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| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  34th Meeting: Marrakech, MA, 12–18 Jan. 2019 | Document: JCTVC-AH0026-v2 |

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| *Title:* | **Usage of video signal type code points: ICTCP** | | |
| *Status:* | Input document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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| *Source:* | Dolby Laboratories, Inc. | | |

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# Abstract

This JCT-VC input document requests that the ICTCP signal format specified by ITU-R BT.2100-1 be incorporated into the first version of the technical report “Usage of video signal type code points,” now Draft 5, in JCTVC-AG1003 (m45220), Macau, October 2018.

# Introduction

JCT-VC is developing a technical report on usage of video signal property description code points and their combinations that are widely used in production and video content workflows [1]. The current draft does not include the ICTCP signal format that is specified by ITU-R BT.2100 [2] despite its wide deployment.

The current draft of the technical report on usage of video signal property description code points and their combinations states that it is intended to “… aid in the automation of content workflows across various domains of capture, production, and distribution.” It also “…aims to help its readers, especially toolset developers, to repurpose tools to work properly across several domains (e.g., capture, production, production distribution, and service distribution) where similar video conversion functions (e.g., chroma sub-sampling or colour space conversions) may be performed.”

ICTCP is a colour representation designed for high dynamic range (HDR) and wide colour gamut (WCG) imagery. It is an operational replacement for Non-Constant Luminance (NCL) Y’C’BC’R [3] that provides the visual-quality benefits of Constant Luminance (CL) Y’CC’BC’R [3] for HDR and WCG signals.

ICTCP colour matrix transformation were specified in the fourth edition on HEVC (12/2016) [4] and the edition of AVC that was approved in 2017 [5].

ICTCP is widely supported:

* ICTCP is supported by widely-used and commercially significant open source video processing tools, including: x264, x265, ffmpeg, and VCL media player.
* ICTCP is supported by leading international vendors of professional test equipment, including: test equipment [6,7], professional test content [8], and reference monitors [9].
* ICTCP is supported by major consumer display manufacturers.
* ICTCP is currently used for prominent worldwide commercial video streaming services and supported in the ATSC 3.0 Digital Television System [10].

The ICTCP signal format should be included in the first version of the technical report to provide information to help the producers of various content processing and test tools avoid mistakes that can result in video quality degradation because of incorrect assumptions about video property combinations.

# Proposed text

Add the following text to the current draft of the technical report on usage video signal property description code points and their combinations [2].

## Section 4 Abbreviations

## Add the following text in the appropriate location in the alphabetic list:

## “ICTCP Constant Intensity signal format (as defined in Rec. ITU-R BT.2100)”

## Section 6 Workflow domains

### Add the text “ICTCP” in Figure 1. at the places indicated below (changes from original are highlighted):

Capture

Production w/ metadata

Service

distribution

Production

distribution

Theatrical/

Scripted TV

Live Events

* Non-linear colour transformations
* Chroma sub-sampling
* Colour representation transformation
* Bit depth reductions
* Chroma sub-sampling
* Colour representation transformation
* Bit depth reduction
* Metadata generation

4:4:4/4:2:2

RGB/Y′CbCr/ICTCP

16/12/10 bit

4:4:4/4:2:2

R′G′B′/Y′CbCr/ICTCP

16/12/10 bit

4:4:4/4:2:2

R′G′B′/Y′CbCr/ICTCP

16/12/10 bit

4:2:0

Y′CbCr/ICTCP

10/8 bit

### In the 6th paragraph, 3rd sentence, change to read (changes from original are highlighted):

“Operations reduce the content (e.g., to a 4:2:0 Y′CbCr 8 or 10 bit compressed stream using HEVC, AVC, or even MPEG-2 (Rec. ITU-T H.262 | ISO/IEC 13818-2)) for the compression representation.”

