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Information technology — JPEG 2000 image coding system —

Part 3: Motion JPEG 2000

AMENDMENT 3: Definition of compliance points and testing for Motion JPEG 2000

Technologies de l'information — Système de codage d'image JPEG 2000 —

Partie 3: Motion JPEG 2000

AMENDEMENT 3: Définition des points et des essais de conformité pour Motion JPEG 2000

Please see the administrative notes on page iii

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Foreword

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Amendment 3 to ISO/IEC 15444-3:2002 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

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Introduction

ITU-T Rec.T.800 | ISO/IEC 15444-1 is a specification that describes an image compression system that allows great flexibility, not only for the compression of images but also for access into the codestream. ITU-T Rec.T.802 | ISO/IEC 15444-3 specifies the use of the wavelet-based JPEG 2000 codec for the coding and display of timed sequences of images. The Motion JPEG 2000 file format (MJ2) is designed to contain one or more motion sequences of JPEG 2000 images, with their timing, and also optional audio annotations, all composed into an overall presentation. ITU-T Rec.T.803 | ISO/IEC 15444-4 provides the framework, concepts, and methodology for testing and the criteria to be achieved to claim compliance to JPEG 2000 standard, i.e. to still images only.

This document makes use of the latter framework of conformance testing to apply it to the mentioned motion sequences. The objective of standardization in this field is to promote interoperability between MJ2 encoders and decoders and to test these systems for compliance to these specifications. Compliance testing is the testing of a candidate product for the existence of specific characteristics required by a standard. It involves testing the capabilities of an implementation against both the compliance requirements in the relevant standard and the statement of the implementation's capability.

With this document the framework, concepts, methodology for testing and the criteria to be achieved to claim compliance to ITU-T Recommendation T.802 | ISO/IEC 15444-3 are specified. Whilst extending the specifications of ITU-T Rec.T.803 | ISO/IEC 15444-4 to timed sequences of images, the mind was on widely used applications. This document describes compliance points and testing procedures for Motion JPEG 2000 decoders only.

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Information technology — JPEG 2000 image coding system —

Part 3:
Motion JPEG 2000

AMENDMENT 3: Definition of compliance points and testing for Motion JPEG 2000

Add the following reference to clause 2:

ITU-T Rec.T.803 | ISO/IEC 15444-4: *Information technology — JPEG 2000 image coding system: Conformance testing*

Add the following clauses after clause 7:

8 Definition of compliance points

This section describes a number of compliance points (Cpoints) for ITU-T Rec.T.802 | ISO/IEC 15444-3. The points and parameters are described to provide assistance in designing a compliant decoder. Actual compliance is determined by the test methods in clause 10 and the codestreams, reference images, and tolerances in clause 11. The definitions of compliance points in this section are useful for the design of an encoder. The parameters may correspond to particular parts of an implementation.

Because of resource limitations, implementations of Motion JPEG 2000 sometimes will not be able to decode a codestream in its entirety. This section defines various parameters for which a specific implementation might be limited. A set of values for every parameter defines a compliance point. Thus an implementation of a particular Cpoint must guarantee resources as defined in all the parameters.

8.1 H, W, C: Image size guarantees

Decoders may be limited in the size of the output image that they are capable of producing, due to physical display characteristics or memory limitations. H, W, and C are respectively the largest height, width, and number of components that are required to be decoded for a decoder in the compliance point. Codestreams containing more samples than the H, W, and C for a Cpoint shall still be decoded, provided they contain a resolution equal to or less than HxW. Compliance for these codestreams is based on the ability to decode at the largest size smaller than or equal to that specified by the decoder's Cpoint, while preserving aspect ratio. The requested image size is defined by the height and width fields in the applicable 'VisualSampleEntry' from the MJ2 file.

Equation 8.1 and Equation 8.2 express these restrictions. The maximum $r \le T_L$ that satisfies both conditions is the number of levels that must be decoded. T_L is defined in subclause 8.8. The variables w_r and h_r denote requested with and height from the VisualSampleEntry segment defined in subclause 6.1. The term $\min_{\forall i}(N_L(i))$ denotes the minimum number of decomposition levels declared in any COD or COC marker segments whether used in main header or in tile-part headers as defined in Annex A of ITU-T Rec.T.800 | ISO/IEC 15444-1.

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If a non-negative r does not exist to satisfy both conditions for any tile or for the whole image, then no decoder obligation exists. A decoder claiming compliance at some Cpoint with image dimensions H x W and number of components C, must also be capable of decoding any sequences with width less than or equal to W, height less than or equal to H, and number of components less than or equal to C. For each Cpoint, the minimum values for H, W, and C are specified in table AMD3-1.

$$\left\lceil \frac{w_r}{2^{\min_{\forall i}(N_L(i))-r}} \right\rceil \leq W \qquad \textbf{8.1}$$

$$\left\lceil \frac{h_r}{2^{\min_{\forall i}(N_L(i))-r}} \right\rceil \leq H \qquad \textbf{8.2}$$

8.2 N_{cb}: Code-block parsing guarantee

Decoders need not decode compressed bits that cannot be recovered from the codestream due to excessive parser memory being required. An upper bound for the parser state memory required to reach a point *x* in the codestream may be determined from the total number of code-blocks for which state information must be kept, the total number of precincts for which a packet has been encountered, and the total number of components of the codestream.

