

H.264 Baseline Profile Encoder (v1.20) on DM6446

FEATURES

- eXpressDSP™ Algorithm Interface Standard (XDAIS) compliant
- eXpressDSP Digital Media (XDM) interface compliant
- Validated on the DM6446 EVM
- 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 and slice boundaries supported
- User controllable multiple slices per picture supported
- Error robustness features such as intra slice insertion in inter frames, adaptive intra refresh, constrained intra prediction, and forcefully encoding any frame as I-Frame supported
- User controllable quantization parameter range supported
- Unrestricted motion vector search which allows motion vectors to be outside the frame boundary supported
- Image width and height which are non multiples of 16 supported
- TI proprietary rate control algorithms supported
- Arbitrary resolutions up to PAL D1 (720x576), including standard image sizes such as SQCIF, QCIF, CIF, QVGA, and VGA supported
- User configurable group of pictures (GOP) length supported
- User configurable parameters such as `pic_order_cnt_type`, `log2_max_frame_num_minus4`, and `chroma_qp_index_offset` supported
- YUV422 interleaved and YUV420 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
- Different methods of AIR (Adaptive Intra Refresh) like cyclic intra macro blocks, and cyclic intra slices supported
- Intra4x4 modes in I and P slices supported
- Run time changes in bit-rate, frame rate, and resolution supported
- Access to motion vector and SAD information for all the macro blocks supported
- Call back function to get bit-stream at NAL unit level supported
- Arbitrary slice ordering and flexible macro block ordering supported
- Byte stream format and NAL stream format supported
- Constrained intra prediction supported
- Constraint to keep macro block bits within 3200 bits as per the standard not 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. The H.264 Encoder is validated on the DM6446 EVM with Code Composer Studio version 3.3.24.1 and code generation tools version 6.0.7.

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Performance Summary

This section describes performance of the H.264 baseline profile encoder.

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 DM6446 EVM with Code Generation Tools Version 6.0.7

CONFIGURATION ID	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) ⁽¹⁾		
	TEST DESCRIPTION ⁽²⁾	AVERAGE ⁽³⁾	PEAK ⁽⁴⁾
H264_ENC_001	ti_commercial_720x576.yuv, YUV420/PAL D1 @ 4 mbps with 1 MV, QPI, LPF, UMV-enabled, high quality preset, 100 frames	574	624
	Tennis.yuv, YUV420/704x480 @ 3 mbps with 1 MV, QPI, LPF, UMV-enabled, high quality preset, 100 frames	553	634
	Tennis.yuv, YUV420/704x480 @ 3 mbps with high speed preset, 100 frames	382	445
	mobile.yuv, YUV420/352x288 @ 768 kbps @ 30 fps with 1 MV, QPI, LPF, UMV, high quality preset, 100 frames	168	184
	mobile.yuv, YUV422/352x288 @ 768 kbps @ 30 fps with 1 MV, QPI, LPF, UMV, high quality preset, 100 frames	173	189

- (1) Measured with program memory, stack, and I/O buffers in external memory with cache configuration: 32K-bytes L1P program cache, 64K-bytes L1D data memory and 16K-bytes L1D data cache, 64K-bytes L2 cache, and 32-bit DDR @ 162 MHz, CPU @ 594 MHz and only used by encoder
- (2) The intra periodicity is ZERO, which means single I frame and all other P frames. Rate Control used is IVIDEO_LOW_DELAY
- (3) Based on average number of cycles per frame @ 30 fps, PAL D1 is quoted @ 25 fps
- (4) Based on worst case cycles on moving average of 4 frames @ 30 fps, PAL D1 is quoted @ 25 fps

