



MPEG4 Restricted Simple Profile Decoder (v1.12.000) on DM355

FEATURES

- eXpressDSP™ Digital Media (xDM) Interface compliant
- IDMA3 compliant
- ImplementsIVIDDEC2 Interface of xDM
- Supports MPEG4 simple profile levels 0, 1, 2 and 3 with the following limitations:
 - No support for 4 MV
 - No support for MV ranges beyond -32 to 31
 - No support for escape 1 and 2 VLC
 - No support for DP and RVLC
- Can also decode the following formats:
 - VGA (640 x 480)
 - D1 (720 x 480)
 - 720P (1280 x 720)
 - SXVGA (1280 x 960)
- Supports Half Pel Interpolation (HPI) for Motion Compensation
- Supports 1 motion vector encoding for motion estimation (1MV/MB) with (-32, +31) half pel search range
- Supports streams with DC and AC prediction
- Supports streams with resync marker (RM)
- Supports streams with Short Video Header (SVH)
- Supports YUV 4:2:2 interleaved data as an output
- Supports Display Width feature; i.e., display width can be greater than the image width
- Supports Rotation (0, 90, 180 and 270 degrees) integrated with the decoder for certain image formats (QVGA (320 x 240), VGA (640 x 480), 720P (1280 x 720) and SXVGA (1280 x 960)). Also supports rotation of 240 x 320 (rotated QVGA) and 480 x 640 (rotated VGA).
- Supports unrestricted motion vector (UMV)
- Can decode all DM355 encoded streams
- Can decode streams of VBR, CBR, and CVBR rate control
- Supports frame level reentrancy
- Supports multi instance of MPEG4 Decoder, and single/multi instance of MPEG4 Decoder with other DM355 codecs
- Validated on DM355 EVM (MontaVista® Linux® 4.0.1).
- Unsupported features: The limitations will not be removed in future releases. These limitations are not defects, but intentional or known deficiencies.
 - The current version of MPEG4 SP decoder is a restricted decoder. It can only decode streams encoded with the DM355 MPEG4 Encoder.
 - Does not support Video packet resynchronization
 - Does not support Data partitioning (DP)
 - Does not support Reversible VLCs (RVLCs)
 - Does not support Header extension code (HEC)
 - does not support 4MV
 - Does not support MV range beyond -32 and +31
 - Does not support for escape 1 and 2 VLC
 - Does not support arbitrary width and height.
 - Supports image width as multiple of 16 and height as multiple of 16.
 - Does not support image width below 160.
 - Does not support decoding of 720 x 1280 (rotated 720P) and 960 x 1280 (rotated SXVGA) formats (Limitation)
 - IDMA3 interface support is limited. MPEG4 Decoder uses following hardcoded

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channels and paRamSets.

- **Channel numbers 32 to 63 (except 51) and corresponding paRamSet number i.e., 32 to 63 (except 51)**
- **Only additional 14 paRamSets are passed to codec through IDMA3 interface.**
- **Only 14 additional PaRamSets are passed to the codec through the IDMA3 interface**

DESCRIPTION

The current version of the MPEG4 SP decoder is a restricted decoder. It can only decode streams encoded by DM355 MPEG4 Encoder. It is validated on DM355 EVM with MontaVista Linux 4.0.1.

Product Support

When contacting TI for support on this codec, please quote the product name (MPEG4 Decoder on DM355) and version number. The version number of the codec is included in the Title of the Release Notes that accompanies this codec.

Validation

The encoder has been validated by running it on the DM355 EVM platform and measuring the resource usage during this process.

Performance Summary

This section describes the performance of the MPEG4 Restricted Simple Profile Decoder (v1.12.000) on DM355.

