

## MPEG4 Simple Profile Encoder (v01.10.00) on DM365

### FEATURES

- eXpressDSP™ Digital Media (XDM 1.0 IVIDENC1) interface and IRES compliant
- Validated on DM365 EVM with Monta Vista® Linux® 5.0
- MPEG4 simple profile levels 0, 1, 2, 3 compliant. In addition, it can encode 720P (1280x720), SXVGA (1280x960), and 1080P (1920x1080) formats
- YUV 4:2:2 interleaved data as an input supported
- YUV 4:2:0 semi-planar (NV12 format, that is, Y planar, Cb Cr interleaved) data as an input supported
- Image width as multiple of 16 and height as multiple of 16 supported
- Half Pel Interpolation (HPI) for motion estimation supported
- One motion vector encoding for motion estimation (1MV/MB) with (-32, +31) half pel search range supported
- 21H (Low quality, high performance), 8421H (medium quality, medium performance), 44421H (high quality, medium performance), or 84221H (High quality, low performance) based on meAlgo API parameter supported
- DC prediction supported
- AC prediction when rate control is disabled, that is, fixed Qp mode supported
- Generation of streams with Resync Marker (RM) supported
- MPEG2 Step 2 TM5 rate control algorithm supported
- Variable Bit Rate (IVIDEO\_STORAGE), Constant Bit Rate (IVIDEO\_LOW\_DELAY), Fixed Qp (IVIDEO\_NONE), supported, and Constrained Variable BitRate (CVBR)
- Intra–inter decision at 16x16 level (for better speed) or 8x8 block level (for better quality) level based on intraAlgo API parameter supported
- Bonus Skip MB logic (for better quality) or non-Bonus skip MB logic (for better performance) based on skipMBAIgo API parameter supported
- Unrestricted Motion Vectors (UMV) supported
- Access of motion vectors and SAD through MV access API supported. The application should pass the buffer required to write the SAD and motion vector generated. This should be passed as an output buffer parameter. MV access API always provides the motion vectors for the best matching MB.
- VOL header generation at frame-level supported. The application has to pass the buffer required to write the VOL header generated. The encoding process is bypassed and frame count is unaltered when the Header generation API is called.
- Modification of target bit-rate and frame rate supported
- Setting of separate Quantization Parameter (Qp) for I-frames and P-frames supported
- Changing the size of video packets at create time supported
- Area encode feature supported. The application can provide width, height, sub window width, and sub window height to the algorithm for encoding. The sub-window width and sub-window height should be multiple of 16.
- Rotation (90, 180, and 270 degrees) integrated with the Encoder up to a resolution of 720x576 supported
- Changing the encoding parameters at run-time (dynamic configurability) supported
- Frame level reentrancy supported
- Multi-instance of MPEG4 Encoder and single/multi instance of MPEG4 Encoder with other DM365 codecs supported
- Insertion of user data by application supported
- This encoder does not support the following:
  - 4 MV



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.

Linux is a registered trademark of Linus Torvalds.

Monta Vista is a registered trademark of MontaVista Software Inc..

All other trademarks are the property of their respective owners.

- AC prediction for varying Qp (rateFix = 0)
  - ME range beyond -32 and +31. Only ME Range = 31 and ME Range = 7 are supported.
  - DP, RVLC, and HEC
  - Input width/height, sub-window width/height, rate control algorithm, VBV size, or rotation as dynamically configurable parameters
  - Arbitrary width and height.
    - Supports image width as multiple of 16 and height as multiple of 8.
    - Image width below 160 (without UMV) and image width below 192 (with UMV) not supported
  - Area encode feature with horizontal and vertical offsets
- Rotation with width more than 720 and height more than 576 (for instance, 720p (1280x720) or SXVGA (1280x960))
  - Does not support image width more than 1920 and image height more than 1920

## DESCRIPTION

MPEG4 is the ISO/IEC recommended standard for video compression. This version of the MPEG4 Encoder is compliant with MPEG4 simple profile levels 0,1,2,3. It is validated on the DM365 EVM with Monta Vista Linux 5.0.

## Performance Summary

This section describes the performance of the MPEG4 Simple Profile Encoder on DM365 EVM.

