SMPTE REGISTERED DISCLOSURE DOCUMENT

XAVC™ MXF Mapping and Operating Points

The attached document is a Registered Disclosure Document prepared by the proponent identified below. It has been examined by the appropriate SMPTE Technology Committee and is believed to contain adequate information to satisfy the objectives defined in the Scope, and to be technically consistent.

This document is NOT a Standard, Recommended Practice or Engineering Guideline, and does NOT imply a finding or representation of the Society.

Errors in this document should be reported to the proponent identified below, with a copy to eng@smpte.org. All other inquiries in respect of this document, including inquiries as to intellectual property requirements that may be attached to use of the disclosed technology, should be addressed to the proponent identified below.

This document is intended to support the development of applications that read and process XAVC MXF files. It is not intended to support the development of hardware or software applications that create XAVC MXF files, and creation of such files is reserved to individuals and organizations that have entered into agreements with the proponent identified below for such file creation.

Proponent contact information:

Satoshi Katsuo
Sony Corporation
4-14-1 Asahi-cho, Atsugi
Kanagawa, 243-0014
Japan

Email: Satoshi.Katsuo@jp.sony.com

Approved
November 24, 2014

Table of Contents

Page

1 Scope

This RDD specifies the MXF mapping of XAVC, i.e. MPEG-4 AVC picture, AES3 audio and ANC packets into the MXF Generic Container or MXF Constrained Generic Container, and two types of essence location style which are compliant with the OP-1a Frame Wrapping.

This document also provides the XAVC specification to support the development of applications that read and process XAVC MXF files at the specified operating points.

2 Related Documents

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 326:2000) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 326M-2000). Documents with the same root number (e.g. 326) and publication year (e.g. 2000) are functionally identical.

The following standards contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All documents are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 326:2000, Television — SDTI Content Package Format (SDTI-CP)

SMPTE ST 331:2011, Element and Metadata Definitions for the SDTI-CP

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

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

SMPTE ST 378:2004, Television — Material Exchange Format (MXF) — Operational pattern 1A (Single Item, Single Package)

SMPTE ST 379-1:2009, Material Exchange Format (MXF) — MXF Generic Container

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

SMPTE ST 381-2:2011, Material Exchange Format (MXF) — Mapping MPEG Streams into the MXF Constrained Generic Container

SMPTE ST 381-3:2013, Material Exchange Format (MXF) — Mapping AVC Streams into the MXF Generic Container

SMPTE ST 382:2007, Material Exchange Format — Mapping AES3 and Broadcast Wave Audio into the MXF Generic Container

SMPTE ST 385:2012, Material Exchange Format (MXF) — Mapping SDTI-CP Essence and Metadata into the MXF Generic Container

SMPTE ST 400:2012, SMPTE Labels Structure

SMPTE ST 436-1:2013, MXF Mappings for VI Lines and Ancillary Data Packets

SMPTE RP 210, Metadata Element Dictionary

SMPTE RP 224, SMPTE Labels Register

SMPTE RP 2027:2012, AVC Intra-Frame Coding Specification for SSM Card Applications

SMPTE RDD 18:2012, Acquisition Metadata Sets for Video Camera Parameters

Recommendation ITU-R BT.709-5 (04/02), Parameter Values for the HDTV Standards for Production and International Programme Exchange

3 Introduction

The MXF Generic Container is a streamable Essence Container that can be placed on any suitable transport and stored. SMPTE ST 379-1 defines the MXF Generic Container as the native Essence Container in MXF files. Also, SMPTE ST 379-2 defines the MXF Constrained Generic Container. SMPTE ST 381-3 defines how AVC streams, as defined in ISO/IEC 14496-10 | Rec. ITU-T H.264, can be mapped in the MXF Generic Container and MXF Constrained Generic Container. SMPTE ST 382 defines how AES3 Audio can be mapped in the MXF Generic Container. SMPTE ST 385 defines the System Item that is compatible with SMPTE ST 326 (SDTI-CP) and also defines how SDTI-CP essence and metadata can be used in the MXF Generic Container.

This document specifies the MXF mapping of XAVC, i.e. MPEG-4 AVC picture, AES3 audio and ANC packets into the MXF Generic Container or MXF Constrained Generic Container. This document also specifies the MXF file format which includes unique identifiers, Operation Pattern, Partitions, Index Table Segments and RIP. The common basic structure is described in this document.

4 Outline of MXF File Structure for this Mapping

4.1 General

XAVC MXF files specified by this document shall have one of the two structures illustrated in Figure 1 and Figure 2 respectively.

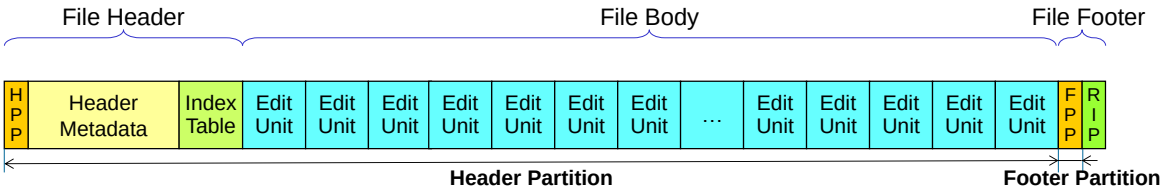

Figure 1 – Single Essence Location Style

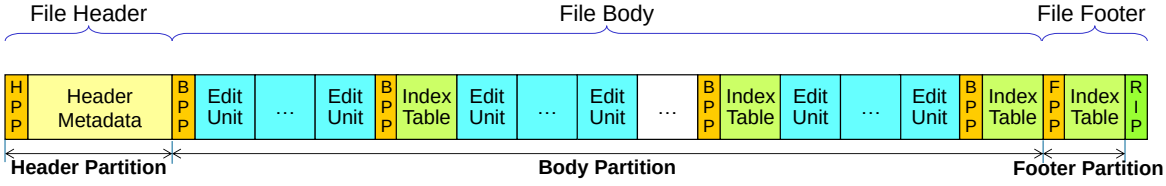

Figure 2 – Multiple Essence Location Style

HPP: Header Partition Pack, **BPP**: Body Partition Pack, **FPP**: Footer Partition Pack
RIP: Random Index Pack

A list of major constraints common to these file structures is given in Table 1.

Table 1 – Constraints for SMPTE RDD 32 Stream Products

Item	Constraints
Operational Pattern	1a - *Origin* and *Duration*[1] are used to express GOP Pre-Charge and Roll-Out in the case of Long GOP.
Wrapping (Interleaving)	Frame by Frame (coded order)
KAG size	512
System Item	Compliant to SMPTE ST 326 and SMPTE ST 385, includes the Frame by Frame Timecode and UMID
Video mapping	Compliant to SMPTE ST 381-3, AVC byte stream
GOP structure (in the case of Long GOP)	0.5 second (e.g. 24 frames for 50p), M=3 (display order: BBIBBPBBP…BBP)
Audio sampling	48 kHz locked to Video
Audio mapping	Compliant to SMPTE ST 382, AES3, 1ch/Element (min 2 to max 16 channels[2])
Data Item	Compliant to SMPTE ST 436-1, used for Ancillary packet
Timecode	System Item and Header Metadata

Detailed constraints are listed in Annex B.

4.2 Single Essence Location Style

As shown in Figure 1, this style consists of a Header Partition, a Footer Partition, and a Random Index Pack. The Index Table is placed prior to the Essence Container.

Some of the aspects of this style are shown below.

- It is easy to handle because of a simple structure.
- It is easy to edit while file transferring.
- It is easy to pick extract a “Partial file”.

It is recommended to have the following Index Layout Properties defined in Amendment 2 to SMPTE ST 377-1.

- Index Table Segment::Single Index Location TRUE (Single Location)
- Index Table Segment::Single Location TRUE (Single Location)
- Index Table Segment::Forward Index Direction TRUE (Forward)
- Preface:: is RIP present TRUE

4.3 Multiple Essence Location Style

As shown in Figure 2, this style consists of a Header Partition, segmented Body Partition(s), a Footer Partition, and a Random Index Pack. Every Partition except Header and the first Body Partitions has one Index Table Segment which carries the Index Entries indexing the Edit Units.

[1] The duration of the top level file package contains the Pre-Charge but does not contain Roll-Out as defined in SMPTE ST 377-1.

[2] Even number only

The purpose of this essence location style is to place the Index Table Segment just after the corresponding essence data. All Index Table Segments follow Essence Container Segments that they index. Thus, when receiving a streamed file, decoders can use Index Table Segments for indexing without a long delay.

Some of the aspects of this style are shown below.

- It is only necessary to include one Index Table Segment for each Body Partition period on the sender side.
- It is easy to perform the function “Play while receiving file” on the receiver side.
- It is easy to pick extract a “Partial file”.

It is recommended to have the following Index Layout Properties.

