DVxpert™ 6110 Single-Chip Encoder

MPEG Encoding for Professional Video Broadcast and Video Contribution/Distribution
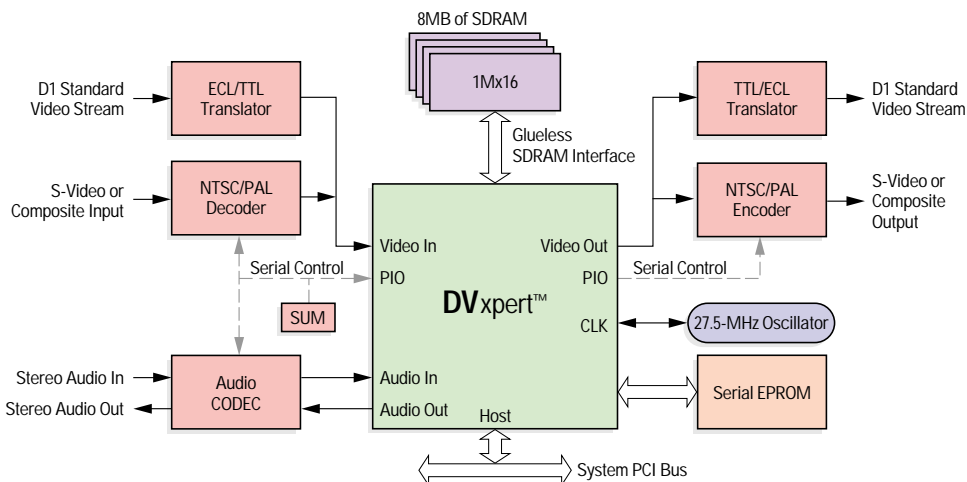
DVxpert

DIGITAL VIDEO BROADCAST

MPEG-2 is the compression format that earns wide acceptance in the digital video broadcast environment. This is due to its interframe encoding capability, which enables high compression, significantly reducing bandwidth for transmission and storage in the broadcast space. MPEG-2 Main Level @ Main Profile (ML@MP) encoding has been the key enabling technology for such important applications as direct direct broadcast satellite (DBS), digital terrestrial broadcast, digital cable television, wireless video broadcast, and satellite news gathering.

VIDEO PRODUCTION AND POST-PRODUCTION

In video production and post-production environments, MPEG-2 Main Level @ 4:2:2 Profile (ML@4:2:2P) is designed to address the insufficient color information of MPEG-2 ML@MP video format because of its 4:2:0 sampling scheme (full sample of the luminance with half of the chrominance information, tossing out the color coordinate on one axis of the color grid). The 4:2:2 Profile increases the chrominance sample to 4:2:2, thereby accounting for both axes on the color grid by sampling every other element, providing better replication of the original signal. In the broadcast environment, 4:2:0 sampling is sufficient since the video signal is directly transmitted to viewers, thus there is no risk of picture degradation due to re-coding. On the other hand, in video production and post-production environments, the risk of picture degradation is high due to multiple generations of signal. For ad-insertion or editing purposes, the video will be compressed and transmitted to different locations. Digital content is typically reviewed and edited many times before it gets to the final destination.

At each step of the way, the content will be decompressed, altered/edited and then recompressed for distribution. In this multi-generational transition environment, the 4:2:2 sampling method can better preserve the video color richness than the 4:2:0 sampling method.

DVxpert™ 6110 Single-Chip Professional Encoder Architecture

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DVxpert™ 6110 Single-Chip Professional Encoder

In addition to 4:2:2 sampling for color richness preservation, the MPEG-2 ML@4:2:2P also supports a compressed bit rate of up to 50 Mbps (light compression), in comparison to the 15 Mbps bit rate upper limit supported by the MPEG-2 ML@MP. This improved performance makes the 4:2:2 profile of MPEG-2 the most well-suited format for most studio and post-production applications.

