

VRT - Application specification for HD-AVC-intra 100

Name: AS-VRT-AVC-intra 100-Core

This document describes the core MXF application specification for the VRT DMF AVC Intra 100 format. It defines the fundamental restrictions of the MXF format in the context of HD.

1. Operational pattern constraints

AS-VRT-AVC-intra 100-Core files shall comply with MXF Operational Pattern **OP1a** and shall be labeled as such in the Preface Set.

2. Essence constraints

Essence container

The MXF Constrained Generic Container **SMPTE 379-2:2010** shall be used.

The mapping of compressed picture data according to **SMPTE RP 2027:2011** (AVC-intra Class 100 1080i/25; SPS/PPS (sequence parameter set and picture parameter set) present for every frame) and 2,4,8 or 16 mono AES3 audio tracks as defined in **SMPTE 381-3:2013 and SMPTE 382M:2007**.

Essence shall be frame-wrapped and each content package shall contain an interleave of system, picture and sound items, aggregating all video and audio essence. These items shall consist of the following:

System Item

- System Item: Shall be present (SMPTE st326:2000 and st385:2004), includes System Metadata Pack and Package Metadata Set.

Picture Item

The video essence container has one label:

- MXF-GC AVC Byte Stream With VideoStream-0 SID Frame-wrapped (06.0e.2b.34.04.01.01.0a.0d.01.03.01.02.10.60.01)

The picture essence has element key:

- MXF Generic Container Version 1 SMPTE 381M MPEG Frame-Wrapped Picture Essence (key = 06.0e.2b.34.01.02.01.01.0d.01.03.01.15.01.05.00)

Sound Item

The audio essence container has one label:

- MXF-GC Frame-wrapped AES3 audio data (06.0e.2b.34.04.01.01.01.0d.01.03.01.02.06.03.00)

The sound item consists of “x” sound elements (x being the number of mono audio tracks; in increasing track order), each element has an element key:

- MXF Generic Container Version 1 SMPTE 382M AES Frame-wrapped Sound Essence, "x" depends on the audio track. (06.0e.2b.34.01.02.01.01.0d.01.03.01.16.08.03.0x)

Optional KLV fill item.

Timecode System Item shall be present and identical with the TC of Source Package.

Video format (CDCIEssenceDescriptor)

PictureEssenceCoding shall be H.264/MPEG-4 AVC High 422 Intra RP2027

Constrained Class 100 1080/50i Coding

(06.0e.2b.34.04.01.01.0a.04.01.02.02.01.32.31.02).

Aspect ratio and Active Format Descriptor

The Aspect Ratio shall be: 16:9. The Active Format Descriptor shall be present and shall indicate 'full format', 'pillar box', 'letter box' or 'undefined'. The value shall be as correct as possible: if set to 'pillar box' or 'letter box', the video essence shall match.

Audio format (AES3AudioEssenceDescriptor)

There are 2, 4, 8 or 16 sound elements in the MXF GC sound item. Audio shall be 48 kHz, 24 bit linear AES3, one mono track per AES sound element.

Sound Essence Coding shall be PCM Uncompressed Sound Coding, Undefined Sound Coding (06.0e.2b.34.04.01.01.01.04.02.02.01.7f.00.00.00).

The ChannelCount should be correctly indicated, ChannelCount = 1.

QuantizationBits shall be correctly indicated, the number of QuantizationBits shall be 24.

3. Header metadata constraints

Material Package

The Material Package shall contain 1 Timecode Track, 1 Video Track, 16 Audio Tracks.

The track order shall be the same as defined for tracks in the source package. 1

Source Package

The Source Package shall contain 1 Timecode Track, 1 Video Track, 16 Audio Tracks.

The track order shall be the same as defined for tracks in the source package. 1

Partitions

There shall be a Header partition, the complete Essence in one Body partition and a Footer partition.

Header partition status:

- Closed, Complete (preferred) / Closed, Incomplete / Open, Incomplete

Body Partition Status:

- Closed, Complete

Body Partition duration:

- Variable (shall be equal to the duration of the Essence)

Footer partition status:

- Closed, Complete

Index tables

Index table location:

- The Index Table segment shall be located in the Header Partition (Forward Indexing)

Index table repetition

- May be present in footer partition

General

- a random index pack shall be present and indicated
- Is RIP Present True (Amendment 2:2012 to SMPTE st377-1:2011)
- Dark as well as descriptive data shall not be present.

4. Time code constraints

The time code (StartTimeCode, Duration) of the Material Package shall correspond to the time code of the Source Package.

The durations in the Header Metadata shall correspond to the number of frames in the Essence Container.

There shall only be one Timecode component on the Timeline Track of the Source and the material Package. The time code of the source package shall be continuous, it will be equal to the time code of the material package.

The start value of time code in the System Item of the Essence Container shall correspond to the StartTimeCode of Material Package and Source Package.

5. MXF Conformance errors

MXF files claiming to be compliant with this specifications shall return no errors when tested using MXF analyzer TM with IRT application specification profile.