**Table 1. Configuration Table**

CONFIGURATION	ID
MPEG4 simple profile, I/D Cache Enabled encodingPreset = XDM_HIGH_QUALITY inputChromaFormat = XDM_YUV_420SP	MPEG4_ENC_01 (High Quality Low Performance)
MPEG4 simple profile, I/D Cache Enabled encodingPreset = XDM_HIGH_SPEED inputChromaFormat = XDM_YUV_420SP	MPEG4_ENC_02 (Low Quality High Performance)
MPEG4 simple profile, I/D Cache Enabled encodingPreset = XDM_HIGH_QUALITY inputChromaFormat = XDM_YUV_422ILE	MPEG4_ENC_03 (High Quality Low Performance)
MPEG4 simple profile, I/D Cache Enabled encodingPreset = XDM_HIGH_SPEED inputChromaFormat = XDM_YUV_422ILE	MPEG4_ENC_04 (Low Quality High Performance)
MPEG4 simple profile (SVH Mode), I/D Cache Enabled encodingPreset = XDM_USER_DEFINED inputChromaFormat = XDM_YUV_422ILE meAlgo = IMP4VENC_ME_HQ_LP svhMode = 1	MPEG4_ENC_05 (SVH: High Quality Low Performance)
MPEG4 simple profile (SVH Mode), I/D Cache Enabled encodingPreset = XDM_USER_DEFINED inputChromaFormat = XDM_YUV_422ILE meAlgo = IMP4VENC_ME_MQ_MP svhMode = 1	MPEG4_ENC_06 (SVH: Low Quality High Performance)
<b>Common Parameters for all Configuration:</b> rateControlPreset=XDM_DEFAULT, frameRate=30000, numMbRows=0, initQ=0, rcQMax=31, rcQMin=1, intraperiod=30, intraAlgo= IMP4VENC_INTRA_INTER_DECISION_LQ_HP(0), skipMBAalgo = IMP4VENC_SKIP_MB_LQ_HP(0), unrestrictedMV = 0(OFF), rotation=0, VBV_Size=0	

**Note:** Codec needs to run in extended parameter mode for SVH mode.

### Performance Measurement Procedure

- Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @297 MHz, MJCP @243 MHz, DDR @243 MHz, Monta Vista Linux 5.0
- DVTB 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.
- 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 ensure file read is successfully completed before the process call.
- After rebooting the board, codec binary must be executed at least once before start of performance measurement.

**Note:** Frame encode load can be divided in ARM load and MJCP load. ARM is idle during MJCP processing, and can be utilized to execute any other program in a different thread during this time.

**Table 2. Cycles Information for MPEG4\_ENC\_01**

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)</sup>					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
BUS	CIF (352x288) @512kbps	0.42	1.53	194.26	0.75	1.90	155.54

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

**Table 2. Cycles Information for MPEG4\_ENC\_01 (continued)**

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)</sup>					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Coastguard	VGA (640x480) @3mbps	0.47	3.71	79.94	1.00	4.29	69.10
Football	D1 (720x480) @4mbps	0.43	4.20	70.75	1.12	4.93	60.14
Stockholm	720p (1280x720) @8mbps	0.44	10.05	29.53	1.04	10.89	27.26
Pedestrian	SXVGA (1280x960) @10mbps	0.40	13.21	22.47	1.02	13.86	21.43
Alexander	1080p (1920x1080) @16mbps	0.48	23.55	12.61	0.73	23.87	12.44

**Table 3. Cycles Information for MPEG4\_ENC\_02**

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)</sup>					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
BUS	CIF (352x288) @512kbps	0.43	1.12	264.42	0.65	1.51	196.42
Coastguard	VGA (640x480) @3mbps	0.47	2.44	121.94	0.76	2.77	106.92
Football	D1 (720x480) @4mbps	0.46	2.67	111.10	0.71	3.12	95.22
Stockholm	720p (1280x720) @8mbps	0.47	6.28	47.31	0.76	6.73	44.13
Pedestrian	SXVGA (1280x960) @10mbps	0.40	8.12	36.58	0.68	8.45	35.15
Alexander	1080p (1920x1080) @16mbps	0.39	13.76	21.59	0.65	14.50	20.50

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

**Table 4. Cycles Information for MPEG4\_ENC\_03**

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)</sup>					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
BUS	CIF (352x288) @512kbps	0.39	1.47	202.15	0.77	1.89	157.32
Coastguard	VGA (640x480) @3mbps	0.39	3.56	83.45	0.98	4.31	68.89
Football	D1 (720x480) @4mbps	0.37	4.22	70.42	1.09	4.98	59.63
Stockholm	720p (1280x720) @8mbps	0.35	9.77	30.39	0.72	10.32	28.79
Pedestrian	SXVGA (1280x960) @10mbps	0.39	12.95	22.93	0.72	13.34	22.27
Alexander	1080p (1920x1080) @16mbps	0.36	23.00	12.91	0.37	23.15	12.83

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

**Table 5. Cycles Information for MPEG4\_ENC\_04**

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)</sup>					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
BUS	CIF (352x288) @512kbps	0.42	1.12	264.73	0.68	1.60	185.81
Coastguard	VGA (640x480) @3mbps	0.45	2.30	129.01	0.52	2.72	109.02
Football	D1 (720x480) @4mbps	0.38	2.60	113.97	0.82	3.26	90.94
Stockholm	720p (1280x720) @8mbps	0.39	6.22	47.77	0.97	7.09	41.86
Pedestrian	SXVGA (1280x960) @10mbps	0.37	6.19	47.96	0.86	6.92	42.91
Alexander	1080p (1920x1080) @16mbps	0.39	13.64	21.77	0.51	13.94	21.30

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

**Table 6. Cycles Information for MPEG4\_ENC\_05**

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)</sup>					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Foreman	CIF (352x288) @512kbps	0.42	1.11	267.41	0.86	1.99	149.13
ICE	4CIF (704x576) @4mbps	0.45	4.60	64.46	1.32	5.51	53.83

