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Information technology — JPEG 2000 image coding system —

Part 4: Conformance testing

*Technologies de l'information — Système de codage d'images JPEG
2000 —*

Partie 4: Tests de conformité

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Foreword

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This document was prepared by ITU-T (as ITU-T Rec T.803) and drafted in accordance with its editorial rules, in collaboration with Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This fourth edition cancels and replaces the third edition (ISO/IEC 15444-4:2021), which has been technically revised.

The main changes are as follows:

- the maximum allowable errors associated with compliance Class 1, for both Rec. ITU-T T.800 | ISO/IEC 15444-1 and Rec. ITU-T T.814 | ISO/IEC 15444-15 codestreams, have been relaxed in a few cases to ensure that well designed 16-bit fixed-point implementations of the inverse discrete wavelet transform should be able to pass all compliance tests for Class 1.
- two additional test codestreams have been added along with conformance bounds, to facilitate testing of inverse wavelet and component decorrelating transform accuracy.
- a number of codestreams and files conforming to Rec. ITU-T T.801 | ISO/IEC 15444-2 have been included for informative purposes only, to facilitate the development of decoders and file format readers that are able to support features beyond the core capabilities found in Rec. ITU-T T.800 | ISO/IEC 15444-1 and Rec. ITU-T T.814 | ISO/IEC 15444-15.

A list of all parts in the ISO/IEC 15444 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

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**INTERNATIONAL STANDARD
ITU-T RECOMMENDATION**

**Information technology — JPEG 2000 image coding system —
Part 4: Conformance testing**

1 Scope

This Recommendation | International Standard specifies the framework, concepts, methodology for testing, and criteria to be achieved to claim compliance to Rec. ITU-T T.800 | ISO/IEC 15444-1 or Rec. ITU-T T.814 | ISO/IEC 15444-15. It provides a framework for specifying abstract test suites (ATSs) and for defining the procedures to be followed during compliance testing.

This Recommendation | International Standard:

- specifies compliance testing procedures for encoding and decoding using Rec. ITU-T T.800 | ISO/IEC 15444-1 and Rec. ITU-T T.814 | ISO/IEC 15444-15;
- specifies codestreams, decoded images, and error metrics to be used with the testing procedures;
- specifies ATSs;
- provides guidance for creating an encoder compliance test

This Recommendation | International Standard does not include the following tests:

Acceptance testing: the process of determining whether an implementation satisfies acceptance criteria and enables the user to determine whether or not to accept the implementation. This includes the planning and execution of several kinds of tests (e.g., functionality, quality, and speed performance testing) that demonstrate that the implementation satisfies the user requirements.

Performance testing: measures the performance characteristics of an implementation under test (IUT) such as its throughput and responsiveness, under various conditions.

Robustness testing: the process of determining how well an implementation processes data which contains errors.

2 References

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

- Recommendation ITU-T T.800 | ISO/IEC 15444-1, *Information technology – JPEG 2000 image coding system: Core coding system*.
- Recommendation ITU-T T.814 | ISO/IEC 15444-15, *Information technology – JPEG 2000 image coding system: High-throughput JPEG 2000*.

3 Definitions

For the purposes of this Recommendation | International Standard, the terms and definitions given in Rec. ITU-T T.800 | ISO/IEC 15444-1, Rec. ITU-T T.814 | ISO/IEC 15444-15 and the following apply.

3.1

abstract test suite (ATS)

generic compliance testing concepts and procedures for a given requirement

3.2

arithmetic coder

entropy coder that converts variable length strings to variable length codes (encoding) and vice versa (decoding)

3.3

big endian

order of bytes in which the most significant byte comes first

3.4

bit

contraction of the term "binary digit"; a unit of information represented by a 0 or a 1

3.5

bit-depth

number of bits required to represent an original component of an image

3.6

bit-plane

two-dimensional array of bits, referring to all the bits of the same magnitude in all coefficients or samples, within a component, a tile- component, a code-block, a region of interest, or other

3.7

bitstream

sequence of bits resulting from the coding of a sequence of symbols, not including any markers or marker segments from the main and tile-part headers, not including packet headers, and not including in stream markers or marker segments or the end of codestream marker

