H.264 Baseline Profile Encoder (v1.10) on DM510

FEATURES

- **eXpressDSP™ Digital Media (XDM 1.0 IVIDENC1) interface compliant**
- **Validated on DM510 EVM**
- **H.264 Baseline Profile up to level 3.0 compliant**
- **Resolutions upto PAL D1 (720 x 576) supported**
- **YUV420 input format for the frames supported**
- **Generates bit-stream compliant with H.264 standard**
- **Unrestricted Motion Vectors (UMV) supported**
- **TI's proprietary motion estimation supported (2 types of search algorithms supported)**
- **Half Pel and Quarter Pel Interpolation for motion estimation supported**
- **All 16x16 and 4x4 Intra-Prediction Mode supported**
- **Progressive frame type picture encoding supported**
- **Multiple slice encoding supported (up to CIF size)**
- **CAVLC encoding supported**
- **16x16, 8x16, 16x8 and 8x8 MB partition supported up to CIF resolution**
- **Adaptive Intra Refresh (AIR) supported up to CIF resolution**
- **Frame based encoding with frame size being multiples of 2 supported**
- **Rate Control (CBR and VBR) supported**
- **Insertion of Buffering Period and Picture Timing Supplemental Enhancement Information (SEI) and Video Usability Information (VUI) supported**
- **MONA interface supported**

DESCRIPTION

H.264 (from ITU-T, also called as H.264/AVC) is a popular video coding algorithm enabling high quality multimedia services on a limited bandwidth network. H.264 standard defines several profiles and levels, which specify restrictions on the bit-stream and hence limits the capabilities needed to decode the bit-streams. This project is developed using Code Composer Studio version 3.3.38.2 and using the code generation tools version 4.1.3.

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Performance Summary

This section describes the performance of standalone H.264 Encoder validated on DM510 EVM.

Table 1. Configuration Table

CONFIGURATION	ID
H.264 Baseline profile levels up to 3.0	H264_ENC_001

Table 2. Cycles Information – Profiled on DM510 EVM with Code Generation Tools Version 4.1.3

CONFIGURATION ID	PERFORMANCE STATISTICS							
	TEST DESCRIPTION	ME TYPE	AVERAGE			PEAK		
			ARM926 MHz	ARM968 MHz	FPS (180 MHz)	ARM926 MHz	ARM968 MHz	FPS (180 MHz)
H264_ENC_001	football_qcif.yuv(QCIF@30fps, 128kbps)	0	3.52	20.46	225.20	3.52	20.46	225.20
		1	3.52	19.01	239.71	3.52	19.01	239.71
	ice_cif.yuv (CIF@30fps, 384 kbps)	0	5.47	51.19	95.30	5.47	51.19	95.30
		1	5.47	50.90	95.79	5.47	50.90	95.79
	foreman_qvga.yuv (QVGA@30fps, 512 kbps)	0	4.88	40.65	118.58	4.88	40.65	118.58
		1	4.88	40.28	119.56	4.88	40.28	119.56
	coastguard_vga.yuv(VGA@30fps, 2mbps)	0	8.23	123.76	40.91	8.23	123.76	40.91
		1	8.23	125.84	40.27	8.23	125.84	40.27
	harrypotter_p720x480.yuv(NTSC-D1@30fps, 4mbps)	0	8.36	142.17	35.87	8.36	142.17	35.87
		1	8.36	143.65	35.52	8.36	143.65	35.52
	ti_commercial_720x576_2633frames_420p.yuv (PAL-D1@25fps, 4mbps)	0	7.90	141.21	30.17	7.90	141.21	30.17
		1	7.90	141.46	30.12	7.90	141.46	30.12

Note:

1. These figures depict the load on ARM926 and ARM968 separately. For calculating FPS, both the loads have been added as these operations happen sequentially. These are the actual cycles as seen from the host on DM510 EVM board and will be close to cycles seen on the final system (for average case).
2. These figures are with cache enabled on ARM926 side.
3. They are measured in standalone mode without actual framework.
4. All numbers are collected (both average and peak) at frame-level processing for first ten frames.
5. The peak and average figures are similar as there is little variation between frame encoding.
6. FPS mentioned is for ARM926 running at 180 MHz
7. ME Type = 0 indicates Standard Motion Estimation and ME Type = 1 indicates Low-Power Motion Estimation. Both algorithms are TI proprietary algorithms.
8. The version of the code used to collect these numbers have the following features included:
   a. Interrupt mode of operation – one interrupt signal processing overhead per frame.
   b. Approximate interrupt latency – 2.7usec
   c. WFI and Power-optimization that is, controlled clock-gating is enabled.
   d. Resetting of vIMCOP and loading of code into ARM968 DTCM – once per stream.

