|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  32nd Meeting: Ljubljana, SI, 12-18 July 2018 | Document: JCTVC-AF1011-v1 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **Draft 1 toward version 2 of technical report on usage of video signal type code points** | | |
| *Status:* | Output Document approved by JCT-VC | | |
| *Purpose:* | Draft Text | | |
| *Author(s) or Contact(s):* | Yasser Syed  Chad Fogg  Lars Borg  Chris Seeger  Alexis Tourapis  Walt Husak  Gary Sullivan | Tel: Email: | +1 303-246-8413 [yasser\_syed@comcast.com](mailto:yasser_syed@comcast.com)  [chad.fogg@gmail.com](mailto:chad.fogg@gmail.com)  [borg@adobe.com](mailto:borg@adobe.com)  chris.seeger@nbcuni.com  [alexismt@apple.com](mailto:alexismt@apple.com)  WJH@dolby.com  [garysull@miscrosoft.com](mailto:garysull@miscrosoft.com) |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

# Scope

# References

## Joint ITU-T and ISO/IEC References

## ISO/IEC References

## ITU-T References

## ITU-R References

Rec. ITU-R BT.2077 Real-time serial digital interfaces for UHDTV

signals

## SMPTE References

SMPTE ST 2022-6:2012 Transport of High Bit Rate Media Signals over IP Networks (HBRMT)

SMPTE ST 2110-20:2017 Professional Media Over Managed IP Networks: Uncompressed Active Video

SMPTE 259M (SD-SDI)

SMPTE 292M (HD-SDI)

SMPTE 372M (Dual-link SDI)

SMPTE 424M (3G-SDI)

SMPTE ST 2081 (6G-SDI)

SMPTE ST 2082 (12G-SDI)

(Camera Logs- In Committee Draft))- SMPTE 10E-CD-ST-2115- FreeScale Gamut and FreeScale Log Characteristics of Camera System- ( 4 sets of Gamuts & Logs- S3, C3, V, C2)

ST 2036-4:2015 Ultra High Definition Television ―Multi-link 10 Gb/s Signal/Data Interface Using 12-Bit Width Container

## Other References

CTA 861-G (A DTV Profile for Uncompressed Hogh Speed Digital Interfaces)

Blu- Ray <http://www.blu-raydisc.com/Assets/Downloadablefile/BD-ROM_Part3_V3.2_WhitePaper_180122(clean).pdf>   (section 3.6.2)  
  
DVB- <https://www.etsi.org/deliver/etsi_ts/101100_101199/101154/02.04.01_60/ts_101154v020401p.pdf>  (section 5.14.3.3)  
  
ATSC (Video HEVC) <https://www.atsc.org/atsc-30-standard/a3412017-video-hevc/>  (section 6.3.2.1)

<https://www.etsi.org/deliver/etsi_ts/101100_101199/101154/02.04.01_60/ts_101154v020401p.pdf>

ARIB- http://www.arib.or.jp/english/html/overview/doc/6-STD-B58v1\_1-E1.pdf

# Definitions

This document defines the following terms. The definitions in AVC (Rec. ITU-T H.264 | ISO/IEC 14496-10) and HEVC (Rec. ITU-T H.265 | ISO/IEC 23008-2) also apply.

|  |  |
| --- | --- |
| * 1. **a** | **xxx** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# Abbreviations and acronyms

This document uses the following abbreviations and acronyms:

|  |  |
| --- | --- |
| 2K | Informally used for HD resolution (1920x1080 or 2048x1080/Film) |
| 4K | Informally used for a UHD resolution (3840x2160 or 4096x 2160/Film) |
| 8K | Informally used for a UHD resolution (7680x4320 or 8192x4320/Film) |
| AVC | Advanced Video Coding (Rec. ITU-T H.264 | ISO/IEC 14496-10) |
| EOTF | Electro-Optical Transfer Function |
| HD | High Definition |
| HDR | High Dynamic Range |
| HEVC | High Efficiency Video Coding (Rec. ITU-T H.265 | ISO/IEC 23008-2) |
| HLG | Hybrid Log-Gamma (as defined in Rec. ITU-R BT.2100) |
| HVS | Human Visual System |
| LUT | Look-up Table |
| NCG | Narrow Colour Gamut (normally referred to 709 as per Rec. ITU-R BT.709) |
| NCL | Non-Constant Luminance |
| PQ | Perceptual Quantizer (as defined in Rec. ITU-R BT.2100) |
| QP | Quantization Parameter |
| RAPAU | Random Access Point Access Unit |
| RGB | Colour System using linear light Red, Green, and Blue components |
| R′G′B′ | Colour System using non-linear (mapped to approximately perceptually uniform steps) Red, Green, and Blue components. The mapping between linear RGB and non-linear R′G′B′ is indicated by the transfer function. The colour representation does not indicate the media component order in the file. |
| SDR | Standard Dynamic Range |
| SEI | Supplemental Enhancement Information |
| OETF | Opto-Electrical Transfer Function |
| OOTF | Opto-Optical Transfer Function |
| UHD | Ultra High Definition |
| VUI | Video Usability Information. A sequence level sub-header in AVC and HEVC bitstreams. |
| WCG | Wide Colour Gamut (a gamut substantially wider than the gamut conveyed by BT.709) |
| XYZ | The CIE 1931 colour space. Y corresponds to the luminance signal. |
| Y′CbCr | Colour space representation commonly used for video/image distribution as a way of encoding RGB information, also commonly expressed as YCbCr, Y′CBCR, or Y′C′BC′R. The relationship between Y′CbCr and RGB is dictated by certain signal parameters, such as colour primaries, transfer characteristics, and matrix coefficients. Unlike the CIE-Y component in the linear light XYZ representation, the non-linear, approximately perceptual uniform Y′ in this representation might not be representing the same quantity, regardless of the transfer function. Y′ is commonly referred to as “luma”. Cb and Cr are colour difference signals commonly referred to as “chroma”. It could also be known as YUV in other documents. |

# Overview

The Coding-Independent Code Points (CICP) standard for Video (ISO/IEC 23091-2) defines code points and fields that identify the video signal type. It is independent from how these properties are carried in a coded video layer bitstream such as an AVC or HEVC bitstream which could differ depending on bitstream format. The compressed representation is often considered to be a temporary, compact distribution, delivery state of the video signal, while the reconstructed video signal output from the decoder should be interpreted as having the same meaning as the video signal immediately prior to compression.

The combinations of all possible video properties and values can result in hundreds of permutations; but many of those combinations are rarely or never used in practice. For example, it is unlikely that ITU-R BT.2100 perceptual quantization (PQ) transfer characteristics would be combined with ITU‑R BT.601 colour primaries. Only a small subset of combinations (such as BT.2020/BT.2100 colour primaries with BT.709/BT.2020 gamma, BT.2100 PQ, or BT.2100 hybrid log-gamma (HLG) transfer characteristics) are used in practice.

Video properties and values are usually expressed in "metadata" that can exist across production and distribution workflows. Knowledge of these properties and their combinations has value as content is processed in the end-to-end (E2E) production-to-distribution workflow chain.

This text is a non-normative document of industry practices for describing present day widely used combinations of video properties and their representations in different carriage domain systems. This document provides information that aims to help vendors of various content processing tools avoid processing mistakes that cause video quality degradation due to a wrong assumption made about video property combinations. There are only limited sets of video property combinations that are widely used in present day production/video distribution equipment chains. This document characterises these limited sets of combinations that are widely used today. This document provides this information and how it is carried to aid in the automation of content workflows across various domains of capture, production, and distribution. Lastly, this Technical Report aims to help its readers, especially toolset developers, to repurpose tools to work across several domains (capture, production, production distribution, service distribution) where similar video conversion functions (e.g. sub-sampling) may be performed.

Table XX indicates some popular applications that uses these widely used industry practices with types of restrictions described in later sections.

Table 1 Target applications for widely used content workflows for video production and distribution workflows

