

SMPTE STANDARD

Dynamic Metadata for Color
Volume Transform —
KLV Encoding and MXF Mapping



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Foreword

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

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

SMPTE ST 2094-2 was prepared by Technology Committee 31FS.

Intellectual Property

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

Introduction

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

The SMPTE ST 2094 suite of documents defines metadata for use in color volume transforms of content. This document specifies:

- The encoding of SMPTE ST 2094 metadata sets using Key-Length-Value (KLV) structures,
- The MXF essence container for using this essence with MXF files.

Metadata items are encoded in data types corresponding to those used in referenced SMPTE ST 2094 documents, with some exceptions. Value ranges, array bounds, and allowed item combinations are specified in the referenced SMPTE ST 2094 documents and are not duplicated in this document.

Section 6 specifies the encoding of SMPTE ST 2094 metadata sets using the Key-Length-Value data encoding protocol (KLV), defined in SMPTE ST 336.

Section 7 defines the coding of the metadata essence element, the essence container label, and the essence descriptor, for MXF Essence Containers containing DMCVT Application Sets.

1 Scope

The SMPTE ST 2094 suite of documents defines metadata for use in color volume transforms of content.

SMPTE ST 2094-2 specifies Key-Length-Value (KLV) representations of metadata sets defined in SMPTE ST 2094-10, SMPTE ST 2094-20, SMPTE ST 2094-30, and SMPTE ST 2094-40.

SMPTE ST 2094-2 specifies frame-based mapping of KLV-encoded SMPTE ST 2094 metadata sets into the MXF generic container. SMPTE ST 2094-2 specifies the key and value fields of the essence elements, the essence container label and the essence descriptor.

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; then 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 engineering document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this engineering document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 336:2007, Data Encoding Protocol Using Key-Length-Value

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

Amendment 1:2012 to SMPTE ST 377-1:2011

Amendment 2:2012 to SMPTE ST 377-1:2011

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

SMPTE ST 2094-1:2016, Dynamic Metadata for Color Volume Transform — Core Components

SMPTE ST 2094-10:2016, Dynamic Metadata for Color Volume Transform — Application 1

SMPTE ST 2094-20:2016, Dynamic Metadata for Color Volume Transform — Application 2

SMPTE ST 2094-30:2016, Dynamic Metadata for Color Volume Transform — Application 3

SMPTE ST 2094-40:2016, Dynamic Metadata for Color Volume Transform — Application 4

4 Terms and Definitions

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

4.1 DMCVT

SMPTE ST 2094 (Dynamic Metadata for Color Volume Transform)

4.2 SMPTE ST 2094 Application document

SMPTE ST 2094 document defining a SMPTE ST 2094 application, such as one of SMPTE ST 2094-10, SMPTE ST 2094-20, SMPTE ST 2094-30, SMPTE ST 2094-40

5 Notations

Table columns have the meanings as defined in Table 1. All columns are not present in all tables.

Table 1 – Definition of Table Headings

Table heading	Definition
Item Name	Name of this set or metadata item as indicated in the defining document
Type	The entry shall have this data type
Len	Length of the value field for this entry, in bytes, according to the data type, where n, if present, represents number of elements in an array
Local Tag	Hexadecimal value of the local tag that identifies this entry
Req	Req indicates that the item is always present. This indicator maps to the isOptional entry in the SMPTE Groups Register, where isOptional corresponds to table entry != "Req". Opt indicates that the item can be present or omitted. Opt* indicates that this item is present or omitted depending on the presence or value of other items. This is detailed in Section 6.
Den	The denominator shall have this specified value (applies only to the Rational data type)
Definition	Description of this entry
Symbol	The registry symbol that is associated with this item
Kind	The kind of the registry entry
Item UL	The SMPTE Universal Label that shall be associated with this item

6 Encoding of SMPTE ST 2094 Metadata Sets

6.1 KLV-Encoded DMCVT Application Sets

When a metadata set defined by a SMPTE ST 2094 Application document is KLV-encoded, it is KLV-encoded using an DMCVT Application Set, which is specific to the SMPTE ST 2094 Application. The DMCVT Application Sets for SMPTE ST 2094-10, SMPTE ST 2094-20, SMPTE ST 2094-30, and SMPTE ST 2094-40 shall be as defined in Sections 6.3 through 6.6, respectively.

Each DMCVT Application Set shall encode exactly one metadata set as defined in the corresponding SMPTE ST 2094 Application document.

