

SMPTE STANDARD

Interoperable Master Format – Application #5 ACES



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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. This SMPTE Engineering Document was prepared by Technology Committee 35PM.

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

This document specifies Compositions for IMF Application #5. It is a specialization of the IMF Framework.

Application #5 targets archival applications where a TV or movie title is to be archived as a single, high-quality set of master files from which one or more content versions can be derived.

It features SMPTE ST 2065-1 (ACES) image essence of arbitrary spatial and temporal resolution with individual frames encoded as ACES images.

The transformation of Application #5 Compositions to the output formats appropriate for different distribution channels is specified in other documents and outside the scope of this document. To facilitate Output Profile List processing, Annex A defines Pixel Color Schemes, as specified in SMPTE ST 2067-101, for the use with IMF Application #5.

2 Conformance Notation

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; followed by formal languages; then figures; and then any other language forms.

3 Normative References

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.

IEEE Std 754-2008, IEEE Standard for Floating-Point Arithmetic

IEC 61996-2-1:1999 Multimedia systems and equipment - Colour measurement and management - Part 2-1: Colour management; Default RGB colour space, sRGB

ISO/IEC 646:1991 Information technology — ISO 7-bit coded character set for information interchange

ISO/IEC 12639:2004 Graphic Technology — Prepress Digital Data Exchange — Tag Image File Format for Image Technology (TIFF/IT)

ISO/IEC 15948:2004, Information technology — Computer graphics and image processing — Portable Network Graphics (PNG): Functional specification

Internet Engineering Task Force (IETF) RFC 2045 (January 2001), Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies

Internet Engineering Task Force (IETF) RFC 2302 (March 1998), Tag Image File Format (TIFF) - image/tiff MIME Sub-type Registration

Internet Engineering Task Force (IETF) RFC 4122 (July 2005). A Universally Unique IDentifier (UUID) URN Namespace

Recommendation ITU-R BT.2100-1 (06/2017) Image parameter values for high dynamic range television for use in production and international exchange

SMPTE RP 431-2:2011, D-Cinema Quality — Reference Projector and Environment

SMPTE ST 377-1:2011, Material Exchange Format (MXF) - File Format Specification

SMPTE ST 429-5:2009, D-Cinema Packaging — Timed Text Track File

SMPTE ST 2065-1:2012, Academy Color Encoding Specification (ACES)

SMPTE ST 2065-4:2013, ACES Image Container File Layout

SMPTE ST 2065-5:2016, Material Exchange Format — Mapping ACES Image Sequences into the MXF Generic Container

SMPTE ST 2067-2:2016, Interoperable Master Format – Core Constraints

SMPTE ST 2067-3:2016, Interoperable Master Format – Composition Playlist

SMPTE ST 2067-21:2016, Interoperable Master Format – Application #2E

SMPTE ST 2067-101:2014, Interoperable Master Format — Output Profile List — Common Image Definitions and Macros

SMPTE ST 2067-102:2014, Interoperable Master Format — Common Image Pixel Color Schemes

SMPTE ST 2080-3:2017, Reference Viewing Environment for Evaluation of HDTV Images

World Wide Web Consortium (W3C) (28 October 2004). XML Schema Part 1: Structures (Second Edition)

World Wide Web Consortium (W3C) (28 October 2004). XML Schema Part 2: Datatypes (Second Edition)

4 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

4.1 ACES image

ACES image container file as defined in SMPTE ST 2065-4.

4.2 Target Frame

A single frame of the Image Essence rendered in a display-referred color space.

5 Overall

5.1 General

All provisions of SMPTE ST 2067-2 shall apply.

5.2 Format

An Image Track File shall conform to SMPTE ST 2065-5.

5.3 Shim Parameters

Track Files shall be associated with the shim parameter values specified in Table 1.

Table 1. Shim Parameter Values Definitions.

Shim Parameter	Value
shim_id	http://www.smp-te-ra.org/ns/2067-50/2017
gc_type	379-2-gc
picture_family	ACES
picture_bitrate	ST 2067-50
picture_format	ST 2067-50
picture_custom_ANC	false
picture_render_ANC	false

6 Image Essence

6.1 General

Image essence shall consist of image frames. All image characteristics shall comply with SMPTE ST 2065-4.

6.2 Constraints (Informative)

Table 2 lists the combinations of characteristics allowed for Image frames.

Table 2. Image Characteristics.

