# MPEG4/H.263 Encoder (v01.00.00) on HDVICP2 and Media Controller Based Platform

## FEATURES

- MPEG4 Simple Profile levels 0, 0b, 1, 2, 3, 4A, 5 and 6 supported
- H.263 baseline profile levels 10, 20, 30, 40, 45, 50, 60 and 70 supported
- Only Progressive frame type picture encoding supported
- AC prediction supported
- Half-pel interpolation for motion estimation supported
- Unrestricted motion vector search that allows motion vectors to be outside the frame boundary is supported
- Custom picture format and GOB interval of H.263 is supported
- Resolution upto 2Kx2K supported
- 1MV/4MV per macro block is supported
- Header Extension Code (HEC) encoding support exists
- Supports low latency features - sub frame level synchronization for input data and bit-stream. Input Data synchronization is based upon MB row and output data synchronization is based upon slices and fixed length of bit-stream
- Encodes multiple slices per picture by inserting Resync Marker(RM), based on H.241 packetization or fixed number of macroblocks
- Rate control for low delay and storage applications
- Image width and height that are multiple of 16 are supported
- Supports Image height being non-multiple of 16 but multiple of 2
- Supports Image width being non-multiple of 16 but multiple of 2
- Supports user configurable Group of Pictures (GOP) length
- IDR frequency control is supported
- Supports different Intra Refresh mechanism
- Force I frame feature
- Scene change detection algorithm supported
- The other explicit features that TI's MPEG4/H.263 Encoder provides are:
  - eXpressDSP Digital Media (XDM IVIDENC2) interface compliant
  - Supports booting of HDVICP2
  - Implements Power Optimization schemes
  - Supports YUV420 semi planar color sub-sampling formats
  - Independent of any Operating System
  - Ability to plug in any multimedia frameworks (For example, Codec engine, OpenMax, GStreamer etc.)
  - Multi-channel functionality supported

## DESCRIPTION

MPEG4(from ISO/IEC) is a popular video coding algorithm enabling high quality multimedia services on a limited band width network. MPEG4 standard defines several profiles and levels, which specify restrictions on the bit-stream, and hence limits the capabilities needed to encode/decode the bit-streams. This MPEG4/H.263 Encoder is validated on HDVICP2 and Media Controller Based Platform with Code Composer Studio version 4.2.0.09000 and code generation tools version 4.5.1.

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## Performance and Memory Summary

This section describes the performance and memory of the MPEG4/H.263 Encoder.

**Table 1. Configuration Table**

| CONFIGURATION | ID |
|---|---|
| MPEG4 Simple profile levels 0, 0b, 1, 2 ,3, 4, 5 and 6. With 4MV , Rate control, adaptive intra refresh | MPEG4_ENC_001 |
| H.263 baseline profile levels 10, 20, 30, 40, 45 ,50, 60, and 70. With Rate control, adaptive intra refresh | MPEG4_ENC_002 |
| MPEG4 Simple profile levels 0, 0b, 1, 2 ,3, 4, 5 and 6. With 4MV , Rate control, adaptive intra refresh, H.241 with packet size of 1200 Bytes | MPEG4_ENC_003 |

**Table 2. Cycles Information – Profiled on DM816x REV-A2 EVM with Code Generation Tools Version 4.5.1**

| CONFIGURATION ID | HDVICP2 PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1) | | |
|---|---|---|---|
| | TEST DESCRIPTION(2) | AVERAGE(3) | PEAK(4) |
| MPEG4_ENC_001 | mobile_p352x288_30fps_420nv12_300fr.yuv, YUV420/CIF @ 1Mbps @ 30 frames per second | 18.36 | 18.5 |
| | parkrun_p720x480_25fps_420nv12_252fr.yuv, YUV420/D1 @ 2Mbps @ 30 frames per second | 44.12 | 44.9 |
| | parkrun_p1280x720_30fps_420nv12_302fr.yuv, YUV420/720P @ 4Mbps @ 30 frames per second | 105.19 | 105.96 |
| | catriverbedvipertrain_p1920x1080_24fps_420nv12_60fr.yuv, YUV420/1080p @ 8Mbps @ 30 frames per second | 231.09 | 233.05 |
| MPEG4_ENC_002 | mobile_p352x288_30fps_420nv12_300fr.yuv, YUV420/CIF @ 1Mbps @ 30 frames per second | 19.14 | 19.27 |
| | parkrun_p720x480_25fps_420nv12_252fr.yuv, YUV420/D1 @ 2Mbps @ 30 frames per second | 46.89 | 48.04 |
| | parkrun_p1280x720_30fps_420nv12_302fr.yuv, YUV420/720P @ 4Mbps @ 30 frames per second with | 112.41 | 113.47 |
| | catriverbedvipertrain_p1920x1080_24fps_420nv12_60fr.yuv, YUV420/1080p @ 8Mbps @ 30 frames per second | 236.93 | 239.47 |
| MPEG4_ENC_003 | mobile_p352x288_30fps_420nv12_300fr.yuv, YUV420/CIF @ 1Mbps @ 30 frames per second | 19.73 | 23.54 |
| | parkrun_p720x480_25fps_420nv12_252fr.yuv, YUV420/D1 @ 2Mbps @ 30 frames per second | 47.96 | 60.34 |
| | parkrun_p1280x720_30fps_420nv12_302fr.yuv, YUV420/720P @ 4Mbps @ 30 frames per second with | 114.27 | 115.89 |
| | catriverbedvipertrain_p1920x1080_24fps_420nv12_60fr.yuv, YUV420/1080p @ 8Mbps @ 30 frames per second | 250.38 | 254.25 |

(1) Measured on DM816x REV-A2 EVM having Cortex-A8 @ 1GHz, HDVICP2 @ 533 MHz, Media Controller @ 250 MHz, L3 interconnect @ 500 MHz and DDR2 @ 400 MHz and there could be a variation of around 1-2% in the numbers.
(a) Media Controller code is placed in cacheable memory region in DDR.
(b) No Latency from system at process call and processing unit as frame (no sub-frame level communications) is assumed.
(c) All Luma 2D Video buffers of codec being in TILED_8 Bit Memory and all Chroma 2D Video buffers of codec being in TILED_16 Bit Memory
(2) Intra frame period is 0 and 1 slice per picture for Non-H241 configurations, assuming no Latency from system at process call, and processing unit as frame (no sub-frame level communications).
(3) It is computed based on worst case cycles having 2 extra input frame buffer.
(4) It is based on worst case cycles having no extra input frame buffer.

