SMPTE STANDARD

Material Exchange Format — Mapping JPEG XS Codestreams into the MXF Generic Container

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Foreword

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SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee 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.

JPEG XS is an intra-frame compression scheme defined by ISO/IEC 21122 and is used for both individual pictures and picture sequences, where each picture is entirely independent and can be extracted as an independent entity. However, the codestreams can be simply concatenated to form a sequence of compressed pictures. This standard specifies the mapping of JPEG XS codestreams conforming to ISO/IEC 21122-1 into a picture essence track of the MXF Generic Container in both frame-wrapped and clip-wrapped forms.

1 Scope

This standard specifies the mapping of JPEG XS codestreams, which contain coded still pictures, into the MXF Constrained Generic Container, as specified in SMPTE ST 379-2.

This standard specifies the mapping of JPEG XS codestreams as either frame-wrapped, where each JPEG XS codestream is individually mapped into a frame; or clip-wrapped, where a sequence of JPEG XS codestreams is mapped into a clip. This standard defines the KLV coding, the essence container and compression label values and the essence descriptor.

This document does not specify mappings for JPEG XS file formats or JPEG XS containers defined in ISO/IEC 21122-3 Annex A to Annex C.

This standard defines the data structure at the signal interfaces of networks or storage media. This standard does not define internal storage formats for MXF compliant devices.

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

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

ISO/IEC 21122-1:2019, Information Technology — JPEG XS Low-Latency Lightweight Image Coding System — Part 1: Core Coding System

ISO/IEC 21122-2:2019, Information Technology — JPEG XS Low-Latency Lightweight Image Coding System — Part 2: Profiles and buffer models

4 Terms and Definitions

For the purposes of this document, the terms and definitions given in SMPTE ST 377-1, SMPTE ST 379-2, ISO/IEC 21122-1 and ISO/IEC 21122-2 apply.

In case of conflict, the terms and definitions of SMPTE ST 377-1 shall take precedence.

5 JPEG XS Mappings

5.1 General

The MXF Constrained Generic Container (GC) is fully described in SMPTE ST 379-2.

This standard specifies the mapping of JPEG XS codestreams into the JPEG XS Picture Element. The JPEG XS Picture Element can be used in the picture item of the MXF Constrained Generic Container. The JPEG XS Picture Element may contain either individual JPEG XS codestreams using frame-wrapping or a sequence of JPEG XS codestreams using clip-wrapping.

This standard specifies the key, the length, and the value fields of the JPEG XS Picture Element. This standard also defines the essence container and compression label values and the essence descriptor.

5.2 JPEG XS Coding Summary (Informative)

A JPEG XS coded bitstream for a single compressed image is defined as a JPEG XS codestream, which is defined by a SOC marker that identifies the start of the JPEG XS codestream and an EOC marker that identifies the end of the JPEG XS codestream. In between the SOC and EOC markers are other markers for identification of key parts of the codestream together with the compressed image data. The syntax of the JPEG XS codestream is defined in ISO/IEC 21122-1.

5.3 Application in the MXF Constrained Generic Container

This mapping shall use the MXF Constrained Generic Container in either the frame-based wrapping or clip-based wrapping mode, as specified in SMPTE ST 379-2.

The following wrapping modes are defined:

- Progressive Frame-based wrapping
- Interlaced Frame-based wrapping, 2 fields per KLV Element
- Clip-based wrapping

These are described in the sections immediately below.

5.4 Progressive Frame-based Wrapping

The essence container shall be frame-wrapped.

As illustrated in Figure 1, each Content Package shall contain a Picture Item that consists of a single JPEG XS Picture Element.

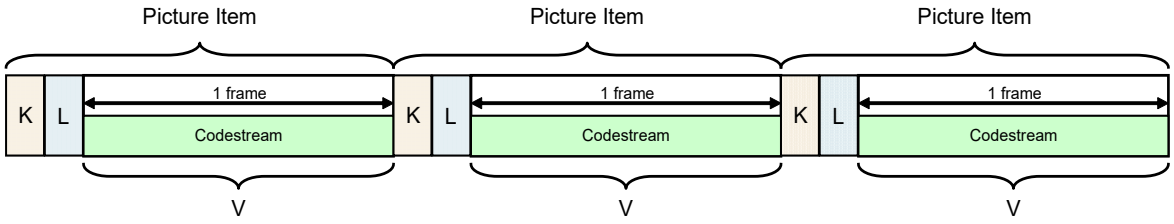

Figure 1 – Progressive Frame-based wrapping

This essence container may contain other interleaved essence elements, as illustrated in Figure 2. These other essence elements shall be as defined by this or other MXF mapping standards. All essence elements shall be frame wrapped. For simplicity of operation, each frame should contain essence elements that are independent of other frames. Interleaved essence elements that are inter-frame coded are not prohibited, but their inclusion might impact the performance of codecs. All essence elements in each interleaved frame should be time coincident within the limits of human recognition.

