DVxpert™ 5110 Broadcast Encoder
MPEG Encoding for Digital Video Broadcast

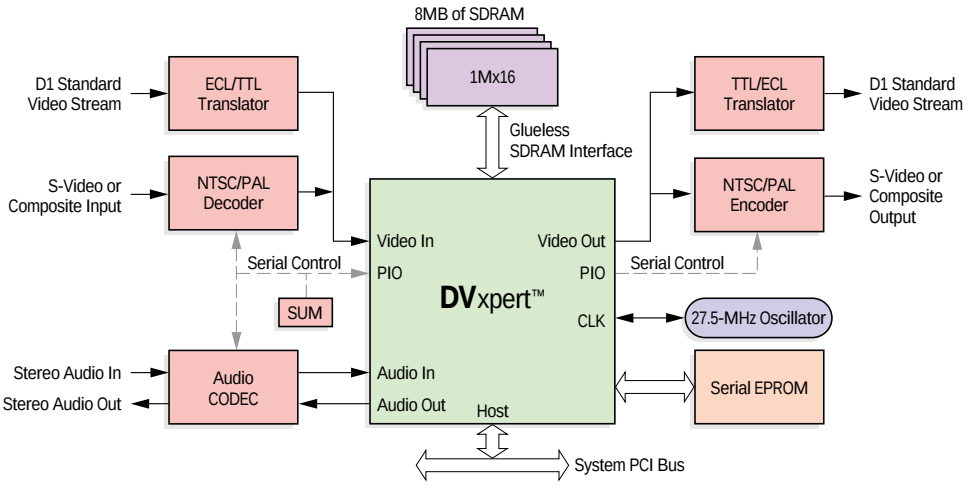
DVxpert

OVERVIEW

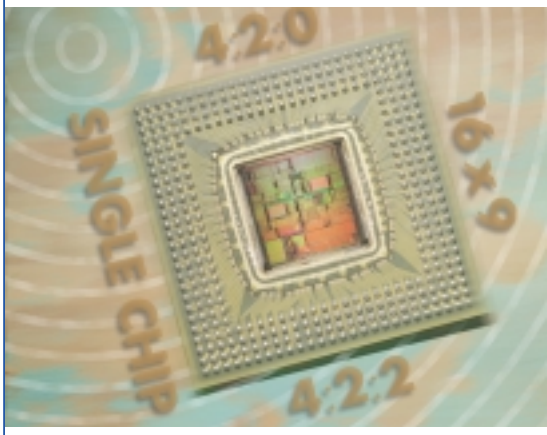
DVxpert™ 5110 Broadcast Encoder is a single-chip MPEG-2 Main Level @ Main Profile encoder. It offers special features designed to optimize multichannel broadcast applications, including statistical multiplexing and real-time variable input resolutions. The encoder performs adaptive field/frame (AFF) encoding at compressed data rates of 2 to 15 Mbps. It also provides high-quality MPEG-1 encoding at bit rates ranging from 56 Kbps to 5 Mbps. LSI Logic's PerfectView® encoding technology delivers excellent quality images with capabilities like inverse telecine and error masking.

In addition to providing wide motion estimation search ranges with half-pel accuracy for high-quality compressed video images, DVxpert 5110 also offers flexible, real-time control of group-of-picture (GOP) and horizontal resolution parameters. As a result, DVxpert 5110 delivers the most advanced encoding solution currently available in the video broadcast market.

MPEG encoding is critical to effective digital video broadcasting. Encoding increases the channel efficiency of satellite transponders and cable networks by compressing video signals before they are transmitted or stored. Several important applications such as direct broadcast satellite (DBS) uplink or cable head-end broadcast, wireless video broadcast, and satellite news gathering are enabled by this technology.



DVxpert™ 5110 Single-Chip AFF Encoder Architecture



FEATURES:

- Flexible bit rate control options, including storage VBR, statistical VBR, CBR (internally controlled or externally signaled), and statistical multiplexing.
- Fast changing, at 1/60th of a second, of encoding parameters such as horizontal resolution, GOP structure, and bit rate control in real-time.
- Flexible, cost-effective programmable preprocessing filters that can accommodate encoding widths of 720, 704, 640, 544, 480, 384, 368, 352, or 320 pixels.
- Programmable temporal noise-reduction filters for better image quality.
- Automatic scene-change detection for more effective motion estimation during compression.
- Frame-by-frame data insertion capability for added flexibility.
- Optimized pipelining to maximize efficiency by minimizing encoding delay.
- Serial Upgrade Module (SUM) that contains a unique identifier for authenticating future upgrades requested by the user.

