# SMPTE REGISTERED DISCLOSURE DOCUMENT

# MXF OP-1a Interoperability Specification for AVC-ULTRA



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## Introduction

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

Operational Pattern 1a (OP-1a) is defined as a conformance point of an MXF file and specifies the minimum constraints on the exchange of an MXF file with a single item and a single package. The purpose of this RDD is to specify additional constraints on OP-1a implementations to facilitate interoperability of MXF file exchanges.

This RDD provides the specification for implementing an MXF OP-1a file to encapsulate AVC-ULTRA encoded video essence, data essence, and uncompressed PCM audio essence. AVC-ULTRA is name of Panasonic implementations of H.264/AVC codec.

The Essence Container is interleaved Frame wrapped MPEG Picture Element, ANC Frame Element, and each channel of AES3 Frame wrapped Element. Each Index Table segment is placed in the separate Partition immediately following the essence they Index.

SMPTE RDD 26 specifies the OP-1b implementation for tape-less camera recording. OP-1a files specified in this document may be generated from OP-1b files conforming to SMPTE RDD 26.

## 1 Scope

This RDD provides the specification for implementing an MXF OP-1a file that encapsulates AVC-ULTRA encoded video essence, data essence originally carried in ancillary packets, uncompressed PCM audio essence.

This document specifies the structure of the MXF OP-1a file, partitioning, Essence Containers, and the structures and the implementations of the Header Metadata and Index Table.

## 2 Normative References

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 378:2004) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 378M-2004). Documents with the same root number (e.g. 378) and publication year (e.g. 2004) are functionally identical.

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

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

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

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

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

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 (MXF) Television — Mapping AES3 and Broadcast Wave Audio into the MXF Generic Container

Amendment 1:2012 to SMPTE ST 382:2007

Amendment 2:2013 to SMPTE ST 382:2007

SMPTE ST 436-1:2013, Material Exchange Format (MXF) Television — Mappings for VBI Lines and Ancillary Data Packets

ISO/IEC 14496-10:2014 | Rec. ITU-T H.264:2016, Information Technology Television — Coding of Audio-Visual Objects — Advanced Video Coding

## 3 Definition of Acronyms, Terms and Data Types

For the purposes of this RDD, the following definitions apply:

The general glossary of acronyms, terms and data types used in the MXF specification is given in SMPTE ST 377-1, SMPTE ST 379-2, SMPTE ST 381-3, and SMPTE ST 382. Definitions of terms, abbreviations and symbols relating to AVC are given in ISO/IEC 14496-10 | Rec. ITU-T H.264.

### 3.1 AVC

Advanced Video Coding – ISO/IEC 14496-10 I Rec. ITU-T H.264

### 3.2 AVC-ULTRA

AVC-ULTRA in this document covers Panasonic implementations of AVC-Long GOP and AVC-Intra VBR codec

### 3.3 AVC Long GOP 4:2:0

AVC Long GOP coding with 4:2:0 sampling

### 3.4 AVC Long GOP 4:2:2

AVC Long GOP coding with 4:2:2 sampling

### 3.5 AVC Intra VBR

AVC Intra frame coding with variable bit rate

### 3.6 AVC Intra 4:4:4

AVC Intra VBR coding for 1080p with 4:4:4 sampling

### 3.7 AVC Intra 2K 4:2:2

AVC Intra VBR coding for 2K with 4:2:2 sampling

### 3.8 AVC Intra 2K 4:4:4

AVC Intra VBR coding for 2K with 4:4:4 sampling

### 3.9 AVC Intra 4K 4:2:2

AVC Intra VBR coding for 4K with 4:2:2 sampling

### 3.10 AVC Intra 4K 4:4:4

AVC Intra VBR coding for 4K with 4:4:4 sampling

### 3.11 2K

Image format of 2048 x 1080 pixels

### 3.12 4K

Image format of 4096 x 2160 and 3840 x 2160 pixels

## 4 Basic Structure of MXF OP-1a File

Figure 1 illustrates the outline of an MXF OP-1a file defined in this document.

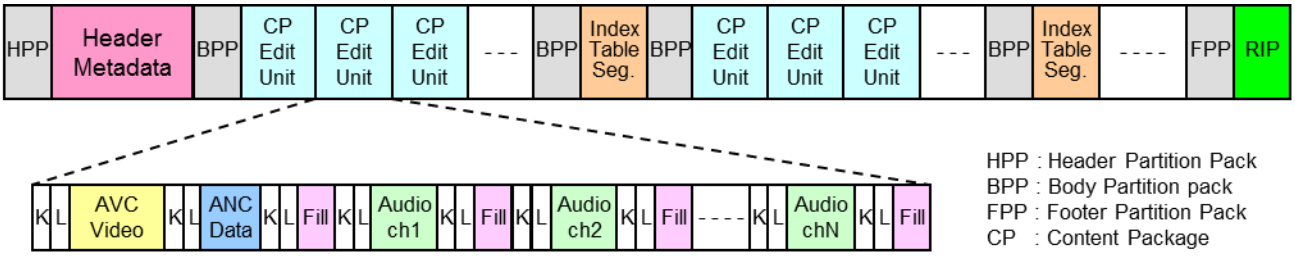


**Figure 1 – Basic structure of MXF OP-1a for AVC-ULTRA**

The MXF file consists of one (1) Header Partition, multiple Body Partitions, and one (1) Footer Partition.

Body Partition is divided into multiple Partitions in a specific duration. The duration of each Partition is constant throughout a file except the end of the file. Every Body Partition has a specific, constant duration, except for the last Partition, which may be shorter.

The Essence Container is structured with a sequence of Content Packages and each Content Package consists of Frame-wrapped Picture, Data, and Sound items.

The video essence is an AVC Long GOP or AVC Intra VBR encoded stream and mapped into the MXF Generic Container using the Frame wrapped MPEG Picture Element.

The data essence contains Ancillary Data Packets (ANC packets) and is mapped into the MXF Generic Container using an ANC Frame Element.

The audio essence is uncompressed PCM audio and is mapped into the MXF Generic Container using the AES3 Frame wrapped Element.

Each Index Table Segment is placed in the separate Partition immediately following the essence they Index.

# 5 Partitions

## 5.1 Partitioning

There shall be one (1) Header Partition, multiple Body Partitions, and one (1) Footer Partition in the file.

Header Partition shall not contain any Essence Elements and shall not contain any Index Table Segments.

