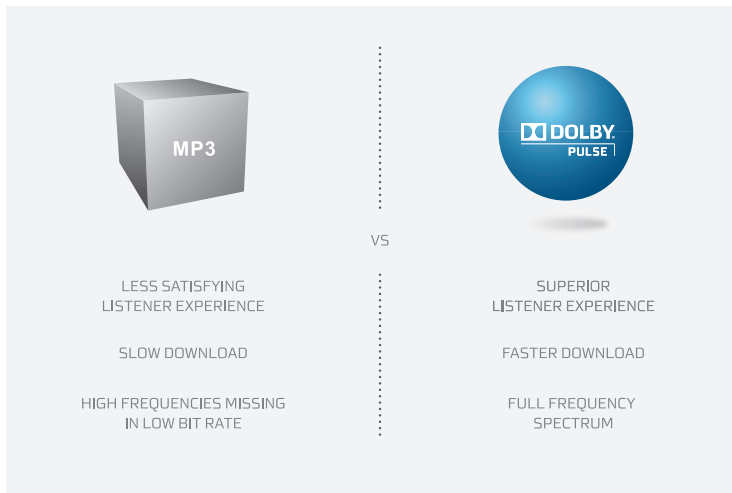
By providing for connectivity between mobile devices and home theater systems, Dolby Digital Plus supports the convergence of entertainment devices. It uses the same bitstream across the full range of file and transport formats, so unaltered audio content can come straight from the source and requires no transcoding or special processing.



Dolby Pulse

Dolby Pulse delivers superior audio quality to mobile devices. Designed for greater efficiency than more conventional formats, its smaller file sizes enable faster downloads and more reliable media streaming for consumers—especially in situations where bandwidth may fluctuate.

A robust evolution of AAC, Dolby Pulse is compatible with the existing ecosystems, making it easy to integrate and reducing the need for manufacturers to license additional decoders. Dolby Pulse has also been extensively tested to ensure content plays back consistently over a wide range of devices. With Dolby Pulse, the listener can enjoy premium quality from the authority in audio.



Audio Processing

Mobile Surround

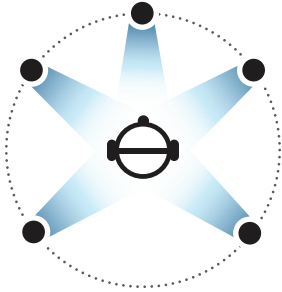
Mobile Surround makes it possible for mobile devices to deliver a 360-degree surround listening experience over any stereo headphones. It works with all stereo content, whether or not the content has been encoded specifically for surround playback. Everything from conventional stereo music files to TV programs and movies come to life with theater-like vibrancy.

Mobile Surround combines an advanced virtualizer with an efficient new matrix surround decoder optimized for use in low-powered portable devices. Mobile Surround's virtualizer applies processing to the matrix decoder's outputs that re-creates the complex combination of direct and reflected sound generated by multiple speakers in a properly calibrated listening room. These sonic signatures are combined into two channels replicating what would reach the left and right ears of the listener. Hearing these two channels over conventional stereo headphones transports the consumer to a virtual listening room equipped with a multispeaker home theater system.

The matrix decoder has been designed specifically to meet the needs of virtualized (as opposed to actual) speakers. For example, a fixed-matrix/variable-gain approach minimizes interchannel leakage that would interfere with the head-related transfer functions (HRTFs) upon which convincing virtualization depends, while any potential side effects from this

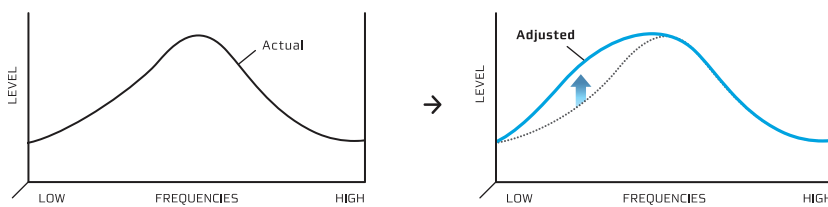
approach are simultaneously minimized. Other new enhancements significantly reduce computational requirements, compared to those of earlier matrix decoders, while maintaining subjectively equivalent audio performance.

Mobile Surround also adds two effects that are either exposed as user-configurable controls on a mobile device or set by the manufacturer and not exposed to the user. Room Size creates the impression of listening to the audio in different sized rooms, from small to large. Brightness adjusts the timbre of the audio, adding “brightness” (more high frequencies) or “warmth” (fewer high frequencies).



