Live Video Broadcast In HD
The shift towards HD video is driving broadcast infrastructure to convert to handle high-definition video throughout the broadcast chain, including the camera head-end. For live video broadcasts it is important to keep delays at the camera head-end very low. In addition, the camera may be wireless, specifically for outdoors shooting, where the video is transmitted directly to a satellite uplink truck. These two features place special constraints on the design of the video encoder that is used with the camera.

We Don't Make It, But We Help Make It Better
W&W Communications does not make the camera head-end add-on encoder-transmitter systems, but we make the video encoders and decoders that make it possible for these systems to:

- Handle video at 1920x1080 resolutions,
- Compress video at up to 2 times lower bit rates than MPEG-2 HD,
- Keep encode-decode tandem delays down to one frame, and
- Achieve near theoretical bit rate versus quality performance.

The encoder efficiency results in bit rates low enough to allow video at 1920x1080 resolution and 60 fields/sec or 30 frames/sec to be carried over a COFDM broadband connection for transmission to a satellite uplink station or production crew.

Single Chip Implementations
The WW20000BA and WW20001BA are single chip implementations of an H.264/MPEG-4 AVC (Part 10) Baseline Profile HD encoder and decoder for video conferencing and telepresence applications.

Key Features
- 1080i/p HD resolution
- H.264 Baseline Profile
- Single chip encoder and decoder
- Low encode-decode tandem delay
- MCTF adaptive noise filtering
- CBR control
- Flexible encoder tool configuration
- DDR2 memory support
- Generic host bus interface
- Software upgradeable

WW20000BA encoder block diagram
The WW20000BA consists of a H.264 Baseline Profile encoder and I/O blocks. A debug video port is available that outputs the video from the encode reconstruction path. The MCTF block performs motion-compensated temporal filtering to remove camera noise. The post-processor performs conversion from interlaced to progressive video formats. The video input port accepts ITU-R BT 709-4, YUV 4:2:2 formatted digital video bit streams for HD resolution video. A generic host bus interface provides access to an external host processor or A/V transport stream multiplexer.

These optimizations address the key challenges facing OEMs of such camera head-end transmission systems.

Low Bit Rates At Very High Quality
The WW20000BA encoder achieves near-perfect bit rate versus quality when measured against the JVT Joint Model (JM) H.264 reference encoder.

Incumbent MPEG-2 MP@HL encoders are no match for the WW20000BA encoder. It outperforms these encoders with bit rates as low as 25Mbps and PSNR of 39dB versus 40Mbps at equivalent PSNR.

Specifically Optimized
The WW20000BA encoder and WW20001BA decoder are specifically optimized for camera head-ends in live video broadcast applications. These specific optimizations include:

- Low bit rates at very high quality
- Camera noise filtering
- Low encode-decode tandem delay
- Error resiliency and concealment
- Bit rate optimization
- Network abstraction

Higher performance versus MPEG-2 Encoders

The WW20000BA implements a complete set of Baseline Profile encoder tools, including 1/2 and 1/4 pixel interpolation and all luma, chroma and inter-frame coding modes. A large search area of 384 x 256 pixels makes it suitable for encoding fast action video.
Camera Noise Filtering
The WW20000BA encoder implements a content-adaptive, motion-compensated, temporal filter (CA-MCTF). The filter uses proprietary algorithms to constantly adapt filter strength based on content, in order to maintain sharpness and clarity. Filtering happens in a single pass to meet low encode-decode tandem delay requirements. The filter provides significant gains in PSNR, while reducing bit rates significantly further.

Low Encode-Decode Tandem Delay
Optimizations in the encoder and the decoder minimize encode-decode tandem delay. These optimizations result in less than 35ms of tandem delay, or about one frame delay at 30 frames/sec. The extra processing and overhead due to other operations, such as noise filtering, interlacing, bit rate control, NAL formatting and parsing, etc., does not impact this delay.

Error Resiliency And Concealment
The WW20000BA encoder supports variable GOP sizes for optimization of bit rate versus error resiliency. In case the transmission channel is noisy, a smaller GOP size can be used than in case of a quieter channel. The WW20001BA decoder freezes the frame buffer on the last good frame and recovers quickly upon receipt of the next good Intra-frame.

Bit Rate Control
The WW20000BA implements CBR (Constant Bit Rate) control to prevent channel bandwidth overflow and uses proprietary algorithms to ensure quality versus quantization strength. To meet low encode-decode tandem delay requirements, single-pass algorithms are used. Despite being single-pass, the video quality remains high.

Network Abstraction
The encoder formats its output bit stream in NAL (Network Abstraction Layer) units for transmission to an external AV transport stream multiplexer. The decoder receives NAL units from an external transport stream demultiplexer for parsing and decodes the payload. NAL formatting specifies a generic format for packet-oriented and bit-stream applications.

Flexibility
The WW20000BA provides a great deal of flexibility in configuration. Various parameters can be set, such as bit rate, GOP size, search area size, CA-MCTF filtering, etc. On the WW20001BA various parameters can be set as well, including output video format and scaling.

Ease Of Design
A generic host bus interface, combined with support for mainstream DDR2 memory and industry standard video interfaces makes designing with the WW20000BA and WW20001BA very easy. In addition, availability of drivers and utilities, further eases system design greatly. Finally, a comprehensive development kit is available that speeds up hardware and software design.

HD live broadcast system block diagram

W&W Communications
Video Broadcast Solutions
Camera Head-End Live Broadcasting

Features

Video Compression
- H.264 Baseline Profile
- Large search area (384 x 256 pixels)
- Single-pass, multiple block motion estimation
- Half and quarter pixel interpolation
- All Intra-4x4 luma modes
- All Intra-16x16 luma and chroma modes
- All Inter modes and SKIP mode
- In-loop de-blocking filter
- CAVLC entropy encoding

Noise Reduction
- CA-MCTF

Error Resiliency
- Variable GOP size

Rate Control
- Constant bit rate, up to 50Mbps

Delay and Latency
- Less than 35ms or single frame encode-decode tandem delay
- ~2ms encoder and decoder latency

Network Support
- Encoder NAL bit stream formatting
- Decoder NAL bit stream parsing

Video Inputs and Outputs
- 1x YUV 4:2:2 encoder video input port
- 1x YUV 4:2:2 decoder video output port
- 1x YUV 4:2:2 encoder video output debug port

External Host Support
- Generic host bus interface

Configuration Support
- Frame rate
- Resolution
- Bit rate
- Quantization
- GOP size
- Number of slices
- Search area
- MCTF on/off
- Statistics

Miscellaneous Interfaces
- JTAG
- GPIO
- Thermal diode output

Operational Characteristics
- Power dissipation ~8W
- 110MHz clock frequency
- 0°– 60° C ambient temperature
- 0-90% RH

Package
- 1,020 pin FineLine BGA
- 33mm x 33mm

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>WW20000BA</td>
<td>Low-delay H.264 BP HD video broadcast encoder</td>
</tr>
<tr>
<td>WW20001BA</td>
<td>Low-delay H.264 BP HD video broadcast decoder</td>
</tr>
</tbody>
</table>

W&W Communications, Inc. reserves the right to make changes to its products and product specifications at any time without notice. W&W Communications is a trademark of W&W Communications, Inc. All other trademarks and registered trademarks are property of their respective holders. Copyright ©2001-2006 W&W Communications, Inc. All rights reserved.