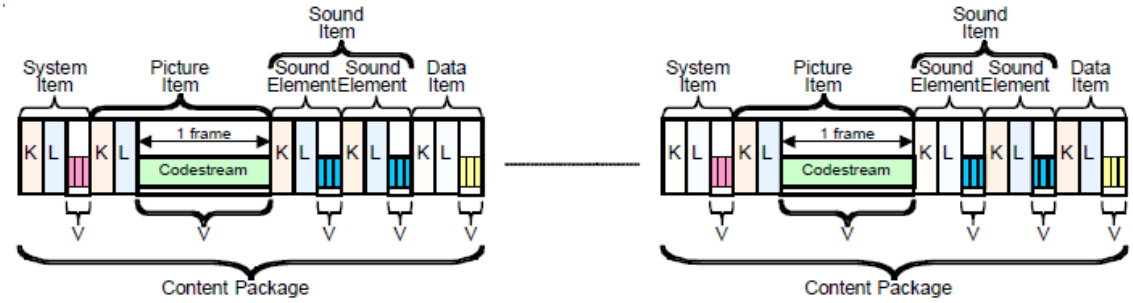

Figure 2 – Frame-based wrapping of interleaved items and elements in the MXF Constrained Generic Container

NOTE 1 The term 'frame-based wrapping' is defined by SMPTE ST 379-2 as the individual wrapping of one or more content packages each having a basic sample unit. This basic sample unit is defined by the JPEG XS codestream and in television systems, and can be the result of coding fields from an interlaced scanned picture or frames from a progressively scanned picture.

NOTE 2 Interleaving essence elements sometimes involve timing tolerances whose specification is beyond the scope of this standard. However, the design of the frame-based interleaved MXF Constrained Generic Container is predicated on the concept of essentially time-aligned essence elements within each content package.

Individual applications may define the JPEG XS Picture Element as the only element present in each content package.

5.5 Interlaced Frame-based Wrapping, 2 Fields per KLV Element

The essence container shall be frame-wrapped.

As illustrated in Figure 3, each Content Package corresponds to a single interlaced picture, and shall contain a Picture Item with a single JPEG XS Picture Element containing two concatenated JPEG XS codestreams, each representing a single picture field.

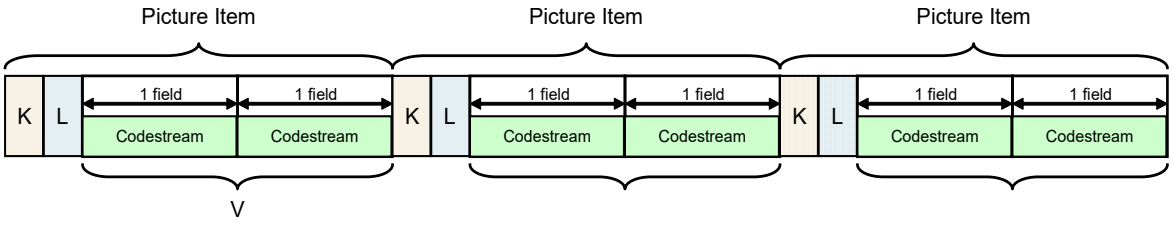

Figure 3 – Interlace Frame-based wrapping, 2 fields per KLV element.

This essence container may contain other interleaved essence elements.

5.6 Clip-based Wrapping

The essence container shall be clip-wrapped.

As illustrated in Figure 4, the Content Package shall contain a Picture Item with a single JPEG XS Picture Element whose value is a sequence of concatenated JPEG XS codestreams.

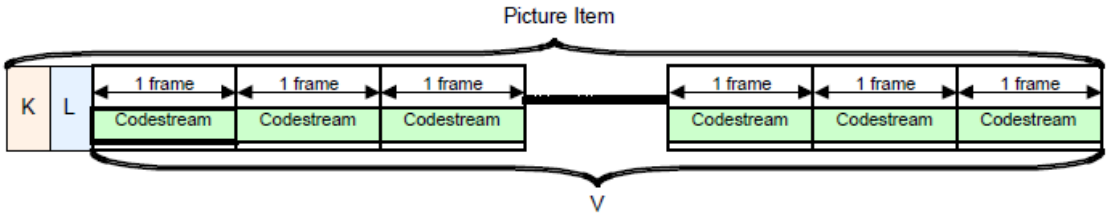

Figure 4 – Clip-based wrapping

The JPEG XS Picture Element may be the sole element in the content package.

The JPEG XS Picture Element may also be accompanied by other essence elements as illustrated in Figure 5. All essence elements should have identical duration.

