

SMPTE Public Committee Draft

Interoperable Master Format — Application #6 UHDTV program workflow (AVC)



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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.

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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.

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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.

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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

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1 Scope

This document specifies a new IMF Application as a specialization of the IMF Framework to improve UHDTV program workflows in broadcasting stations mainly in terms of processing time and storage capacity, enabling late editorial changes to a completed master program file to be carried out efficiently.

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The new IMF Application targets UHDTV image essence coded as an AVC stream and audio essence coded as a linear PCM stream with reference to the program exchange standards used by, but not limited to, Japanese broadcasting stations.

2 Normative References

The following Standard contains provisions that, through reference in this text, constitute provisions of this standard. 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 STs 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 274:2008, for Television — 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

SMPTE ST 296:2012, 1280 × 720 Progressive Image 4:2:2 and 4:4:4 Sample Structure — Analog and Digital Representation and Analog Interface

SMPTE ST 377-1:2019, Material Exchange Format (MXF) — File Format Specification

SMPTE ST 379-2:2010, for Television — Material Exchange Format (MXF) — MXF Constrained Generic Container

SMPTE ST 381-3:2017, Material Exchange Format — Mapping AVC Streams into the MXF Generic Container

SMPTE ST 2036-1:2014, Ultra High Definition Television — Image Parameter Values for Program Production

SMPTE ST 2067-2:2020, Interoperable Master Format — Core Constraints

SMPTE ST 2067-21:2020, Interoperable Master Format — Application #2E

SMPTE ST 2067-21:2020 Am1:2020, Interoperable Master Format — Application #2E Amendment 1

SMPTE ST 2067-101:2018, Interoperable Master Format — Output Profile List — Common Image Definitions and Macros

SMPTE ST 2067-102:2021, Interoperable Master Format — Common Image Pixel Color Schemes

SMPTE ST 2115:2019, Free Scale Gamut and Free Scale Log Characteristics of Camera Signals

ISO/IEC 14496-10 | Rec. ITU-T H.264 (2014), Information technology — Coding of audio-visual objects – Advanced Video Coding

Recommendation ITU-R BT.2020-2 (10/2015) Parameter values for ultra-high definition television systems for production and international programme exchange

Recommendation ITU-R BT.2100-2 (07/2018) Image Parameter Values for High Dynamic Range Television for use in Production and International Programme Exchange

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

3 Terms and Definitions

No terms and definitions are listed in this document.

4 Overall

4.1 General

All provisions of SMPTE ST 2067-2 shall apply.

4.2 UHDTV program workflow (Informative)

4.2.1 Processing model

Figure 1 shows a typical UHDTV program workflow used in many broadcasting stations.

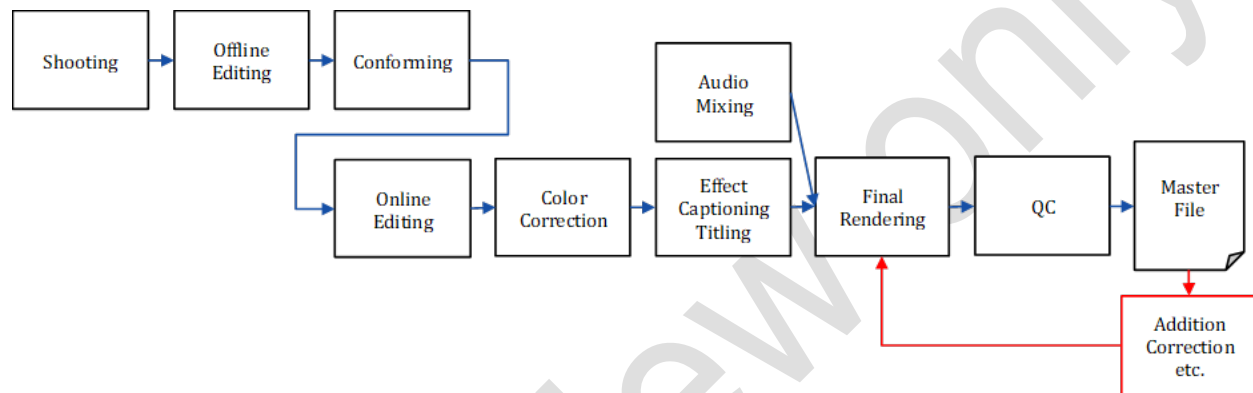


Figure 1 — UHDTV program workflow

Re-rendering and re-QC of a completed master program file prior to its broadcast is often needed due to late stage editorial changes required by program producers that involve editing to make additions or corrections to the program content. The full-scale re-rendering and re-QC from beginning to end of a master program file are very heavy load processes in terms of the time taken and the storage capacity involved in the creation of multiple file versions, especially for beyond-HD image sizes such as UHDTV.

By applying IMF file-based operations to a master program file (Master File in Figure 1), an IMF Application, which enables multiple versions to be created from a common set of essence components, solves these issues by executing rendering and QC only for the required frames as a function of the Composition Playlist (CPL) specified in SMPTE ST 2067-3. This is to provide effective version management in every broadcasting station and a more efficient UHDTV program workflow.

5 Image Essence

5.1 Image Formats

The image format characteristics shall be as defined in Table 1.

Table 1 — Image Formats

Image Format	Bit Depth	Signal Format Sampling Structure	Frame/Field Rates	Reference SMPTE Standard
1920 x 1080	10 or 12 bits	4:2:2 (Y'C'B'C'R)	60, 60/1.001, 50, 30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive or 60, 60/1.001 and 50 Fields Interlaced	ST 274
		4:4:4 (Y'C'B'C'R)		
		4:4:4 (R'G'B')		
1280 x 720	10 bits	4:2:2 (Y'C'B'C'R)	60, 60/1.001, 50, 30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	ST 296
		4:4:4 (Y'C'B'C'R)		
		4:4:4 (R'G'B')		
3840 x 2160 ^a	10 or 12 bits	4:2:2 (Y'C'B'C'R)	120, 120/1.001, 100, 60, 60/1.001, 50, 30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	ST 2036-1
7680 x 4320 ^a	10 or 12 bits	4:4:4 (Y'C'B'C'R)		
		4:4:4 (R'G'B')		
		4:2:2 (Y'C'B'C'R)		
		4:4:4 (Y'C'B'C'R)		
		4:4:4 (R'G'B')		
		4:4:4 (R'G'B')		
^a This is the maximum pixel array, the active image may not fill the maximum array.				

5.2 Encoding

The Image Essence shall be encoded using one of the Profiles and Levels of ISO/IEC 14496-10 listed in Table 2.

Table 2 — Profiles and Levels

Image Format	Profile	Level			Maximum bitrate for video coding layer (Mbit/s)							
		24/1.001 –30fps	50-60 fps	100- 120fps	Level							
					4.1	4.2	5	5.1	5.2	6	6.1	6.2
Group 1: 1280 x 720 1920 x 1080	High 10 Intra	4.1 4.2	4.2 5	5.2	150	150	405		720			
	High 4:2:2 Intra				200	200	540		960			
	CAVLC 4:4:4 Intra											
Group 2: 3840 x 2160	High 10 Intra	5.1 5.2	5.2 6 6.1	6 6.1 6.2				720	720	720	1440	2400
	High 4:2:2 / High 4:2:2 Intra							960	960	960	1920	3200
	CAVLC 4:4:4 Intra											
Group 3: 7680 x 4320	High 10 Intra	6 6.1	6.1 6.2	6.2						720	1440	2400
	High 4:2:2 Intra									960	1920	3200
	CAVLC 4:4:4 Intra											

NOTE: The Japan Commercial Broadcasters Association (JBA) favors use of High 4:2:2, 10-bit depth, and a predefined bit-rate of 200 Mbit/s, for file exchange of programs having a frame size of 3840 x 2160 pixels in JBA Technical Regulation T033 – 2020.

6 Track Files

6.1 General

Track Files shall conform to SMPTE ST 379-2 and SMPTE ST 2067-2.

6.2 Image Track Files

6.2.1 Essence

The Image Essence contained in Image Track Files shall conform to Section 5.

6.2.2 Shim Parameters

Track Files shall be associated with the shim parameter values specified in Table 3.

Table 3 — Shim Parameter Values Definitions

Shim Parameter	Value
shim_id	http://www.smp-te-ra.org/ns/2067-60/2020
gc_type	379-2-constrained-gc
picture_family	H.264
picture_bitrate	See Table 2 for maximum bitrate.
picture_format	1920/1080/23.98p, 24p, 25p, 29.97p, 30p, 50p, 59.94p, 60p 1920/1080/50i, 59.94i, 60i 1280/720/23.98p, 24p, 25p, 29.97p, 30p, 50p, 59.94p, 60p 3840/2160/23.98p, 24p, 25p, 29.97p, 30p, 47.95p, 48p, 50p, 59.94p, 60p, 100p, 119.88p, 120p 7680/4320/23.98p, 24p, 25p, 29.97p, 30p, 47.95p, 48p, 50p, 59.94p, 60p, 100p, 119.88p, 120p
picture_custom_ANC	false ^a
picture_render_ANC	false ^a
^a Not applicable in this application.	

