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SERIES T: TERMINALS FOR TELEMATIC SERVICES

Still-image compression – JPEG XR

Information technology – JPEG XR image coding system – Reference software

Recommendation ITU-T T.835

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Recommendation ITU-T T.835

Information technology – JPEG XR image coding system – Reference software

Summary

Recommendation ITU-T T.835 has been developed jointly with ISO/IEC JTC 1 SC 29/WG 1 in a collaborative team that is referred to as the Joint Photographic Experts Group (JPEG). It will be published as a technically-aligned twin text by both organizations (ITU-T and ISO/IEC).

This Recommendation | International Standard provides a reference software for Rec. ITU-T T.832 | ISO/IEC 29199-2 (*Information technology – JPEG XR image coding system – Image coding specification*) as an electronic attachment. The reference software is an integral part of this Recommendation | International Standard.

Reference software is useful in aiding users of an image coding standard to establish and test conformance and interoperability, and to educate users and demonstrate the capabilities of the associated standard. For these purposes, the accompanying software is provided as an aid for the study and implementation of Rec. ITU-T T.832 | ISO/IEC 29199-2 technology. The reference software includes both encoder and decoder functionality. The reference decoder software is capable of decoding codestreams (or files) that conform to Rec. ITU-T T.832 | ISO/IEC 29199-2 in a manner that conforms to the decoding process specified in Rec. ITU-T T.832 | ISO/IEC 29199-2. The sample encoder software is capable of producing codestreams (or files) that conform to Rec. ITU-T T.832 | ISO/IEC 29199-2.

This Recommendation | International Standard includes a normative electronic attachment containing a reference ANSI C source code.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T T.835	2010-01-13	16
1.1	ITU-T T.835 (2010) Cor. 1	2011-06-13	16
2.0	ITU-T T.835	2012-01-13	16

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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Electronic attachment: Reference ANSI C source code

Introduction

This Recommendation | International Standard has been developed by ITU-T and ISO/IEC in a collaborative team that is referred to as the Joint Photographic Experts Group (JPEG). It is published as a technically-aligned twin text by both organizations (ITU-T and ISO/IEC).

This Recommendation | International Standard provides a reference software for Rec. ITU-T T.832 | ISO/IEC 29199-2 (*Information technology – JPEG XR image coding system – Image coding specification*) as an electronic attachment. The reference software is an integral part of this Recommendation | International Standard.

Reference software is useful in aiding users of an image coding standard to establish and test conformance and interoperability, and to educate users and demonstrate the capabilities of the associated standard. For these purposes, the accompanying software is provided as an aid for the study and implementation of Rec. ITU-T T.832 | ISO/IEC 29199-2 technology. The reference software includes both encoder and decoder functionality.

0.1   Purpose

The purpose of this Recommendation | International Standard is to provide the following.

–   Reference decoder software capable of decoding codestreams (or files) that conform to Rec. ITU-T T.832 | ISO/IEC 29199-2 in a manner that conforms to the decoding process specified in Rec. ITU-T T.832 | ISO/IEC 29199-2.

–   Sample encoder software capable of producing codestreams (or files) that conform to Rec. ITU-T T.832 | ISO/IEC 29199-2.

The use of this reference software is not required for making an implementation of an encoder or decoder in conformance to Rec. ITU-T T.832 | ISO/IEC 29199-2. Requirements established in Rec. ITU-T T.832 | ISO/IEC 29199-2 take precedence over the behaviour of the reference software.

0.2   Examples of use

Some examples of uses for the reference decoder software are as follows:

–   As an illustration of how to perform the decoding process specified in Rec. ITU-T T.832 | ISO/IEC 29199-2.

–   As the starting basis for the implementation of a decoder that conforms to Rec. ITU-T T.832 | ISO/IEC 29199-2.

–   For testing the conformance of a decoder implementation with the decoding process specified in Rec. ITU-T T.832 | ISO/IEC 29199-2 (as the values of the samples in all decoded pictures will be identical from all conforming decoder implementations that support the profile and level used in a codestream that conforms to Rec. ITU-T T.832 | ISO/IEC 29199-2, with limited allowances for colour sampling format conversions as specified in Rec. ITU-T T.832 | ISO/IEC 29199-2).

