C-CUBE

ZiVA-5 DVD-Audio

October 2000

Part Number: ZiVA5-WP-DVDAUD-0.1

INTRODUCTION

The digital audio revolution was started by the Compact Disc Digital Audio (CDDA) format in 1982. The CDDA 2-channel stereo format has been extremely successful and has been accepted as the replacement for the legacy vinyl album format. DVD-Audio will now take digital audio to the next step with new features such as true multi-channel high-resolution audio, visual menus, lyrics and high-resolution still pictures. DVD-Audio brings the unprecedented sound quality and fullness of the live music experience into the home. Together, DVD-Video and DVD-Audio technologies will become the center of high-quality home entertainment.

Using the new C-Cube ZiVA-5 DVD System Processor, consumer electronics manufacturers can introduce products that will play both DVD-Video and DVD-Audio discs across the full price-point spectrum of consumer DVD products.

TECHNOLOGY BACKGROUND

With any new technology and format come new specifications and terminology. Key DVD-Audio specifications, contrasted with CDDA, are listed in Table 1.

Table 1: DVD-Audio Specifications versus CDDA Specifications

Specification	DVD-Audio	CDDA
Disc type	Single-sided, single-layer: 4.7GB Single-sided, double-layer: 8.5 GB Double-sided, single-layer: 9.4 GB Double-sided, double layer: 17 GB	650 MB
Play time	Variable: - Up to 86 hours of stereo audio - More than 74 minutes of multi-channel audio	Fixed: - 74 minutes of stereo audio
Bit rate	Up to 9.6 Mbps	1.4 Mbps
Uncompressed audio format	Linear Pulse Code Modulation (LPCM)	Pulse Code Modulation (PCM)
Advanced compressed audio format	Meridian Lossless packing (MLP)	N/A
Optional audio formats	Dolby Digital, DTS, MPEG stereo, MPEG multi-channel	N/A
Audio channels	Up to 6 channels	2 channels (stereo only)
Sampling Frequency, 2-channel	48 kHz, 96 kHz, 192 kHz; or 44.1 kHz, 88.2 kHz, 176.4 kHz	44.1 kHz
Sampling rate, multi-channel	48 kHz, 96kHz; or 44.1 kHz, 88.2 kHz	N/A
Sample resolution	12, 16, 20 or 24 bits	16 bits
Frequency response	0 – 96 kHz	5 – 22.05 kHz
Dynamic range	144 dB	96 dB

The listed specifications are quite impressive once they are understood in terms of listening experience. CDDA quality sound is good, but the frequency response and dynamic range of DVD-Audio takes sound quality to the next level, as discussed below.

Sampling Frequency and Frequency Response

The human ear can detect sound up to approximately 20 kHz. The frequency response of a sampled signal is ½ the sampling frequency. The CDDA sampling frequency of 44.1 kHz gives a frequency response of 22.05 kHz. Although this is above the hearing limits of typical human detection, complaints of "flat" or "metallic" sound have circulated around CDDA since its inception, in part due to lack of frequencies above 22.05 kHz. DVD-Audio takes the sampling frequency up to 192 kHz, resulting in a frequency response of 96 kHz. This increase in frequency content of music will bring out sounds that are not possible with CDDA. See Figure 1.

Sample Resolution

Sample resolution determines how accurate amplitudes can be reproduced. CDDA has a 16-bit sample resolution that can render a total of 65,536 equally spaced amplitudes or 96dB of dynamic range. DVD-Audio, with up to 24-bit sample resolution, can render a total of 16,777,216 equally spaced amplitudes or 144dB of dynamic range. This drastically reduces distortion and allows the DVD-Audio player to accurately reproduce sounds that are not possible with CDDA. See Figure 1.