Table 1. Configuration Table

Configuration	ID
MPEG4 simple profile, I/D Cache Enabled Output Format: YUV422ILE Rotation 0,ME 31,UMV OFF	MPEG4_DEC_001 (UMV OFF: Resolution Grouping)
MPEG4 simple profile, I/D Cache Enabled Output Format: YUV422ILE Rotation 0,ME 31,UMV ON	MPEG4_DEC_002 (UMV ON: Resolution Grouping)
MPEG4 simple profile, I/D Cache Enabled Output Format: YUV422ILE Rotation 0,ME 7	MPEG4_DEC_003 (UMV ON/OFF with ME7)
MPEG4 simple profile, I/D Cache Enabled Output Format: YUV422ILE Rotation 0/90/180/270, ME 31,UMV ON	MPEG4_DEC_004 (Rotation Grouping)
MPEG4 simple profile (SVH Mode), I/D Cache Enabled Output Format: YUV422ILE Rotation 0, ME 31,UMV OFF	MPEG4_DEC_005 (SVH: Resolution Grouping)
MPEG4 simple profile (SVH Mode), I/D Cache Enabled Output Format: YUV422ILE Rotation 0, ME 7,UMV OFF	MPEG4_DEC_006 (SVH with ME7)
MPEG4 simple profile (SVH Mode), I/D Cache Enabled Output Format: YUV422ILE Rotation 0/90/180/270, ME 31,UMV OFF	MPEG4_DEC_007 (SVH: Rotation Grouping)

Performance Measurement Procedure

1. Standalone codec test application, which makes codec process call at xDM layer (without codec engine), is used to measure the performance numbers in this Datasheet.
2. The process time is measured across algActivate/process/algDeactivate function call using gettimeofday() utility of linux.
3. NAND File system is used as an environment in performance measurement. A variation of upto 0.35ms is

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seen in performance numbers between multiple runs of same test.

4. To avoid the impact of file I/O operation in performance measurement, file write operation is disabled and checksum calculation is included after fread() function to make sure file read has really completed before process call.
5. Very first I frame time is excluded in calculation of Average and Peak I frame time.
6. After rebooting the board, codec binary must be executed at least once before start of performance measurement.

NOTE:

Codec process time is divided in ARM load and MJCP load. ARM is idle during MJCP processing, and can be utilized to execute any other program in different thread during this time.

Table 2. Cycles Information for MPEG4_DEC_001⁽¹⁾

Input Name	Resolution	Average Process Time (ms/frame) ⁽²⁾⁽³⁾		Peak Process Time (ms/frame) ⁽²⁾⁽⁴⁾		Average ARM Load (ms/frame) ⁽⁵⁾	Average MJCP Load (ms/frame) ⁽⁵⁾	Average ARM Load (Mcycles/30frames) ⁽⁵⁾
		I Frames	P Frames	I Frames	P Frames			
foreman_cif.bits	CIF (352 x 288)	4.09	4.10	4.11	4.34	1.45	2.66	9.39
akiyo_vga.bits	VGA (640 x 480)	9.31	9.27	9.38	9.38	1.46	7.84	9.43
fire_720x480.bits	D1 (720 x 480)	12.08	12.07	12.14	12.41	1.45	10.63	9.37
720p5994_stockholm.bits	720p (1280 x 720)	24.76	24.86	24.80	25.43	1.43	23.43	9.29
Pedestrian_1280x960.bits	SXVGA (1280 x 960) ⁽⁶⁾	26.23	26.13	26.31	26.38	1.16	24.98	7.50

- (1) Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @216 MHz, DDR @ 171 MHz, MontaVista Linux 4.0.1.
- (2) Total Process Time (Process + activate + deactivate) (ms/frame). This includes the overhead in Multi Instance (i.e., activate + deactivate) of ~0.28 ms.
- (3) Based on the average number of cycles per frame (for I and P Frames separately) at 30 fps. The first I frame is excluded in this calculation.
- (4) Peak Process Time (except for the first I Frame). The first I Frame has an additional overhead of ~1.5 ms.
- (5) Average is across all frames (both I and P) at 30 fps.
- (6) Performance numbers for SXVGA are interpolated for the DM355UH part; i.e., ARM @270 MHz, DDR @216 MHz.