6.2.3 Track Format and Mapping

An Image Track File shall conform to SMPTE ST 381-3:

- The values of the Essence Element Key and Essence Container UL are defined in SMPTE ST 381-3. The value of Byte 15 of the Essence Element Key shall indicate frame-wrapped essence. The values of Byte 14 of the Essence Container UL shall indicate AVC byte stream.
- The Edit Rate and Sample Rate are equal to the image frame rate as defined in SMPTE ST 379-2.
- Indexing is image frame-based, using Index Edit Rates defined by the Edit Rates of the Essence Track, as defined in SMPTE ST 377-1.

In the case of progressive source image:

- Each frame-coded Access Unit (AU) shall be wrapped in a single KLV.

In the case of interlaced source image:

- Two field-coded AUs each shall be wrapped in a single KLV where the first field AU precedes the second field AU.

The Top-Level File Package of Image Track File shall reference:

- A CDCI Picture Essence Descriptor as defined in SMPTE ST 377-1 if the Image Essence uses Y'C'B'C'R color components.
- An RGBA Picture Essence Descriptor as defined in SMPTE ST 377-1 if the Image Essence uses R'G'B' color components.

6.2.3.1. Generic Picture Essence Descriptor

6.2.3.1.1. General

The Generic Picture Essence Descriptor items shall be as specified in Annex G of SMPTE ST 377-1:2019 and Annexes F and G of SMPTE ST 2067-2:2020 and then further constrained as specified in this section. Table 4 specifies the following items:

- Items which are further constrained, i.e. required items which are specified as Optional or Decoder Required in SMPTE ST 377-1, StoredF2Offset, DisplayF2Offset and FieldDominance
- Best Effort items which are specified in SMPTE ST 377-1
- Optional items which are specified in SMPTE ST 2067-2

Table 4 — Generic Picture Essence Descriptor Items

Generic Picture Essence Descriptor Item	Constraints	Required status of SMPTE ST 377-1	Required status of SMPTE ST 2067-2
Frame Layout	See Section 6.2.3.1.2.	B.Effort	-
Stored Width	See Section 6.2.3.1.3.	B.Effort	-
Stored Height	See Section 6.2.3.1.4.	B.Effort	-
StoredF2Offset	Shall be present if the image is Interlaced. See Section 6.2.3.1.5.	Opt	-
Sampled Width	Shall be present. See Section 6.2.3.1.6.	Opt	-
Sampled Height	Shall be present. See Section 6.2.3.1.7.	Opt	-
SampledXOffset	Shall be present. See Section 6.2.3.1.8.	Opt	-
SampledYOffset	Shall be present. See Section 6.2.3.1.9.	Opt	-
DisplayHeight	Shall be present. See Section 6.2.3.1.10.	Opt	-
DisplayWidth	Shall be present. See Section 6.2.3.1.11.	Opt	-
DisplayXOffset	Shall be present. See Section 6.2.3.1.12.	Opt	-
DisplayYOffset	Shall be present. See Section 6.2.3.1.13.	Opt	-
DisplayF2Offset	Shall be present if the image is Interlaced. See Section 6.2.3.1.14.	Opt	-
ActiveHeight	See Section 6.2.3.1.15.	-	Opt
ActiveWidth	See Section 6.2.3.1.16.	-	Opt
ActiveXOffset	See Section 6.2.3.1.17.	-	Opt
ActiveYOffset	See Section 6.2.3.1.18.	-	Opt
Aspect Ratio	See Section 6.2.3.1.19.	B.Effort	-
Video Line Map	See Section 6.2.3.1.20.	B.Effort	-
Transfer Characteristic	Shall be present. See Section 6.2.3.1.21.	Opt	-

FieldDominance	Shall be present if the image is Interlaced. See Section 6.2.3.1.22.	Opt	-
Picture Essence Coding	Shall be present. See Section 6.2.3.1.23.	D/req	-
Coding Equations	Shall be present. See Section 6.2.3.1.21.	Opt	
Color Primaries	Shall be present. See Section 6.2.3.1.21.	Opt	
Alternative Center Cuts	See Section 6.2.3.1.24.	-	Opt

6.2.3.1.2. Frame Layout

The value of the Frame Layout item shall be equal to:

- 0x00 (FULL_FRAME) if the image structure is progressive.
- 0x01 (SEPARATE_FIELDS) if the image structure is interlaced.

6.2.3.1.3. Stored Width

The value of the Stored Width item shall be equal to:

- 1920 if the image format is 1920x1080.
- 1280 if the image format is 1280x720.
- 3840 if the image format is 3840x2160.
- 7680 if the image format is 7680x4320.

6.2.3.1.4. Stored Height

The value of the Stored Height item shall be equal to:

- 1088¹ if the image format is 1920x1080 and progressive.
- 544¹ if the image format is 1920x1080 and interlaced.
- 720 if the image format is 1280x720 and progressive.
- 2160 if the image format is 3840x2160 and progressive.
- 4320 if the image format is 7680x4320 and progressive.

6.2.3.1.5. StoredF2Offset

The default value is 0.

6.2.3.1.6. Sampled Width

The value of the Sampled Width item shall be equal to:

- 1920 if the image format is 1920x1080.
- 1280 if the image format is 1280x720.
- 3840 if the image format is 3840x2160.

¹ The displayable part of the Stored Rectangle is top-aligned in the encoded video.

- 7680 if the image format is 7680x4320.

6.2.3.1.7. Sampled Height

The value of the Sampled Height item shall be equal to:

- 1080 if the image format is 1920x1080 and progressive.
- 540 if the image format is 1920x1080 and interlaced.
- 720 if the image format is 1280x720 and progressive.
- 2160 if the image format is 3840x2160 and progressive.
- 4320 if the image format is 7680x4320 and progressive.

6.2.3.1.8. SampledXOffset

The typical value is 0.

6.2.3.1.9. SampledYOffset

The typical value is 0.

6.2.3.1.10. DisplayHeight

The value of the DisplayHeight item shall be equal to:

- 1080 if the image format is 1920x1080 and progressive.
- 540 if the image format is 1920x1080 and interlaced.
- 720 if the image format is 1280x720 and progressive.
- 2160 if the image format is 3840x2160 and progressive.
- 4320 if the image format is 7680x4320 and progressive.

6.2.3.1.11. DisplayWidth

- 1920 if the image format is 1920x1080.
- 1280 if the image format is 1280x720.
- 3840 if the image format is 3840x2160.
- 7680 if the image format is 7680x4320.

6.2.3.1.12. DisplayXOffset

The typical value is 0.

6.2.3.1.13. DisplayYOffset

The typical value is 0.

6.2.3.1.14. DisplayF2Offset

The default value is 0.

6.2.3.1.15. ActiveHeight

The value of the ActiveHeight is the number of vertical pixels of the Active Area Rectangle, as defined in Annex G of SMPTE ST 2067-2:2020.

6.2.3.1.16. ActiveWidth

The value of the ActiveWidth is the number of horizontal pixels of the Active Area Rectangle, as defined in Annex G of SMPTE ST 2067-2:2020.

6.2.3.1.17. ActiveXOffset

The value of the ActiveXOffset is the horizontal offset in Pixels of the Active Area Rectangle relative to the Display Rectangle, as defined in Annex G of SMPTE ST 2067-2:2020.

6.2.3.1.18. ActiveYOffset

The value of the ActiveYOffset is the vertical offset in Pixels of the Active Area Rectangle relative to the Display Rectangle, as defined in Annex G of SMPTE ST 2067-2:2020.

6.2.3.1.19. Aspect Ratio

The value of the Aspect Ratio item shall be equal to:

- 16:9 if the image format is 1920x1080.
- 16:9 if the image format is 1280x720.
- 16:9 if the image format is 3840x2160.
- 16:9 if the image format is 7680x4320.

6.2.3.1.20. Video Line Map

The value of the Video Line Map item should be equal to:

- {42,0} if the image format is 1920x1080 and progressive.
- {21,584} if the image format is 1920x1080 and interlaced.
- {26,0} if the image format is 1280x720 and progressive.
- {42,0} if the image format is 3840x2160 and progressive.
- {42,0} if the image format is 7680x4320 and progressive.

