SMPTE PCD RP 268-3:20xx

SMPTE Public Committee Draft

Reference Materials for DPX V2.0 HDR Implementations

This material is work under development and shall not be referred to as a SMPTE Standard, Recommended Practice, or Engineering Guideline. It is distributed for review and comment; distribution does not constitute publication.

Please be aware that all contributions to this material are being conducted in accordance with the SMPTE Standards Operations Manual, which is accessible on the SMPTE website with the Society Bylaws:

https://www.smpte.org/about/policies-and-governance

Your comments and contributions, whether as a member or guest, are governed by these provisions and any comment or contribution made by you indicates your acknowledgement that you understand and are complying with the full form of the Operations Manual. Please take careful note of the sections requiring contributors to inform the Committee of personal knowledge of any claims under any issued patent or any patent application that likely would be infringed by an implementation of this material. This general reminder is not a substitute for a contributor's responsibility to fully read, understand, and comply with the full Standards Operations Manual.

Copyright Notice

Patent Notice

Attention is drawn to the possibility that some of the elements of this material may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

A list of all public CDs can be found on the SMPTE website

https://www.smpte.org/public-committee-drafts#listing

Proposed SMPTE Recommended Practice

This document is subject to change.

Table of Contents Page

Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE"s Engineering Documents, including Standards, Recommended Practices, and Engineering Guidelines, are prepared by SMPTE"s Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee 31FS.

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword "reserved" indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword "forbidden" indicates "reserved" and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; then formal languages; then figures; and then any other language forms.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

The Digital Picture eXchange (DPX) format is defined in SMPTE ST 268-1, and DPX format extensions for high dynamic range and wide color gamut pictures are defined in SMPTE ST 268-2. This document provides reference materials for testing reader and writer implementations that conform to the extensions in SMPTE ST 268-2.

At the time of publication, no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

1 Scope

This Recommended Practice specifies test images and a procedure to check correct operation of SMPTE ST 268-2 DPX reader implementations. While the parsing of metadata such as colorimetric specification and transfer characteristic is verified by the specified procedure, application of an appropriate color transform (e.g., to render to a display device) is considered out of scope.

2 Normative References

The following documents contains provisions that, through reference in this text, constitute provisions of this Recommended Practice. Dated references require that the specific edition cited shall be used as the reference. Undated citations refer to the edition of the referenced document (including any amendments) current at the date of publication of this document. All documents are subject to revision, and users of this engineering document are encouraged to investigate the possibility of applying the most recent edition of any undated reference.

SMPTE ST 268-1:2014, File Format for Digital Moving-Picture Exchange (DPX)

SMPTE ST 268-2:2018, Digital Moving-Picture Exchange (DPX) – Format Extensions for High Dynamic Range and Wide Color Gamut

3 Terms and Definitions

For the purposes of this document, the terms and definitions given in SMPTE ST 268-1 and SMPTE ST 268-2 apply.

3.1. full range

pixel encoding where component values are mapped to 2^N - 1 quantization levels in the range of [0, 2^N - 1], where N is the component bit depth

3.2. narrow range

pixel encoding where component values other than color differences are mapped to 219 · 2^{N-8} + 1 quantization levels in the range of [16 · 2^{N-8}, 235 · 2^{N-8}], and color difference component values are mapped to 224 · 2^{N-8} + 1 quantization levels in the range of [16 · 2^{N-8}, 240 · 2^{N-8}], where N is the component bit depth

4 Test Images

4.1. General

This document defines test procedures intended to help ascertain the correct operation of DPX reader implementations. For each image in Table 2, Table 3, and Table 4, the following procedure shall be executed:

1) The implementation shall be induced to read the test image.
2) The implementation shall be induced to output a representation of the samples contained within the test image that was read. The representation may be comprised of raw pixel data or may simply be the output of one or more suitable hash functions of the pixel samples (e.g., CRC-32, SHA-256, etc.). The selection of a hash function is outside the scope of this Recommended Practice.