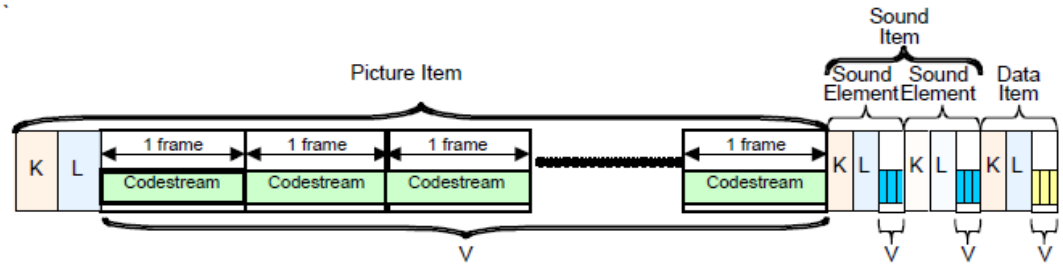

Figure 5 – Clip-based wrapping with other essence elements

6 Key-length-value Coding

6.1 JPEG XS Picture Element Key

6.1.1 General

The values of the first 12 bytes of the essence element key are defined in SMPTE ST 379-2. The values of the last four bytes of the Picture Element key shall be as specified in Table 1.

Table 1 – Key value for the JPEG XS Picture Element

Byte No.	Description	Value (hex)	Meaning
1~12	Defined by Generic Container		See SMPTE ST 379-2
13	Item Type Identifier	0x15	GC Picture Item (as defined in SMPTE ST 379-2)
14	Essence Element Count	0xkk	Count of Picture Elements in the Picture item
15	Essence Element Type	0x1a 0x1b	Frame-wrapped JPEG XS Picture Element Clip-wrapped JPEG XS Picture Element
16	Essence Element Number	0xnn	The Number (used as an Index) of this Picture Element in the Picture Item

6.1.2 Essence element count — Byte 14

This is a count of the number of Picture Elements in the picture item of the generic container.

In all wrapping modes defined in this document, one Picture Item is composed of one KLV Element, and the Essence Element Count shall be equal to 1 for each Picture Element.

6.1.3 Essence element type — Byte 15

The value of 0x1a identifies that each JPEG XS codestream is Frame-wrapped.

The value of 0x1b identifies that the sequence of JPEG XS codestreams is Clip-wrapped.

6.1.4 Essence element number — Byte 16

The essence element number shall comply with SMPTE ST 379-2.

6.2 JPEG XS Picture Element Length

The length field shall comply with SMPTE ST 379-2.

6.3 JPEG XS Picture Element Value

6.3.1 General (informative)

Each JPEG XS codestream starts with the unique SOC (start of codestream) 2-byte marker and ends with the unique EOC (end of codestream) 2-byte marker, as specified in ISO/IEC 21122-1.

NOTE Users are cautioned that the code values for SOC and EOC are not protected and can occur elsewhere in the codestream. Thus, it is not safe to parse the concatenated JPEG XS codestreams by merely scanning for SOC and/or EOC values. The structure of a JPEG XS codestream is essentially key-length-value, thus it is easy to read the lengths of the various codestream pieces and compute the length of the entire codestream. But applications which attempt to parse the bitstream at a randomly accessed point within the sequence of codestreams are cautioned that SOC and EOC values are not guaranteed to be absent between the true SOC and EOC markers.

6.3.2 Frame-wrapped progressive

The value field shall comprise a single JPEG XS codestream, representing a progressively scanned picture (see Section 5.4).

6.3.3 Frame-wrapped interlaced, 2 fields per KLV Element

The value field shall comprise two concatenated JPEG XS codestreams, corresponding to the first field followed by the second field of the interlaced picture (see section 5.5).

NOTE Decoders can derive the bytestream offsets of each field by analysing the codestream format within the essence element as described in ISO/IEC 21122-1.

6.3.4 Clip-wrapped

The value field shall comprise a sequence of one or more concatenated JPEG XS codestreams (see Section 5.6).

7 SMPTE Label Values

7.1 Essence Container Label

This Essence Container Label is the UL value carried in the Essence Containers Properties of the Partition Packs, Preface Set and File Descriptor. Partition Packs, Preface Set and File Descriptor are as defined in SMPTE ST 377-1.

The values for the essence container Label, as specified in SMPTE ST 379-2, shall be as given in Table 2.