At position *x* in the codestream, $N_{cb}(x)$ is defined as the total number of code-blocks in every precinct where the first header byte of at least one received packet for the precinct lies outside the range 0x80 to 0x8F.

Decoders are permitted to stop parsing the codestream at the point, *x*, once $N_{cb}(x) > N_{cb}$, where N_{cb} is defined for each compliance point. Decoders are permitted to stop parsing the codestream once packet headers with more than N_{cb} code-blocks have been encountered. Code-blocks in packets prior to the packet with the N_{cb}^{th} code-block shall be decoded up to the limits of other parameters in the compliance point.

NOTE — Packets headers with the first bit set to 0 are defined as empty. The above definition adds all the code-blocks associated with such precincts to N_{cb} for these empty packets because a decoder requires more memory for these packets than for packets starting in the listed range.

8.3 N_{comp}: Component parsing guarantee

Decoders could be required to buffer information about each component for many thousands of components just to parse a codestream. To limit the required memory, decoders are permitted to stop parsing the codestream at a point, *x*, once the following condition is reached:

$C_{max}(x) > N_{comp}$

where $C_{max}(x)$ is defined as the largest component index for which a packet has been encountered up to point *x* regardless of the emptiness or the relevance of the packet.

Code-blocks in packets prior to the above stop condition shall be decoded up to the limits of other parameters in the compliance point.

8.4 L_{body}: Coded data buffering guarantee

The parser state memory described in subclause 8.2 is required to parse packets regardless of whether their code-blocks are relevant to the dimensions and number of components for which compliance is being claimed. For those code-blocks that are relevant, the implementation is required to store the recovered packet bytes. These are the code bytes that are processed by the block decoder (Annexes C and D, ITU-T Rec.T.800 | ISO/IEC 15444-1).

After a given number of decoded codestream bytes, *x*, the quantity $L_{body}(x)$ is defined as the total number of packet bytes that have been encountered so far in packets whose precincts are relevant to the dimensions

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and components for which compliance is being claimed. Although some implementations may be able to decode some of these packet bytes incrementally, L_{body} represents an upper bound on the number of packet bytes that must be stored by the decoder prior to decoding. If the number of relevant packet bytes exceeds L_{body}, then the Implementation Under Test (IUT) is allowed to stop reading the codestream and to decode the code-blocks obtained up to the limits of other parameters in the compliance point.

8.5 M: Decoded Bit-plane guarantee

The decoder shall decode all of the packet bytes recovered by the parser in accordance with the requirements described above. This obligation is limited to the most significant *M* bit-planes of each code-block. Specifically, the block decoder must correctly decode the first $3(M - P_B) - 2$ coding passes, if available, of any relevant code-block, *b*, where P_b is the number of zero-valued most significant bit-planes signaled in the relevant packet header as described in Annex B of ITU-T Rec.T.800 | ISO/IEC 15444-1. The decoder is free to decode any number of additional coding passes for any code-block. Codestreams with large values for the number of guard bits will have a larger number of zero-valued most significant bit planes, and thus a decoder of any given Cpoint will decode fewer useful bit-planes. Likewise, codestreams with large values for the shift in the RGN marker segment may have fewer bit-planes decoded.

8.6 P: 9-7I Precision guarantee

Codestreams that make use of the irreversible 9-7 discrete wavelet transform will require dequantization, the 9-7 inverse discrete wavelet transform, and potentially the inverse irreversible component transform (ICT). The precision values for the wavelet transform are chosen to allow high quality imagery at various bit-depths, e.g. 8, 12, or 16 bits per sample. However, for Cpoint-0, the accuracy of the 9-7I filter required is set such that it is possible to be compliant by decoding and inverse quantizing and performing a 5-3I (irreversible 5-3) inverse wavelet transform. This allows lower cost decoders to be used for the lowest compliance point only. For higher compliance points, using the 5-3 filter in place of the 9-7 filter will not be sufficient to pass the compliance tests.

Using the 5-3 inverse wavelet transform to decode imagery compressed with the 9-7 wavelet introduces signal dependent noise. For example errors are highest around edges in the imagery. Because induced errors are signal dependent, there is no “precision” specified for the implementation of the wavelet transform for Cpoint-0. Instead, the bounds on accuracy of the 9-7 transform have been set for each Cpoint-0 reference image to allow an implementation to use the 5-3I inverse wavelet filter. Using the 5-3I inverse wavelet transform instead of a 9-7I filter does not relieve a decoder of the requirement to perform inverse quantization.

For compliance points other than Cpoint-0, the precision guarantee in Table 1 refers to the implementation’s minimum word size that will achieve the target MSE values for the test streams.

To facilitate end-to-end testing for compliance, dequantization may be performed using mid-point rounding. That is, the value of *r* in Equation G.6 of ITU-T Rec.T.800 | ISO/IEC 15444-1 can be $r = 1/2$. Implementations under test may provide the option of using different values for the reconstruction parameter, *r*; however, if the value $r = 1/2$ is supported and employed for compliance testing this will typically increase the ease of passing.