The file Body Partition shall be divided into multiple Body Partitions. This specification utilizes “unique use” for Body Partitions where each Body Partition contains either Essence or an Index Table Segment, but not both. In effect, Body Partitions appear in pairs: one with Essence and one with an Index Table Segment. The duration of each Body Partition containing Essence shall be no more than ten (10) seconds. The recommended Partition duration is two (2) seconds. The number of video frames included in each Body Partition containing Essence shall be constant throughout a file except for the final Body Partition in the file.

The 1st Body Partition shall contain Essence Elements and no Index Table Segments.

The 2nd Body Partition shall contain an Index Table Segment for the Essence Elements in the previous Body Partition and no Essence Elements.

All pairs of Body Partitions shall follow the above pattern as illustrated in Figure 2.

The Footer Partition may contain the complete repetition of the Index Table that includes all the Index Table Segments in the Body Partitions.

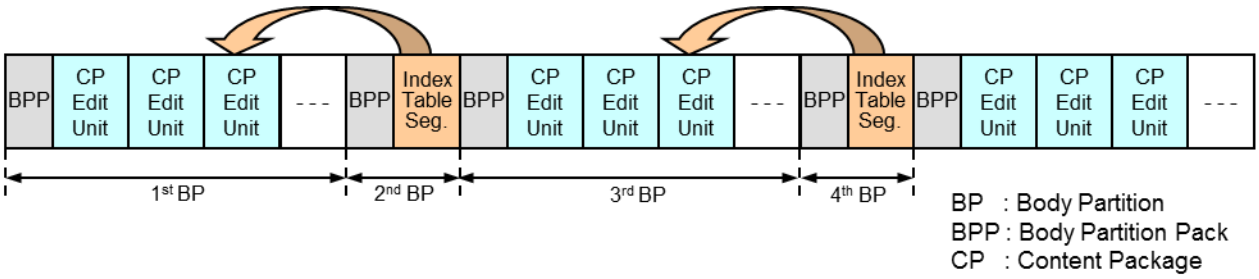


**Figure 2 – Structure of Body Partitions**

## 5.2 Partition Pack

The Header Partition should be Closed and Complete with the correct value of the Footer Partition property and with the correct updated Header Metadata including the duration.

Body Partition shall be Open and Complete.

Footer Partition shall be Closed and Complete.

# 6 Operational Pattern

Operational Pattern shall be OP-1a (Single Item, Single Package) as specified in SMPTE ST 378. The value of Universal Label for Operational Pattern 1a shall be as defined in Section 8 of SMPTE ST 377-1. Byte 15 values of MXF Operational Pattern UL shall be as given in Table 1.

**Table 1 – Byte 15 value of MXF Operational Pattern UL**

| Bit No. | Value (bin) | Meaning |
|---|---|---|
| 0 | 1 | Marker bit to prevent a zero value |
| 1 | 0 | Internal essence |
| 2 | 0 | Stream file |
| 3 | 1 | Multi-track |
| 7-4 | 0000 | Reserved for future use, and should be set to zero |

# 7 Essence Container

## 7.1 Generic Container

Essence Container shall be the MXF Constrained Generic Container defined in SMPTE ST 379-2. The Essence in the Generic Container shall be Frame-wrapped.

## 7.2 Video Essence

### 7.2.1 Generic Container Mapping

Video essence shall be an AVC Long GOP or AVC Intra VBR encoded stream. The bit stream format shall be the AVC byte stream specified in ISO/IEC 14496-10 I Rec. ITU-T H.264.

The AVC byte stream shall be mapped into the MXF Generic Container using Frame wrapped MPEG Picture Element defined in SMPTE ST 381-2 and SMPTE ST 381-3.

### 7.2.2 Universal Label for Essence Container Identification

The Essence Container Universal Label for Frame wrapped AVC byte stream is as given in Table 2.

**Table 2 – Essence Container Universal Label for AVC byte stream**

| Byte No. | Description | Value (hex) | Meaning |
|---|---|---|---|
| 1-12 | Specified by the MXF Generic Container Specification SMPTE ST 379-2 | | |
| 13 | Essence Container Kind | 02h | MXF Generic Container |
| 14 | Mapping Kind | 10h | AVC byte stream |
| 15 | Stream_id | 60h | ISO13818-1 stream_id bits 6..0 |
| 16 | Wrapping scheme | 01h | Frame wrapping |

### 7.2.3 KLV coding of Picture Element

#### 7.2.3.1 Picture Element Key

The Essence Element Key shall be the MPEG Picture Element Key defined in SMPTE ST 381-2. The Key value of the MPEG Picture Element is as given in Table 3. The value of Byte 15 shall be set to 05h to signal the Frame wrapped Picture Element.

**Table 3 – Key Value for the MPEG Picture Element**

| Byte No. | Description | Value (hex) | Meaning |
|---|---|---|---|
| 1-12 | Specified by the MXF Generic Container Specification SMPTE ST 379-2 | | |
| 13 | Item Type Identifier | 15h | GC Picture Item as defined in SMPTE ST 379-2 |
| 14 | Essence Element Count | 01h | Count of Picture Elements in this Item |
| 15 | Essence Element Type | 05h | Frame Wrapped Picture Element |
| 16 | Essence Element Number | nnh | A number (used as an Index) of this Picture Item in this Generic Container as defined in SMPTE ST 379-2 |

#### 7.2.3.2 Picture Element Length

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

#### 7.2.3.3 Picture Element Value

For AVC Long GOP essence, the Essence Element Value within each KLV triplet shall be an AVC Long GOP coded frame or a pair of coded fields. In the 1080/59.94i and 50i systems with an interlaced image source, each field shall be field-encoded and a pair of fields shall be wrapped into a KLV packet. The Value field of each KLV packet shall contain the field-encoded data of a complete frame. Figure 3 illustrates the structures of KLV packets for progressive and interlaced source images.

For AVC Intra VBR essence, the Essence Element Value within each KLV triplet shall be an AVC Intra VBR coded frame.

The Essence Element Value shall be 4-byte aligned.

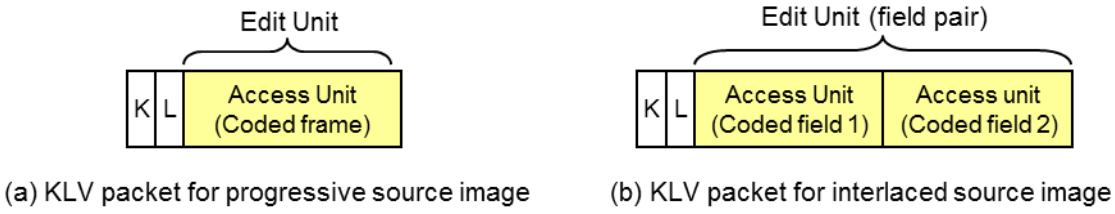


**Figure 3 – KLV packet structure for AVC Long GOP video essence**

### 7.3 Data Essence

#### 7.3.1 Generic Container Mapping

Data essence consists of Ancillary Data Packets (ANC packets), and shall be mapped into the MXF Generic Container using the ANC Frame Element defined in SMPTE ST 436-1.

