

CAST

JPEG2K-E

JPEG 2000 Encoder Core

The JPEG2K-E core is a complete high performance JPEG2000 - ISO/IEC 15444-1 image compression solution targeted for video and high bandwidth image compression applications.

The JPEG2k-E core delivers real JPEG2000 compression efficiency. Commonly used hardware simplification compromises, such as bypass and parallel mode of the entropy coding process, that damage the JPEG2000 rate-distortion efficiency have not been adopted. Furthermore the core implements an accurate rate-control that delivers quality practically equivalent to de-facto software encoders. Region of interest coding, progressive streams with multiple quality layers, lossy and lossless compression are JPEG2000 standard benefits also delivered from the JPEG2k-E core.

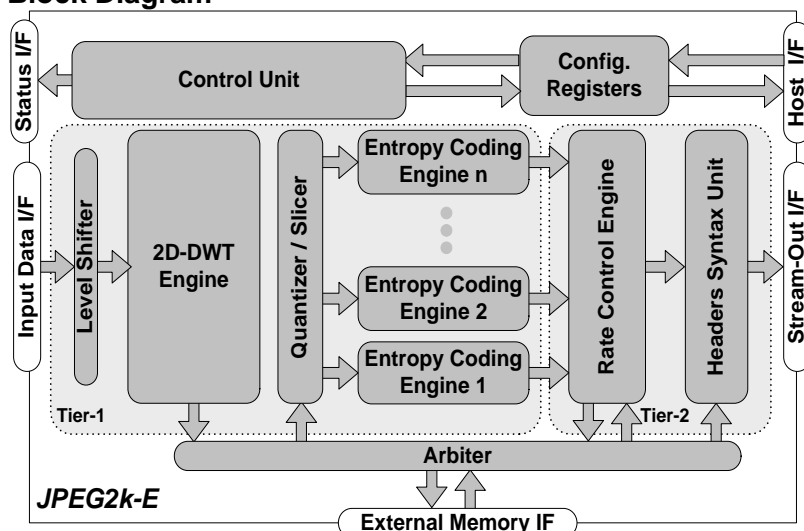
A single JPEG2k-E core can process multiple Full HD (1080p@30) channels, as for example it supports an input rate of 190 MSamples/sec when mapped on a 90nm technology. Users of the core can use parallel instantiations to meet the processing rate requirements even of the most demanding applications.

The JPEG2K-E is a reliable and easy-to-integrate core as it is carefully designed, rigorously verified and production proven. The architecture can be fine-tuned based on the application specific needs. Ease of integration is served by a complete verification environment, and additional aids for system on chip simulation, such as a software bit-accurate model.

Applications

- Digital still cameras and camcorders
- Networked video (Motion JPEG 2000) and image distribution systems
- Wireless video and image distribution systems
- Digital CCTV and surveillance systems
- Image/Video editing systems
- Medical imaging - DICOM
- Military/Aerospace imaging systems

Block Diagram



Features

JPEG 2000 compliance

- Both lossless and lossy compression
- Error-resilient compression
- Rate control
- Headers syntax processing (JPC, JP2, proprietary)

Real JPEG2000 Performance

- No hardware simplification compromises
- Not based on bypass and parallel mode of entropy coding
- High-quality, accurate rate-control
- Region Of Interest

Flexible Input Image Format

- All widely used sub-sampling formats (e.g. 444, 422, etc)
- Image up to 65,535x65,535
- Tile size up to 8,192x8,192
- Up to 4 color components
- 8 up to 16 bits per sample

Programmable JPEG2000 options

- 2D-DWT filter type (5/3 or 9/7)
- Number of 2D-DWT levels
- Quantization tables
- Entropy-coding switches
- Code-block size (64 or 32 or 16 on each dimension)
- Up to 30 quality layers
- Compression ratio per quality layer
- CPRL and LRCP (grayscale only) progression
- Region Of Interest size

Tunable architecture during synthesis

- Configurable number of entropy coding engines
- Configurable maximum image/tile size

Flexible Interfaces

- 16-bit synchronous SRAM-style host interface
- Dedicated pixel-in and stream-out interfaces
- Independent of external memory type (DDR2/3, SDRAM, SRAM, etc.)
- Glue-less connection to CAST memory controllers

Functional Description

The JPEG2K-E operates either on an entire image or on a rectangular section of an image called a tile. The maximum supported image/tile size depends on the size of the external memory, while provided enough external memory the core can support up to 4096x4096 images.

In terms of internal operation, the input pixels are first level-shifted and then transformed using either the reversible 5/3 or the irreversible 9/7 two-dimensional discrete wavelet transform; the transformed coefficients are stored in the external memory. After an entire tile has been transformed, the transformed coefficients are quantized; the quantized coefficients are fed to the Entropy Coding Engines in a code-block per code-block basis.

The coded-segments along with the code-block attributes (truncation lengths and distortion metrics) produced by the Entropy Coding Engines are fed to the Rate Control Engine. If enabled, the Rate Control Engine implements a proprietary PCRD algorithm that outputs code-stream at the required compression ratio with the minimum possible quality loss. The JPEG2K-E core can optionally support multiple quality layers, in which case the user can program the desired compression ratio per each quality layer. Finally the Headers-Syntax Unit forms global, tile and packet headers, and outputs a compliant stream or file.

Implementation Results

The silicon requirements and the maximum sustained throughput of the JPEG2K-E depend strongly on the selected configuration of the core and on the available external memory bandwidth. The following are ASIC, pre-layout, results reported from synthesis tool and silicon vendor design kit under worst case conditions. Internal memory figures are given for planar scan input image format, up to 1920x1080 resolution.

ASIC Technology	Eq. NAND2 gates	Fmax (MHz)	Throughput (MSamples/s)	Memory (kbits)
TSMC 130nm	450 K	190	135	2180
TSMC 90nm	400 K	266	190	2180

Support

The core as delivered is warranted against defects for ninety days from purchase. Thirty days of phone and email technical support are included, starting with the first interaction. Additional maintenance and support options are available.

Verification

The core has been verified through extensive synthesis, place and route and simulation runs. It has also been embedded in several products, and is proven in both ASIC and FPGA technologies. Evaluation boards are available upon request.

Deliverables

The core is available in ASIC (synthesizable HDL) and FPGA (netlist) forms, and includes everything required for successful implementation. The ASIC version includes:

- VHDL RTL source code
- Sophisticated self-checking Testbench
- Software (C++) Bit accurate model and test vector generator
- Simulation scripts, test vectors, and expected results
- Synthesis script
- Comprehensive user documentation, including detailed specifications and a system integration guide

Related Cores

- DDR/DDR2 SDRAM Memory Controller IP core
- AES encryption IP cores
- CMMI (Multimedia Interface with DMA for AHB bus) core
- PCI and PCI Express IP cores