H.264 HD Baseline Profile Encoder (v02.02.00) on DM6446

FEATURES

- **eXpressDSP™ Digital Media (XDM 1.0 IVIDENC1) interface compliant**
- **Validated on the DM6446 EVM**
- **H.264 Baseline Profile upto level 4.1 supported**
- **Quarter-pel interpolation for motion estimation supported**
- **In-loop filtering, which can be switched off for whole picture and 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 of any frame, such 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 that are non-multiple of 16 supported (multiples of 4, 8 supported, non-multiples of 4 not supported)**
- **TI proprietary rate control algorithms supported**
- **Arbitrary resolutions up to HD resolutions of 3840x2176 including standard image sizes such as PAL D1 (720x576), 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 defined motion estimation settings and encoding Preset option**
- **Constraint to keep macro block bits within 3200 bits as per the standard not supported**
- **This codec can be used on any of TI's C64x+ based platforms**

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 DM6446 EVM with Code Composer Studio version 3.2.37.12 and code generation tools version 6.1.2.

PRODUCT PREVIEW

Performance Summary

This section describes the performance of the H.264 HD Baseline Profile Encoder on DM6446 EVM.

Table 1. Configuration Table

CONFIGURATION	ID
H.264 base profile levels up to level 4.1	H264_ENC_001

Table 2. Cycles Information - Profiled on DM6446 EVM without IMCOP and Code Generation Tools Version 6.1.2

CONFIGURATION ID	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1)(2)		
	TEST DESCRIPTION	AVERAGE(3)	PEAK(4)(5)
H264_ENC_001	parkrun_p720x480_25fps_420pl_252fr with 1 MV, QPI, LPF, RC , UMV enabled, High Quality preset ,bit rate = 2000000 bps, target frame rate = 19 fps, NFAVG3 = 110 frames.	446	482
	shields_p1280x720_30fps_420pl_302fr, with 1 MV, QPI, LPF, RC, UMV enabled, High Quality preset, bit rate = 4000000 bps, target frame rate = 7 fps, NFAVG = 30 frames	494	556
	stockholm_p1280x720_30fps_420pl_302fr with 1 MV, QPI, LPF, RC UMV enabled, High Quality preset, bit rate = 6000000 bps, target frame rate = 7 fps, NFAVG = 30 frames	498	562
	football_p704x480_30fps_420pl_150fr with 1 MV, QPI, LPF, RC, UMV enabled, High Quality preset , bit rate = 2000000 bps, target frame rate = 19 fps, NFAVG = 140 frames.	533	590
	football_p704x480_30fps_420pl_150fr with 1 MV, QPI, LPF, RC, UMV enabled, High Speed preset ,bit rate = 2000000 bps, target frame rate = 19 fps, NFAVG = 140 frames.	413	457
	manInRestaurant_p1920x1080_30fps_420pl with 1 MV, QPI, LPF, RC, UMV enabled, High Quality preset, bit rate = 9000000 bps, target frame rate = 3 fps, NFAVG = 10 frames	450	492
	mobile_p352x288_30fps_420pl with 1 MV, QPI, LPF, RC, UMV enabled, High Quality preset, bit rate = 768000 bps, target frame rate = 7 fps, NFAVG = 10 frames	211	231

(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, 32 bit DDR @ 162 MHz, CPU @ 594 MHz and only used by encoder
(2) Average and peak MCPS measurements can vary by +/-5%.
(3) Average MCPS is calculated by multiplying average Mega Cycles Per Frame numbers by target frame rates. Average MCPS is calculated over NFAVG frames.
(4) Peak MCPS is calculated on moving average of 4 frames over NFAVG frames.
(5) For heigher bit-rates of encoding, actual cycles performance will be worse than the above mentioned numbers.

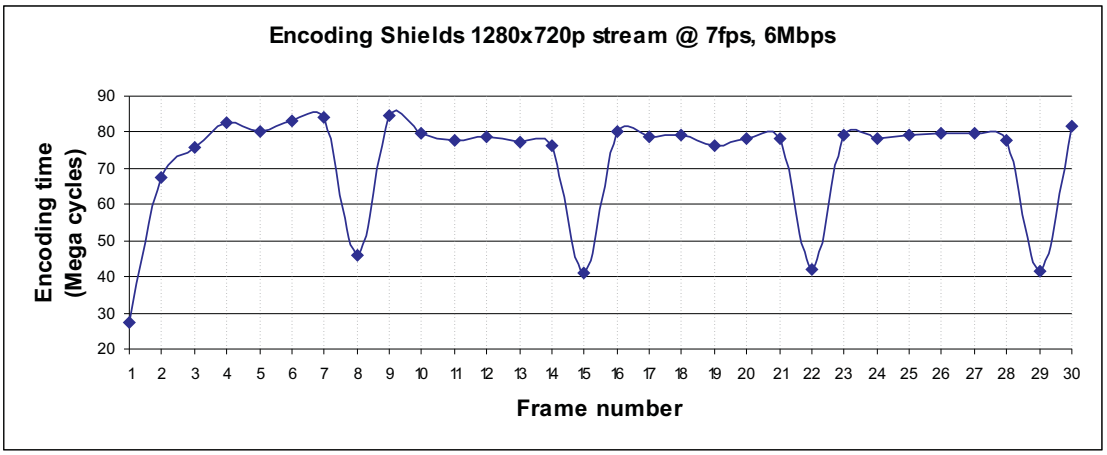

Figure 1. Encoding Time for Individual Frames (shields_p1280x720_30fps_420pl_302fr.yuv, YUV420/1280x720)