6.2.3.1.21. Transfer Characteristic, Coding Equations and Color Primaries

Transfer Characteristic, Coding Equations and Color Primaries should be one of the combinations per Signal Format of Table 5.

Table 5 — Transfer Characteristic, Coding Equations and Color Primaries

System	Picture Essence Descriptor Properties	UL
COLOR.3 ^a	Transfer Characteristic: ITU-R BT.709 Transfer Characteristic	urn:smpte:ul:060e2b34.04010101.04010101.01020000
	Coding Equations: ITU-R BT.709 Coding Equations	urn:smpte:ul:060e2b34.04010101.04010101.02020000
	Color Primaries: ITU-R BT.709 Color Primaries	urn:smpte:ul:060e2b34.04010106.04010101.03030000
COLOR.5 ^a	Transfer Characteristic: ITU-R BT.2020 Transfer Characteristic	urn:smpte:ul:060e2b34.0401010e.04010101.01090000
	Coding Equations: ITU-R BT.2020 Non-Constant Luminance Coding Equations	urn:smpte:ul:060e2b34.0401010d.04010101.02060000
	Color Primaries: ITU-R BT.2020 Color Primaries	urn:smpte:ul:060e2b34.0401010d.04010101.03040000
COLOR.7 ^a	Transfer Characteristic: SMPTE ST 2084 Transfer Characteristic	urn:smpte:ul:060e2b34.0401010d.04010101.010a0000
	Coding Equations: ITU-R BT.2020 Non-Constant Luminance Coding Equations	urn:smpte:ul:060e2b34.0401010d.04010101.02060000
	Color Primaries: ITU-R BT.2020 Color Primaries	urn:smpte:ul:060e2b34.0401010d.04010101.03040000
COLOR.8 ^b (ITU-R BT.2100 HLG)	Transfer Characteristic: Hybrid Log-Gamma OETF Transfer Characteristic	urn:smpte:ul:060e2b34.0401010d.04010101.010b0000
	Coding Equations: ITU-R BT.2020 Non-Constant Luminance Coding Equations	urn:smpte:ul:060e2b34.0401010d.04010101.02060000
	Color Primaries: ITU-R BT.2020 Color Primaries	urn:smpte:ul:060e2b34.0401010d.04010101.03040000
COLOR.APP6.1	Transfer Characteristic: SMPTE ST 2115 Camera Log S3 Transfer Characteristic ^c	urn:smpte:ul:060e2b34.0401010d.04010101.010e0000
	Coding Equations: ITU-R BT.2020 Non-Constant Luminance Coding Equations	urn:smpte:ul:060e2b34.0401010d.04010101.02060000
	Color Primaries: ITU-R BT.2020 Color Primaries	urn:smpte:ul:060e2b34.0401010d.04010101.03040000
COLOR.APP6.2	Transfer Characteristic: SMPTE ST 2115 Camera Log V Transfer Characteristic ^c	urn:smpte:ul:060e2b34.0401010d.04010101.010f0000
	Coding Equations: ITU-R BT.2020 Non-Constant Luminance Coding Equations	urn:smpte:ul:060e2b34.0401010d.04010101.02060000
	Color Primaries: ITU-R BT.2020 Color Primaries	urn:smpte:ul:060e2b34.0401010d.04010101.03040000
COLOR.APP6.3	Transfer Characteristic: SMPTE ST 2115 Camera Log C2 Transfer Characteristic ^c	urn:smpte:ul:060e2b34.0401010d.04010101.01100000
	Coding Equations: ITU-R BT.2020 Non-Constant Luminance Coding Equations	urn:smpte:ul:060e2b34.0401010d.04010101.02060000
	Color Primaries: ITU-R BT.2020 Color Primaries	urn:smpte:ul:060e2b34.0401010d.04010101.03040000
COLOR.APP6.4	Transfer Characteristic: SMPTE ST 2115 Camera Log C3 Transfer Characteristic ^c	urn:smpte:ul:060e2b34.0401010d.04010101.01110000
	Coding Equations: ITU-R BT.2020 Non-Constant Luminance Coding Equations	urn:smpte:ul:060e2b34.0401010d.04010101.02060000
	Color Primaries: ITU-R BT.2020 Color Primaries	urn:smpte:ul:060e2b34.0401010d.04010101.03040000

^a Specified in SMPTE ST 2067-21:2020.

^b Specified in Amendment 1:2020 to SMPTE ST 2067-21:2020.

^c The ISO/IEC 14496-10 | Rec. ITU-T H.264 value of transfer_characteristics is equal to 2.

6.2.3.1.22. FieldDominance

The default value is 1.

6.2.3.1.23. Picture Essence Coding

The value of the Picture Essence Coding item shall be as specified in SMPTE ST 381-3.

6.2.3.1.24. Alternative Center Cuts

The Alternative Center Cuts item specifies the alternate aspect ratio subset(s) of the active area as specified in Annex F of SMPTE ST 2067-2:2020.

Active area is defined in Annex G of SMPTE ST 2067-2:2020.

6.2.3.2. RGBA Picture Essence Descriptor

6.2.3.2.1. General

The RGBA Picture Essence Descriptor items shall be as specified in Annex G of SMPTE ST 377-1:2019 and then further constrained as specified in this section. Table 6 specifies the following items:

SMPTE PCD ST 2067-60:20xx

- Items which are further constrained, i.e. required items which are specified as Optional in SMPTE ST 377-1.
- Best Effort items which are specified in SMPTE ST 377-1.

Table 6 — RGBA Picture Essence Descriptor items

RGBA Picture Essence Descriptor Item	Constraints	Required status of SMPTE ST 377-1
Component Max Ref	Shall be present. See Section 6.2.3.2.2.	Opt
Component Min Ref	Shall be present. See Section 6.2.3.2.2.	Opt
PixelLayout	See Section 6.2.3.2.3.	B.Effort

6.2.3.2.2. Component Max Ref and Component Min Ref

Component Max Ref is an item, whose unsigned 32-bit integer value shall specify the R'G'B' sample value for reference white level. Similarly, Component Min Ref is an item, whose unsigned 32-bit integer value shall specify the R'G'B' sample value for reference black level. Table 7 describes the “narrow range” and “full range” signal representations of Recommendation ITU-R BT.2100.

Table 7 — Component Max Ref and Component Min Ref values

Range	Narrow range		Full range	
Bit Depth	10	12	10	12
Component Min Ref	64	256	0	0
Component Max Ref	940	3760	1023	4095

6.2.3.2.3. PixelLayout

The value of the PixelLayout item shall be equal to { 'G', x, 'B', x, 'R', x, 0, 0, 0, 0, 0, 0, 0, 0, 0 } where x is equal to 10 or 12 if 10-bit or 12-bit color components are used per Section 5.1.

6.2.3.3. CDCI Picture Essence Descriptor

6.2.3.3.1. General

The CDCI Picture Essence Descriptor items shall be as specified in Annex G of SMPTE ST 377-1:2019 and then further constrained as specified in this section. Table 8 specifies the following items:

- Items which are further constrained, i.e. required items which are specified as Optional in SMPTE ST 377-1.
- Best Effort items which are specified in SMPTE ST 377-1.

Table 8 — CDCI Picture Essence Descriptor items

CDCI Picture Essence Descriptor Item	Constraints	Required status of SMPTE ST 377-1
Component Depth	See Section 6.2.3.3.2.	B.Effort
Horizontal Subsampling	See Section 6.2.3.3.3.	B.Effort
Vertical Subsampling	Shall be present. See Section 6.2.3.3.4.	Opt
Color Siting	Shall be present. See Section 6.2.3.3.5.	Opt
ReversedByteOrder	See Section 6.2.3.3.6.	Opt
PaddingBits	See Section 6.2.3.3.7.	Opt
Black Ref Level	Shall be present. See Section 6.2.3.3.8.	Opt
White Ref level	Shall be present. See Section 6.2.3.3.8.	Opt
Color Range	Shall be present. See Section 6.2.3.3.8.	Opt

6.2.3.3.2. Component Depth

The value shall be equal to the Bit Depth used. (see Section 5.1)

6.2.3.3.3. Horizontal Subsampling

The value of Horizontal Subsampling item shall be equal to:

- 0x01 if 4:4:4 sampling is used per Section 5.2.
- 0x02 if 4:2:2 or 4:2:0 sampling is used per Section 5.2.

6.2.3.3.4. Vertical Subsampling

The value of Vertical Subsampling item shall be equal to:

- 0x01 if 4:4:4 or 4:2:2 sampling is used per Section 5.2.
- 0x02 if 4:2:0 sampling is used per Section 5.2.

6.2.3.3.5. Color Siting

The value shall be 0x00.

6.2.3.3.6. ReversedByteOrder

The typical value is 0.