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

**Table 7. Cycles Information for MPEG4\_ENC\_06**

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)</sup>					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Foreman	CIF (352x288) @512kbps	0.40	1.10	269.71	0.95	1.68	176.73
ICE	4CIF (704x576) @4mbps	0.46	3.04	97.50	0.91	3.53	84.04

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

**Note:**

- The values in Table 2, 3, 4, 5, 6, and 7 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.
- Encode frame time is the time seen from ARM926 only. Since most of the processing happens at MJCP, the active load on ARM926 is the value mentioned in ARM926 column. Encode frame time has no connection with MJCP running at 243 MHz.
- All values are collected (both average and peak) at frame-level processing.
- They are measured with Linux without any system traffic.

**Table 8. PSNR and Bit-Rate Details (Configuration MPEG4\_ENC\_01)**

TEST SEQUENCE	BIT-RATE / AVERAGE LUMA PSNR (in dB)		
	LOW BIT RATE	MID BIT RATE	HIGH BIT RATE
Foreman CIF (352x288) @30fps VBR	<b>384 kbps</b>	<b>768 kbps</b>	<b>1 mbps</b>
	31.87	34.70	35.77
Football D1 (720x480) @30fps VBR	<b>2 mbps</b>	<b>4 mbps</b>	<b>6 mbps</b>
	33.10	36.03	37.94

**Table 9. Memory Statistics**

RESOLUTION	MEMORY STATISTICS (IN BYTES)					
	PROGRAM MEMORY	DATA MEMORY				TOTAL
		CONSTANT	INTERNAL	EXTERNAL	STACK	
1080p(1920x1080)	250592	374	0	7055016	8192	7314174
SXVGA (1280x960)	250592	374	0	4296360	8192	4555518
720P (1280x720)	250592	374	0	3319080	8192	3578238
D1 (720x480)	250592	374	0	1416120	8192	1675278
VGA (640x480)	250592	374	0	1283880	8192	1543038
CIF (352x288)	250592	374	0	566088	8192	825246

**Table 10. Usage of External Memory (split-up) through CMEM**

BUFFER	SIZE (IN BYTES)	
Input Buffer	422ILE: (frameSize*2) <sup>(1)</sup> (2) , 420SP: (frameSize*1.5)	
Output Buffer <sup>(2)</sup>	(frameSize*1.5)	
External Data Memory	memTab[0]	14500
	memTab[1]	512
	memTab[2]	(3*frameSize_padded <sup>(3)</sup> ) + 24576
	memTab[3]	Max(Width,Height)*6
	memTab[4]	4
	memTab[5]	81920
	memTab[6]	(frameSize/32)

(1) frameSize = (maxWidth \* maxHeight).

(2) Output Buffer size is the theoretical maximum based on 420 format and 1:1 compression ratio. Actual output buffer size requirement will be lower than this.

(3) frameSize\_padded = ((maxWidth + 64)\*(maxHeight+64))

## Notes

- The entire MJCP is a video resource and is used by the codec.
- DMA configuration

**Table 11. DMA Configuration**

TC Q's	TC 0	TC 1	TC 2	TC 3	TOTAL
Usage	Reserved for system	Used by codec	Not used by codec	Not used by codec	
Priority	0	Not touched by codec (Default – 7)			
EDMA Channels	0	28	0	0	28/64
PaRAM Entries	0	66	0	0	66/256
QDMA Channels	0	0	0	0	0/8

- The MJCP/EDMA resources are acquired using a generic resource manager known as Framework Component. See *MPEG4 Simple Profile Encoder 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 14496-2:2004, Information technology -- Coding of audio-visual objects -- Part 2: Visual (Approved in 2004-05-24)
- *MPEG4 Simple Profile Encoder on DM365 User's Guide* (literature number: SPRUEV1C)

## 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
CBR	Constant Bit Rate
CIF	Common Intermediate Format
CVBR	Constrained Variable Bit Rate
DP	Data Partitioning
EVM	Evaluation Module
HPI	Half Pel Interpolation
MJCP	MPEG4 JPEG Co-Processor
MV	Motion Vector
NV12	YUV 420 format with Y plane and CbCr plane
QP	Quantization Parameter
QCIF	Quarter Common Intermediate Format
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

ACRONYM	DESCRIPTION
VBR	Variable Bit Rate
VGA	Video Graphics Array
VUI	Video Usability Information
XDM	eXpressDSP Digital Media

## Revision History

This datasheet revision history highlights the changes made to SPRS545B codec specific datasheet to make it SPRS545C.

**Table 12. Revision History for MPEG4 Simple Profile Encoder (v01.10.00) on DM365**

SECTION	ADDITION/MODIFICATION/DELETION
Global	<p style="text-align: center;"><b>NOTE:</b></p> <p style="text-align: center;">There are no changes in data sheet for this release</p>

## 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:

<b>Products</b>		<b>Applications</b>	
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>	Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>	Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>	Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Energy	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>	Space, Avionics & Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>	Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless-apps">www.ti.com/wireless-apps</a>