JPEG2000 2K DECODER MODULE

The IPX-JP2K module is a FPGA based JPEG 2000 decoder designed to meet the needs of high data rate processing for such demanding applications as Digital Cinema playback system and large picture and document archive access.

The FPGA flexibility enables custom combination of IPX-JP2K core with others, such as the intoPIX security and MXF cores, to meet specific application requirements.

Efficiently combining on-chip hardware and software operations for an optimal code-sign repartition of the decoding blocks the IPX-JP2K also provides a unique post-deployment core renewability for field upgrade and update.

IPX-JP2K supports input bitrate up to 500 Mbps and can be adapted to provide any picture size (up to 2048 x 1080) and frame rate (up to 96 fps), supporting up to 7.6 Gbit/s output.

The IPX-JP2K output can be provided in RGB or XYZ component formats and provides easy input and output data interfacing through a simple synchronous FIFO.

JPEG2000 PARSER

The JPEG2000 parser analyses the main and tile-part headers of the JPEG2000 codestream and sends the compressed bit-stream to the entropy decoder.

ENTROPY DECODER

The reconstruction of each wavelet sub-band divided into several code-blocks is achieved by two blocks: the Context Modeller and the Arithmetic Decoder. The Context Modeller successively decodes each bit-plane of the codeblock by sending information describing the neighbourhood of each bit to the Arithmetic Decoder. With this information, the Arithmetic Decoder decodes the bit-stream.

INVERSE QUANTIZER

The coefficients of the wavelet subbands are inverse quantized. The quantization steps are defined in the main header of the JPEG2000 file and can be different for each subband.

EXTERNAL MEMORY

A double frame memory buffer is used at the Inverse Quantizer output and enables an efficient IDWT processing. This buffer, containing two DDR-SDRAM external memories, always keeps at least one valid frame that could be repeated when convenient. The required DDR-SDRAM type is a 512 Mbit memory (32 Meg x 16; 133 MHz for 2K and 48 fps).

INVERSE DISCRETE WAVELET TRANSFORM (IDWT)

A bidimensional wavelet recomposition of the subbands is achieved. Two filter banks, with a 18-bit fixed point precision, may be used: either the Le Gall (5/3) filter bank prescribed for lossless encoding or either the more complex Daubechies (9/7) filter bank for lossy encoding.
MULTIPLE COMPONENT TRANSFORMATION (MCT)
In the JPEG 2000 standard, in order to improve compression efficiency, multiple component transformations can be used. Depending on the wavelet filters used, different transformations are defined. The reversible transform (RCT) is used with the 5/3 filter, and the irreversible transform (ICT) with the 9/7 filter. Both transformations are implemented with a 18-bit fixed point precision.

ERROR HANDLING
The decoder is designed to detect errors in the input data. This detection is achieved at two levels:
• JPEG2000 header
  Codestream characteristics such as image size and bits per components are checked. The coherence of the J2K headers with the specifications given by the decoder controller is analysed.
• JPEG2000 packet headers and compressed bit-stream
  Packet headers are analysed to verify the coherence of tag trees, number of bit-planes, code-block compressed bit-stream length, ...
When an error is detected, specific error codes are sent to the device managing the decoder. In the case of a corrupted frame codestream, the decoder can try to decode the next frame. This can be repeated until a correct frame is encountered. If no frame can be decoded during the elapsed time determined by the frame rate, the previous correctly decoded frame is sent to the output to prevent display artifact.

PROCESS CONTROL
Taking advantage of the JPEG2000 intra-framecoding, the decoder controller can manage the stream at the frame accuracy. When there is no data to decode at its input, the decoder can loop on the latest decoded frame, output a black frame or stop to output frames.
By controlling the input stream and the output options, the decoder controller can manage pause, step by step, slow motion, fast forward and rewind, and random access.

INTERFACES
The input receives data by 32-bit bursts of in Little or Big-Endian representations. A burst of two pixels (RGB, XYZ or YUV) is output. The output clock depends on the sequence frame rate and picture size.

### DC requirement check list
- JPEG 2000 (ISO/IEC 15444-1)
- 250 Mbits/sec input
- 2K / 24 FPS
- 2K / 48 FPS
- 12-bit color depth
- X-Y-Z color space
- 9/7 wavelet filter
- 18-bit fixed point IDWT
- 18-bit fixed point ICT

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