3.8

box

portion of the file format defined by a length and unique box type

Note on entry: boxes of some types may contain other boxes

3.9

byte

eight bits

3.10

Cclass

defines a level of performance for a decoder, also providing guidance for encoders to produce codestreams that are easily decodable by compliant decoders

3.11

code-block

arectangular grouping of coefficients from the same sub-band of a tile-component

3.12

coder

embodiment of either an encoding or decoding process

3.13

codestream

collection of one or more bitstreams and the main header, tile-part headers, and the end of codestream marker required for their decoding and expansion into image data

Note on entry: this is the image data in a compressed form with all of the signalling needed to decode, but not including the file format

3.14

coding pass

procedure accessing coefficients in a code-block where the context and bit are determined

Note on entry: typically, there are three different coding passes for each bit-plane, each coefficient will be represented in exactly one of the three passes; for an encoder a coding pass examines coefficients and augments a bitstream; for a decoder a coding pass reads a bitstream and updates coefficients

3.15

coefficient

value that result from a transformation

3.16

component

two-dimensional array of samples

Note on entry: an image typically consists of several components (e.g., red, green, and blue)

3.17

compressed image data

part or all of a codestream, or a collection of bitstreams in part or all of a codestream

3.18

compliance

fulfilment of the specified requirements, as defined in this Recommendation | International Standard, for a given Profile and Cclass

3.19

compliance test procedure

the process of assessing compliance

3.20

context

function of coefficients previously decoded and used to condition the decoding of the present coefficient

3.21

decoder

embodiment of a decoding process, and optionally a colour transformation process

3.22

decoding process

process that takes as its input all or part of a codestream and outputs all or part of a reconstructed image

3.23

decomposition level

collection of wavelet sub-bands where each coefficient has the same spatial impact or span with respect to the source component samples, including all sub-bands of the same two-dimensional sub-band decomposition, where the last decomposition level also includes the LL sub-band

3.24

discrete wavelet transformation (DWT)

transformation that iteratively transforms one signal into two or more filtered and decimated signals corresponding to different frequency bands

Note on entry: this transformation operates on spatially discrete samples

3.25

encoder

embodiment of an encoding process, optionally including a colour transformation process

3.26

encoding process

process that takes as its input all or part of a source image data and outputs a codestream

3.27

executable test suite (ETS)

set of executable test cases that support the abstract test cases

3.28

file format

codestream and additional support data and information not explicitly required for the decoding of the codestream

Note on entry: examples of such support data include text fields providing titling, security and historical information, data to support placement of multiple codestreams within a given data file, and data to support exchange between platforms or conversion to other file formats

3.29

fully decode

applying Rec. ITU-T T.800 | ISO/IEC 15444-1 to produce an image from a codestream where all coded data in the codestream has been used to produce the image

3.30

guard bits

additional most significant bitplanes, beyond the nominal dynamic range of a wavelet sub-band, that have been included in coding of the sample data

3.31

header

either a part of the codestream that contains only markers and marker segments (main header and tile part header) or the signalling part of a packet (packet header)

3.32

image

set of all components

3.33

image data

component samples making up an image

Note on entry: image data can refer to either the source image data or the reconstructed image data

3.34

implementation

realization of a specification

3.35

implementation compliance statement (ICS)

statement of specification options and the extent to which they have been implemented by an implementation under test

3.36

implementation under test (IUT)

implementation that is being evaluated for compliance

3.37

irreversible

transformation, progression, system, quantization, or other process that, due to systemic or quantization error, prevents lossless recovery

3.3

JPEG

Joint Photographic Experts Group – The joint ISO/ITU committee responsible for developing standards for continuous-tone still picture coding, also referring to the standards produced by this committee: Rec. ITU-T T.81 | ISO/IEC 10918-1, Rec. ITU-T T.83 | ISO/IEC 10918-2, Rec. ITU-T T.84 | ISO/IEC 10918-3 and Rec. ITU-T T.87 | ISO/IEC 14495-1

3.39

LL sub-band

sub-band obtained by forward horizontal low-pass filtering and vertical low-pass filtering