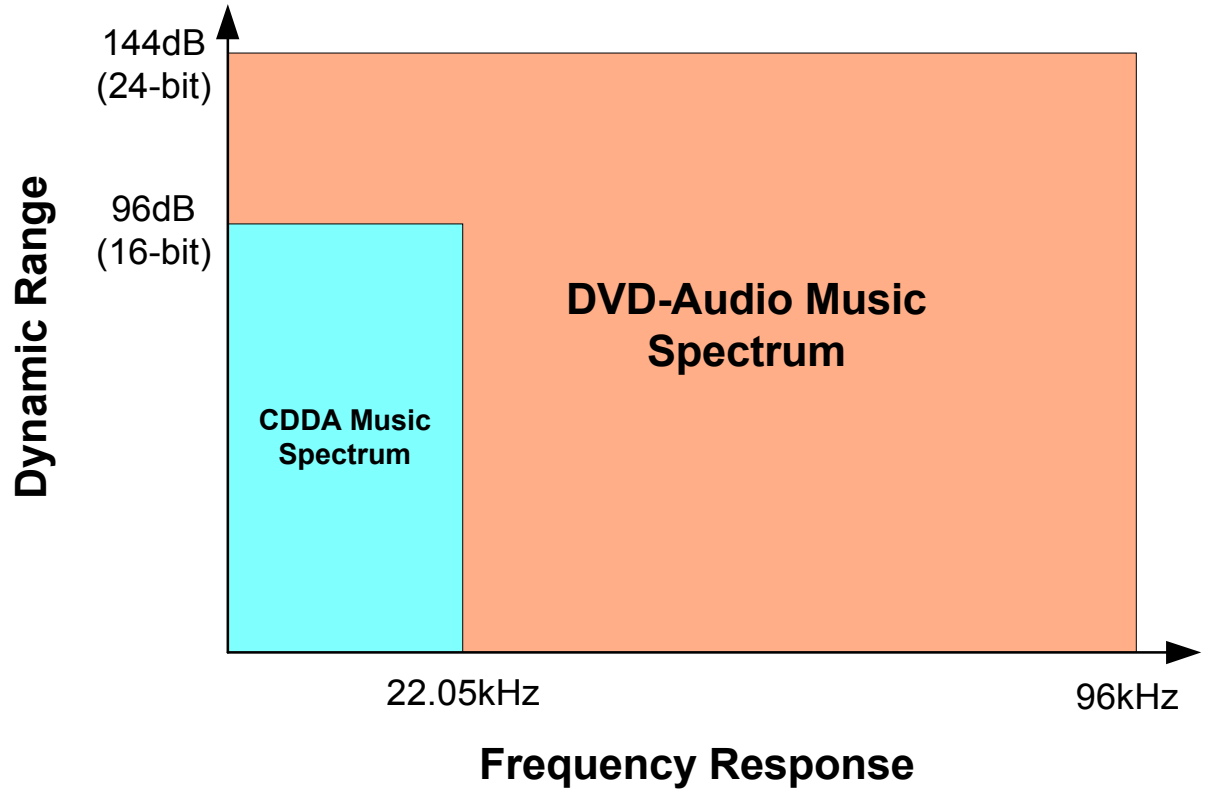

Figure 1: DVD-Audio and CDDA Music Spectrums

CDDA 2-Channel Stereo Audio

The CDDA format uses a fixed 2-channel or stereo representation of digital music, as shown in Figure 2. This stereo presentation gives the listener a feeling of spatial placement of some parts of the music with the listening environment. The spatial feeling is limited by audio that has been mixed to the 2-channel format.