Natural Bass

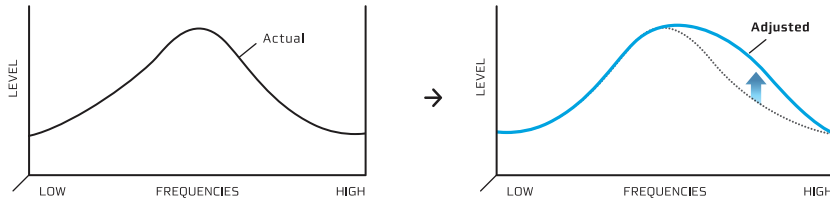
Natural Bass works within the specific capabilities of the headphones supplied with the mobile device or the speakers built into it to maximize bass output without adding distortion or risking physical damage. Its operation is keyed to the bass rolloff characteristics of the particular headphone or speaker drivers and the bass content of the signal. On the initial peak of loud bass sounds, Natural Bass compresses the peak to avoid distortion and physical damage. On softer bass sounds, such as the “tails” following the initial peak of loud sounds, Natural Bass boosts the bass by a user-selectable amount, up to the maximum the drivers can handle. The result is a true, natural-sounding bass extension without the risk of distortion typical of fixed bass-boost technology. Natural Bass has no side effects such as the coloration introduced by bass “enhancers” that work by generating artificial harmonics of the fundamental bass frequencies.



High-Frequency Enhancer

High-Frequency Enhancer improves the playback quality of compressed digital content, which can sound muffled or muddled due to the loss of high frequencies discarded by lossy compression algorithms. The high-frequency losses can also reduce the subjective width of the stereo image.

High-Frequency Enhancer uses special techniques to synthesize missing high-frequency components from the remaining part of the signal spectrum, and thus restores crispness, clarity, and stereo width to the audio. It can also be used to improve sound brightness features on full-bandwidth signals.



Sound Level Controller

Sound Level Controller manages sudden volume changes in wide-dynamic-range content such as movies and orchestral recordings. Instead of having to turn the volume down to avoid distortion on loud peaks and then turn it up to hear quieter passages, the listener can set the volume to a preferred level and forget it. Sound Level Controller evens loud peaks and sudden drops in amplitude for a more consistent and enjoyable listening experience, reducing the need to constantly adjust the volume control, even when listening in a noisy environment. The distortion or audible “squashing” effects associated with conventional limiters are greatly reduced by processing critical Center information, such as movie dialogue, differently from less critical information that is typically more prominent in the Left or Right channels.



Mono-to-Stereo Creator

Mono-to-Stereo Creator derives a convincing stereo effect from mono content. Without the audible side effects of earlier, less sophisticated attempts, Mono-to-Stereo Creator uses a unique process to add stereo-like spaciousness by creating a slightly delayed second channel from the mono signal. Simply delaying the original signal results in unpleasant frequency aberrations caused by a comb-filter effect between the original and delayed signals. Mono-to-Stereo Creator employs a sophisticated algorithm that varies the delay with frequency to maintain both frequency and phase response, essentially eliminating the comb-filter effect and such side effects as unnatural harshness.



Sound Space Expander

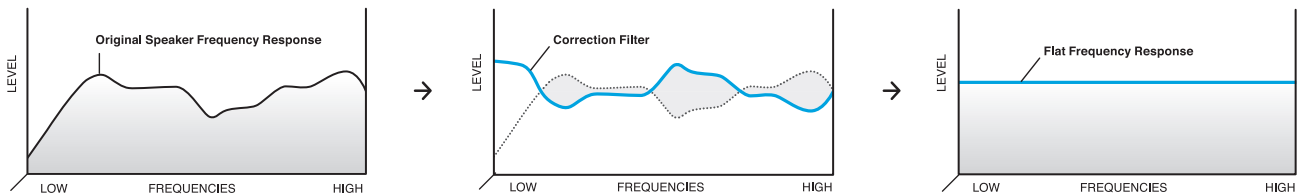
Sound Space Expander widens the perceived stereo field of closely placed speakers like those built into mobile devices and docking stations. Without any unnatural side effects, Sound Space Expander creates stable, solid stereo images with a wide field that wrap around the listener.