Note on entry: this sub-band contributes to reconstruction with inverse vertical low-pass filtering and horizontal low-pass filtering

3.40

layer

collection of compressed image data from coding passes of one, or more, code-blocks of a tile- component, where layers have an order for encoding and decoding that has to be preserved

3.41

lossless

descriptive term for the effect of the overall encoding and decoding processes in which the output of the decoding process is identical to the input to the encoding process, such that distortion-free restoration can be assured and all of the coding processes or steps used for encoding and decoding are reversible

3.42

lossy

descriptive term for the effect of the overall encoding and decoding processes in which the output of the decoding process is not identical to the input to the encoding process, because at least one of the coding processes or steps used for encoding and decoding is irreversible

3.43

main header

group of markers and marker segments at the beginning of the codestream that describe the image parameters and coding parameters that can apply to every tile and tile-component

3.44**marker**

two-byte code in which the first byte is hexadecimal FF (0xFF) and the second byte is a value between 1 (0x01) and hexadecimal FE (0xFE)

3.45**marker segment**

marker and associated (not empty) set of parameters

3.46**packet**

part of the codestream comprising a packet header and the compressed image data from one layer of one precinct of one resolution level of one tile-component

3.47**packet header**

portion of the packet that contains signalling necessary for decoding that packet

3.48**parser**

reads and identifies components of the codestream down to the code-block level

3.49**partial decoding**

producing an image from a subset of an entire codestream

3.50**precinct**

rectangular region of a transformed tile-component, within each resolution level, used for limiting the size of packets

3.51**precision**

number of bits allocated to a particular sample, coefficient, or other binary numerical representation

3.52**progression**

order of a codestream where the decoding of each successive bit contributes to a "better" reconstruction of the image

Note on entry: what metrics make the reconstruction "better" is a function of the application; some examples of progression are increasing resolution or improved sample fidelity

3.53**profile**

subset of technology, from Rec. ITU-T T.800 | ISO/IEC 15444-1, that meets the needs of a given application with limits on parameters within a selected technology

Note on entry: profiles are codestream limitations

3.54**quantization**

method of reducing the precision of the individual coefficients to reduce the number of bits used to represent them

Note on entry: quantization can be achieved by an explicit operation with a given quantization value (scalar quantization) or by dropping (truncating) coding passes from the codestream

3.55**reconstructed image**

image that is the output of a decoder

3.56**reference grid**

regular rectangular array of points used to define other rectangular arrays of data

Note on entry: the reference grid is used to determine the number of samples in tile-components for example

3.57**region of interest (ROI)**

collection of coefficients that are considered of particular relevance by some user-defined measure

3.58

reversible

transformation, progression, system, or other process that does not suffer systemic or quantization error and therefore allows for lossless signal recovery

3.59

reversible filter

particular filter pair used in the wavelet transformation which allows lossless compression

3.60

sample

one element in the two-dimensional array that comprises a component

3.61

selective arithmetic coding bypass

coding style where some of the code-block passes are not coded by the arithmetic coder, where the bits to be coded are instead appended directly to the bitstream without coding

3.62

shift

multiplication or division of a number by powers of two, where division of an integer via shift implies truncation toward minus infinity of the non-integer portion

3.63

sign bit

bit that indicates whether a number is positive (value 0) or negative (value 1)

3.64

sign-magnitude notation

binary representation of an integer where the distance from the origin is expressed with a positive number and the direction from the origin (positive or negative) is expressed with a separate single sign bit

3.65

source image

image used as input to an encoder

3.66

sub-band

group of transform coefficients resulting from the same sequence of low-pass and high-pass filtering operations, both vertically and horizontally

3.67

testing

process of evaluating compliance

3.68

tile

rectangular array of points on the reference grid, registered with an offset from the reference grid origin and defined by a width and height

3.69

tile-component

all the samples of a given component in a tile

3.70

tile-part

portion of the codestream with compressed image data for some, or all, of a tile, including one or more packets that make up the coded tile

3.71

tile-part header

group of markers and marker segments at the beginning of each tile-part in the codestream that describe the tile-part coding parameters

3.72

transformation

mathematical mapping from one signal space to another