–   For (non-exhaustive) testing of the conformance of a codestream (or file) to the constraints specified for codestream (or file) conformance in Rec. ITU-T T.832 | ISO/IEC 29199-2, as the software can detect and report many codestream conformance violations.

    NOTE 1 – However, the lack of the detection of any conformance violation by the reference decoder software should not be considered as definitive proof that the codestream (or file) conforms to all constraints specified for conformance in Rec. ITU-T T.832 | ISO/IEC 29199-2.

Some examples of uses for the sample encoder software are as follows:

–   As an illustration of how to perform an encoding process that produces codestreams (or files) that conform to the constraints specified for codestream (or file) conformance in Rec. ITU-T T.832 | ISO/IEC 29199-2.

–   As the starting basis for the implementation of an encoder that conforms to Rec. ITU-T T.832 | ISO/IEC 29199-2.

–   As a means of generating codestreams (or files) for testing the conformance of a decoder implementation with the decoding process specified in Rec. ITU-T T.832 | ISO/IEC 29199-2.

–   As a means of demonstrating and evaluating examples of the quality that can be achieved by an encoding process that conforms to Rec. ITU-T T.832 | ISO/IEC 29199-2.

NOTE 2 – However, no guarantee of the quality that will be achieved by an encoder is provided by its conformance to Rec. ITU-T T.832 | ISO/IEC 29199-2, as the conformance of an encoder to Rec. ITU-T T.832 | ISO/IEC 29199-2 is defined only in terms of specified constraints imposed on the syntax of the output of the encoder. In particular, while the sample encoder software may suffice to provide some illustrative examples of what quality can be achieved in conformance to Rec. ITU-T T.832 | ISO/IEC 29199-2, it provides neither an assurance of minimum guaranteed image encoding quality nor maximum achievable image encoding quality.

NOTE 3 – Similarly, the computational resource characteristics (in terms of program or data memory usage, processing speed, types and characteristics of computational operations, etc.) of the sample software encoder or decoder should not be construed as representative of the typical, minimum or maximum computational resource characteristics to be exhibited by implementations of Rec. ITU-T T.832 | ISO/IEC 29199-2.

0.3   Warranty disclaimer

Regardless of any and all statements made herein or elsewhere regarding the possible uses of the reference software, the following disclaimers of warranty apply to the provided reference software.

–   ITU, ISO, and IEC disclaim any and all warranties, whether express, implied, or statutory, including any implied warranties of merchantability or of fitness for a particular purpose.

–   In no event shall the contributor(s) or ITU, ISO, or IEC be liable for any incidental, punitive, or consequential damages of any kind whatsoever arising from the use of these programs.

–   This disclaimer of warranty extends to the user of these programs and the user's customers, employees, agents, transferees, successors, and assignees.

–   ITU, ISO, and IEC do not represent or warrant that the software is free of infringement of any patents.

–   Commercial implementations of ITU-T Recommendations and ISO/IEC International Standards, including shareware, may be subject to royalty fees to patent holders.

–   Information regarding the common patent policy for ITU-T/ITU-R/ISO/IEC is available at
    http://www.itu.int/ITU-T/dbase/patent/patent-policy.html/.

Recommendation ITU-T T.835

Information technology – JPEG XR image coding system – Reference software[1]

1 Scope

This Recommendation | International Standard provides a reference software for Rec. ITU-T T.832 | ISO/IEC 29199-2 (*Information technology – JPEG XR image coding system – Image coding specification*) as an electronic attachment. The reference software is an integral part of this Recommendation | International Standard.

The purpose of this Recommendation | International Standard is to provide the following.

– Reference decoder software capable of decoding codestreams (or files) that conform to Rec. ITU-T T.832 | ISO/IEC 29199-2 in a manner that conforms to the decoding process specified in Rec. ITU-T T.832 | ISO/IEC 29199-2.