Table 3. Cycles Information for MPEG4_DEC_002⁽¹⁾

Input Name	Resolution	Average Process Time (ms/frame) ⁽²⁾⁽³⁾		Peak Process Time (ms/frame) ⁽²⁾⁽⁴⁾		Average ARM Load (ms/frame) ⁽⁵⁾	Average MJCP Load (ms/frame) ⁽⁵⁾	Average ARM Load (Mcycles/30frames) ⁽⁵⁾
		I Frames	P Frames	I Frames	P Frames			
foreman_cif.bits	CIF (352 x 288)	4.87	4.85	4.95	5.11	2.13	2.72	13.81
akiyo_vga.bits	VGA (640 x 480)	10.38	10.34	10.46	10.71	2.40	7.96	15.56
fire_720x480.bits	D1 (720 x 480)	13.67	13.57	13.79	13.88	2.42	11.16	15.69
720p5994_stockholm.bits	720p (1280 x 720)	26.34	26.42	26.47	27.90	2.83	23.60	18.31
Pedestrian_1280x960.bits	SXVGA (1280 x 960) ⁽⁶⁾	27.72	27.66	27.76	28.16	2.50	25.17	16.17

- (1) Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @216 MHz, DDR @ 171 MHz, MontaVista Linux 4.0.1.
- (2) Total Process Time (Process + activate + deactivate) (ms/frame). This includes the overhead in Multi Instance (i.e., activate + deactivate) of ~0.28 ms.
- (3) Based on the average number of cycles per frame (for I and P Frames separately) at 30fps. The first I frame is excluded in this calculation.
- (4) Peak Process Time (except for the first I Frame). The first I Frame has an additional overhead of ~1.5 ms.
- (5) Average is across all frames (both I and P) at 30fps.
- (6) Performance numbers for SXVGA are interpolated for the DM355UH part; i.e., ARM @270 MHz, DDR @216 MHz.

Table 4. Cycles Information for configuration ID MPEG4_DEC_003⁽¹⁾

Input Name	Resolution	UMV	Average Process Time (ms/frame) ⁽²⁾⁽³⁾		Peak Process Time (ms/frame) ⁽²⁾⁽⁴⁾		Average ARM Load (ms/frame) ⁽⁵⁾	Average MJCP Load (ms/frame) ⁽⁵⁾	Average ARM Load (Mcycles/30frames) ⁽⁵⁾
			I Frames	P Frames	I Frames	P Frames			
Foreman	CIF (352 x 288)	ON	4.40	4.43	4.41	4.65	2.12	2.32	13.76
		OFF	3.70	3.72	3.75	3.92	1.44	2.28	9.36
Akiyo	VGA (640 x 480)	ON	9.17	9.15	9.24	9.51	2.39	6.78	15.51
		OFF	8.20	8.14	8.25	8.41	1.44	6.71	9.33
Fire	D1 (720 x 480)	ON	12.35	12.25	12.64	12.57	2.41	9.85	15.61
		OFF	10.79	10.72	10.86	11.01	1.43	9.07	9.28
stockholm	720p (1280 x 720)	ON	22.90	23.99	22.99	24.23	2.84	20.15	18.42
		OFF	21.41	21.49	21.51	22.16	1.43	20.06	9.27
Pedestrian	SXVGA (1280 x 960)	ON	30.476	30.367	30.646	30.687	3.222	27.154	20.07
		OFF	28.32	28.22	28.38	28.43	1.49	26.74	9.66

- (1) Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @216 MHz, DDR @ 171 MHz, MontaVista Linux 4.0.1.
- (2) Total Process Time (Process + activate + deactivate) (ms/frame). This includes the overhead in Multi Instance (i.e., activate + deactivate) of ~0.28 ms.
- (3) Based on the average number of cycles per frame (for I and P Frames separately) at 30 fps. The first I frame is excluded in this calculation.
- (4) Peak Process Time (except for the first I Frame). The first I Frame has an additional overhead of ~1.5 ms.
- (5) Average is across all frames (both I and P) at 30fps.

Table 5. Cycles Information for Configuration ID MPEG4_DEC_004⁽¹⁾

Input Name	Resolution	Rotation	Average process time (ms/frame) ⁽²⁾⁽³⁾		Peak process time (ms/frame) ⁽²⁾⁽⁴⁾		Average ARM load (ms/frame) ⁽⁵⁾	Average MJCP load (ms/frame) ⁽⁵⁾	Average ARM load (MCycles/30frames) ⁽⁵⁾
			I Frames	P Frames	I Frames	P Frames			
Foreman	CIF (352 x 288)	0	4.94	4.89	4.97	5.18	2.17	2.72	14.06
		90	4.98	5	5.04	5.51	2.27	2.74	14.69
		180	5.16	4.97	5.21	5.43	2.24	2.74	14.52
		270	4.94	4.97	4.95	5.29	2.24	2.73	14.53
Akiyo	VGA (640 x 480)	0	10.37	10.37	10.39	10.71	2.43	7.96	15.73
		90	10.56	10.51	10.71	10.7	2.57	7.96	16.64
		180	10.52	10.45	10.66	10.64	2.51	7.96	16.28
		270	10.54	10.46	10.67	10.8	2.52	7.96	16.33

