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File Format for Digital Moving- Picture Exchange (DPX)



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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.

SMPTE ST 268 was prepared by Technology Committee 31FS.

Intellectual Property

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

1.1 This standard defines a file format for the exchange of digital moving pictures on a variety of media between computer-based systems. It does not define the characteristics of input or output devices or displays. This format will be known as the SMPTE digital picture exchange format version 2.0, or DPX in short form. The file extension will be .dpx.

1.2 This flexible, resolution-independent file format describes pixel-based (raster) images with attributes defined in the binary file header. Each file represents a single image with up to eight image elements. Image elements are defined as a single component (e.g. luma) or multiple components (e.g. red, green, and blue) as defined by Table 1.

1.3 Image data is packed for efficient storage with the option to pad to 32-bit word boundaries (two alternative padding formats are allowed: see table 3B and annex B). Multibyte quantities may be stored with either the most significant byte first or the least significant byte first, where first means in the location with the lowest address, or the first byte in sequence from a byte-serial data channel. Both byte-order conventions are supported. The “magic number” in field 1 of the file information section is used to distinguish the byte order (annex A provides an historical perspective for the existence of the two byte-order conventions).

2 Normative References

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 240:1999) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 240M-1999). Documents with the same root number (e.g. 240) and publication year (e.g. 1999) are functionally identical.

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI/IEEE 754-1985 (R1991), Binary Floating-Point Arithmetic

SMPTE ST 12-1:2014, Time and Control Code

SMPTE ST 125:2013, SDTV Component Video Signal Coding 4:4:4 and 4:2:2 for 13.5 MHz and 18 MHz Systems

SMPTE ST 240:1999, Television — 1125-Line High-Definition Production Systems — Signal Parameters

SMPTE ST 254:2008, Motion-Picture Film (35-mm) — Manufacturer-Printed, Latent Image Identification Information

SMPTE ST 274:2008, Television — 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

SMPTE ST 296:2012, 1280x720 Progressive Image 4:2:2 and 4:4:4 Sample Structure — Analog and Digital Representation and Analog Interface

SMPTE ST 2065-3:2012, Academy Density Exchange Encoding (ADX) — Encoding Academy Printing Density (APD) Values

ISO 8601:2004, Data Elements and Interchange Formats — Information Interchange — Representation of Time and Dates

ISO/IEC 8859-1:1998, Information Processing — 8-Bit Single-Byte Coded Graphics Character Sets — Latin Alphabets 1

ITU-R BT.601-5 (10/95), Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-Screen 16:9 Aspect Ratios

ITU-R BT.709-5 (04/02), Parameter Values for the HDTV Standards for Production and International Programme Exchange

3 Definitions

The reference field number from Sections 5 and 6 is indicated in brackets at the end of each definition:

3.1

magic number

Indicates the start of the image file and is used to determine byte order. The file format allows machines to create files in either of the two most common byte orders, whichever is easier for that machine. Byte-order translation is only required for machines reading files that were created on a machine with reverse byte order. Programs creating DPX files should write the magic number with the ASCII value of "SDPX" (0x53445058 hex). Programs reading DPX files should use the first four bytes to determine the byte order of the file. The first four bytes will be S, D, P, X if the byte order is most significant byte first, or X, P, D, S if the byte order is least significant byte first. [1]

3.2

image file size

Indicates the size of the entire file; i.e. containing both header and image data. [4]

3.3

ditto key

Indicates that all fields are the same as the previous frame in the sequence except for fields related to the frame number (48, 50, 58, 61). Also, the offsets to the image data (21.12) will change if run-length encoding is used. The ditto key is a read-time shortcut only, and the other fields in the header must still be filled in when the file is created. [5]

3.4

creation date/time

Defined as yyyy:mm:dd:hh:mm:ssLTZ, formatted according to ISO 8601. [10]

"LTZ" means "Local Time Zone;" format is:

LTZ = Z (*time zone = UTC*), or LTZ = +/-hh, or LTZ = +/-hhmm (*local time is offset from UTC*)