6.2.3.3.7. PaddingBits

The typical value is 0.

6.2.3.3.8. Black Ref Level, White Ref Level and Color Range

The values of the Black Ref Level, White Ref Level and Color Range items shall be set according to the component bit depth used. Table 9 describes the “narrow range” and “full range” signal representations of Recommendation ITU-R BT.2100.

Table 9 — Black Ref Level, White Ref Level and Color Range values

Range	Narrow range		Full range	
Bit Depth	10	12	10	12
Black Ref Level	64	256	0	0
White Ref Level	940	3760	1023	4095
Color Range	897	3585	1023	4095

NOTE: The White Ref Level item applies only to the Y' component and the Color Range item to the C'_B and C'_R components.

6.2.3.4. AVC Sub Descriptor

6.2.3.4.1. General

The AVC Sub Descriptor items shall be as specified in Section 9.1 of SMPTE ST 381-3:2017 and then further constrained as specified in this section. Table 10 specifies the following items:

- Items which are further constrained, i.e. required items which are specified as Optional in SMPTE ST 381-3.
- Required items which are specified in SMPTE ST 381-3.

Table 10 — AVC Sub Descriptor items

AVC Sub Descriptor Item	Constraints	Required status of SMPTE ST 381-3
AVC Decoding Delay	See Section 6.2.3.4.2.	Req
AVC Constant B Picture Flag	See Section 6.2.3.4.3	Opt
AVC Coded Content Kind	Shall be present. See Section 6.2.3.4.4.	Opt
AVC Closed GOP Indicator	See Section 6.2.3.4.5.	Opt
AVC Identical GOP Indicator	See Section 6.2.3.4.6.	Opt
AVC Maximum GOP Size	See Section 6.2.3.4.7.	Opt
AVC Maximum B Picture Count	See Section 6.2.3.4.8.	Opt
AVC Maximum Bitrate	Shall be present. See Table 2.	Opt
AVC Average Bitrate	See Section 6.2.3.4.9.	Opt
AVC Profile	Shall be present. See Section 6.2.3.4.10.	Opt
AVC Profile Constraint	Shall be present. See Section 6.2.3.4.11.	Opt
AVC Level	Shall be present. See Section 6.2.3.4.12.	Opt
AVC Maximum Ref Frames	Shall be present. See Section 6.2.3.4.13.	Opt
AVC Sequence Parameter Set Flag	Shall be present. See Section 6.2.3.4.14.	Opt
AVC Picture Parameter Set Flag	Shall be present. See Section 6.2.3.4.15.	Opt

6.2.3.4.2. AVC Decoding Delay

The value of AVC Decoding Delay item shall be equal to:

- 0 if High 10 Intra is used per Section 5.2.
- delay required for decoded pictures in number of access units if High 4:2:2 is used per Section 5.2.
- 0 if High 4:2:2 Intra is used per Section 5.2.
- 0 if CAVLC 4:4:4 Intra is used per Section 5.2.

6.2.3.4.3. AVC Constant B Picture Flag

The value of AVC Constant B Picture Flag item shall be equal to:

- FALSE if High 10 Intra is used per Section 5.2.
- TRUE if High 4:2:2 is used per Section 5.2 and the number of consecutive B Pictures is always constant.
- FALSE if High 4:2:2 Intra is used per Section 5.2.
- FALSE if CAVLC 4:4:4 Intra is used per Section 5.2.

6.2.3.4.4. AVC Coded Content Kind

The value of AVC Coded Content Kind item shall be equal to:

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- 1 if Frames Progressive is used per Section 5.1.
- 3 if Fields Interlaced is used per Section 5.1.

6.2.3.4.5. AVC Closed GOP Indicator

The value of AVC Closed GOP Indicator item shall be equal to:

- FALSE if High 10 Intra is used per Section 5.2.
- TRUE or FALSE if High 4:2:2 is used per Section 5.2.
- FALSE if High 4:2:2 Intra is used per Section 5.2.
- FALSE if CAVLC 4:4:4 Intra is used per Section 5.2.

6.2.3.4.6. AVC Identical GOP Indicator

The value of AVC Identical GOP Indicator item shall be equal to:

- TRUE if High 10 Intra is used per Section 5.2.
- TRUE or FALSE if High 4:2:2 is used per Section 5.2.
- TRUE if High 4:2:2 Intra is used per Section 5.2.
- TRUE if CAVLC 4:4:4 Intra is used per Section 5.2.

6.2.3.4.7. AVC Maximum GOP Size

The value of AVC Maximum GOP Size item shall be equal to:

- 1 if High 10 Intra is used per Section 5.2.
- maximum occurring spacing between I Pictures if High 4:2:2 is used per Section 5.2.
- 1 if High 4:2:2 Intra is used per Section 5.2.
- 1 if CAVLC 4:4:4 Intra is used per Section 5.2.

6.2.3.4.8. AVC Maximum B Picture Count

The value of AVC Maximum B Picture Count item shall be equal to:

- 0 if High 10 Intra is used per Section 5.2.
- maximum number of consecutive B Pictures between P or I Pictures if High 4:2:2 is used per Section 5.2.
- 0 if High 4:2:2 Intra is used per Section 5.2.
- 0 if CAVLC 4:4:4 Intra is used per Section 5.2.

6.2.3.4.9. AVC Average Bitrate

The value of AVC Average Bitrate item shall be an average bit rate throughout the stream.

6.2.3.4.10. AVC Profile

The value of AVC Profile item shall be equal to:

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- 110 if High 10 Intra is used per Section 5.2.
- 122 if High 4:2:2 / High 4:2:2 Intra is used per Section 5.2.
- 44 if CAVLC 4:4:4 Intra is used per Section 5.2.

6.2.3.4.11. AVC Profile Constraint

The value of AVC Profile Constraint item shall be equal to:

- 0x10 if High 10 Intra is used per Section 5.2.
- 0x00 if High 4:2:2 is used per Section 5.2.
- 0x10 if High 4:2:2 Intra is used per Section 5.2.
- 0x10 if CAVLC 4:4:4 Intra is used per Section 5.2.

6.2.3.4.12. AVC Level

The value of AVC Level item shall be equal to:

- 41 if Level 4.1 is used per Section 5.2.
- 42 if Level 4.2 is used per Section 5.2.
- 50 if Level 5 is used per Section 5.2.
- 51 if Level 5.1 is used per Section 5.2.
- 52 if Level 5.2 is used per Section 5.2.
- 60 if Level 6 is used per Section 5.2.
- 61 if Level 6.1 is used per Section 5.2.
- 62 if Level 6.2 is used per Section 5.2.

6.2.3.4.13. AVC Maximum Ref Frames

The value of AVC Maximum Ref Frames item shall be equal to:

- 0 if High 10 Intra is used per Section 5.2.
- maximum number of reference frames if High 4:2:2 is used per Section 5.2.
- 0 if High 4:2:2 Intra is used per Section 5.2.
- 0 if CAVLC 4:4:4 Intra is used per Section 5.2.

6.2.3.4.14. AVC Sequence Parameter Set Flag

The value of In-band location should be 2 (Every access unit in the stream).

6.2.3.4.15. AVC Picture Parameter Set Flag

The value of In-band location should be 2 (Every access unit in the stream).

7 Composition

7.1 General

Composition shall conform to SMPTE ST 2067-2.

7.2 Application Identification

The ApplicationIdentification element (see SMPTE ST 2067-2) shall include the value listed in Table 11.

Table 11 — Application Identification

http://www.smpte-ra.org/ns/2067-60/2020

7.3 Homogeneous Essence

7.3.1 Image

Within a given a composition, the following shall remain constant:

- All Image Essence characteristics specified in Section 5.1.
- The codestream profile specified in Section 5.2.

7.4 Segment Duration

If the average number of audio samples per Composition Edit Unit is not an integer, the duration of each Segment shall be an integer multiple of 5/Composition Edit Rate.

8 Pixel Color Schemes

Annex B defines Pixel Color Schemes, as specified in SMPTE ST 2067-101, for the use with IMF Application #6. Annex C provides a consolidated schema for the Pixel Color Schemes.

NOTE: Annex B is for the sole purpose of enabling Output Profile List (OPL) processing of Application #6 IMF packages.

Annex A Display Rectangle, Active Area Rectangle and Alternative Center Cut Examples (Informative)

As illustrated in Figure A.1 — Active Area Examples, this specification allows the user to choose which portion of the Display Rectangle to identify as the active area, which can be associated with each Alternative Center Cut. For instance, as shown in (a) and (b), two different users or the same user in different circumstances can elect to identify a different portion of the same image as active.