|  |  |  |
| --- | --- | --- |
| **System** | **Format** | **Other restrictions** |
| CD Video | BT.601 525  BT.601 625 | 8-bit 4:2:0 (MPEG-1 bitstreams) |
| DVD | BT.709 YCC  BT.601 525  BT.601 625 | 8-bit 4:2:0 (MPEG-2 Main Profile bitstreams) |
| Blu-Ray | BT.709 YCC | 8-bit 4:2:0  (MPEG-2 Main Profile, AVC Main, AVC High Profile) |
| Ultra HD Blu-Ray (4K) HDR | BT.2100 YCC( ?) | 10-bit 4:2:0 (HEVC Main 10 Profile) |
| Ultra HD Blu-Ray (4K) WCG | BT.2020 YCC NCL | 10-bit 4:2:0 (HEVC Main 10 Profile)  TransferCharacteristics = 14 |
| DVB 1.0 | BT.709 YCC | 8-bit 4:2:0 |
| DVB UHD WCG | BT.2020 YCC NCL | 8-bit 4:2:0 (HEVC Main Profile)  10-bit 4:2:0 (HEVC Main 10 Profile)  TransferCharacteristics = 14 |
| DVB UHD HDR | BT.2100 PQ YCC  BT.2100 HLG YCC | 10-bit 4:2:0 (HEVC Main 10 Profile) |
| ATSC v1.0 | BT.709 YCC | 8-bit 4:2:0 (MPEG-2 Main Profile) |
| ATSC v3.0 WCG UHD | BT.2020 YCC NCL | 10-bit 4:2:0 (HEVC Main 10 Profile)  TransferCharacteristics = 1 |
| ATSC v3.0 HDR UHD | BT.2100 PQ YCC | 10-bit 4:2:0 (HEVC Main 10 Profile) |
| ARIB HDR (B32 v3) | BT.2100 HLG YCC | 10-bit 4:2:0 (HEVC Main 10 Profile) |
| ARIB WCG (B32 v3 ?) | BT.2020 YCC NCL | 10-bit 4:2:0 (HEVC Main 10 Profile)  TransferCharacteristics = 14 |
| SCTE (cable TV) SDR | BT.709 YCC | 8-bit 4:2:0  (MPEG-2 Main Profile, AVC Main, AVC High Profile) |
| SCTE (cable TV) HDR | BT.2100 PQ YCC | 10-bit 4:2:0 (HEVC Main 10 Profile) |

Sections 7.1 or 7.2 of this Technical Report define system identifier tags for each combination of commonly used values of more intransient video properties and their combinations that go across domains.In addition, these sections will also identify how the video property values are carried in the stream. Future sections of this technical report will characterize more transient video properties/combinations where values may be more determined by the domain and subsampling of the video (e.g. chroma location type).

# Domains- capture, production, production distribution, service distribution

Figure 1 illustrates workflow domains (capture, production, production distribution, service distribution) in which video content may exist, be edited, or be converted. Typical content workflows across these domains are theatrical/scripted TV or live events. There are many similar video processing functions that can be performed in each domain and often may be repeated in the next successive domain (see Figure 1).



Figure 1 Video workflows through different carriage domains

[ED/YS] Need to add Camera log information in a combined section or its own section?

[ED/YS] Q1- At the capture level should we try to identify the widely used camera outputs combinations? 1)Camera RAW RGB /4:4:4 – 16 bpp 2) 4 different types of camera logs R’G’B’ or YCbCr w/ 4:2:2 or 4:2:0 and either 12 or 10 bit. This is the describes the signal outputs that need to be converted ( e.g. LUT for PQ or HLG/ RGB or R’G’B’ to Y’CbCr)

[ED/YS] Q2: Is every other operation in the workflow just a degradation of the signal information through a conversion.

[ED/YS] Table for Baseband resolution to type of interface. E.g. UHD resolution baseband transmission could use quad3G or 12G. Accommodates cameration that only may have 1 type of connections.

In the capture domain, content is created through sensors on cameras converting optical signals into a digital format. Content is retained at its highest informational format though some conversions to reduce transport bandwidth demands may happen during sensor processing.

In the interface to the production domain, content undergoes processing further transformations such as non-linear transformations (e.g. NCL), Pixel Subsampling (4:4:4🡪4:2:2), colour representation changes (RGB🡪 Y’CbCr), and bit rate reduction (16 bpp🡪10 bpp). For theatrical/ Scripted TV workflows entering in the production domain, content can be added to by CGI sources, overlayed with graphics, and colour graded using a Mastering display. For Live Event workflows, there is always a real-time constraint, which limits content processing to real-time operations. After the colour grading, both static and dynamic metadata may be generated that are to be attached to the content workflow. However, for live events this may not be practical and metadata may need to be generated further downstream by automated content analysis approaches.

In the production distribution domain, some additional processing is done to the content to further reduce transport bandwidth demands. This may include some pixel transformations (chroma- subsampling[[1]](#footnote-1), bit depth ) and compression (e.g. AVC, HEVC) but mostly employing spatial compression techniques.

At the service distribution domain, the content version in the workflow is in final form though the presentation of it may have some additional overlay graphics. Content processing at this interface continues to reduce signal information to address transport bandwidth distribution demands while still maximizing perceptual optimizations to retain content video quality. Operations reduce the content to a 4:2:0 Y’CbCr 8 or 10 bit compressed stream using HEVC, AVC, or even MPEG-2 coded representation. This content workflow then finishes by the content being distributed to the customer through broadcast, multicast, or unicast approaches and then presented for viewing.

A lot of the content processing operations may employ multiple 3rd party content processing tools. Currently most tools are designed and operate within a specific domain with general assumptions of how content was handled in the preceeding domain. Tools may also have further constraints depending on content resolutions (HD or 2K in Film/ UHD or 4K or 8K in Film).