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Header Partition (closed/complete or closed/incomplete or open/incomplete; KAG Size 1)

MXF Header Metadata

Index Table Segment

KLV Fill Item
(minimum 2MB)

Body Partition

Essence Container (Frame Wrapped)

Content Package (1 per Video Frame)

System Item
(containing System Metadata Pack and Package Metadata Set)

Picture Item
Picture Element
AVC High 422 Intra RP2027 Constrained Class 100 1080/50i Coding
(SPS and PPS in every frame)

Sound Item
Sound Element 1 (= AudioTrack 1)
Uncompressed Sound Coding, Undefined Sound Coding
(PCM 24bit 48kHz)
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Sound Element n (= AudioTrack n)
Uncompressed Sound Coding, Undefined Sound Coding
(PCM 24bit 48kHz)

KLV Fill Item
(optional)

Footer Partition

MXF Header Metadata (if Header Partition Status incomplete)

RIP

Schematic MXF file layout (non-normative)

Property Name	Property Specification
Profile short description	
Type	MXF OP1a / AVC-I 100
MXF structure	Header partition, complete Essence in one Body partition, Footer partition
Essence Mapping	According to SMPTE st381-3:2013 and SMPTE st382:2007
Generic Container	Frame-based mapping according to SMPTE 379-2:2010
Video Coding Syntax	AVC-I 100 (according to RP2027:2011, Class 100 Specification using the High 4:2:2 Intra Profile)
Scanning raster	1080i/25
Audio	16 AES Audio Tracks (containing PCM or Dolby-E)

General	
File format	MXF (SMPTE st377-1:2011) - Version 1.3
Operational Pattern	OP1a (SMPTE st378:2004)
Is RIP Present (Amendment 2:2012 to SMPTE st377-1:2011)	True
Header Partition Status	Closed, Complete (preferred) / Closed, Incomplete / Open, Incomplete
Body Partition Status	Closed, Complete
Body partition duration	Variable (shall be equal to the duration of the Essence)
Footer Partition Status	Closed, Complete
KAG Size	1 (consistent for all Partition Packs)
KLV fill items	Shall be present: - at least one KLV Fill Item of >= 2 MB, after Header Metadata in Header Partition.
System Item	Shall be present (SMPTE st326:2000 and st385:2004) includes System Metadata Pack and Package Metadata Set
Essence location	No Essence in Header Partition. Complete Essence in one Body Partition.
Index table location	The Index Table segment shall be located in the Header Partition (Forward Indexing)
Index table repetition	May be present in footer partition
Header Metadata Location	Header Metadata shall be located in the Header Partition. If the Header Partition Status is "Open, incomplete" or "Closed, incomplete" (e.g. update needed because of "on the fly generation") they shall be completed ("Closed, completed") in Footer Partition.
Descriptive Metadata	Shall not be present
Random Index Pack	Shall be present

Essence Elements in Essence Container	Shall be in the order: System Item, Picture Item, Sound Item. The Sound Elements within the Sound Item shall be in the order: Audio Essence Element 1, [...], Audio Essence Element 16. ¹
Tracks in Material Package	The Material Package shall contain 1 Timecode Track, 1 Video Track, 16 Audio Tracks. The track order shall be the same as defined for tracks in the source package. ¹
Tracks in Source Package	The Source Package shall contain 1 Timecode Track, 1 Video Track, 16 Audio Tracks. The track order shall match with the order of the essence elements in the essence container. ¹
Timecode Material Package	Shall be present
Timecode Source Package	Shall be present (it shall not be static)
Timecode System Item	Shall be present and identical with the TC of Source Package

¹ In order to have the possibility to link an audio track to an external channel assignment (e.g. from Technical Production Guidelines).

Index Table Segment Set	
Index Edit Rate	25 / 1
Index Start Position	0
Index Duration	0
Edit Unit Byte Count	Constant (within the MXF file)
Slice Count	0
Single Index Location	True
Single Essence Location	True
Forward Index Direction	True
Delta Entry Array	Shall be present and complete

Timeline Track	
Edit Rate	25 / 1
Origin (Pre-Charge)	0

Video	
Essence Container Label (Video essence mapping)	06.0e.2b.34.04.01.01.0a.0d.01.03.01.02.10.60.01 (= MXF-GC AVC Byte Stream With VideoStream-0 SID Frame-wrapped)
Picture Element Key	06.0e.2b.34.01.02.01.01.0d.01.03.01.15.01.05.00 (= MXF Generic Container Version 1 SMPTE 381M MPEG Frame-Wrapped Picture Essence)
CDCI Descriptor	
Picture Essence Coding	06.0e.2b.34.04.01.01.0a.04.01.02.02.01.32.31.02 (= H.264/MPEG-4 AVC High 422 Intra RP2027 Constrained Class 100)

