



General

Zirene[®] is AM3D's world-class post-processing solution capable of enhancing the audio on devices such as mobile phones, TVs, portable music players, portable navigation devices, or other kinds of devices where audio is an essential part of the user experience. The solution is purely software-based and is easily integrated into existing software systems. All features has very low memory footprint and requires extremely low computation power.

The physical nature of mobile devices means that listening conditions often differ greatly from those preferred by the creators of the original media source. For example, stereo music and multi-channel audio are produced with specific loudspeaker arrangements in mind, and these are not directly achievable in a mobile device. There are also other limitations caused by low acoustic output power and reduced bandwidth capability.

To overcome the inherent audio performance limitations of mobile phones and portable devices, AM3D has developed Zirene[®], which offers market-leading audio enhancement technology for transducer optimization and spatial audio effects, all of which are based on AM3D's world patents. Whether audio is reproduced on headphones or loudspeakers, Zirene[®] greatly boosts the quality of the audio playback by adding high-quality effects, such as a broadening the aural image, improving the perception of low frequency sounds, and making it possible to experience the playback in various acoustical environments. The end result is an improved and much more refined listening experience.

In addition to the Zirene[®] enhancement features, AM3D offers tuning and filter design tools for quick and easy testing and implementation of the enhancement components.

Zirene[®] offers the following features:

- Mono Widening
- Stereo Widening
- Virtual 5.1 Surround
- Virtual Surround 2.0
- Reverb
- Power Bass
- Dynamic Bass Boost
- Treble Enhancement
- Level Max
- Transducer EQ
- Level Alignment
- Graphic EQ

Zirene[®] Mono Widening

In some cases where a monophonic audio signal is presented to a listener through stereo headphones, it is possible to improve the spatial properties of the sound image. Normally, the sound image will be perceived as being in the middle of the head. This unnatural listening situation can be burdensome, and can lead to fatigue after long periods of listening. Mono Widening moves the sound image to a position outside the head within a natural listening environment. This gives an enhanced feeling of comfort and relief during use and brings the listener closer to a natural listening situation.

Zirene[®] Stereo Widening

In typical portable devices with stereo micro-speakers, transducers are placed close together. When listening to music through the speakers, the stereo sound stage is very narrow. The Stereo Widening algorithm creates virtual sound sources that are perceived to be placed beyond the extent of the physical device. In this way a much wider and more natural sound stage is perceived.

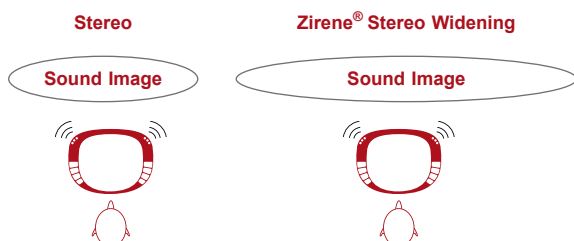


Figure 1: Stereo Widening effect.

The Stereo Widening algorithm also supports headphone playback. Normal headphone playback is often perceived as playing 'inside the head'. This is an undesirable effect because the sound is not perceived to originate from two loudspeakers in a room in front of the listener. By using Stereo Widening for headphones, the user perceives the sound to be outside the head, which improves the overall listening experience. Figure 2 illustrates how a user perceives the audio coming from two virtual speakers to give an 'out of head' listening experience.



Figure 2: 'Out of head' experience.

Zirene[®] Virtual 5.1 Surround

The introduction of video streaming in portable devices is driving the need for functionality capable of producing surround sound on headphones or closely spaced loudspeakers. Virtual 5.1 Surround enables the experience of 5.1 Surround Sound on headphones or narrow spaced stereo loudspeakers when presented with a 5.1 input signal, Zirene[®] Virtual 5.1 Surround creates the illusion that the sound is actually coming from six loudspeakers placed in a 5.1 set-up. See Figure 1. This illusion is produced by the use of interactive binaural processing through worldwide patented Head-Related Transfer Functions (HRTFs).