## Section 7 Common video signal type combinations

### Add the following highlighted row in Table 1:

**Table 1 – SD, HD, and UHD video colorimetry properties**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Tag** | **Colour** | | **Light** | | **Container space properties** | | |
| **Gamut** | **Primaries** | **Dynamic Range** | **Transfer function** | **Colour Represen‌tation** | **Integer code level scaling** | **4:2:0 chroma sample location alignment (ChromaLocType)** |
| **HD or SD** | BT601\_525 | NCG | BT.601 | SDR | BT.709 | Y′CbCr | Narrow | Vertically interstitial (ChromaLocType = 0) |
| BT601\_625 | Y′CbCr | Narrow | Vertically interstitial (ChromaLocType = 0) |
| BT709\_YCC | BT.709 | Y′CbCr | Narrow | Vertically interstitial (ChromaLocType = 0) |
| BT709\_RGB | R′G′B′ | Narrow | N/A |
| FR709\_RGB | R′G′B′ | Full | N/A |
| **UHD** | BT2020\_YCC\_NCL | WCG | BT.2020 | Y′CbCr | Narrow | Co-sited (ChromaLocType = 2) |
| BT2020\_RGB | R′G′B′ | Narrow | N/A |
| FR2020\_RGB | R′G′B′ | Full | N/A |
| BT2100\_PQ\_YCC | BT.2100 | HDR | PQ | Y′CbCr | Narrow | Co-sited (ChromaLocType = 2) |
| BT2100\_PQ\_ICTCP | ICTCP | Narrow | Co-sited (ChromaLocType = 2) |
| BT2100\_PQ\_RGB | R′G′B′ | Narrow | N/A |
| BT2100\_HLG\_YCC | HLG | Y′CbCr | Narrow | Co-sited (ChromaLocType = 2) |
| BT2100\_HLG\_RGB | R′G′B′ | Narrow | N/A |

### Add the following highlighted text in Table 2:

**Table 2 – Video colour description properties and their common usage**

|  |  |  |
| --- | --- | --- |
| **Carriage parameter names** | **Colloquial names** | **Common usage** |
| ColourPrimaries [CICP]  colour\_primaries [HEVC or AVC]  colour primaries [MXF] | Colour space, colour gamut | SDR video uses a Rec. ITU-R BT.709 colour representation. WCG video may restrict colour to the P3D65 gamut (SMPTE ST 2067-21) but in a Rec. ITU-R BT.2020 colour space container. HDR over time is expected to exhibit a more complete coverage of the Rec. ITU-R BT.2020 colour representation. |
| TransferCharacteristics [CICP]  transfer\_characteristics [HEVC or AVC]  transfer characteristic [MXF] | Transfer curves, log curves, gamma curves | HDR video uses either PQ or HLG. SDR video typically uses the transfer characteristic for Rec. ITU-R BT.709, assuming a display characteristic corresponding to Rec. ITU-R BT.1886. |
| MatrixCoefficients [CICP]  matrix\_coeffs [HEVC]  matrix\_coefficients [AVC]  coding equations [MXF] | Colour representation, GBR, NCL, YCC, ICTCP, YUV, Y′UV, R′G′B′ | Specifies the encoding equations to convert RGB image components to component colour difference image components. For R′G′B′ representations, no matrix applies, which is typically indicated by the value 0. (The colour representation notation does not indicate the media component order in a coded representation.) |
| VideoFullRangeFlag [CICP]  video\_full\_range\_flag [HEVC or AVC]  N/A [MXF] | Full range, narrow range, headroom, footroom, legal range, SMPTE range, QE.1, QE.2 | Y′CbCr colour representations ordinarily use narrow range scaling for video. |
| ChromaLocType [HEVC]  chroma\_sample\_loc\_type\_top\_field and chroma\_sample\_loc\_type\_bottom\_field [AVC or HEVC]  N/A [CICP or MXF] | 4:2:0 sub-sampled chroma location type | Indicates the horizontal and vertical positions of chroma samples (Cb, Cr, CT, CP) with respect to luma samples with sub-sample position accuracy. The alignment is typically horizontally co-sited with even-numbered columns of luma samples (indexed starting from 0). For SD and HD video, the alignment is typically vertically interstitial between rows of luma samples (ChromaLocType = 0). For UHD video, the alignment is typically vertically co-sited with even-numbered rows of luma samples (ChromaLocType = 0). |

### Add the following highlighted row in Table 3:

**Table 3 – Code point values widely used for colorimetry properties**

| **HEVC property** | **Code point value** | **Meaning** |
| --- | --- | --- |
| colour\_primaries | 1 | Rec. ITU-R BT.709 primaries |
| 5 | Rec. ITU-R BT.601 625-line systems primaries |
| 6 | Rec. ITU-R BT.601 525-line systems primaries |
| 9 | Rec. ITU-R BT.2020 and Rec. ITU-R BT.2100 primaries  (share the same code point since their values are identical) |
| transfer\_characteristics | 1, 6, 14, 15 | Rec. ITU-R BT.709, Rec. ITU-R BT.601, Rec. ITU-R BT.2020, and Rec. ITU-R BT.2100 transfer characteristics  (functionally equivalent values) |
| 16 | Rec. ITU-R BT.2100 PQ |
| 18 | Rec. ITU-R BT.2100 HLG (Hybrid Log-Gamma) |
| matrix\_coeffs | 0 | R′G′B′ (identity matrix applied to primaries after transfer function) |
| 1 | Y′CbCr for Rec. ITU-R BT.709 primaries |
| 5 | Y′CbCr for Rec. ITU-R BT.601 625-line primaries |
| 6 | Y′CbCr for Rec. ITU-R BT.601 525-line primaries |
| 9 | Y′CbCr for Rec. ITU-R BT.2020 and Rec. ITU-R BT.2100 primaries |
| 14 | ICTCP for Rec. ITU-R BT.2100 |
| ChromaLocType | 0 | Vertically interstitial, horizontally co-sited |
| 2 | Vertically co-sited, horizontally co-sited |