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### Table 3. Memory Statistics of Media Controller - Generated with Code Generation Tools Version 4.5.1

| CONFIGURATION ID | RESOLUTION | MEMORY STATISTICS[1] | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | | PROGRAM MEMORY | DATA MEMORY[2] | | | | | | |
| | | | INTERNAL | EXTERNAL | | | | STACK | |
| | | | | PERSISTENT[3] | | | CONST | | |
| | | | | TILED8 (numBufs x Width x Height) | TILED16 (numBufs x Width x Height) | TILEDPAGE/RAW(KBytes) | RAW | | |
| MPEG4_ENC_001<br>MPEG4_ENC_002<br>MPEG4_ENC_003 | 352x288 (Progressive) | 14 | 0 | 2x416x352 | 2x416x208 | 476 | 108 | 16 | 1069 |
| | 720x480 (Progressive) | 14 | 0 | 2x784x544 | 2x784x304 | 1374 | 108 | 16 | 2811 |
| | 1280x720 (Progressive) | 14 | 0 | 2x1344x784 | 2x1344x424 | 3492 | 108 | 16 | 6802 |
| | 1920x1088 (Progressive) | 14 | 0 | 2x1984x1152 | 2x1984x608 | 7785 | 108 | 16 | 14743 |
| | 2048x2048 (Progressive) | 14 | 0 | 2x2112x2112 | 2x2112x1088 | 15527 | 108 | 16 | 28865 |

(1) All memory requirements are expressed in kilobytes (1 K-byte = 1024 bytes) and there might be rounding to next interger K-byte. Stack can be kept in internal/external memory, negligible performance impact can be observed in Media Controller cycles if it is placed in external memory

(2) Codec's request of memory container can be over-ridden by application, adhering to the below rule:
(a) TILED PAGE can be overridden by RAW
(b) TILED8, TILED16 can be overridden by TILED PAGE, RAW
(c) TILED16 can be overridden by TILED8, RAW, TILED PAGE
However, in case of overriding of 2(b) and 2 (c), there can be some performance impact

(3) Persistent memory is instance specific and does not include I/O buffers.

### Table 4. Split-up of Media Controller Internal Data Memory Statistics

| CONFIGURATION ID | DATA MEMORY - INTERNAL [1] | | |
|---|---|---|---|
| | SHARED | | INSTANCE |
| | CONSTANTS | SCRATCH | |
| MPEG4_ENC_001<br>MPEG4_ENC_002<br>MPEG4_ENC_003 | 0 | 0 | 0 |

(1) Internal memory refers to on-chip memory. If the system doesn't have enough internal memory, then external memory can also be used. Memory requirements are expressed in kilobytes.

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## Notes

- I/O buffers:
  - Input buffer size = 3037. 5 K-bytes (1080p, one YUV420 SP)
  - Output buffer size = 3037.5 K-bytes (for encoding one 1080p frame)
- None of the buffers at input and output level is accessed by Media Controller processor hence the data should be valid in DDR (not in cache)
- Total data memory for N non pre-emptive instances = Constants + Runtime Tables + Scratch + N * (Instance + I/O buffers + Stack)
- Total data memory for N pre-emptive instances = Constants + Runtime Tables + N * (Instance + I/O buffers + Stack + Scratch)
- MAIL BOX FIFO #0 and #1 are used and user numbering for Media Controller as 2 and for HDVICP2 as 3 is assumed
- It is assumed that RTS library from ARM is available in system because few symbols like memcpy, div are used in codec
- All constants and Input Output Buffer to encoder is assumed in vDMA addressable space in DDR

## References

- ISO/IEC 14496-2:2004, Information technology - Coding of audio-visual objects -- Part 2: Visual (Approved in 2004-05-24)
- H.263 ITU-T Standard - Video Coding for low bit rate communication
- MPEG4/H.263 Encoder on HDVICP2 and Media Controller based platform User's Guide (Literature Number: SPRUGQ2)

## Glossary

| Term | Description |
|---|---|
| Constants | Elements that go into .const memory section |
| Scratch | Memory space that can be reused across different instances of the algorithm |
| Shared | Sum of Constants and Scratch |
| Instance | Persistent-memory that contains persistent information - allocated for each instance of the algorithm |

## Acronyms

| Acronym | Description |
|---|---|
| AIR | Adaptive Intra Fresh |
| CIF | Common Intermediate Format |
| DMA | Direct Memory Access |
| EVM | Evaluation Module |
| GOB | Group of Blocks |
| GOP | Group of Pictures |
| H241 | Packetization scheme based on Bytes encoded |
| MV | Motion Vector |
| QCIF | Quarter Common Intermediate Format |
| QPI | Quarter Pel Interpolation |
| QVGA | Quarter Video Graphics Array |
| SQCIF | Sub Quarter Common Intermediate Format |
| UMV | Unrestricted Motion Vectors |
| VGA | Video Graphics Array |
| XDM | eXpressDSP Digital Media |

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