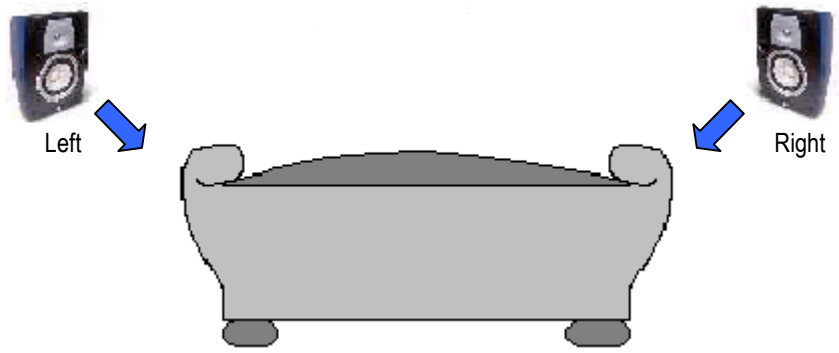

Figure 2: Typical 2-channel Stereo Sound Listening Environment

DVD-Audio Multi-channel Audio

The DVD-Audio format allows up to 6-channels of music, as shown in Figure 3. This gives the listener a feeling of being completely immersed by the music. Full 3-dimensional sound creates a listening environment never before enabled for the home. This high quality, multi-channel playback format creates new possibilities for artists and music producers to expand their creativity.

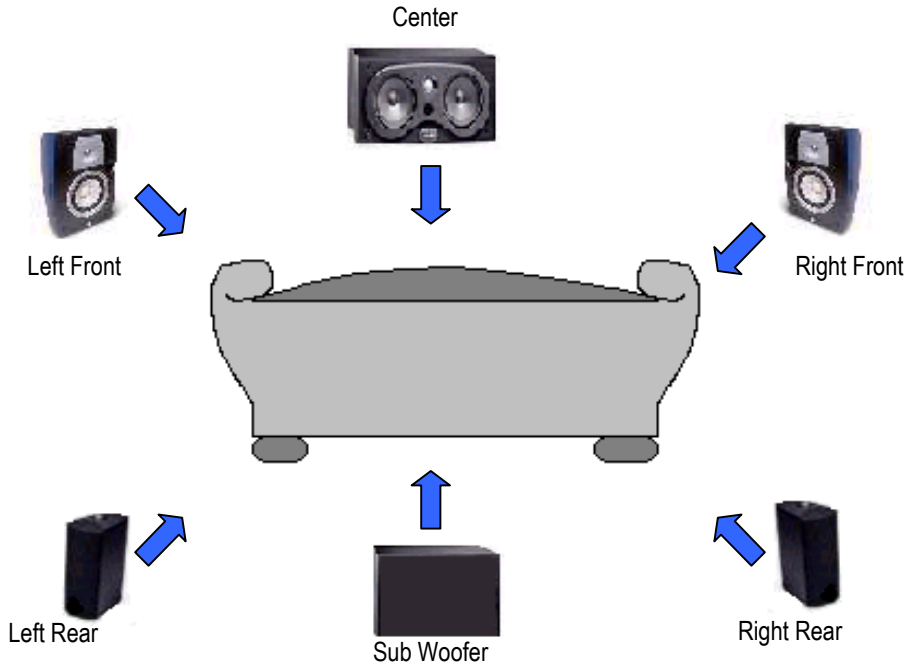

Figure 3: Typical Multi-channel Listening Environment

Storage Media
CDDA uses storage technology based on CD-ROM, which allows for 650MB of storage. DVD-Audio uses the same storage technology found in DVD-Video, which allows for multiple disc configurations from 4.7GB to 17GB.

Meridian Lossless Packing (MLP)
Consumers have come to expect 74 minutes of 2-channel audio playback for a CDDA disc. MLP is a lossless compression method that allows DVD-Audio discs to also meet the minimum of 74 minutes of high quality true 6-channel, 96kHz, 24-bit audio. MLP is available for sample rates from 44.1kHz to 192kHz and up to 6 channels of up to 24-bit audio.

Bitrate
The CDDA bitrate of 1.4Mbps provides only enough data to reproduce 16-bit, 44.1kHz, 2-channel audio. DVD-Audio increases the bitrate to 9.6Mbps. This is enough bandwidth to reproduce 24-bit, 192kHz, 2-channel audio. If MLP is used, this is enough bandwidth to reproduce 24-bit, 96kHz, 6-channel audio.

