



H.264 : Support of additional colour spaces and removal of the High 4:4:4 Profile

Recommendation H.264 (2005) Amendment 1 (06/06)

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ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

H.264
Amendment 1
(06/2006)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS
Infrastructure of audiovisual services – Coding of moving
video

Advanced video coding for generic audiovisual
services

**Amendment 1: Support of additional colour
spaces and removal of the High 4:4:4 Profile**

ITU-T Recommendation H.264 (2005) – Amendment 1



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Advanced video coding for generic audiovisual services

Amendment 1

Support of additional colour spaces and removal of the High 4:4:4 Profile

Summary

This amendment contains, in the form of a list of changes, alterations to ITU-T Rec. H.264 | ISO/IEC 14496-10 Advanced Video Coding to specify the support of additional colour spaces and to remove the definition of the High 4:4:4 Profile.

NOTE – ITU-T Rec. H.264 is a twin text with ISO/IEC 14496-10 and this amendment is published in two different documents in the ISO/IEC series:

- The removal of the High 4:4:4 profile is found in ISO/IEC 14496-10:2005/Cor.2.
- The specification for support of additional colour space will be found in ISO/IEC 14496-10:2005/Amd.1 (currently under FPDAM stage of the ISO/IEC approval process).

Source

Amendment 1 to ITU-T Recommendation H.264 (2005) was approved on 13 June 2006 by ITU-T Study Group 16 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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Advanced video coding for generic audiovisual services

Amendment 1

Support of additional colour spaces and removal of the High 4:4:4 Profile

1) Clause 0.6 "Overview of the design characteristics"

In clause 0.6, replace the sentence:

With the exception of the transform bypass mode of operation for lossless coding in the High 4:4:4 profile and the I_PCM mode of operation in all profiles, the algorithm is typically not lossless, as the exact source sample values are typically not preserved through the encoding and decoding processes.

with

The algorithm is typically not lossless, as the exact source sample values are typically not preserved through the encoding and decoding processes.

2) Clause 0.7 "How to read this specification"

In clause 0.7, replace the sentence:

Annex A specifies seven profiles (Baseline, Main, Extended, High, High 10, High 4:2:2 and High 4:4:4), each being tailored to certain application domains, and defines the so-called levels of the profiles.

with

Annex A specifies six profiles (Baseline, Main, Extended, High, High 10 and High 4:2:2), each being tailored to certain application domains, and defines the so-called levels of the profiles.

3) Clause A.2.7 "High 4:4:4 profile"

Remove clause A.2.7.

4) Clause A.3.2 "Level limits common to the High, High 10, High 4:2:2, and High 4:4:4 profiles"

a) *Replace the title of clause A.3.2 with:*

Level limits common to the High, High 10, and High 4:2:2 profiles

b) *In clause A.3.2, replace the sentence:*

Bitstreams conforming to the High, High 10, High 4:2:2, or High 4:4:4 profiles at a specified level shall obey the following constraints:

with

Bitstreams conforming to the High, High 10, or High 4:2:2 profiles at a specified level shall obey the following constraints:

5) Clause A.3.3 "Profile-specific limits"

a) *In clause A.3.3 replace all occurrences of:*

In bitstreams conforming to the Main, High, High 10, High 4:2:2, or High 4:4:4

with

In bitstreams conforming to the Main, High, High 10, or High 4:2:2

b) *In clause A.3.3 replace all occurrences of:*

In bitstreams conforming to the High, High 10, High 4:2:2, or High 4:4:4 profiles

with

In bitstreams conforming to the High, High 10, or High 4:2:2 profiles

c) *In clause A.3.3 replace all occurrences of:*

... in Table A-4 for the Main, High, High 10, High 4:2:2, and High 4:4:4 profiles ...

with

... in Table A-4 for the Main, High, High 10, and High 4:2:2 profiles ...

d) *In clause A.3.3, replace Table A-2 with the following:*

Profile	cpbBrVclFactor	cpbBrNalFactor
High	1 250	1 500
High 10	3 000	3 600
High 4:2:2	4 000	4 800

6) Clause A.3.3.2 "Main, High, High 10, High 4:2:2, or High 4:4:4 profile limits"

a) *Replace the title of clause A.3.3.2 with:*

Main, High, High 10, and High 4:2:2 profile limits

b) *In clause A.3.3.2, replace the sentence:*

Table A-4 specifies limits for each level that are specific to bitstreams conforming to the Main, High, High 10, High 4:2:2, or High 4:4:4 profiles.

with

Table A-4 specifies limits for each level that are specific to bitstreams conforming to the Main, High, High 10, or High 4:2:2 profiles.