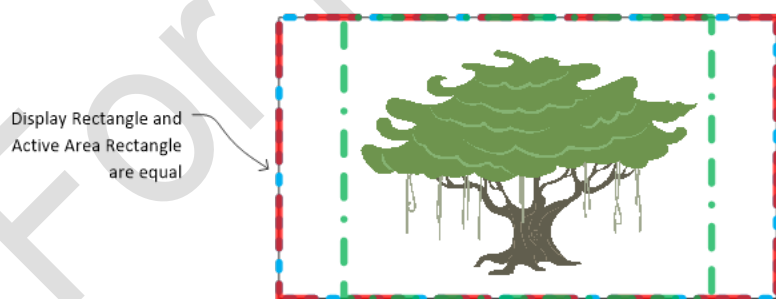
The process by which the dimension of the active area is set depends on individual workflows and can include a combination of manual and automated processing, during and after ingest.



(a) Alternate 4:3 Center in the 16:9 Source Image which includes black bars



(b) Alternate 4:3 Center in >16:9 Active Area in the 16:9 Source Image



(c) Alternate 4:3 Center in the 16:9 Source Image

Figure A.1 — Active Area Examples

Annex B Pixel Color Schemes Definition (Normative)**B.1 XML Schema Definition**

The XML schema root element for Pixel Color Schemes shall be as defined in Table B.1.

Table B.12 – XML Schema root element definition

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="http://www.smpte-ra.org/ns/2067-60/2020/opl-color-
scheme"
xmlns:oplcs="http://www.smpte-ra.org/ns/2067-101/2018/color-
schemes"
xmlns:oplc="http://www.smpte-ra.org/ns/2067-102/2017/
xmlns:app6cs="http://www.smpte-ra.org/ns/2067-60/2020/opl-color-
scheme"
xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified" attributeFormDefault="unqualified">
<xs:import namespace="http://www.smpte-ra.org/ns/2067-101/2018/color-
schemes"/>
<xs:import namespace="http://www.smpte-ra.org/ns/2067-102/2017"/>
<!-- schema definitions found in this document excluding this one -->
</xs:schema>
```

B.2 APP6LogS3-VideoDataRange-YCbCr-10

The APP6LogS3-VideoDataRange-YCbCr-10 color scheme shall be as specified in Table B.2. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.2 shall be as defined in SMPTE ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in SMPTE ST 2067-102.

Table B.13 – APP6LogS3-VideoDataRange-YCbCr-10 Color Scheme

Name	APP6LogS3-VideoDataRange-YCbCr-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color- scheme#APP6LogS3-VideoDataRange-YCbCr-10
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.1 colorimetry in Table 5 and "narrow range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_1 + 0.5) + 64)$ $C'_B = \text{clamp}(4, 1019, \text{floor}(896 \cdot P_2 + 0.5) + 512)$ $C'_R = \text{clamp}(4, 1019, \text{floor}(896 \cdot P_3 + 0.5) + 512)$
Mapping to Reference Image Pixel	$P_1 = (Y' - 64) / 876$ $P_2 = (C'_B - 512) / 896$ $P_3 = (C'_R - 512) / 896$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogS3-VideoDataRange-YCbCr-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType></pre>

```

<xs:restriction base="oplc:Integer1024TripletType"/>
</xs:simpleType>
</xs:restriction>
</xs:simpleContent>
</xs:complexType>

```

The three elements of the triplet shall correspond to the Y' , C'_B and C'_R components.

B.3 APP6LogV-VideoDataRange-YCbCr-10

The APP6LogV-VideoDataRange-YCbCr-10 color scheme shall be as specified in Table B.3. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.3 shall be as defined in SMPTE ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in SMPTE ST 2067-102.

Table B.14 – APP6LogV-VideoDataRange-YCbCr-10 Color Scheme

Name	APP6LogV-VideoDataRange-YCbCr-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogV-VideoDataRange-YCbCr-10
Description	Y' , C'_B and C'_R components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.2 colorimetry in Table 5 and "narrow range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_1 + 0.5) + 64)$ $C'_B = \text{clamp}(4, 1019, \text{floor}(896 \cdot P_2 + 0.5) + 512)$ $C'_R = \text{clamp}(4, 1019, \text{floor}(896 \cdot P_3 + 0.5) + 512)$
Mapping to Reference Image Pixel	$P_1 = (Y' - 64) / 876$ $P_2 = (C'_B - 512) / 896$ $P_3 = (C'_R - 512) / 896$ $P_4 = 1.0$
Pixel Encoding Type	<pre> <xs:complexType name="APP6LogV-VideoDataRange-YCbCr-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType> </pre>

The three elements of the triplet shall correspond to the Y' , C'_B and C'_R components.

B.4 APP6LogC2-VideoDataRange-YCbCr-10

The APP6LogC2-VideoDataRange-YCbCr-10 color scheme shall be as specified in Table B.4. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.4 shall be as defined in SMPTE ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in SMPTE ST 2067-102.

Table B.15 – APP6LogC2-VideoDataRange-YCbCr-10 Color Scheme

Name	APP6LogC2-VideoDataRange-YCbCr-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC2-VideoDataRange-YCbCr-10
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.3 colorimetry in Table 5 and “narrow range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_1 + 0.5) + 64)$ $C'_B = \text{clamp}(4, 1019, \text{floor}(896 \cdot P_2 + 0.5) + 512)$ $C'_R = \text{clamp}(4, 1019, \text{floor}(896 \cdot P_3 + 0.5) + 512)$
Mapping to Reference Image Pixel	$P_1 = (Y' - 64) / 876$ $P_2 = (C'_B - 512) / 896$ $P_3 = (C'_R - 512) / 896$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC2-VideoDataRange-YCbCr-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the Y', C'_B and C'_R components.</p>

B.5 APP6LogC3-VideoDataRange-YCbCr-10

The APP6LogC3-VideoDataRange-YCbCr-10 color scheme shall be as specified in Table B.5. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.5 shall be as defined in SMPTE ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in SMPTE ST 2067-102.

Table B.16 – APP6LogC3-VideoDataRange-YCbCr-10 Color Scheme

Name	APP6LogC3-VideoDataRange-YCbCr-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC3-VideoDataRange-YCbCr-10
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.4 colorimetry in Table 5 and “narrow range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_1 + 0.5) + 64)$

	$C'_B = \text{clamp}(4, 1019, \text{floor}(896 \cdot P_2 + 0.5) + 512)$ $C'_R = \text{clamp}(4, 1019, \text{floor}(896 \cdot P_3 + 0.5) + 512)$
Mapping to Reference Image Pixel	$P_1 = (Y' - 64) / 876$ $P_2 = (C'_B - 512) / 896$ $P_3 = (C'_R - 512) / 896$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC3-VideoDataRange-YCbCr-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the Y', C'_B and C'_R components.</p>

B.6 APP6LogS3-VideoDataRange-RGB-10

The APP6LogS3-VideoDataRange-RGB-10 color scheme shall be as specified in Table B.6. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.6 shall be as defined in SMPTE ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in SMPTE ST 2067-102.

Table B.17 – APP6LogS3-VideoDataRange-RGB-10 Color Scheme

Name	APP6LogS3-VideoDataRange-RGB-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogS3-VideoDataRange-RGB-10
Description	R', G' and B' components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.1 colorimetry in Table 5 and "narrow range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_1 + 0.5) + 64)$ $G' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_2 + 0.5) + 64)$ $B' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_3 + 0.5) + 64)$
Mapping to Reference Image Pixel	$P_1 = (R' - 64) / 876$ $P_2 = (G' - 64) / 876$ $P_3 = (B' - 64) / 876$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogS3-VideoDataRange-RGB-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType></pre>