# Common combinatorial descriptions

This section enumerates common combinations of video properties and values used within the content industry today. This section also describes common methods of conveying video property information for capture, production, production distribution, and service distribution carriage domains.

System identifier tags are to be used in this document to identify succinctly each commonly used combination. System identifier tags may be used as out of band metadata for conversion tools, and by production/distribution teams, to identify the workflow path needed to process and distribute content.

Content conversion tools need the locations and values of stream properties and associated metadata through the knowledge of the appropriate system identifier . In some cases, the information to identify and locate video properties of the stream information is described in the specific coded video stream specification. For example, a SMPTE MXF structured stream indicates parameters and values through SMPTE UL structures[[2]](#footnote-2) located in MXF headers. In another example, HEVC/AVC streams indicate parameters and values through VUI and SEI constructs at the parameter set level.

## Colourimetry and range scalability descriptions

Common colour volume information describes combinations of video properties that are needed to convert between colour volumes. Such conversions may include changes in bit depth, changes in colour sub-sampling, non-linear optimizations, and may also include transformations based on carriage and bit rate restrictions. SD, HD, and UHD material carry certain colorimetry properties as indicated in Table 1 but this information can be carried in different places or inferred depending on the storage or streaming format.

Table 2 SD, HD, UHD Colorimetry Video Properties

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Tag** | **Color** | | **Light** | | **container space properties** | | |
|  | **Gamut** | **Primaries** | **Dynamic Range** | **Transfer function** | **Domain** | **Integer code level scaling** | **4:2:0-only chroma sample vertical alignment  (ChromaLocType)** |
| SD | BT.601\_525 | NCG | BT.601 | SDR | gamma | Y′CbCr | Narrow | Interstitial  (0) [ |
| BT.601\_625 | Y′CbCr | Narrow | Interstitial  (0) |
| HD | BT.709\_YCC | BT.709 | Y′CbCr | Narrow | Interstitial  (0) |
| BT.709\_RGB | R′G′B′ | Narrow | N/A |
| FR709\_RGB | R′G′B′ | Full | N/A |
| UHD | BT.2020\_YCC\_NCL | WCG | BT.2020 | Y′CbCr | Narrow | Co-sited  (2) |
| BT.2020\_RGB | R′G′B′ | Narrow | N/A |
| FR2020\_RGB | R′G′B′ | Full | N/A |
| BT.2100\_PQ\_YCC | BT.2100 | HDR | PQ | Y′CbCr | Narrow | Co-sited  (2) |
| BT.2100\_PQ\_RGB | R′G′B′ | Narrow | N/A |
| BT.2100\_HLG\_YCC | HLG | Y′CbCr | Narrow | Co-sited  (2) |
| BT.2100\_HLG\_RGB | R′G′B′ | Narrow | N/A |

*Note: BT.709 was intended for HD applications (1080i, 720p), but some SD (480i, 576i) systems adopted it.*

Carriage formats for colour properties in each domain (capture, production, production distribution, service distribution) contain the same payload but in different wrappers. In the capture and production domains, the colour property information can be carried in an MXF wrapper using a generic picture essence descriptor as specified by Annex C of ST 2067-21[[3]](#footnote-3). Colour volume information in the distribution domain can be carried within the video stream as syntax information in the selected video format such as AVC, HEVC, MPEG-2, etc., through VUI headers according to ISO/IEC 23091-2. The full and narrow range scalability video property is not carried explicitly in all technologies and may need to be taken implicitly through the system identifier. In common practice, Y′CbCr colour representation uses narrow range-scaled levels.

### Defined properties

For the colourimetry and range scalability descriptions, the following video properties are included, whose values in specific combinations specify what is widely used in industry content. This document uses the coding independent code points terminology as described in ITU-T H.273|ISO/IEC 23091-2 for each video properties below:

1. ColourPrimaries

|  |  |  |
| --- | --- | --- |
| Carriage Parameter Names | Colloquial | Utilization |
| colour\_primaries [HEVC/AVC]  colour primaries [SMPTE-MXF] | colorspace, color gamut | SDR uses a BT.709 colour space, Digital Cinema restricts colours to P3 values (ST 2067-30) but in a 2020 colourspace container, HDR over time will use the complete 2020 values |

1. TransferCharacteristics

|  |  |  |
| --- | --- | --- |
| Carriage Parameter Names | Colloquial | Utilization |
| transfer\_characteristics [HEVC/AVC]  transfer charasteristic [SMPTE-MXF] | Transfer curves, log curves | Widely used practices: For HDR uses either PQ or HLG, for SDR uses transfer characteristic for BT.709 assuming a display characteristic corresponding to BT.1886 |

