H.264 High Profile Decoder (v01.10.00) on DM365

FEATURES

- **eXpressDSP™ Digital Media (XDM 1.2 IVIDDEC2) interface compliant**
- **Validated on DM365 EVM with MVL 5.0**
- **H.264 High Profile up to level 4.2 compliant (limited to maximum of 1920x1088 frame resolution)**
- **Both adaptive and sliding window DPB management supported**
- **Byte stream NAL unit format for input bit-stream**
- **Progressive, Field, PAFF and MBAff picture decoding supported**
- **Multiple slices and multiple reference frames supported**
- **CAVLC and CABAC decoding supported**
- **Main Profile features like B-Slice decoding and CABAC supported**
- **Weighted prediction for motion compensation in both P and B-slices supported**
- **Transform 8x8 mode, interspersed with transform 4x4 MBs supported**
- **Parsing and decoding with scaling lists present both in SPS and PPS NAL units supported**
- **Second chroma qp index offset value present in PPS supported**
- **All intra-prediction and inter-prediction modes supported**
- **Up to 16 MV per MB supported**
- **Output order conformance using frame bumping process supported**
- **Frame based decoding with frame size being multiples of 2 supported**
  - **Field based decoding with frame height being multiples of 4 supported**
- **Outputs are available in YUV420 interleaved big endian format**
- **Supplemental Enhancement Information (SEI) and Video Usability Information (VUI) supported**
- **Uses configurable frame display delay for out of order display**
- **Performs predictor based spatial and temporal error concealment on erroneous frames and reports the type of error occurred**
- **Supports up to 1080p (1920x1088) resolution.**
- **This version of the decoder does not support the following features:**
  - **Error concealment features such as ASO/FMO and redundant slices**
  - **Dynamic change in resolution**
  - **Raw NAL unit format for input bit-stream**
  - **Monochrome format in High Profile**

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 3.3.81.6 and using the code generation tools version 4.1.4.

PRODUCT PREVIEW

Performance Summary

This section describes the performance of Standalone H.264 High Profile Decoder validated on DM365 EVM resulting in performance equivalent to 30fps.

Table 1. Configuration Table

CONFIGURATION	ID
H.264 High Profile levels up to 4.2	H264_DEC_01

Performance Measurement Procedure

- Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @297 MHz, HDVICP @243 MHz, DDR @243 MHz, Monta Vista® Linux® 5.0
- Linux is used to measure the performance numbers in this Datasheet.
- The process time is measured across algActivate/process/algDeactivate function call using gettimeofday() utility of linux.
- NFS File system is used as an environment in performance measurement.

Table 2. Cycles Information for H264_DEC_01

INPUT NAME	PERFORMANCE STATISTICS (MEGA CYCLES)(1)						
	RESOLUTION	AVERAGE			PEAK		
		ARM926 PER FRAME	DECODE PER FRAME (ARM 926 and HDVICP)	FPS	ARM926 PER FRAME	DECODE PER FRAME (ARM 926 and HDVICP)	FPS
CIF_L1.2_384Kbps_15fps_news.264	CIF(352x288)	0.19	1.08	274.64	0.40	1.64	180.69
foreman_p640x480_30fps_420pl_300fr_1ref.264	VGA(640x480)	0.21	2.81	105.56	0.53	3.02	98.21
D1_football_720x480_384_30fBP.264	D1(720x480)	0.24	3.01	98.71	0.57	3.31	89.72
16MV_Ipb_city_p1280x720_30fps_420pl_600fr.264	720p (1280 x 720)	0.20	8.47	35.08	0.50	9.83	30.20
720p50_parkrun_field1.264	720p (1280 x 720)	0.48	10.22	29.06	0.82	15.97	18.59
720p50_parkrun_mbaff.264	720p (1280 x 720)	0.30	13.20	22.50	0.63	15.63	19.00
colorful_toys_cif_5frms_420P.264	CIF(352x288)	0.37	1.20	246.30	0.67	1.41	209.23

(1) Average and peak values may vary by +/-5%.