#### 7.3.2 Universal Label for Essence Container Identification

The Essence Container Universal Label for an ANC packet is as given in Table 4.

**Table 4 – Essence Container Universal Label for an ANC Packet**

| Byte No. | Description | Value (hex) | Meaning |
|---|---|---|---|
| 1-12 | Specified by the MXF Generic Container Specification SMPTE ST 379-2 | | |
| 13 | Essence Container Kind | 02h | MXF Generic Container |
| 14 | Mapping Kind | 0Eh | ANC Packet |
| 15 | Reserved | 00h | Not used |
| 16 | Reserved | 00h | Not used |

### 7.3.3 KLV coding of Data Element

#### 7.3.3.1 Data Element Key

The Essence Element Key shall be the ANC Frame Element Key defined in SMPTE ST 436-1. The Key value of the ANC Frame Element is as given in Table 5.

**Table 5 – Key Value for the ANC Frame Element**

| Byte No. | Description | Value (hex) | Meaning |
|---|---|---|---|
| 1-12 | Specified by the MXF Generic Container Specification SMPTE ST 379-2 | | |
| 13 | Item Type Identifier | 17h | GC Data Item as defined in SMPTE ST 379-2 |
| 14 | Essence Element Count | 01h | Count of ANC Frame Elements in this Data Item |
| 15 | Essence Element Type | 02h | Frame-Wrapped ANC Data Element |
| 16 | Essence Element Number | nnh | A number (used as an Index) of this ANC Frame Element in this Generic Container as defined in SMPTE ST 379-2 |

#### 7.3.3.2 Data Element Length

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

#### 7.3.3.3 Data Element Value

The Essence Element Value within each KLV triplet shall be in ANC packets form as specified by SMPTE ST 436-1.

In the 1080/59.94i and 50i systems, the Value field of each KLV packet shall contain ANC packets carried in a pair of fields. ANC packets carried in the first field shall precede ANC packets carried in the second field within a single ANC Frame Element.

ANC Elements shall be stored in a display order even though AVC Long GOP Picture Essence Elements are reordered.

### 7.3.4 Implementation of ANC Frame Element

The ANC Frame Element shall be present and the length shall be 512 bytes per frame as a minimum including the KLV Fill item for padding. The structure of the ANC Frame Element shall be identical throughout the file. The length of every ANC Frame Element plus the following KLV Fill item shall be the same.

If no ANC packets are carried, the ANC Frame Element shall be present and shall have the Number of packets item set to the value zero and shall be followed by a KLV Fill item for padding. The Data Track shall be present in the Header Metadata even if the ANC Frame Element carries no ANC packets.

## 7.4 Audio Essence

### 7.4.1 Generic Container Mapping

Audio essence shall be 16-bit or 24-bit uncompressed PCM audio at a sampling rate of 48 kHz or 96 kHz. Audio data shall be mapped into the MXF Generic Container using the AES3 Frame wrapped Element defined in SMPTE ST 382.

### 7.4.2 Universal Label for Essence Container Identification

The Essence Container Universal Label for AES audio is as given in Table 6.

**Table 6 – Essence Container Universal Label for AES Audio**

| Byte No. | Description | Value (hex) | Meaning |
|---|---|---|---|
| 1-12 | Specified by the MXF Generic Container Specification SMPTE ST 379-2 | | |
| 13 | Essence Container Kind | 02h | MXF Generic Container |
| 14 | Mapping Kind | 06h | AES3-BWF |
| 15 | Content Kind | 03h | AES Frame Wrapped Element |
| 16 | Reserved | 00h | |

### 7.4.3 KLV coding of Sound Element

#### 7.4.3.1 Sound Element Key

The Essence Element Key shall be the AES Sound Element Key defined in SMPTE ST 382. The Key value of the AES Sound Element is as given in Table 7.

**Table 7 – Key Value for the Sound Essence Element**

| Byte No. | Description | Value (hex) | Meaning |
|---|---|---|---|
| 1-12 | Specified by the MXF Generic Container Specification SMPTE ST 379-2 | | |
| 13 | Item Type Identifier | 16h | GC Sound item |
| 14 | Essence Element Count | 0xh | Number of Essence Elements present in this Sound item |
| 15 | Essence Element Type | 03h | AES Frame wrapped Element |
| 16 | Essence Element Number | nnh | Unique Number amongst the elements in this Sound item |

#### 7.4.3.2 Sound Element Length

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

#### 7.4.3.3 Sound Element value

The Essence Element Value within each KLV triplet shall be audio samples presented per frame. The number of audio samples per one video frame or five video frames at 48 kHz sampling shall be the following:

| | |
|---|---|
| 59.94i, 29.97p | : 8008 samples / 5 frames |
| 50i, 25p | : 1920 samples / frame |
| 59.94p | : 4004 samples / 5 frames |
| 50p | : 960 samples / frame |
| 24p | : 2000 samples / frame |
| 23.98p | : 2002 samples / frame |

In the 59.94i and 29.97p systems, the number of audio samples per frame shall be within range between 1600 and 1602. Typical 5-frame sequences are “1600, 1602, 1602, 1602, 1602” or “1602, 1601, 1602, 1601, 1602”.

In the 59.94p system, the number of audio samples per frame shall be 800 or 801. Typical 5-frame sequences are “800, 801, 801, 801, 801” or “801, 801, 800, 801, 801”.

Actual number of audio samples in each frame can be calculated from the length field of the KLV coded element.

In the 59.94i, 29.97p, and 59.94p systems, each Sound Element shall be followed by the KLV Fill item to make the size of each Element constant and to give 4-byte alignment.

### 7.5 Content Package

The Essence Container is structured with a sequence of Content Packages and each Content Package shall consist of Picture, Data, and Sound Items in that order.

The Picture Item shall be the Frame-wrapped MPEG Picture Element.

The Data Item shall be the ANC Frame Element followed by the KLV Fill item.

The Sound Item shall be multiple channels of the AES3 Frame wrapped Elements followed by the KLV Fill item.

# 8 MXF Header Metadata

## 8.1 Header Metadata Structure

Figure 4 illustrates the overall structure of the MXF Header Metadata.