- Index Table Segment::Single Index Location FALSE (Distributed Location)
- Index Table Segment::Single Essence Location FALSE (Distributed Location)
- Index Table Segment::Forward Index Direction FALSE (Backward)
- Preface:: is RIP present TRUE
- Essence Container Data:: Following Index Table TRUE (A Complete Index Table follows all Essence)

5 AVC Picture Data and AES3 Data Mapping

5.1 General

The mapping of XAVC, i.e. MPEG-4 AVC Picture data, is as defined in SMPTE ST 381-3. The mapping of AES3 digital audio data is defined by SMPTE ST 382. This specification uses Frame Wrapping as defined by SMPTE ST 379-2. The System Item is defined by SMPTE ST 326, and mapped into the MXF by SMPTE ST 385. The order of Items in each Edit Unit is System, Picture, Sound and Data.

5.2 Edit Unit Structure

The XAVC MXF Mapping shall make use of Frame Wrapping as defined by SMPTE ST 379-2 Section 8.4.1.

An arrangement of System, Picture, Sound, and Data Items in a Frame Wrapping, i.e. the structure of Edit Unit is shown in Figure 3.

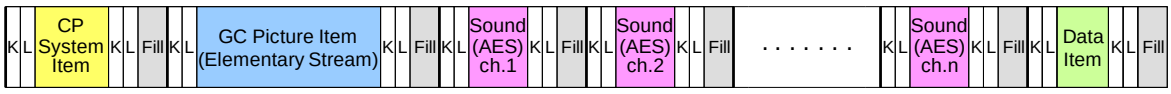

Figure 3 – Structure of Generic Edit Unit

5.3 System Item Mapping

5.3.1 General

The System Item in each Edit Unit consists of System Metadata Pack, a Package Metadata set and Picture Metadata Set.

5.3.2 Overview of System Item

The System Item is placed at the beginning of every Edit Unit and contains information on the essence item and the metadata attached to the frames, and it shall comply with SMPTE ST 385.

Typical System Item consists of the following two KLV packets and a fill item, and its size is the same as one KAG size (200h).

- System Metadata Pack contains Package Rate, Multiple EC UL, LTC
- Package Metadata Set contains Body UMID
- Fill Item

Figure 4 shows the outline of System Item.

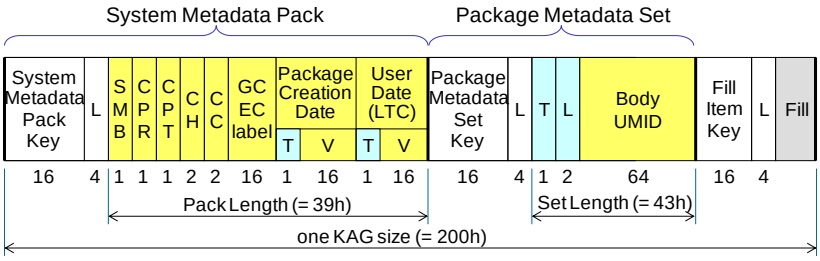

Figure 4 – Typical System Item structure

5.3.3 System Metadata Pack

The Pack Key is `06.0E.2B.34.02.05.01.01.0D.01.03.01.04.01.01.00`, in accordance with SMPTE ST 385. The Length of this pack shall be fixed, i.e. 57-byte payload. Also, each property shall be described in the provided field without tag and length. The sequence and values shall comply with SMPTE ST 326.

- System Metadata Bitmap ("SMB" in the figure) indicates the presence of metadata in the Pack, and of essence data within the Edit Unit, should be set to 0101_1100_b, when Data Item is not recorded or 0101_1110_b when Data Item is recorded.
- The value of Continuity Count ("CC" in the figure) shall be monotonically increasing within a file. It does not have to start from 0, and reverts to 0000_h following full count $FFFF_h$.
- SMPTE Universal Label ("GC EC label" in the figure) shall be set to the same label as the Essence Container Property of Multiple Descriptor Set.
- Package Creation Date should be blank. Tag ("T" in the figure) and the remains are filled with 00_h.
- LTC shall be described in the User Date column. Since it complies with SMPTE ST 331, it starts with CP-Tag 81_h and digits of Frame, Second, Minute, and Hour are placed with flags such as DF, and then Binary Group data (4 bytes) is placed, and remaining 8 bytes are filled with 0. In the 50p/59.94p system, the LTC is handled in half the rate of the Main-Stream video, and the field mark flag in the Time Code is used to identify the first or second frame of a frame pair.

5.3.4 Package Metadata Set

The Set Key is `06.0E.2B.34.02.43.01.01.0D.01.03.01.04.01.02.nn`, in accordance with SMPTE ST 385. This `nn` indicates the number of Metadata Block in the Set and is typically 1 for Body UMID in this specification.

Each metadata block is described with 1-byte CP-Tag and 2-byte Length field. Typical metadata in this specification, shown in Figure 4 is defined as follows:

- Body UMID should be described as the first Metadata Block.
  - Extended UMID (64 bytes) should be described with CP-Tag 83_h.
  - Decoders should support the case of having just Basic UMID (32 bytes) or blank data (i.e. Local Length is zero) in the Metadata Block.

Adding other Metadata Blocks to package Metadata Set is possible, but it may be ignored; for instance, even if Timecode is placed with Tag 81_h, TimeCode in System Metadata Pack is prioritized.

5.4 Picture Item Mapping

5.4.1 General

This element contains MPEG-4 AVC Video byte stream, and shall comply with SMPTE ST 381-3.

Figure 5 shows the mapping of MPEG Picture Item Element for XAVC Intra and Figure 6 shows the mapping of MPEG Picture Item Element for XAVC Long GOP. In the interlaced system of XAVC Long GOP, field coding shall be used and the Value of Picture Item shall contain a byte stream of a complementary field pair

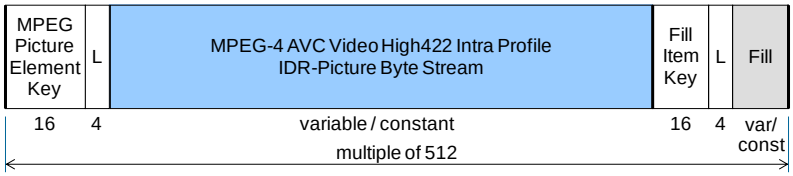

Figure 5 – Mapping of XAVC Intra Picture in a Picture Item Element

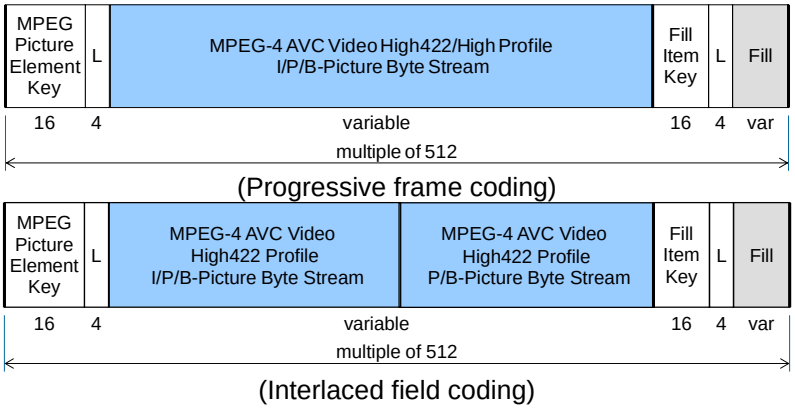

Figure 6 – Mapping of XAVC Long GOP Picture in a Picture Item Element

5.4.2 MPEG Picture Element Key

The Key is `06.0E.2B.34.01.02.01.01.0D.01.03.01.15.kk.05.nn`, in accordance with SMPTE ST 381-3, as it is a Frame Wrapped GC-Picture element.

The parameter `kk` specifies the count of Picture Elements in the Picture Item, and `nn` indicates the index number of the Element. In this specification, the tail of the key shall be set to `15.01.05.00`.

5.4.3 MPEG Picture Element Length

The length field of the KLV coded Element is 4 bytes BER long-form encoded (i.e. 83h.xx.yy.zz) for Frame wrapping.

5.4.4 MPEG Picture Element Value

The MPEG-4 AVC Picture Element complies with SMPTE ST 381-3.

- The constraints on the conformant implementations are described in Annex B.8.2.
- Operating Points of the elementary stream are described in Annex C.
- The property values of Picture Essence Descriptor are described in Annex D.

5.5 AES3 Sound Item Mapping

5.5.1 General

This element contains a Linear-PCM Audio data stream, and shall comply with SMPTE ST 382.

Figure 7 shows the mapping of generic AES Sound Item Element.

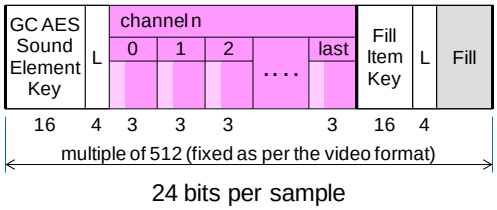

Figure 7 – Mapping of AES Sound in a Sound Item Element

5.5.2 AES3 Sound Element Key

The Key is `06.0E.2B.34.01.02.01.01.0D.01.03.01.16.kk.03.nn`, in accordance with SMPTE ST 382 as it is a Frame Wrapped AES GC-Sound element.

The parameter `kk` specifies the count of Sound Elements, and `nn` indicates the index number of the Element. In this specification, `nn` shall be assigned as an incremental integer number starting from zero., for the 3rd element of 8 channels, the tail of the key is set to `16.08.03.02`.