Table 3. Memory Statistics - Generated with Code Generation Tools Version 6.1.2

CONFIGURATION ID	LEVEL AND RESOLUTION	MEMORY STATISTICS[1]						
		PROGRAM MEMORY	DATA MEMORY					TOTAL
			INTERNAL	EXTERNAL			STACK	
				PERSISTENT	CONSTANTS	SCRATCH		
H264_ENC_001	Level 3.0 D1 (720x576)	222	63.25	1535	3.89	8192	8	10024.14
	Level 4.0 HD (1280x720)	222	63.25	3217	3.89	8192	8	11706.14
	Level 4.0 HD (1920x1080)	222	63.25	6975	3.89	8192	8	15464.14
	Level 4.1 HD (3840x2176)	222	63.25	26694	3.89	8192	8	35333.14

(1) All memory requirements are expressed in kilobytes (1 K-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 [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 around 1-2% in numbers.
(2) I/O buffers not included. Some of the instance memory buffers could be scratch.

Table 5. PSNR and Bit-Rate Details

TEST SEQUENCE	BITRATE / AVERAGE LUMA PSNR (in dB)									
	TARGET BITRATE 1572000 (bps)		TARGET BITRATE 2000000 (bps)		TARGET BITRATE 4000000 (bps)		TARGET BITRATE 6000000 (bps)		TARGET BITRATE 8000000 (bps)	
	PSNR	ACTUAL BITRATE (kbps)	PSNR	ACTUAL BITRATE (kbps)	PSNR	ACTUAL BITRATE (kbps)	PSNR	ACTUAL BITRATE (kbps)	PSNR	ACTUAL BITRATE (kbps)
parkrun_p1280x720_30fps_420pl_302fr, target frame rate = 7.5 fps, rcAlgo=PLR3_RC, NFAVG=75, IntraPeriod=1 sec	-	-	26.05	2086	29.11	4083	31.29	6076.79	33.07	8077
shields_p1280x720_30fps_420pl_302fr, target frame rate = 7.5 fps, rcAlgo=PLR3_RC, NFAVG=75, IntraPeriod=1 sec	-	-	35.21	2065	37.61	4068.77	38.97	6058	40.11	8057
stockholm_p1280x720_30fps_420pl_302fr, target frame rate = 7.5 fps, rcAlgo=PLR3_RC, NFAVG=75, IntraPeriod=1 sec	-	-	34.72	2098	36.49	4090	37.74	6074.41	38.85	8056
parkrun_p720x480_25fps_420pl_252fr.yuv, target frame rate = 25fps, rcAlgo=PLR3_RC, NFAVG=252, IntraPeriod=1 sec	28.61	2012.71	-	-	-	-	-	-	-	-
tennis_p704x480_30fps_420pl_252fr.yuv, target frame rate = 25fps, rcAlgo= DCES_TM5, NFAVG=150, IntraPeriod=0.5 sec	30.12	1573.95	-	-	-	-	-	-	-	-

Note:

1. Scene change detection is OFF
2. Loop Filter enabled

Notes

- I/O buffers:
  - Input buffer size = 4 M-bytes (1080P, one YUV422 interleaved frame)
  - Output buffer size = 4050 Kbytes (for encoding one 1080P frame)
- Memory Configuration
  - L1P: 32 K-bytes Program Cache
  - L1D: 64 K-bytes Data Memory and 16K-bytes Data Cache
  - L2: 64 K-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 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 HD Baseline Profile Encoder on DM6446 User's Guide* (literature number: SPRUFQ6C)

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
UMV	Unrestricted Motion Vectors
VGA	Video Graphics Array (640x480 resolution)
XDM	eXpressDSP Digital Media

Revision History

This data sheet revision history highlights the changes made to the SPRS527A codec specific data sheet to make it SPRS527B.

Table 6. Revision History for H264 HD Encoder on DM6446

SECTION	ADDITIONS/MODIFICATIONS/DELETIONS
Global	• Modified version number in the title • Modified XDM version from 0.9 to 1.0
Section 1	Cycles Information: • . Updated Average and Peak values • Updated table footnotes • Updated the graph
Table 3	Memory Statistics: • Updated values for Program Memory, Constant, and Scratch Co-Processor(s) Memory Statistics: • Removed Co-Processor(s) Memory Statistics table
Table 5	PSNR and Bit-rate Details: • Updated values

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