



Sequential JPEG Encoder (v1.12.000) on DM355

FEATURES

- eXpressDSP™ algorithm interface standard (xDAIS) compliant
- eXpressDSP™ digital media (xDM) interface compliant
- IDMA3 compliant
- Implements IIMGENC1 interface of xDM
- Supports baseline sequential process with the following limitations:
 - Cannot support non-interleaved scans
 - Only supports 3 components
 - Huffman tables and quantization tables for U and V components must be the same
- Supports YUV 422 interleaved input format
- Supports YUV422 and YUV420 planar input
- Supports YUV422 and YUV420 encoded format
- Supports ring buffer configuration of bitstream buffer for reducing buffer size requirement
- Quantization tables are fixed with a quality factor (1-97) adjusting the quantization level
- Supports rotation of 90, 180 and 270 degrees
- Supports frame-based encoding
- Supports slice mode encoding
- Images with resolutions up to 1000 Mpixels can be decoded. This is the theoretical maximum; however, only images up to 10 Mpixels have been tested).
- Supports frame level reentrancy
- Supports multi instance of JPEG Encoder and single/multi instance of JPEG Encoder with other DM355 codecs
- Includes a standard JPEG header. Does not include a JFIF or EXIF style header. The application is expected to insert the APP0 (JFIF) or APP1 (EXIF) markers to create a JFIF or EXIF style header.
- 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.
 - Extended DCT-based process
 - Lossless process
 - Hierarchical process
 - Progressive scan
 - Minimum image width/height requirement of 64 pixels
 - Huffman tables are fixed by the algorithm
 - Ring buffer size should be multiple of 4096 bytes
 - IDMA3 interface support is limited. The JPEG encoder uses the following hardcoded TCCs for its DMA resource requirements along with its associated PaRAMSets.
 - Channel numbers 34 to 49 and corresponding paRAMSet number i.e., 34 to 49
 - Only 23 additional PaRAMSets are passed to the codec through the IDMA3 interface.

DESCRIPTION

The JPEG Encoder accepts planar image data in YUV4:2:0, YUV4:2:2 and interleaved data in YUV4:2:2 format. Encoded output is YUV4:2:0 or YUV4:2:2 format. It is validated on the DM355 EVM with MontaVista Linux 4.0.1.

PRODUCT PREVIEW


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Product Support

When contacting TI for support on this codec, please quote the product name (JPEG Encoder 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 (MontaVista Linux 4.0.1) platform and measuring the resource usage during this process.

Performance Summary

This section describes the performance of the Sequential JPEG Encoder (v1.12.000) on DM355.

Table 1. Configuration Table

CONFIGURATION	ID
Sequential JPEG Encoder, I/D Cache Enabled, Input Format: YUV422ILE, Output Format: YUV420P, Rotation OFF, Slice Mode OFF.	JPEG_ENC_001 (Resolution Grouping)
Sequential JPEG Encoder, I/D Cache Enabled Input Format: YUV422ILE Output Format: YUV422P Rotation OFF, Slice Mode OFF.	JPEG_ENC_002 (Resolution Grouping)
Sequential JPEG Encoder, I/D Cache Enabled, Input Format: YUV422ILE, Output Format: YUV422ILE, Rotation OFF, Slice Mode ON	JPEG_ENC_003 (Slice Mode ON)

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 data sheet.
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 0.35 ms is 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. 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 JPEG_ENC_001 – Profiled on DM355 EVM (ARM=216 MHz, DDR=171 MHz, MontaVista Linux 4.0.1)

Input name	Resolution	Q Value	Compression Ratio	Total Process Time ⁽¹⁾	Time Across MJCP (ms)	ARM Load (ms) ⁽²⁾	Total Process Load ⁽³⁾	MJCP Load (Mcycles)	ARM Load (Mcycles)	Process Time (Single Instance) ⁽⁴⁾
fruitbasket-cif-422.uvuv	CIF (352 x 288)	97	2.05	2.529	1.184	0.467	0.546	0.256	0.101	1.651
		73	5.01	2.520	1.170	0.479	0.544	0.253	0.103	1.649
		30	9.98	2.544	1.174	0.474	0.550	0.254	0.102	1.648

(1) Total Process Time (Process + activate + deactivate) (ms/frame) in MJPEG scenario. The first frame will have an additional overhead of ~1.1 ms.
 (2) ARM load is only for a process call. It does not include activate + deactivate time.
 (3) Total Process Load in Mcycles/frame (Process + activate + deactivate).
 (4) Process Time (without activate/ deactivate) (ms/frame).