3) The output representation shall be compared to the corresponding reference representation. Each reference representation is provided as a set of raw pixel planes, which may be processed appropriately (e.g., using a hash function) to create a representation suitable for comparisons.
    a. If the output representation matches with the reference representation, then step 4 is then performed.
    b. If the output representation does not match with the reference representation, then the test shall conclude with a result of “Fail: pixel data does not match.”
4) If capable, the implementation shall be induced to dump the header metadata. The dumped header metadata shall be compared with the reference header metadata.
    a. If the dumped metadata matches the reference metadata, then the test shall conclude with a result of “Pass.”
    b. If the dumped metadata matches the reference metadata, but some of the reference metadata is not present in the dumped metadata, then the test shall conclude with a result of “Pass. Warning: some of the reference metadata is not present.”
    c. If any dumped metadata does not match the reference metadata, then the test shall conclude with a result of “Fail.”

NOTE 1. In DPX files, components can be either linear or nonlinear as indicated by the transfer characteristic header field. The component type notation in this section does not employ a prime designation (e.g., R’ to represent red) as is sometimes used in other documents to distinguish linear from nonlinear samples.

4.2. Location of Test Images and References

The root directory for the companion elements is referred to herein as `${ROOT}`.

All image files referenced herein are located in the directory:

`${ROOT}/examples`

Raw pixel planes and metadata dumps are located in the directory:

`${ROOT}/refs`

The pixel planes and metadata dumps have the same base file name as the corresponding image file. A pixel plane file extension includes a number that indicates the image element in which it was carried (extension `.0` corresponds to image element #1, extension `.1` corresponds to image element #2, etc.) and a letter indicating the component type as specified in Table 1. The metadata dump is contained in a text file with the extension `.txt`.

EXAMPLE The image file `metadata-test.dpx` has associated raw pixel plane files called `metadata-test.0.r`, `metadata-test.0.g`, and `metadata-test.0.b` that correspond to the red, green, and blue component planes, respectively, of image element #1. The file `metadata-test.txt` contains a text representation of the metadata in `metadata-test.dpx`.

Table 1 – File extension used for component types

File extension	Pixel plane component type
.r	Red (R)
.g	Green (G)
.b	Blue (B)
.y	Luma (Y)
.u	Color Difference C_B
.v	Color Difference C_R
.a	Alpha (A)

4.3. Color Test Pattern

The test images listed in Table 2 are used to test a number of permutations of bit depth, image element descriptors, byte ordering, datum ordering, packing methods, and run-length encoding.

Table 2 – List of color test pattern images

Image Name	Pixel encoding	Image element descriptors used	Byte order, packing, & encoding
ctest_8bpclr_BGR444_msbf_l2r_packed_norle.dpx	8 bpc narrow range	53 (B, G, R)	MSBF, left-to-right, packed, no RLE
ctest_8bpclr_BGR444p_msbf_l2r_packed_rle.dpx	8 bpc narrow range	3 (B), 2 (G), 1 (R)	MSBF, left-to-right, packed, RLE
ctest_8bpclr_CYAYA420_lsbf_l2r_packed_rle.dpx	8 bpc narrow range	105 (C, Y, A, Y, A [4:2:0:4])	LSBF, left-to-right, packed, RLE
ctest_8bpclr_CYY420_lsbf_l2r_packed_norle.dpx	8 bpc narrow range	104 (C, Y, Y [4:2:0])	LSBF, left-to-right, packed, no RLE
ctest_8bpclr_YCbCr420p_msbf_r2l_packed_norle.dpx	8 bpc narrow range	6 (Y), 10 (C_B [4:2:0]), 11 (C_R [4:2:0])	MSBF, right-to-left, packed, no RLE
ctest_8bpclr_YCbCr422p_lsbf_r2l_packed_norle.dpx	8 bpc narrow range	6 (Y), 7 (C_B, C_R [4:2:2])	LSBF, right-to-left, packed, no RLE
ctest_8bpclr_YCbCrA420p_msbf_r2l_packed_rle.dpx	8 bpc narrow range	6 (Y), 10 (C_B [4:2:0]), 11 (C_R [4:2:0]), 4 A	MSBF, right-to-left, packed, RLE
ctest_8bpclr_YCbCrA422p_lsbf_r2l_packed_rle.dpx	8 bpc narrow range	6 (Y), 7 (C_B, C_R [4:2:2]), 4 (A)	LSBF, right-to-left, packed, RLE
ctest_10bpcfr_BGRA444p_lsbf_l2r_packed_rle.dpx	10 bpc full range	3 (B), 2 (G), 1 (R), 4 (A)	LSBF, left-to-right, packed, RLE
ctest_10bpcfr_RGB444_lsbf_l2r_mb_norle.dpx	10 bpc full range	56 (R, G, B)	LSBF, left-to-right, method B, no RLE
ctest_10bpcfr_RGB444_msbf_l2r_ma_norle.dpx	10 bpc full range	56 (R, G, B)	MSBF, left-to-right, method A, no RLE