Table 3. Cycles Information for H264_DEC_01 for Closed Loop Configuration

INPUT NAME	PERFORMANCE STATISTICS (MEGA CYCLES)(1)						
	RESOLUTION	AVERAGE			PEAK		
		ARM926 PER FRAME	DECODE PER FRAME (ARM 926 and HDVICP)	FPS	ARM926 PER FRAME	DECODE PER FRAME (ARM 926 and HDVICP)	FPS
akiyo_p352x288_30fps_420pl_300fr.264	CIF(352x288)	0.21	1.08	273.08	0.43	1.66	178.28
foreman_i640x480_30fps_420pl_300fr.264	VGA(640x480)	0.23	2.81	105.38	0.49	3.58	82.75
shields_p720x480_25fps_420pl_252fr.264	D1(720x480)	0.23	3.093	96.02	0.53	4.04	73.49
parkrun_p1280x720_30fps_420pl_300fr.264	720p (1280 x 720)	0.25	7.49	39.61	0.59	9.16	32.42

(1) Average and peak values may vary by +/-5%.

Note:

- Decode frame depicts the cumulative load on ARM926 and HDVICP.
- The values in Table 2 and Table 3 are as measured on the ARM926 side. These are the actual cycles as seen from the host on the DM365 EVM board and will be close to cycles seen on the final system (for average case).
- ARM926 represents mega cycles per frame spend on ARM926.
- Decode frame time is the time seen from ARM926 only. Since most of the processing happens at HDVICP, the active load on ARM926 is the value mentioned in ARM926 column. Decoder frame time has no connection with HDVICP running at 243 MHz.
- All the values are collected (both average and peak) at frame-level processing.
- They are measured with Linux without any system traffic.
- The version of the code used to collect these numbers have the following features included:
  - Interrupt mode of operation – one interrupt signal processing overhead per frame.
  - Resetting of HDVICP and loading of code into HDVICP program and data memory – once per stream.

Table 4. Memory Statistics (Host ARM926 External Memory)

CONFIGURATION ID	MEMORY STATISTICS (IN BYTES)(1)						
	PROGRAM MEMORY	DATA MEMORY					TOTAL
		CONSTANT(2)	HEAP		STACK	DPB FOR LEVEL 4.2(3)	
			PERSISTENT(4)	SCRATCH			
H264_DEC_01	246036	324258	19036064	99200	16348	19000000	38821106

(1) All these memory requirements are for ARM926 decoder library only. They do not include any memory requirements from test application side and input stream buffer. Stack, heap and code requirements for test-application are additional.
(2) Constant memory size requirements include HDVICP program memory since it forms a constant table on ARM926 before transfer. The constant size is the sum of .cinit, .bss, and .const sections used by H.264 decoder library.
(3) DPB for level 4.2 indicates tentative buffer requirements on the test application side to manage the DPB requirements of level 4.2 (however limited to the maximum resolution of 1920x1088) compliant H.264 decoder library implementing XDM1.2 API. DPB memory requirements given here include padding requirements along all dimensions (luma and packed chroma) assuming 4:2:0 format. It also includes memory required for holding the current frame. To enable optimal DMA transfers in the application, the picture width has been aligned to next 32-byte boundary. For eg: Padded and aligned 1080p picture would have a width of 1920 + 48 (Padding) + 16(alignment) = 1984. Because of these padding and alignment constraints, the DPB requirement for a normal picture would be different from that of its rotated version. The DPB requirement for some of the supported resolutions on the higher-end is given in Table 5.
(4) Persistent memory includes space required for 256 PPS and 32 SPS.

