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Mapping VC-6 into IMF

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Project Group: *DG-VC6-IMF*

Project Technology Committee: TC-35PM

Document type: *ST*

Document state: *WD*

Project chair(s): *Bruce Devlin*

Document editor(s): *Bruce Devlin*

Document number: *2067-xxx*

Document title: *Mapping VC-6 into IMF*

**Title Page**

This page will be provided by SMPTE HQ Staff.

See AG-16 clause 3.1 (Title Page), and ISO Directive Part 2 clause 11 (Title).

Proposed SMPTE Standard

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# Foreword

See AG-16 3.2 (Foreword), and ISO Directive Part 2 clause 12 (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 its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee TC-35PM.

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.

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If this is a revision, a topical list of changes [should/shall be included here]

# Introduction

An Introduction section is Optional / Conditional

The introduction provides specific information or commentary about the technical content of the document, and about the reasons prompting its preparation. See AG-16 clause 3.3 (Introduction), AG-16 clause 4.2 (Conformance Terms), and ISO Directive Part 2 clause 13 (Introduction).

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

SMPTE ST 2117-1 (VC-6) is a versatile intra-frame compression scheme. This document maps the VC-6 bitstream into the Interoperable Mastering Format.

[Editors notes: The following paragraph will be replaced with the appropriate patent information during the SMPTE Headquarters publication process.]

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# 1 Scope

The scope clearly defines the subject of the document and the aspects covered, thereby indicating the limits of applicability of the document. See AG-16 clause 3.4 (Scope), and ISO Directive Part 2 clause 14 (Scope).

This document specifies a new IMF Application as a specialization of the IMF Framework to noproxy workflow using the hierarchical properties of VC-6 to create workflow efficiencies through layered storage and transport whilst retaining the auditing and versioninng capabilities of IMF.

The new IMF Application targets UHDTV and larger images that are encoded using SMPTE ST 2117-1 with multiple echelons and bitrates that deliver visually lossless and mathematically lossless storage.

# 2 Normative References

The normative references clause lists, for information, those documents which are cited normatively in the document. See AG-16 clause 3.5 (Normative References), AG-16 clause 4.3 (Normative References to Standards and Recommended Practices), and the ISO Directives Clause 15 (Normative References).

The following SMPTE STANDARD contains provisions that, through reference in this text, constitute provisions of this standard. [Dated references require that the specific edition cited shall be used as the reference]. Undated citations refer to the edition of the referenced document (including any amendments) current at the date of publication of this document. All SMPTE STANDARDs are subject to revision, and users of this engineering document are encouraged to investigate the possibility of applying the most recent edition of any undated reference.

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

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 2067-21, Interoperable Master Format Application #2e

SMPTE ST 2771-10, Mapping ST 2117-1 into the MXF Generic Container

**Delete these references**

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

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 381-2:2011, Material Exchange Format (MXF) — Mapping MPEG Streams into the MXF Constrained 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 Packet

# 3 Terms and Definitions

The terms and definitions clause provide definitions necessary for the understanding of certain terms used in the document. See AG-16 clause 3.6 (Terms and Definitions), AG-16 clause 4.4 (Terms and Definitions), and ISO Directive Part 2 clause 16 (Terms and Definitions).

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If sentence b) or d) is selected, nothing else appears in the Clause.

If sentence a) or c) is selected, one or more terms is defined in the clauses immediately following.

Your terms and definitions follow.

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

# 4 VC-6 in IMF

## 4.1 General

This document deals only with the image essence track. All other aspects of an IMF composition shall comply with the provisions of SMPTE ST 2067-2.

## 4.2 Image Formats

TBC Potentially a list of operating points HD, UHD & beyond with preferred bit depths & layers - like the ProRes clone list. Interlace && psf && progressive??

## 4.3 Layering

All Image Essence Track Files shall have all echelons and planes for that image contained within a single MXF Essence Stream.