PRODUCT PREVIEW

Table 2. Cycles Information for JPEG_ENC_001 – Profiled on DM355 EVM (ARM=216 MHz, DDR=171 MHz, MontaVista Linux 4.0.1) (continued)

Input name	Resolution	Q Value	Compression Ratio	Total Process Time ⁽¹⁾	Time Across MJCP (ms)	ARM Load (ms) ⁽²⁾	Total Process Load ⁽³⁾	MJCP Load (Mcycles)	ARM Load (Mcycles)	Process Time (Single Instance) ⁽⁴⁾
test_2.uvuv	VGA (640 x 480)	97	2.83	4.642	3.279	0.371	1.003	0.708	0.080	3.650
		88	5.14	4.630	3.193	0.569	1.000	0.690	0.123	3.762
		62	10.14	4.572	3.208	0.469	0.988	0.693	0.101	3.677
Sherk_720x480.uvuv	D1 (720 x 480)	95	4.41	5.022	3.597	0.510	1.085	0.777	0.110	4.107
		79	8.75	4.914	3.562	0.461	1.061	0.769	0.100	4.023
		77	10.05	4.564	3.212	0.460	0.986	0.694	0.099	3.672
720 pshields	720p (1280 x 720)	97	8.51	12.262	10.867	0.484	2.649	2.347	0.105	11.351
		76	12.00	11.579	10.122	0.552	2.501	2.186	0.119	10.674
		63	16.56	11.212	9.805	0.530	2.422	2.118	0.114	10.335
mire_YUV422_sxvga	SXVGA (1280 x 960)	97	2.74	14.504	13.112	0.486	3.133	2.832	0.105	13.598
		83	6.28	14.301	12.997	0.448	3.089	2.807	0.097	13.445
		43	10.01	14.317	12.988	0.451	3.092	2.805	0.097	13.439

Table 3. Cycles Information for JPEG_ENC_002 – Profiled on DM355 EVM (ARM=216 MHz, DDR=171 MHz, MontaVista Linux 4.0.1)

Input name	Resolution	Q Value	Compression Ratio	Total Process Time ⁽¹⁾	Time Across MJCP (ms)	ARM Load (ms) ⁽²⁾	Total Process Load ⁽³⁾	MJCP Load (Mcycles)	ARM Load (Mcycles)	Process Time (Single Instance) ⁽⁴⁾
fruitbasket-cif-422.uvuv	CIF (352 x 288)	97	2.61	3.796	2.385	0.487	0.820	0.515	0.105	2.872
		87	4.17	3.729	2.373	0.497	0.805	0.513	0.107	2.870
		60	8.16	3.792	2.395	0.474	0.819	0.517	0.102	2.869
test_2.uvuv	VGA (640 x 480)	97	3.33	7.937	6.621	0.455	1.714	1.430	0.098	7.076
		91	5.23	8.060	6.597	0.464	1.741	1.425	0.100	7.061
		80	8.35	8.052	6.597	0.523	1.739	1.425	0.113	7.120
Sherk_720x480.uvuv	D1 (720 x 480)	97	5.11	8.689	7.343	0.498	1.877	1.586	0.108	7.841
		85	8.06	8.661	7.343	0.460	1.871	1.586	0.099	7.803
		77	12.44	8.691	7.337	0.461	1.877	1.585	0.100	7.798
720pshields	720p (1280 x 720)	97	9.76	20.353	19.050	0.454	4.396	4.115	0.098	19.504
		88	12.76	20.263	18.938	0.458	4.377	4.091	0.099	19.396
		78	16.54	20.125	18.802	0.465	4.347	4.061	0.100	19.267
mire_YUV422_sxvga	SXVGA (1280 x 960)	97	3.27	26.328	25.035	0.447	5.687	5.408	0.097	25.482
		91	5.23	26.310	25.003	0.456	5.683	5.401	0.098	25.459
		73	10.06	26.378	25.008	0.455	5.698	5.402	0.098	25.463

- (1) Total Process Time (Process + activate + deactivate) (ms/frame) in MJPEG scenario. The first frame will have an additional overhead of ~1.28 ms.
- (2) ARM load is only for a process call. It does not include activate + deactivate time.
- (3) Total Process Load in Mcycles/frame (Process + activate + deactivate).
- (4) Process Time (without activate/ deactivate) (ms/frame).