Table 2 – Specification of the essence container label

Item Name	Symbol	Kind	Item UL
MXF-GC JPEG XS Pictures	MXFGCJPEGXSPictures	NODE	urn:smpte:ul:060e2b34.0401010d.0d010301.02210000
MXF-GC Frame-wrapped Progressive JPEG XS Pictures	MXFGCFrameWrappedProgressiveJPEGXSPictures	LEAF	urn:smpte:ul:060e2b34.0401010d.0d010301.02210100
MXF-GC Frame-wrapped Interlaced JPEG XS Pictures	MXFGCFrameWrappedInterlacedJPEGXSPictures	LEAF	urn:smpte:ul:060e2b34.0401010d.0d010301.02210200
MXF-GC Clip-wrapped JPEG XS Pictures	MXFGCClipWrappedJPEGXSPictures	LEAF	urn:smpte:ul:060e2b34.0401010d.0d010301.02210300

NOTE The essence container UL is used within a batch of ULs in partition packs and the preface set and on its own in the essence descriptor.

7.2 Picture Essence Coding Label

Labels intended for use as values for the Picture Essence Coding item of the Generic Picture Essence Descriptor, specified in SMPTE ST 377-1, are given in Table 3.

Table 3 – Picture Essence Coding Labels for codestreams according to ISO/IEC 21122-2.

Item Name	Symbol	Kind	Item UL
JPEG XS Picture Coding Schemes	JPEGXSPictureCodingSchemes	NODE	urn:smpte:ul:060e2b34.0401010d.04010202.03080000
JPEG XS Unrestricted Codestream	JPEGXSUnrestrictedCodestream	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.03080100
JPEG XS Main 422 10 Profile	JPEGXSMain422_10Profile	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.03080200
JPEG XS Main 444 12 Profile	JPEGXSMain444_12Profile	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.03080300
JPEG XS Main 4444 12 Profile	JPEGXSMain4444_12Profile	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.03080400
JPEG XS Light 422 10 Profile	JPEGXSLight422_10Profile	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.03080500
JPEG XS Light 444 12 Profile	JPEGXSLight444_12Profile	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.03080600
JPEG XS Light Subline 422 10 Profile	JPEGXSLightSubline422_10Profile	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.03080700
JPEG XS High 444 12 Profile	JPEGXSHigh444_12Profile	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.03080800
JPEG XS High 4444 12 Profile	JPEGXSHigh4444_12Profile	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.03080900

NOTE The Picture Essence Coding item of the Generic Picture Essence Descriptor is intended to allow a decoder to fast-fail when processing the MXF file. The CAP, and PIH marker segments present within the JPEG XS codestream, and replicated in the JPEG XS Picture SubDescriptor, provide complete information (profile, level and sublevel) on the capabilities required to decode the codestream and the profile to which the codestream conforms, if any. For example, the value of the Ppih field in the PIH marker segment can indicate that the JPEG XS codestream belongs to a constrained codestream set (as specified in ISO/IEC 21122-2) even though the Picture Essence Coding Label indicates no application coding constraints.

8 Application Issues

8.1 General

Issues related to coding of television signals, particularly concerning interlaced pictures, are discussed in Annex A.

8.2 Application of the KAG and the KLV Fill Item

MXF encoders and decoders shall comply with the KAG rules defined in SMPTE ST 377-1.

The default value of the KAG is 1. Other KAG values may be used within the range defined by SMPTE ST 377-1.

The KLV fill item may be used to maintain a constant content package size so permitting the use of a single index table segment.

8.3 Index Table Usage

Since JPEG XS coding is frame-based, the KLV fill item can provide for a constant edit unit size for all frames in many applications.

Where the application defines a constant edit unit size, an index table shall be used. This includes the cases where the JPEG XS essence element is the sole essence component and where it is interleaved with other essence components.

Where the application has a variable edit unit size an index table should be used wherever possible.

SMPTE EG 377-3 illustrates the use of index tables for both mono and multi-essence mappings and for both constant and variable length edit unit sizes.

8.4 Operational Pattern Usage

This essence mapping may be used with any generalized operational pattern.

NOTE This does not preclude the use of specialized operational patterns.

8.5 Mapping Track Numbers to Generic Container Elements

Each track number value for an essence element defined in this standard shall be derived as described in the MXF Constrained Generic Container specification (SMPTE ST 379-2).

8.6 Essence Container Partitions

Frame wrapping maintains each content package of the generic container as a separate editable unit with the contents of the system, picture, sound and data items in synchronism. If a frame-wrapped essence container is partitioned, then individual content packages should not be fragmented by the partitioning process.

If the essence container is clip wrapped it is recommended that each essence element be multiplexed in a sequence of partitions.

NOTE SMPTE ST 377-1:2019, Section 6.2.2 (Partition Rules Summary) summarizes the use of partitions in MXF files.

9 Essence Descriptors

9.1 File Descriptor Sets (informative)

The file descriptor sets are those structural metadata sets in the header metadata that describe the essence and metadata elements defined in this standard. The structure of these sets is defined in the MXF file format specification (SMPTE ST 377-1) and in some generic container mapping specifications.