TBC indicate single layer vs multi-layer MXF wrapping

## 4.4 Image Encoding

TBC anything special about the encoding //mapping e.g. bit allocation between echelons or do we nuke this section?

# 5 Track files

## 5.1 General

Track Files shall conform to SMPTE ST 379-2 and SMPTE ST 2067-2.

## 5.2 Image Track Files

### 5.2.1 Essence

The Image Essence contained in Image Track Files shall conform to Section 4.

### 5.2.2 Track Format and Mapping

An Image Track File shall conform to SMPTE ST 2771-10:

* The Edit Rate and Sample Rate are equal to the image frame rate as defined in SMPTE ST 379-2.
* Indexing is image frame-based, using Index Edit Rates defined by the Edit Rates of the Essence Track, as defined in SMPTE ST 377-1. The Top-Level File Package of Image Track File shall reference:
* A CDCI Picture Essence Descriptor as defined in SMPTE ST 377-1 if the Image Essence uses Y’C’BC’R color components.
* An RGBA Picture Essence Descriptor as defined in SMPTE ST 377-1 if the Image Essence uses R’G’B’ color components
* A VC6SubDescriptor as defined in SMPTE ST 2110-10 shall be present

#### 5.2.2.1 Generic Picture Essence Descriptor

##### 5.2.2.1.1 General

The Generic Picture Essence Descriptor items shall be as specified in Annex G of SMPTE ST 377-1:2019 and Annexes F and G of SMPTE ST 2067-21:2020 and then further constrained as specified in this section. Table 4 specifies the following items:

* Items which are further constrained, i.e. required items which are specified as Optional or Decoder Required in SMPTE ST 377-1, StoredF2Offset, DisplayF2Offset and FieldDominance
* Best Effort items which are specified in SMPTE ST 377-1
* Optional items which are specified in SMPTE ST 2067-2

Table 1 - Generic Picture Essence Descriptor  
Items

| **Item** | **Constraints** | **Status: ST 377-1** | **Status: ST 2067-2** |
| --- | --- | --- | --- |
| Frame Layout | See Section 5.2.2.1.2. | B.Effort | - |
| Stored Width | See Section 5.2.2.1.3. | B.Effort | - |
| Stored Height | See Section 5.2.2.1.4. | B.Effort | - |
| StoredF2Offset | Shall be present for Interlaced. See Section 5.2.2.1.5. | Opt | - |
| Sampled Width | Shall be present. See Section 5.2.2.1.6. | Opt | - |
| Sampled Height | Shall be present. See Section 5.2.2.1.7. | Opt | - |
| SampledXOffset | Shall be present. See Section 5.2.2.1.8. | Opt | - |
| SampledYOffset | Shall be present. See Section 5.2.2.1.9. | Opt | - |
| DisplayHeight | Shall be present. See Section 5.2.2.1.10. | Opt | - |
| DisplayWidth | Shall be present. See Section 5.2.2.1.11. | Opt | - |
| DisplayXOffset | Shall be present. See Section 5.2.2.1.12. | Opt | - |
| DisplayYOffset | Shall be present. See Section 5.2.2.1.13. | Opt | - |
| DisplayF2Offset | Shall be present for Interlaced. See Section 5.2.2.1.14. | Opt | - |
| ActiveHeight | See Section 5.2.2.1.15. | - | Opt |
| ActiveWidth | See Section 5.2.2.1.16. | - | Opt |
| ActiveXOffset | See Section 5.2.2.1.17. | - | Opt |
| ActiveYOffset | See Section 5.2.2.1.18. | - | Opt |
| Aspect Ratio | See Section 5.2.2.1.19. | B.Effort | - |
| Video Line Map | See Section 5.2.2.1.20. | B.Effort | - |
| Transfer Characteristic | Shall be present. See Section 5.2.2.1.21. | Opt | - |
| FieldDominance | Shall be present for Interlaced. See Section 5.2.2.1.22. | Opt | - |
| Picture Essence Coding | Shall be present. See Section 5.2.2.1.23. | D/req | - |
| Coding Equations | Shall be present. See Section 5.2.2.1.21. | Opt |  |
| Color Primaries | Shall be present. See Section 5.2.2.1.21. | Opt |  |
| Alternative Center Cuts | See Section 5.2.2.1.24. | - | Opt |