8.7 B: 5-3R Precision guarantee

A decoder is expected to implement the reversible 5-3R IDWT exactly, for component bit-depths of *B* bits/sample or less, as specified in the SIZ marker segment (see Annex A of ITU-T Rec.T.800 | ISO/IEC 15444-1). If a codestream employs the reversible component transform (RCT) and the IUT claims compliance at 3 or more components, it must be able to perform both the 5-3R IDWT and the inverse RCT exactly for bit-depths of *B* bits/sample or less.

8.8 T_L: Transform level guarantee

For each Cpoint, a decoder is expected to be able to synthesize a minimum number of levels of the IDWT, T_L. For codestreams that contains more than T_L decomposition levels, the decoded image from a compliant decoder in a given Cpoint may include only the top resolution levels.

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8.9 L: Layer guarantee

For each Cpoint, a decoder is expected to decode a minimum number of layers, *L*, in a codestream. For codestreams that contains more than *L* layers, the decoded image from a compliant decode in a given Cpoint may include only the top *L* layers. This relieves compliant decoders from the burden of decoding inefficient codestreams with an excessive number of layers.

8.10 Progressions

For all Cpoints, a decoder is expected to decode all possible progressions as specified in the COD marker segment. If a POC marker segment is used in a codestream, Cpoint-0 to Cpoint-3 decoders shall decode packets associated with the first progression order specified in the POC marker segment for that tile. Additional packets in the tile may be skipped.

8.11 Tiles

If an image is divided into tiles the following restrictions apply to tile dimensions:

$$128 \le XTsiz / \min(XRsiz^{i}, YRsiz^{i}) \le 1024 \qquad \textbf{8.3}$$

$$XTsiz = YTsiz \qquad \textbf{8.4}$$

8.12 Tile-parts

Codestreams may contain multiple tile-parts for each tile. Profile-0 codestreams require all initial tile-parts to appear in spatial order in the codestream before other tile parts. Cpoint-0 to Cpoint-3 decoders may ignore tile-parts beyond the first even if N_{cb} or L_{body} has not been reached.

8.13 Precincts

Tiles may contain several precincts. Cpoint-0 decoders need only decode the first precinct in each subband of each tile.

8.14 Frame-rate and bit-rate

Frame-rate: A compliant real-time decoder must report the lowest frame rate that it can sustain when decoding all frames, as well as the number of skipped frames (fields) when it achieves real-time.

Bit-rate: A compliant real-time decoder must also report the highest bit-rate which can always be fully decoded in real-time (bit-rate guarantee).

8.15 Profile: codestream guarantee

Profiles provide limits on the codestream syntax parameters. Two profiles are defined in ITU-T Rec.T.802 | ISO/IEC 15444-3, labeled ‘unrestricted’ and ‘simple’. Conformance testing of the rich feature set of unrestricted codestreams is not targeted in this document. Thus, for all Cpoints compliant decoders need only to handle motion representations in MJ2 simple profile, indicated by the brand ‘mj2s’ in top-level file-type box.

NOTE — Conforming to simple profile means that restrictions of Profile-0 defined in Annex A.10 of ITU-T Rec.T.800 | ISO/IEC 15444-1 apply to embedded codestreams, with the exception of tile dimensions where YTsiz = XTsiz = 128 is replaced by definitions of subclause 8.11

9 Compliance point definitions

Table AMD3-1 defines four compliance points in terms of the parameters.

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Table AMD3-1 — Definitions of compliance points (Cpoint) for Part-3

Parameter	**Cpoint-0**	**Cpoint-1**	**Cpoint-2**	**Cpoint-3**
WxH(Size)	360x288	720x576	1920x1080	4096x3112
C(Components)	3	3	4	4
N_{cb}	399	1371	8428	50656
N_{comp}	4	4	4	4
L_{body}	2^{17} bytes	2^{20} bytes	2^{23} bytes	2^{26} bytes
M	11	13	15	19
P	Low enough to allow 5x3 l decoding of 9x7 l data	16 bit fixed point implementation	16-bit fixed point implementation	20 bit fixed point implementation
B	8	10	12	16
T_L	3	4	5	5
L	15	15	15	15
Progressions	For all Cpoints, a decoder is expected to decode all possible progressions as specified in the COD marker segment. If a POC marker segment is used in a codestream, a Cpoint-0 decoder shall decode packets associated with the first progression order specified in the POC marker segment for that tile. Additional packets in the tile may be skipped. For all other Cpoints, packets may be skipped only due to other limitations (e.g. N_{cb} and L_{body}) and there is no explicit limitation on the number of progression order changes that may occur.			
Tiles	Single tile image or square tiles with dimensions ranging from 128 to 1024	Single tile image or square tiles with dimensions ranging from 128 to 1024	Single tile image or square tiles with dimensions ranging from 128 to 1024	Single tile image or square tiles with dimensions ranging from 128 to 1024
Tile-parts	Decode only first tile-part per tile	Decode only first tile-part per tile	Decode only first tile-part per tile	Decode only first tile-part per tile
Precincts	Decode first precinct per sub-band	Decode all precincts	Decode all precincts	Decode all precincts
File format	MJ2 simple profile	MJ2 simple profile	MJ2 simple profile	MJ2 simple profile

10 Definition of test methods

Compliance testing procedures apply as defined in Annex B of ITU-T Rec.T.803 | ISO/IEC 15444-4, with following extensions:

1. A particular executable test suite (ETS) defines the test codestreams (TCS), output images and error tolerances. This is done in clause 11 for the four defined compliance points by taking specified frames from MJ2 sequences. Implementations under test (IUT) must therefore be able to output decoded visual samples in a format (see Annex G) that they can be compared as defined in ITU-T Rec.T.803 | ISO/IEC 15444-4. Any visual composition transformations do not apply to this test method.