3.5

encryption key

Indicates that the image data is encrypted to prevent unauthorized use. The default is **FFFFFFF** for no encryption. Any other value indicates that the image data is encrypted and this value can be used as the encryption key. Note that the header data is not encrypted. [15]

3.6

image orientation

Indicates the orientation of the image data required for display. The possible orientations are listed in Table 2. The standard orientation for core set images (code 0) is left to right (line direction) and top to bottom (frame direction). [17]

3.7

image element data structure

A data structure (group of fields) is repeated for each image element. An image element can contain a single component or multiple components, as defined in Table 1. The presentation order of both whole elements

and components of multi-component image elements is also defined in Table 1. All components in an image element must have the same number of bits, transfer function, and colorimetric specification. [21]

3.8

reference low data code value

Defines the minimum expected code value for image data. For printing density, the default value is 0. For ITU-R 601-5 luma, the default value is 16. [21.2]

3.9

reference low quantity represented

Defines the corresponding signal level or measured value to the reference low data code value. For printing density, the default is a density of 0.00. For ITU-R 601-5, the luma default is 0 mV. [21.3]

3.10

reference high data code value

Defines the maximum expected code value for image data. For 10-bit printing density, the default code value is 1023. For ITU-R 601-5 luma, the default value is 235. [21.4]

3.11

reference high quantity represented

Defines the corresponding signal level or measured value to the reference high data code value. For printing density, the default is a density of 2.048. For ITU-R 601-5 luma, the default is 700 mV. [21.5]

3.12

descriptor for image element n

Defines the components that make up an image element and their pixel packing order. The valid components are listed in Table 1. [21.6]

3.13

transfer characteristic

Defines the amplitude transfer function used to transform the data from a linear original. The inverse of the transfer function is needed to recreate a linear image element (see Table 5A). [21.7]

3.14

colorimetric specification

Defines the appropriate color reference primaries (for additive color systems like television) or color responses (for printing density) (see Table 5B). [21.8]

3.15

bit depth

Defines the number of bits for each component in the image element. All components must have the same bit depth. Valid bit depths are 1-, 8-, 10-, 12-, and 16-bit integer, and 32- and 64-bit IEEE floating point (see Table 3A). [21.9]

3.16

packing

For image element n, defines the data packing mode. The valid options are listed in Table 3B. [21.10]

3.17

encoding

For image element n, defines whether or not the element is run-length encoded. The valid options are listed in Table 3C. [21.11]

3.18

offset

To data for image element n, defines the offset in bytes to the image data for element n from the beginning of the file. [21.12]

3.19

end-of-line padding

Specifies the number of padded bytes at the end of each line. The default is 0 (no padding). [21.13]

3.20

end-of-image padding

Specifies the number of padded bytes at the end of each image element. The default is 0 (no padding). [21.14]

3.21

X offset

Defines the line offset (in pixels) from the first pixel in the original image. The default is 0. This is useful if an image is cropped and the user wishes to specify its location with respect to the original contiguous image.[30]

3.22

Y offset

Defines the frame offset (in lines) from the first line in the original contiguous image. The default is 0. [31]

3.23

X center

Defines the X image center in pixel units (floating point). [32]

3.24

Y center

Defines the Y image center in line units (floating point). [33]

3.25

X pixel count

Defines the number of pixels per line in the original image. [34]

3.26

Y pixel count

Defines the number of lines per image in the original image. [35]

3.27

source image filename

Defines the source image from which this image was extracted or processed. [36]

3.28

source image date/time

Defines the creation time of the source image from which the image was extracted or processed. Formatting is as per Section 3.4 [37]

3.29

border validity

Defines the region of an image that is eroded due to edge-sensitive filtering operations. The X-left, X-right, Y-top, and Y-bottom value defines the width of the eroded border. The default is 0,0,0,0 in pixel units (no erosion). [40]