1. MatrixCoefficients[[4]](#footnote-4)

|  |  |  |
| --- | --- | --- |
| Carriage Parameter Names | Colloquial | Utilization |
| matrix\_coeffs [HEVC]  matrix\_coefficients (AVC)  coding equations [SMPTE-MXF] | Color Representation, GBR, NCL, YCC, YUV, Y’UV, R’B’G’ | Widely used practices: Specifies the encoding equations to convert RGB image components to component colour difference image components. No matrix is used for R’G’B’ |

1. VideoFullRangeFlag

|  |  |  |
| --- | --- | --- |
| Carriage Parameter Names | Colloquial | Utilization |
| video\_full\_range\_flag [HEVC/AVC]  n/a [SMPTE-MXF] | Full, narrow, head, legal, QE.1, QE.2 | Y’CbCr colour representation uses narrow range scalability values |

1. ChromaLocType

|  |  |  |
| --- | --- | --- |
| Carriage Parameter Names | Colloquial | Utilization |
|  |  |  |

Table 2 indicate the code values for each property that are widely used for video content production and distribution systems.

Table 2 Code point values widely used for colourimetry properties

|  |  |  |
| --- | --- | --- |
| HEVC property | Code point | Meaning |
| colour\_primaries | 1 | BT.709 primaries |
| 5 | BT.601 625-line systems primaries |
| 6 | BT.601 525-line systems primaries |
| 9 | BT.2020 and BT.2100 primaries  (share the same code point since their values are identical) |
| transfer\_characteristics | 1, 6, 14 | functionally equivalent, gamma (SDR) |
| 16 | BT.2100 PQ (Perceptual Quantizer) |
| 18 | BT.2100 HLG (Hybrid Log-Gamma) |
| matrix\_coefficients | 0 | R′G′B′ (identity matrix applied to primaries) |
| 1 | Y′CbCr for BT.709 primaries |
| 5 | Y′CbCr for BT.601 625-line primaries |
| 6 | Y′CbCr for BT.601 525-line primaries |
| 9 | Y′CbCr for BT.2020 and BT.2100 primaries |
| ChromaLocType | 0 | Interstitial |
| 2 | Co-sited |

### Common descriptions and carriage: Standard Dynamic Range - Narrow Colour Gamut

This colour volume describes SDR video, which includes the majority of the production and distribution workflows used in the industry today. There are several combinations of values of video properties that are used for this colour volume. Table 1 describes these combinations. Note, there are several one-way operations that can be performed for this colour volume including bit depth reductions, colour sampling reductions, and full-to-narrow level range scaling operations.

The following system identifier tags are described:

* BT.709\_YCC
* BT.709\_RGB
* FR709\_RGB
* BT.601\_525
* BT.601\_625

Table 3 SDR/NCG Common Colour Volume Descriptions

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **System Identifier** | **BT.709\_YCC** | **BT.709\_RGB** | | **FR709\_RGB** | | **BT.601\_525** | **BT.601\_625** |
| *Colour properties* | Colour primaries | BT.709 | BT.709 | | BT.709 | | BT.601 | BT.601 |
| Transfer characteristics | BT.70 (TC) | BT.709 (TC) | | BT.709 (TC) | | BT.709 (TC) | BT.709 (TC) |
| Colour representation | Y′CbCr | R′G′B′ | | R′G′B′ | | Y′CbCr | Y′CbCr |
| *Other* | Full/narrow range | Narrow | Narrow | | Full | | Narrow | Narrow |
| 4:2:0 chroma sample vertical alignment | Interstitial | Interstitial | | Interstitial | | Interstitial | Interstitial |
| *CICP parameters* | ColourPrimaries | 1 | 1 | | 1 | | 6 | 5 |
| TransferCharacteristics | 1 | 1 | | 1 | | 6 | 6 |
| MatrixCoefficients | 1 | 0 | | 0 | | 6 | 5 |
| |  | | --- | | VideoFullRangeFlag | |  | | 0 | 0 | | 1 | | 0 | 0 |
| ChromaLocType | 0 | 0 | | 0 | | 0 | 0 |
| *SMPTE MXF parameters* | Colour primaries | 06.0E.2B.34.04.01.01.06.04.01.01.01.03.03.00.00 | | | | | 06.0E.2B.34.04.01.01.06.04.01.01.01.03.01.00.00 | 06.0E.2B.34.04.01.01.06.04.01.01.01.03.02.00.00 |
| Transfer characteristic | 06.0E.2B.34.04.01.01.01.04.01.01.01.01.02.00.00 | | | | | | |
| Coding equations | 06.0E.2B.34.04.01.01.01.04.01.01.01.02.02.00.00 | | N/R | | N/R | 06.0E.2B.34.04.01.01.01.04.01.01.01.02.01.00.00 | |
| Full/Narrow level range  indicated in black ref level, white ref level, colour range | Inferred | | | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *HDMI parameters?* | ColourPrimaries |  |  |  |  |  |
| TransferCharacteristics |  |  |  |  |  |
| MatrixCoefficients |  |  |  |  |  |
| |  | | --- | | VideoFullRangeFlag | |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *SD-SDI parameters* | ColourPrimaries |  |  |  |  |  |
| TransferCharacteristics |  |  |  |  |  |
| MatrixCoefficients |  |  |  |  |  |
| |  | | --- | | VideoFullRangeFlag | |  |  |  |  |  |

