

## MJPEG Encoder (v01.00.04) on HDVICP2 and Media Controller Based Platform

### FEATURES

- Supports baseline sequential mode for interleaved data formats (single scan)
- Supports YUV 444 Planar, YUV 422 IBE (YUYV), YUV 420 Semi-Planar and Grayscale chroma sub-sampling formats as input
- Supports all resolutions ranging from 32x32 to 4320x4096
- Supports sub-frame data synchronization for input and output buffers
- Supports selection of quality level by user
- Supports user-defined quantization tables
- Supports 8-bit and 16-bit quantization tables
- Supports insertion of restart marker
- Supports insertion of JPEG File Interchange Format (JFIF) marker segment
- Supports insertion of comment marker segment
- Supports insertion of Exif marker segment
- Supports insertion of thumbnail in JFIF or Exif marker segment
- Graceful exit under error conditions is supported
- Does not support Arithmetic encoding
- Does not support non-interleaved YCbCr output (multiple scans)
- Does not support encoding inputs with 12-bits per sample
- Does not support encoding of thumbnails. This encoder supports only insertion of encoded thumbnail data provided by the application.
- The other explicit features that TI's MJPEG Encoder supports are
  - eXpressDSP Digital Media (XDM IVIDENC2) interface compliant
  - Supports multi-channel functionality
  - Supports booting of HDVICP2
  - Implements different power optimization schemes
  - Independent of any operating system
  - Ability to get plugged in any multimedia frameworks (eg. Codec Engine, OpenMax, GStreamer, etc)

### DESCRIPTION

JPEG is an international standard for color image compression. This standard is defined in the ISO10918-1 JPEG Draft International Standard | CCITT Recommendation T .81. JPEG supports baseline sequential mode with both interleaved and non-interleaved input format and progressive mode. MJPEG (Motion JPEG) is JPEG used in video mode (for continuous image encoding/decoding in JPEG format).

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## Performance and Memory Summary

This section describes the performance and memory usage of MJPEG Encoder.

**Table 1 Configuration Table**

CONFIGURATION	ID
Baseline Sequential Encoder (4:2:0 Semi Planar input and 4:2:0 interleaved output) with quality factor = 50	MJPEG_ENC_001
Baseline Sequential Encoder (4:4:4 Planar input and 4:4:4 interleaved output) with quality factor = 50	MJPEG_ENC_002

**Table 2 Cycles Information - Profiled on DM816x REV-A2 EVM with Code Generation Tools Version 4.5.1**

CONFIGURATION ID	HDVICP2 PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) <sup>(1)</sup>		
	TEST DESCRIPTION <sup>(2)</sup>	AVERAGE <sup>(3)</sup>	PEAK <sup>(4)</sup>
MJPEG_ENC_001	Motion1_640x360_420SP,Baseline Sequential	13.85	15.26
	Motion1_640x480_420SP,Baseline Sequential	17.94	19.24
	Office_720x480_420SP.xls, Baseline Sequential	18.58	19.04
	Lamborghini_p1280x720_fps_420SP, Baseline Sequential	43.38	44.39
	Tractor_1920x1080_420SP, Baseline Sequential	98.23	100.61
MJPEG_ENC_002	Motion1_640x360_444P, Baseline Sequential	29.22	30.67
	Motion1_640x480_444P, Baseline Sequential	37.2	38.53
	Office_720x480_444P, Baseline Sequential	41.09	42.83
	Lamborghini_1280x720_444P, Baseline Sequential	102.99	103.81
	Tractor_1920x1080_444P, Baseline Sequential	228.72	230.42

- (1) Measured on DM816x REV-A2 EVM having Cortex-A8 @ 1GHz, HDVICP2 @ 533MHz, Media Controller @ 250 MHz, L3 interconnect @ 500 MHz and DDR2 @ 400 MHz and there could be a variation of around 1-2% in the numbers.
- a) Media Controller code is placed in cacheable memory region in DDR.
- b) No latency from system at process call and processing unit as frame (no sub-frame level communication) is assumed.
- c) All Luma 2D Video buffers of codec being in TILED\_8 Bit Memory and all Chroma 2D Video buffers of codec being in TILED\_16 Bit Memory
- (2) Streams have been compressed with Quantization Tables and Huffman Tables suggested in the JPEG Standard document.
- (3) Average is computed based on worst case cycles having 2 extra input frame buffer. Average is calculated @ 30fps
- (4) Peak is based on worst case cycles having no extra input frame buffer. It is computed based on peak among 30 frames @30fps.