2. In addition to the testing of single visual samples IUT will be evaluated by using MJ2 reference sequences defined in clause 11. The test procedure is:

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- To decode all frames (fields) of a sequence as defined in subclause 8.14. Therefore it must report, that no frames (fields) were skipped.
- To decode in correct frame order and correct field order. Therefore it must report, that the correct frame (field) order has been respected.
- To report the lowest frame rate it can sustain as defined in subclause 8.14
- To report the highest bit-rate which can always be fully decoded as defined in subclause 8.14

Table AMD3-2 lists the obligations for an IUT evaluated to be compliant to a certain Cpoint.

Table AMD3-2 — Obligations for IUTs

	Cpoint-0 TCS	Cpoint-1 TCS	Cpoint-2 TCS	Cpoint-3 TCS
Cpoint-0 IUT	Must decode everything	Must decode up to compliance point parameters defined in Cpoint-0	Must decode up to compliance point parameters defined in Cpoint-0	Must decode up to compliance point parameters defined in Cpoint-0
Cpoint-1 IUT	Must decode everything	Must decode everything	Must decode up to compliance point parameters defined in Cpoint-1	Must decode up to compliance point parameters defined in Cpoint-1
Cpoint-2 IUT	Must decode everything	Must decode everything	Must decode everything	Must decode up to compliance point parameters defined in Cpoint-2
Cpoint-3 IUT	Must decode everything	Must decode everything	Must decode everything	Must decode everything

11 Executable test suite (ETS)

This section defines four ETSs for the compliance points (Cpoints) defined in clause 9. Additional ETSs may be made available after the publication of this standard, see http://www.jpeg.org/software for the latest set of ETSs.

Each ETS consists of motion sequence and single image codestreams, reference decoded images, and tolerance values for MSE and peak error.

11.1 Test sequences

The following compressed test sequences listed in Tables AMD3-3 to AMD3-5 are attached to ITU-T Rec.T.802 | ISO/IEC 15444-3.

Table AMD3-3 — List of test sequences (Cpoint-3)

Sequence name	Resolution	Video Type	Number of Frames	Format	Bit depth
cp31.mj2	4096x3112	24P	80	RGB 4:4:4	16

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Table AMD3-4 — List of test sequences (Cpoint-2)

Sequence name	Resolution	Video Type	Number of Frames	Format	Bit depth
cp21.mj2	1920x1080	30P	240	YCC 4:2:2	8
cp22.mj2	1920x1080	24P	90	RGB 4:4:4	12
cp23.mj2	1280x1024	15P	90	YCC 4:4:4	10 / 11

Table AMD3-5 — List of test sequences (Cpoint-1)

Sequence name	Resolution	Video Type	Number of Frames	Format	Bit depth
cp11.mj2	720x480	30P	150	YCC 4:2:0	8
cp12.mj2	640x480	24P	90	RGB 4:4:4	8
cp13.mj2	720x576	50I	200 (400 fields)	YCCM 4:2:0:4	8

Table AMD3-6 — List of test sequences (Cpoint-0)

Sequence name	Resolution	Video Type	Number of Frames	Format	Bit depth
cp01.mj2	360x240	30P	150	YCC 4:2:0	8
cp02.mj2	320x240	24P	150	RGB 4:4:4	8
cp03.mj2	352x288	25P	200	Mono	8

NOTE — Resolutions in above tables are in the form width x height, referred to the component(s) with the least sub-sampling. The column Video Type in above tables are in form ##[P|I] with '##' indicating the original frame/field rate per second, 'P' indicating progressive scan (i.e. single frame images) and 'I' indicating interlaced scan (i.e. images consisting of two fields). Format information explains color representation and sub-sampling style of color components. Sequence 'cp13.mj2' has a 4th component which represents a two-level mask used during encoding.

11.2 Cpoint-3

11.2.1 Codestreams

The test codestreams for this ETS as listed in Tables AMD3-7 and AMD3-8 are in the directory 'Cpoint3'. There are motion sequences, with names of the form 'xxx.mj2' and single image codestreams, with names of the form 'xxx_###.j2k', where '###' is the frame number extracted from the corresponding motion sequence.

11.2.2 Reference decoded images

The reference decoded single images for this ETS are in the directory 'reference_Cpoint3'. The filenames are of the form 'xxx_###_?.pgx' where '###' is the frame number (starting from 1) extracted from the corresponding motion sequence and '?' denotes the component number (starting from 1).

11.2.3 Tolerances

The maximum allowable MSE and peak errors are listed in Table AMD3-8, along with information on image properties.