Each DMCVT Application Set shall be a local set, as defined in SMPTE ST 336. The set key indicates the Application Identifier and Application Version. The set length field shall be 4 bytes long. The local tag and local length fields, as defined in SMPTE ST 336, shall be 2 bytes long.

The local tag values shall map to SMPTE Universal Labels (ULs) and Symbols as specified in Table A.2 in Annex A.

Note: Local tags in local sets outside MXF Header Metadata cannot be dynamically allocated.

Each DMCVT Application Set shall be a subclass of the DMCVT Generic Set 1, which is defined in Section 6.2.

For each item defined in the DMCVT Application Set, the item's name, presence, value, and default value, if any, shall be as specified in the SMPTE ST 2094 Application document, unless otherwise specified for the DMCVT Application Set. The metadata group headings specified in the SMPTE ST 2094 Application document are not encoded.

Items can be in any order within the DMCVT Application Set, unless otherwise specified. Multi-byte values shall be coded as big-endian (most significant byte first), which is defined in SMPTE ST 377-1. Multi-dimensional items are represented as one-dimensional. The values of coordinates and sampled functions, defined in SMPTE ST 2094-1, shall be ordered u' , v' , or x , y , or x_1 , y_1 , x_2 , y_2 ... The values of matrices and two-input sampled functions, defined in SMPTE ST 2094-1, shall be ordered z_{11} , z_{12} ... z_{MN} , where the number of columns (N) is the number of elements (n) in the item, divided by the number of rows (M).

Decimal numbers with fractions are encoded using the Rational data type, unless otherwise stated. The denominator is specified in column Den, and corresponds to the increment value used in the SMPTE ST 2094 Application document. When comparing with representations using other increment values, the values should be rounded to the larger increment value before comparing.

Example: Average MaxRGB is specified as a multiple of 0.00001, so that 0.004 is encoded as 400 / 100 000.

Sets and items are listed in the SMPTE Groups Register and the SMPTE Metadata Elements Dictionary using the names, symbols, types, kinds, ULs, and definitions found in this document.

Annex B provides examples of DMCVT Application Sets.

6.2 DMCVT Generic Set 1

The DMCVT Generic Set 1 shall be an abstract class as defined in SMPTE ST 377-1.

The metadata items defined in SMPTE ST 2094-1 shall be encoded as defined in Table 3.

The Application Version item defined in SMPTE ST 2094-1 shall be named Application Version Number in the DMCVT Generic Set 1. (An Application Version item already exists in the SMPTE Metadata Elements Dictionary.)

The Backwards Version item is not defined in any SMPTE ST 2094 Application document, may be present, and shall indicate the lowest Application Version for which this metadata set is valid. The value shall be in the range 0 to the value of the Application Version Number. The default value is the value of the Application Version Number.

For other items defined in the DMCVT Generic Set 1,

- The item shall be present, omitted, or optional, as specified in the SMPTE ST 2094 Application document that corresponds to the DMCVT Application Set using the DMCVT Generic Set 1, and
- The item's name, value and default value, if any, shall be as specified in SMPTE ST 2094-1, unless otherwise specified in the SMPTE ST 2094 Application document.

The group nodes and the set key shall have the ULs defined in Table 2. These are listed in the SMPTE Groups Register.

Table 2 – Group Node and Set Key for DMCVT Sets

Item Name	Symbol	Kind	Item UL
Color Transform Sets	ColorTransformSets	NODE	06.0E.2B.34.02.7F.01.01.05.31.00.00.00.00.00.00
DMCVT Generic Sets	DMCVTGenericSets	NODE	06.0E.2B.34.02.7F.01.01.05.31.01.00.00.00.00.00
DMCVT Generic Set 1	DMCVTGenericSet1	LEAF	06.0E.2B.34.02.7F.01.01.05.31.01.01.00.00.00.00
DMCVT Application Sets	DMCVTApplicationSets	NODE	06.0E.2B.34.02.7F.01.01.05.31.02.00.00.00.00.00

