



- eXpressDSP™ Algorithm Interface Standard (XDAIS) compliant
- eXpressDSP Digital Media (XDM) interface compliant
- Validated on the DM6437 EVM
- H.264 baseline profile up to level 3 and level 1b 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
- 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
- Image width and height which are non-multiple 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 like `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
- Constraint to keep macro block bits within 3200 bits as per the standard not supported



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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 DM6437 EVM with Code Composer Studio version 3.3.24.1 and code generation tools version 6.0.7.

summary of performance

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 DM6437 EVM with Code Generation Tools Version 6.0.7

CONFIGURATION ID	PERFORMANCE STATISTICS (IN MEGA CYCLES PER SEC) ¹		
	TEST DESCRIPTION ²	AVERAGE ³	PEAK ⁴
H264_ENC_001	mobile.yuv, YUV420/CIF@ 768 kbps @ 30 fps with 1 MV, QPI, LPF, UMV, High Quality Preset, 100 frames	160	165
	mobile.yuv, YUV422/CIF@ 768 kbps @ 30 fps with High Quality Preset, 100 frames	164	168
	Foreman.yuv, YUV420/VGA@ 1Mbps @ 30 fps with 1 MV, QPI, LPF, UMV, High Quality Preset, 100 frames	395	430
	Foreman.yuv, YUV420/VGA@ 2Mbps @ 30 fps with 1 MV, QPI, LPF, UMV, High Quality Preset, 100 frames	459	479
	Tennis.yuv, YUV420/704x480@3 mbps @ 30 fps with 1 MV, QPI, LPF, UMV enabled, High Quality Preset, 100 frames	505	533
	Tennis.yuv, YUV420/704x480@3 mbps @ 30 fps with 1 MV, QPI, LPF, UMV enabled, High Speed Preset, 100 frames	472	501
	ti_commercial_720x576.yuv, YUV420/PAL D1@2 mbps @ 25 fps with 1 MV, QPI, LPF, UMV enabled, High Quality Preset, 75 frames	500	515
	ti_commercial_720x576.yuv, YUV420/PAL D1@4 mbps @ 25 fps with 1 MV, QPI, LPF, UMV enabled, High Quality Preset, 75 frames	538	562

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, 128K-bytes L2 cache, 32 bit DDR @ 162 MHz, CPU @ 594 MHz and only used by encoder

² The intra period for the test vectors is 30 frames. That is, with one I-frame and 29 P-frames. PAL D1 test case has intra period of 25

³ Based on average cycles for 1 second @ 30 fps, PAL D1 is quoted @ 25 fps

⁴ Based on worst case cycles on moving average of 4 frames @ 30 fps

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Figure 1. Encoding Time for Individual Frames (Foreman.Yuv, YUV420/VGA @ 2 mbps @ 30 fps with 1 MV, QPI, LPF, UMV, and High Quality Preset)

