Sequential JPEG Encoder (v01.00.00) on DM365

FEATURES

- eXpressDSP™ Digital Media (XDM 1.0 IIMGDEC1) interface and IRES interface compliant
- Validated on DM365 EVM using Monta Vista® Linux® 5.0
- JPEG baseline DCT encoding process supported with following limitations:
  - Non-interleaved scans are not supported
  - Huffman tables and quantization tables for U and V components must be the same
  - No support for user defined Huffman tables. Default Huffman tables are used
  - No support for number of components other than 3
- YUV 4:2:0/4:2:2 planar and YUV 4:2:2 interleaved data as input supported
- YUV 4:2:0 semi-planar (NV12 format that is, Y planar, Cb Cr interleaved) data as input supported
- YUV4:2:2 and YUV4:2:0 encoded format supported
- Arbitrary image width and height (minimum width and height requirement of 97 and 16 pixels, respectively) supported
- Insertion of Application Maker and Comment Marker by test application supported
- Images with resolutions up to (Horizontal MCU size * 1024)*(Vertical MCU size * 1024) pixels can be encoded. This is the theoretical maximum; however, only images up to 10 Mpixels have been tested. If the codec memory and I/O buffer requirements exceed the DDR memory availability for frame based encoding, use ring buffer and slice mode encoding to encode higher resolution images.
- Restart interval supported
- Quantization tables are fixed with a quality factor (2 – 97) adjusting the quantization level
- Ring buffer configuration of bit-stream buffer for reducing buffer size requirement supported
- Rotation by 90, 180, and 270 degree supported
- Frame based encoding supported
- Slice mode encoding supported
- Frame level reentrancy supported
- Multi-instance of JPEG Encoder, and single/multi instance of JPEG Encoder with other DM365 codecs supported
- Minimum image width and height requirement is 97 and 16 pixels, respectively
- Huffman tables are fixed by the algorithm
- Ring buffer size should be multiple of 4096 Bytes
- This encoder does not support the following:
  - Extended DCT based encoding process
  - Loss-less encoding process
  - Hierarchical encoding process
  - Progressive scan
  - No support for number of components other than 3

DESCRIPTION

The JPEG Encoder accepts YUV 4:2:0/4:2:2 planar, YUV 420 semi-planar and YUV 4:2:2 interleaved data as input. Encoded output is YUV 4:2:0 or YUV 4:2:2 format. It is validated on DM365 EVM with Monta Vista Linux 5.0.

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Performance Summary

This section describes the performance of the JPEG Encoder on DM365 EVM.

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
Sequential JPEG Encoder, I/D Cache Enabled Input Format: YUV422ILE Output Format: YUV422P Rotation OFF Slice Mode OFF	JPEG_ENC_002
Sequential JPEG Encoder, I/D Cache Enabled Input Format: YUV420SP Output Format: YUV420P Rotation OFF Slice Mode OFF	JPEG_ENC_003
Sequential JPEG Encoder, I/D Cache Enabled Input Format: YUV420SP Output Format: YUV422P Rotation OFF Slice Mode OFF	JPEG_ENC_004
Sequential JPEG Encoder, I/D Cache Enabled Input Format: YUV422ILE Output Format: YUV420P Rotation ON Slice Mode OFF	JPEG_ENC_005
Sequential JPEG Encoder, I/D Cache Enabled Input Format: YUV422ILE Output Format: YUV422P Rotation ON Slice Mode OFF	JPEG_ENC_006

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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 that file read is successfully completed before process call.
- After rebooting the board, codec binary must be executed at least once before starting 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 different thread during this time.

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Table 2. Cycles Information for JPEG_ENC_001

INPUT NAME	RESOLUTION	Q VALUE	COMPRESSION RATIO	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Fruitbasket.uyuv	CIF (352x288)	97	2.05	0.57	0.91	326.69
		30	9.98	0.56	0.89	332.45
forman.uyuv	VGA (640x480)	97	2.83	0.57	1.47	202.55
		62	10.14	0.56	1.45	204.54
Sherk_720x480.uyuv	D1 (720x480)	95	4.41	0.56	1.55	191.61
		77	10.05	0.58	1.57	189.54
720pshields.uyuv	720p (1280x720)	97	8.51	0.57	3.10	95.68
		63	16.56	0.58	3.11	95.45

Table 3. Cycles Information for JPEG_ENC_002

INPUT NAME	RESOLUTION	Q VALUE	COMPRESSION RATIO	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Fruitbasket.uyuv	CIF (352x288)	97	2.61	0.56	1.21	245.16
		60	8.16	0.58	1.23	241.72
forman.uyuv	VGA (640x480)	97	3.33	0.56	2.36	126.07
		80	8.35	0.56	2.35	126.47
Sherk_720x480.uyuv	D1 (720x480)	97	5.11	0.58	2.56	115.79
		77	12.44	0.56	2.55	116.58
720pshields.uyuv	720p (1280x720)	97	9.76	0.57	5.68	52.33
		78	16.54	0.56	5.67	52.41