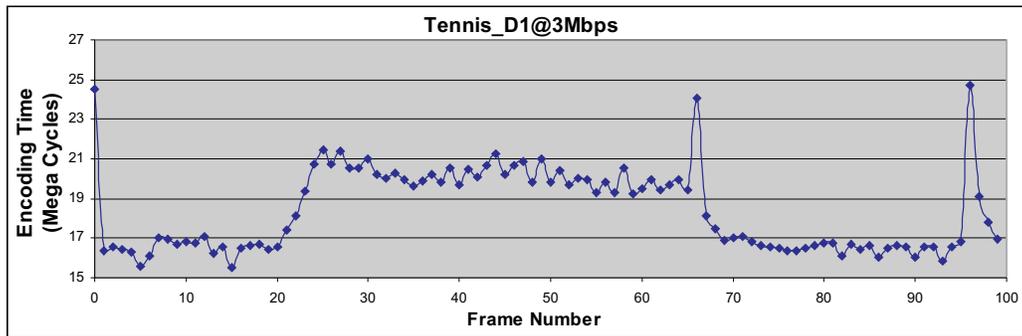


Figure 1. Encoding Time for Individual Frames (Tennis.yuv, YUV420/704x480 @ 3 Mbps @ 30 fps with 1MV, intra4x4, QPI, LPF: High Quality Preset)

Table 3. Memory Statistics - Generated with Code Generation Tools Version 6.0.7 for Level 3.0

CONFIGURATION ID	LEVEL AND RESOLUTION	MEMORY STATISTICS ⁽¹⁾					TOTAL
		PROGRAM MEMORY	INTERNAL	DATA MEMORY		STACK	
				PERSISTENT	SCRATCH		
H264_ENC_001	Level 1.1 QCIF	240	63.25	249	325	12	889.25
	Level 1.3 CIF	240	63.25	552	325	12	1192.25
	Level 3.0 PAL D1	240	63.25	1653	325	12	2293.25

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

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Table 4. Internal Data Memory Split-Up

CONFIGURATION ID	DATA MEMORY - INTERNAL ⁽¹⁾		
	SHARED		INSTANCE ⁽²⁾
	CONSTANTS	SCRATCH	
H264_ENC_001	0	63.25	0

(1) Internal memory refers to L1DRAM. All memory requirements are expressed in kilobytes and there could be a variation of approximately 1-2% in values.

(2) I/O buffers not included. Some of the instance memory buffers could be scratch.

Table 5. Co Processor(s) Memory Statistics

CONFIGURATION ID	SEQ DATA MEMORY ⁽¹⁾	SEQ PROG MEMORY ⁽¹⁾	IMX WORKING MEM ⁽¹⁾	IVCLD MEM ⁽¹⁾	IMX IMG BUF ⁽¹⁾	IMX CMD MEM ⁽¹⁾
H264_ENC_001	1	4	30	9	5	4

(1) All memory requirements are expressed in kilobytes and all are scratch buffers.

Notes

- Evaluation version performance may be off by up to 30 MHz
- I/O buffers:
 - Input buffer size = 675K-bytes (D1, one YUV422 interleaved frame)
 - Output buffer size = 320K-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. Refer 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 35 parameter entries. The algorithm uses DMAN3 interface for logical allocation of these channels.
- 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)
- 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

References

- ISO/IEC 14496-10:2005 Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding
- *H.264 Baseline Profile Encoder on C64x+ User's Guide* (literature number SPRUE71D)

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
CIF	Common intermediate format
DMA	Direct memory access
DMAN3	DMA manager
EVM	Evaluation module
GOP	Group of pictures
IDR	Instantaneous decoding refresh
LPF	Loop filter
MV	Motion vector
QCIF	Quarter common intermediate format
QDMA	Quick direct memory access
QPI	Quarter pel interpolation
QVGA	Quarter video graphics array
SQCIF	Sub quarter common intermediate format

(continued)

Acronym	Description
UMV	Unrestricted motion vectors
VGA	Video graphics array
XDAIS	eXpressDSP Algorithm Interface Standard
XDM	eXpressDSP Digital Media

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