3.30

pixel aspect ratio

Specified as the ratio of a horizontal integer and a vertical integer. For example, a SMPTE ST 274 signal has a pixel aspect ratio of 1:1, which is 1920 active pixels and 1080 active lines in a 16:9 frame. [41]

3.31

X scanned size

Defines the horizontal size of the original scanned optical image in millimeters. [42.1]

3.32**Y scanned size**

Defines the vertical size of the original scanned optical image in millimeters. [42.2]

3.33**film edge code information**

Encodes data from machine readable portion of film edge code, according to SMPTE ST 254. [43, 44, 45, 46, 47, 48]

3.34**frame position in sequence**

Defines the frame number in the image sequence. [50]

3.35**sequence length**

Defines the total number of frames in the image sequence. [51]

3.36**held count**

Specifies how many sequential frames for which to hold the current frame. In animation, it is often desirable to hold identical frames. [52]

3.37**shutter angle**

Defines the shutter angle in degrees of the motion-picture camera. This specifies the temporal sampling aperture. [54]

3.38**frame identification**

A user-defined field that labels select frames as key frames or wedge frames, etc. [55]

3.39**slate information**

A user-defined ASCII field for recording production information from the camera slates. [56]

3.40**SMPTE time code**

The characters are encoded into the 32-bit word according to Table 6. [58]

3.41**SMPTE user bits**

These are encoded according to Table 6. [59]

3.42**field number**

Of the first field in the file, may be 1 or 2 for component video, 1 to 4 for NTSC or component video decoded from NTSC, or 1 to 12 for PAL or component video decoded from PAL. Color frame sequence information is useful when decoding and subsequently re-encoding component video. The field number is set to 0 where field designation is inappropriate. [61]

3.43**video signal standard**

Defines the video source. Video signal standards are listed in Table 4. [62]

3.44**horizontal sampling rate (Hz)**

The clock rate at which samples were acquired. This is an inverse function of the total number of samples per scan line, rather than the active number of pixels per line indicated in field 19. Thus, for SMPTE ST 274 at 24.00 Hz frame rate, for example, it would be 74.25 MHz. [64]

3.45**vertical sampling rate (Hz)**

The rate at which the scanning of the whole extent of the image is repeated, even if each such scan is incomplete, i.e. is interlaced. Thus, for example, although 625/50 scanning has a true frame rate of 25 Hz, its vertical sampling rate would be considered to be 50 Hz. [65]

3.46**time offset from sync to first pixel (microseconds)**

Defines the edge of the digital image with respect to sync and the sampling phase which is necessary to reconstruct a composite image. The sync reference is the reference edge of horizontal sync. [67]

3.47**Gamma**

Defines the power law exponent that represents the gamma correction applied to a video image. In the expression $Y = X^{1/\gamma}$, the default gamma for NTSC is 2.2. [68]

3.48**black level code value**

Defines the digital code value representing reference black (camera lens capped, RGB signal set to 0 mV). For ITU-R 601-5, the default black level code value is 16. [69]

3.49**black gain**

Defines the linear gain applied to signals below the breakpoint (this is 4.5 for SMPTE ST 274). [70]

3.50**Breakpoint**

Defines the signal level above which the gamma law is applied (this is 0.018 of full scale for SMPTE ST 274). [71]

3.51**reference white level code value**

Defines the digital code value representing reference white (90% reflectance white card, RGB signal set to 700 mV). For ITU-R 601-5, the default reference white level code value is 235. [72]

3.52**integration time**

Defines the temporal sampling aperture of the television camera; most useful for CCD cameras. [73]

4 File

4.1 The file contains four sections, the first three of which are header information:

- (i) Generic file information, image information, data format, and image origination information (fixed length) [Section 5];
- (ii) Motion-picture and television industry-specific information (fixed length) [Section 6];
- (iii) User-defined information. This section provides an extended area for customized information needed by some users. The format of this section is not defined by the standard. This section is variable length with a maximum length of 1 Mbyte. It may be of zero length [Section 7];
- (iv) Image data [Section 8].