The sophisticated algorithm used by Sound Space Expander widens the stereo image while simultaneously preserving the clarity of vocals and dialogue. Sound Space Expander also un.masks sounds that were previously obscured in the clutter, increasing angular separation so that the listener hears the complete frequency spectrum of each individual sound element in a clearly discernible location.



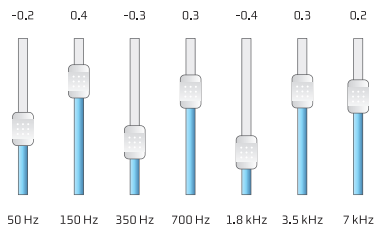
Speaker EQ

Speaker EQ is an equalizer that improves speaker and headphone transfer functions. Speaker EQ has a configurable number of one to four cascaded infinite impulse response (IIR) filters to implement a custom frequency response. It uses custom coefficients that are designed to equalize the device headphone or speaker transfer function. Speaker EQ also includes an individual gain on each channel to align the output levels of stereo devices. Tuning of the Speaker EQ is done with Auditest, the measurement and analysis tool that Dolby provides to licensees.



Graphic EQ

Graphic EQ is a graphic equalizer with a configurable number of frequency bands. A mobile device incorporating Graphic EQ can allow for user adjustment as well as predefined settings for content-specific listening modes. Unlike traditional graphic equalizers that can produce undesirable frequency response aberrations when adjacent bands are raised, Graphic EQ has been specially developed so that the measured boost provided in any particular band is consistent with the desired gain setting.



Technical Specifications

All of the following estimates are from measurements made while using the ARM Cortex™-A8 processor.

MIPS Examples for Audio Kernel

Playback	MIPS
Mono speaker playback	23.26
Stereo headphones, music playback	23.86
Stereo speakers, movie playback	30.43
Headphones, movie playback (stereo)	30.78
Headphones, movie playback (5.1 input)	34.13

MIPS Examples for the Dolby Pulse Decoder

Content	MIPS
Stereo, 48 kbps, 44.1 kHz, HE AAC v1	22
Stereo, 32 kbps, 44.1 kHz, HE AAC v2	25
5.1-channel, 160 kbps, 44.1 kHz, HE AAC v1	63

MIPS Examples for the Dolby Digital Plus Decoder

Content	MIPS
384 kbps	34.6
448 kbps	30.8

Memory Usage for Audio Kernel

Type	Memory Usage
Code coefficient (ROM)	149.2 K
Data memory (RAM)	38.4 K

Memory Usage for the Dolby Pulse Decoder

Type	Memory Usage
Code coefficient (ROM)	190 K
Data memory (RAM)	110 K

Memory Usage for the Dolby Digital Plus Decoder

Type	Memory Usage
Code coefficient (ROM)	113 K
Data memory (RAM)	115 K

Code Characteristics

The code is operating system agnostic. Dolby provides support for Android™ (all versions), Windows® Phone 7, Symbian™, MeeGo™, and all other common mobile operating systems.

- PCM processing on blocks of 32 samples or multiples thereof
- Sample rates of 8, 11.025, 12, 22.05, 24, 32, 44.1, and 48 kHz
- Supports 1-, 2-, 3-, 4-, 5-, 5.1-, and 7.1-channel inputs
- Set/get feature parameter API for all controls
- Maximum delay: 8 ms
- Reference C code targets 16-bit, 24-bit, mixed 16-bit/32-bit, and floating-point ICs

Product Development Experience

Dolby Laboratories has been licensing cutting-edge audio technologies to electronics manufacturers for decades, and knows what it takes to go from signing a licensing agreement to delivering a product that meets both the licensees' expectations and those of their customers. Everything Dolby does is based on the premise that the licensees' success is Dolby's success.

Dolby provides licensees with a system integration kit containing documentation, API information, lists of available implementations of Dolby Mobile from IC makers, and other information to help integrate Dolby Mobile technologies into their products. Dolby also helps maximize a device's functional operation and user interface by recommending customized presets combining technologies ideal for movies, music, TV programs, and other content.

The Dolby Mobile program includes not only premium audio technologies but also device testing, tuning advice, and rights to use the renowned and trusted Dolby brand. One of the more noteworthy components of the system kit is the measurement and analysis tool Auditest, which a licensee can use during development to test the codecs and postprocessing functions in the mobile device. This allows for faster, smoother integration.

With over 40 years of audio engineering expertise, Dolby Laboratories has transformed the entertainment experience in the cinema and through the more than three billion consumer products that incorporate our technologies. Dolby Mobile continues that tradition of innovation.



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