Playback Time
CDDA bitrate is fixed which limits disc playback capacity to 74 minutes. DVD-Audio bitrate is variable so the disc playback capacity can be as long as 5140 minutes or more than 85 hours when using a double-sided, double-layer disc with 44.1kHz, 16-bit, 2-channel audio and MLP compression. If listening to 6-channel audio encoded with MLP at 96kHz with 24-bit resolution, a single-sided, single-layer disc has the playback capacity of between 74 and 135 minutes.

Copy Protection
DVD-Audio makes full use of the newest copy protection technologies such as Copy Protection for Pre-recorded Media (CPPM) encryption and Audio Watermarking.

Multimedia Capabilities
DVD-Audio is built upon the technological innovations of DVD-Video. Combining limited DVD-Video features on the DVD-Audio format brings another layer of enjoyment to the audio-visual experience. Now a listener can simultaneously enjoy high-quality audio together with video clips or slides shows. Artists and producers are free to include information such as linear notes (album title, song titles, lyrics, artist information, etc.) and also Internet URLs. These multimedia features are all easily accessible via an intuitive disc navigation menu.

CURRENT DVD AUDIO SOLUTIONS

There are several products for DVD-Audio available today, but these solutions are still quite expensive, as they require a number of separate components inside the player. A typical design includes a standard DVD-Video decoder and external components to perform DVD-Audio specific processing, such as a custom ASIC to perform CPPM decryption and a DSP to perform MLP audio decode and audio watermark detection. As these products are currently considered to be “high-end” products, they typically also include progressive-scan or 480P support, which also increases the price of the product and the number of internal components used in the design.

An example of a current DVD audio solution is shown in Figure 4.