5.5.3 AES3 Sound Element Length

The length field of the KLV coded Element is 4 bytes BER long-form encoded (i.e. 83h.xx.yy.zz) for Frame wrapping.

5.5.4 AES3 Sound Element Value

The Sound Element Value complies with SMPTE ST 382.

- The constraints on the conformant implementations are described in Annex B.8.3.
- The property values of Sound Essence Descriptor are described in Annex D.

5.6 Data Item Mapping

5.6.1 General

This element contains data stream, e.g. caption or sub-title, and shall comply with SMPTE ST 436-1. Figure 8 shows the mapping of ANC Data Item Element.

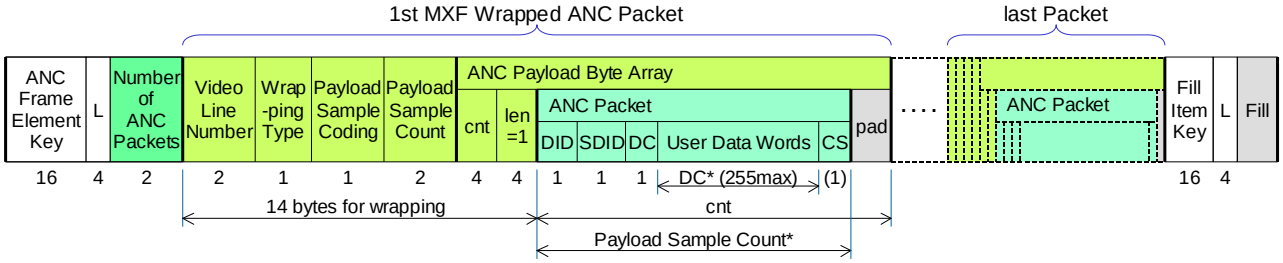

Figure 8 – Mapping of ANC Data in a Data Item Element

The Set Key is `06.0E.2B.34.01.02.01.01.0D.01.03.01.17.01.02.01`, in accordance with SMPTE ST 436-1, because it allows one Frame Wrapped ANC Data Element in an Edit Unit.

5.6.2 Acquisition Metadata Set

Acquisition Metadata Sets are specified in SMPTE RDD 18 and a Sony Private Acquisition Metadata Set Format may be attached as ANC packets in the Data Item.

6 SMPTE Labels

6.1 XAVC Intra Picture Essence

Table 2 and Table 3 show the Universal Labels used in the Picture Descriptor for XAVC HD Intra Profile and XAVC 4K Intra Profile respectively.

Table 2 – Universal Labels in Picture Descriptor for XAVC HD Intra Profile

Class	Frame Rate	Essence Container	Picture Essence Coding
Class 50: 1440x1080	59.94i	Generic Container AVC byte stream Frame Wrap 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01	RP 2027 Constrained Class 50 1080/59.94i Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 21 01
	50i		RP 2027 Constrained Class 50 1080/50i Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 21 02
	23.98p 29.97p 59.94p		RP 2027 Constrained Class 50 1080/29.97p Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 21 03
	25p 50p		RP 2027 Constrained Class 50 1080/25p Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 21 04
Class 100: 1280x720	59.94p		RP2027 Constrained Class 100 720/59.94p Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 31 08
	50p		RP2027 Constrained Class 100 720/50p Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 31 09
Class 100: 1920x1080	59.94i		RP 2027 Constrained Class 100 1080/59.94i Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 31 01
	50i		RP 2027 Constrained Class 100 1080/50i Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 31 02
	23.98p 29.97p 59.94p		RP 2027 Constrained Class 100 1080/29.97p Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 31 03
	25p 50p		RP 2027 Constrained Class 100 1080/25p Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 31 04
Class 200: 1920x1080	59.94i		RP 2027 Constrained Class 200 1080/59.94i Coding 06 0e 2b 34 04 01 01 0d 04 01 02 02 01 32 32 01
	50i		RP 2027 Constrained Class 200 1080/50i Coding 06 0e 2b 34 04 01 01 0d 04 01 02 02 01 32 32 02
	23.98p 29.97p 59.94p		RP 2027 Constrained Class 200 1080/29.97p Coding 06 0e 2b 34 04 01 01 0d 04 01 02 02 01 32 32 03
	25p 50p		RP 2027 Constrained Class 200 1080/25p Coding 06 0e 2b 34 04 01 01 0d 04 01 02 02 01 32 32 04

Table 3 – Universal Labels in Picture Descriptor for XAVC 4K Intra Profile

Picture Pixel Array	Essence Container	Picture Essence Coding
2048x1080 3840x2160 4096x2160	Generic Container AVC byte stream Frame Wrap 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01	AVC High 422 Intra Profile Unconstrained Coding 06 0e 2b 34 04 01 01 0a 04 01 02 02 01 32 30 01

6.2 XAVC Long GOP Picture Essence

Table 4 and Table 5 show the Universal Labels used in the Picture Descriptor for XAVC HD Profile and XAVC 4K Profile respectively.

Table 4 – Universal Labels in Picture Descriptor for XAVC HD Profile

Picture Pixel Array	Essence Container	Picture Essence Coding
1280x720 1920x1080	Generic Container AVC byte stream Frame Wrap 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01	AVC High 422 Profile Unconstrained Coding 06 0e 2b 34 04 01 01 0d 04 01 02 02 01 31 60 01

Table 5 – Universal Labels in Picture Descriptor for XAVC 4K Profile

Picture Pixel Array	Essence Container	Picture Essence Coding
3840x2160	Generic Container AVC byte stream Frame Wrap 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01	AVC High Profile Unconstrained Coding 06 0e 2b 34 04 01 01 0d 04 01 02 02 01 31 40 01

6.3 Sound Essence

Table 6 shows the Universal Labels used in the Sound Descriptor of MXF file.

Table 6 – Universal Labels in Sound Descriptor Sets

Format	Essence Container	Sound Essence Coding
AES3	Generic Container AES Frame Wrap 06.0E.2B.34.04.01.01.01.0D.01.03.01.02.06.03.00	SMPTE ST 382 Default Uncompressed Sound Coding 06.0e.2b.34.04.01.01.0a.04.02.02.01.01.00.00.00

7 Application Issues

7.1 Partition Pack

As shown in Figure 1 and Figure 2, a Partition Pack which summarizes the partition characteristics is placed at the top of each partition.

Figure 9 shows the outline and the property names.

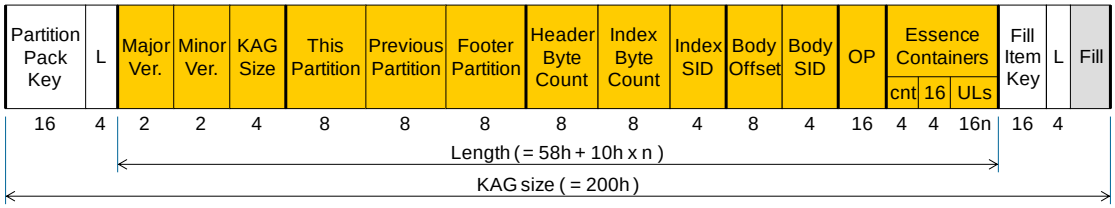

Figure 9 – Partition Pack

The Pack Key is `06.0E.2B.34.02.05.01.01.0D.01.02.01.01.nn.04.00`, in accordance with SMPTE ST 377-1. The parameter `nn` indicates the type of the Partition, i.e. "2" for Header, "3" for Body, and "4" for Footer.

Each property shall be set as shown in Table 7.

Table 7 – MXF file Fundamental Settings

Item in Partition Pack	Setting
Partition Status	Closed and Complete (Byte 15 of Pack key = 04h) or Open and Incomplete (Byte 15 of Pack key = 01h)
MXF Version Number	1.3
KAG Size	512
Operational Pattern	OP1a
the Number of Essence Containers (kinds of the UL)	3 (GC Picture, Sound, Essence Multiple) or 4 (GC Picture, Sound, Data, Essence Multiple)

The Essence Container batch should contain all Essence Container labels described in any Descriptor Sets.

The UL of Operational Pattern shall be `06.0E.2B.34.04.01.01.01.0D.01.02.01.01.01.09.00` for OP1a. The value of Byte 15, 09_h indicates that the form is internal Essences on a multi-track stream file.

The use of Run-in is prohibited in this specification. The Header Byte Count and Index Byte Count properties in Partition Packs include the trailing Fill item.

Index SID should be set to "1", and Body SID should be set to "2". When the Index Table or Essence Container data are not recorded in the Partition, these SID values shall each be set to "0".

7.2 Application of the KLV Fill Item

The Fill item is used for padding. It is a kind of KLV Metadata, and contains meaningless byte stream.

The Metadata Key is `06.0E.2B.34.01.01.01.02.03.01.02.10.01.00.00.00`, in accordance with SMPTE ST 377-1.

In this specification, the KLV Fill item is used to pad items to the KAG boundary or to reserve space for additional data insertion.

7.3 Application of MXF structure and indexing style

This section illustrates the structures of various MXF file layouts, and explains how the Edit Units are indexed.