c) *In clause A.3.3.2, replace the title of Table A-4 with:*

Table A-4 – Main, High, High 10, or High 4:2:2 profile level limits

7) Clause E.2

a) *In clause E.2, replace Table E-3 with the following:*

Table E-3 – Colour primaries

Value	Primaries	Informative Remark															
0	Reserved	For future use by ITU-T ISO/IEC															
1	<table border="0"> <tr> <td>primary</td> <td>x</td> <td>y</td> </tr> <tr> <td>green</td> <td>0.300</td> <td>0.600</td> </tr> <tr> <td>blue</td> <td>0.150</td> <td>0.060</td> </tr> <tr> <td>red</td> <td>0.640</td> <td>0.330</td> </tr> <tr> <td>white D65</td> <td>0.3127</td> <td>0.3290</td> </tr> </table>	primary	x	y	green	0.300	0.600	blue	0.150	0.060	red	0.640	0.330	white D65	0.3127	0.3290	ITU-R Rec. BT.709-5, ITU-R Rec. BT.1361 conventional colour gamut system and extended colour gamut system, IEC 61966-2-4
primary	x	y															
green	0.300	0.600															
blue	0.150	0.060															
red	0.640	0.330															
white D65	0.3127	0.3290															

Table E-3 – Colour primaries

Value	Primaries	Informative Remark
2	Unspecified	Image characteristics are unknown or are determined by the application.
3	Reserved	
4	primary x y green 0.21 0.71 blue 0.14 0.08 red 0.67 0.33 white C 0.310 0.316	ITU-R Rec. BT.470-6 System M
5	primary x y green 0.29 0.60 blue 0.15 0.06 red 0.64 0.33 white D65 0.3127 0.3290	ITU-R Rec. BT.470-6 System B, G
6	primary x y green 0.310 0.595 blue 0.155 0.070 red 0.630 0.340 white D65 0.3127 0.3290	Society of Motion Picture and Television Engineers 170M (1999)
7	primary x y green 0.310 0.595 blue 0.155 0.070 red 0.630 0.340 white D65 0.3127 0.3290	Society of Motion Picture and Television Engineers 240M (1999)
8	primary x y green 0.243 0.692 (Wratten 58) blue 0.145 0.049 (Wratten 47) red 0.681 0.319 (Wratten 25) white C 0.310 0.316	Generic film (colour filters using Illuminant C)
9-255	Reserved	For future use by ITU-T ISO/IEC

b) *In clause E.2, replace Table E-4 with the following:*

Table E-4 – Transfer characteristics

Value	Transfer Characteristic	Informative Remark
0	Reserved	For future use by ITU-T ISO/IEC
1	$V = 1.099 * L_c^{0.45} - 0.099$ for $1 \geq L_c \geq 0.018$ $V = 4.500 * L_c$ for $0.018 > L_c \geq 0$	ITU-R Rec. BT.709-5, ITU-R Rec. BT.1361 conventional colour gamut system
2	Unspecified	Image characteristics are unknown or are determined by the application.
3	Reserved	For future use by ITU-T ISO/IEC
4	Assumed display gamma 2.2	ITU-R Rec. BT.470-6 System M
5	Assumed display gamma 2.8	ITU-R Rec. BT.470-6 System B, G
6	$V = 1.099 * L_c^{0.45} - 0.099$ for $1 \geq L_c \geq 0.018$ $V = 4.500 * L_c$ for $0.018 > L_c \geq 0$	Society of Motion Picture and Television Engineers 170M (1999)
7	$V = 1.1115 * L_c^{0.45} - 0.1115$ for $1 \geq L_c \geq 0.0228$ $V = 4.0 * L_c$ for $0.0228 > L_c \geq 0$	Society of Motion Picture and Television Engineers 240M (1999)
8	$V = L_c$ for $1 > L_c \geq 0$	Linear transfer characteristics

Table E-4 – Transfer characteristics

Value	Transfer Characteristic	Informative Remark	
9	$V = 1.0 - \text{Log}_{10}(L_c) \div 2$ $V = 0.0$	for $1 \geq L_c \geq 0.01$ for $0.01 > L_c \geq 0$	Logarithmic transfer characteristic (100:1 range)
10	$V = 1.0 - \text{Log}_{10}(L_c) \div 2.5$ $V = 0.0$	for $1 \geq L_c \geq 0.0031622777$ for $0.0031622777 > L_c \geq 0$	Logarithmic transfer characteristic (316.22777:1 range)
11	$V = 1.099 * L_c^{0.45} - 0.099$ $V = 4.500 * L_c$ $V = -1.099 * (-L_c)^{0.45} + 0.099$	for $L_c \geq 0.018$ for $0.018 > L_c > -0.018$ for $-0.018 \geq L_c$	IEC 61966-2-4
12	$V = 1.099 * L_c^{0.45} - 0.099$ $V = 4.500 * L_c$ $V = -(1.099 * (-4 * L_c)^{0.45} - 0.099) \div 4$	for $1.33 > L_c \geq 0.018$ for $0.018 > L_c \geq -0.0045$ for $-0.0045 > L_c \geq -0.25$	ITU-R Rec. BT.1361 extended colour gamut system
13..255	Reserved		For future use by ITU-T ISO/IEC

c) *In clause E.2, replace the semantics of matrix_coefficients and Table E-5 with:*

matrix_coefficients describes the matrix coefficients used in deriving luma and chroma signals from the green, blue, and red primaries, as specified in Table E-5.