– Sample encoder software capable of producing codestreams (or files) that conform to Rec. ITU-T T.832 | ISO/IEC 29199-2.

The use of this reference software is not required for making an implementation of an encoder or decoder in conformance to Rec. ITU-T T.832 | ISO/IEC 29199-2, and conforming implementations of Rec. ITU-T T.832 | ISO/IEC 29199-2 are not expected to follow the algorithms or programming techniques used therein. Conformance requirements established in Rec. ITU-T T.832 | ISO/IEC 29199-2 take precedence over the behaviour of the reference software.

2 Normative 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.

2.1 Identical Recommendations | International Standards

None.

2.2 Paired Recommendations | International Standards equivalent in technical content

– Recommendation ITU-T T.832 (in force) | ISO/IEC 29199-2:in force, *Information technology – JPEG XR image coding system – Image coding specification*.

2.3 Additional references

None.

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[1] This Recommendation | International Standard includes a normative electronic attachment containing a reference ANSI C source code.

3 Definitions

For the purposes of this Recommendation | International Standard, the terms, definitions, abbreviations and symbols specified in Rec. ITU-T T.832 | ISO/IEC 29199-2 (particularly in its clause 3) apply. The following terms are further defined or clarified for purposes herein as follows.

3.1 **codestream**: A sequence of bits contained in a sequence of bytes that conforms to the codestream requirements specified by Rec. ITU-T T.832 | ISO/IEC 29199-2 or is to be tested to determine whether it conforms to the codestream requirements specified by Rec. ITU-T T.832 | ISO/IEC 29199-2.

3.2 **decoder**: An embodiment of the decoding process specified by Rec. ITU-T T.832 | ISO/IEC 29199-2 or a process embodiment that is to be tested to determine whether it conforms to the decoding process specified by Rec. ITU-T T.832 | ISO/IEC 29199-2.

NOTE – The decoder does not include the display process, which is outside the scope of this Recommendation | International Standard.

3.3 **encoder**: A process that produces *codestreams* or *files* that conform to Rec. ITU-T T.832 | ISO/IEC 29199-2 or are to be tested to determine whether these codestreams or files conform to Rec. ITU-T T.832 | ISO/IEC 29199-2.

3.4 **file**: (When used in reference to Annex A of Rec. ITU-T T.832 | ISO/IEC 29199-2) A finite-length sequence of bytes produced by an encoder that conforms to Rec. ITU-T T.832 | ISO/IEC 29199-2 Annex A or is to be tested to determine whether it conforms to Rec. ITU-T T.832 | ISO/IEC 29199-2 Annex A.

3.5 **output formatting**: (When used in reference to clause 9.10 of ITU-T Rec. T.832 | ISO/IEC 29199-2) The processes of formatting the output of the sample reconstruction process of the *decoder*.

3.6 **raw file**: A *file* used to store the resulting image buffers after the *output formatting* process. The *raw file* is described in detail in clause 6.2.4.

3.7 **reference software decoder**: The *decoder* software provided as an electronic attachment to this Recommendation | International Standard.

3.8 **sample software encoder**: The *encoder* software provided as an electronic attachment to this Recommendation | International Standard.

4 Abbreviations

For the purposes of this Recommendation | International Standard, relevant abbreviations are specified in clause 4 of Rec. ITU-T T.832 | ISO/IEC 29199-2.

5 Conventions

For the purposes of this Recommendation | International Standard, relevant conventions are specified in clause 5 of ITU-T Rec. T.832 | ISO/IEC 29199-2.

6 Reference software

6.1 General

The reference software for Rec. ITU-T T.832 | ISO/IEC 29199-2 is provided as an electronic attachment to this Recommendation | International Standard, and is an integral part thereof.

6.2 Structure and use of the software

This clause is not an integral part of this Recommendation | International Standard.

The reference software is written in the C programming language.

The "jpegxr" program is an example program that performs encoding or decoding, and uses data structures defined in the "jxr_priv.h" header file.

6.2.1 Use of the reference decoder

Usage

jpegxr <flags> <input-file>

Supported options

-o <path>

When this flag is present, it specifies an output file destination pathname. This is the pathname of the output decoded image data file.

