# SMPTE RECOMMENDED PRACTICE

RP 2008-2008
Revision of
RP 2008-2007

# Material Exchange Format — Mapping AVC Streams into the MXF Generic Container



## Table of Contents





Approved February 13, 2008

## Foreword

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

SMPTE Engineering Documents are drafted in accordance with the rules given in Part XIII of its Administrative Practices.

SMPTE RP 2008 was prepared by Technology Committee W25.

# 1 Scope

This document specifies the mapping of all AVC coding data as defined in ISO/IEC 14496-10 | ITU-T Rec. H.264 into the Material Exchange Format Generic Container (MXF-GC) based on the MXF MPEG mapping standard (SMPTE 381M)

The MXF specification is written in several parts. This is one of a set of documents that define the contents of the MXF File Body.

In order to achieve interoperability within any given Operational Pattern, restrictions may be placed on the way in which this Generic Container type can be implemented. The reader is advised to carefully study the appropriate Operational Pattern document before implementation.

# 2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

# 3 Normative References

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

ISO/IEC 14496-10:2005, Information Technology — Coding of Audio-Visual Objects – Part 10: Advanced Video Coding or ITU-T Recommendation H2.64 — Advanced Video Coding for Generic Audio-Visual Services

SMPTE 377M-2004, Television — Material Exchange Format (MXF) – File Format Specification

SMPTE 379M-2004, Television — Material Exchange Format (MXF) – MXF Generic Container

SMPTE 381M-2005, Television — Material Exchange Format (MXF) – Mapping MPEG Streams into the MXF Generic Container

# 4 Symbols and Abbreviations

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

AVC Advanced Video Coding — ISO/IEC 14496-10 (Part 10) I ITU-T Rec. H.264

NAL Network Abstraction Layer

# 5 Introduction (Informative)

## 5.1 AVC Coding Summary

The AVC (Advanced Video Coding) standard defined in the ISO/IEC 14496-10 | ITU-T Rec. H.264 has been developed as an advanced high performance compression technology. In the AVC coding streams, the bit stream can be in one of two formats: the NAL unit stream or the byte stream.

The NAL unit stream format consists of a sequence of NAL unit syntax structures.

The byte stream format can be constructed from the NAL unit stream format by ordering the NAL units in decoding order and prefixing each NAL unit with a start code prefix and zero or more zero-valued bytes to form a stream of bytes.

## 5.2 Requirements of Mapping AVC Streams into MXF

The specification on the MXF AVC mapping was developed using a number of fundamental requirements. These requirements are the following:

- The mapping needs to support the NAL unit stream format and the byte stream format.
- AVC streams need to be wrapped using the MPEG picture element key as defined in SMPTE 381M.
- The Picture Element can contain all variants of AVC coding streams using frame-wrapping or clip-wrapping.
- As is stated by SMPTE 381M, full details of the precise AVC stream needs to be specified in the Essence Descriptor and AVC coding variants need to be specified in the Picture Essence Compression Label.

This document provides the specification, which meets the above requirements for the MXF mapping of the AVC streams. This document constrains the options available in SMPTE381M to provide the targeted AVC mapping.

Note: The transport of the AVC data stream using MPEG-2 Systems is specified in ISO/IEC 13818-1:2000 Amendment 3. Therefore, an MPEG transport stream or an MPEG program stream, which contains the AVC video data can be also wrapped using the MPEG Data element as described in SMPTE 381M, Section 4.2.

# 6 Mapping the AVC Streams to the MXF Generic Container

The mapping of the AVC stream shall use the MXF Generic Container in either the Frame-based wrapping or Clip-based wrapping as defined in SMPTE 379M.

# 7 Key-Length-Value Coding

## 7.1 Essence Element Key

AVC streams shall be wrapped using the MPEG picture element key as defined in SMPTE 381M. The values of the first 12 bytes of the essence element Key are defined in SMPTE 379M. The values of the last four bytes of the Picture Element Key are given in Table 1.

**Table 1 – Key Value for the MPEG Picture Element** (Informative)

| Byte No. | Description | Value (hex) | Meaning |
|---|---|---|---|
| 1-12 | Specified by the MXF Generic Container Specification SMPTE379M | | |
| 13 | Item Type Identifier | 15h | GC Picture Item as defined in SMPTE 379M |
| 14 | Essence Element Count | kkh | Count of Picture Elements in this Item |
| 15 | Essence Element Type | 05h<br>06h | Frame Wrapped Picture Element<br>Clip 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 379M |

## 7.2 Essence 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. The length field of the KLV coded Element shall be 8 bytes BER long-form encoded (i.e., 87h.aa.bb.cc.dd.ee.ff.gg) for Clip wrapping.