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Table AMD3-7 — Reference motion sequences (Cpoint-3)

TCS	Number of frames	Bit depth	Width	Height	Video type	Format
cp31.mj2	80	16	4096	3112	24P	RGB 4:4:4

Table AMD3-8 — Reference image and allowable error (Cpoint-3)

TCS	Reference image file name	Frame number	Bit depth	Width	Height	Peak	MSE
cp31_045.j2k	cp31_045_1.pgx cp31_045_2.pgx cp31_045_3.pgx	45	16 16 16	4096 4096 4096	3112 3112 3112	0 0 0	0 0 0

11.3 Cpoint-2

11.3.1 Codestreams

The test codestreams for this ETS as listed in Tables AMD3-9 and AMD3-10 are in the directory ‘Cpoint2’. There are motion sequences, with names of the form ‘xxx.mj2’ and single image codestreams, with names of the form ‘xxx_###.j2k’, where ‘###’ is the frame number extracted from the corresponding motion sequence.

11.3.2 Reference decoded images

The reference decoded single images for this ETS are in the directory ‘reference_Cpoint2’. The filenames are of the form ‘xxx_###_?.pgx’ where ‘###’ is the frame number (starting from 1) extracted from the corresponding motion sequence and ‘?’ denotes the component number (starting from 1).

11.3.3 Tolerances

The maximum allowable MSE and peak errors are listed in Table AMD3-10, along with information on image properties.

Table AMD3-9 — Reference motion sequences (Cpoint-2)

TCS	Number of frames	Bit depth	Width	Height	Video type	Format
cp21.mj2	240	8	1920	1080	24P	YCC 4:2:2
cp22.mj2	90	12	1920	1080	24P	RGB 4:4:4
cp23.mj2	90	10/11	1280	1024	15P	YCC 4:4:4

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Table AMD3-10 — Reference image and allowable error (Cpoint-2)

TCS	Reference image file name	Frame number	Bit depth	Width	Height	Peak	MSE
cp21_045.j2k	cp21_045_1.pgx cp21_045_2.pgx cp21_045_3.pgx	45	8 8 8	1920 960 960	1080 1080 1080	0 0 0	0 0 0
cp22_045.j2k	cp22_045_1.pgx cp22_045_2.pgx cp22_045_3.pgx	45	12 12 12	1920 1920 1920	1080 1080 1080	14 11 18	6.46 4.28 8.18
cp23_045.j2k	cp23_045_1.pgx cp23_045_2.pgx cp23_045_3.pgx	45	10 11 11	1280 1280 1280	1024 1024 1024	2 5 5	0.42 0.64 0.52

11.4 Cpoint-1

11.4.1 Codestreams

The test codestreams for this ETS as listed in Tables AMD3-11 and AMD3-12 are in the directory ‘Cpoint1’. There are motion sequences, with names of the form ‘xxx.mj2’ and single image codestreams, with names of the form ‘xxx_###.j2k’, where ‘###’ is the frame number extracted from the corresponding motion sequence.

11.4.2 Reference decoded images

The reference decoded single images for this ETS are in the directory ‘reference_Cpoint1’. The filenames are of the form ‘xxx_###_?.pgx’ where ‘###’ is the frame number (starting from 1) extracted from the corresponding motion sequence and ‘?’ denotes the component number (starting from 1). For interlaced material the top and bottom fields are denoted with ‘top’ and ‘bot’ together with the frame number.

11.4.3 Tolerances

The maximum allowable MSE and peak errors are listed in Table AMD3-12, along with information on image properties.

Table AMD3-11 — Reference motion sequences (Cpoint-1)

TCS	Number of frames	Bit depth	Width	Height	Video type	Format
cp11.mj2	150	8	720	480	30P	YCC 4:2:0
cp12.mj2	90	8	640	480	24P	RGB 4:4:4
cp13.mj2	200 (400 fields)	8	720	576	50I	YCCM 4:2:0:4

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Table AMD3-12 — Reference image and allowable error (Cpoint-1)

TCS	Reference image file name	Frame number	Bit depth	Width	Height	Peak	MSE
cp11_045.j2k	cp11_045_1.j2k cp11_045_2.j2k cp11_045_3.j2k	45	8 8 8	720 360 360	480 240 240	4 3 4	0.09 0.12 0.06
cp12_045.j2k	cp12_045_1.j2k cp12_045_2.j2k cp12_045_3.j2k	45	8 8 8	640 640 640	480 480 480	0 0 0	0 0 0
cp13_045_top.j2k	cp13_045_top_1.j2k cp13_045_top_2.j2k cp13_045_top_3.j2k	45	8 8 8	720 360 360	576 288 288	3 1 1	0.19 0.09 0.08
cp13_045_bot.j2k	cp13_045_bot_1.j2k cp13_045_bot_2.j2k cp13_045_bot_3.j2k	45	8 8 8	720 360 360	576 288 288	3 2 2	0.20 0.08 0.08

11.5 Cpoint-0

11.5.1 Codestreams

The test codestreams for this ETS as listed in Tables AMD3-13 and AMD3-14 are in the directory ‘Cpoint0’. There are motion sequences, with names of the form ‘xxx.mj2’ and single image codestreams, with names of the form ‘xxx_###.j2k’, where ‘###’ is the frame number extracted from the corresponding motion sequence.

11.5.2 Reference decoded images

The reference decoded single images for this ETS are in the directory ‘reference_Cpoint0’. The filenames are of the form ‘xxx_###_?.pgx’ or ‘xxx_###.pgx’ where ‘###’ is the frame number (starting from 1) extracted from the corresponding motion sequence and ‘?’ denotes the component number (starting from 1).