Default: out.raw

-w

When this flag is present, the program will test the conditions that necessitate the syntax element LONG_WORD_FLAG to be equal to TRUE, and the decoding function will return an error message if the encoded value of LONG_WORD_FLAG is equal to FALSE and the associated constraints are violated. The input file will still be decoded regardless of the actual encoded value of the LONG_WORD_FLAG.

-P [44 | 55 | 66 | 111]

When this flag is present, the program will only decode codestreams conforming to the specified profile value.

Default: 111

NOTE 1 – The profile value and its interpretation are defined in Annex B of Rec. ITU-T T.832 | ISO/IEC 29199-2.

-L [4 | 8 | 16 | 32 | 64 | 128 | 255]

When this flag is present, the program will only decode codestreams conforming to the specified level value.

Default: 255

NOTE 2 – The level value and its interpretation are defined in Annex B of Rec. ITU-T T.832 | ISO/IEC 29199-2.

6.2.2 Use of the sample encoder

Usage

jpegxr-c <flags> <input-file>

Supported options

-c

When this flag is present, the program performs encoding. This flag is necessary to enable encoding.

-o <path>

When this flag is present, it specifies an output file destination pathname. When encoding (-c) this is the pathname of the encoded output file; otherwise, this is the pathname of the output decoded image data file.

Default: out.jxr

-b [ALL | NOFLEXBITS | NOHIGHPASS | DCONLY]

When this flag is present, it selects the sub-bands to encode (using terminology specified in Rec. ITU-T T.832 | ISO/IEC 29199-2).

Default: ALL

-a [0 | 1| 2]

When this flag is present, it selects the alpha encoder mode. The value 0 corresponds to no alpha image plane being encoded. The value 1 corresponds to encoding with an interleaved alpha image plane. The value 2 corresponds to encoding with a separate alpha plane.

Default: For TIFF input files, the method described in clause 6.2.5 is used to infer whether an alpha channel is available for encoding. When the encoder infers that an alpha channel is available and the -p described below is not used, the default alpha encoding mode is 2. When the encoder infers that an alpha channel is present and the -p flag described below is used, the default alpha encoder mode is 0.

For raw input files, when the -M parameter specified by the user is 9, 10, 11, 12 13, 14, 23, 24, 25, 26 or 28, the default alpha encoder mode is 2.

In all other cases, the default alpha encoder mode is 0.

NOTE 1 – The definition of an interleaved alpha image plane is specified in Annex A of Rec. ITU-T T.832 | ISO/IEC 29199-2.

-p

When this flag is present, the encoder produces an output pixel format that includes a padding channel.

For TIFF input files, the method described in clause 6.2.5 is used to infer whether an alpha channel is available for encoding. When the encoder infers that an alpha channel is available, the -p flag causes the encoder to treat the inferred alpha channel as a padding channel instead.

-f [YUV420 | YUV422 | YUV444]

When this flag is present, it selects the internal colour format (INTERNAL_CLR_FMT) for codestreams with OUTPUT_CLR_FMT equal to RGB.

Default: YUV444

-F <bits>

When this flag is present, it sets the value of the syntax element TRIM_FLEXBITS in the codestream. If TRIM_FLEXBITS are enabled (-b ALL) then the <bits> value is the number of bits to trim. The useful values range from 0 to 15, inclusive. -F 0 keeps the most flexbits, and -F 15 keeps the fewest flexbits.

Default: 0

-h

When this flag is present, it enables encoding using "hard" tile boundaries. When this flag is present, the overlap operators are not applied across tile boundaries. Otherwise, "soft" tile boundaries are used – i.e., overlap operators are applied regardless of tile boundaries.

Default: soft tile boundaries

-m

When this flag is present, the encoder produces frequency-mode ordered codestreams. Otherwise, the encoder produces spatially ordered codestreams.

Default: spatially ordered codestreams

-l [0 | 1 |2]

When this flag is present, it controls the overlap stage of the encoding transformation process. The value 0 turns off overlap transform processing for both levels of transform processing. The value 1 enables first level overlapping only. The value 2 enables both first and second level overlapping.