9/24 Do we want to add SDI and HDMI to the table section?

SD- SDI- SMPTE 259M

HD-SDI- SMPTE 292M

Dual-Link SDI – SMPTE 372M

3G-SDI- SMPTE 424M

6G-SDI-ST 2081

12G-SDI- ST-2082

ST-2022

ST-2113

How do you identify location of information (e.g. what byte type of frame)?

9/24 What to put

### Common descriptions and carriage: Standard Dynamic Range – Wide Colour Gamut

This colour volume describes SDR with wide colour gamut video, which is keyed off the colour primary video property. In some cases, the same colour property may be described with two different values depending on the colour primary container used. It is important for tools to process video according to the colour volume it is operating in to make sure the conversion is consistent.

The following system identifier tags are described:

* BT.2020\_YCC\_NCL
* BT.2020\_RGB
* FR2020\_RGB

Table 4 SDR w/ WCG Common colour volume descriptions[[5]](#footnote-6)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **System Identifier** | **BT.2020\_YCC\_NCL** | **BT.2020\_RGB** | **FR2020\_RGB** |
| *Colour properties* | Colour primaries | BT.2020 | BT.2020 | BT.2020 |
| Transfer characteristics | BT.2020 (TC) | BT.2020(TC) | BT.2020(TC) |
| Colour representation | YCbCr | RGB | RGB |
| *Other* | Full/narrow range | Narrow | Narrow | Full |
| 4:2:0 chroma sample vertical alignment | Co-sited | Co-sited | Co-sited |
| *CICP parameters* | ColourPrimaries | 9 | 9 | 9 |
| TransferCharacteristics | 14 | 14 | 14 |
| MatrixCoefficients | 9 | 0 | 0 |
| |  | | --- | | VideoFullRangeFlag | | 0 | 0 | 1 |
| ChromaLocType | 2 | 2 | 2 |
| *SMPTE MXF parameters* | Colour primaries | 06.0E.2B.34.04.01.01.0D.04.01.01.01.03.04.00.0 | | |
| Transfer characteristic | 06.0E.2B.34.04.01.01.0E.04.01.01.01.01.09.00.00 | | |
| Coding equations | 06.0E.2B.34.04.01.01.0D.04.01.01.01.02.06.00.00 | N/R | N/R |
| Full/narrow level range  indicated in black ref level, white ref level, colour range | Inferred | | |

*Note: Chroma sample vertical alignment is only applicable in chroma subsampling operations to create 4:2:0 content*

### Common descriptions and carriage: High Dynamic Range- Wide Colour Gamut

This colour volume describes HDR video, which is typically associated with ultra high definition video.

The following system identifier tags are described:

* BT.2100\_PQ\_YCC
* BT.2100\_HLG\_YCC
* BT.2100\_PQ\_RGB
* BT.2100\_HLG\_RGB

Table 5 HDR/WCG common colour volume descriptions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **System Identifier** | **BT.2100\_PQ\_YCC** | **BT.2100\_HLG\_YCC** | **BT.2100\_PQ\_RGB** | **BT.2100\_HLG\_RGB** |
| *Colour properties* | Colour primaries | BT.2020 / BT.2100 | BT.2020 / BT.2100 | BT.2020 / BT.2100 | BT.2020 / BT.2100 |
| Transfer characteristics | PQ | HLG | PQ | HLG |
| Colour representation | YCbCr | YCbCr | RGB | RGB |
| *Other* | Full/narrow range | Narrow | Narrow | Narrow | Narrow |
| 4:2:0 chroma sample vertical alignment | Co-sited | Co-sited | Co-sited | Co-sited |
| *CICP parameters* | ColourPrimaries | 9 | 9 | 9 | 9 |
| TransferCharacteristics | 16 | 18 | 16 | 18 |
| MatrixCoefficients | 9 | 9 | 0 | 0 |
| |  | | --- | | VideoFullRangeFlag | | 0 | 0 | 0 | 0 |
| ChromaLocType | 2 | 2 | 2 | 2 |
| *SMPTE MXF parameters* | Colour primaries | 06.0E.2B.34.04.01.01.0D.04.01.01.01.03.04.00.00 | | | |
| Transfer characteristic | 06.0E.2B.34.04.01.01.0D.04.01.01.01.01.0A.00.00 | 06.0E.2B.34.04.01.01.0D.04.01.01.01.01.0B.00.00 | 06.0E.2B.34.04.01.01.0D.04.01.01.01.01.0A.00.00 | 06.0E.2B.34.04.01.01.0D.04.01.01.01.01.0B.00.00 |
| Coding equations | 06.0E.2B.34.04.01.01.0D.04.01.01.01.02.06.00.00 | | N/R | N/R |
| Full/narrow level range  indicated in black ref level, white ref level, colour range | Inferred | | | |

*Note: Chroma sample vertical alignment is only applicable in chroma subsampling operations to create 4:2:0 content*

## Widely used video/image characteristics in workflow domains

Several video properties can be associated as video/image characteristics. These types of video properties can be converted as it moves through each domain (capture, production distribution, service distribution) in the workflow. For distribution domains, bit depth, colour sampling structure, colour form, and compression format can be discovered through the format profile definition and bitstream syntax. The remainder of video properties in this description is not carried in any wrapper but can be identified through the system identifier tags which may be sent as out of stream information

## Video/image characteristics for capture domain

In the capture domain content originates from camera capture from one or multiple cameras. The process in this domain are often in real-time and can include some real-time production processes (e.g. adding graphics, colour grading, static/dynamic LUTs for things like transfer curves changes (HLG to PQ), full/narrow range scalability conversion). A real-time delivery through all the domains in the workflow to the viewer is generally a live event workflow. If production or service distribution is non realtime, this may become a part of a theatrical or scripted type of workflow. In the capture domain, content needs to be kept at a high information rate so it is stored/transmitted generally as editable images in a lossless or uncompressed format.

AVC Class 100, or 100 Mb/s, is an example of a **common** lossy compression level used for professional 709 capture. Corresponding uncompressed bit rate for 709 is about 3 Gb/s.

Table 6- Widely Used Video/Image Workflow Characteristics in the Capture Domain

|  |  |
| --- | --- |
| SDR/NCG | |
| Colour sampling structure | 4:4:4 [Y’CbCr, R’G’B’], 4:2:2 [Y’CbCr] |
| Frame structure | Interlaced, progressive |
| Bit depth | 10, 8 |
| Compression type | Lossless, uncompressed |
| Compression dimension | None |
| Compression format | None |
| File Wrappers | None, MXF |
| Wireline Frame Digital Interface | SDI, HD-SDI, ST.2022 (IP/Mux), ST.2110 (IP/UnMux) |

|  |  |
| --- | --- |
| HDR/WCG, SDR/WCG | |
| Colour sampling structure | 4:4:4 [R’G’B’], 4:2:2 [Y’CbCr], 4:4:4 [Y’CbCr] |
| Frame structure | Progressive |
| Bit depth | 16, 12, 10 |
| Compression type | Lossless, uncompressed |
| Compression dimension | None |
| Compression format | None |
| File Wrappers | None, MXF |
| Wireline Frame Digital Interface | HD-SDI, ST.2022-6 (IP/Mux), ST.2110-20 (IP/UnMux) |

## Video/image characteristics for production domain

In the production domain, the video/image content can be mixed with other sources such as CGI content. It can also undergo colour space, sampling structure, and bit-depth conversions as well as alterations of the content through colour grading processes to provide an intended “look” to the content to the viewer. Content conversions may lose come of the information from the capture domain, but the content is still of a high quality, and editable. Content is more in an uncompressed or lightly compressed format.