NOTE 1 Applications or constraints specifications that use particular JPEG XS profiles are responsible for determining the values of required and best efforts properties of MXF Descriptors.

NOTE 2 With the exception of those properties that have been defined in SMPTE ST 377-1, all local tag values in descriptors defined in this standard are dynamically allocated (Dyn) as described in SMPTE ST 377-1:2019, Section 9.2.2 (local tag values). The translation from each dynamically allocated local tag value to its full UL value can be found using the primer pack mechanism defined in SMPTE ST 377-1:2019, Section 9.2 (primer pack).

Annex B illustrates the chain of MXF descriptors and their relationships.

Annex C illustrates a potential mapping of color encoding metadata contained in transport containers other than MXF into MXF metadata.

9.2 JPEG XS Picture SubDescriptor

For the JPEG XS wrapping, a single instance of the JPEG XS Picture SubDescriptor, which is strongly referenced from the CDCI Descriptor or the RGBA Descriptor, should be present. The JPEG XS Picture SubDescriptor shall consist of the JPEG XS-specific properties as shown in Table 4 and Table 5. If the properties in Table 5 are present, their values shall apply to the entire essence container.

Certain values of the metadata in the JPEG XS Picture SubDescriptor are copies of values used in the syntax of the JPEG XS codestream, as detailed in Table 5. If there is any discrepancy between values, those in the codestream shall take precedence and the values in the SubDescriptor should be updated.

NOTE 1 The JPEG XS Picture SubDescriptor is a sub-class of the MXF header metadata abstract superclass and inherits only the InstanceUID and GenerationUID properties. In order to use this set, the "SubDescriptors" property in the MXF generic descriptor allows both the CDCI and RGBA picture essence descriptors to inherit this property and thus either can make a strong reference to the JPEG XS Picture SubDescriptor.

NOTE 2 The JPEG XS Picture SubDescriptor can only be used when the required properties are consistent for all JPEG XS codestreams in the essence container.

NOTE 3 Applications specify requirements for the presence of optional items. Applications can, for instance, require the presence of optional items if the underlying parameters are present in the JPEG XS codestreams.

Table 4 –JPEG XS Picture SubDescriptor ULs

Item Name	Symbol	Kind	Item UL
JPEG XS SubDescriptor [1,2]	JPEGXSSubDescriptor	LEAF	urn:smpte:ul:060e2b34.027f0101.0d010101.01018102
JPEG XS Coding Parameters	JPEGXSCodingParameters	NODE	urn:smpte:ul:060e2b34.0101010e.0401060b.00000000
JPEG XS Ppih	JPEGXSPpih	LEAF	urn:smpte:ul:060e2b34.0101010e.0401060b.01000000
JPEG XS Plev	JPEGXSPlev	LEAF	urn:smpte:ul:060e2b34.0101010e.0401060b.02000000
JPEG XS Wf	JPEGXSWf	LEAF	urn:smpte:ul:060e2b34.0101010e.0401060b.03000000
JPEG XS Hf	JPEGXSHf	LEAF	urn:smpte:ul:060e2b34.0101010e.0401060b.04000000
JPEG XS Nc	JPEGXSNc	LEAF	urn:smpte:ul:060e2b34.0101010e.0401060b.05000000
JPEG XS Component Table	JPEGXSComponentTable	LEAF	urn:smpte:ul:060e2b34.0101010e.0401060b.06000000
JPEG XS Cw	JPEGXSCw	LEAF	urn:smpte:ul:060e2b34.0101010e.0401060b.07000000
JPEG XS Hsl	JPEGXSHsl	LEAF	urn:smpte:ul:060e2b34.0101010e.0401060b.08000000
JPEG XS Maximum Bit Rate	JPEGXSMaximumBitRate	LEAF	urn:smpte:ul:060e2b34.0101010e.0401060b.09000000

Notes:

1. SMPTE ST 377-1 defines the byte structure of Sets and Groups
2. The JPEGXSSubDescriptor version byte is set to 1 according to SMPTE policy

Table 5 – Specification of the values of the JPEG XS Picture SubDescriptor

Symbol	Type	Len	Req ?	Meaning	Default
JPEGXSSubDescriptor	Set UL	16	Req	JPEG XS Picture SubDescriptor	
Length	BER Length	4	Req	Set length	
All items from the abstract SubDescriptor as specified in SMPTE ST 377-1:2019 annex B.3					
JPEGXSPpih	UInt16	2	Req	Profile this codestream complies to, as defined in ISO/IEC 21122-1.	
JPEGXSPlev	UInt16	2	Req	Level and sublevel to which this codestream complies, as defined in ISO/IEC 21122-1.	
JPEGXSWf	UInt16	2	Req	Width of the image in sample grid positions, as defined in ISO/IEC 21122-1	
JPEGXSHf	UInt16	2	Req	Height of the image in sample grid positions, as defined in ISO/IEC 21122-1	
JPEGXSNc	UInt8	1	Req	Number of components in the image, as defined in ISO/IEC 21122-1.	