7.3.1 Single Essence Location Style

7.3.1.1 Indexing structure for CBE Picture format

The XAVC Intra CBG format in this specification uses CBE (Constant Bytes per Element) Picture Item. As shown in Figure 10, the MXF file consists of a Header Partition and a Footer Partition. The System, Picture, Sound, and Data Item are mapped into Essence Container and placed in the Header Partition.

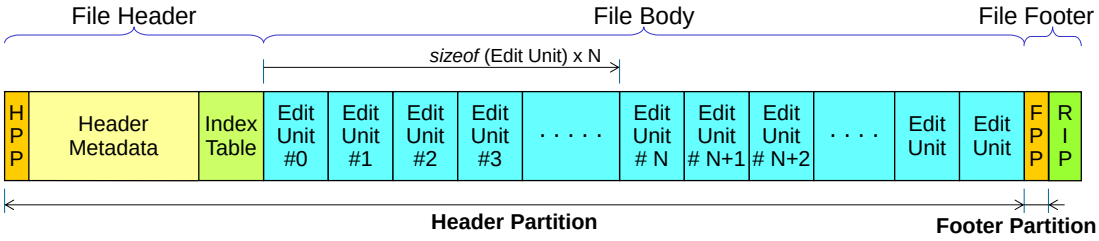

Figure 10 – Layout of CBE Picture MXF File

When performing random accesses, the location of a target Edit Unit can be determined by a simple multiplication; this is because the Edit Unit length is constant. The Index Table shall be present in Header Partition, and the Index Table has empty Index Entry array and Delta Entry array.

7.3.1.2 CBE Picture MXF File for on-the-fly generation

This layout is an extension of the layout specified in the previous section. If an MXF file starts to be generated whilst recording and has not yet been closed, the duration of the clip and the offset of the Footer Partition relative to the Header Partition are not determined. In such a situation, the Header Metadata within the File Header will contain -1 for durations and possibly Distinguished Values for Best Effort items. Therefore, a valid Header Metadata block will instead be attached in the File Footer after the recording is finished as shown in Figure 11.

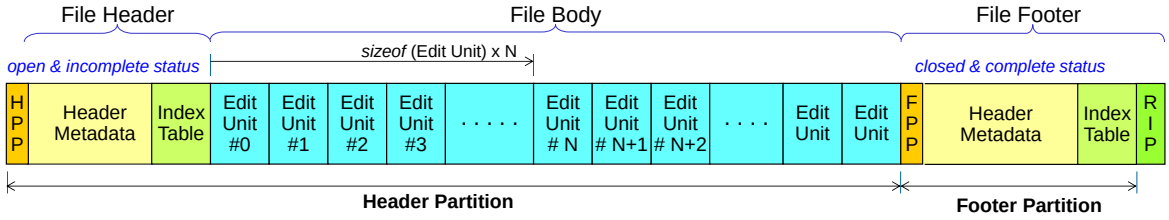

Figure 11 – Layout of CBE Picture MXF File after the on-the-fly generation

Even while recording, it is possible to compute the Essence Container byte offset for the start of Edit Unit of stored Essence N as N * Edit Unit Byte Count, where N=0 is the beginning of the sequence.

A file of this layout contains some particular values as follows (where *pFP* means Footer Partition property in the Partition Packs, *imUMID* means the 12th byte lower nibble of the UMID of Material Package).

- Header Partition is Open/Incomplete, *pFP* is set to 0, *imUMID* is F_h, and Duration properties are set to -1.
- Footer Partition is Closed/Complete, *imUMID* is set to 3_h and Duration properties are set to the conclusive value. Index Table in Footer Partition may be present.

Note: *imUMID* value F_h means "Live stream" and 3_h is the normal value in this specification.

7.3.1.3 Indexing structure for VBE Picture format

The XAVC Intra VBR format and XAVC Long GOP format in this specification use VBE (Variable Bytes per Element) Picture Item. Figure 12 shows an instance of the structure layout.

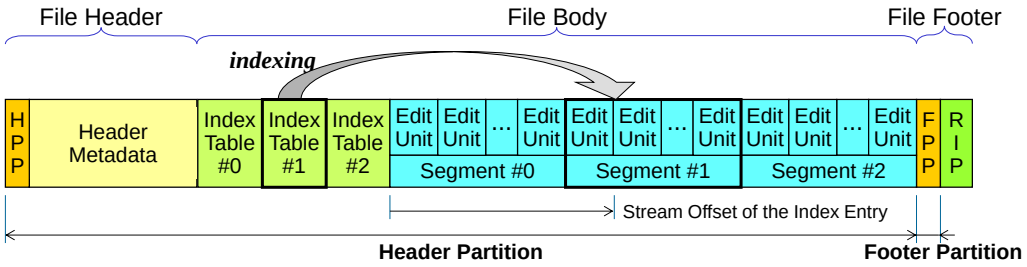

Figure 12 – Layout of VBE Picture MXF file in Single Essence Location Style

Though File Body is not partitioned, Index Table shall be segmented as specified in Annex B.6. The Random Index Pack shall be present to indicate that the Essence Container is stored just in the Header Partition and that it is not necessary to find more Index Tables.

7.3.2 Multiple Essence Location Style

7.3.2.1 Indexing structure for VBE Picture format

The XAVC Intra VBR format and AVC Long GOP format in this specification use VBE (Variable Bytes per Element) Picture Item. Figure 13 shows an instance of the structure layout.

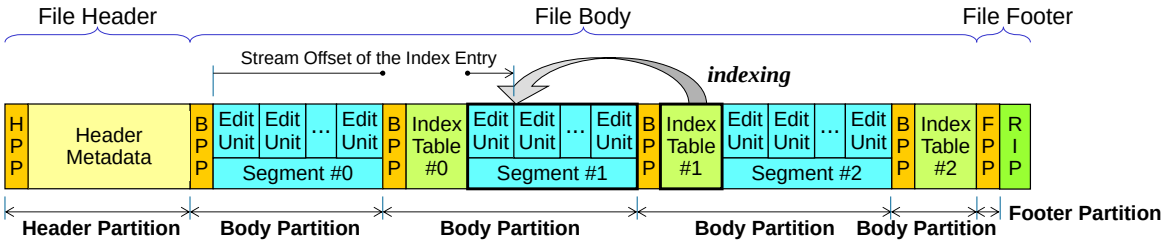

Figure 13 – Layout of VBE Picture MXF file in Multiple Essence Location Style

As an extension of the layout, Figure 14 shows the layout of VBE Picture MXF file with Repeated Index Table.

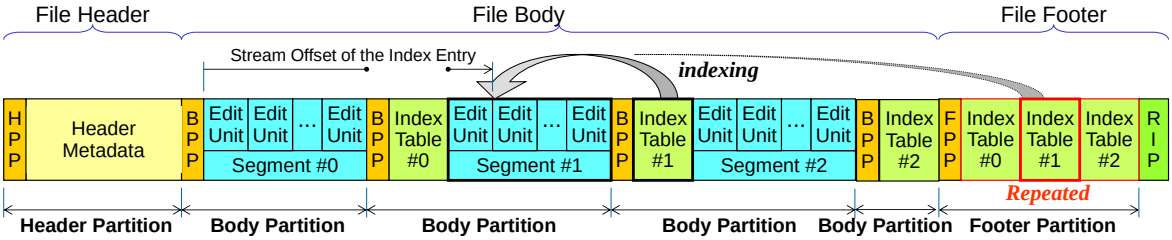

Figure 14 – Layout of VBE Picture MXF file with Repeated Index Table in Multiple Essence Location Style

7.3.2.2 VBE Picture MXF File for on-the-fly generation

This layout is an extension of the layout specified in the previous section. If an MXF file starts to be generated whilst recording and has not yet been closed, the duration of the clip and the offset of the Footer Partition relative to the Header Partition are not determined. In such a situation, the Header Metadata within the File

Header will contain -1 for durations and possibly Distinguished Values for Best Effort items. Therefore, a valid Header Metadata block will instead be attached in the File Footer after the recording is finished as shown in Figure 15.

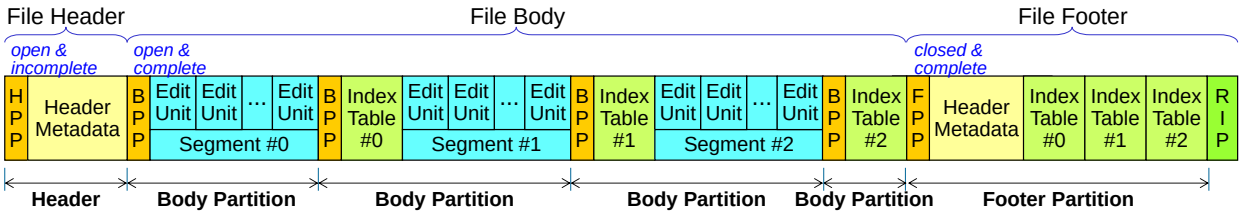

Figure 15 – Layout of VBE Picture MXF File after the on-the-fly generation

7.4 Application of Index Table for Frame Wrapped MPEG-4 AVC Picture and AES Sound Essence

7.4.1 Index Table structure

Index Table is a lookup table which converts a desired time offset on the timeline of a File Package into a stream offset within an Essence Container in an MXF file. An Index Table may be divided into multiple Index Table segments. Each segment consists of an Index Table Segment Set and Fill item as shown in Figure 16.