### Add the following highlighted item in the bullet list following first paragraph of Section 7.2.5:

“The following system identifier tags are described, as defined in Table 6:

* BT2100\_PQ\_YCC
* BT2100\_PQ\_ICTCP
* BT2100\_HLG\_YCC
* BT2100\_PQ\_RGB
* BT2100\_HLG\_RGB”

### Add the following highlighted column to Table 6:

**Table 6 – HDR WCG common colour volume descriptions**

|  | **System Identifier** | **BT2100\_PQ\_YCC** | **BT2100\_PQ\_ICTCP** | | **BT2100\_HLG\_YCC** | **BT2100\_PQ\_RGB** | **BT2100\_HLG\_RGB** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Colour properties** | Colour primaries | BT.2020 / BT.2100 | BT.2100 | | BT.2020 / BT.2100 | BT.2020 / BT.2100 | BT.2020 / BT.2100 |
| Transfer characteristics | BT.2100 PQ | BT.2100 PQ | | BT.2100 HLG | BT.2100 PQ | BT.2100 HLG |
| Colour representation | Y′CbCr | ICTCP | | Y′CbCr | R′G′B′ | R′G′B′ |
| **Other** | Full/narrow range | Narrow | Narrow | | Narrow | Narrow | Narrow |
| 4:2:0 chroma sample location alignment | Co-sited | Co-sited | | Co-sited | Co-sited | Co-sited |
| **CICP parameters** | ColourPrimaries | 9 | 9 | | 9 | 9 | 9 |
| TransferCharacteristics | 16 | 16 | | 18 | 16 | 18 |
| MatrixCoefficients | 9 | 14 | | 9 | 0 | 0 |
| VideoFullRangeFlag | 0 | 0 | | 0 | 0 | 0 |
| **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 | 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 reference level, white reference level, colour range | Inferred | | | | | |
| 4:2:0 chroma sample location alignment | Inferred (ChromaLocType = 2) | | | | | |

# References

1. JCTVC-AG1003 (m45220) “Usage of video signal type code points (Draft 5)” 33rd meeting of JCT-VC, Macau, October 2018.
2. Rec. ITU-R BT.2100-1 “Image parameter values for high dynamic range television for use in production and international programme exchange” (06/2017)
3. Rec. ITU-R BT.2020-2 “Parameter values for ultra-high definition television systems for production and international programme exchange” (10/2015)
4. Rec. ITU-T H.265 | ISO/IEC 23008-2 version 4 “High Efficiency Video Coding” (12/2016)
5. Rec. ITU-T H.264 | ISO/IEC 14496-10 “Advanced Video Coding” (04/2017)
6. “Video Clarity at IBC2016,” Video Clarity, 15-Jul-2016. [Online]. Available: https://videoclarity.com/video-clarity-at-ibc2016/. [Accessed: 19-Dec-2018].
7. “Color Volume Analysis Workflow” CalMAN. [Online]. Available: <http://www.spectracal.com/Documents/QSGs/Color_Volume_Analysis_SetupGuide.pdf>. [Accessed: 19-Dec-2019]
8. “SRI INTERNATIONAL,” IBC Show, 17-Aug-2018. [Online]. Available: https://show.ibc.org/node/8247. [Accessed: 19-Dec-2018].
9. “Canon extends reference display line-up with the 12G-SDI capable DP-V2421, DP-V1711 and firmware updates for improved 4K HDR workflow - Canon Press Centre.” [Online]. Available: https://www.canon-europe.com/press-centre/press-releases/2018/03/improved-4k-hdr-workflow/. [Accessed: 19-Dec-2018].
10. ATSC “ATSC Standard: Video – HEVC",” Doc. A/341:2018, Advanced Television Systems Committee, Washington, D.C., 28 August 2018.

# Patent rights declaration(s)

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