Symbol	Type	Len	Req ?	Meaning	Default
JPEGXSComponentTable	UInt8Array	var	Req	The value shall be an exact byte-wise copy of the component_table() Marker Segment in the codestream, as defined in ISO/IEC 21122-1. NOTE: component_table() contains Bit precision, horizontal and vertical subsampling, for each component.	
JPEGXSCw	UInt16	2	Opt	Width of a precinct, as defined in ISO/IEC 21122-1.	
JPEGXSHsl	UInt16	2	Opt	Height of a slice in precincts other than the last slice, as defined in ISO/IEC 21122-1.	
JPEGXSMaximumBitRate	UInt32	4	Opt	Maximum bit rate of the video stream. The value shall be a maximum instantaneous bit rate, expressed in megabits per second, that shall not be exceeded by the codestream sequence. In addition, the value shall not exceed the bit rate specified for the signalled profile, level and sublevel combination. NOTE: If the Video Information Box, as defined in ISO/IEC 21122-3 is present in the input stream, the value of JPEGXSMaximumBitRate is expected to be consistent with the brat field contained in this box.	

Annex A JPEG XS Coding of Television Signals (normative)

JPEG XS can be used to compress any known television standard.

The format of the source coding shall be specified in the 'FrameLayout' property in the Generic Picture Essence descriptor. This indicates whether the source picture was full frame (for Progressive), separate fields (for Interlaced), or segmented frame.

When using the separate fields Frame Layout, the optional FieldDominance property, also in the generic picture essence descriptor, shall indicate the field number (1 or 2) which is temporally the first field of an interlaced frame.

The values of other Properties in the MXF Header Metadata shall be as specified in Table A.1 below.

NOTE 1 Applications referencing this standard are expected to specify signaling of color primaries, transfer characteristic, coding equations and quantization for unambiguous processing of the codestreams.

The EditRate of other Essence Tracks in MXF Header Metadata is defined in SMPTE ST 377-1:2019 Section 9.4.

NOTE 2 Timecode counts Frames, not Fields, thus the EditRate of Timecode Tracks will always be the precise frame rate, in all wrapping modes.

NOTE 3 SMPTE ST 377-1 does not define how to reconstruct SMPTE ST 12-1 timecode values from a Timecode Track whose EditRate is measured in Fields, thus decoders cannot determine synchronization from such Tracks.

SMPTE ST 377-1:2019 Annex F.4 and Annex G give normative provisions for specifying the values of other properties of the Picture Essence Descriptor, including Video Line Map, Stored Height and Width, Sampled Height and Width, and Display Height and Width. The correspondence between the values of these and frame or field is implied by the value of the FrameLayout property, as tabulated in SMPTE ST 377-1:2019 Annex G.2.7, G.2.8 and G.2.14.

Table A.1 – MXF Header Metadata Property Values

Essence Container	JPEG XS code-streams per KLV Element	Frame Layout SMPTE ST 377-1:2019 Annex G.2.1	Sample Rate SMPTE ST 377-1:2019 Annex G.2.2	Edit Rate SMPTE ST 377-1:2019 Annex B.12	Index Edit Rate SMPTE ST 377-1:2019 Section 11.2.3	Aspect Ratio SMPTE ST 377-1:2019 Annex G.2.4
Frame- wrapped Picture Element	1	0 (full_frame)	Frame	Frame	Frame	Frame
Interlaced Frame, 2 fields KLV Element	2	1 (separate_fields) or 4 (segmented_frame)	Frame	Frame	Frame	Frame
Clip- wrapped Picture Element	n/a	0 (full_frame) or 1 (separate_fields) or 4 (segmented_frame)	Frame	Frame	Frame	Frame

Annex B Illustration of the JPEG XS Picture SubDescriptor (informative)

Figure 6 illustrates how the JPEG XS Picture SubDescriptor can be the target of a strong reference from either the CDCI descriptor or the RGBA descriptor. The distinction between the arrow and diamond symbols is that the arrow symbol represents inheritance (dependency) and the diamond symbol represents ownership (composition). The modelling method used in this illustration is based on the Unified Modelling Language (UML). The graphical presentation of UML relationships is defined in ISO/IEC 19501.