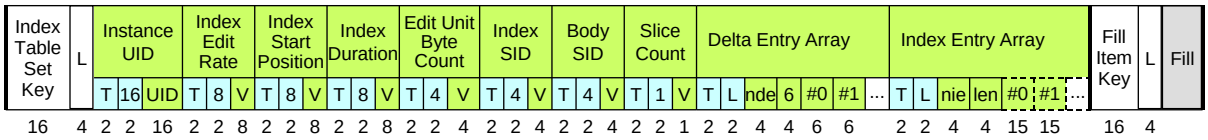

Figure 16 – Index Table Segment Set

The Set Key is `06.0E.2B.34.02.xx.01.01.0D.01.02.01.01.10.01.00`, in accordance with SMPTE ST 377-1. In addition, in this specification, the 6th byte is restricted to be "`53`" which implies the size of each local length field shall be 2. Consequently, the size of each property is limited up to 65535 bytes.

Optional properties which are not mentioned in this specification should be placed prior to Delta Entry Array and Index Entry Array.

The properties in the array elements are shown in Figure 17 and are detailed in the following sections.

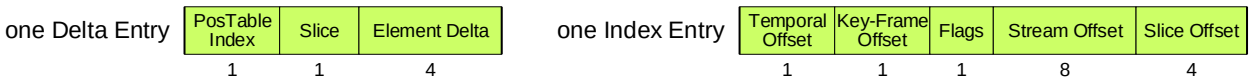

Figure 17 – Array Elements in Index Table Segment Set

7.4.2 Implementation of the Set

As described in Section 5, the Length of System, Sound or Data Item is constant through an XAVC MXF file. On the other hand, as for Picture Item, there are two patterns: CBE (Constant Bytes per Element) Picture and VBE (Variable Bytes per Element) Picture. The pattern is determined by the picture essence format, and the implementation of the Index Table is also different along with the pattern as follows.

The Index Table for CBE Picture which is used in constant or constraint bitrate video (i.e., XAVC Intra CBG) is described as follows:

- Only one Index Table Segment Set shall be present in the File Header.
  - Index Start Position and Index Duration shall be set to 0.
  - Edit Unit Byte Count shall be set to the value which is determined by the recording format.
- One slice
  - Slice Count shall be set to 0.
  - Slice in Delta Entry shall be set to 0.
- Index Entry Array shall be present and empty.
  - Array header ("nie", "len" in the figure) shall be set to 0 and no entries.
- Index Byte Count in the Header Partition Pack shall be 512.

The Index Table for VBE Picture which is used in variable bitrate video (i.e. XAVC Intra VBR or XAVC Long GOP) is described as follows.

- In the case of Single Essence Location Style, one or more Index Table Segment Set(s) constituting a complete Index Table shall be present in the File Header. On the other hand, in the case of Multiple Essence Location Style, one Index Table Segment shall be present in each Body Partition except the first Body Partition immediately following Header Partition.
  - Index Start Position and Index Duration shall be set exactly to represent the Edit Unit number.
  - Edit Unit Byte Count shall be set to 0.
- Two slices
  - Slice Count shall be set to 1.
  - Slice in Delta Entry shall be set to 0 for System and Picture Items, and 1 for Sound and Data item.
- Index Entry Array shall be present.
  - The array contains Index Entries for all Edit Units within the segment.
  - All "Req" properties and Slice Offset property shall be described, and others should not be.

Annex A UL Code List

The following is a sample list of UL codes used by SMPTE RDD 32 products.

Table A.1 – Sample of UL Code List

Header Partition Pack	Closed Complete or Open Incomplete	06 0e 2b 34 02 05 01 01 0d 01 02 01 01 02 04 00 06 0e 2b 34 02 05 01 01 0d 01 02 01 01 02 01 00
Operational Pattern	1a	06 0e 2b 34 04 01 01 01 0d 01 02 01 01 01 09 00
Essence Containers	Generic Container AVC byte stream Frame Wrap	06 0e 2b 34 04 01 01 0a 0d 01 03 01 02 10 60 01
	Generic Container AES Frame Wrap	06 0e 2b 34 04 01 01 01 0d 01 03 01 02 06 03 00
Fill Item		06 0e 2b 34 01 01 01 02 03 01 02 10 01 00 00 00
Header Metadata	Primer Pack	06 0e 2b 34 02 05 01 01 0d 01 02 01 01 05 01 00
	Preface Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 2f 00
	Identification Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 30 00
	Content Storage Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 18 00
	Essence Container Data Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 23 00
	Material Package Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 36 00
	File Package Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 37 00
	Generic Picture Essence Descriptor Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 27 00
	Picture Essence Coding	See Section 6.1 and Section 6.2
	Multiple Descriptor Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 44 00
	Essence Container (Multiple EC UL)	06 0e 2b 34 04 01 01 03 0d 01 03 01 02 7f 01 00
	MPEG Video Descriptor Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 51 00
	Container Constraints Sub Descriptor Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 67 00
	AVC Sub Descriptor Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 6e 00
	AES3 Audio Descriptor Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 47 00
	Timecode Definition	06 0e 2b 34 04 01 01 01 01 03 02 01 01 00 00 00
	Picture Definition	06 0e 2b 34 04 01 01 01 01 03 02 02 01 00 00 00
	Sound Definition	06 0e 2b 34 04 01 01 01 01 03 02 02 02 00 00 00
	Data Definition	06 0e 2b 34 04 01 01 01 01 03 02 02 03 00 00 00
	Descriptive Metadata Definition	06 0e 2b 34 04 01 01 01 01 03 02 01 10 00 00 00
	Track Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 3b 00
	Sequence Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 0f 00
	Source Clip Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 11 00
	Timecode 12M Component Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 14 00
	DM Static Track Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 3a 00
	DM Segment Set	06 0e 2b 34 02 53 01 01 0d 01 01 01 01 01 41 00
	Text-based DM Framework Set	06 0e 2b 34 02 53 01 01 0d 01 04 01 04 01 01 00
	UTF-8 Text-based Set	06 0e 2b 34 02 13 01 01 0d 01 04 01 04 02 02 00 or 06 0e 2b 34 02 53 01 01 0d 01 04 01 04 02 02 00
	XML Document Text[3]	06 0e 2b 34 01 01 01 05 03 01 02 20 01 00 00 00

[3] This key is for a stand alone KLV packet whose value contains XML document text.

Body Partition Pack	Closed Complete or Open Complete	06 0e 2b 34 02 05 01 01 0d 01 02 01 01 03 04 00 06 0e 2b 34 02 05 01 01 0d 01 02 01 01 03 03 00
Index Table Segment	Index Table Segment Key	06 0e 2b 34 02 53 01 01 0d 01 02 01 01 10 01 00
System Item	System Metadata Pack	06 0e 2b 34 02 05 01 01 0d 01 03 01 04 01 01 00
	Package Metadata Set	06 0e 2b 34 02 43 01 01 0d 01 03 01 04 01 02 xx
Picture Item	MPEG Frame Wrapped Picture Element	06 0e 2b 34 01 02 01 01 0d 01 03 01 15 01 05 00
Sound Item	AES Frame Wrapped Sound Element	06 0e 2b 34 01 02 01 01 0d 01 03 01 16 xx 03 0y
Data Item	ANC Frame Wrapped Data Element	06 0e 2b 34 01 02 01 01 0d 01 03 01 17 01 02 01
Footer Partition Pack	Closed Complete	06 0e 2b 34 02 05 01 01 0d 01 02 01 01 04 04 00
Random Index Pack	Random Index Pack Key	06 0e 2b 34 02 05 01 01 0d 01 02 01 01 11 01 00

Annex B Constraints of a Conformant Implementation

This section describes the constraints on conformant implementations of SMPTE RDD 32 products.

B.1 Structure

This SMPTE RDD 32 file shall be an MXF file which has the following structure.

- A file shall have a KAG size of 512.
- A file shall be signaled as OP-1a.
- A file shall use the MXF Generic Container or MXF Constrained Generic Container.
- A file shall be Frame Wrapped.
- The order of Items in the Content Package shall be System, Picture, Sound and Data Items.
- A file shall include one CP System Item.
- A file shall include one MPEG Frame Wrapped Picture Elements.
- A file shall include two or more AES Frame Wrapped Sound Elements.
- A file shall include zero or one ANC Element.

B.2 Header and BodyPartition Pack Values

The FooterPartition Property specifies the byte offset of the start of the Footer Partition relative to the start of the Header Partition. In Open Partitions, the value of FooterPartition Property in the Header or Body Partition is zero (0). In Closed Partitions, the value of FooterPartition Property in the Header or Body Partition is as defined in Section 7.1 Partition Pack of SMPTE ST 377-1.

B.3 Essence Descriptors

The following Essence Descriptor and Sub Descriptor Sets are used to describe the parametric information of the essence data in each Essence Track in the File Package.

