ZEN / ZEN Vision Series — Video Encoding Guidelines

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Introduction

Creative

For more than a quarter century, Creative has been a pioneer in digital entertainment products. Innovative hardware, proprietary technology, applications and services enable consumers to experience high-quality digital entertainment - anytime, anywhere. The Creative family of brands includes Sound Blaster audio products, Cambridge SoundWorks consumer electronics, E-MU Systems professional audio, and 3DLabs professional visual processing. Built on this foundation, the award-winning ZEN portable media players take premium audio and video experiences wherever you want to go.

This Guide

Creative Digital Media Relations has prepared this guide to assist you in encoding video content for Creative ZEN and ZEN Vision Series portable media players. Registered partners also have access to priority encoding, programming, and technical support. If you need further assistance, please contact your nearest Digital Media Relations office.

Encoding Considerations

Aspect Ratio

Whenever possible, the aspect ratio of the source material should be preserved. Encoding a 16:9 aspect ratio film to 4:3 with black bars increases the file size without improving visual quality, and prevents a widescreen portable media player from scaling properly.

Codec

The coding efficiency of video compression algorithms has improved steadily over the years. While the ZEN Vision Series portable media players support a wide range of codecs for compatibility with legacy media, best results are usually obtained with more modern codecs. Microsoft Windows Media Video (WMV) and Moving Picture Experts Group MPEG-4 (MPEG-4) both offer advanced video encoding at superior compression rates.

Digital Rights Management

Digital Rights Management (DRM) allows content owners to secure and limit the use of their digital assets. ZEN and ZEN Vision Series portable media players support Microsoft Windows Media DRM for Portable Devices (WMDRM-PD or “Janus”). WMDRM-PD requires content to be encoded in Windows Media Video (WMV). In addition to decoding compressed media streams, the portable device must also decrypt any DRM, placing an additional load on its processor. This effectively limits the size of DRM-protected content to lower resolutions than unprotected content.

Frame Rate

Content is best experienced at its native frame rate: 24 fps for film, 25 fps for PAL, 30 fps for NTSC. Encoding a 24 frame per second film at 30 frames per second only increases the load on the decoder, with no improvement in visual quality.

Quality versus Size

First generation portable media players required content to be down sampled to the native resolution of the player. While this reduces storage requirements, it also degrades the quality of the video image. This is particularly noticeable when the image is fed to a larger external display, like a television. ZEN Vision Series portable media players are capable of storing and rendering video larger than their native displays so that when attached to an external display, image quality is maintained. This increases the file size, reducing the amount of content that can be stored on a portable device.

Device Display Capabilities

Resolution

ZEN and ZEN Vision Series portable media players offer an array of display sizes to suit different viewing environments and preferences. In addition to their high quality internal displays, ZEN Vision Series players also support viewing on an external display, and will automatically detect and switch between NTSC and PAL as appropriate.

Display Resolution

Model	Size	Aspect Ratio	Internal Display	External Output
ZEN	2.5”	4:3	320 x 240	None
ZEN Vision:M	2.5”	4:3	320 x 240	720 x 480 NTSC, 720 x 576 PAL
ZEN Vision	3.7”	4:3	640 x 480	720 x 480 NTSC, 720 x 576 PAL
ZEN Vision W	4.3”	16:9	480 x 272	720 x 480 NTSC, 720 x 576 PAL

Modes

Since the content resolution may differ from the internal display resolution, there are multiple display modes to suit user preference.

Display Modes

Fit to Screen	Content is scaled to the limits of the display, while preserving the original aspect ratio.
Stretch to Full	Content is scaled to fill the entire frame, stretching the image if necessary, without regard to aspect ratio.
Zoom to Full	Content is scaled to fill the entire frame, cropping the image if necessary, while preserving the original aspect ratio.
Original Size	Content is presented at its native resolution.

Aspect Ratio

Widescreen video may exist in a variety of aspect ratios. Video files should be encoded to preserve the aspect ratio of the source material, allowing the ZEN and ZEN Vision Series portable media players to scale the video properly for the display. Suitable encode resolutions are listed below.

Widescreen Resolutions

Aspect Ratio	ZEN Vision Series MPEG-4	ZEN (all codecs) ZEN Vision Series WMV
1.33:1 Television [4:3]	640 x 480	320 x 240
1.37:1 Academy	640 x 468	320 x 234
1.66:1 European Theatrical	640 x 386	320 x 192
1.78:1 HDTV [16:9]	640 x 360	320 x 180
1.85:1 US/UK Theatrical	640 x 346	320 x 172
2.20:1 70 mm	640 x 290	320 x 144
2.35:1 CinemaScope <1970	640 x 272	320 x 136
2.39:1 CinemaScope >1970	640 x 268	320 x 134

Performance

Playback performance is a function of CODEC, resolution, frame rate, and data rates for the video and audio streams. Recommended combinations should result in optimal quality and smooth playback performance. Video rendering limits are also detailed. To produce conforming video files, ensure that all limits for a codec are observed.