```

<xs:restriction base="oplc:Integer1024TripletType"/>
</xs:simpleType>
</xs:restriction>
</xs:simpleContent>
</xs:complexType>

```

The three elements of the triplet shall correspond to the R', G' and B' components.

B.7 APP6LogV-VideoDataRange-RGB-10

The APP6LogS3-VideoDataRange-RGB-10 color scheme shall be as specified in Table B.7. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.7 shall be as defined in SMPTE ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in SMPTE ST 2067-102.

Table B.18 – APP6LogV-VideoDataRange-RGB-10 Color Scheme

Name	APP6LogV-VideoDataRange-RGB-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogV-VideoDataRange-RGB-10
Description	R', G' and B' components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.2 colorimetry in Table 5 and "narrow range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_1 + 0.5) + 64)$ $G' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_2 + 0.5) + 64)$ $B' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_3 + 0.5) + 64)$
Mapping to Reference Image Pixel	$P_1 = (R' - 64) / 876$ $P_2 = (G' - 64) / 876$ $P_3 = (B' - 64) / 876$ $P_4 = 1.0$
Pixel Encoding Type	<pre> <xs:complexType name="APP6LogV-VideoDataRange-RGB-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType> </pre>

The three elements of the triplet shall correspond to the R', G' and B' components.

B.8 APP6LogC2-VideoDataRange-RGB-10

The APP6LogC2-VideoDataRange-RGB-10 color scheme shall be as specified in Table B.8. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.8 shall be as defined in SMPTE ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in SMPTE ST 2067-102.

Table B.19 – APP6LogC2-VideoDataRange-RGB-10 Color Scheme

Name	APP6LogC2-VideoDataRange-RGB-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC2-VideoDataRange-RGB-10
Description	R', G' and B' components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.3 colorimetry in Table 5 and “narrow range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_1 + 0.5) + 64)$ $G' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_2 + 0.5) + 64)$ $B' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_3 + 0.5) + 64)$
Mapping to Reference Image Pixel	$P_1 = (R' - 64) / 876$ $P_2 = (G' - 64) / 876$ $P_3 = (B' - 64) / 876$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC2-VideoDataRange-RGB-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the R', G' and B' components.</p>

B.9 APP6LogC3-VideoDataRange-RGB-10

The APP6LogC3-VideoDataRange-RGB-10 color scheme shall be as specified in Table B.9. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.9 shall be as defined in SMPTE ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in SMPTE ST 2067-102.

Table B.20 – APP6LogC3-VideoDataRange-RGB-10 Color Scheme

Name	APP6LogC3-VideoDataRange-RGB-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC3-VideoDataRange-RGB-10
Description	R', G' and B' components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.4 colorimetry in Table 5 and “narrow range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_1 + 0.5) + 64)$

	$G' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_2 + 0.5) + 64)$ $B' = \text{clamp}(4, 1019, \text{floor}(876 \cdot P_3 + 0.5) + 64)$
Mapping to Reference Image Pixel	$P_1 = (R' - 64) / 876$ $P_2 = (G' - 64) / 876$ $P_3 = (B' - 64) / 876$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC3-VideoDataRange-RGB-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the R', G' and B' components.</p>

B.10 APP6LogS3-Full-YCbCr-10

The APP6LogS3-Full-YCbCr-10 color scheme shall be as specified in Table B.10. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.10 shall be as defined in ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in ST 2067-102.

Table B.21 – APP6LogS3-Full-YCbCr-10 Color Scheme

Name	APP6LogS3-Full-YCbCr-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogS3-Full-YCbCr-10
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.1 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_1 + 0.5))$ $C'_B = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_2 + 0.5) + 512)$ $C'_R = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_3 + 0.5) + 512)$
Mapping to Reference Image Pixel	$P_1 = Y' / 1023$ $P_2 = (C'_B - 512) / 1023$ $P_3 = (C'_R - 512) / 1023$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogS3-Full-YCbCr-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType></pre>

```

<xs:restriction base="oplc:Integer1024TripletType"/>
</xs:simpleType>
</xs:restriction>
</xs:simpleContent>
</xs:complexType>

```

The three elements of the triplet shall correspond to the Y' , C'_B and C'_R components.

B.11 APP6LogV-Full-YCbCr-10

The APP6LogV-Full-YCbCr-10 color scheme shall be as specified in Table B.11. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.11 shall be as defined in ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in ST 2067-102.

Table B.22 – APP6LogV-Full-YCbCr-10 Color Scheme

Name	APP6LogV-Full-YCbCr-10
URI	http://www.smp-te-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogV-Full-YCbCr-10
Description	Y' , C'_B and C'_R components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.2 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_1 + 0.5))$ $C'_B = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_2 + 0.5) + 512)$ $C'_R = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_3 + 0.5) + 512)$
Mapping to Reference Image Pixel	$P_1 = Y' / 1023$ $P_2 = (C'_B - 512) / 1023$ $P_3 = (C'_R - 512) / 1023$ $P_4 = 1.0$
Pixel Encoding Type	<pre> <xs:complexType name="APP6LogV-Full-YCbCr-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType> </pre>

The three elements of the triplet shall correspond to the Y' , C'_B and C'_R components.

B.12 APP6LogC2-Full-YCbCr-10

The APP6LogC2-Full-YCbCr-10 color scheme shall be as specified in Table B.12. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.12 shall be as defined in ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in ST 2067-102.

Table B.23 – APP6LogC2-Full-YCbCr-10 Color Scheme

Name	APP6LogS3-Full-YCbCr-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC2-Full-YCbCr-10
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.3 colorimetry in Table 5 and “full range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_1 + 0.5))$ $C'_B = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_2 + 0.5) + 512)$ $C'_R = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_3 + 0.5) + 512)$
Mapping to Reference Image Pixel	$P_1 = Y' / 1023$ $P_2 = (C'_B - 512) / 1023$ $P_3 = (C'_R - 512) / 1023$ $P_4 = 1.0$
Pixel Encoding Type	<pre> <xs:complexType name="APP6LogC2-Full-YCbCr-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType> </pre> <p>The three elements of the triplet shall correspond to the Y', C'_B and C'_R components.</p>

B.13 APP6LogC3-Full-YCbCr-10

The APP6LogC3-Full-YCbCr-10 color scheme shall be as specified in Table B.13. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.13 shall be as defined in ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in ST 2067-102.

Table B.24 – APP6LogC3-Full-YCbCr-10 Color Scheme

Name	APP6LogC3-Full-YCbCr-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC3-Full-YCbCr-10
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.4 colorimetry in Table 5 and “full range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_1 + 0.5))$

	$C'_B = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_2 + 0.5) + 512)$ $C'_R = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_3 + 0.5) + 512)$
Mapping to Reference Image Pixel	$P_1 = Y' / 1023$ $P_2 = (C'_B - 512) / 1023$ $P_3 = (C'_R - 512) / 1023$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC3-Full-YCbCr-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the Y', C'_B and C'_R components.</p>

B.14 APP6LogS3-Full-RGB-10

The APP6LogS3-Full-RGB-10 color scheme shall be as specified in Table B.14. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.14 shall be as defined in ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in ST 2067-102.

Table B.25 – APP6LogS3-Full-RGB-10 Color Scheme

Name	APP6LogS3-Full-RGB-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogS3-Full-RGB-10
Description	R', G' and B' components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.1 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_1 + 0.5))$ $G' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_2 + 0.5))$ $B' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_3 + 0.5))$
Mapping to Reference Image Pixel	$P_1 = R' / 1023$ $P_2 = G' / 1023$ $P_3 = B' / 1023$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogS3-Full-RGB-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType></pre>


```

<xs:restriction base="oplc:Integer1024TripletType"/>
</xs:simpleType>
</xs:restriction>
</xs:simpleContent>
</xs:complexType>

```

The three elements of the triplet shall correspond to the R', G' and B' components.

B.15 APP6LogV-Full-RGB-10

The APP6LogV-Full-RGB-10 color scheme shall be as specified in Table B.15. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.15 shall be as defined in ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in ST 2067-102.

Table B.26 – APP6LogV-Full-RGB-10 Color Scheme

Name	APP6LogV-Full-RGB-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogV-Full-RGB-10
Description	R', G' and B' components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.2 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_1 + 0.5))$ $G' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_2 + 0.5))$ $B' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_3 + 0.5))$
Mapping to Reference Image Pixel	$P_1 = R' / 1023$ $P_2 = G' / 1023$ $P_3 = B' / 1023$ $P_4 = 1.0$
Pixel Encoding Type	<pre> <xs:complexType name="APP6LogV-Full-RGB-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType> </pre>

The three elements of the triplet shall correspond to the R', G' and B' components.

B.16 APP6LogC2-Full-RGB-10

The APP6LogC2-Full-RGB-10 color scheme shall be as specified in Table B.16. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.16 shall be as defined in ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in ST 2067-102.

Table B.27 – APP6LogC2-Full-RGB-10 Color Scheme

Name	APP6LogC2-Full-RGB-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC2-Full-RGB-10
Description	R', G' and B' components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.3 colorimetry in Table 5 and “full range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_1 + 0.5))$ $G' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_2 + 0.5))$ $B' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_3 + 0.5))$
Mapping to Reference Image Pixel	$P_1 = R' / 1023$ $P_2 = G' / 1023$ $P_3 = B' / 1023$ $P_4 = 1.0$
Pixel Encoding Type	<pre> <xs:complexType name="APP6LogC2-Full-RGB-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType> </pre> <p>The three elements of the triplet shall correspond to the R', G' and B' components.</p>

B.17 APP6LogC3-Full-RGB-10

The APP6LogC3-Full-RGB-10 color scheme shall be as specified in Table B.17. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.17 shall be as defined in ST 2067-102. The XML datatype Integer1024TripletType shall be as defined in ST 2067-102.

Table B.28 – APP6LogC3-Full-RGB-10 Color Scheme

Name	APP6LogC3-Full-RGB-10
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC3-Full-RGB-10
Description	R', G' and B' components as specified in Section 5.1, using 10-bit bit depth, COLOR.APP6.4 colorimetry in Table 5 and “full range” signal representation of Recommendation ITU-R BT.2100.

Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_1 + 0.5))$ $G' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_2 + 0.5))$ $B' = \text{clamp}(0, 1023, \text{floor}(1023 \cdot P_3 + 0.5))$
Mapping to Reference Image Pixel	$P_1 = R' / 1023$ $P_2 = G' / 1023$ $P_3 = B' / 1023$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC3-Full-RGB-10-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer1024TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the R', G' and B' components.</p>

B.18 APP6LogS3-VideoDataRange-YCbCr-12

The APP6LogS3-VideoDataRange-YCbCr-12 color scheme shall be as specified in Table B.18. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.18 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.29 – APP6LogS3-VideoDataRange-YCbCr-12 Color Scheme

Name	APP6LogS3-VideoDataRange-YCbCr-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogS3-VideoDataRange-YCbCr-12
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.1 colorimetry in Table 5 and "narrow range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $C'_B = \text{clamp}(16, 4079, \text{floor}(3584 \cdot P_2 + 0.5) + 2048)$ $C'_R = \text{clamp}(16, 4079, \text{floor}(3584 \cdot P_3 + 0.5) + 2048)$
Mapping to Reference Image Pixel	$P_1 = (Y' - 256) / 3504$ $P_2 = (C'_B - 2048) / 3584$ $P_3 = (C'_R - 2048) / 3584$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogS3-VideoDataRange-YCbCr-12-ColorEncodingType"> <xs:simpleContent></pre>