Table 3 – DMCVT Generic Set 1

Item Name	Type	Len	Local Tag	Req	Den	Definition
DMCVT Generic Set 1	Set key	16		Req		Identifies a DMCVT Generic Set 1
Length	BER length	4		Req		Set length (up to 180 bytes)
Application Identifier	UInt8	1	36.01	Req		Identifying an application and its defining document in the SMPTE ST 2094 suite
Application Version Number	UInt8	1	36.02	Req		The Application Version of the identified SMPTE ST 2094 application
Backwards Version	UInt8	1	36.03	Opt		The lowest Application Version for which this metadata set is valid
Time Interval Start	UInt32	4	36.04	Opt*		Start point of the portion of image essence for which the metadata set is specified, as an index
Time Interval Duration	UInt32	4	36.05	Opt*		Duration of the portion of image essence for which the metadata set is specified, as a count of index positions
Upper Left Corner	UInt16Array	8+ 2*2	36.06	Opt*		Coordinate of the top-left pixel of the Processing Window
Lower Right Corner	UInt16Array	8+ 2*2	36.07	Opt*		Coordinate of the bottom-right pixel of the Processing Window
Window Number	UInt8	1	36.08	Opt*		Identifier of the Processing Window
Targeted System Display Primaries	RationalArray	8+ 8*6	36.09	Opt*	10 000	xy chromaticity coordinates of the three primaries of the targeted system display
Targeted System Display White Point Chromaticity	RationalArray	8+ 8*2	36.0A	Opt*	10 000	xy chromaticity coordinate of the targeted system display's white point
Targeted System Display Maximum Luminance	Rational	8	36.0B	Opt*	100	Maximum luminance of the targeted system's display
Targeted System Display Minimum Luminance	Rational	8	36.0C	Opt*	10 000	Minimum luminance of the targeted system's display

6.3 DMCVT Application 1 Set

The metadata set defined in SMPTE ST 2094-10 shall be encoded as defined Table 5.

The set key shall be the UL defined in Table 4.

Table 4 – Set Key for DMCVT Application 1 Set

Item Name	Symbol	Kind	Item UL
DMCVT App1 Set	DMCVTApp1Set	LEAF	06.0E.2B.34.02.53.01.01.05.31.02.01.00.00.00.00

Table 5 – DMCVT Application 1 Set

Item Name	Type	Len	Local Tag	Req	Den	Definition
DMCVT App1 Set	Set key	16		Req		Identifies a DMCVT Application 1 Set
Length	BER length	4		Req		Set length (up to 324 bytes)
All items in DMCVT Generic Set 1 except Set key and Length						DMCVT Generic Set 1
Minimum PQ-encoded maxRGB	Rational	8	36.0D	Req	100 000	The lowest PQ-encoded maxRGB value of the reduced pixel set
Average PQ-encoded maxRGB	Rational	8	36.0E	Req	100 000	The average of the PQ-encoded maxRGB values of the reduced pixel set
Maximum PQ-encoded maxRGB	Rational	8	36.0F	Req	100 000	The highest PQ-encoded maxRGB value of the reduced pixel set
Minimum PQ-encoded maxRGB Offset	Rational	8	36.10	Opt	100 000	Offset to be added to Minimum PQ-encoded maxRGB
Average PQ-encoded maxRGB Offset	Rational	8	36.11	Opt	100 000	Offset to be added to Average PQ-encoded maxRGB
Maximum PQ-encoded maxRGB Offset	Rational	8	36.12	Opt	100 000	Offset to be added to Maximum PQ-encoded maxRGB
Tone Mapping Offset	Rational	8	36.13	Opt	100 000	Tone Mapping Offset
Tone Mapping Gain	Rational	8	36.14	Opt	10 000	Tone Mapping Gain
Tone Mapping Gamma	Rational	8	36.15	Opt	1 000	Tone Mapping Gamma
Chroma Compensation Weight	Rational	8	36.16	Opt	10 000	Amount of chroma adjustment
Saturation Gain	Rational	8	36.17	Opt	10 000	Amount of saturation adjustment
Tone Detail Factor	Rational	8	36.18	Opt	1 000	Contribution of the detail management function

6.4 DMCVT Application 2 Set

The metadata set defined in SMPTE ST 2094-20 shall be encoded as defined in Table 7.

The numerator of the Shadow Gain Control, Highlight Gain Control, and Mid-Tone Width Adjustment Factor items shall be a multiple of 2.

The set key shall be the UL defined in Table 6.

Table 6 – Set Key for DMCVT Application 2 Set

Item Name	Symbol	Kind	Item UL
DMCVT App2 Set	DMCVTApp2Set	LEAF	06.0E.2B.34.02.53.01.01.05.31.02.02.00.00.00.00