Table 4. Cycles Information for JPEG_ENC_003

INPUT NAME	RESOLUTION	Q VALUE	COMPRESSION RATIO	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Fruitbasket_sp.uyuv	CIF (352x288)	97	2.05	0.74	1.20	247.10
		30	9.98	0.74	1.20	247.04
Hall_monitor_sp.uyuv	VGA (640x480)	97	2.83	0.74	2.06	144.28
		62	10.14	0.74	2.06	144.45
Sherk_720x480_sp.uyuv	D1 (720x480)	95	4.41	0.74	2.23	133.48
		77	10.05	0.77	2.25	132.08
720pshields_sp.uyuv	720p (1280x720)	97	8.51	0.75	4.61	64.47
		63	16.56	0.77	4.62	64.30

Table 5. Cycles Information for JPEG_ENC_004

INPUT NAME	RESOLUTION	Q VALUE	COMPRESSION RATIO	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Fruitbasket_sp.uyuv	CIF (352x288)	97	2.61	0.76	1.62	182.95
		60	8.16	0.78	1.64	181.59
Hall_monitor_sp.uyuv	VGA (640x480)	97	3.33	0.76	3.21	92.64
		80	8.35	0.78	3.19	93.25
Sherk_720x480_sp.uyuv	D1 (720x480)	97	5.11	0.75	3.47	85.52
		77	12.44	0.77	3.48	85.41
720pshields_sp.uyuv	720p (1280x720)	97	9.76	0.81	7.91	37.54
		78	16.54	0.79	7.90	37.58

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Table 6. Cycles Information for JPEG_ENC_005

INPUT NAME	RESOLUTION	Q VALUE	ROTATION	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Fruitbasket.uyuv	CIF (352x288)	87	90	0.72	1.39	212.99
			180	0.71	1.38	214.92
			270	0.71	1.38	215.10
Forman_422ILE.uyuv	VGA (640x480)	91	90	0.74	2.70	109.99
			180	0.69	2.65	112.13
			270	0.76	2.72	109.09

Table 7. Cycles Information for JPEG_ENC_006

INPUT NAME	RESOLUTION	Q VALUE	ROTATION	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Fruitbasket.uyuv	CIF (352x288)	73	90	0.70	1.72	172.18
			180	0.77	1.74	170.59
			270	0.72	1.74	170.24
Forman_422ILE.uyuv	VGA (640x480)	88	90	0.70	3.64	81.52
			180	0.74	3.59	82.82
			270	0.71	3.64	81.49

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. Decode 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. Memory Statistics

RESOLUTION	MEMORY STATISTICS (IN BYTES)					
	PROGRAM MEMORY	DATA MEMORY				TOTAL
		CONSTANT	INTERNAL	EXTERNAL	STACK	
SXVGA (1280x960)	68058	3228	0	59664	8192	130950
720P (1280x720)	68058	3228	0	59664	8192	130950
D1 (720x480)	68058	3228	0	59664	8192	130950
VGA (640x480)	68058	3228	0	59664	8192	130950
CIF (352x288)	68058	3228	0	59664	8192	130950

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Table 9. Codec Usage of External Memory through CMEM

BUFFER	BUFFER SIZE	
Input Buffer	YUV_422_ILE	Buffer1: frameSize(1)*2
	YUV_422_P	Buffer1: frameSize Buffer2: frameSize/2 Buffer3: frameSize/2
	YUV_420_P	Buffer1: frameSize Buffer2: frameSize/4 Buffer3: frameSize/4
	YUV_420_SP	Buffer1: frameSize Buffer2: frameSize/2
Output Buffer(2)	YUV_420_P	frameSize(1)*1.5
	YUV_422_P	frameSize*2
External Data Memory	memTab[0]	3908 Bytes
	memTab[1]	3072 Bytes
	memTab[2]	50176 Bytes
	memTab[3]	2408 Bytes
	memTab[4]	100 Bytes

(1) frameSize = (Width * Height).
(2) Output buffer size is theoretical value based on encoding resulting into expansion. Actual size will be lower than this.

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Notes

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

Table 10. 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	17	0	0	17/64
PaRAM Entries	0	40	0	0	40/256
QDMA channels	0	0	0	0	0/8

- The MJCP/EDMA resources are acquired using a generic resource manager known as Framework component. See *Sequential JPEG 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.

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References

- ISO/IEC 10918-1 Digital compression and coding of continuous-tone still images (JPEG)
- *Sequential JPEG Encoder on DM365 User's Guide* (literature number: SPRUEV4)

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	Compression ratio of N:1 means 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
Exif	Exchangeable image file format
IDMA3	DMA Resource specification and negotiation protocol
JFIF	JPEG File Interchange Format
JPEG	Joint Photographic Experts Group
MCU	Minimum Coded Unit
MJCP	MPEG4 JPEG co-processor
NV12	YUV 420 format with Y plane and CbCr plane
XDM	eXpressDSP Digital Media
YUV	Raw Image format, Y: Luminance Component U,V : Chrominance components

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