

H.264 Encoder (v1.14) on DM648/TNETV2685

FEATURES

- eXpressDSP™ Digital Media (XDM 0.9 IVIDENC) interface compliant
- Validated on the DM648/TNETV2685 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 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 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
- 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 DM648/TNETV2685 EVM with Code Composer Studio version 3.3.24.1 and code generation tools version 6.0.7.

PRODUCT PREVIEW



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

eXpressDSP is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

Performance Summary

This section describes the performance of the H.264 Encoder on C64x+ (on DM648).

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 DM648 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	410	435
	Tennis.yuv, YUV420/704x480 @ 3 mbps with 1 MV, QPI, LPF, UMV-enabled, high quality preset, 100 frames	399	423
	Tennis.yuv, YUV420/704x480 @ 3 mbps with high speed preset, 100 frames	382	399
	mobile.yuv, YUV420/352x288 @ 768 kbps @ 30 fps with 1 MV, QPI, LPF, UMV, high quality preset, 100 frames	123	130
	mobile.yuv, YUV422/352x288 @ 768 kbps @ 30 fps with 1 MV, QPI, LPF, UMV, high quality preset, 100 frames	125	132

- (1) Measured with program memory, stack, and I/O buffers in external memory with cache configuration : 32 K-bytes L1P program cache, and 32 K-bytes L1D data cache, 256 K-bytes L2 cache, 32 bit DDR @ 266.5 MHz, CPU @ 594 MHz and only used by encoder.
- (2) The intra periodicity is 1 second, which means intraPeriod of 30 for 30 fps and intraPeriod of 25 for 25 fps. 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.

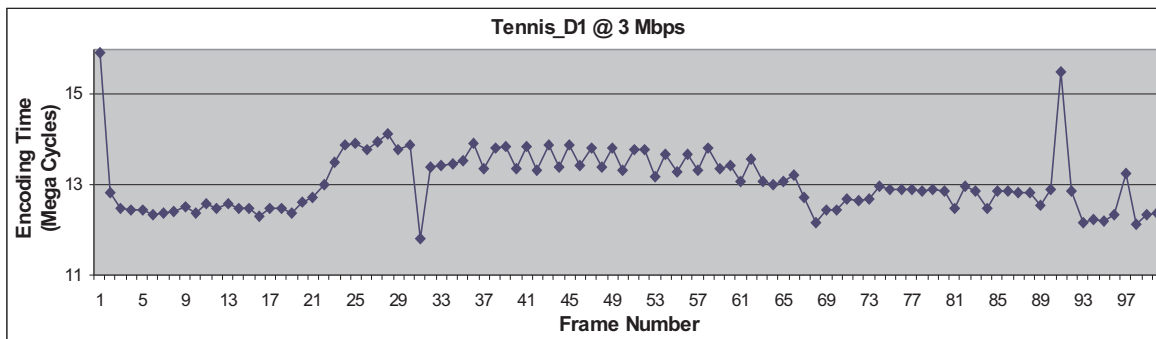


Figure 1. Encoding Time for Individual Frames (Tennis.yuv, YUV420/704x480 @ 3 Mbps @ 30 fps with 1 MV, QPI, LPF, UMV, and High Quality Preset)

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	DATA MEMORY				
			INTERNAL	EXTERNAL		STACK	
				PERSISTENT	SCRATCH		
H264_ENC_001	Level 1.1 QCIF	137	63.25	163	320	8	691.25
	Level 1.3 CIF	137	63.25	456	320	8	984.25
	Level 3.0 PAL D1	137	63.25	1533	320	8	2061.25

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

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⁾	IMX IMG BUF ⁽¹⁾	IMX CMD MEM ⁽¹⁾
H264_ENC_001	1	4	30	5	4

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

Table 6. PSNR and Bit Rate Details

TEST SEQUENCE	BIT RATE/AVERAGE LUMA PSNR									
	BIT RATE RANGE	LOW RATE			MID RATE			HIGH RATE		
Mobile CIF (352x288), 30 fps		P ⁽¹⁾	FD ⁽²⁾	BD ⁽³⁾	P ⁽¹⁾	FD ⁽²⁾	BD ⁽³⁾	P ⁽¹⁾	FD ⁽²⁾	BD ⁽³⁾
		384 kbps			768 kbps			1280 kbps		
	Case 1 ⁽⁴⁾	24.33	0	4	27.83	0	3.3	30.32	0	2.48
	Case 2 ⁽⁵⁾	24.51	0	3.27	27.74	0	2.6	30.23	0	0.0
Tennis D1 (704x480), 30 fps		1572 kbps			2560 kbps			4096 kbps		
	Case 1 ⁽⁴⁾	30.54	0	7.2	31.90	0	5.08	33.30	0	3.1
	Case 2 ⁽⁵⁾	30.17	0	3.83	31.64	0	2.92	33.16	0	1.89

(1) PSNR in decibels, in case of frame drop, PSNR is measured by repeating previous frame.

(2) Number of frame drops.

(3) Percentage deviation in bit-rate

(4) Rate control used is IVIDEO_LOW_DELAY, number of frames are 100, High Quality Preset.

(5) Rate control used is IVIDEO_STORAGE, number of frames are 100, High Quality Preset.

Table 7. PSNR Comparison with Reference Encoder⁽¹⁾

TEST SEQUENCE	BIT RATE/AVERAGE LUMA PSNR			
	BIT RATE RANGE	LOW RATE	MID RATE	HIGH RATE
Mobile CIF (352x288), 30 fps		PD⁽²⁾	PD⁽²⁾	PD⁽²⁾
		384 kbps	768 kbps	1280 kbps
	Case 1 ⁽³⁾	0.85	0.44	0.24
	Case 2 ⁽⁴⁾	0.67	0.54	0.33
Tennis D1(704x480), 30 fps		1572 kbps	2560 kbps	4096 kbps
	Case 1 ⁽³⁾	0.10	0.24	0.24
	Case 2 ⁽⁴⁾	0.47	0.50	0.38

(1) Reference encoder is JVT version 10.3 configured to use single reference frame, no hadamard, no intra 4x4 prediction mode, no RDO.

(2) PSNR differences of TI encoder and JVT encoder in db.

(3) Rate control used is IVIDEO_LOW_DELAY, number of frames are 100, High Quality Preset.

(4) Rate Control used is IVIDEO_STORAGE, number of frames are 100, High Quality Preset.

Notes

- Evaluation version performance may be off by up to 30 MHz
- I/O buffers:
 - Input buffer size = 675 K-bytes (D1, one YUV422 interleaved frame)
 - Output buffer size = 150 K-bytes (for encoding one D1 frame)
- Memory Configuration
 - L1P : 32 K-bytes program cache
 - L1D : 64 K-bytes data memory and 16K-bytes data cache
 - L2 : 256 K-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).

References

- ISO/IEC 14496-10:2005 Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding
- *H.264 Baseline Profile Encoder on DM648/TNETV2685 User's Guide*(literature number SPRUF68)

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	DMA Manager
DMAN3	Direct Memory Access
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
XDM	eXpressDSP Digital Media

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright 2008, Texas Instruments Incorporated