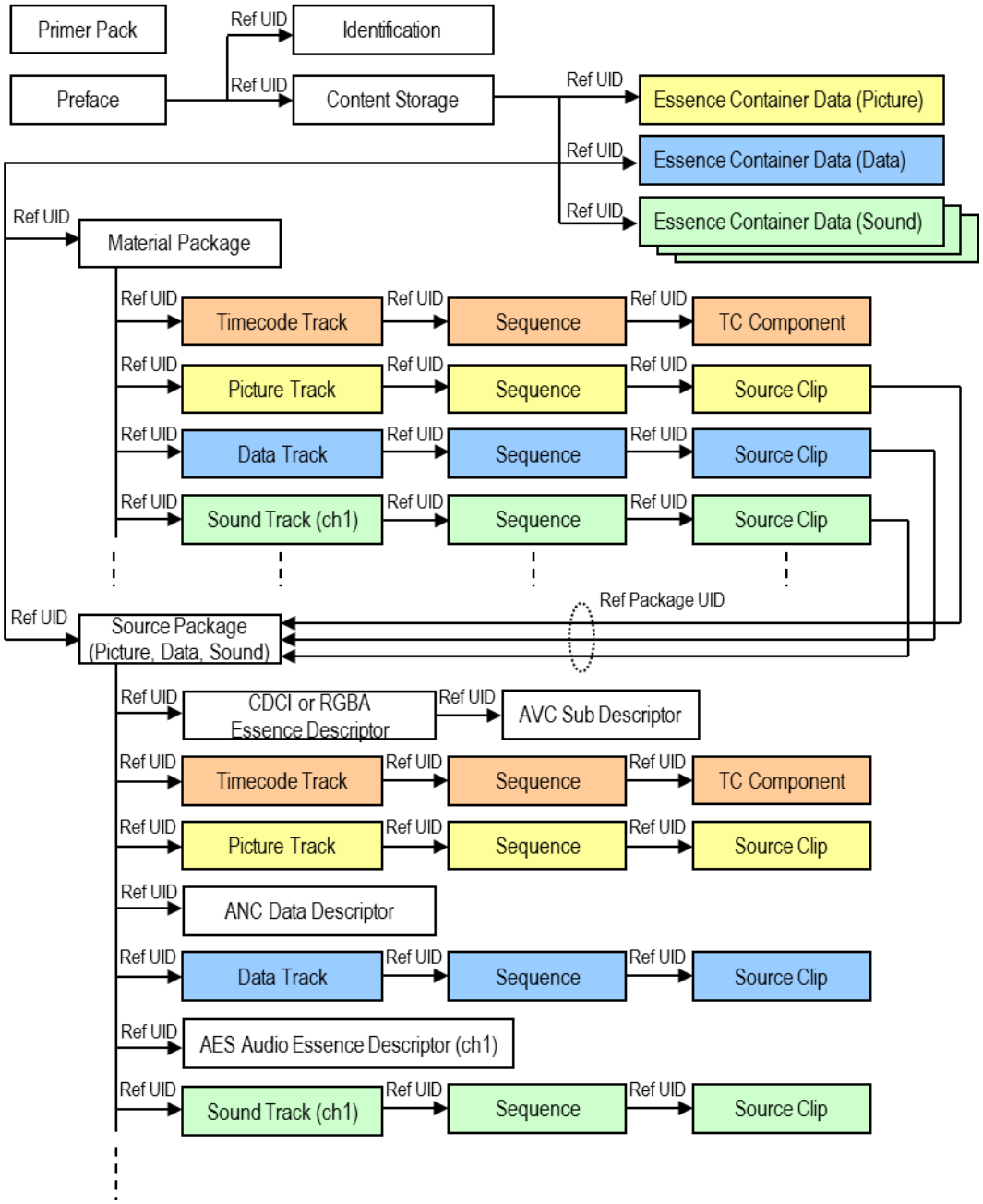


**Figure 4 – Structure of MXF Header Metadata**

The Header Metadata shall contain one Material Package and one File Package.

The Material Package shall include the sets for Timecode Track, Picture Track, Data Track, and multiple Sound Tracks.

The File Package shall include the sets for Timecode Track, Picture Track, Data Track, and multiple Sound Tracks and respective Essence Descriptors.

## 8.2 Essence Descriptor

### 8.2.1 Essence Descriptor for AVC Long GOP essence

The constraint item values of the Essence Descriptors for AVC Long GOP essence shall be as given in Table 8 thru Table 13. Type and Len fields are specified in SMPTE ST 377-1 and SMPTE ST 381-3.

**Table 8 – Item values of CDCI Picture Essence Descriptor for AVC Long GOP 1080-line system**

| Item Name | Type | Len | Value in this RDD | |
|---|---|---|---|---|
| | | | Interlaced | Progressive |
| SubDescriptors | StrongRef | 8+16 | Instance UID of AVC Sub Descriptor | |
| Linked Track ID | UInt32 | 4 | Track ID of the Picture Track | |
| Sample Rate | Rational | 8 | 59.94i: 30000,1001<br>50i: 25,1 | 59.94p: 60000,1001<br>50p: 50,1<br>29.97p: 30000,1001<br>25p: 25,1<br>23.98p: 24000,1001 |
| Container Duration | Length | 8 | Number of frames present | |
| Essence Container | UL | 16 | 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01 | |
| Frame Layout | Uint8 | 1 | 1 | 0 |
| Stored Width | Uint32 | 4 | 1920 | |
| Stored Height | Uint32 | 4 | 540 | 1080 |
| Aspect Ratio | Rational | 8 | 16,9 | |
| Video Line Map | Array of Int32 | 8+8 | 21,584 | 42,0 |
| Picture Essence Coding | UL | 16 | See Table 10 | |
| Component Depth | UInt32 | 4 | AVC Long GOP 4:2:2: 10<br>AVC Long GOP 4:2:0: 8 | |
| Horizontal Subsampling | UInt32 | 4 | 2 | |
| Vertical Subsampling | UInt32 | 4 | AVC Long GOP 4:2:2: 1<br>AVC Long GOP 4:2:0: 2 | |

**Table 9 – Item values of CDCI Picture Essence Descriptor for AVC Long GOP 720-line system**

| Item Name | Type | Len | Value in this RDD |
|---|---|---|---|
| SubDescriptors | StrongRef | 8+16 | Instance UID of AVC Sub Descriptor |
| Linked Track ID | UInt32 | 4 | Track ID of the Picture Track |
| Sample Rate | Rational | 8 | 59.94p: 60000,1001<br>50p: 50,1<br>29.97p: 30000,1001<br>25p: 25,1<br>23.98p: 24000,1001 |
| Container Duration | Length | 8 | Number of frames present |
| Essence Container | UL | 16 | 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01 |
| Frame Layout | Uint8 | 1 | 0 |
| Stored Width | Uint32 | 4 | 1280 |
| Stored Height | Uint32 | 4 | 720 |
| Aspect Ratio | Rational | 8 | 16,9 |
| Video Line Map | Array of Int32 | 8+8 | 26,0 |
| Picture Essence Coding | UL | 16 | See Table 10 |
| Component Depth | UInt32 | 4 | AVC Long GOP 4:2:2:10<br>AVC Long GOP 4:2:0: 8 |
| Horizontal Subsampling | UInt32 | 4 | 2 |
| Vertical Subsampling | UInt32 | 4 | AVC Long GOP 4:2:2: 1<br>AVC Long GOP 4:2:0: 2 |

