

## H.264 Baseline Profile Encoder (v2.01) on OMAP3530

### FEATURES

- eXpressDSP™ Digital Media (XDM 1.0 IVIDENC1) interface compliant
- Validated on the OMAP3530 EVM
- Motion estimation is performed using the iME hardware accelerator provided on the IVA2.2 subsystem
- CAVLC is performed using the iVLCDC hardware accelerator provided on the IVA2.2 subsystem
- H.264 baseline profile up to level 3 supported
- Quarter-pel interpolation for motion estimation supported
- In-loop filtering which can be switched off for whole picture as well for slice boundaries supported
- User controllable multiple slices per picture supported
- Intra 4x4 modes in I and P slices supported
- Hierarchical coding of P frames supported
- Access to motion vector and SAD information for all the macro blocks supported
- Constrained intra prediction supported
- Byte stream format and NAL stream format supported
- Call back function to get bit-stream at NAL unit level supported
- Error-robustness features like intra slice insertion in inter frames, adaptive intra refresh, constrained intra prediction, and forcefully encoding any frame as Instantaneous Decoding Refresh (IDR) supported
- User controllable quantization parameter range supported
- Unrestricted motion vector search which allows motion vectors to be outside the frame boundary supported
- User controllable maximum MV per macroblock
- Image width and height which are non-multiple of 16 supported
- TI proprietary rate control algorithms supported
- Arbitrary resolutions up to CIF(352x288), including standard image sizes such as SQCIF, QCIF, CIF, D1 and PAL D1 supported
- Different methods of Adaptive Intra Refresh (AIR like cyclic intra macro blocks, cyclic intra slices, and rd-optimized intra macro blocks supported
- User configurable parameters like `pic_order_cnt_type`, `log2_max_frame_num_minus4`, and `chroma_qp_index_offset` supported
- YUV 422 interleaved and YUV 420 planar color sub-sampling formats supported
- Controls the balance between encoder speed and quality by using the user definable motion estimation settings and encoding Preset option
- Arbitrary slice ordering and flexible macro block ordering only with raster scan supported
- User configurable Group of Pictures (GOP) length supported

### DESCRIPTION

H.264 is the latest video compression standard from the ITU-T Video Coding Experts Group and the ISO/IEC Moving Picture Experts Group. This H.264 Encoder is validated on the OMAP3530 EVM with Code Composer Studio version 3.3.46.1 and code generation tools version 6.0.8.



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## Performance Summary

This section describes the performance of the H.264 Baseline Profile Encoder on OMAP3530 EVM.

**Table 1. Configuration Table**

CONFIGURATION	ID
H.264 base profile levels 1, 1.b, 1.1, 1.2, 1.3, 2, 2.1, 2.2, and 3	H264_ENC_001

**Table 2. Cycles Information – Profiled on OMAP3530 EVM with Code Generation Tools Version 6.0.8**

CONFIGURATION ID	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)(2)</sup>		
	TEST DESCRIPTION <sup>(3)</sup>	AVERAGE <sup>(4)</sup>	PEAK <sup>(5)</sup>
H264_ENC_001	mobile.yuv, YUV422/CIF @ 768kbps @30 fps with 1MV, LPF, UMV, Quarter Pixel Interpolation, intra16x16 100 frames	96	97
	mobile.yuv, YUV422/CIF @ 768kbps @30 fps with 4MV, LPF, UMV, Quarter Pixel Interpolation, intra16x16 100 frames	144	144
	mobile.yuv, YUV420/CIF @ 768kbps @30 fps with 1MV, LPF, UMV, Quarter Pixel Interpolation, intra16x16 100 frames	95	96
	football.yuv YUV YUV420/VGA @ 2 Mbps @30 fps with 1MV, LPF, UMV, Quarter Pixel Interpolation, intra16x16 100 frames	290	318
	fire.yuv, YUV422/D1 @ 4Mbps @ 30 fps with 1 MV, LPF, UMV, Quarter Pixel Interpolation, intra16x16 100 frames	328	332
	fire.yuv, YUV422/D1 @ 4Mbps @ 30 fps with 4 MV, LPF, UMV, Quarter Pixel Interpolation, intra16x16 100 frames	395	397
	fire.yuv, YUV422/D1 @ 4Mbps @ 30 fps with 1 MV, LPF, UMV, Quarter Pixel Interpolation,intra16x16, (only base params) 100 frames	328	331
	fire.yuv, YUV422/D1 @ 4Mbps @ 30 fps with 1 MV, LPF,UMV, Quarter Pixel Interpolation,intra16x16, (encodingPreset == XDM_USER_DEFINED_HIGH_SPEED) 100 frames	297	301

- (1) Measured with program memory, stack, and I/O buffers in external memory with cache configuration : 32 K-bytes L1P program cache, 64 K-bytes L1D data memory and 16K-bytes L1D data cache, 64K-bytes L2 cache, 32 bit DDR @ 166 MHz, CPU @ 360 MHz and only used by encoder.
- (2) Average and peak MCPS measurements can vary by +/-5%.
- (3) The intra period for the test vectors is 0. That is, one I-frame followed by all P-frames.
- (4) Based on average cycles for 1 second @ 30 fps.
- (5) Based on worst case cycles on moving average of 4 frames @ 30 fps.