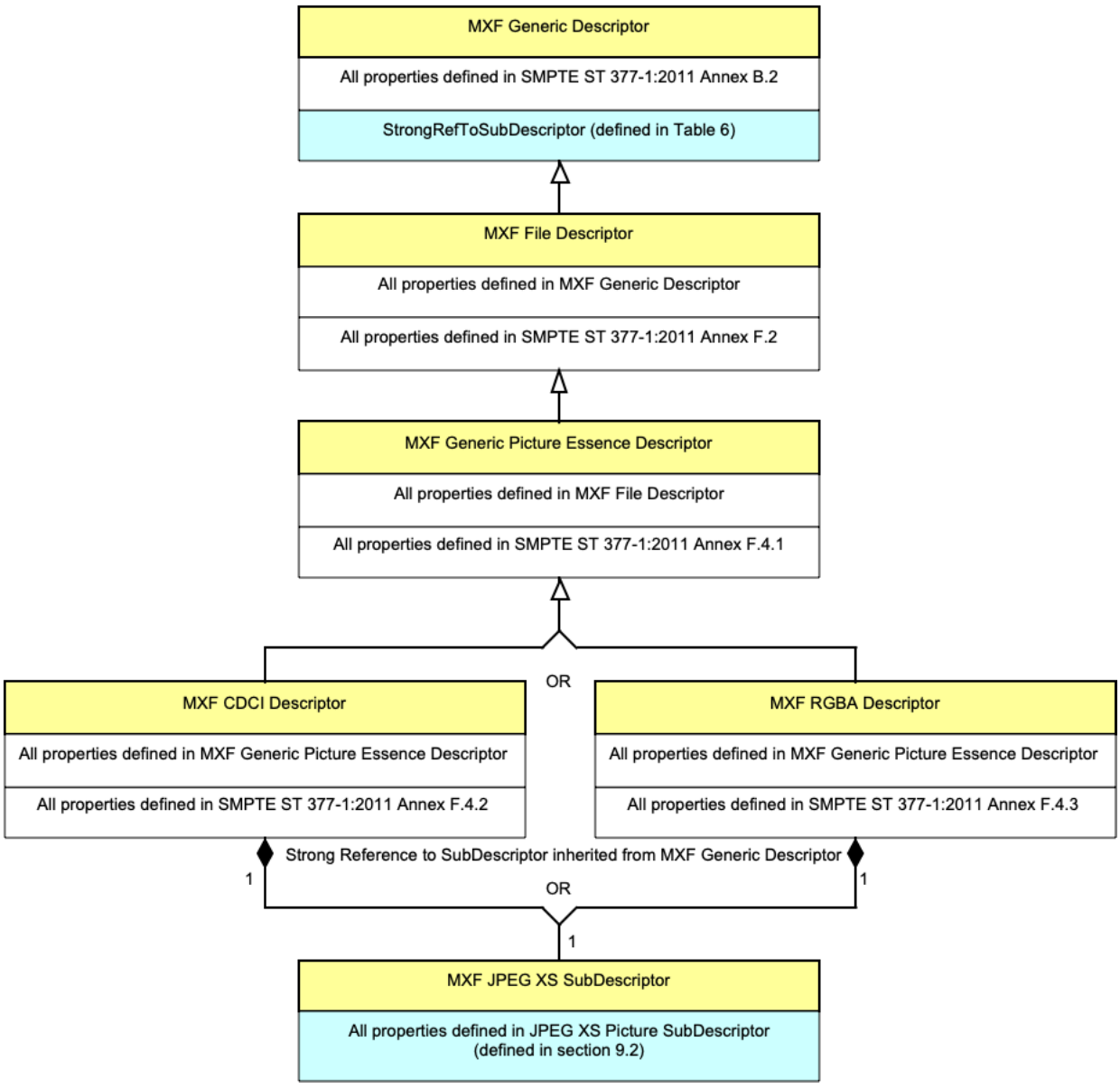

Figure 6 – JPEG XS Picture SubDescriptor

Annex C Color Encoding Metadata (informative)

C.1 General

An unambiguous definition of color encoding parameters is essential for a proper processing and visualization of JPEG XS codestreams. This section illustrates the specification of such color information in JPEG XS transport containers other than MXF, and how this information can be translated into metadata items of MXF Picture Essence Descriptors.

NOTE Applications referencing this standard are expected to specify mandatory color encoding metadata.

C.2 Color Specification as Defined in ISO/IEC 21122-3

ISO 221122-3 defines a Colour Specification Box to be present in transport containers defined by ISO/IEC 21122-3. The METHDAT field of the Colour Specification Box contains the information items detailed in Table C.1.