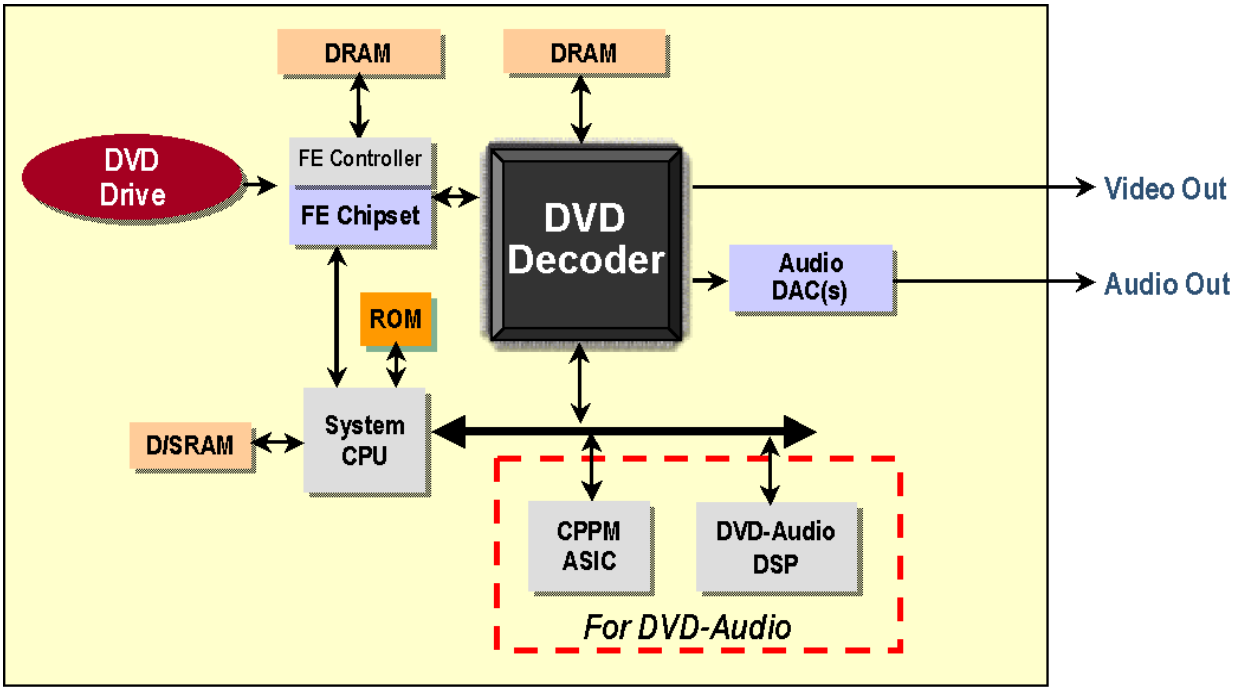

Figure 4: External Chipset based DVD-Audio Block Diagram

ZiVA-5 DVD-AUDIO SOLUTION

ZiVA-5 provides the best solution for DVD-Audio, as it integrates all the features required for DVD-Audio players into one chip. Not only does ZiVA-5 integrate all of the DVD-Audio specific processing functions (CPPM decryption, MLP decode, audio watermark detection and still picture functions) to provide a single-chip, full DVD-Audio solution, it also integrates a high-quality progressive-scan de-interlacing engine, TrueScan™. ZiVA-5 will enable consumer manufacturers to bring what is considered a high-end DVD-Audio product today into the mainstream tomorrow.

The ZiVA-5 super-integrated DVD-Audio solution is shown in Figure 5.

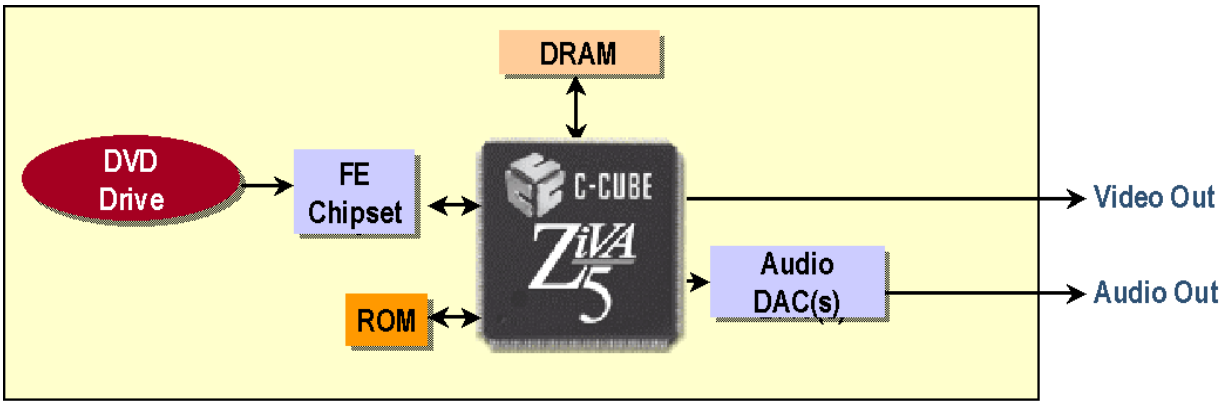

Figure 5: ZiVA-5 based DVD-Audio Block Diagram

SUMMARY

DVD-Audio technology takes full advantage of the wealth of innovations of DVD-Video to bring unprecedented realism and fullness in ambience reproduction, truly bringing the live music experience into the homes of consumers. ZiVA-5 offers the most integrated DVD-Audio player solution for the DVD market.

ZiVA-5 Integrates Copy Protection

New CPPM, and Audio Watermark copy protection technology is completely integrated into ZiVA-5. Other solutions use external ASIC's and DSP's, resulting in increased cost and limited flexibility.

ZiVA-5 Integrates MLP Decoder

MLP enables the highest-possible quality audio from the DVD-Audio experience. ZiVA-5 integrates a high-performance MLP decoder.

In summary, C-Cube's ZiVA-5 provides a highly integrated DVD-Video and DVD-Audio solution to DVD player manufacturers, resulting in products that bring a true-to-life audio/visual listening experience to the consumer.

ABOUT C-CUBE

The company is a worldwide leader in digital media processing and is leading the way with new communication processors and networked consumer products. With a focus on DVD, set-top boxes and codec-enabled products, C-Cube is driving the technology for the “networked digital home”

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