SMPTE STANDARD

Interoperable Master Format — Common Image Pixel Color Schemes

Table of Contents

Approved
December 12, 2014

Foreword

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

SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual.

SMPTE ST 2067-102 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 Standard. 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 defines Image Pixel Color Schemes, as specified in SMPTE ST 2067-101, that are of general use to Interoperable Master Format (IMF) Applications.

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.

SMPTE ST 2067-20:2013, Interoperable Master Format — Application #2

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

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

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

4 General

4.1 XML Schema Definitions

This section shall apply whenever a data structure is specified using XML schema definitions as specified in W3C XML Schema Part 1: Structures and W3C XML Schema Part 2: Datatypes.

In order to avoid duplication between text and schema, the cardinality and default values of elements are specified in the schema definitions only.

In the event of a conflict between schema definitions and the prose, the prose shall take precedence.

The XML schema root element shall be as defined in Table 1.

Table 1 – XML Schema root element definition

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="http://www.smpte-ra.org/schemas/2067-102/2014"
  xmlns:oplcs="http://www.smpte-ra.org/schemas/2067-101/2014/color-schemes"
xmlns:oplc="http://www.smpte-ra.org/schemas/2067-102/2014"
 xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:import namespace="http://www.smpte-ra.org/schemas/2067-101/2014/color-schemes"
                    />
<!-- schema definitions found in this document excluding this one -->
</xs:schema>
```

4.2 Common Type Definitions

4.2.1 Integer1024TripletType

`Integer1024TripletType` represents a triplet of integers between 0 and 1023, inclusively. It shall be as specified in Table 2.

Table 2 – Integer1024TripletType definition

```
<xs:simpleType name="Integer1024TripletType">
  <xs:restriction>
     <xs:simpleType>
      <xs:list>
       <xs:simpleType>
        <xs:restriction base="xs:integer">
          <xs:minInclusive value="0"/>
          <xs:maxInclusive value="1023"/>
        </xs:restriction>
       </xs:simpleType>
      </xs:list>
     </xs:simpleType>
     <xs:length value="3"/>
  </xs:restriction>
</xs:simpleType>
```

4.2.2 Integer256TripletType

`Integer256TripletType` represents a triplet of integers between 0 and 255, inclusively. It shall be as specified in Table 3.

Table 3 – Integer256TripletType definition