Codecs

Motion JPEG (MJPEG)

Motion JPEG (MJPEG) is an informal name for multimedia formats where each video frame or interlaced field of a digital video sequence is separately compressed as a JPEG image. As digital cameras normally have JPEG compression capabilities in hardware, MJPEG is often used to record video clips in these devices.

Motion JPEG uses intraframe coding technology that is very similar in technology to the I-frame part of video coding standards such as MPEG-1 and MPEG-2, but does not use interframe prediction. This results in a loss of compression capability, but eases video editing, since simple edits can be performed at any frame when all frames are I-frames. Using only intraframe coding technology also makes the degree of compression capability independent of the amount of motion in the scene, since temporal prediction is not being used. Using temporal prediction can ordinarily substantially improve video compression capability, but makes the compression performance dependent on how well the motion compensation performs for the scene content. Because of this, it is used in surveillance cameras which only take one frame per second, in which time there could be large amounts of change.

Due to lack of compression efficiency, Creative does not recommend encoding of video content in MJPEG. Support for this codec in our devices is primarily to support migrated digital camera content.

MJPEG					
Usage	**Resolution**	**Frame Rate**	**Video Bitrate**	**Audio Bitrate**	**Container**
ZEN	320 x 240	Up to 30 fps	1.0 Mbps	320 Kbps MP3	AVI
ZEN Vision Series	640 x 480	Up to 30 fps	2.5 Mbps	320 Kbps MP3	AVI

MPEG-1

MPEG-1 defines a group of Audio and Video (AV) coding and compression standards agreed upon by the Moving Picture Experts Group. MPEG-1 video is used by the Video CD (VCD) format. The quality at standard VCD resolution and bitrate is near the quality and performance of a VHS tape. MPEG-1, Audio Layer 3 is the popular audio format known as MP3. Enhancements led to the development of the more advanced formats MPEG-2 and MPEG-4. These newer formats are more complex and require more powerful hardware, but the formats also achieve greater coding efficiency.

MPEG-1 video was originally designed with a goal of achieving acceptable video quality at 1.5 Mbit/s data rates and 352 x 240 (29.97 frame per second) / 352 x 288 (25 frame per second) resolution. While MPEG-1 applications are often low resolution and low bitrate, the standard allows any resolution less than 4095 x 4095.

At present MPEG-1 is the most compatible format in the MPEG family; it is playable in almost all computers and VCD/DVD players. One big disadvantage of MPEG-1 video is that it supports only progressive pictures. This deficiency helped prompt development of the more advanced MPEG-2.

MPEG-1					
Usage	**Resolution**	**Frame Rate**	**Video Bitrate**	**Audio Bitrate**	**Container**
ZEN	No Native Support — Requires Transcoding				
ZEN Vision Series					
Recommended	352 x 288	Up to 30 fps	1.15 Mbps	224 Kbps MP2	MPG
Maximum	640 x 480	Up to 30 fps	1.15 Mbps	384 Kbps MP2	MPG, DAT

MPEG-2

MPEG-2 is widely used as the format of digital television signals that are broadcast by terrestrial, cable, and direct broadcast satellite TV systems. It also specifies the format of movies and other programs that are distributed on DVD and similar disks. As such, TV stations, TV receivers, DVD players, and other equipment are often designed to this standard. MPEG-2 was the second of several standards developed by the Moving Pictures Expert Group (MPEG) and is an international standard (ISO/IEC 13818).

The Video section, part 2 of MPEG-2, is similar to the previous MPEG-1 standard, but also provides support for interlaced video, the format used by analog broadcast TV systems. MPEG-2 video is not optimized for low bit-rates, especially less than 1 Mbps at standard definition resolutions. However, it outperforms MPEG-1 at 3 Mbps and above. All standards-compliant MPEG-2 Video decoders are fully capable of playing back MPEG-1 Video streams.

The MPEG-2 Audio section, defined in part 3 of the standard (commonly known as MP3), enhances MPEG-1's audio by allowing the coding of audio programs with more than two channels. This method is backwards-compatible, allowing MPEG-1 audio decoders to decode the two main stereo components of the presentation.

MPEG-2					
Usage	**Resolution**	**Frame Rate**	**Video Bitrate**	**Audio Bitrate**	**Container**
ZEN	No Native Support — Requires Transcoding				
ZEN Vision Series					
Recommended	640 x 480	Up to 30 fps	2.0 Mbps	128 Kbps MP3	MPG
Maximum	640 x 480	Up to 30 fps	2.5 Mbps	160 Kbps MP3	MPG

MPEG-4

MPEG-4 is the designation for a group of audio and video coding standards and related technology agreed upon by the ISO/IEC Moving Picture Experts Group (MPEG) under the formal standard ISO/IEC 14496. MPEG-4 absorbs many of the features of MPEG-1 and MPEG-2 and other related standards, adding new features such as (extended) VRML support for 3D rendering, object-oriented composite files (including audio, video and VRML objects), support for externally-specified Digital Rights Management and various types of interactivity.