Table 3. Memory Statistics

CONFIGURATION ID		MEMORY STATISTICS (IN BYTES)(1)(2)					TOTAL
		PROGRAM MEMORY (BYTES)	DATA MEMORY				
			CONSTANT	HEAP		STACK	
				PERSISTENT	SCRATCH		
H264_ENC_001	WVGA	35756	58888	1487452	42824	512	1625432
	PAL - D1	35756	58888	1483420	38856	512	1617432
	NTSC – D1	35756	58888	1257628	38856	512	1391640
	VGA	35756	58888	1129948	35912	512	1261016
	CIF	35756	58888	430684	26952	512	552792
	QCIF	35756	58888	147484	22088	512	264728

(1) All these memory requirements are for ARM926 encoder library (including DMA library). They do not include any memory requirements from test application side. Stack, heap, and code requirements for test-application are extra. Constant memory size requirements include code memory of ARM968 since it forms a constant table on ARM926 before transfer.
(2) The constant size is the sum of .cinit, .bss, and .const sections used by H.264 encoder library.

Table 4. Internal Data Memory Split-Up

CONFIGURATION ID	DATA MEMORY - INTERNAL		
	SHARED		INSTANCE
	CONSTANTS	SCRATCH	
H264_ENC_001	NA	NA	NA

Table 5. Co-Processor(s) Memory Statistics (vIMCOP, ARM968 ITCM and DTCM)

CONFIGURATION ID	MEMORY STATISTICS (IN BYTES)				
	PROGRAM MEMORY (AVAILABLE:48KB)	DATA MEMORY (AVAILABLE:32KB)			
		CONSTANT	PERSISTENT	STACK	TOTAL
H264_ENC_001	41448	5904	17408	6960	30272

Note:

Persistent memory on DTCM of ARM968 constitutes interrupt vectors, decoder state handle structure, DMA state handle structure and other elements required for frame-level processing.

Table 6. PSNR and Bit-Rate Details

Test Sequence	BIT-RATE / AVERAGE LUMA PSNR					
	Low rate		Mid rate		High rate	
	PSNR (1)	BD (2)	PSNR (1)	BD (2)	PSNR (1)	BD (2)
Foreman CIF (352x288), 30fps, CBR	**384 kbps**		**768 kbps**		**1 Mbps**	
	34.34	0.26	37.22	0.30	38.32	0.42
Parkrun D1 (720x480), 30fps, CBR	**2 Mbps**		**4 Mbps**		**6 Mbps**	
	27.96	0.50	30.66	0.24	32.38	0.12
Football CIF (352x288), 30fps, VBR	**384 kbps**		**768 kbps**		**1 Mbps**	
	28.61	0.57	31.90	0.53	33.30	0.42

(1) PSNR in decibels. In case of frame drop, PSNR is measured by repeating previous frame.
(2) Percentage deviations in bit-rate.

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Table 7. PSNR Comparison with Reference Encoder

	BIT-RATE / AVERAGE LUMA PSNR		
Test Sequence	**Low rate**	**Mid rate**	**High rate**
	PD(1)	**PD(1)**	**PD(1)**
Foreman CIF (352x288), 30fps, CBR	**384 kbps**	**768 kbps**	**1 Mbps**
	0.16	0.20	0.19
Parkrun D1 (720x480), 30fps, CBR	**2 Mbps**	**4 Mbps**	**6 Mbps**
	0.43	0.13	0.00
Football CIF (352x288), 30fps, VBR	**384 kbps**	**768 kbps**	**1 Mbps**
	NA(2)	NA(2)	NA(2)

(1) PSNR differences of TI encoder and JM encoder (PSNR of JM encoder – PSNR of TI Encoder).
(2) JM reference version does not support VBR coding.

References

- ISO/IEC 14496-10:2005 (E) Rec. - Information technology – Coding of audio-visual objects – H.264 (E) ITU-T Recommendation.
- *H.264 Baseline Profile Encoder on DM510 User's Guide* (literature number: SPRUFC1A).

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
ASO	Arbitrary Slice Order
CIF	Common Intermediate Format
D1	Video Resolution for PAL(720x576) and NTSC(720x480)
DMA	Direct Memory Access
DPB	Decoded Picture Buffer
EVM	Evaluation Module
FMO	Flexible Macro-block Ordering
MHz	Mega Hertz
MONA	Media Oriented Negotiation Acceleration
NTSC	National Television System Committee
PAL	Phase Alternating Line
PSNR	Peak Signal to Noise Ratio
QCIF	Quarter Common Intermediate Format
QVGA	Quarter Video Graphics Array
RS	Redundant Slice
SEI	Supplementary Enhancement Information
SQCIF	Sub Quarter Common Intermediate Format
UMV	Unrestricted Motion Vectors
vIMCOP	Video and Imaging Co-processor
VUI	Visual Usability Information
XDM	eXpressDSP Digital Media

Revision History

This datasheet revision history highlights the changes made to the SPRS467 codec specific data manual to make it SPRS467A.

Table 8. Revision History of H264 Baseline Profile Encoder on DM510

SECTION	ADDITIONS/MODIFICATIONS/DELETIONS
Section 1	Features: • Updated Features list
Table 2	Cycles Information: • Updated average and peak values
Table 3	Memory Statistics: • Updated Program Memory and Data Memory values
Table 5	Co-processor(s) Memory Statistics: • Updated values

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