**Table 10 – Picture Essence Coding Label for AVC Long GOP**

| Codec type | UL |
|---|---|
| AVC Long GOP 4:2:0 | 06.0E.2B.34.04.01.01.0D 04.01.02.02.01.31.40.01<br>H.264/MPEG-4 AVC High Profile Unconstrained Coding |
| AVC Long GOP 4:2:2 | 06.0E.2B.34.04.01.01.0D.04.01.02.02.01.31.60.01<br>H.264/MPEG-4 AVC High 4:2:2 Profile Unconstrained Coding |

**Table 11 – Item values of AVC Sub Descriptor for AVC Long GOP**

| Item Name | Type | Len | Value in this RDD |
|---|---|---|---|
| AVC Decoding Delay | UInt8 | 1 | Delay required for decoded pictures in number of access units |
| AVC Constant B Picture Flag | Boolean | 1 | TRUE if the number of consecutive B Pictures is always constant. |
| AVC Coded Content Kind | Enum | 1 | 1080p, 720p: 1 (Frame picture, Frame coding)<br>1080i: 2 (Field picture, Field coding) |
| AVC Closed GOP Indicator | Boolean | 1 | FALSE |
| AVC Identical GOP Indicator | Boolean | 1 | TRUE if every GOP in the sequence has the same number of pictures and the same types of pictures in the same order |
| AVC Maximum GOP Size | UInt16 | 2 | Maximum occurring spacing between I Pictures |
| AVC Maximum B-Picture Count | UInt16 | 2 | Maximum number of consecutive B Pictures between P or I Pictures |
| AVC Maximum BitRate | UInt32 | 4 | HRD bit rate given by HRD parameters |
| AVC Average BitRate | UInt32 | 4 | Average bit rate throughout the stream |
| AVC Profile | UInt8 | 1 | AVC Long GOP 4:2:2: 122 (High 4:2:2 profile)<br>AVC Long GOP 4:2:0: 100 (High profile) |

| Item Name | Type | Len | Value in this RDD |
|---|---|---|---|
| AVC Profile Constraint | UInt8 | 1 | 00h |
| AVC Level | UInt8 | 1 | 1080/59.94i, 50i: 40 (Level 4)<br>1080/59.94p, 50p: 42 (Level 4.2)<br>1080/29.97p, 25p, 23.98p: 40 (Level 4)<br>720p: 40 (Level 4) |
| AVC Maximum Ref Frames | UInt8 | 1 | Maximum number of reference frames |
| AVC Sequence Parameter Set Flag | UInt8 | 1 | See Table 12 |
| AVC Picture Parameter Set Flag | UInt8 | 1 | See Table 13 |

**Table 12 – AVC Sequence Parameter Set Flag for AVC Long GOP**

| Bit number | Name | Value in this RDD |
|---|---|---|
| 7 | Constancy flag | Specifies whether all sequence parameter sets are constant<br>0: unknown<br>1: constant |
| 6-4 | In-band location | 3: Periodically placed at the first access unit in each GOP |
| 3-0 | reserved | 0 |

**Table 13 – AVC Picture Parameter Set Flag for AVC Long GOP**

| Bit number | Name | Value in this RDD |
|---|---|---|
| 7 | Constancy flag | Specifies whether all picture parameter sets are constant<br>0: unknown<br>1: constant |
| 6-4 | In-band location | 3: Periodically placed at the first access unit in each GOP |
| 3-0 | reserved | 0 |

### 8.2.2 Essence Descriptor for AVC Intra VBR essence

The constraint item values of the Essence Descriptors for AVC Intra VBR essence shall be as given in Table 14 thru Table 22. Type and Len fields are specified in SMPTE ST 377-1 and SMPTE ST 381-3.

**Table 14 – Item values of RGBA Picture Essence Descriptor for AVC Intra 4:4:4**

| Item Name | Type | Len | Value in this RDD |
|---|---|---|---|
| SubDescriptors | StrongRef | 8+16 | Instance UID of AVC Sub Descriptor |
| Linked Track ID | UInt32 | 4 | Track ID of the Picture Track |
| Sample Rate | Rational | 8 | 59.94p: 60000,1001<br>50p: 50,1<br>29.97p: 30000,1001<br>25p: 25,1<br>24p: 24,1<br>23.98p: 24000,1001 |
| Container Duration | Length | 8 | Number of frames present |
| Essence Container | UL | 16 | 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01 |
| Frame Layout | Uint8 | 1 | 0 |
| Stored Width | Uint32 | 4 | 1920 |
| Stored Height | Uint32 | 4 | 1080 |
| Aspect Ratio | Rational | 8 | 16,9 |
| Video Line Map | Array of Int32 | 8+8 | 42,0 |
| Picture Essence Coding | UL | 16 | See Table 19 |
| PixelLayout | RGBALayout | 16 | RGB 12 bit:<br>{‘B’,12,‘G’,12,‘R’,12,0,0,0,0,0,0,0,0,0,0}<br>42.0C.47.0C.52.0C.00.00.00.00.00.00.00.00.00.00 |

**Table 15 – Item values of CDCI Picture Essence Descriptor for AVC Intra 2K 4:2:2**

| Item Name | Type | Len | Value in this RDD |
|---|---|---|---|
| SubDescriptors | StrongRef | 8+16 | Instance UID of AVC Sub Descriptor |
| Linked Track ID | UInt32 | 4 | Track ID of the Picture Track |
| Sample Rate | Rational | 8 | 59.94p: 60000, 1001<br>50p: 50,1<br>29.97p: 30000,1001<br>25p: 25,1<br>24p: 24,1<br>23.98p: 24000,1001 |
| Container Duration | Length | 8 | Number of frames present |
| Essence Container | UL | 16 | 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01 |
| Frame Layout | Uint8 | 1 | 0 |
| Stored Width | Uint32 | 4 | 2048 |
| Stored Height | Uint32 | 4 | 1080 |
| Aspect Ratio | Rational | 8 | 256,135 |
| Video Line Map | Array of Int32 | 8+8 | 42,0 |
| Picture Essence Coding | UL | 16 | See Table 19 |
| Component Depth | UInt32 | 4 | 10 |
| Horizontal Subsampling | UInt32 | 4 | 2 |
| Vertical Subsampling | UInt32 | 4 | 1 |