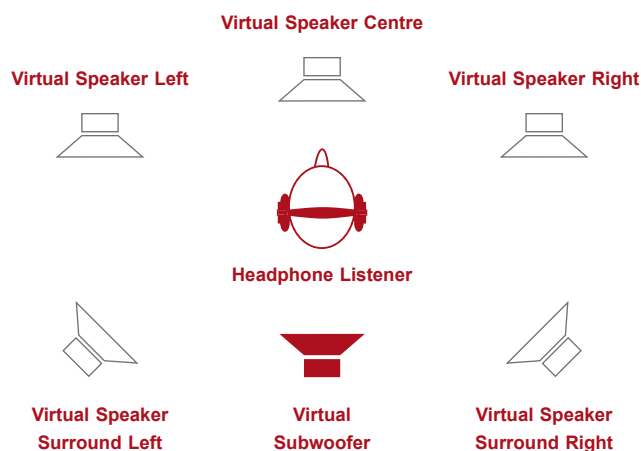


Figure 3: Virtual 5.1 Surround sound set-up.

Zirene[®] Virtual Surround 2.0

If a 5.1 surround signal not is available, AM3D's Virtual Surround 2.0 algorithm can convert a 2-channel stereo signal into a virtual surround sound experience similar to multi-channel surround sound. The advanced digital signal processing effectively 'tricks' the ear into experiencing sounds as coming from various directions, while voices are kept at the centre of the aural image. The solution requires very little additional computation power in the host device.

Zirene[®] Reverb

Reverb is a sophisticated binaural room simulation algorithm for creating many different listening environments. The room simulation algorithm helps substantially to create the perception of distance. The focus in developing this algorithm was to create a high sound quality without using excessive processing resources. Furthermore, it is designed to allow for the creation of many different listening environments such as rooms, halls, an alley, an arena, a hangar, a cave, a plate etc. The user can select from a number of predefined listening environments and is then able to adjust the reverberation level and time.

Zirene® Power Bass

Power Bass is a bass enhancement algorithm that boosts the low frequency part of the signal and leaves the remaining part of the frequency range unchanged in terms of loudness and timbre. Through the application of our technology and drawing on our knowledge of how the human auditory system perceives low frequency tones, it is possible to create the perception of extreme bass enhancement without changing the amplifiers and loudspeakers already installed in the device. Power Bass maximizes the bass output depending on the amount of headroom available in the original signal. It is thus a non-linear bass enhancement process. Power Bass works for all types of headsets and external speakers (small to medium size speakers).

Zirene® Dynamic Bass Boost

Internal speakers on portable devices are due to physical constraints typically very small. The Dynamic Bass Boost is optimized to boost the low to medium frequency region i.e. to be used with transducers having a very limited efficient region. Internal micro speakers typically have such characterization.

Zirene® Treble Enhancement

Since loudspeakers which reproduce sound in the low to mid frequency range are generally poor at reproducing high frequency sounds, a common approach in playback systems is to use a second loudspeaker for reproducing the high frequencies. Such a loudspeaker is often referred to as a tweeter. The Treble Enhancement algorithm developed by AM3D amplifies the high frequency content of an audio signal by means of non-linear processing, thus making it possible to manufacture playback systems without using tweeters. As a result, AM3D's Treble Enhancement provides a clear and crisp treble which emphasizes details that are usually lost in audio signals played on loudspeakers with poor high frequency playback capabilities.

Zirene® Level Max

Level Max has the simple goal of boosting the level of the audio signal beyond what would be possible with a linear gain. In other words, the sound level is raised by means of non-linear processing. This is done without degrading the sound quality, the advantage being that small loudspeakers in a device can then deliver a much louder acoustic output.

Zirene® Transducer EQ

Often speakers especially in small devices do not have an ideal frequency response, e.g. some frequencies are reproduced louder than intended. The Transducer EQ compensates for this. The technology is based on an acoustic measurement combined with tuning by a sound engineer. By using Transducer EQ the overall listening experience will be improved considerably. Together with Transducer EQ AM3D can offer the AM3D Filter Design Tool, which enables the audio engineer to create optimal EQ-filters.