- (1) Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @216 MHz, DDR @ 171 MHz, MontaVista Linux 4.0.1.
- (2) Total Process Time (Process + activate + deactivate) (ms/frame). This includes the overhead in Multi Instance (i.e activate+deactivate) of ~0.36 ms.
- (3) Based on average number of cycles per frame (for I and P frame separately) @ 30 fps . First I frame is excluded in this calculation.
- (4) Peak Process time (except first I frame). Very first I frame will have additional overhead of ~1.5 ms.
- (5) Average across all frames (both I & P) @ 30 fps

Table 6. Cycles Information for Configuration ID MPEG4_DEC_005⁽¹⁾

Input Name	Input Name	Average process time (ms/frame) ⁽²⁾⁽³⁾		Peak process time (ms/frame) ⁽²⁾⁽⁴⁾		Average ARM load (ms/frame) ⁽⁵⁾	Average MJCP load (ms/frame) ⁽⁵⁾	Average ARM load (MCycles/30frames) ⁽⁵⁾
		I Frames	P Frames	I Frames	P Frames			
Akiyo	QCIF (176 x 144)	2.44	2.44	2.51	2.76	1.56	0.89	10.13
Crew	CIF (352 x 248)	4.19	4.19	4.26	4.46	1.54	2.65	10.01
Harbour	2CIF (704 x 576)	11.84	11.94	11.9	12.25	1.49	10.45	9.65

- (1) Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @216 MHz, DDR @ 171 MHz, MontaVista Linux 4.0.1.
- (2) Total Process Time (Process + activate + deactivate) (ms/frame). This includes the overhead in Multi Instance (i.e activate+deactivate) of ~0.28 ms.
- (3) Based on average number of cycles per frame (for I and P frame separately) @ 30 fps . First I frame is excluded in this calculation.
- (4) Peak Process time (except first I frame). Very first I frame will have additional overhead of ~1.5 ms.
- (5) Average across all frames (both I & P) @ 30 fps.

Table 7. Cycles Information for configuration ID MPEG4_DEC_006⁽¹⁾

Input Name	Input Name	Average process time (ms/frame) ⁽²⁾⁽³⁾		Peak process time (ms/frame) ⁽²⁾⁽⁴⁾		Average ARM load (ms/frame) ⁽⁵⁾	Average MJCP load (ms/frame) ⁽⁵⁾	Average ARM load (MCycles/30frames) ⁽⁵⁾
		I Frames	P Frames	I Frames	P Frames			
Akiyo	QCIF (176 x 144)	2.34	2.32	2.4	2.8	1.54	0.8	9.98
Crew	CIF (352 x 248)	3.8	3.81	3.89	4.32	1.54	2.28	9.95
Harbour	2CIF (704 x 576)	10.32	10.45	10.35	10.87	1.49	8.96	9.68

- (1) Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @216 MHz, DDR @ 171 MHz, MontaVista Linux 4.0.1.
- (2) Total Process Time (Process + activate + deactivate) (ms/frame). This includes the overhead in Multi Instance (i.e activate+deactivate) of ~0.28 ms.
- (3) Based on average number of cycles per frame (for I and P frame separately) @ 30 fps . First I frame is excluded in this calculation.
- (4) Peak Process time (except first I frame). Very first I frame will have additional overhead of ~1.5 ms.
- (5) Average across all frames (both I & P) @ 30 fps.