```
<xs:restriction base="oplcs:ColorEncodingType">
  <xs:simpleType>
    <xs:restriction base="oplc:Integer4096TripletType"/>
  </xs:simpleType>
</xs:restriction>
</xs:simpleContent>
</xs:complexType>
```

The three elements of the triplet shall correspond to the Y', C'B and C'R components.

B.19 APP6LogV-VideoDataRange-YCbCr-12

The APP6LogV-VideoDataRange-YCbCr-12 color scheme shall be as specified in Table B.19. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.19 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.30 – APP6LogV-VideoDataRange-YCbCr-12 Color Scheme

Name	APP6LogV-VideoDataRange-YCbCr-12
URI	http://www.smp-te-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogV-VideoDataRange-YCbCr-12
Description	Y', C'B and C'R components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.2 colorimetry in Table 5 and “narrow range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $C'_B = \text{clamp}(16, 4079, \text{floor}(3584 \cdot P_2 + 0.5) + 2048)$ $C'_R = \text{clamp}(16, 4079, \text{floor}(3584 \cdot P_3 + 0.5) + 2048)$
Mapping to Reference Image Pixel	$P_1 = (Y' - 256) / 3504$ $P_2 = (C'_B - 2048) / 3584$ $P_3 = (C'_R - 2048) / 3584$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogV-VideoDataRange-YCbCr-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre>

The three elements of the triplet shall correspond to the Y', C'B and C'R components.

B.20 APP6LogC2-VideoDataRange-YCbCr-12

The APP6LogC2-VideoDataRange-YCbCr-12 color scheme shall be as specified in Table B.20. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.20 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.31 – APP6LogC2-VideoDataRange-YCbCr-12 Color Scheme

Name	APP6LogC2-VideoDataRange-YCbCr-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC2-VideoDataRange-YCbCr-12
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.3 colorimetry in Table 5 and "narrow range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $C'_B = \text{clamp}(16, 4079, \text{floor}(3584 \cdot P_2 + 0.5) + 2048)$ $C'_R = \text{clamp}(16, 4079, \text{floor}(3584 \cdot P_3 + 0.5) + 2048)$
Mapping to Reference Image Pixel	$P_1 = (Y' - 256) / 3504$ $P_2 = (C'_B - 2048) / 3584$ $P_3 = (C'_R - 2048) / 3584$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC2-VideoDataRange-YCbCr-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the Y', C'_B and C'_R components.</p>

B.21 APP6LogC3-VideoDataRange-YCrCb-12

The APP6LogC3-VideoDataRange-YCbCr-12 color scheme shall be as specified in Table B.21. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.21 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.32 – APP6LogC3-VideoDataRange-YCbCr-12 Color Scheme

Name	APP6LogC3-VideoDataRange-YCbCr-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC3-VideoDataRange-YCbCr-12

Description	Y', C' _B and C' _R components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.4 colorimetry in Table 5 and “narrow range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $C'_B = \text{clamp}(16, 4079, \text{floor}(3584 \cdot P_2 + 0.5) + 2048)$ $C'_R = \text{clamp}(16, 4079, \text{floor}(3584 \cdot P_3 + 0.5) + 2048)$
Mapping to Reference Image Pixel	$P_1 = (Y' - 256) / 3504$ $P_2 = (C'_B - 2048) / 3584$ $P_3 = (C'_R - 2048) / 3584$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC3-VideoDataRange-YCbCr-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the Y', C'_B and C'_R components.</p>

B.22 APP6LogS3-VideoDataRange-RGB-12

The APP6LogS3-VideoDataRange-RGB-12 color scheme shall be as specified in Table B.22. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.22 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.33 – APP6LogS3-VideoDataRange-RGB-12 Color Scheme

Name	APP6LogS3-VideoDataRange-RGB-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogS3-VideoDataRange-RGB-12
Description	R', G' and B' components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.1 colorimetry in Table 5 and “narrow range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $G' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $B' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$
Mapping to Reference Image Pixel	$P_1 = (R' - 256) / 3504$ $P_2 = (G' - 256) / 3504$ $P_3 = (B' - 256) / 3504$

$$P_4 = 1.0$$

Pixel Encoding Type	<pre><xs:complexType name="APP6LogS3-VideoDataRange-RGB-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre>
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The three elements of the triplet shall correspond to the R', G' and B' components.

B.23 APP6LogV-VideoDataRange-RGB-12

The APP6LogV-VideoDataRange-RGB-12 color scheme shall be as specified in Table B.23. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.23 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.34 – APP6LogV-VideoDataRange-RGB-12 Color Scheme

Name	APP6LogV-VideoDataRange-RGB-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogV-VideoDataRange-RGB-12
Description	R', G' and B' components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.2 colorimetry in Table 5 and "narrow range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $G' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $B' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$
Mapping to Reference Image Pixel	$P_1 = (R' - 256) / 3504$ $P_2 = (G' - 256) / 3504$ $P_3 = (B' - 256) / 3504$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogV-VideoDataRange-RGB-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre>

The three elements of the triplet shall correspond to the R', G' and B' components.

B.24 APP6LogC2-VideoDataRange-RGB-12

The APP6LogC2-VideoDataRange-RGB-12 color scheme shall be as specified in Table B.24. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.24 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.35 – APP6LogC2-VideoDataRange-RGB-12 Color Scheme

Name	APP6LogC2-VideoDataRange-RGB-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC2-VideoDataRange-RGB-12
Description	R', G' and B' components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.3 colorimetry in Table 5 and "narrow range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $G' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $B' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$
Mapping to Reference Image Pixel	$P_1 = (R' - 256) / 3504$ $P_2 = (G' - 256) / 3504$ $P_3 = (B' - 256) / 3504$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC2-VideoDataRange-RGB-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the R', G' and B' components.</p>

B.25 APP6LogC3-VideoDataRange-RGB-12

The APP6LogC3-VideoDataRange-RGB-12 color scheme shall be as specified in Table B.25. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.25 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.36 – APP6LogC3-VideoDataRange-RGB-12 Color Scheme

Name	APP6LogC3-VideoDataRange-RGB-12
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URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC3-VideoDataRange-RGB-12
Description	R', G' and B' components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.4 colorimetry in Table 5 and "narrow range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $G' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$ $B' = \text{clamp}(16, 4079, \text{floor}(3504 \cdot P_1 + 0.5) + 256)$
Mapping to Reference Image Pixel	$P_1 = (R' - 256) / 3504$ $P_2 = (G' - 256) / 3504$ $P_3 = (B' - 256) / 3504$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC3-VideoDataRange-RGB-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the R', G' and B' components.</p>

B.26 APP6LogS3-Full-YCbCr-12

The APP6LogS3-Full-YCbCr-12 color scheme shall be as specified in Table B.26. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.26 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.37 – APP6LogS3-Full-YCbCr-12 Color Scheme

Name	APP6LogS3-Full-YCbCr-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogS3-Full-YCbCr-12
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.1 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_1 + 0.5))$ $C'_B = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_2 + 0.5) + 2048)$ $C'_R = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_3 + 0.5) + 2048)$

Mapping to Reference Image Pixel	$P_1 = Y' / 4095$
	$P_2 = (C'_B - 2048) / 4095$
	$P_3 = (C'_R - 2048) / 4095$
	$P_4 = 1.0$

Pixel Encoding Type	<pre><xs:complexType name="APP6LogS3-Full-YCbCr-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre>
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The three elements of the triplet shall correspond to the Y' , C'_B and C'_R components.

B.27 APP6LogV-Full-YCbCr-12

The APP6LogV-Full-YCbCr-12 color scheme shall be as specified in Table B.27. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.27 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.38 – APP6LogV-Full-YCbCr-12 Color Scheme

Name	APP6LogV-Full-YCbCr-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogV-Full-YCbCr-12
Description	Y' , C'_B and C'_R components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.2 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_1 + 0.5))$ $C'_B = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_2 + 0.5) + 2048)$ $C'_R = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_3 + 0.5) + 2048)$
Mapping to Reference Image Pixel	$P_1 = Y' / 4095$ $P_2 = (C'_B - 2048) / 4095$ $P_3 = (C'_R - 2048) / 4095$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogV-Full-YCbCr-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre>

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</xs:simpleContent>
</xs:complexType>
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The three elements of the triplet shall correspond to the Y', C'_B and C'_R components.

B.28 APP6LogC2-Full-YCbCr-12

The APP6LogC2-Full-YCbCr-12 color scheme shall be as specified in Table B.28. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.28 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.39 – APP6LogC2-Full-YCbCr-12 Color Scheme

Name	APP6LogC2-Full-YCbCr-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC2-Full-YCbCr-12
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.3 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_1 + 0.5))$ $C'_B = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_2 + 0.5) + 2048)$ $C'_R = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_3 + 0.5) + 2048)$
Mapping to Reference Image Pixel	$P_1 = Y' / 4095$ $P_2 = (C'_B - 2048) / 4095$ $P_3 = (C'_R - 2048) / 4095$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC2-Full-YCbCr-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre>

The three elements of the triplet shall correspond to the Y', C'_B and C'_R components.

B.29 APP6LogC3-Full-YCbCr-12

The APP6LogC3-Full-YCbCr-12 color scheme shall be as specified in Table B.29. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.29 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.40 – APP6LogC3-Full-YCbCr-12 Color Scheme

Name	APP6LogC3-Full-YCbCr-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC3-Full-YCbCr-12
Description	Y', C' _B and C' _R components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.4 colorimetry in Table 5 and “full range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$Y' = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_1 + 0.5))$ $C'_B = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_2 + 0.5) + 2048)$ $C'_R = \text{clamp}(0, 4095, \text{floor}(4095 \cdot P_3 + 0.5) + 2048)$
Mapping to Reference Image Pixel	$P_1 = Y' / 4095$ $P_2 = (C'_B - 2048) / 4095$ $P_3 = (C'_R - 2048) / 4095$ $P_4 = 1.0$
Pixel Encoding Type	<pre> <xs:complexType name="APP6LogC3-Full-YCbCr-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType> </pre> <p>The three elements of the triplet shall correspond to the Y', C'_B and C'_R components.</p>

B.30 APP6LogS3-Full-RGB-12

The APP6LogS3-Full-RGB-12 color scheme shall be as specified in Table B.30. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.30 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.41 – APP6LogS3-Full-RGB-12 Color Scheme

Name	APP6LogS3-Full-RGB-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogS3-Full-RGB-12
Description	R', G' and B' components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.1 colorimetry in Table 5 and “full range” signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{floor}(4095 \cdot \text{clamp}(0, 1, P_1) + 0.5)$

	$G' = \text{floor}(4095 \cdot \text{clamp}(0, 1, P_2) + 0.5)$ $B' = \text{floor}(4095 \cdot \text{clamp}(0, 1, P_3) + 0.5)$
Mapping to Reference Image Pixel	$P_1 = R' / 4095$ $P_2 = G' / 4095$ $P_3 = B' / 4095$ $P_4 = 1.0$
Pixel Encoding Type	<pre> <xs:complexType name="APP6LogS3-Full-RGB-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType> </pre> <p>The three elements of the triplet shall correspond to the R', G' and B' components.</p>

B.31 APP6LogV-Full-RGB-12

The APP6LogV-Full-RGB-12 color scheme shall be as specified in Table B.31. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.31 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.42 – APP6LogV-Full-RGB-12 Color Scheme

Name	APP6LogV-Full-RGB-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogV-Full-RGB-12
Description	R', G' and B' components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.2 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{floor}(4095 \cdot \text{clamp}(0, 1, P_1) + 0.5)$ $G' = \text{floor}(4095 \cdot \text{clamp}(0, 1, P_2) + 0.5)$ $B' = \text{floor}(4095 \cdot \text{clamp}(0, 1, P_3) + 0.5)$
Mapping to Reference Image Pixel	$P_1 = R' / 4095$ $P_2 = G' / 4095$ $P_3 = B' / 4095$ $P_4 = 1.0$
Pixel Encoding Type	<pre> <xs:complexType name="APP6LogV-Full-RGB-12-ColorEncodingType"> <xs:simpleContent> </pre>

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<xs:restriction base="oplcs:ColorEncodingType">
  <xs:simpleType>
    <xs:restriction base="oplc:Integer4096TripletType"/>
  </xs:simpleType>
</xs:restriction>
</xs:simpleContent>
</xs:complexType>
```