##### 5.2.2.1.2 Frame Layout

The value of the Frame Layout item shall be equal to:

* 0x00 (FULL\_FRAME) if the image structure is progressive.
* 0x01 (SEPARATE\_FIELDS) if the image structure is interlaced.

##### 5.2.2.1.3 Stored Width

The value of the Stored Width item shall be equal to:

* 1920 if the image format is 1920x1080.
* 1280 if the image format is 1280x720.
* 3840 if the image format is 3840x2160.
* 7680 if the image format is 7680x4320.

##### 5.2.2.1.4 Stored Height

The value of the Stored Height item shall be equal to:

* 10881 if the image format is 1920x1080 and progressive.
* 5441 if the image format is 1920x1080 and interlaced.
* 720 if the image format is 1280x720 and progressive.
* 2160 if the image format is 3840x2160 and progressive.
* 4320 if the image format is 7680x4320 and progressive.

##### 5.2.2.1.5 StoredF2Offset

The default value is 0.

##### 5.2.2.1.6 Sampled Width

The value of the Sampled Width item shall be equal to:

* 1920 if the image format is 1920x1080.
* 1280 if the image format is 1280x720.
* 3840 if the image format is 3840x2160.
* 7680 if the image format is 7680x4320.

##### 5.2.2.1.7 Sampled Height

The value of the Sampled Height item shall be equal to:

* 1080 if the image format is 1920x1080 and progressive.
* 540 if the image format is 1920x1080 and interlaced.
* 720 if the image format is 1280x720 and progressive.
* 2160 if the image format is 3840x2160 and progressive.
* 4320 if the image format is 7680x4320 and progressive.

##### 5.2.2.1.8 SampledXOffset

The typical value is 0.

##### 5.2.2.1.9 SampledYOffset

The typical value is 0.

##### 5.2.2.1.10 DisplayHeight

The value of the DisplayHeight item shall be equal to:

* 1080 if the image format is 1920x1080 and progressive.
* 540 if the image format is 1920x1080 and interlaced.
* 720 if the image format is 1280x720 and progressive.
* 2160 if the image format is 3840x2160 and progressive.
* 4320 if the image format is 7680x4320 and progressive.

##### 5.2.2.1.11 DisplayWidth

* 1920 if the image format is 1920x1080.
* 1280 if the image format is 1280x720.
* 3840 if the image format is 3840x2160.
* 7680 if the image format is 7680x4320.

##### 5.2.2.1.12 DisplayXOffset

The typical value is 0.

##### 5.2.2.1.13 DisplayYOffset

The typical value is 0.

##### 5.2.2.1.14 DisplayF2Offset

The default value is 0.

##### 5.2.2.1.15 ActiveHeight

The value of the ActiveHeight is the number of vertical pixels of the Active Area Rectangle, as defined in Annex G of SMPTE ST 2067-2:2020.

##### 5.2.2.1.16 ActiveWidth

The value of the ActiveWidth is the number of horizontal pixels of the Active Area Rectangle, as defined in Annex G of SMPTE ST 2067-2:2020.

##### 5.2.2.1.17 ActiveXOffset

The value of the ActiveXOffset is the horizontal offset in Pixels of the Active Area Rectangle relative to the Display Rectangle, as defined in Annex G of SMPTE ST 2067-2:2020.

##### 5.2.2.1.18 ActiveYOffset

The value of the ActiveYOffset is the vertical offset in Pixels of the Active Area Rectangle relative to the Display Rectangle, as defined in Annex G of SMPTE ST 2067-2:2020.