11.5.3 Tolerances

The maximum allowable MSE and peak errors are listed in Table AMD3-14, along with information on image properties.

Table AMD3-13 — Reference motion sequences (Cpoint-0)

TCS	Number of frames	Bit depth	Width	Height	Video type	Format
cp01.mj2	150	8	360	240	30P	YCC 4:2:0
cp02.mj2	90	8	320	240	30P	RGB 4:4:4
cp03.mj2	200	8	352	288	25P	Mono

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Table AMD3-14 — Reference image and allowable error (Cpoint-0)

TCS	Reference image file name	Frame number	Bit depth	Width	Height	Peak	MSE
cp01_045.j2k	cp01_045_1.j2k cp01_045_2.j2k cp01_045_3.j2k	45	8 8 8	360 180 180	240 120 120	3 1 1	0.16 0.18 0.17
cp02_045.j2k	cp02_045_1.pgx cp02_045_2.pgx cp02_045_3.pgx	45	8 8 8	320 320 320	240 240 240	0 0 0	0 0 0
cp03_045.j2k	cp03_045.pgx	45	8	352	288	3	0.21

Add the following Annexes after Annex D:

Annex E
(informative)

Guidelines for Implementing Motion JPEG 2000

E.1 Introduction

The Motion JPEG 2000 file format is derived from the ISO Base Media File Format. Members from the ISO/IEC JPEG and MPEG committees jointly maintain the ISO Base Media File Format, known as ISO/IEC 15444-12 and ISO/IEC 14496-12 (two standards with identical text). It is expected that the ISO/IEC Base Media File Format will be extended as new features are proposed to support desired new functionality.

When implementing the MJ2 file format it is important to note that not all features of the ISO Base Media File Format are required. Features that are not required for a compliant Motion JPEG 2000 implementation may be used as an option. However, use of optional features could limit interoperability with other Motion JPEG 2000 compliant implementations. And, use of optional features from the ISO Base Media File Format may require a license. A compliant MJ2 file format is targeted to be IP free.

NOTE — To implement Motion JPEG 2000 both ISO/IEC 15444-3 and ISO/IEC 15444-12 documents will be needed and will be supplied by ISO when ordering the 15444-3 standard. Since there are features in ISO/IEC 15444-12 that are not part of a compliant Motion JPEG 2000 implementation, please refer to the following guidelines and tables for required (normative) features and optional features. A compliant Motion JPEG 2000 implementation must support required features. A compliant implementation need not support optional features, but it must not fail if optional features are present.

E.2 Guidelines

Motion JPEG 2000 video is stored in video tracks, as documented in the ISO Base Media File Format. This standard defines the structure of video tracks in a format-independent fashion. The exact format of the video is declared by the sample description; the sample description for Motion JPEG 2000 is defined in ISO/IEC 15444-3.

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The format of the samples is defined by the declarations in the sample description and the corresponding specification. For Motion JPEG 2000, the sample format contains JPEG 2000 code-streams; again, the precise format is defined in Part 1 and in Part 3 of the JPEG 2000 Standard.

Since Motion JPEG 2000 is an I-frame coder (there are no difference frames), some of the structures in the base ISO media file format are not needed: the sync sample table (and shadow sync.) are only needed when there are difference frames, and so are unused here. Similarly, the composition time to sample table is only needed when there is decode/composition re-ordering (as happens with B frames), and so is un-needed.

Motion JPEG 2000 files may also contain audio. The structure of an audio track is like that of a video track. Support for uncompressed (raw) audio is defined in this specification (both sample description and sample format). The definitions for MPEG-4 audio may be found in the MPEG-4 specifications.

Padding bits are only needed for MPEG-4 audio (the padb table) and since support of MPEG-4 audio is optional, so is support of this table.

Hinting and support for hinting (such as hint tracks) are not part of the Motion JPEG 2000 specification, so all the structures relating to hint tracks are not required. Track references are not used by the basic Motion JPEG 2000 specification, but are used for various purposes including hinting; therefore track reference atoms are optional.

The Motion JPEG 2000 specification uses only audio and video media tracks; the null media header used by other tracks, including MPEG-4 systems tracks, is not used here.

The use of interlaced material is not recommended, but possible if necessary. Refer to clause 6 where organization of media data and meta data is explained. Explicitly, when two fields are present in the samples, the JP2 Header Box applies to the complete image, not to each field individually. Therefore the height as declared in the JP2 Header Box (‘jp2h’) and the VisualSampleEntry (‘mjp2’) applies to the entire de-interlaced image. `Entry-size` in the Sample Size Box (‘stsz’) is therefore the sum of the two corresponding JP2 Codestream Boxes (‘jp2c’). Those codestream boxes shall always appear in temporal order, whilst `fieldorder` entries in the Field Coding Box (‘fiel’) and `original_fieldorder` entries in MJP2 Original Format Box (‘orfo’) help properly reconstructing the decoded images.

When encoding video source images provided in a chrominance sub-sampled YCC format, it is recommended to signal this through MJP2 Sub-sampling Box (‘jsub’). Decoders should be aware that this box is optional and therefore eventually sub-sampling information shall be retrieved from the JP2 codestream.