The standard is still evolving and is divided into a number of parts. Part 1 defines the MPEG-4 ecosystem and transport stream. Part 2 defines a compression codec for visual data. MPEG-4 Part 2 is what most consumers refer to as "MPEG-4" video. Most early implementations of the codec combine MPEG-4 Part 2 video streams with MPEG-1 Layer 3 (MP3) audio streams in an AVI container. Later, MPEG-4 Part 3 defined Advanced Audio Coding (AAC) as the audio standard, Part 12 adopted the ISO Base Media File Format, and Part 14 defined an MPEG-4 File Format (.MP4). By the time these standards were adopted however, many hardware and software products existed in the market supporting the AVI container solution.

Another source of confusion is MPEG-4 Part 10. This codec was originally developed as a joint venture between the International Telecommunications Union (ITU) and the ISO/IEC Moving Picture Experts Group (MPEG). The ITU name is H.264; the MPEG name is Advanced Video Coding (AVC). The MPEG-4 standard now permits either Part 2 or Part 10 video compression in a Part 14 (MP4) container, even though these different codecs have vastly different applications and processing requirements. Most consumers have come to refer to MPEG-4 Part 10 as "H.264" video to differentiate it from the earlier Part 2 codec.

DivX originally referred to a hacked version of the Microsoft MPEG-4 Version 3 video codec. It was later cleaned and released as an open source project, OpenDivX. At this point, development branched, with the commercialized version becoming DivX, Inc. and the open source effort becoming XviD. DivX v4 and v5 files, as well as XviD files, are essentially MPEG-4 Part 2 video streams in an AVI container with a modified file extension. DivX introduced a proprietary file format with DivX v6, yet retained the .DivX file extension, which can lead to consumer confusion.

Most portable media players can support Simple Profile (SP). Higher end devices will often support Advanced Simple Profile (ASP) with certain limitations. Global motion Compensation (GMC) and Quarter Pixel Motion Compensation (Qpel) are both computationally intensive procedures that often result in little noticeable picture improvement, and support for these features is frequently excluded.

MPEG-4

Usage	Resolution	Frame Rate	Video Bitrate	Audio Bitrate	Container
ZEN	MPEG-4 SP or ASP without GMC or Qpel				
	320 x 240	Up to 30 fps	1.0 Mbps	320 Kbps AAC	MP4
	320 x 240	Up to 30 fps	1.0 Mbps	320 Kbps MP3	AVI
ZEN Vision Series	MPEG-4 SP or ASP without GMC				
Recommended	640 x 480	Up to 30 fps	1.5 Mbps	128 Kbps MP3	AVI
Maximum	720 x 576 640 x 480	Up to 25 fps Up to 30 fps	3.0 Mbps 2.0 Mbps	320 Kbps MP3	AVI

Windows Media Video

Windows Media Video (WMV) is a compressed video file format for several proprietary codecs developed by Microsoft. Successful marketing efforts from Microsoft and the implementation of the PlaysForSure certification program have made WMV one of the most popular formats for compressed video. Through standardization from the Society of Motion Picture and Television Engineers (SMPTE), WMV has gained adoption for physical-delivery formats such as HD DVD and Blu-ray Disc. SMPTE 421M defines the VC-1 standard; WMV 9 is Microsoft's implementation of that standard.

A WMV file is in most circumstances encapsulated in the Advanced Systems Format (ASF) container format. The file extension .WMV typically describes ASF files that use Windows Media Video codecs. The audio codec used in conjunction with Windows Media Video is typically some version of Windows Media Audio. Microsoft recommends that ASF files containing non-Windows Media codecs use the generic .ASF file extension.

This container can optionally support digital rights management, and is the dominant format for commercial video rental and sale.

Most portable media players can support Simple Profile at Low Level (SP@LL) and at Medium Level (SP@ML). Higher end devices may support Main Profile at Low Level (MP@LL) with certain limitations, typically at reduced bitrates.

WMV / VC-1

Usage	Resolution	Frame Rate	Video Bitrate	Audio Bitrate	Container Bitrate
ZEN	WMV9 SP@ML; combined video and audio bitrates not to exceed specified container bitrate				
	320 x 240	Up to 30 fps	736 Kbps	160 Kbps WMA	800 Kbps WMV
ZEN Vision Series	WMV9 SP@ML or MP@LL; combined video and audio bitrates not to exceed specified container bitrate				
Recommended	320 x 240	Up to 25 fps Up to 30 fps	640 Kbps 544 Kbps	128 Kbps WMA	800 Kbps WMV
Maximum	320 x 240	Up to 30 fps	736 Kbps	160 Kbps WMA	800 Kbps WMV
	480 x 272	Up to 25 fps	802 Kbps	160 Kbps WMA	850 Kbps WMV
	480 x 272	Up to 30 fps	668 Kbps	160 Kbps WMA	708 Kbps WMV