	1080/50i Coding)
Aspect Ratio	16 : 9
Sample Rate	25 / 1
Container Duration	Shall be present and identical with audio Container Duration.
Field Dominance	1 (= Field 1 is first in temporal order)
Signal Standard	4 (= HD422 1920x1080, 23.98p/25p/29.97p/50i/59.94i)
Frame Layout	1 (= separate_fields)
Display Width x Display Height	1920 x 540
Sample Width x Sample Height	1920 x 540
Stored Width x Stored Height	1920 x 544
Stored F2 Offset	0
Sampled X Offset	0
Sampled Y Offset	0
Display X Offset	0
Display Y Offset	0
Display F2 Offset	0
Active Format Descriptor	Shall be present (full format, pillar box, letter box, undefined)
Video Line Map	21, 584 (= for Interlace)
Transfer Characteristic / Capture Gamma	06.0e.2b.34.04.01.01.01.04.01.01.01.01.02.00.00 (= ITU-R BT 709; HD color triangle, gamma etc)
Image Start Offset	0
Color Siting	0 (= coSiting as in ITU-R Rec 601)
Padding Bits	0
Black Ref Level	64
White Ref Level	940
Color Range	897
Horizontal Subsampling	2 (= 4:2:2)
Vertical Subsampling	1 (= 4:2:2)
Component Depth	10 bit
SubDescriptor	Reference to AVC Sub Descriptor (see below)
AVC Sub Descriptor (st 381-3:2013)	
AVC Decoding Delay	0
AVC Coded Content Kind	Shall be present
AVC Identical GOP Indicator	True
AVC Maximum GOP Size	1

AVC Maximum B Picture Count	0
AVC Maximum Bitrate	ca. 112 Mbit/s (according to RP 2027:2012)
AVC Average Bitrate	ca. 112 Mbit/s (according to RP 2027:2012)
AVC Profile	122 (= High 4:2:2 Intra)
AVC Profile Constraint	<i>binary value: 0001 0000 (signals conformance to the "High 4:2:2 Intra" encoding profile and it's constraints. See ISO-IEC 14496-10 2010)</i>
AVC Level	41 (= Level 4.1)
AVC Sequence Parameter Set Flag	<i>binary value: 1010 0000 (= is present in every frame)</i>
AVC Picture Parameter Set Flag	<i>binary value: 1010 0000 (= is present in every frame)</i>

Audio	
Essence Container Label (Audio essence mapping)	06.0e.2b.34.04.01.01.01.0d.01.03.01.02.06.03.00 (= MXF-GC Frame-wrapped AES3 audio data)
Sound Element Key	06.0e.2b.34.01.02.01.01.0d.01.03.01.16.08.03.0x (= MXF Generic Container Version 1 SMPTE 382M AES Frame-wrapped Sound Essence, "x" depends on the audio track)
Audio channels per Sound Element	One channel per AES Sound Element.
Audio Descriptor (AES3AudioEssenceDescriptor, st382:2007)	
Sound Essence Coding / Sound Essence Compression	PCM (default): 06.0e.2b.34.04.01.01.01.04.02.02.01.7f.00.00.00 (= Uncompressed Sound Coding, Undefined Sound Coding) Dolby-E: 06.0E.2B.34.04.01.01.01.04.02.02.02.03.02.1C.00 (= Dolby-E Compressed Audio)
Sample Rate	48000 / 1
Container Duration	Shall be present and identical with video Container Duration
Audio sampling rate	48000 / 1
Locked/Unlocked	1 (= locked)
Dial Norm	If available the correct gain to be applied to normalize perceived loudness of the clip, defined by ITU-R BS.1196-2:2010
Audio Ref Level	If the value is known it shall be present
Channel Count	1
Quantization bits	24
Block Align	3 (= 24 Bit)
Average Bytes per Second (AvgBps)	144 KBytes / sec

Channel Status Mode (Byte Pattern)	<i>00 00 00 01 00 00 00 01 02</i> (= standard)
Fixed Channel Status Data (for PCM Audio)	<i>00 00 00 01 00 00 00 18</i> <i>85 00 04 00 00 00 00 00</i> <i>00 00 00 00 00 00 00 00</i> <i>00 00 00 00 00 00 00 60</i> (= Professional Use, Linear PCM, No Emphasis, 48kHz Sampling, CRCC value: 60)
Fixed Channel Status Data (for Dolby-E)	<i>00 00 00 01 00 00 00 18</i> <i>83 00 04 00 00 00 00 00</i> <i>00 00 00 00 00 00 00 00</i> <i>00 00 00 00 00 00 00 39</i> (= Professional Use, Non-PCM, No Emphasis, 48kHz Sampling, No indicated Channel Mode, No User Information indicated, Max. Audio Sample Word Length: 24 bit, Encoded Audio Sample Word Length: not indicated, CRCC value: 39)
Operational requirements according to "Technical production guidelines for ARD, ZDF and ORF" (TPRF-HDTV)	
Channel Assignment	See current version of TPRF-HDTV

Ancillary Data	
Data content (EssenceContainers)	Shall not be present

Other	
Dark Metadata ¹	Shall not be present

¹ According to SMPTE st377-1:2011 the data in an MXF file that are considered as "Dark" is application-dependent. In the scope of this profile, "Dark Metadata" comprises all data that are not defined in the latest version of RP210 or RP224 (e.g. proprietary metadata).