- CDCI Picture Essence Descriptor Set which is specified in SMPTE ST 377-1 describes the Picture Track. The Set Key is
  - 06.0E.2B.34.02.53.01.01.0D.01.01.01.01.01.28.00.
- Container Constraints Sub Descriptor defined in SMPTE ST 379-2 is necessary to describe MPEG-4 AVC Sub Descriptor specified in SMPTE ST 381-3. The Set Key is
  - 06.0E.2B.34.02.53.01.01.0D.01.01.01.01.01.67.00.
- MPEG-4 AVC Video Sub Descriptor Set which is specified in SMPTE ST 381-3 is strongly referenced from the CDCI Picture Descriptor and is also described for the Picture Track. The Set Key is
  - 06.0E.2B.34.02.53.01.01.0D.01.01.01.01.01.6E.00.
- MPEG Video Descriptor Set which is specified in SMPTE ST 381-1 is described for the Picture Track. The Set Key is
  - 06.0E.2B.34.02.53.01.01.0D.01.01.01.01.01.51.00.
- AES3 Sound Descriptor Set which is specified in SMPTE ST 382 is described for each Sound Track. The Set Key is
  - 06.0E.2B.34.02.53.01.01.0D.01.01.01.01.01.47.00.
- ANC Data Descriptor Set which is specified in SMPTE ST 436-1 is described for the ANC Element when the Data Track exists in the MXF file. The Set Key is
  - 06.0E.2B.34.02.53.01.01.0D.01.01.01.01.01.5C.00.

Note: MPEG Video Descriptor which extends the CDCI Picture Essence Descriptor is used for XAVC HD Intra profile. On the other hand, CDCI Picture Essence Descriptor and MPEG-4 AVC Video Sub Descriptor are used for other profiles described in this document.

The Structural Metadata Sets shall contain the properties which are marked with "Req" in SMPTE MXF documents. Also, all "E/req" / "B.Effort" properties, and listed "D/req" / "Opt" properties in the following table should be included.

Table B.1 – D/Req and Opt Properties in Structural Metadata Sets

Set	Property	Tag
Content Storage	Essence Container Data	19.02
Essence Container Data	IndexSID	3F.06
Track	Track ID	48.01
Structural Component	Duration	02.02
Sequence or Source Clip (inheriting Structural Component)		
Descriptor	Linked Track ID, Sub Descriptors	30.06, dynamic tag
Picture Descriptor (inheriting Descriptor)	SampledHeight, SampledWidth, SampledXOffset, SampledYOffset, DisplayHeight, DisplayWidth, DisplayXOffset, DisplayYOffset, Transfer Characteristic, ImageAlignmentOffset, ImageStartOffset, ImageEndOffset, Picture Essence Coding	32.04, 32.05, 32.06, 32.07, 32.08, 32.09, 32.0A, 32.0B, 32.10, 32.11, 32.13, 32.14 32.01
CDCI Picture Essence Descriptor (inheriting Picture Descriptor)	ColorSiting, BlackRefLevel, WhiteRefLevel, ColorRange, PaddingBits, VerticalSubsampling, ReversedByteOrder	33.03, 33.04, 33.05, 33.06, 33.07, 33.08, 33.0B
MPEG Video Descriptor (inheriting CDCI Picture Essence Descriptor)		
MPEG-4 AVC Video Sub-Descriptor	AVC Constant B Picture Flag, AVC Coded Content Kind, AVC Closed GOP Indicator, AVC Identical GOP Indicator, AVC Maximum GOP Size, AVC Maximum B-Picture Count, AVC Maximum Bitrate, AVC Average Bitrate, AVC Profile, AVC Profile Constraint, AVC Level, AVC Decoding Delay, AVC Maximum Ref Frames, AVC Sequence Parameter Set Flag, AVC Picture Parameter Set Flag	dynamic tags
Sound Descriptor (inheriting Descriptor)	Locked/Unlocked, Audio Ref Level, Sound Essence Coding	3D.02, 3D.04 3D.06
AES3 Audio Descriptor (inheriting Sound Descriptor)	Channel Status Mode, Fixed Channel Status Data	3D.10, 3D.11

B.4 Identification Set Value

The optional Generation UID Property of the Interchange Object Class is not to be encoded in Identification Set instances as defined in SMPTE ST 377-1.

B.5 Timecode Representation in MXF Header and an Essence Container

- In Material Package, there shall be only one continuous Timecode Track.
- In File Package, there shall be only one continuous Timecode Track.
- System Item timecode may contain discontinuities.

B.6 Index Table Segments

The number of frames contained in an Index Table Segment Set should be regulated as shown in Table B.2.

Table B.2 – Size of Index Table Segment

Frame Rate	Index Duration [frames]	Duration [s]	Size of Index Table Segment [bytes]
23.98p	240	10.01	4096 (1000h)
24p	240	10.0	4096 (1000h)
25p, 50i	240	9.6	4096 (1000h)
29.97p, 59.94i	300	10.01	5120 (1400h)
50p	480	9.6	7680 (1E00h)
59.94p	600	10.01	9216 (2400h) or 9728 (2600h)

- The Size of Index Table Segment is the sum of an Index Table Segment Set and the following KLV Fill item.
- This restriction shall not be applied to the final Index Table Segment within the file.
- The final Index Table Segment contains remaining frames, so the Index Duration and Duration may be fewer than the values in Table B.2.
- The Size of Index Table Segments should be uniform in an MXF file.

B.7 Random Index Pack

The Random Index Pack (RIP) shall be present.

B.8 Essence

B.8.1 System Item

This RDD 32 file includes one CP System Item as defined in Annex B.1.

B.8.2 Picture Item

The Picture Item includes one or more MPEG Video Elements as defined in Annex B.1.

B.8.3 Sound Item

The Sound Item includes one or more AES3 Elements as defined in Annex B.1.

- Sound data stream is coded in 2's complement, in little endian, and void bits shall be set to 0.
- Preferable 5-frame sequence of audio sampling number is 801-801-800-801-801 for 59.94fps, or 1602-1601-1602-1601-1602 for 29.97fps.
- Extracted AES3 Channel Status data shall be described into the Audio Descriptor in Header Metadata.

B.8.4 Data Item

The Data Item includes zero or one ANC Frame Element as defined in Annex B.1.

- Typical settings, e.g. for a minimum implementation, are defined as follows:
  - Wrapping Type value is chosen from VANC codes. HANC is not used.
  - Payload Sample Coding value is set to 8-bit luma sample type.
- CS(Check Sum) in each ANC Packet may be omitted.
- Each Payload Byte Array shall be padded to achieve 4-byte alignment.
- The size of Data Item, i.e. from the first byte of the Element Key to the end of Fill, shall be less than or equal to 11776 bytes. The size shall always be multiple of 512 bytes due to the KAG size.
- The size of Data Item shall be constant through the file.

Annex C Operating Points

This annex defines signal format restrictions that should be imposed widely on XAVC Recorders and Players. It is not mandatory for XAVC Recorders and Players to support all of the Operating Points defined in this annex.

C.1 XAVC Intra

C.1.1 General Characteristics

The XAVC HD Intra Profile and the XAVC 4K Intra Profile are specified for XAVC Intra in this specification. Table C.1 indicates supported compressions for the XAVC File Formats.

Table C.1 – Supported XAVC Intra Profiles and compression types for the XAVC File Formats

XAVC Profiles	Compression types
XAVC HD Intra	CBG compression
XAVC 4K Intra	CBG compression
	VBR compression

The Operating Points for the XAVC Intra are specified as follows.

Note: The coded frame size of Intra CBG or the maximum coded size of Intra VBR is defined as the total length of the slice data and the padding bytes.

Table C.2 indicates the Operating Points of XAVC HD Intra Profile. The coding specifications of these Operating Points conform to Class 50, Class 100 and Class 200 of SMPTE RP 2027.

Table C.2 – Operating Points of XAVC HD Intra Profile for the XAVC MXF File Format (Intra CBG)

Picture Pixel Array	RP 2027	Coded frame size [bytes]	Frame Rate							
			50i	59.94i	23.98p	24p	25p	29.97p	50p	59.94p
1280x720	Class 100	230,912								✓
		279,040							✓	
1440 x 1080	Class 50	223,232		✓	✓			✓		
		271,360	✓				✓			
1920 x 1080	Class 100	462,848		✓	✓			✓		✓
		559,104	✓				✓		✓	
	Class 200	943,104		✓	✓			✓		✓
		1,134,592	✓				✓		✓	

Note: The class number represents the approximate bitrate value at 59.94p for 1280x720 or at 29.97p for 1920x1080.

Table C.3 and Table C.4 indicate the Operating Points of XAVC 4K Intra Profile, which uses Intra CBG compression and Intra VBR compression respectively.

Table C.3 – Operating Points of XAVC 4K Intra Profile for the XAVC MXF File Format (Intra CBG)

Picture Pixel Array	Class	Coded frame size [bytes]	Frame Rate							
			50i	59.94i	23.98p	24p	25p	29.97p	50p	59.94p
2048 x 1080	Class 100	462,848			✓	✓	✓	✓	✓	✓
3840 x 2160	Class 300	1,250,304			✓		✓	✓	✓	✓
	Class 480	1,999,872			✓		✓	✓	✓	✓
4096 x 2160	Class 300	1,250,304			✓	✓	✓	✓	✓	✓
	Class 480	1,999,872			✓	✓	✓	✓	✓	✓

Table C.4 – Operating Points of XAVC 4K Intra Profile for the XAVC MXF File Format (Intra VBR)

Picture Pixel Array	Class	Max coded frame size [bytes]	Frame Rate							
			50i	59.94i	23.98p	24p	25p	29.97p	50p	59.94p
2048 x 1080	Class 100	462,848			✓	✓	✓	✓	✓	✓
3840 x 2160	Class 300	1,250,304			✓		✓	✓	✓	✓
	Class 480	1,999,872			✓		✓	✓	✓	✓
4096 x 2160	Class 300	1,250,304			✓	✓	✓	✓	✓	✓
	Class 480	1,999,872			✓	✓	✓	✓	✓	✓

Note: The class number represents the approximate bitrate value at 29.97p.