Element	Reference	Value / Range	
Image Frame Width	§6.3.1	1..2 ³² -1	
Image Frame Height	§6.3.1	1..2 ³² -1	
Pixel Encoding	§6.3.5	16 bit half-float	
Frame Structure	§6.3.2	Progressive	
Stereoscopy	§6.3.8	Stereoscopic Monoscopic	
Frame Rate	§6.3.3	Any, see 6.3.3	
Sampling	§6.3.7	4:4:4:4	4:4:4
Color Components	§6.3.4	R G B A	R G B
Colorimetry	§6.3.6	COLOR.APP5.AP0, see 6.3.6	

6.3 Characteristics

6.3.1 Frame Dimensions (Informative)

The width and height of the frame are defined as the number of horizontal and vertical pixel elements, respectively.

The Image Frame Width is further constrained by the maximum value of pixel data size, as defined in SMPTE ST 2065-4.

6.3.2 Frame Structure (Informative)

Image frames are of progressive structure only.

An image frame with progressive structure consists of a complete image frame, scanned progressively from left to right and from top to bottom.

6.3.3 Frame Rate

The frame rate shall be specified in frames per second. The frame rate shall be a rational number; n/d . n and d shall both be UInt32 values greater than zero. The UInt32 data type is defined in SMPTE ST 377-1.

6.3.4 Color Components (Informative)

Image frames are sampled using linear RGB color component triplets plus an optional Alpha channel.

6.3.5 Pixel Values (Informative)

Each color component of each pixel is represented by a half float value according to SMPTE ST 2065-4.

6.3.6 Colorimetry

The values of the RGB component signals shall be mapped to ACES tristimulus values according to SMPTE ST 2065-1 (see Table 3).

Table 3. Colorimetry System.

System	Description
COLOR.APP5.AP0	Mapped as specified in SMPTE ST 2065-1

6.3.7 Sampling (Informative)

Sampling is 4:4:4 for RGB components and sampling is 4:4:4:4 for RGBA components.

In both 4:4:4 and 4:4:4:4 sampling, each component is sampled once at each image frame pixel.

6.3.8 Stereoscopic and Monoscopic Image Essence (Informative)

Monoscopic essence consists of a sequence of single image frames.

Stereoscopic essence, as defined in SMPTE ST 2067-2, consists of a sequence of pairs of image frames, a left eye frame and a right eye frame, for stereoscopic viewing. The two images of a pair are coincident in time.

Stereoscopic essence is wrapped into two Track Files, each consisting of monoscopic essence as defined in SMPTE ST 2067-2.

6.4 Encoding (Informative)

Each frame is encoded as a single ACES image according to SMPTE ST 2065-4. The component ordering is defined in SMPTE ST 2065-4.

7 Target Frames

7.1 General

The ACES Image Essence may be accompanied by Target Frames. Target Frames are individual, display-referred images as displayed on a Mastering Display. Each Target Frame is associated with a specific image of the ACES Image Essence. Target Frames are carried in the same Track File as the ACES Image Essence – see section 8.2.1

NOTE 1: Target Frames are intended to assist users in calibrating an Output Transform workflow by comparing the Target Frames to the result of the Output Transform workflow applied to the ACES Image Essence. See informative Annex D for further information.

NOTE 2: The position indicated by the Target Frame Index might or might not be part of the Virtual Image Track defined in the CPL. In particular, specific artificial test images could be provided covering the intended dynamic range and color space. Artificial test images are usually not part of the visible timeline (i.e. the Virtual Image Track).

NOTE 3: The number of Target Frames is expected to be representative, e.g. one frame per clip of a movie. The number of Target Frames is limited by the size of the header metadata.

7.2 File format

If present, Target Frames shall be either encoded in Tag Image File Format (TIFF), as defined in Annex C, or in Portable Network Graphics (PNG) format, as defined in Annex B.

8 Image Track File

8.1 Essence

An Image Track File shall contain image essence conforming to Section 6.

8.2 Wrapping

8.2.1 General

The image essence shall be Frame-wrapped as specified in SMPTE ST 2065-5.

Each Image Track File may contain one or more Target Frames (as defined in Section 7). The associated ACES Image within the Image Essence of a particular Image Track File shall be specified by a Target Frame Index, as defined in section 8.2.5.6.

There shall be no more than 500 Target Frames per Image Track File.

Each Target Frame shall be an Ancillary Resource in its own Generic Stream Partition, using Ancillary Resource Wrapping as defined in SMPTE ST 429-5.

Each Ancillary Resource shall be referenced by one Target Frame SubDescriptor, as defined in section 8.2.5.

The Top-Level File Package of an Image Track File shall reference an RGBA Picture Essence Descriptor as defined in SMPTE ST 377-1.