Table 4. Cycles Information for JPEG_ENC_003 – Profiled on DM355 EVM (ARM=216 MHz, DDR=171 MHz, MV4.0 Kernel 2.6.10)

Input name	Resolution	Q Value	Compression Ratio	Total Process Time ⁽¹⁾	Process Time ⁽²⁾
352x288_fruitbasket-cif-422.uvuv	CIF (352 x 288)	92	2.84	3.112	2.140
		90	4.61	3.111	2.207
		74	8	3.079	2.173

- (1) Total Process Time (Process + activate + deactivate) (ms/frame) in MJPEG scenario. The first frame will have additional overhead of ~1.28 ms.
- (2) Process Time (without activate/ deactivate) (ms/frame).

Table 4. Cycles Information for JPEG_ENC_003 – Profiled on DM355 EVM (ARM=216 MHz, DDR=171 MHz, MV4.0 Kernel 2.6.10) (continued)

Input name	Resolution	Q Value	Compression Ratio	Total Process Time ⁽¹⁾	Process Time ⁽²⁾
test_2.uvuv	VGA (640 x 480)	97	4.14	4.396	3.512
		80	7.9	4.381	3.471

Table 5. Codec Memory Statistics Generated with Code Generation Tools v 6.0.3

Resolution	MEMORY STATISTICS ⁽¹⁾				TOTAL
	PROGRAM MEMORY	DATA MEMORY			
		INTERNAL	EXTERNAL	STACK	
SXVGA (1280 x 960)	61.36	0	56.34	2	119.70
720P (1280 x 720)	61.36	0	56.34	2	119.70
D1 (720 x 480)	61.36	0	56.34	2	119.70
VGA (640 x 480)	61.36	0	56.34	2	119.70
CIF (352 x 288)	61.36	0	56.34	2	119.70

(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 6. Codec Usage of External Memory via CMEM

Buffer		Buffer Size	
Input Buffer ⁽¹⁾		YUV 422ILE	Buffer1: FrameSize*2 ⁽²⁾
		YUV 422P	Buffer1: FrameSize Buffer2: FrameSize/2 Buffer3: FrameSize/2
		YUV 420P	Buffer1: FrameSize Buffer2: FrameSize/4 Buffer3: FrameSize/4
Output Buffer		(FrameSize)*4	
External Memory	memTab[0]	3072 Bytes	
	memTab[1]	3072 Bytes	
	memTab[2]	41984 Bytes	
	memTab[3]	1656 Bytes	
	memTab[4]	4096 Bytes	
	memTab[5]	2408 Bytes	
	memTab[6]	100 Bytes	

(1) Output buffer size is theoretical value based on encoding resulting into expansion. Actual size will be lower than this.

(2) FrameSize = (maxWidth * maxHeight).

Table 7. DDR Bandwidth Usage for Worst Case

Resolution	Number of MBs per Frame	DDR Bandwidth for One Frame (in KB)
CIF (352 x 288)	396	198
VGA (640 x 480)	1200	600
D1 (720 x 480)	1350	675
720p (1280 x 720)	3600	1800
SXVGA (1280 x 960)	4800	2400

References

- ISO/IEC 10918-1: *Digital compression and coding of continuous-tone still images (JPEG)*

Glossary

Term	Description
Constants	Elements that go into .const memory section

Term	Description
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
CIF	Common Intermediate Format
DCT	Discrete Cosine Transform
DMA	Direct Memory Access
DMAN3	DMA Resource Manager
EVM	Evaluation Module
IDMA3	DMA Resource specification and negotiation protocol
JPEG	Joint Photographic Experts Group
MCU	Minimum Coded Unit
XDAIS	eXpressDSP Algorithm Interface Standard
XDM	eXpressDSP Digital Media
YUV	Raw Image format Y: Luminance component U, V : Chrominance components
Exif	Exchangeable image file format
JFIF	JPEG File Interchange Format
MJCP	MPEG4-JPEG co-processor

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