ctest_10bpcfr_RGBA444p_msbf_l2r_mb_rle.dpx	10 bpc full range	1 (R), 2 (G), 3 (B), 4 (A)	MSBF, left-to-right, method B, RLE
ctest_10bpclr_ARGB444_lsbf_l2r_ma_norle.dpx	10 bpc narrow range	55 (A, R, G, B)	LSBF, left-to-right, method A, no RLE
ctest_10bpclr_ARGB444_msbf_l2r_packed_norle.dpx	10 bpc narrow range	55 (A, R, G, B)	MSBF, left-to-right, packed, no RLE
ctest_10bpclr_ARGB444p_lsbf_l2r_ma_rle.dpx	10 bpc narrow range	4 (A), 1 (R), 2 (G), 3 (B)	LSBF, left-to-right, method A, RLE
ctest_10bpclr_ARGB444p_msbf_l2r_packed_rle.dpx	10 bpc narrow range	4 (A), 1 (R), 2 (G), 3 (B)	MSBF, left-to-right, packed, RLE
ctest_10bpclr_BGRA444_lsbf_l2r_packed_norle.dpx	10 bpc narrow range	54 (B, G, R, A)	LSBF, left-to-right, packed, no RLE
ctest_10bpclr_CbYACrYA422_lsbf_r2l_ma_rle.dpx	10 bpc narrow range	101 (C_B, Y, A, C_R, Y, A [4:2:2:4])	LSBF, right-to-left, method A, RLE
ctest_10bpclr_CbYACrYA422_msbf_r2l_packed_rle.dpx	10 bpc narrow range	101 (C_B, Y, A, C_R, Y, A [4:2:2:4])	MSBF, right-to-left, packed, RLE
ctest_10bpclr_CbYCr444_lsbf_r2l_packed_norle.dpx	10 bpc narrow range	102 (C_B, Y, C_R [4:4:4])	LSBF, right-to-left, packed, no RLE
ctest_10bpclr_CbYCrA444_lsbf_r2l_packed_rle.dpx	10 bpc narrow range	103 (C_B, Y, C_R, A [4:4:4:4])	LSBF, right-to-left, packed, RLE
ctest_10bpclr_CbYCrY422_lsbf_r2l_ma_norle.dpx	10 bpc narrow range	100 (C_B, Y, C_R, Y [4:2:2])	LSBF, right-to-left, method A, no RLE
ctest_10bpclr_CbYCrY422_msbf_r2l_packed_norle.dpx	10 bpc narrow range	100 (C_B, Y, C_R, Y [4:2:2])	MSBF, right-to-left, packed, no RLE
ctest_10bpclr_CYAYA420_msbf_r2l_mb_rle.dpx	10 bpc narrow range	105 (C, Y, A, Y, A [4:2:0:4])	MSBF, right-to-left, method B, RLE
ctest_10bpclr_CYY420_msbf_r2l_mb_norle.dpx	10 bpc narrow range	104 (C, Y, Y [4:2:0])	MSBF, right-to-left, method B, no RLE
ctest_10bpclr_RGB444p_lsbf_l2r_mb_rle.dpx	10 bpc narrow range	1 (R), 2 (G), 3 (B)	LSBF, left-to-right, method B, RLE
ctest_10bpclr_RGB444p_msbf_l2r_ma_rle.dpx	10 bpc narrow range	1 (R), 2 (G), 3 (B)	MSBF, left-to-right, method A, RLE