VIDEO NETWORKING

While the majority of TV broadcasting continues to be primarily supported by satellite technology, the use of digital cable, terrestrial and fiber-optic-based transport is increasing among TV broadcasters. Thanks to the advancement of video compression technology, the broadcast industry applications supported by high-speed data services are continually increasing. For compression, transmission, and multiplexing, MPEG-2 ML@4:2:2P encoding technology delivers digitally compressed video transmissions at the highest levels of quality over a given bandwidth, thus rapidly making the economics of high-speed networking even more attractive. A variety of digital transmission options can be employed to address specific requirements. These include:

Asynchronous Transfer Mode (ATM). Its ability to handle large file sizes, transmit integrated voice, data, and video at high speeds (up to 622 Mbps and soon 2.4 Gbps), and multicast to multiple end points makes ATM the most well-suited transport method for broadcast industry requirements.

DS-3. This transport method allows for digital video to be carried over a fiber-based network at up to 45 Mbps, using one- or two-way transmission, point-to-point, or multipoint connections. Typical applications include live video feeds from venues to a broadcast center, backhaul from a satellite uplink or downlink, and selective (one-to-several) distributions.

Internet. Enabling convergence of the personal computer and television, the Internet is rapidly becoming another distribution tool for the broadcast industry. Today, the MPEG-1 compression technology enables consumers to view video files or to download video clips or commercials from the Web. The DVxpert™ 6110 encoder is capable of providing high-quality MPEG-1 compression with bit rates ranging from 56 Kbps to 5 Mbps.

DVXPERT™ 6110 ENCODER

DVxpert is a revolutionary new multimedia architecture from LSI Logic that achieves a superior video compression ratio to optimize bandwidth, while producing the highest-quality output images. Employing LSI Logic's proprietary PerfectView® encoding algorithm, the DVxpert 6110 single-chip professional encoder architecture delivers the best images currently available at significant bit rate savings.

The DVxpert 6110 encoder handles video streams from 2 to 50 Mbps and provides a highly integrated video compression solution in the studio production and high-speed video networking environments, where MPEG-2 ML@4:2:2P is rapidly becoming the mainstream. For the digital video broadcast application where the typical compression bit rates are 2 to 15 Mbps, DVxpert 6110 delivers excellent image quality compressed in ML@MP format, all at significant bit rate savings. This is due to a rich portfolio of broadcast features offered by the encoder: flexible bit rate control options including real-time variable bit rate (VBR), externally signaled or internally controlled constant bit rate (CBR), and statistical multiplexing. The DVxpert 6110 encoder further enhances the video quality with an error masking algorithm and an automatic scene-change detection built into the motion estimation algorithm.

Optimal System Design Features. In addition to delivering a high-quality video image at sufficient bandwidth saving, the DVxpert 6110 encoder enables system operators to make changes "on-the-fly" via a user-friendly application program interface (API). Features such as Frame-by-Frame User Data Insertion, Frame-Accurate Start/Stop/Pause, variable GOP structure, encode bit rate and horizontal resolution variation can be done instantaneously by choosing the appropriate buttons on the API. Film and video material conversion is fully supported with the Inverse Telecine or 3:2 Pull-down feature. Users can optionally turn on Closed Caption during line 21 of the video frame to extract information from the video input such as program name, program time remaining, and text conversion for the hearing impaired audience.

The DVxpert 6110 encoder is capable of encoding vertical resolutions of 512 lines NTSC and 608 lines PAL, making it fully compliant with the MPEG-2 ML@4:2:2P specification. Consequently, DVxpert 6110 meets the high performance and quality demands of today's professional video broadcasting and video contribution/distribution applications.

By offering ML@4:2:2P in addition to the ML@MP available in DVxpert 5110 single-chip broadcast encoder, DVxpert 6110 encoder is the superset encoding solution, targeting both traditional broadcast and professional studio market applications. In comparison to the DVxpert 6210 dual-chip professional encoder, the DVxpert 6110 encoder is a more integrated solution which reduces system design cost, board space and total power consumption. The feature differences among the encoders are outlined in the DVxpert feature comparison table.