**Table 16 – Item values of RGBA Picture Essence Descriptor for AVC Intra 2K 4:4:4**

| Item Name | Type | Len | Value in this RDD |
|---|---|---|---|
| SubDescriptors | StrongRef | 8+16 | Instance UID of AVC Sub Descriptor |
| Linked Track ID | UInt32 | 4 | Track ID of the Picture Track |
| Sample Rate | Rational | 8 | 59.94p: 60000,1001,<br>50p: 50,1<br>29.97p: 30000,1001<br>25p: 25,1<br>24p: 24,1<br>23.98p: 24000,1001 |
| Container Duration | Length | 8 | Number of frames present |
| Essence Container | UL | 16 | 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01 |
| Frame Layout | Uint8 | 1 | 0 |
| Stored Width | Uint32 | 4 | 2048 |
| Stored Height | Uint32 | 4 | 1080 |
| Aspect Ratio | Rational | 8 | 256,135 |
| Video Line Map | Array of Int32 | 8+8 | 42,0 |
| Picture Essence Coding | UL | 16 | See Table 19 |
| PixelLayout | RGBALayout | 16 | RGB 12 bit:<br>{‘B’,12,‘G’,12,‘R’,12,0,0,0,0,0,0,0,0,0,0}<br>42.0C.47.0C.52.0C.00.00.00.00.00.00.00.00.00.00 |

**Table 17 – Item values of CDCI Picture Essence Descriptor for AVC Intra 4K 4:2:2**

| Item Name | Type | Len | Value in this RDD | |
|---|---|---|---|---|
| | | | 3840 x 2160 | 4096 x 2160 |
| SubDescriptors | StrongRef | 8+16 | Instance UID of AVC Sub Descriptor | |
| Linked Track ID | UInt32 | 4 | Track ID of the Picture Track | |
| Sample Rate | Rational | 8 | 59.94p: 60000,1001<br>50p: 50,1<br>29.97p: 30000,1001<br>25p: 25,1<br>24p: 24,1 (only for 4096 x 2160)<br>23.98p: 24000,1001 | |
| Container Duration | Length | 8 | Number of frames present | |
| Essence Container | UL | 16 | 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01 | |
| Frame Layout | Uint8 | 1 | 0 | |
| Stored Width | Uint32 | 4 | 3840 | 4096 |
| Stored Height | Uint32 | 4 | 2160 | |
| Aspect Ratio | Rational | 8 | 16,9 | 256,135 |
| Video Line Map | Array of Int32 | 8+8 | 42,0 | |
| Picture Essence Coding | UL | 16 | See Table 19 | |
| Component Depth | UInt32 | 4 | 10 | |
| Horizontal Subsampling | UInt32 | 4 | 2 | |
| Vertical Subsampling | UInt32 | 4 | 1 | |

**Table 18 – Item values of RGBA Picture Essence Descriptor for AVC Intra 4K 4:4:4**

| Item Name | Type | Len | Value in this RDD | |
|---|---|---|---|---|
| | | | 3840 x 2160 | 4096 x 2160 |
| SubDescriptors | StrongRef | 8+16 | Instance UID of AVC Sub Descriptor | |
| Linked Track ID | UInt32 | 4 | Track ID of the Picture Track | |
| Sample Rate | Rational | 8 | 29.97p: 30000,1001<br>25p: 25,1<br>24p: 24,1 (only for 4096 x 2160)<br>23.98p: 24000,1001 | |
| Container Duration | Length | 8 | Number of frames present | |
| Essence Container | UL | 16 | 06.0E.2B.34.04.01.01.0A.0D.01.03.01.02.10.60.01 | |
| Frame Layout | Uint8 | 1 | 0 | |
| Stored Width | Uint32 | 4 | 3840 | 4096 |
| Stored Height | Uint32 | 4 | 2160 | |
| Aspect Ratio | Rational | 8 | 16,9 | 256,135 |
| Video Line Map | Array of Int32 | 8+8 | 42,0 | |
| Picture Essence Coding | UL | 16 | See Table 19 | |
| PixelLayout | RGBALayout | 16 | RGB 12 bit :<br>{‘B’,12,‘G’,12,‘R’,12,0,0,0,0,0,0,0,0,0,0}<br>42.0C.47.0C.52.0C.00.00.00.00.00.00.00.00.00.00 | |

**Table 19 – Picture Essence Coding Label for AVC Intra VBR**

| Codec type | UL |
|---|---|
| AVC Intra 2K 4:2:2<br>AVC Intra 4K 4:2:2 | 06.0E.2B.34.04.01.01.0A.04.01.02.02.01.32.30.01<br>H.264/MPEG-4 AVC High 4:2:2 Intra Profile<br>Unconstrained Coding |
| AVC Intra 4:4:4<br>AVC Intra 2K 4:4:4<br>AVC Intra 4K 4:4:4 | 06.0E.2B.34.04.01.01.0D.04.01.02.02.01.32.50.01<br>H.264/MPEG-4 AVC CAVLC 4:4:4 Intra Profile<br>Unconstrained Coding |

**Table 20 – Item values of AVC Sub Descriptor for AVC Intra VBR**

| Item Name | Type | Len | Value in this RDD |
|---|---|---|---|
| AVC Decoding Delay | UInt8 | 1 | 0 |
| AVC Constant B Picture Flag | Boolean | 1 | Not implemented |
| AVC Coded Content Kind | Enum | 1 | 1 (Frame picture, Frame coding) |
| AVC Closed GOP Indicator | Boolean | 1 | Not implemented |
| AVC Identical GOP Indicator | Boolean | 1 | Not implemented |
| AVC Maximum GOP Size | UInt16 | 2 | Not implemented |
| AVC Maximum B-Picture Count | UInt16 | 2 | Not implemented |
| AVC Maximum BitRate | UInt32 | 4 | Maximum bit rate |
| AVC Average BitRate | UInt32 | 4 | Average bit rate throughout the stream |

| Item Name | Type | Len | Value in this RDD | |
|---|---|---|---|---|
| AVC Profile | UInt8 | 1 | 4:2:2: 122 (High 4:2:2 Intra profile)<br>4:4:4: 44 (CAVLC 4:4:4 Intra profile) | |
| AVC Profile Constraint | UInt8 | 1 | 10h (Intra profile) | |
| AVC Level | UInt8 | 1 | AVC Intra 4:4:4 | 59.94p, 50p: 50 (Level 5)<br>29.97p, 25p, 24p, 23.98p: 41(Level 4.1) |
| | | | AVC Intra 2K 4:2:2 | 42 (Level 4.2) |
| | | | AVC Intra 2K 4:4:4 | 59.94p, 50p: 50 (Level 5)<br>29.97p, 25p, 24p, 23.98p: 42(Level 4.2) |
| | | | AVC Intra 4K 4:2:2 | 52 (Level 5.2) |
| | | | AVC Intra 4K 4:4:4 | 52 (Level 5.2) |
| AVC Sequence Parameter Set Flag | UInt8 | 1 | See Table 21 | |
| AVC Picture Parameter Set Flag | UInt8 | 1 | See Table 22 | |