ctest_10bpclr_RGBA444_msbf_l2r_mb_norle.dpx	10 bpc narrow range	57 (R, G, B, A)	MSBF, left-to-right, method B, no RLE
ctest_10bpclr_YCbCr422p_lsbf_r2l_mb_norle.dpx	10 bpc narrow range	6 (Y), 7 (C_B, C_R [4:2:2])	LSBF, right-to-left, method B, no RLE
ctest_10bpclr_YCbCr422p_msbf_r2l_ma_norle.dpx	10 bpc narrow range	6 (Y), 7 (C_B, C_R [4:2:2])	MSBF, right-to-left, method A, no RLE
ctest_10bpclr_YCbCrA422p_lsbf_r2l_mb_rle.dpx	10 bpc narrow range	6 (Y), 7 (C_B, C_R [4:2:2]) 4 (A)	LSBF, right-to-left, method B, RLE
ctest_10bpclr_YCbCrA422p_msbf_r2l_ma_rle.dpx	10 bpc narrow range	6 (Y), 7 (C_B, C_R [4:2:2]) 4 (A)	MSBF, right-to-left, method A, RLE
ctest_12bpcfr_BGR444_lsbf_r2l_mb_norle.dpx	12 bpc full range	53 (B, G, R)	LSBF, right-to-left, method B, no RLE
ctest_12bpcfr_BGR444_msbf_r2l_ma_norle.dpx	12 bpc full range	53 (B, G, R)	MSBF, right-to-left, method A, no RLE
ctest_12bpcfr_BGRA444p_msbf_r2l_mb_rle.dpx	12 bpc full range	3 (B), 2 (G), 1 (R), 4 (A)	MSBF, right-to-left, method B, RLE
ctest_12bpcfr_RGBA444p_lsbf_l2r_packed_rle.dpx	12 bpc full range	1 (R), 2 (G), 3 (B), 4 (A)	LSBF, left-to-right, packed, RLE
ctest_12bpclr_ABGR444_lsbf_l2r_ma_norle.dpx	12 bpc narrow range	58 (A, B, G, R)	LSBF, left-to-right, method A, no RLE
ctest_12bpclr_ABGR444_msbf_l2r_packed_norle.dpx	12 bpc narrow range	58 (A, B, G, R)	MSBF, left-to-right, packed, no RLE
ctest_12bpclr_ABGR444p_lsbf_l2r_ma_rle.dpx	12 bpc narrow range	4 (A), 3 (B), 2 (G), 1 (R)	LSBF, left-to-right, method A, RLE
ctest_12bpclr_ABGR444p_msbf_l2r_packed_rle.dpx	12 bpc narrow range	4 (A), 3 (B), 2 (G), 1 (R)	MSBF, left-to-right, packed, RLE
ctest_12bpclr_BGR444p_lsbf_r2l_mb_rle.dpx	12 bpc narrow range	3 (B), 2 (G), 1 (R)	LSBF, right-to-left, method B, RLE