**Table 3. Memory Statistics - Generated with Code Generation Tools Version 6.0.8**

CONFIGURATION ID	LEVEL AND RESOLUTION	MEMORY STATISTICS <sup>(1)</sup>					TOTAL
		PROGRAM MEMORY	INTERNAL	EXTERNAL		STACK	
				PERSISTENT	SCRATCH		
H264_ENC_001	Level 1.1 QCIF	271	63.75	235	326	12	907.75
	Level 1.3 CIF	271	63.75	546	326	12	1218.75
	Level 3 PAL D1	271	63.75	1699	326	12	2371.75

- (1) All memory requirements are expressed in kilobytes (1 K-byte = 1024 bytes) and there could be a variation of around 1-2% in the numbers.

**Table 4. Internal Data Memory Split-Up**

CONFIGURATION ID	DATA MEMORY - INTERNAL <sup>(1)</sup>		
	SHARED		INSTANCE <sup>(2)</sup>
	CONSTANTS	SCRATCH	
H264_ENC_001	0	63.75	0

- (1) Internal memory refers to L1DRAM. All memory requirements are expressed in kilobytes and there could be a variation of around 1-2% in numbers.
- (2) I/O buffers are not included. Some of the instance memory buffers could be scratch.

**Table 5. External Data Memory Split-up**

CONFIGURATION ID	DATA MEMORY – EXTERNAL <sup>(1)</sup>		
	SHARED		INSTANCE <sup>(2)</sup>
	CONSTANTS	SCRATCH	
H264_ENC_001	21.10	326	0

- (1) External memory refers to DDR2. All memory requirements are expressed in kilobytes and there could be a variation of around 1-2% in numbers.
- (2) I/O buffers are not included. Some of the instance memory buffers could be scratch.

**Table 6. Co-processor(s) Memory Statistics (IVA2.2)**

CONFIGURATION ID	MEMORY STATISTICS <sup>(1)</sup>					
	SEQ(ARM9) PROG MEM (ITCM)		SEQ(ARM9) DATA MEM (DTCM)		SHARED L2 (SL2) MEMORY	
	TOTAL	UTILIZED	TOTAL	UTILIZED	TOTAL	UTILIZED
H264_ENC_001	8	6.4	4	3.5	32	28

- (1) All memory requirements are expressed in kilobytes (1K-byte = 1024 bytes), and there could be a variation of around 1-2% in the numbers.

## Notes

- I/O buffers:
  - Input buffer size = 600K-bytes (VGA, one YUV422 interleaved frame)
  - Output buffer size = 150K-bytes (for encoding one D1 frame)
- Memory configuration:
  - L1P: 32K-bytes program cache
  - L1D: 64K-bytes data memory and 16K-bytes data cache
  - L2: 64K-bytes cache
- The performances obtained in [Table 2](#) are sensitive to algorithm code placement. See the sample linker file provided in the test application setup for algorithm code placement. This is used for profiling in [Table 2](#).
- The algorithm uses 6 QDMA channels and parameter space equal to 39 parameter entries. The algorithm uses DMAN3 interface for logical allocation of these channels.
- The following QDMA properties are not programmed/configured inside the codec. They need to be programmed by the application:
  - Mapping of QDMA channels to queues.
  - Mapping of queues to transfer controllers.
  - Queue priorities
- 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)

## References

- ISO/IEC 14496-10:2005 Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding
- *H.264 Baseline Profile Encoder on OMAP3530 User's Guide* (literature number: SPRUET9)

## 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
DMAN3	DMA Manager
EVM	Evaluation Module
GOP	Group of Pictures
H-P	Hierarchal P frame
IDR	Instantaneous Decoding Refresh
LPF	Loop Filter
MV	Motion Vector
NAL	Network Abstraction Layer
PPS	Picture Parameter Set
QCIF	Quarter Common Intermediate Format

<b>ACRONYM</b>	<b>DESCRIPTION</b>
QDMA	Quick Direct Memory Access
QPI	Quarter Pel Interpolation
QVGA	Quarter Video Graphics Array
SPS	Sequence Parameter Set
SQCIF	Sub Quarter Common Intermediate Format
UMV	Unrestricted Motion Vectors
VGA	Video Graphics Array (640x480 resolution)
XDM	eXpressDSP Digital Media

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