Default: 1

-q <q1:q2:q3...>

When this flag is present, it sets the quantization parameter settings for each channel. If only one value is given, then the same quantization parameter value is used for all channels. If multiple values are given, separated by a ':' character, then each is assigned to a channel. If fewer values are given than the number of channels, then the last value is used for all the remaining channels. For example, one can use "-q 2:4" to specify Q=2 for Y and Q=4 for U and V channels of a colour image. The default is '-q 0', which along with '-b ALL' makes the encoding lossless. The useful range for this value is 0 to 255.

Default: 0 (lossless)

-Q <QP_FILE path>

When this flag is present, it specifies the pathname of a file that contains detailed information about the quantization parameters to be used when encoding (including macroblock-level specific quantization parameter selection), as further described below in clause 6.2.3.

-d

When this flag is present, derived quantization parameter settings are used. When this parameter is included, only one argument for -q is required and the encoder selects quantization parameter values for the U and V chroma components itself. With respect to a single set quantization parameter, this option can sometimes significantly improve compression capability under some circumstances. This setting has a close relationship with colour transformation processing.

-U <rows:columns>

When this flag is present, it specifies the number of tiles to encode. Based on the values set, the encoder gives uniform tile sizes, except when such uniformity is impossible. If one value is specified (for example -U 3), then that value is used to set both the number of tile rows and tile columns. If two values are given, separated by a ':' character, then tile rows are set using the first value and tile columns are set using the second value.

Default: 1

-C <width1:width2:width3...>

When this flag is present, it specifies the number of tile columns and the width of each tile column, in units of macroblocks. The number of tile columns is set equal to the number of values, separated by a ':' character, specified. Each value specifies the width of the tile corresponding to its order in units of macroblocks. If the width of the image, in units of macroblocks, exceeds the sum of the column widths specified, the additional macroblocks are added to the final tile column.

-R <height1: height2: height3...>

When this flag is present, it specifies the number of tile rows and the height of each tile row, in units of macroblocks. The number of tile rows is set equal to the number of values, separated by a ':' character, specified. Each value specifies the height of the tile corresponding to its order in units of macroblocks. If the height of the image, in units of macroblocks, exceeds the sum of the row heights specified, the additional macroblocks are added to the final tile row.

-w

When this flag is present, the program will set the syntax element LONG_WORD_FLAG to be equal to FALSE. If the encoder determines that the constraints associated with LONG_WORD_FLAG equal to FALSE are violated during the encoding of the codestream, the encoding will fail and produce an error message.

Default: LONG_WORD_FLAG is set equal to TRUE

-P [44 | 55 | 66 | 111]

When this flag is present, the encoder will set the PROFILE_IDC syntax element equal to the specified value. If the codestream fail to meet the conditions of this profile, the encoding fails.

Default: 111

NOTE 2 – The profile value and interpretations are defined in Annex B of Rec. ITU-T T.832 | ISO/IEC 29199-2.

-L [4 | 8 | 16 | 32 | 64 | 128 | 255]

When this flag is present, the encoder will set the LEVEL_IDC syntax element equal to the specified value. If the codestream fail to meet the conditions of this level, the encoding fails.

Default: 255

NOTE 3 – The level value and its interpretation are defined in Annex B of Rec. ITU-T T.832 | ISO/IEC 29199-2.

-s < top:left:bottom:right>

When this flag is present, it specifies the top, left, bottom and right margins used as windowing parameters for encoding the image.

-r

When this flag is present, the encoder reads from a raw (.raw) file. The raw file consists of the buffer of each channel in raster scan order, sequentially for each channel. When this flag is used, the flags '-W', '-H' and '-M' must also be present.

-W <value>

When this flag is present, it specifies the width of the image stored in the input file. When this flag is present, the flags '-r', '-H' and '-M' must also be present.

-H <value>

When this flag is present, it specifies the height of the image stored in the input file. When this flag is present, the flags '-r', '-W' and '-M' must also be present.