Table 8. Cycles Information for configuration ID MPEG4_DEC_007⁽¹⁾

Input Name	Resolution	Rotation	Average process time (ms/frame) ⁽²⁾⁽³⁾		Peak process time (ms/frame) ⁽²⁾⁽⁴⁾		Average ARM load (ms/frame) ⁽⁵⁾	Average MJCP load (ms/frame) ⁽⁵⁾	Average ARM load (MCycles/30frames) ⁽⁵⁾
			I Frames	P Frames	I Frames	P Frames			
Crew	CIF (352 x 288)	0	4.21	4.19	4.3	4.51	1.55	2.65	10.01
		90	4.33	4.31	4.6	4.81	1.66	2.66	10.72
		180	4.29	4.32	4.33	4.81	1.66	2.66	10.76
		270	4.33	4.32	4.53	4.82	1.67	2.66	10.8
Harbour	2CIF (704 x 576)	0	11.83	11.94	11.86	13.16	1.49	10.46	9.64
		90	11.94	12.05	11.99	13.3	1.6	10.46	10.34
		180	11.96	12.07	11.99	13.32	1.62	10.46	10.48
		270	12	12.07	12.24	13.32	1.61	10.46	10.46

- (1) Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @216 MHz, DDR @ 171 MHz, MontaVista Linux 4.0.1.
- (2) Total Process Time (Process + activate + deactivate) (ms/frame). This includes the overhead in Multi Instance (i.e activate+deactivate) of ~0.36 ms
- (3) Based on average number of cycles per frame (for I and P frame separately) @ 30fps . First I frame is excluded in this calculation.
- (4) Peak Process time (except first I frame). Very first I frame will have additional overhead of ~1.5 ms.
- (5) Average across all frames (both I & P) @ 30fps.

Table 9. Codec Memory Statistics

Resolution	Memory Statistics ⁽¹⁾				
	Program Memory	Data Memory			Total
		Internal	External	Stack	
SXVGA (1280 x 960)	89.7	0	4050	2	4141
720P (1280 x 720)	89.7	0	3105	2	3197
D1 (720 x 480)	89.7	0	1267	2	1359
VGA (640 x 480)	89.7	0	1140	2	1232
CIF (352 x 288)	89.7	0	447	2	539

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

Table 10. Codec Usage of External Memory via CMEM

Buffer	Buffer Size	
Input Buffer	frameSize*2	
Output Buffer	frameSize*2	
External Data Memory	memTab[0]	4948 Bytes
	memTab[1]	3* frameSize_padded
	memTab[2]	5760 Bytes
	memTab[3]	8192 Bytes

NOTE:

$$\text{frameSize} = (\text{Width} * \text{Height}).$$

$$\text{frameSize_padded} = ((\text{Width} + 64) * (\text{Height} + 64)).$$

Input buffer size is theoretical size based on 1:1 compression. Actual input size will be lower than this.

Table 11. DDR Bandwidth Usage

Resolution	Bit rates (in Mbps)	Number of MBs per frame	DDR bandwidth for one second (in Mbytes)
CIF (352 x 288)	1	396	18.98
VGA (640 x 480)	2	1200	57.38

Table 11. DDR Bandwidth Usage (continued)

Resolution	Bit rates (in Mbps)	Number of MBs per frame	DDR bandwidth for one second (in Mbytes)
D1 (720 x 480)	4	1350	64.77
720p (1280 x 720)	10	3600	172.64
SXVGA (1280 x 960)	20	4800	231.02

References

- ISO/IEC 14496-2:2004, Information technology -- Coding of audio-visual objects -- Part 2: Visual (Approved in 2004-05-24)

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
Compression ratio	A compression ratio of N:1 indicates that compressed data occupies N times less space than original data

Acronyms

Acronym	Description
CBR	Constant bit rate
CIF	Common Intermediate Format
CVBR	Constrained variable bit rate
DP	Data Partitioning
DMA	Direct Memory Access
EVM	Evaluation Module
HPI	Half Pel Interpolation
IDMA3	DMA Resource specification and negotiation protocol
MV	Motion Vector
QCIF	Quarter Common Intermediate Format
QP	Quantization Parameter
QVGA	Quarter Video Graphics Array
RVLC	Reversible Variable Length Coding
SQCIF	Sub Quarter Common Intermediate Format
SSE	Sum of Square of Errors
SXVGA	Super eXtended Graphics Array
UMV	Unrestricted Motion Vectors
VBR	Variable bit rate
VGA	Video Graphics Array
XDAIS	eXpressDSP Algorithm Interface Standard
XDM	eXpressDSP Digital Media
MJCP	MPEG4-JPEG co-processor

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