## 7.3 Essence Element Value

The Essence Element Values shall be the AVC NAL unit stream or the AVC byte stream. The bit streams carried in the Value field shall contain complete NAL units including its relevant Parameter Sets, other Supplementary Enhancement Information (SEI) and padding zeroes.

NOTE – Stream format is defined in the Byte 14 of the Essence Container Label described in section 8.1.

# 8 SMPTE Label Values

## 8.1 Essence Container Label

This Essence Container Label is the individual ‘Essence Container’ property used in the Partition Pack, in the Preface Set and in the appropriate File Descriptor.

The values of the Essence Container Label for the AVC coding are defined in SMPTE 381M as shown in Table 2.

**Table 2 – Specification of the AVC Essence Container Label** (Informative)

| Byte No. | Description | Value (hex) | Meaning |
|---|---|---|---|
| 1-12 | Defined by Generic Container | | |
| 13 | Essence Container Kind | 02h | MXF Generic Container |
| 14 | Mapping Kind | 07h<br>08h<br>09h<br>0Fh<br>10h | MPEG PES<br>MPEG PS<br>MPEG TS<br>AVC NAL unit stream<br>AVC byte stream |
| 15 | Locally defined | xxh | As defined in SMPTE 381M |
| 16 | Locally defined | yyh | As defined in SMPTE 381M |

Byte 14 identifies the container as the MPEG mapping into the Generic Container. The value of byte 14 shall be set to 0Fh for the AVC NAL unit stream and 10h for the AVC byte stream.

When the AVC byte stream is carried using MPEG PES, PS and TS, the value of byte 14 shall be set to 07h, 08h and 09h respectively. In this case, the AVC stream should be specified in the Picture Essence Compression Label.

### 8.2 Picture Essence Compression Label

The Picture Essence Compression Label is used in the Generic Picture Essence Descriptor. The values for the Picture Essence Compression Label for the AVC are given in Table 3. These Label values are listed in the SMPTE Labels Registry, RP 224.

**Table 3 – Specification of the Picture Essence Compression Label**

| Byte No. | Description | Value (hex) | Meaning |
|---|---|---|---|
| 1-8 | Registry Designator | See SMPTE 400M | Designator value is defined in SMPTE 400M |
| 9 | Parametric | 04h | Node used to define parametric data |
| 10 | Picture Essence | 01h | Identifies picture essence coding |
| 11 | Picture Coding Characteristics | 02h | Identifies picture coding characteristics |
| 12 | Compressed Picture Coding | 02h | Identifies compressed picture coding |
| 13 | MPEG Picture Coding | 01h | Identifies MPEG picture coding |
| 14 | AVC Picture Coding and Profile Category | 3xh | Identifies AVC picture coding by setting bit [7..4] to the value of '3h' as listed in SMPTE RP 224<br><br>Identifies Profile category for AVC using bit [3..0] as listed in SMPTE RP 224 |
| 15 | AVC Profile Constraints | xxh | Identifies Profile and its constraints for AVC as listed in SMPTE RP 224 |
| 16 | AVC Coding variants | yyh | Identifies variants of AVC coding as listed in SMPTE RP 224 |

Byte 14 identifies the AVC picture coding and Profile category.

Byte 15 identifies the Profile and its constraints of the AVC picture coding. A value of '0h' of bit [3..0] shall indicate a generic application that has no coding constraints.

Byte 16 identifies details of the AVC coding variants. The values of byte 16 shall be defined depending on the value of byte 15. When bit [3..0] of byte 15 indicates a generic application, the value of byte 16 shall be set to '01h'.

## 9 Essence Descriptor for AVC Mapping

Picture Essence tracks that use the AVC essence mapping shall use the values of the MPEG video descriptor as defined in SMPTE 381M.

## 10 Index Table for AVC Mapping (Informative)

The Index Table should be implemented according to the recommendation described in SMPTE 381M.

In clip wrapping mode, the Index Table points to the first byte of the AVC streams.

In frame wrapping mode, the Index Table points to the first byte of the Key in the KLV.

## **Annex A** (Informative)
## **Bibliography**

SMPTE 336M-2007, Television — Data Encoding Protocol Using Key-Length-Value

SMPTE 400M-2004, Television — SMPTE Labels Structure

SMPTE RP 224, SMPTE Labels Registry

## Revision Notes

This version incorporates Amendment #1 to SMPTE RP 2008 approved February 13, 2008. The purpose of this revision is to update byte 14 and byte 15 of table 3 in Section 8.2 in order to better accommodate current and future AVC profiles. The changes are summarized below:

1. Revised Byte No. 14 in Table 3 in Section 8.2 and the three paragraphs following the table.

2. Updated the SMPTE 336M reference in Annex A, Bibliography.