Zirene® Level Alignment

The purpose of Level Alignment is to adjust the gain of different signals to compensate for the (potentially large) differences in sound level. This is useful when, for example, two consecutive pieces of music have very different loudness. This can be because songs (in MP3 format for example) have been recorded at different levels, because passages in a piece of classical music have very different volumes, or because the sound level of advertisements on the radio is much louder than the music being played. In such cases, Level Alignment effectively aligns the signals to minimize the difference, and softer pieces of music are much easier to hear as a result.

Zirene® Graphic EQ

Graphic EQ is a conventional ten-band graphic equalizer with attack frequencies from 31 Hz to 16 kHz with one octave of separation. The Graphic EQ's gain settings are converted internally to standard IIR filters to reduce the CPU load. Graphic EQ also enables you to add a number of equalization settings for different kinds of music. This makes it possible to change the frequency characteristics of the playback system to suit a particular style of music. The following well-known music pre-sets are supported: classical, pop, jazz and rock.

Integration of Zirene®

The Zirene® product is based on digital signal processing algorithms implemented in software and must be embedded into the software layer of the portable device. A conceptual block diagram of how Zirene® is integrated into a typical portable device is illustrated in Figure 4. Whenever an audio signal is played back in e.g. a music player application, the audio signal must be routed through Zirene®, and the stereo output from Zirene® must then be routed to the codec and amplifier stage in the hardware layer.

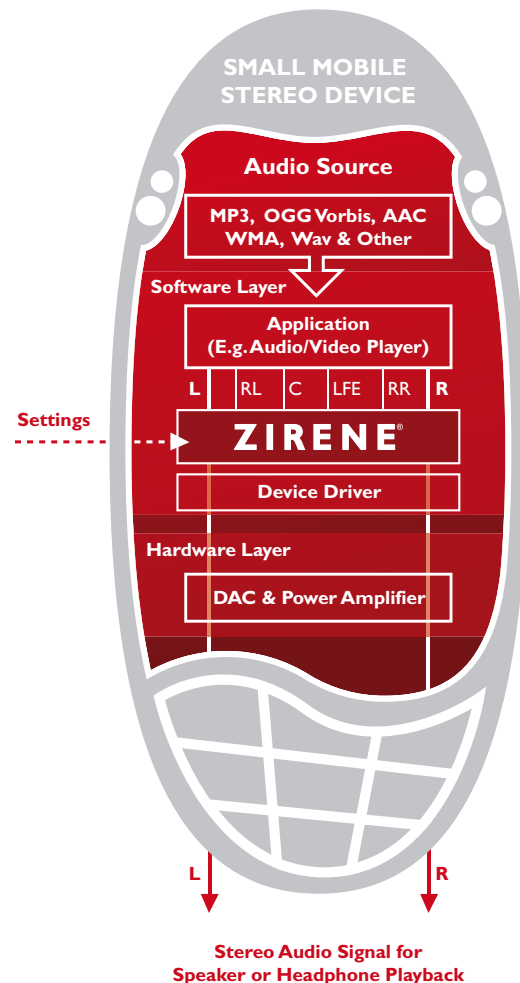


Figure 4: Integration of Zirene®.

Zirene® is easily implemented in existing software systems and is generic and module-based. The solution is not dependent on any external libraries, e.g. open source code, and is developed in ANSI C using assembly optimized code for the resource intense parts that are targeted at various platforms. An entirely ANSI C reference solution is available for fast prototyping on any customer device. Zirene® is already available for a number of platforms and can within short time be ported to other dedicated platforms.

Together with the Audio Enhancement features AM3D offers the AM3D Tuning Tool (AMHost) that allows the audio engineer to optimize and tune the sound of the transducer in any given configuration.

The Zirene® product can be customized to meet specific functionality, computation and memory requirements through the selection of individually requested processing elements.

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