##### 5.2.2.1.19 Aspect Ratio

The value of the Aspect Ratio item shall be equal to:

* 16:9 if the image format is 1920x1080.
* 16:9 if the image format is 1280x720.
* 16:9 if the image format is 3840x2160.
* 16:9 if the image format is 7680x4320.

##### 5.2.2.1.20 Video Line Map

The value of the Video Line Map item should be equal to:

* {42,0} if the image format is 1920x1080 and progressive.
* {21,584} if the image format is 1920x1080 and interlaced.
* {26,0} if the image format is 1280x720 and progressive.
* {42,0} if the image format is 3840x2160 and progressive.
* {42,0} if the image format is 7680x4320 and progressive.

##### 5.2.2.1.21 Transfer Characteristic, Coding Equations and Color Primaries

Transfer Characteristic, Coding Equations and Color Primaries should be one of the combinations per Signal Format of Table 5.

TBC do we need a table of color primaries like tST 2067-60

##### 5.2.2.1.22 FieldDominance

The default value is 1.

##### 5.2.2.1.23 Picture Essence Coding

The value of the Picture Essence Coding item shall be as specified in SMPTE ST 381-3.

##### 5.2.2.1.24 Alternative Center Cuts

The Alternative Center Cuts item specifies the alternate aspect ratio subset(s) of the active area as specified in Annex F of SMPTE ST 2067-2:2020. Active area is defined in Annex G of SMPTE ST 2067-2:2020.

#### 5.2.2.2 RGBA Picture Essence Descriptor

##### 5.2.2.2.1 General

The RGBA Picture Essence Descriptor items shall be as specified in Annex G of SMPTE ST 377-1:2019 and then further constrained as specified in this section. Table 6 specifies the following items:

Items which are further constrained, i.e. required items which are specified as Optional in SMPTE ST 377-1.

Best Effort items which are specified in SMPTE ST 377-1.

Table 6 — RGBA Picture Essence Descriptor items

| **RGBA Item** | **Constraints** | **Status: ST 377-1** |
| --- | --- | --- |
| Component Max Ref | Shall be present. See Section 5.2.2.2.2. | Opt |
| Component Min Ref | Shall be present. See Section 5.2.2.2.2. | Opt |
| PixelLayout | See Section 5.2.2.2.3. | B.Effort |

##### 5.2.2.2.2 Component Max Ref and Component Min Ref

Component Max Ref is an item, whose unsigned 32-bit integer value shall specify the R’G’B’ sample value for reference white level. Similarly, Component Min Ref is an item, whose unsigned 32-bit integer value shall specify the R’G’B’ sample value for reference black level. Table 7 describes the “narrow range” and “full range” signal representations of Recommendation ITU-R BT.2100.

Table 7 — Component Max Ref and Component Min Ref values

| **Range** | **Narrow range** | **Full range** |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Bit Depth** | **10** | **12** | **10** | **12** |  |  |
| Component Min Ref | 64 | 256 | 0 | 0 |  |  |
| Component Max Ref | 940 | 3760 | 1023 | 4095 |  |  |
|  |  |  |  |  |  |  |

##### 5.2.2.2.3 PixelLayout

The value of the PixelLayout item shall be equal to { ‘G’, x, ‘B’, x, ‘R’, x, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } where x is equal to 10 or 12 if 10-bit or 12-bit color components are used per Section 4.1.

#### 5.2.2.3 CDCI Picture Essence Descriptor

##### 5.2.2.3.1 General

The CDCI Picture Essence Descriptor items shall be as specified in Annex G of SMPTE ST 377-1:2019 and then further constrained as specified in this section. Table 8 specifies the following items:

Items which are further constrained, i.e. required items which are specified as Optional in SMPTE ST 377-1.

Best Effort items which are specified in SMPTE ST 377-1.