C.1.2 XAVC HD Intra Profile

See Table C.5 and Table C.6 for permitted profile and level in the XAVC HD Intra Profile.

Table C.5 – MPEG4 AVC/H.264 Profiles supported in XAVC HD Intra Profile

Profiles	profile_idc	Note
High 10 Intra profile	110(6Eh)	Only for Class 50 of CBG Compression
High 4:2:2 Intra profile	122(7Ah)	

Table C.6 – MPEG4 AVC/H.264 Levels supported in XAVC HD Intra Profile

Levels	level_idc	1280x720	1440x1080	1920x1080
Level 4	40(28h)	✓	✓	✓
Level 4.1	41(29h)	✓		✓
Level 4.2	42(2Ah)			✓
Level 5	50(32h)			✓

C.1.3 XAVC 4K Intra Profile

See Table C.7 and Table C.8 for permitted profile and level in the XAVC 4K Intra Profile.

Table C.7 – MPEG4 AVC/H.264 Profiles supported in XAVC 4K Intra Profile

Profiles	profile_idc	Note
High 4:2:2 Intra profile	122(7Ah)	

Table C.8 – MPEG4 AVC/H.264 Levels supported in XAVC 4K Intra Profile

Levels	level_idc	2048x1080	3840x2160	4096x2160
Level 4.2	42(2Ah)	✓		
Level 5	50(32h)	✓(*1)		
Level 5.1	51(33h)		✓	✓
Level 5.2	52(34h)		✓(*2)	✓(*3)

(*1) for 59.94fps; (*2) for 50fps or more; (*3) for 29.97fps or more

C.2 XAVC Long GOP

C.2.1 General characteristics

The XAVC HD Profile and the XAVC 4K Profile are specified for XAVC Long GOP in this specification.

The Operating Points for the XAVC Long GOP are specified as follows.

Note: The Max Bit Rate is defined as the maximum value of Bitrate[SchedSelIdx] for both VCL and NAL HRD parameters.

Table C.9 indicates the Operating Points of XAVC HD Profile for the XAVC MXF File Format.

Table C.9 – Operating Points of XAVC HD Profile for the XAVC MXF File Format

Picture Pixel Array	Max Bit Rate [Mbps]	Frame Rate							
		50i	59.94i	23.98p	24p	25p	29.97p	50p	59.94p
1280 x 720	50							✓	✓
1920 x 1080	50	✓	✓	✓		✓	✓	✓	✓
1920 x 1080	35	✓	✓	✓		✓	✓	✓	✓
1920 x 1080	25	✓	✓	✓		✓	✓		

Table C.10 indicates the Operating Points of XAVC 4K Profile for the XAVC MXF File Format.

Table C.10 – Operating Points of XAVC 4K Profile for the XAVC MXF File Format

Picture Pixell array	Max Bit Rate [Mbps]	Frame Rate							
		50i	59.94i	23.98p	24p	25p	29.97p	50p	59.94p
3840 x 2160	188			✓		✓	✓		
3840 x 2160	300							✓	✓

C.2.2 XAVC HD Profile

See Table C.11 and Table C.12 for permitted profile and level in the XAVC HD Profile.

Table C.11 – MPEG4 AVC/H.264 Profiles supported in XAVC HD Profile

Profiles	profile_idc	Note
High 4:2:2 profile	122(7Ah)	

Table C.12 – MPEG4 AVC/H.264 Levels supported in XAVC HD Profile

Levels	level_idc	1280x720	1440x1080	1920x1080
Level 4	40(28h)	✓	✓	✓
Level 4.1	41(29h)	✓	✓	✓
Level 4.2	42(2Ah)	✓	✓	✓
Level 5	50(32h)		✓	✓

C.2.3 XAVC 4K Profile

See Table C.13 and Table C.14 for permitted profile and level in the XAVC 4K Profile.

Table C.13 – MPEG4 AVC/H.264 Profiles supported in XAVC 4K Profile

Profiles	profile_idc	Note
High profile	100(64h)	

Table C.14 – MPEG4 AVC/H.264 Levels supported in XAVC 4K Profile

Levels	level_idc	2048x1080	3840x2160	4096x2160
Level 4.2	42(2Ah)	✓		
Level 5	50(32h)	✓(*1)		
Level 5.1	51(33h)		✓	✓
Level 5.2	52(34h)		✓(*2)	✓(*3)

(*1) for 59.94fps; (*2) for 50fps or more; (*3) for 29.97fps or more

Annex D Property Values of the Essence Descriptors

Table D.1 to Table D.5, Table D.7 and Table D.8 enumerate the Property values of Picture, Sound and Data Essence that specify the constraints on the conformant implementation of the SMPTE RDD 32 file.

Table D.1 – An Instance of MPEG Video Descriptor

Set Key	Value	Description	Note
MPEG Video Descriptor	06.0e.2b.34.02.53.01.01. 0d.01.01.01.01.01.51.00	Defines the MPEG Video Descriptor Set	
File Descriptor			
Property	**Value**	**Description**	**Note**
Sample Rate	00 00 ea 60 00 00 03 e9	59.94p	
	00 00 00 32 00 00 00 01	50p	
	00 00 75 30 00 00 03 e9	59.94i, 29.97p	
	00 00 00 19 00 00 00 01	50i, 25p	
	00 00 5d c0 00 00 03 e9	23.98p	
Essence Container	06 0e 2b 34 04 01 01 02 0d 01 03 01 02 04 60 01		GC MPEG ES Frame Wrap

Table D.2 – Property Values of CDCI Picture Essence or MPEG Video Descriptor for XAVC Intra

Property	XAVC Intra							
	XAVC HD Intra Profile					XAVC 4K Intra Profile		
	Class 50		Class 100	Class 100 / Class 200				
	1440x1080 i	1440x1080 p	1280x720 p	1920x1080 i	1920x1080 p	2048x1080 p	3840x2160 p	4096x2160 p
SignalStandard	4 (ST274)(*1)		5 (ST296)	4 (ST274)		0	0	0
FrameLayout	1	0	0	1	0	0	0	0
StoredHeight	544	1088	720	544	1088		2160	
SampledHeight	540	1080	720	540	1080		2160	
DisplayHeight	540	1080	720	540	1080		2160	
their "Width" properties	1440		1280	1920		2048	3840	4096
VideoLineMap[0] (1st field)	21	42	26	21	42		42	
VideoLineMap[1] (2nd field)	584	0	0	584	0			
DisplayYOffset	0							
other "Offset" properties	0							
Aspect Ratio	16 / 9					256 / 135	16 / 9	256 / 135
HorizontalSubsampling	2							
VerticalSubsampling	2		1					
ColorSiting	6		0					
ComponentDepth	10							
BlackRefLevel	64							
WhiteRefLevel	940							

ColorRange	897

(*1) External I/O is 1920x1080.

Table D.3 – Property Values of MPEG-4 AVC Video Sub-Descriptor for XAVC Intra

Property	Frame Rate / Format	Value	Meaning
AVC Constant B Picture Flag		1	TRUE
AVC Coded Content Kind	23.98p, 24p, 25p, 29.97p, 50p, 59.94p	1	Progressive frame coding
	50i, 59.94i	3	Interlaced frame coding
AVC Closed GOP Indicator		1	TRUE
AVC Identical GOP Indicator		1	TRUE
AVC Maximum GOP Size		1	
AVC Maximum B-Picture Count		0	
AVC Maximum Bitrate		See Note	Maximum bit rate of the AVC stream in bit/s is given by bit_rate_scale and bit_rate_value_minus1 in the HRD parameters in the sequence parameter set. The equivalent value is assigned for this property of the stream even if the stream does not include the HRD parameters. If an encoder does not know the value, this property shall not be present.
AVC Average Bitrate		See Note	Average bitrate of the AVC stream in bit/s over the entire AVC bitstream. If an encoder does not know the value, this property shall not be present.
AVC Profile		same as profile_idc in Table C.5 or Table C.7	
AVC Profile Constraint		10h	The value of bit [7..2] is taken from constraint_set0_flag, constraint_set1_flag, constraint_set2_flag, constraint_set3_flag. constraint_set4_flag and constraint_set5_flag in the Sequence Parameter Set. The value of bit [1..0] shall be set to zero.
AVC Level		same as level_idc in Table C.6 or Table C.8	
AVC Decoding Delay		0	
AVC Maximum Ref Frames		0	
AVC Sequence Parameter Set Flag	XAVC HD Intra Profile (Intra CBG)	A0h	Bit7 (Constancy flag) = 1 (constant) Bit[6:4] (In-band location) = 2 (every AU)
	XAVC 4K Intra Profile (Intra VBR / Intra CBG)	20h	Bit7 (Constancy flag) = 0 (unknown) Bit[6:4] (In-band location) = 2 (every AU)
AVC Picture Parameter Set Flag	XAVC HD Intra Profile (Intra CBG)	A0h	Bit7 (Constancy flag) = 1 (constant) Bit[6:4] (In-band location) = 2 (every AU)