-M [3..34]

When this flag is present, it specifies the format of the image stored in the input file. Interpretation of the associated number is as follows:

- 3 – 3 channel.
- 4 – 4 channel.
- 5 – 5 channel.
- 6 – 6 channel.
- 7 – 7 channel.
- 8 – 8 channel.
- 9 – 3 channel Alpha.
- 10 – 4 channel Alpha.

- – 11 – 5 channel Alpha.
- – 12 – 6 channel Alpha.
- – 13 – 7 channel Alpha.
- – 14 – 8 channel Alpha.
- – 15 – 32bppRGBE.
- – 16 – 16bppBGR555.
- – 17 – 16bppBGR565.
- – 18 – 32bppBGR101010.
- – 19 – YCC420.
- – 20 – YCC422.
- – 21 – YCC444.
- – 22 – YCC444 Fixed Point.
- – 23 – YCC420 Alpha.
- – 24 – YCC422 Alpha.
- – 25 – YCC444 Alpha.
- – 26 – YCC444 Fixed Point Alpha.
- – 27 – CMYKDIRECT.
- – 28 – CMYKDIRECT Alpha.
- – 29 – 24bppBGR.
- – 30 – 32bppBGR.
- – 31 – 32bppBGRA.
- – 32 – 32bppPBGRA.
- – 33 – 64bppPRGBA.
- – 34 – 128bppPRGBAFloat.

When this flag is present, the flags '-r', '-W' and '-H' must also be present.

Default: 3

-B <value>

When this flag is present, it specifies the format of the image stored in the input file. Interpretation of the associated number is as follows:

- – 8 – 8 bits / sample / channel.
- – 10 – 10 bits / sample / channel.
- – 16 – 16 bits / sample / channel.

When this flag is present, the flags '-r', '-W', '-H' and '-M' must also be present.

Default: 8

6.2.3 QP file syntax

Comments start with a '#' character and continue to the end of the line. A comment can start anywhere on the line. Comments are ignored when parsing the file.

The keywords are:

- – DC, LP, HP
- – channel
- – independent

– separate

– tile

– uniform

A NUMBER is an unsigned decimal value.

A file consists of a number of tile descriptors, one tile descriptor for each encoded tile in the image. A tile descriptor is formatted as follows:

tile (<n>, <n>) { tile_comp_mode tile_body }

A tile_comp_mode is one of the following keywords:

– uniform

– separate

– independent

A tile_body is an unordered list of tile_items, where each is one of the following:

– channel <n> { channel_body }

– LP [map_list]

– HP [map_list]

A channel_body gives channel-specific information. The number of channels depends on the number of channels for the image encoding and the tile_comp_mode. A channel_body is one of the following:

– DC { <n> }

– LP { <n>... }

– HP { <n>... }

6.2.4 Raw file description

The raw file makes it possible to store the results of the output formatting process directly. The raw file output consists of either interleaved or sequential data from each of the channels in the image, without any header information. Buffers are stored in a raster scan order.

If OUTPUT_CLR_FMT is equal to YUV420, YUV422, YUV444 or CMYKDIRECT, the buffer for each channel is stored sequentially. For example, when OUTPUT_CLR_FMT is equal to YUV444, all Y samples are stored in the output file, followed by all U samples, followed by all V samples. If OUTPUT_CLR_FMT is equal to YUV422, half as many bytes used for the Y channel will be used to store the U and V channels. Otherwise, if OUTPUT_CLR_FMT is equal to YUV420, one quarter of the number of bytes used for the Y channel will be used to store the U and V channels. If OUTPUT_CLR_FMT is equal to YUV444 or YUV422 and OUTPUT_BITDEPTH is equal to BD10, two bytes are used per sample, and the 10 bits are stored in the LSBs of each 2-byte pair. Samples decoded from the alpha image plane (when present), are concatenated with the output obtained from the primary image.