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Table E.1 — Required features for Motion JPEG 2000

ftyp						*		*file type and compatibility*
moov						*		*container for all the meta-data*
	mvhd					*		*movie header, overall declarations*
	trak					*		*container for an individual track or stream*
		tkhd				*		*track header, overall information about the track*
		tref						*track reference container*
		edts						*edit list container*
			elst					*an edit list*
		mdia				*		*container for the media information in a track*
			mdhd			*		*media header, overall information about the media*
			hdlr			*		*handler, declares the media (handler) type*
			minf			*		*media information container*
				vmhd				*video media header, overall information (video track only)*
				smhd				*sound media header, overall information (sound track only)*
				dinf		*		*data information box, container*
					dref	*		*data reference box, declares source(s) of media data in track*
				stbl		*		*sample table box, container for the time/space map*
					stsd	*		*sample descriptions (codec types, initialisation etc.)*
					stts	*		*(decoding) time-to-sample*
					stsc	*		*sample-to-chunk, partial data-offset information*
					stsz			*sample sizes (framing)*
					stz2			*compact sample sizes (framing)*
					stco	*		*chunk offset, partial data-offset information*
					co64			*64-bit chunk offset*
	mvex							*movie extends box*
		mehd						*movie extends header box*
		trex				*		*track extends defaults*
moof								*movie fragment*
	mfhd					*		*movie fragment header*
	traf							*track fragment*
		tfhd				*		*track fragment header*
		trun						*track fragment run*
mfra								*movie fragment random access*
	tfra							*track fragment random access*
	mfro					*		*movie fragment random access offset*
mdat								*media data container*
free								*free space*
skip								*free space*
	udta							*user-data*
		cprt						*copyright etc.*

Table E.2 — Optional features for Motion JPEG 2000

				hmhd				*hint media header, overall information (hint track only)*
					ctts			*(composition) time to sample*
					stss			*sync sample table (random access points)*
					stsh			*shadow sync sample table*
					padb			*sample padding bits*
					stdp			*sample degradation priority*
				nmhd				*Null media header, overall information (some tracks only)*

In addition to the optional features here listed, any new features added to ISO/IEC 15444-12 will be optional until such time as the might be added via amendment as a normative part of ISO/IEC 15444-3.

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Annex F
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Guide to JPEG 2000

F.1 Structure and status of the standard

JPEG 2000 is published as a multipart International Standard, jointly by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). The standard as a whole is known as ISO/IEC 15444. Certain parts of JPEG 2000 are also published as Recommendations by the Telecommunication Standardization Sector of the International Telecommunication Union (ITU-T). The main text of the ISO/IEC and ITU-T documents is identical; they differ only in minor non-normative details.

The following is the current list of JPEG 2000 parts.

1. Core coding system.
2. Extensions.
3. Motion JPEG 2000.
4. Conformance testing.
5. Reference software.
6. Compound image file format.
8. Secure JPEG 2000.
9. Interactivity tools, APIs and protocols.
10. 3-D and floating point data.
11. Wireless.
12. ISO base media file format.

F.2 JPEG 2000 file formats

Several parts of JPEG 2000 define file formats. To clarify the relationship between them we address this aspect of JPEG 2000 briefly here. Further details will be found under each of the specific parts.

Part 1 includes the definition of a simple file format called JP2. JP2 is optional, but is a normative part of the standard. That is, applications are free to use JPEG 2000 compression without implementing JP2, but if they do choose to implement JP2 then they must conform to all of the relevant provisions in the standard in order to be able to claim compliance. Thus JP2 provides a basic level of interoperability for applications that wish to interchange JPEG 2000 data. It plays a role akin to the JFIF file format for JPEG. (Almost all JPEG files are in the JFIF format, which has never been formally standardized and does not fully utilize JPEG's features. To avoid a recurrence of this situation is one of the aims of including an official file format in the first part of the new standard.)

JP2 was designed to be inherently extensible. The extended file formats that are defined in later parts of the standard all incorporate a degree of backwards-compatibility with JP2: for each extended format it is possible to construct extended files that also conform to JP2. (A JP2 reader would ignore any extensions that it did not understand.) Thus, the definition of JP2 in Part 1 can also be considered an implicit definition of an architecture known informally as the 'JP family'. All of the extended file formats are members of this family and share the common box architecture, which was derived from the RIFF file format on which Apple's QuickTime file format is also based.

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A JP family file is a sequence of 'boxes'. A box consists of a 4-byte length field followed by a 4-byte type field followed by the content of the box. The content is defined for each box type and may include boxes. A box whose content consists *only* of boxes is called a superbox. There are two special values of the length field. A value of zero means that the box extends to the end of the file. A value of 1 means that the true length of the box follows the type field (before the content) in an 8-byte extended length field; this permits boxes up to $(2^{64} - 1)$ bytes in length. The length includes the whole box from the start of the length field to the end of the content.

All JP family files begin with the JPEG 2000 Signature box, which is always exactly the same sequence of 12 bytes. It may therefore be used for recognizing a JPEG 2000 file, as its name suggests. The next box in the file is the File Type box, whose content varies across the JP family and may therefore be used for more specific recognition.