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**Table 3 Memory Statistics of Media Controller - Generated with Code Generation Tools Version 4.5.1**

CONFIGURATION ID	RESOLUTION	MEMORY STATISTICS <sup>(1)</sup>							TOTAL
		PROGRAM MEMORY	DATA MEMORY						
			INTERNAL	EXTERNAL <sup>(2)</sup>				STACK	
				PERSISTENT <sup>(3)</sup>			CONST		
				TILED8 (numBufs x Width x Height)	TILED16 (numBufs x Width x Height)	TILED PAGE / RAW	RAW		
MJPEG_ENC_001 MJPEG_ENC_002	All	8.8	0	0	0	1.8	144.5	2	157.1

- (1) All memory requirements are expressed in kilobytes (1 K-byte = 1024 bytes) and there might be rounding to next integer K-byte. Stack can be kept in internal/external memory, negligible performance impact can be observed in Media Controller cycles if it is placed in external memory.
- (2) Codec's request of memory container can be over-riden by application, adhering to the below rules
- TILED PAGE can be overridden by RAW
  - TILED8, TILED16 can be overridden by TILED PAGE, RAW
  - TILED16 can be overridden by TILED8, RAW, TILED PAGE
- However, in case of overriding of 2B and 2C, there can be some performance impact.
- (3) Persistent memory is instance specific and does not include I/O buffers.

**Table 4 Split-up of Media Controller Internal Data Memory Statistics**

CONFIGURATION ID	DATA MEMORY - INTERNAL <sup>(1)</sup>		
	SHARED		INSTANCE
	CONSTANTS	SCRATCH	
MJPEG_ENC_001 / MJPEG_ENC_002	0	0	0

- (1) Internal memory refers to on chip memory. If the system doesn't have enough internal memory, then external memory can also be used. Memory requirements are expressed in kilobytes.

## Notes

- I/O buffers:
  - Input buffer size = 6120 KB (for 1920x1088, YUV444 image)
  - Output buffer size = 4080 KB (considering worst case for 1920x1088, YUV444 image)
- None of the buffers at input and output level is accessed by Media Controller processor hence the data should be valid in DDR (not in cache)
- Total data memory for N non pre-emptive instances = Constants + Runtime Tables + Scratch + N \* (Instance + I/O buffers + Stack)
- Total data memory for N pre-emptive instances = Constants + Runtime Tables + N \* (Instance + I/O buffers + Stack + Scratch)
- MAIL BOX FIFO #0 and #1 are used and user numbering for Media Controller as 2 and for HDVICP2 as 3 is assumed
- It is assumed that RTS library from ARM is available in system because few symbols like memcpy are used in codec
- All constants and Input/Output Buffers to encoder are assumed to be in VDMA addressable space in DDR

## References

- ITU-CCITT recommendation T.81 (reproduction of ISO/IEC 10918-1)
- eXpressDSP Algorithm Interoperability Standard (TMS320 Algorithm Interface Standard)
- MJPEG Encoder on HDVICP2 and Media Controller Based Platform User's Guide

## 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
CCITT	Committee Consultative International Telephone and Telegraph
DCT	Discrete Cosine Transform
DRI	Define Restart Interval Marker
DSP	Digital Signal Processing
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JFIF	JPEG File Interchange Format
JPEG	Joint Photographic Experts Group
MJPEG	Motion JPEG
RST	Restart Marker
XDM	eXpressDSP Digital Media

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