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DVxpert™ 5110 Broadcast Encoder

FEATURES (CONT'D):

- Adaptive field/frame MPEG-2 ML@MP
- External reference rate control
- Frame-accurate start/stop/pause
- Closed captioning
- Picture user data insertion
- Encoded bit rate range: 2 to 15 Mbps
- GOP Structures (real-time variable): I-only, IP, IBP, IB, IBBP
- Video input resolutions (real-time variable)
  - Horizontal: 720, 704, 640, 544, 480, 384, 368, 352, 320
  - Vertical: 480 (NTSC), 576 (PAL)
- Motion estimation search ranges with half-pel accuracy
  - Horizontal: ±202
  - Vertical: ±62
- Frame rates
  - NTSC: 29.97 Hz
  - PAL: 25 Hz
  - Film: 23.976 Hz

DVx™ is LSI Logic's revolutionary new multimedia architecture that achieves a superior video compression ratio to optimize bandwidth, while producing the highest-quality output images. The architecture employs LSI Logic's proprietary PerfectView® encoding algorithm to deliver the best images currently available at significant bit rate savings. The DVxpert product line implements LSI Logic's DVx architecture in digital video broadcast applications. Each DVxpert product has its own set of downloadable microcode for compressing video into a particular type of MPEG-2 format.

DVxpert is the latest stage in a video encoding evolution that has earned LSI Logic an Emmy Award and established the company's technology as the industry's quality reference standard.

PERFECTVIEW ENCODING ALGORITHM

PerfectView, LSI Logic's patented encoding algorithm, ensures that the DVxpert 5110 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 years of successful research, this technology includes the capabilities described below.

Multilayer Motion Estimation. This technique determines 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.

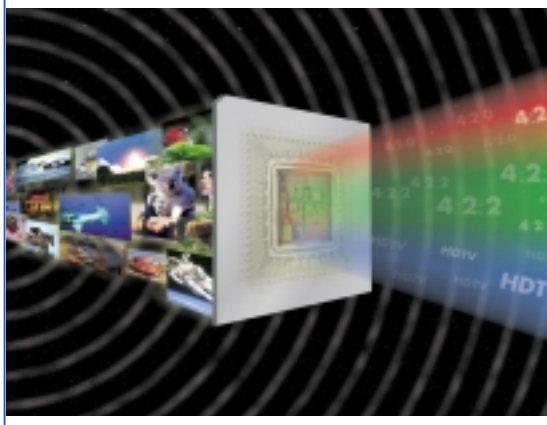
The temporal filters help remove the background graininess and noise that is often apparent in lower-quality input images, making the material easier to encode. The alpha de-interlace filters combine the even and odd fields of an image into a single frame, primarily used for image decimation purposes.

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, presentation time stamp (PTS) or decoding time stamp (DTS), 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. VBR encoding enables the DVxpert 5110 to encode difficult sequences with higher data rates and simpler sequences with lower data rates in real-time, constantly



FEATURES (CONT'D):

- MPEG-1 encoding
  - Vertical/temporal filtering
  - Picture user data insertion
  - Frame dropping mode
  - Encoded bit rate range: 56 Kbps to 5 Mbps
  - GOP structures (real-time variable): I-only, IP, IB, IBBP
  - Video input resolutions (real-time variable)
    - Horizontal: 352, 320, 176, 160
    - Vertical: 340, 240 (NTSC); 288, 144 (PAL)

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varying the bit rate representing the video to achieve optimal output image quality. The DVxpert 5110 performs either storage or statistical VBR encoding. Storage VBR encoding outputs data at a changing bit rate. The average bit rate is lower than that in a constant bit rate design, resulting in as much as 35% storage space savings for encoding movie material. Statistical (or DVD) VBR encoding predicts the output video quality during encoding and modifies the output bit rate accordingly. The generated bitstream obeys the MPEG-2 VBR-VBV restrictions with the specified peak rate and VBV size. This feature is important for DVD authoring because it allows you to fit a two-hour movie onto a single-sided 4.7-Gbyte disc.

Statistical Multiplexing. To multiplex channels for the most efficient use broadcast bandwidth, this feature keeps the quality constant while allowing the bit rate for each channel to fluctuate – that is, the rate at which each encoder's buffer is drained will fluctuate. The more channels that are multiplexed together, the more likely it becomes that some channels display easy-to-encode material using fewer bits, while other channels display hard-to-encode material requiring more bits.

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Order No. I20074
1101.1K.JG.IK - Printed in USA

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