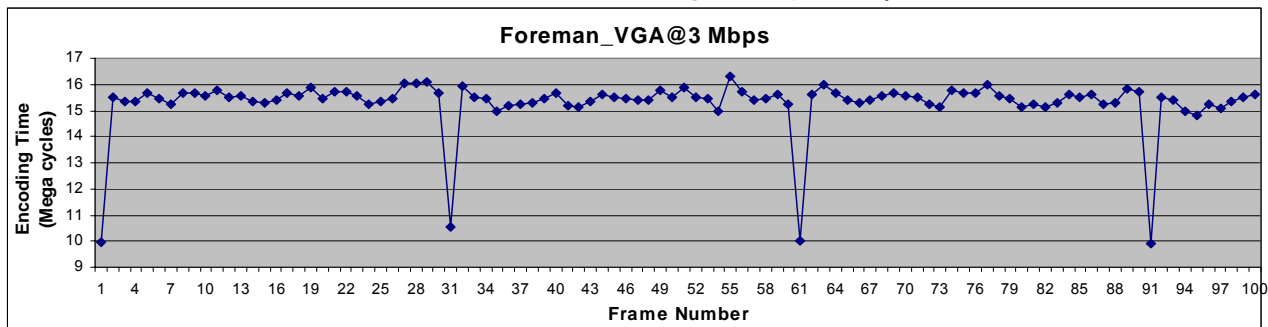


Table 3. Memory Statistics - Generated with Code Generation Tools Version 6.0.7

CONFIGURATION ID	LEVEL AND RESOLUTION	MEMORY STATISTICS ⁵					TOTAL
		PROGRAM MEMORY	DATA MEMORY			STACK	
			INTERNAL	EXTERNAL			
				PERSISTENT	SCRATCH		
H264_ENC_001	Level 1.1 QCIF	138	63.25	166.75	320	8	696
	Level 1.3 CIF	138	63.25	464.75	320	8	994
	Level 3.0 PAL D1	138	63.25	1568	320	8	2097.25

⁵ All memory requirements are expressed in kilobytes (1K-byte = 1024 bytes) and there could be a variation of around 1-2% in numbers.

Table 4. Internal Data Memory Split-up

CONFIGURATION ID	DATA MEMORY – INTERNAL ⁶		
	SHARED		INSTANCE ⁷
	CONSTANTS	SCRATCH	
H264_ENC_001	0	63.25	0

⁶ Internal memory refers to L1DRAM. All memory requirements are expressed in kilobytes and there could be a variation of around 1-2% in numbers.

⁷ I/O buffers not included. Some of the instance memory buffers could be scratch.



Table 5. PSNR and Bit-rate details

		BITRATE / AVERAGE LUMA PSNR								
		LOW RATE			MID RATE			HIGH RATE		
Test Sequence	BIT RATE RANGE	P ⁸	FD ⁹	BD ¹⁰	P ⁸	FD ⁹	BD ¹⁰	P ⁸	FD ⁹	BD ¹⁰
Soccer QCIF(176x144), 15 fps		64 kbps			128 kbps			256 kbps		
	Case1 ¹¹	29.47	0	1.15	33.06	0	1.12	37.16	0	1
	Case2 ¹²	29.44	0	0.89	33.01	0	0.68	37.03	0	0.67
Mobile CIF (352x288), 30 fps		384 kbps			768 kbps			1280 kbps		
	Case1 ¹¹	24.73	0	4.14	27.93	0	3.34	30.34	0	2.48
	Case2 ¹²	24.64	0	3.27	27.82	0	2.57	30.24	0	1.84

⁸ PSNR in decibels, in case of frame drop, PSNR is measured by repeating previous frame

⁹ Number of frame drops

¹⁰ Percentage Deviation in bit rate

¹¹ Rate Control used is IVIDEO_LOW_DELAY, number of frames are 100, High Quality Preset

¹² Rate Control used is IVIDEO_STORAGE, number of frames are 100, High Quality Preset

Table 6. PSNR Comparison with Reference Encoder¹³

		BITRATE / AVERAGE LUMA PSNR		
		LOW RATE	MID RATE	HIGH RATE
Test Sequence	BIT RATE RANGE	PD ¹⁴	PD ¹⁴	PD ¹⁴
Soccer QCIF(176x144), 15 fps		64 kbps	128 kbps	256 kbps
	Case1 ¹¹	1.12	0.83	0.81
	Case2 ¹²	1.15	0.88	0.94
Mobile CIF (352x288), 30 fps		384 kbps	768 kbps	1280 kbps
	Case1 ¹¹	0.45	0.35	0.22
	Case2 ¹²	0.54	0.46	0.32

¹¹ Rate Control used is IVIDEO_LOW_DELAY, number of frames are 100, High Quality Preset

¹² Rate Control used is IVIDEO_STORAGE, number of frames are 100, High Quality Preset

¹³ Reference encoder is JVT version 10.3 configured to use single reference frame, no Hadamard, no Intra 4x4 prediction mode, no RDO

¹⁴ PSNR differences of TI encoder and JVT encoder in decibels

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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 = 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 : 128K-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 4 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)

references

- ISO/IEC 14496-10:2005 Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding
- *H264 Baseline Profile Encoder on C64x+* User Guide (literature number SPRUE71B)

glossary

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

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
UMV	Unrestricted Motion Vectors
VGA	Video Graphics Array
XDAIS	eXpressDSP Algorithm Interface Standard
XDM	eXpressDSP Digital Media

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