Table 5. DPB Requirement (for level 4.2)

RESOLUTION	DPB REQUIREMENT
1080p (1920x1088)	19000000

Table 6. Internal Data Memory Split-Up

CONFIGURATION ID	DATA MEMORY - HDVICP (IN BYTES)			
	HDVICP PROGRAM MEMORY	HDVICP DATA MEMORY	HDVICP BUFFERS	VICP (BYTES)
H264_DEC_01	48000	32000	ALL	55808

Table 7. H264 Decoder DM365 Codec Usage of Memory Through CMEM

BUFFER	YUV420P
Input Buffer(1)	0x200000 (Max)
Output Buffer	3523584
MEMTAB NUMBER	**SIZE IN BYTES(2)**
Memtab 0	1024
Memtab 1	14976
Memtab 2	14976
Memtab 3	2688
Memtab 4	8192
Memtab 5	18321120
Memtab 6	282624
Memtab 7	47752
Memtab 8	146116
Memtab 9	58144
Memtab 10	384
Memtab 11	10240
Memtab 12	65792
Memtab 13	30720

(1) The size of the input buffer should be equal to or greater than one frame data..
(2) The table has numbers for 1080p resolution.

The following CMEM allocations are dependent on the maxWidth and maxheight and it provides the formula for calculating the size based on the input resolution:

- Output Buffer = Luma_frameSize_padded + Chroma_frameSize_padded
  where Luma_frameSize_padded = ((maxWidth + 48 + alignment)*(maxHeight+ 96)). and Chroma_frameSize_padded = Luma_frameSize_padded / 2.
- Memtab 4 = 2 * ((((maxWidth + 4 * 16) * 2) + 8 + 127) & 0xFFFFFF80)
  This is for storing the top rows for intra prediction. One for even row and one for odd row.
- Memtab 5 = Frame level collocated MB Info + Extra Frame Padding buffers
  where MB_Info_frame = ((((maxWidth >> 4) + 1) * (maxHeight >> 4)) + 1) * (dpb_limit at level 4.2 + 1). This is for storing ecd mb info data.and Frame_Pad_Buf = Luma_Frame_Pad_Buf + Chroma_Frame_Pad_Bufwhere Luma_Frame_Pad_Buf = ((maxWidth + 48 + alignment)*(48 + 1MB BB + 6) and Chroma_Frame_Pad_Buf = Luma_Frame_Pad_Buf / 2 Output Buffer maintains Field type padding only. Frame padding requires additional memory.

Notes

- HDVICP and VICP
  - The entire HDVICP is a video resource and is used by the codec
  - The codec uses VICP memory as scratch buffers and hence there is restriction on the usage of VICP concurrently.
- DMA configuration

Table 8. DMA Configuration

TC Q's	TC 0	TC 1	TC 2	TC 3	TOTAL
Usage	Used by codec	Used by codec	Used by codec	Reserved for system	-
Priority	1	1	1	0	-
EDMA Channels	16	9	1	NA	26
PaRAM Entries	14	52	1	NA	67
QDMA Channels	0	0	0	NA	0

- The HDVICP/VICP/EDMA resources are acquired using a generic resource manager known as Framework Component. See *H.264 High Profile Decoder on DM365 User's Guide* for details.
- Code Placement
  - All the algorithm code are placed in external memory. The performance quoted is not sensitive to algorithm code placement.

References

- ISO/IEC 14496-10:2005 (E) Rec. - Information technology – Coding of audio-visual objects – H.264 (E) ITU-T Recommendation.
- *H.264 High Profile Decoder on DM365 User's Guide* (literature number: SPRUEV0D)

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
720p	1280x720 resolution
DMA	Direct Memory Access
DPB	Decoded Picture Buffer
EVM	Evaluation Module
FMO	Flexible Macro-block Ordering
HDVICP	High Definition Video and Imaging Co-Processor sub-system
PPS	Picture Parameter Set
SEI	Supplemental Enhancement Information
SPS	Sequence Parameter Set
VICP	Video and Imaging Co-Processor sub-system
VUI	Video Usability Information
XDM	eXpressDSP Digital Media

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