Table 8 — CDCI Picture Essence Descriptor items

| **CDCI Item** | **Constraints** | **Status: ST 377-1** |
| --- | --- | --- |
| Component Depth | See Section 5.2.2.3.2. | B.Effort |
| Horizontal Subsampling | See Section 5.2.2.3.3. | B.Effort |
| Vertical Subsampling | Shall be present. See Section 5.2.2.3.4. | Opt |
| Color Siting | Shall be present. See Section 5.2.2.3.5. | Opt |
| ReversedByteOrder | See Section 5.2.2.3.6. | Opt |
| PaddingBits | See Section 5.2.2.3.7. | Opt |
| Black Ref Level | Shall be present. See Section 5.2.2.3.8. | Opt |
| White Ref level | Shall be present. See Section 5.2.2.3.8. | Opt |
| Color Range | Shall be present. See Section 5.2.2.3.8. | Opt |

##### 5.2.2.3.2 Component Depth

The value shall be equal to the Bit Depth used. (see Section 4.1)

##### 5.2.2.3.3 Horizontal Subsampling

The value of Horizontal Subsampling item shall be equal to:

* 0x01 if 4:4:4 sampling is used per Section 4.2.
* 0x02 if 4:2:2 or 4:2:0 sampling is used per Section 4.2.

##### 5.2.2.3.4 Vertical Subsampling

The value of Vertical Subsampling item shall be equal to:

* 0x01 if 4:4:4 or 4:2:2 sampling is used per Section 4.2.
* 0x02 if 4:2:0 sampling is used per Section 4.2.

##### 5.2.2.3.5 Color Siting

The value shall be 0x00.

##### 5.2.2.3.6 ReversedByteOrder

The typical value is 0.

##### 5.2.2.3.7 PaddingBits

The typical value is 0.

##### 5.2.2.3.8 Black Ref Level, White Ref Level and Color Range

The values of the Black Ref Level, White Ref Level and Color Range items shall be set according to the component bit depth used. Table 9 describes the “narrow range” and “full range” signal representations of Recommendation ITU-R BT.2100.

Table 9 — Black Ref Level, White Ref Level and Color Range values

| **Range** | **Narrow range** | **Full range** |  |  |
| --- | --- | --- | --- | --- |
| **Bit Depth** | **10** | **12** | **10** | **12** |
| Black Ref Level | 64 | 256 | 0 | 0 |
| White Ref Level | 940 | 3760 | 1023 | 4095 |
| Color Range | 897 | 3585 | 1023 | 4095 |
|  |  |  |  |  |

NOTE: The White Ref Level item applies only to the Y’ component and the Color Range item to the C’B and C’R components.

#### 5.2.2.4 VC6 Sub Descriptor

Do we need a constrained IMF label? pCD process question?

TBC Table of values

# 6 Composition

## 6.1 General

Composition shall conform to SMPTE ST 2067-2.

## 6.2 Application Identification

The ApplicationIdentification element (see SMPTE ST 2067-2) shall include the value listed in Table 11.

Table 2 — Application Identification

| Application Identifier |
| --- |
| http://www.smpte-ra.org/ns/2067-xxx/202x |

## 6.3 Homogeneous Essence

### 6.3.1 Image

Within a given a composition, the following shall remain constant:

* The height and width of the image
* The color profile of the image
* The number of echelons used to encode the image

## 6.4 Segment Duration

If the average number of audio samples per Composition Edit Unit is not an integer, the duration of each Segment shall be an integer multiple of 5/Composition Edit Rate

## 6.5 Color

TBC Do we want to constrain Color representation e.g. DoVi, P3 etc or be silent?

**Information for Document Editors (this page is to be deleted prior to FCD ballot)**

The following documents have useful reference material for document editors. SMPTE AG 16:2018 – SMPTE Engineering Document Style Guidelines

International Organization for Standardization (ISO) / International Electrotechnical Commission (IEC), Directives, Part 2:2016-05, Principles and rules for the structure and drafting of ISO and IEC documents, 7.0

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