The three elements of the triplet shall correspond to the R', G' and B' components.

B.32 APP6LogC2-Full-RGB-12

The APP6LogC2-Full-RGB-12 color scheme shall be as specified in Table B.32. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.32 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.43 – APP6LogC2-Full-RGB-12 Color Scheme

Name	APP6LogC2-Full-RGB-12
URI	http://www.smp-te-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC2-Full-RGB-12
Description	R', G' and B' components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.3 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	R' = floor(4095 • clamp(0, 1, P ₁) + 0.5) G' = floor(4095 • clamp(0, 1, P ₂) + 0.5) B' = floor(4095 • clamp(0, 1, P ₃) + 0.5)
Mapping to Reference Image Pixel	P ₁ = R' / 4095 P ₂ = G' / 4095 P ₃ = B' / 4095 P ₄ = 1.0
Pixel Encoding Type	<xs:complexType name="APP6LogC2-Full-RGB-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType>

The three elements of the triplet shall correspond to the R', G' and B' components.

B.33 APP6LogC3-Full-RGB-12

The APP6LogC3-Full-RGB-12 color scheme shall be as specified in Table B.33. The mathematical functions "floor(x)" and "clamp(a, b, x)" in Table B.33 shall be as defined in ST 2067-102. The XML datatype Integer4096TripletType shall be as defined in ST 2067-102.

Table B.44 – APP6LogC3-Full-RGB-12 Color Scheme

Name	APP6LogC3-Full-RGB-12
URI	http://www.smpte-ra.org/ns/2067-60/2020/opl-color-scheme#APP6LogC3-Full-RGB-12
Description	R', G' and B' components as specified in Section 5.1, using 12-bit bit depth, COLOR.APP6.4 colorimetry in Table 5 and "full range" signal representation of Recommendation ITU-R BT.2100.
Mapping from Reference Image Pixel	$R' = \text{floor}(4095 \cdot \text{clamp}(0, 1, P_1) + 0.5)$ $G' = \text{floor}(4095 \cdot \text{clamp}(0, 1, P_2) + 0.5)$ $B' = \text{floor}(4095 \cdot \text{clamp}(0, 1, P_3) + 0.5)$
Mapping to Reference Image Pixel	$P_1 = R' / 4095$ $P_2 = G' / 4095$ $P_3 = B' / 4095$ $P_4 = 1.0$
Pixel Encoding Type	<pre><xs:complexType name="APP6LogC3-Full-RGB-12-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer4096TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType></pre> <p>The three elements of the triplet shall correspond to the R', G' and B' components.</p>

Annex C Additional Elements (Informative)

This annex lists non-prose elements of this document.

This specification is accompanied by the following element, which is a consolidated XML schema document as specified in W3C XML Schema Part 1: Structures.

st2067-60a-20xx.xsd

This element collects the XML schema definitions defined in this specification. It is informative and, in case of conflict, this specification takes precedence.

Bibliography (Informative)

JBA Technical Regulation T033 – 2020, 4K TV Program File Exchange