Table 7- Widely Used Video/Image Workflow Characteristics in the Production Domain

|  |  |
| --- | --- |
| SDR/NCG | |
| Colour sampling structure | 4:4:4 [Y’CbCr, R’G’B’], 4:2:2 [Y’CbCr] |
| Frame structure | Interlaced, progressive |
| Bit depth | 10, 8 |
| Compression type | uncompressed, Lossless, compressed |
|  | None |
| Compression format | None |
| File Wrappers | None, MXF, |
| Wireline Frame Digital Interface | SDI, HD-SDI, ST.2022-6 (IP/Mux), ST.2110-10 (IP/UnMux), Others |

|  |  |
| --- | --- |
| HDR/WCG, SDR/WCG | |
| Colour sampling structure | 4:4:4 [R’G’B’], 4:2:2 [Y’CbCr] |
| Frame structure | Progressive |
| Bit depth | 12, 10 |
| Compression type | Lossless, uncompressed |
| Compression dimension | None, spatial |
| Compression format | None, J2K |
| File Wrappers | None, MXF, |
| Wireline Frame Digital Interface | HD-SDI, ST 2022-6 (IP/Mux), ST.2110-20 (IP/UnMux), Others |

## Video/Image Characteristics for Production Distribution Domain

In the production distribution domain, is intended for distribution of content to other facilities or to act as a mezzanine or contribution feed (e.g. IMF, HEVC, J2K, AVC) to a service provider. Content is usually lightly compressed in a spatial dimension or both a spatial/temporal dimension.

Table 8- Widely Used Video/Image Workflow Characteristics in the Production Distribution Domain

|  |  |
| --- | --- |
| SDR/NCG | |
| Colour sampling structure | 4:2:2 [YCbCr], 4:2:0 [YCbCr] |
| Frame structure | Interlaced, progressive |
| Bit depth | 10, 8 |
| Compression type | Lossless, uncompressed |
| Compression dimension | None |
| Compression format | None, J2K, HEVC, AVC, MPEG-2 |
| File Wrappers | MXF, MPEG2-TS, ISOBMFF |
| Wireline Frame Digital Interface | SDI, HD-SDI, ST.2022-6 (IP/MUX), ST 2110-20 (IP/UnMux), others |

|  |  |
| --- | --- |
| HDR/WCG, SDR/WCG | |
| Colour sampling structure | 4:2:2 [Y’CbCr], 4:2:2 [Y’CbCr] |
| Frame structure | Progressive |
| Bit depth | 16, 12, 10 |
| Compression type | Lossless, uncompressed |
| Compression dimension | None, spatial, spatial/temporal |
| Compression format | None, J2K, HEVC, AVC, MPEG-2 |
| File Wrappers | MXF, MPEG2-TS, ISOBMFF |
| Wireline Frame Digital Interface | SDI, HD-SDI, ST.2022 (IP/MUX), ST.2110-20 (IP/UnMux) , others |

## Video/image characteristics for service distribution domain

In the service distribution domain, the remaining conversion stage of the content is intended to be the final format that is consumed by the viewer’s player device. Video content may be reduced by further subsampling, bit depth, and traditional distribution video codec techniques.

Table 9- Widely Used Video/Image Workflow Characteristics in the Service Distribution Domain

|  |  |
| --- | --- |
| SDR/NCG | |
| Colour sampling structure | 4:2:0 [Y’CbCr] |
| Frame structure | Interlaced, progressive |
| Bit depth | 10, 8 |
| Compression type | Lossless, uncompressed |
| Compression dimension | None |
| Compression format | HEVC, AVC, MPEG-2, Others |
| File Wrappers | MPEG2-TS, ISOBMFF |
| Wireline Frame Digital Interface |  |

|  |  |
| --- | --- |
| HDR/WCG, SDR/WCG | |
| Colour sampling structure | 4:2:0 [Y’CbCr] |
| Frame structure | Progressive |
| Bit depth | 10 |
| Compression type | Lossless, uncompressed |
| Compression dimension | Spatial, spatial/temporal |
| Compression format | HEVC, AVC, others |
| File Wrappers | MPEG2-TS, ISOBMFF |
| Wireline Frame Digital Interface |  |

1. For 4:2:0 chroma subsampling operations, it is important to make known the initial subsampling location processing of the content to avoid unnecessary quality degradation upon further content processing. For NCG material, ChromaLocType = 0. For WCG material, ChromaLocType = 2. [↑](#footnote-ref-1)
2. SMPTE MXF structures make use of UL (Universal Labels) which are a set of registered labels maintained by SMPTE (registry.smpte-ra.org). This is a 16 byte structure comprised of SMPTE UL Header [4bytes-“0”] [12], SMPTE UL Designator [4bytes-“0”] [13], and an Item Designator [8 bytes-“000”] [14][15][16]. SMPTE MXF Sub tables will provide these 16 byte labels in addition to any values associated with the label. [↑](#footnote-ref-2)
3. In some capture, production, and distribution domains, the colorimetry property information may also be carried combined as single string of values (e.g. “9-1-9”) . [↑](#footnote-ref-3)
4. The colour representation does not indicate the media component order in the file. [↑](#footnote-ref-4)
5. [↑](#footnote-ref-6)