

## 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<br>Input Format: YUV422ILE<br>Output Format: YUV420P<br>Rotation OFF<br>Slice Mode OFF | JPEG_ENC_001 |
| Sequential JPEG Encoder, I/D Cache Enabled<br>Input Format: YUV422ILE<br>Output Format: YUV422P<br>Rotation OFF<br>Slice Mode OFF | JPEG_ENC_002 |
| Sequential JPEG Encoder, I/D Cache Enabled<br>Input Format: YUV420SP<br>Output Format: YUV420P<br>Rotation OFF<br>Slice Mode OFF  | JPEG_ENC_003 |
| Sequential JPEG Encoder, I/D Cache Enabled<br>Input Format: YUV420SP<br>Output Format: YUV422P<br>Rotation OFF<br>Slice Mode OFF  | JPEG_ENC_004 |
| Sequential JPEG Encoder, I/D Cache Enabled<br>Input Format: YUV422ILE<br>Output Format: YUV420P<br>Rotation ON<br>Slice Mode OFF  | JPEG_ENC_005 |
| Sequential JPEG Encoder, I/D Cache Enabled<br>Input Format: YUV422ILE<br>Output Format: YUV422P<br>Rotation ON<br>Slice Mode OFF  | JPEG_ENC_006 |

### 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.

**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  |

**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 |

**Table 9. Codec Usage of External Memory through CMEM**

| BUFFER                       | BUFFER SIZE |  |
|------------------------------|-------------|--|
| Input Buffer                 | YUV_422_ILE | Buffer1: frameSize <sup>(1)*2</sup>                                |
|                              | YUV_422_P   | Buffer1: frameSize<br>Buffer2: frameSize/2<br>Buffer3: frameSize/2 |
|                              | YUV_420_P   | Buffer1: frameSize<br>Buffer2: frameSize/4<br>Buffer3: frameSize/4 |
|                              | YUV_420_SP  | Buffer1: frameSize<br>Buffer2: frameSize/2                         |
| Output Buffer <sup>(2)</sup> | YUV_420_P   | frameSize <sup>(1)*1.5</sup>                                       |
|                              | 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.

## 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.

## 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: SPRUEV4A)

## 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 |

## Revision History

There are no changes in the data sheet as compared to the previous version.

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