**Table 21 – AVC Sequence Parameter Set Flag for AVC Intra VBR**

| Bit number | Name | Value in this RDD |
|---|---|---|
| 7 | Constancy flag | Specifies whether all sequence parameter sets are constant<br>0: unknown<br>1: constant |
| 6-4 | In-band location | 2: Every access unit in the stream |
| 3-0 | reserved | 0 |

**Table 22 – AVC Picture Parameter Set Flag for AVC Intra VBR**

| Bit number | Name | Value in this RDD |
|---|---|---|
| 7 | Constancy flag | Specifies whether all picture parameter sets are constant<br>0: unknown<br>1: constant |
| 6-4 | In-band location | 2: Every access unit in the stream |
| 3-0 | reserved | 0 |

### 8.2.3 Essence Descriptor for Audio essence

The constraint item values of the Essence Descriptors for Audio essence shall be as given in Table 23. Type and Len fields are specified in SMPTE ST 377-1 and SMPTE ST 382.

**Table 23 – Item values of AES3 Audio Essence Descriptor**

| Item Name | Type | Len | Value in this RDD |
|---|---|---|---|
| Linked Track ID | UInt32 | 4 | Track ID of each Sound Track |
| Sample Rate | Rational | 8 | 48 kHz: 48000,1<br>96 kHz: 96000,1 |
| Container Duration | Length | 8 | Created by the application |
| Essence Container | UL | 16 | 06.0E.2B.34.04.01.01.05.0D.01.03.01.02.06.0B.00 |
| Audio sampling rate | Rational | 8 | 48 kHz: 48000,1<br>96 kHz: 96000,1 |
| Locked/Unlocked | Boolean | 1 | 1: Locked |
| ChannelCount | Uint32 | 4 | 1 |
| Quantization bits | Uint32 | 4 | 16 bits: 16<br>24 bits: 24 |
| Block Align | Uint16 | 2 | 16 bits: 2<br>24 bits: 3 |
| Average Bytes Per Second | Uint32 | 4 | 48 kHz, 16 bits: 96000<br>48 kHz, 24 bits: 144000<br>96 kHz, 16 bits: 192000<br>96 kHz, 24 bits: 288000 |

Note: This Descriptor is required for each audio track.

# 9 Index Table

## 9.1 General

Index Table Segment shall be generated respectively for the Essence Container in each Body Partition and shall be placed in the separate Partition immediately following the essence they index. The Footer Partition may contain the complete Index Table that includes all the Index Table Segments in the Body. Figure 5 illustrates the relation between the Index Table Segment and the Essence Container in each Body Partition.

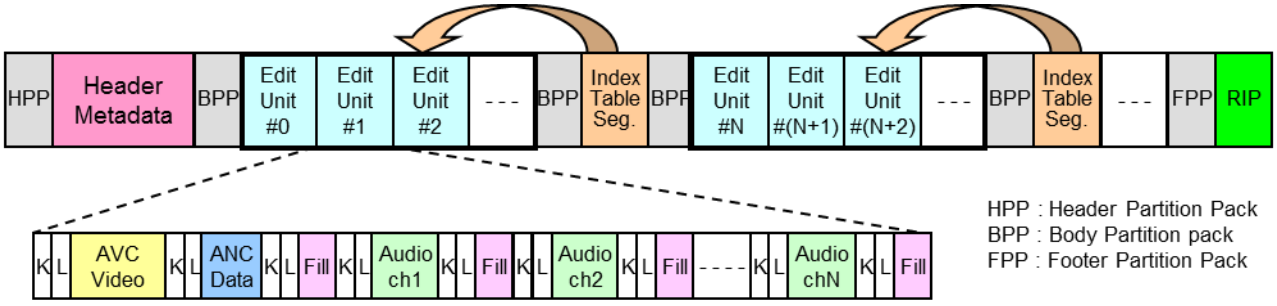


**Figure 5 – Essence Container and respective Index Table Segment**

## 9.2 Index Table Segment

### 9.2.1 Index Table Segment for video essence

The item values of Index Table Segment Set shall be as given in Table 24.

Index Edit Rate shall be frame rate.

The Delta Entry Array shall be used to provide the byte offset for the start of each essence Element within a Content Package.

Table 25 gives the structure of Delta Entry Array when there are four audio channels.

The Index Entry Array shall be used to provide the byte offset for the start of each Edit Unit and shall be as given in Table 26.

Figure 6 illustrates the item values in the Delta Entry Array and the Index Entry Array.

**Table 24 – Item values of Index Table Segment Set**

| Item Name | Type | Len | Value in this RDD |
|---|---|---|---|
| Index Edit Rate | Rational | 8 | Frame rate |
| Index Start Position | Position | 8 | Total number of Edit Units included in the Partitions preceding this Partition |
| Index Duration | Length | 8 | Number of Edit Units in this Partition |
| Edit Unit Byte Count | Uint32 | 4 | 0: Byte count of Edit Unit is variable and is given by the Index Entry Array |
| Delta Entry Array | Array of DeltaEntry | var | See Table 25 |
| Index Entry Array | Array of IndexEntry | var | See Table 26 |