ctest_12bpclr_BGR444p_msbf_r2l_ma_rle.dpx	12 bpc narrow range	3 (B), 2 (G), 1 (R)	MSBF, right-to-left, method A, RLE
ctest_12bpclr_BGRA444_msbf_r2l_mb_norle.dpx	12 bpc narrow range	54 (B, G, R, A)	MSBF, right-to-left, method B, no RLE
ctest_12bpclr_CbYACrYA422_msbf_l2r_mb_rle.dpx	12 bpc narrow range	101 (C_B, Y, A, C_R, Y, A [4:2:2:4])	MSBF, left-to-right, method B, RLE
ctest_12bpclr_CbYCr444_lsbf_l2r_mb_norle.dpx	12 bpc narrow range	102 (C_B, Y, C_R [4:4:4])	LSBF, left-to-right, method B, no RLE
ctest_12bpclr_CbYCr444_msbf_l2r_ma_norle.dpx	12 bpc narrow range	102 (C_B, Y, C_R [4:4:4])	MSBF, left-to-right, method A, no RLE
ctest_12bpclr_CbYCrA444_lsbf_l2r_mb_rle.dpx	12 bpc narrow range	103 (C_B, Y, C_R, A [4:4:4:4])	LSBF, left-to-right, method B, RLE
ctest_12bpclr_CbYCrA444_msbf_l2r_ma_rle.dpx	12 bpc narrow range	103 (C_B, Y, C_R, A [4:4:4:4])	MSBF, left-to-right, method A, RLE
ctest_12bpclr_CbYCrY422_msbf_l2r_mb_norle.dpx	12 bpc narrow range	100 (C_B, Y, C_R, Y [4:2:2])	MSBF, left-to-right, method B, no RLE
ctest_12bpclr_CYAYA420_lsbf_r2l_packed_rle.dpx	12 bpc narrow range	105 (C, Y, A, Y, A [4:2:0:4])	LSBF, right-to-left, packed, RLE
ctest_12bpclr_CYY420_lsbf_r2l_packed_norle.dpx	12 bpc narrow range	104 (C, Y, Y [4:2:0])	LSBF, right-to-left, packed, no RLE
ctest_12bpclr_RGBA444_lsbf_l2r_packed_norle.dpx	12 bpc narrow range	57 (R, G, B, A)	LSBF, left-to-right, packed, no RLE
ctest_12bpclr_YCbCr420p_lsbf_r2l_ma_norle.dpx	12 bpc narrow range	6 (Y), 10 (C_B [4:2:0]), 11 (C_R [4:2:0])	LSBF, right-to-left, method A, no RLE
ctest_12bpclr_YCbCr420p_msbf_r2l_packed_norle.dpx	12 bpc narrow range	6 (Y), 10 (C_B [4:2:0]), 11 (C_R [4:2:0])	MSBF, right-to-left, packed, no RLE
ctest_12bpclr_YCbCrA420p_lsbf_r2l_ma_rle.dpx	12 bpc narrow range	6 (Y), 10 (C_B [4:2:0]), 11 (C_R [4:2:0]), 4 A	LSBF, right-to-left, method A, RLE
ctest_12bpclr_YCbCrA420p_msbf_r2l_packed_rle.dpx	12 bpc narrow range	6 (Y), 10 (C_B [4:2:0]), 11 (C_R [4:2:0]), 4 A	MSBF, right-to-left, packed, RLE

4.4. Metadata Test Images

The test images listed in Table 3 are used to test user data and standards-based metadata carried in DPX files.

Table 3 – List of standards-based metadata and user data test images

Image Name	Description
metadata-test.dpx	Test image with no standards-based metadata or user data
metadata-test-klv.dpx	Test image with ST 336 (KLV) standards-based metadata
metadata-test-regxml.dpx	Test image with Reg-XML standards-based metadata
metadata-test-xmp.dpx	Test image with XMP standards-based metadata
metadata-test-user-klv.dpx	Test image with KLV standards-based metadata, user data, SMPTE time code (ST 268-1), VIC

4.5. Other Test Images

The images listed in Table 4 are used to test other aspects of a reader implementation as described.

Table 4 – List of other test images

Image Name	Description
1bit_test.dpx	Test image with 1-bit components
1x1.dpx	Test image of size 1x1 (only one pixel)
1x4096.dpx	Test image of size 1x4096 (only one column)
24kx1.dpx	Test image of size 24000x1 (only one row)
24kx4k.dpx	Large test image (size 24000x4000)
331x113.dpx	Test image of size 331x113 (test of odd width and height)

cb_16b.dpx	Test image with 16-bit components
cb_32b.dpx	Test image with 32-bit (floating point) components
cb_64b.dpx	Test image with 64-bit (floating point) components
cb_8ie.dpx	Test image utilizing 8 image elements
cb_pad.dpx	Test image that includes end-of-line and end-of-image padding

Annex A (Informative) Reference Code

A.1 Repository

A reference implementation that is believed to be compliant to SMPTE ST 268-2 is provided as a companion software element of this document.