```
<xs:simpleType name="Integer256TripletType">
  <xs:restriction>
     <xs:simpleType>
      <xs:list>
       <xs:simpleType>
        <xs:restriction base="xs:integer">
          <xs:minInclusive value="0"/>
          <xs:maxInclusive value="255"/>
        </xs:restriction>
       </xs:simpleType>
      </xs:list>
     </xs:simpleType>
     <xs:length value="3"/>
  </xs:restriction>
</xs:simpleType>
```

4.3 Mathematical Functions

4.3.1 Floor

floor(x) shall be equal to the largest integer not greater than x.

4.3.2 Clamp

clamp(a, b, x) shall be defined as follows:

$$\text{clamp}(a, b, x) = \begin{cases} x, \text{ if } x \in [a, b] \\ a \text{ if } x < a \\ b \text{ if } x > b \end{cases}$$

5 REC709-RGB-8

The REC709-RGB-8 color scheme shall be as specified in Table 4.

Table 4 – REC709-RGB-8 Color Scheme

Name	REC709-RGB-8
URI	`http://www.smpte-ra.org/schemas/2067-102/2014#REC709-RGB-8`
Description	R', G' and B' components as specified in SMPTE ST 2067-20, using 8-bit bit depth, COLOR.3 colorimetry and QE.1 quantization system.
Mapping from Reference Image Pixel	R' = floor(219 • clamp(0, 1, P1) + 0.5) + 16 G' = floor(219 • clamp(0, 1, P2) + 0.5) + 16 B' = floor(219 • clamp(0, 1, P3) + 0.5) + 16
Mapping to Reference Image Pixel	P_1 = (R' – 16) / 219 P_2 = (G' – 16) / 219 P_3 = (B' – 16) / 219 P_4 = 1.0
Pixel Encoding Type	<xs:complexType name="REC709-RGB-8-ColorEncodingType"> <xs:simpleContent> <xs:restriction base="oplcs:ColorEncodingType"> <xs:simpleType> <xs:restriction base="oplc:Integer256TripletType"/> </xs:simpleType> </xs:restriction> </xs:simpleContent> </xs:complexType> The three elements of the triplet shall correspond to the R', G' and B' components.

6 REC709-RGB-10

The REC709-RGB-10 color scheme shall be as specified in Table 5.

Table 5 – REC709-RGB-10 Color Scheme

Name	REC709-RGB-10
URI	`http://www.smpte-ra.org/schemas/2067-102/2014#REC709-RGB-10`
Description	R', G' and B' components as specified in SMPTE ST 2067-20, using 10-bit bit depth, COLOR.3 colorimetry and QE.1 quantization system.
Mapping from Reference Image Pixel	$R' = \text{floor}(876 \cdot \text{clamp}(0, 1, P_1) + 0.5) + 64$ $G' = \text{floor}(876 \cdot \text{clamp}(0, 1, P_2) + 0.5) + 64$ $B' = \text{floor}(876 \cdot \text{clamp}(0, 1, P_3) + 0.5) + 64$
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	`<xs:complexType name="REC709-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>`
	The three elements of the triplet shall correspond to the R', G' and B' components.

7 REC709-Full-RGB-10

The REC709-Full-RGB-10 color scheme shall be as specified in Table 6.

Table 6 – REC709-Full-RGB-10 Color Scheme

Name	REC709-Full-RGB-10
URI	`http://www.smpte-ra.org/schemas/2067-102/2014#REC709-Full-RGB-10`
Description	R', G' and B' components as specified in SMPTE ST 2067-20, using 10-bit bit depth, COLOR.3 colorimetry and QE.2 quantization system.
Mapping from Reference Image Pixel	$R' = \text{floor}(1023 \cdot \text{clamp}(0, 1, P_1) + 0.5)$ $G' = \text{floor}(1023 \cdot \text{clamp}(0, 1, P_2) + 0.5)$ $B' = \text{floor}(1023 \cdot \text{clamp}(0, 1, P_3) + 0.5)$
Mapping to Reference Image Pixel	$P_1 = R' / 1023$ $P_2 = G' / 1023$ $P_3 = B' / 1023$ $P_4 = 1.0$

Pixel Encoding Type	`<xs:complexType name="REC709-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>`
	The three elements of the triplet shall correspond to the R', G' and B' components.

8 REC709-YCbCr-8

The REC709-YCbCr-8 color scheme shall be as specified in Table 7.

Table 7 – REC709-YCbCr-8 Color Scheme

Name	REC709-YCbCr-8
URI	`http://www.smpte-ra.org/schemas/2067-102/2014#REC709-YCbCr-8`
Description	Y', $C'_{B,}$ and C'_R components as specified in SMPTE ST 2067-20, using 8-bit bit depth, COLOR.3 colorimetry and QE.1 quantization system.
Mapping from Reference Image Pixel	$Y' = \text{floor}(219 \cdot \text{clamp}(0, 1, P_1) + 0.5) + 16$ $C'_B = \text{floor}(224 \cdot \text{clamp}(-0.5, 0.5, P_2) + 0.5) + 128$ $C'_R = \text{floor}(224 \cdot \text{clamp}(-0.5, 0.5, P_3) + 0.5) + 128$
Mapping to Reference Image Pixel	$P_1 = (Y' - 16) / 219$ $P_2 = (C'_B - 128) / 224$ $P_3 = (C'_R - 128) / 224$ $P_4 = 1.0$

Pixel Encoding Type	`<xs:complexType name="REC709-YCbCr-8-ColorEncodingType">`
	`  <xs:simpleContent>`
	`  <xs:restriction base="oplcs:ColorEncodingType">`
	`  <xs:simpleType>`
	`  <xs:restriction base="oplc:Integer256TripletType"/>`
	`  </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.

Annex A Consolidated Schema (Informative)

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

st2067-102a-2014.xsd

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