Otherwise, if OUTPUT_CLR_FMT is not equal to YUV420, YUV422, YUV444 or CMYKDIRECT, the raw file output consists of interleaved data from each channel. The number of bytes used to store each sample depends on the value of OUTPUT_BITDEPTH and whether the format is a packed output format or not. The samples decoded from the image alpha plane (when present), are interleaved with the samples decoded from the primary image. For example, when OUTPUT_CLR_FMT is equal to 32bppBGRA, data is stored pixel by pixel, and each pixel is stored as 4 bytes (1 byte for B, followed by 1 byte for G, followed by 1 byte for R, and followed by 1 byte for A).
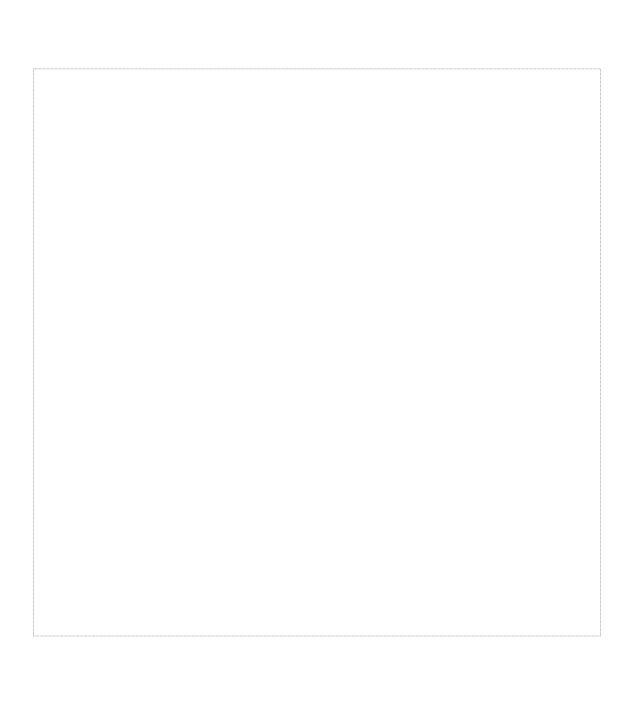
6.2.5 Encoder pixel format inference based on TIFF header

Table 1 specifies the mapping between the TIFF header and the pixel format inferred by the encoder. An entry in the table marked with "*" indicates a "don't care" condition. A check mark "✓" in the "alpha channel" column indicates the inference of the presence of an alpha channel, and a blank entry in this column indicates the inference of a lack of the presence of an alpha channel.

Table 1 – Mapping between TIFF header and encoder inferred pixel format

Bit depth	Number of components	Sample format	Photometric value	Alpha channel	Inferred pixel format
8	3	1	2		24bppRGB
16	3	1	2		48bppRGB
16	3	2	2		48bppRGBFixedPoint
16	3	3	2		48bppRGBHalf
32	3	2	2		96bppRGBFixedPoint
16	3	2	2		64bppRGBFixedPoint
16	3	3	2		64bppRGBHalf
32	3	2	2		128bppRGBFixedPoint
32	3	3	2		128bppRGBFloat
16	4	1	2	✓	64bppRGBA
16	4	2	2	✓	64bppRGBAFixedPoint
16	4	3	2	✓	64bppRGBAHalf
32	4	2	2	✓	128bppRGBAFixedPoint
32	4	3	2	✓	128bppRGBAFloat
8	4	1	5		32bppCMYK
8	5	1	5	✓	40bppCMYKAlpha
16	4	1	5		64bppCMYK
16	5	1	5	✓	80bppCMYKAlpha
8	1	1	*		8bppGray
16	1	1	*		16bppGray
16	1	2	*		16bppGrayFixedPoint
16	1	3	*		16bppGrayHalf
32	1	2	*		32bppGrayFixedPoint
32	1	3	*		32bppGrayFloat
1	1	*	*		BlackWhite

When the -p argument is used in conjunction with a TIFF input file for which 64bppRGBAFixedPoint, 64bppRGBAHalf, 128bppRGBAFixedPoint or 128bppRGBAFloat has been inferred, the encoder instead chooses 64bppRGBFixedPoint, 64bppRGBHalf, 128bppRGBFixedPoint or 128bppRGBFloat, respectively.

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