**Table 25 – Structure of Delta Entry Array**

| | Item Name | Type | Len | Value in this RDD |
|---|---|---|---|---|
| | NDE | UInt32 | 4 | 6 |
| | Length | UInt32 | 4 | 6 |
| Picture Delta Entry | PostTableIndex | Int8 | 1 | -1 Apply temporal reordering |
| | Slice | UInt8 | 1 | 0 |
| | Element delta | UInt32 | 4 | 0 |
| Data Delta Entry | PostTableIndex | Int8 | 1 | 0 No temporal reordering |
| | Slice | UInt8 | 1 | 1 |
| | Element delta | UInt32 | 4 | 0 |
| Sound 1 Delta Entry | PostTableIndex | Int8 | 1 | 0 No temporal reordering |
| | Slice | UInt8 | 1 | 1 |
| | Element delta | UInt32 | 4 | Delta from start of slice to this Element |
| Sound 2 Delta Entry | PostTableIndex | Int8 | 1 | 0 No temporal reordering |
| | Slice | UInt8 | 1 | 1 |
| | Element delta | UInt32 | 4 | Delta from start of slice to this Element |
| Sound 3 Delta Entry | PostTableIndex | Int8 | 1 | 0 No temporal reordering |
| | Slice | UInt8 | 1 | 1 |
| | Element delta | UInt32 | 4 | Delta from start of slice to this Element |
| Sound 4 Delta Entry | PostTableIndex | Int8 | 1 | 0 No temporal reordering |
| | Slice | UInt8 | 1 | 1 |
| | Element delta | UInt32 | 4 | Delta from start of slice to this Element |

**Table 26 – Structure of Index Entry Array**

| | N | Item Name | Type | Len | Value in this RDD |
|---|---|---|---|---|---|
| | 1 | NIE | UInt32 | 4 | Equal to number of frames |
| | 1 | Length | UInt32 | 4 | 15 |
| One Index Entry for each frame | NIE | Temporal Offset | Int8 | 1 | Set according to AVC Picture type |
| | | Key Frame Offset | Int8 | 1 | Set according to AVC Picture type |
| | | Flags | EditUnitFlag | 1 | See Table 27 and Table 28 |
| | | Stream Offset | UInt64 | 8 | Offset in bytes from the first byte of the key of the first Picture Element to the first byte of the key of each Picture element |
| | | Slice Offset | NSL x UInt32 | 4 | Offset in bytes from the Stream Offset to the start of this Slice |

**Table 27 – Settings of Flags properties for AVC Long GOP**

| Bit | Meaning | Value in this RDD |
|---|---|---|
| Bit 7 | Random Access | Set to one for IDR Picture |
| Bit 6 | Sequence Parameter Set | Set to one if sequence parameter set exists |
| Bits 5,4 | Forward/backwards prediction flag | Naïve setting:<br>00: I Picture (No prediction)<br>10: P Picture (Forward prediction)<br>11: B Picture (Forward or Backward or Forward and Backward) |
| Bit 3 | Offsets out of range | 0 |
| Bits 2-0 | AVC picture type | 000: I Picture<br>100: IDR Picture<br>110: P Picture<br>011: B Picture<br>111: Br Picture |

**Table 28 – Settings of Flags properties for AVC Intra VBR**

| Bit | Meaning | Value in this RDD |
|---|---|---|
| Bit 7 | Random Access | 1 |
| Bit 6 | Sequence Parameter Set | 1 |
| Bits 5,4 | Forward/backwards prediction flag | 00: I Picture (No prediction) |
| Bit 3 | Offsets out of range | 0 |
| Bits 2-0 | AVC picture type | 100: IDR Picture |

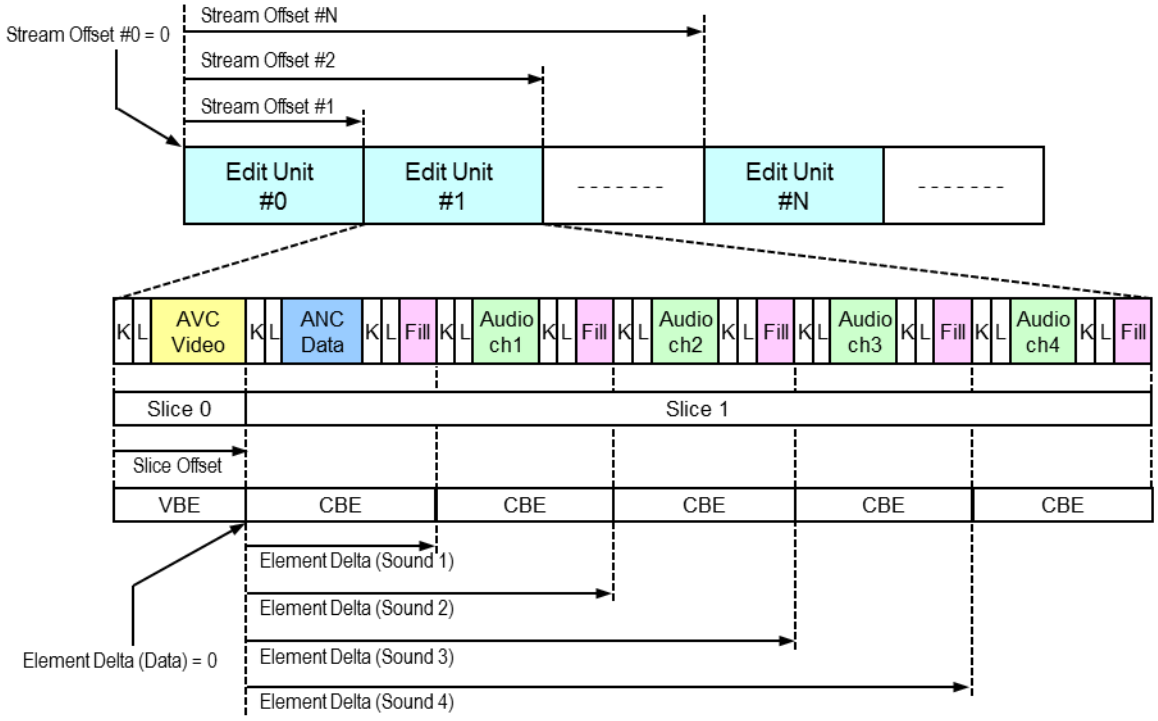


**Figure 6 – Item values in Delta Entry Array and Index Entry Array**

## 10 Random Index Pack (RIP)

The Random Index Pack (RIP) shall be present at the Footer to provide byte offset for all Partitions. Note that the unique usage of body Partitions means that the BodySID value in the RIP will indicate which Partitions contain Essence and which contain Index Table Segments.

## 11 Alignment

KAG size shall be KLV Alignment Grid of 4.

Each Essence Element shall be 4-byte aligned. The Sound Essence Element in the last Body Partition for each audio essence needs not be 4-byte aligned and may be followed by the KLV Fill item.

Each Index Table Segment followed by the KLV Fill item as needed shall be 4-byte aligned.

## Annex A Bibliography (Informative)

SMPTE RP 210, Metadata Element Dictionary

SMPTE RP 224, SMPTE Labels Register

SMPTE RDD 26:2015, MXF OP-1b specification for AVC with Chunk Audio

AVC-ULTRA White paper http://pro-av.panasonic.net/en/sales_o/p2/AVC-ULTRAoverview.pdf