Part 2 includes the definition of an extended file format called JPX. The JPX extensions to JP2 include support for extended JPEG 2000 compression features (those defined elsewhere in Part 2), images with multiple compositing layers, animated images, and the fragmentation of data over several files or network resources. JPX also includes an XML metadata set targeted at photographic imagery.

Part 3 defines the Motion JPEG 2000 format, MJ2 (also called MJP2). MJ2 inherits more of QuickTime's features than do the other JP family file formats, and it is closely related to the MPEG-4 (ISO/IEC 14496-1) file format, MP4. For this reason, the MJ2 and MP4 file formats are derived from a common base format called the ISO Base Media File Format, published as a part of both JPEG 2000 and MPEG-4, the two documents having the same text and being referred to jointly as 'ISO/IEC 14496-12 & ISO/IEC 15444-12'.

Part 6 defines the JPM file format for document imaging.

The diagram below shows the relationship between the different formats assuming that the rewritten MJ2 is approved. The dotted box encompasses the scope of JPEG 2000. The dashed arrows indicate implied inheritance and the solid arrows explicit inheritance. Thus, Part 1 alone defines JP2; there is no need to read QuickTime in order to implement it. However, Parts 2 and 6 refer to Part 1 in defining JPX and JPM respectively. Part 3 is intended to be independent of Part 1 as a document, partly because of its dependence on the ISO base media format in Part 12. ISO/IEC 15444-3 is entirely stand-alone in this sense.

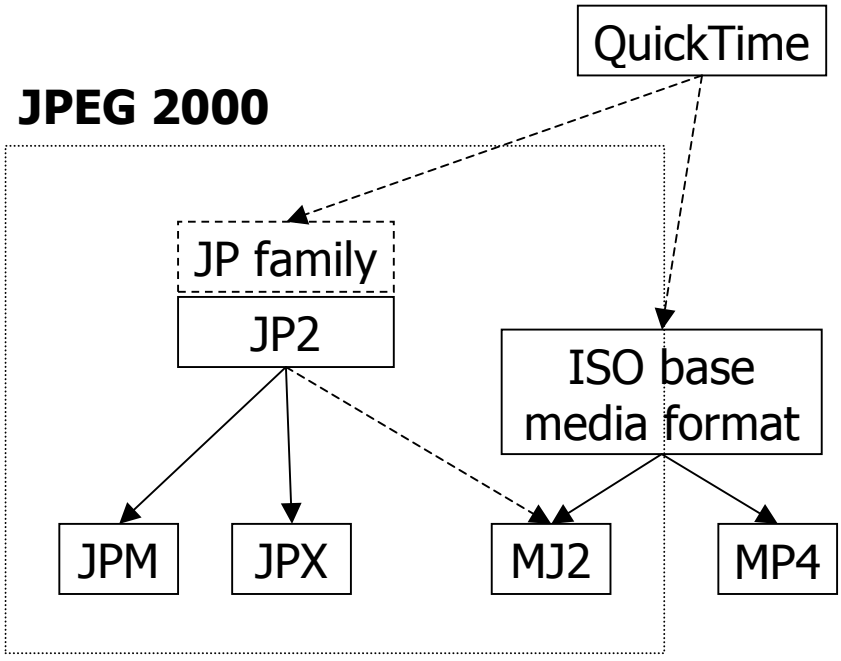


Figure F.1 — File Format Family

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Annex G
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Reference components file format

G.1 PGX file format

This section describes the file format, called **PGX**, of the reference images used for comparison with the output of the decoder under test. The decoder under test is not required to produce this particular file format. Any necessary conversion may be applied. The reference decoder files are stored with one file per component. There is also a header line that describes the size of the components.

NOTE — In some operating systems the PGX test files provided may be split into a header only file and a raw data file with no header using the commands 'head-1 file.pgx >header.txt' and 'tail+1 file.pgx>file.raw'.

G.2 Header format

The header used by the reference images consists of a single text line of the form:

PG <byte order> [+|-]<bit-depth><width><height><newline>

Each of the fields is separated by one space character, 0x20.

<byte order> literal "ML" (0x4D, 0x4C)

NOTE — Some PGX writers will use the literal "LM" to indicate least significant byte first. This is not used by the reference images with this standard.

[+|-]<bit-depth> If this field begins with an ASCII digit or a '+' character, the image data is unsigned; if the field begins with a '-' character the data is signed. The ASCII value indicates the bit-depth. There may be a space(0x20) between the sign('+' or '-') and the bit-depth.

<width> the number of samples horizontally for the image. There are no offsets or sub-sampling with this format.

<height> the number of samples vertically for the image. There are no offsets or sub-sampling with this format.

<newline> may consist of the two bytes 0x0d, 0x0a, or the single character 0x0a, the character 0x0a shall be the last before the beginning of the raw data and will always be present.

Example:

PG ML +8 128 128

G.3 Data format

The binary data appears immediately after the 0x0a byte in the header. The data in the raw file is stored most significant byte first using 1,2, or 4 bytes per sample. One byte is used for component depths of 1 to 8 bits, two bytes are used for component depths of 9 to 16 bits, and four bytes are used for depths of 17 to 32 bits. Signal data is stored in 2's complement, with sign extension throughout the 1,2, or 4 bytes(e.g. –1 is stored as 0xFFFF for a 12-bit signed image).

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