



JPEG2K-E

JPEG 2000 Encoder Megafunction

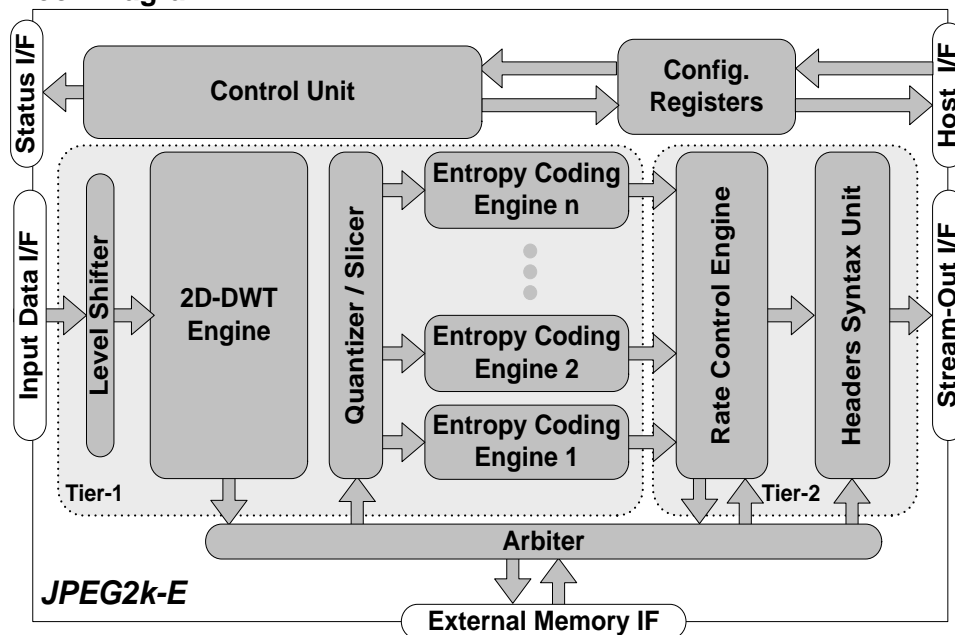
The JPEG2K-E megafunction is a complete high performance JPEG2000 - ISO/IEC 15444-1 image compression solution targeted for video and high bandwidth image compression applications.

The JPEG2k-E megafunction 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 megafunction 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 megafunction.

A single JPEG2k-E core provides processing rates higher than 120 MSamples/sec. Users of the megafunction 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 megafunction 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.

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 Altera and CAST memory controllers

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

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 megafunction 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 megafunction 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.

Related Megafunctions

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

Implementation Results

The processing speed and area requirements of the JPEG2K-E heavily depend on the synthesis configuration as well as the external memory bandwidth. The following Altera implementation data are indicative of the JPEG2K-E megafunction capabilities and resources requirements.

Altera Device	Area	Fmax (MHz)	Throughput (MSamples/s)	Memory	DSP
Cyclone III EP3C80-C6	65,675 LEs	120	75	268 M9Ks	122 9-bits
Cyclone IV EP4CE75-C6	65,621 LEs	120	75	268 M9Ks	122 9-bits
Stratix III EP3SE80-C2	58,001 ALUTs	180	112	250 M9Ks, 1 M144Ks	124 18-bits
Stratix IV EP4SE230-C2	57,544 ALUTs	215	134	250 M9Ks, 1 M144Ks	124 18-bits

Support

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

- Post-synthesis VQM or QXP netlist
- Sophisticated self-checking Testbench
- Software (C++) Bit accurate model and test vector generator
- Simulation scripts, test vectors, and expected results
- Place and route scripts
- Comprehensive user documentation, including detailed specifications and a system integration guide