PERFECTVIEW ENCODING ALGORITHM

PerfectView, LSI Logic's patented encoding algorithm, ensures that DVx™ produces superior MPEG-2 image quality at all bit rates, providing broadcast video equipment manufacturers with the most flexible platform for video applications. Based on more than nine years of successful research, this technology includes motion estimation, programmable, pre- and post-processing filters, intelligent rate control, and improved visual masking as described below.

Multilayer Motion Estimation. This technique is used to determine the extent of changes between frames of a video sequence, comparing pixels of a reference frame with pixels of previous and subsequent frames. LSI Logic's multilayer, hierarchical search methodology yields precise matches, at half-pel resolution, without the need for exhaustive, time-consuming pixel-by-pixel comparisons.

Programmable Filtering. The pre- and post-processing filters include vertical, temporal, and alpha de-interlace filters that are all programmable and can be changed while the encoder is running. The vertical filters are designed to filter out the high spatial vertical line frequencies resulting in less blocking and fewer artifacts in the compressed image. The temporal filters help remove the background graininess and noise that is often apparent in

lower-quality input images, making the material easier to encode. The alpha de-interlace filters combine the even and odd fields of an image into a single frame, primarily used for image decimation purpose.

Optimal Bit Allocation. Through the use of proprietary quality metrics, the encoder is able to output data at the desired bit rate while redistributing bits among individual frames to boost overall quality. The manner in which bits are distributed during compression is largely determined by motion estimation, the process of predicting from a previous or subsequent frame what the contents of the current frame are. When there is little motion—and, therefore, minimal changes—between frames, the majority of the available data budget is spent on "intra" or predicted frames. However, when there is rapid movement from one frame to the next, the data budget is distributed more evenly using bidirectional frames.

Error Masking. This LSI Logic MPEG encoding algorithm controls data distribution by searching for and hiding an undesirable compression artifact called ringing, a fuzz-like pattern that surrounds low-activity images produced by over-quantized AC coefficients. LSI Logic's masking algorithm determines where ringing would be visible in an image and budgets data bandwidth to eliminate these artifacts.

Picture User Data Insertion. This feature enables user data information such as frame number, PTS (presentation time stamp) or DTS (decoding time stamp), to be inserted into the picture user data field of the picture header. The encoder can either read data into a "reordering" buffer, where it is held until the frame is encoded, or it can directly "pass through" data to the output bitstream without reordering. The reordering mode allows dependency between user data and the associated frame, while the pass-through mode does not.

Variable Bit Rate (VBR) Encoding. This feature enables an MPEG encoder to encode difficult sequences with higher data rates, and simpler sequences with lower data rates in realtime, constantly varying the bit rate representing the video to achieve optimal output image quality.

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DVxpert Feature Comparison		
Features	**DVxpert 5110**	**DVxpert 6110**
Adaptive Field/Frame MPEG-2 ML@MP	x	x
Adaptive Field/Frame MPEG-2 ML@4:2:2P		x
4:2:0 Chroma	x	x
4:2:2 Chroma		x
Luma Temporal Filter	x	
Chroma Temporal Filter	x	
Luma Vertical Filter	x	
Chroma Vertical Filter	x	
Variable Bit Rate	x	x
Statistical Multiplexing	x	x
Inverse Telecine	x	x
External Reference Rate Control	x	x
Frame-Accurate Start/Stop/Pause	x	x
Closed Captioning	x	x
Picture User Data Insertion	x	x
Encoded Bit Rate Range	2 to 15 Mbps	2 to 50 Mbps
GOP Structure (real-time variable)	I-only, IP, IBP, IB, IBBP	I-only, IP, IBP, IB, IBBP
Video Input Resolutions (real-time variable)		
Horizontal	720, 704, 640, 544, 480, 384, 368, 352, 320	720, 704, 640, 544, 480, 384, 368, 352, 320
Vertical	NTSC:480; PAL:576	NTSC:480; PAL:576
Motion Estimation Search Ranges with Half-Pel Accuracy		
Horizontal	+/-202 pels	+/-202 pels
Vertical	+/-62 pels	+/-62 pels
Frame Rates		
NTSC	29.97 Hz	29.97 Hz
PAL	25 Hz	25 Hz
Film	23.976 Hz	23.976 Hz

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