Table C.1 – Information contained in the METHDAT field of the Colour Specification Box

Name	Data Type	Size in Byte	Meaning
COLOUR_PRIMARIES	UInt16	2	Contains an enumerated value for the color primaries as defined in Rec. ITU-T H.273 for video code points.
TRANSFER_CHARACTERISTICS	UInt16	2	Contains an enumerated value for the transfer characteristics as defined in Rec. ITU-T H.273 for video code points.
MATRIX_COEFFICIENTS	UInt16	2	Contains an enumerated value for the matrix coefficients as defined in Rec. ITU-T H.273 for video code points.
VIDEO_FULL_RANGE_FLAG	UInt8	1	This flag specifies the scaling and offset values applied in association with the Matrix Coefficients as defined in Rec. ITU-T H.273 for video code points. If the color space supports multiple value ranges, the value 1 indicates full range. If the color space does not support multiple value ranges, the value 0 is used. This field is specified as 1-bit field and this bit is located as MSB.

C.3 Mapping of Color Encoding-Related Information into MXF Descriptors

The information present in the Colour Specification Box, as defined in ISO 21122-3 and outlined in section C.2, can be mapped into MXF descriptors as detailed in Table C.2.

Table C.2 – Mapping of the Colour Specification Box into MXF descriptors

ISO/IEC 21122-3 item	MXF Descriptor	Item	Remarks
COLOUR_PRIMARIES	Generic Picture Essence Descriptor	Color Primaries	The value can be mapped to a UL. In case no corresponding UL is defined in the SMPTE registry, applications requiring the signaling of that particular set of Color Primaries will have to register a new UL.
TRANSFER_CHARACTERISTICS	Generic Picture Essence Descriptor	Transfer Characteristic	The value can be mapped to a UL. In case no corresponding UL is defined in the SMPTE registry, applications requiring the signaling of that particular Transfer Characteristic will have to register a new UL.
MATRIX_COEFFICIENTS	Generic Picture Essence Descriptor	Coding Equations	The value can be mapped to a UL. In case no corresponding UL is defined in the SMPTE registry, applications requiring the signaling of that particular set of Coding Equations will have to register a new UL.
VIDEO_FULL_RANGE_FLAG	RGBA Picture Essence Descriptor	Component Min Ref / Component Max Ref	For RGBA signals, Full Range and Legal Range are specified implicitly by providing the Component MinRef and Component Max Ref items.
	CDCI Picture Essence Descriptor	Black Ref Level / White Ref Level	For color difference signals, Full Range and Legal Range are specified implicitly by providing the Black Ref Level and White Ref Level items.

EXAMPLE: Table C.3 lists examples of mappings of color encoding information contained in a Colour Specification Box to SMPTE Universal labels and vice versa.

Table C.3 – Examples of mappings of color coding parameters

	ISO/IEC 21122-3 Colour Specification Box		SMPTE Essence Descriptor Metadata	
	Field	Value (dec.)	Essence Descriptor Item	Value (Symbol for UL types)
ITU-R BT.709 4:2:2 10 bit	COLOUR_PRIMARIES	1	Color Primaries	ColorPrimaries_ITU709
	TRANSFER_CHARACTERISTICS	1	Transfer Characteristic	TransferCharacteristic_ITU709
	MATRIX_COEFFICIENTS	1	Coding Equations	CodingEquations_ITU709
	VIDEO_FULL_RANGE_FLAG	0	Black Ref Level	64
			White Ref Level	940
ITU-R BT.2100 Y´CbCr HLG 12 bit Narrow Range	COLOUR_PRIMARIES	9	Color Primaries	ColorPrimaries_ITU2020
	TRANSFER_CHARACTERISTICS	18	Transfer Characteristic	TransferCharacteristic_HLG_OETF
	MATRIX_COEFFICIENTS	9	Coding Equations	CodingEquations_ITU2020_NCL
	VIDEO_FULL_RANGE_FLAG	0	Black Ref Level	256
			White Ref Level	3760
IEC 61966-2-1 sRGB 8 bit	COLOUR_PRIMARIES	1	Color Primaries	ColorPrimaries_ITU709
	TRANSFER_CHARACTERISTICS	13	Transfer Characteristic	TransferCharacteristic_sRGB
	MATRIX_COEFFICIENTS	0	Coding Equations	CodingEquations_ITU709[1]
	VIDEO_FULL_RANGE_FLAG	1	Component Min Ref	0
			Component Max Ref	255

NOTE The Symbols correspond to ULs, as listed in the SMPTE Registry.

[1] Coding Equations that can be used for converting from sRGB to sYCC

Bibliography (informative)

ISO/IEC 19501:2005, Information technology — Open Distributed Processing — Unified Modeling Language (UML) Version 1.4.2 (also available at https://www.omg.org/spec/UML/ISO/19501/PDF)

ISO/IEC 21122-3:2019, Information Technology — JPEG XS Low-Latency Lightweight Image Coding System— Part 3: Transport and container formats

SMPTE EG 377-3:2013, Material Exchange Format (MXF) — Engineering Guideline (Informative)

Recommendation ITU-T H.273, Coding-independent code points for video signal type identification