	XAVC 4K Intra Profile (Intra VBR / Intra CBG)	20h	Bit7 (Constancy flag) = 0 (unknown) Bit[6:4] (In-band location) = 2 (every AU)
AVC Sequence Parameter Set Flag (old implementation)	XAVC HD Intra Profile (Intra CBG)	50h	Bit7 (Out-of-band flag) = 0 (In-band) Bit6 (Constancy flag) = 1 (constant) Bit[5:3] (In-band location) = 2 (every AU)
	XAVC 4K Intra Profile (Intra VBR)	10h	Bit7 (Out-of-band flag) = 0 (In-band) Bit6 (Constancy flag) = 0 (unknown) Bit[5:3] (In-band location) = 2 (every AU)
AVC Picture Parameter Set Flag (old implementation)	XAVC HD Intra Profile (Intra CBG)	50h	Bit7 (Out-of-band flag) = 0 (In-band) Bit6 (Constancy flag) = 1 (constant) Bit[5:3] (In-band location) = 2 (every AU)
	XAVC 4K Intra Profile (Intra VBR)	10h	Bit7 (Out-of-band flag) = 0 (In-band) Bit6 (Constancy flag) = 0 (unknown) Bit[5:3] (In-band location) = 2 (every AU)

Note: In the XAVC Intra CBG/VBR case, the AVC Maximum Bitrate should be present. If the sequence parameter set does not include the HRD parameters, the value of the AVC Maximum Bitrate should be calculated by multiplying the coded frame size (bytes/frame) specified in Table C.2, Table C.3 or Table C.4 by the rounded frame rate per second i.e. 24,25,30,50 or 60 (frames/second), then multiplying it by eight (bits/byte). If the AVC Maximum Bitrate is described, it is not necessary to set the AVC Average Bitrate.

Table D.4 – Property Values of CDCI Picture Essence or MPEG Video Descriptor for XAVC Long GOP

Property	XAVC Long GOP			
	XAVC HD Profile			XAVC 4K Profile
	4:2:2 10bit			4:2:0 8bit
	1280x720 p	1920x1080 i	1920x1080 p	3840x2160 p
SignalStandard	5 (ST298)	4 (ST274)		0
FrameLayout	0	1	0	0
StoredHeight	720	544	1088	2160
SampledHeight	720	540	1080	2160
DisplayHeight	720	540	1080	2160
their "Width" properties	1280	1920	1920	3840
VideoLineMap[0] (1st field)	26	21	42	42
VideoLineMap[1] (2nd field)	0	584	0	0
DisplayYOffset	0			
other "Offset" properties	0			
Aspect Ratio	16 / 9			
HorizontalSubsampling	2			
VerticalSubsampling	1			2
ColorSiting	0			6
ComponentDepth	10			8
BlackRefLevel	64			16
WhiteRefLevel	940			235
ColorRange	897			225

Table D.5 – Property Values of MPEG-4 AVC Video Sub-Descriptor for XAVC Long GOP

Property	Frame Rate / Format	Value	Meaning
AVC Constant B Picture Flag		0	Unknown
AVC Coded Content Kind	23.98p, 25p, 29.97p, 50p, 59.94p	1	Progressive frame coding
	50i, 59.94i	2	Interlaced field coding
AVC Closed GOP Indicator		0 or 1	Open or Closed
AVC Identical GOP Indicator		0 or 1	FALSE or TRUE
AVC Maximum GOP Size		Depending on the encoding	
AVC Maximum B-Picture Count	23.98p, 25p, 29.97p, 50p, 59.94p	3 or less	
	50i, 59.94i	6 or less	
AVC Maximum Bitrate		See Note	Maximum bit rate of the AVC stream in bit/s is given by bit_rate_scale and bit_rate_value_minus1 in the HRD parameters in the sequence parameter set. The equivalent value is assigned for this property of the stream even if the stream does not include the HRD parameters. If an encoder does not know the value, this property shall not be present.
AVC Average Bitrate		See Note	Average bitrate of the AVC stream in bit/s over the entire AVC bitstream. If an encoder does not know the value, this property shall not be present.
AVC Profile		same as profile_idc in Table C.11 or Table C.13	
AVC Profile Constraint		00h	The value of bit [7..2] is taken from constraint_set0_flag, constraint_set1_flag, constraint_set2_flag, constraint_set3_flag. constraint_set4_flag and constraint_set5_flag in the Sequence Parameter Set. The value of bit [1..0] shall be set to zero.
AVC Level		same as level_idc in Table C.12 or Table C.14	
AVC Decoding Delay	23.98p, 25p, 29.97p, 50p, 59.94p	2 or less	Specifies the delay required for decoded pictures in number of access units
	50i, 59.94i	4 or less	
AVC Maximum Ref Frames			same as max_num_ref_frames
AVC Sequence Parameter Set Flag		30h	Bit7 (Constancy flag) = 0 (unknown) Bit[6:4] (In-band location) = 3 (Periodically placed at the first access unit in each GOP)

AVC Picture Parameter Set Flag		20h or 30h	Bit7 (Constancy flag) = 0 (unknown) Bit[6:4] (In-band location) = 2 (Every access unit in the stream) or 3 (Periodically placed at the first access unit in each GOP)

Note: In the XAVC Long GOP case, AVC Maximum Bitrate shall be present only if bit_rate_scale and bit_rate_value_minus1 exists in the HRD parameters in the sequence parameter set. If AVC Maximum Bitrate is not present, AVC Average Bitrate should be present.

Table D.6 indicates the Sequence Parameter Set Flag and Picture Parameter Set Flag information in one place.

Table D.6 – Sequence Parameter Set Flag and Picture Parameter Set Flag Properties

XAVC Profiles	Sequence Parameter Set Flag		Picture Parameter Set Flag	
	Constancy	In-band location	Constancy	In-band location
XAVC HD Intra	✓	Every access unit in the stream	✓	Every access unit in the stream
XAVC 4K Intra		Every access unit in the stream		Every access unit in the stream
XAVC HD XAVC 4K		Periodically placed at the first access unit in each GOP		Every access unit in the stream or Periodically placed at the first access unit in each GOP

Table D.7 – An Instance of AES3 Audio Essence Descriptor

Set Key	Value	Description	Note
AES3 Audio Essence Descriptor	06.0e.2b.34.02.53.01.01. 0d.01.01.01.01.01.47.00	Defines the AES3 Audio Essence Descriptor Set (a collection of Parametric metadata)	
File Descriptor			
Property	**Value**	**Description**	**Note**
Sample Rate	00 00 bb 80 00 00 00 01	48000, 1	in MXF version1.3
Essence Container	06 0e 2b 34 04 01 01 02 0d 01 03 01 02 06 03 00		GC AES Frame Wrap
Generic Sound Essence Descriptor			
Property	**Value**	**Description**	**Note**
Audio sampling rate	00 00 bb 80 00 00 00 01	48000, 1	
Locked/Unlocked	01	Number of samples per frame is locked to video	
Audio Ref Level	00	Number of dBm for 0VU	
Channel Count	00 00 00 01	Number of sound channels	
Quantization bits	00 00 00 18	Number of quantization bits	24 bits
Wave Audio Essence Descriptor			
Property	**Value**	**Description**	**Note**
Block Align	00 03	Sample Block alignment	24 bits
Average Bytes Per Second	00 02 32 80	Average Bytes per second	144k bytes/sec (24bit)
AES3 Audio Essence Descriptor			
Property	**Value**	**Description**	**Note**
Channel Status Mode	00 00 00 01 00 00 00 01 01		MINIMUM mode

Fixed Channel Status Data	00 00 00 01 00 00 00 18 85 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00		Professional use Linear PCM No emphasis 48KHz sampling
	00 00 00 01 00 00 00 18 87 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00		Professional use Non-Linear PCM No emphasis 48KHz sampling

Table D.8 – An Instance of ANC Packets Descriptor

Set Key	**Value**	**Description**	**Note**
ANC Data Descriptor	06.0e.2b.34.02.53.01.01. 0d.01.01.01.01.01.5C.00	Defines the ANC Data Descriptor Set	
File Descriptor			
Property	**Value**	**Description**	**Note**
Sample Rate Essence Container	00 00 ea 60 00 00 03 e9	59.94p	
	00 00 00 32 00 00 00 01	50p	
	00 00 75 30 00 00 03 e9	59.94i, 29.97p	
	00 00 00 19 00 00 00 01	50i, 25p	
	00 00 5d c0 00 00 03 e9	23.98p	
Essence Container	06 0e 2b 34 04 01 01 09 0d 01 03 01 02 0e 00 00		GC Generic ANC data with an undefined payload
Generic Data Essence Descriptor			
No Property			
ANC Data Descriptor			
No Property			