matrix_coefficients shall not be equal to 0 unless both of the following conditions are true

- BitDepth_C is equal to BitDepth_Y
- chroma_format_idc is equal to 3 (4:4:4)

The specification of the use of matrix_coefficients equal to 0 under all other conditions is reserved for future use by ITU-T | ISO/IEC.

matrix_coefficients shall not be equal to 8 unless one or both of the following conditions are true

- BitDepth_C is equal to BitDepth_Y
- BitDepth_C is equal to BitDepth_Y + 1 and chroma_format_idc is equal to 3 (4:4:4)

The specification of the use of matrix_coefficients equal to 8 under all other conditions is reserved for future use by ITU-T | ISO/IEC.

When the matrix_coefficients syntax element is not present, the value of matrix_coefficients shall be inferred to be equal to 2.

The interpretation of matrix_coefficients is defined as follows.

- If transfer_characteristics is not equal to 11 or 12, E'_R, E'_G, and E'_B are analog with values in the range of 0 to 1.
- Otherwise (transfer_characteristics is equal to 11 (IEC 61966-2-4) or 12 (ITU-R BT.1361 extended colour gamut system)), E'_R, E'_G and E'_B are analog with a larger range not specified in this Recommendation.
- Nominal white is specified as having E'_R equal to 1, E'_G equal to 1, and E'_B equal to 1.
- Nominal black is specified as having E'_R equal to 0, E'_G equal to 0, and E'_B equal to 0.
- If video_full_range_flag is equal to 0, the following equations apply.
 - If matrix_coefficients is equal to 1, 4, 5, 6, or 7, the following equations apply.

$$Y = \text{Clip}_{1Y}(\text{Round}((1 \ll (\text{BitDepth}_Y - 8)) * (219 * E'_Y + 16))) \quad (\text{E-1})$$

$$Cb = \text{Clip}_{1C}(\text{Round}((1 \ll (\text{BitDepth}_C - 8)) * (224 * E'_{PB} + 128))) \quad (\text{E-2})$$

$$Cr = \text{Clip}_{1C}(\text{Round}((1 \ll (\text{BitDepth}_C - 8)) * (224 * E'_{PR} + 128))) \quad (\text{E-3})$$

- Otherwise, if `matrix_coefficients` is equal to 0 or 8, the following equations apply.

$$R = \text{Clip1}_C((1 \ll (\text{BitDepth}_Y - 8)) * (219 * E'_R + 16)) \quad (\text{E-4})$$

$$G = \text{Clip1}_Y((1 \ll (\text{BitDepth}_Y - 8)) * (219 * E'_G + 16)) \quad (\text{E-5})$$

$$B = \text{Clip1}_C((1 \ll (\text{BitDepth}_Y - 8)) * (219 * E'_B + 16)) \quad (\text{E-6})$$

- Otherwise, if `matrix_coefficients` is equal to 2, the interpretation of the `matrix_coefficients` syntax element is unknown or is determined by the application.
- Otherwise (`matrix_coefficients` is not equal to 0, 1, 2, 4, 5, 6, 7, or 8), the interpretation of the `matrix_coefficients` syntax element is reserved for future definition by ITU-T | ISO/IEC.
- Otherwise (`video_full_range_flag` is equal to 1), the following equations apply.
 - If `matrix_coefficients` is equal to 1, 4, 5, 6, or 7, the following equations apply.

$$Y = \text{Clip1}_Y(\text{Round}(((1 \ll \text{BitDepth}_Y) - 1) * E'_Y)) \quad (\text{E-7})$$

$$Cb = \text{Clip1}_C(\text{Round}(((1 \ll \text{BitDepth}_C) - 1) * E'_{PB} + (1 \ll (\text{BitDepth}_C - 1)))) \quad (\text{E-8})$$

$$Cr = \text{Clip1}_C(\text{Round}(((1 \ll \text{BitDepth}_C) - 1) * E'_{PR} + (1 \ll (\text{BitDepth}_C - 1)))) \quad (\text{E-9})$$

- Otherwise, if `matrix_coefficients` is equal to 0 or 8, the following equations apply.

$$R = \text{Clip1}_Y(((1 \ll \text{BitDepth}_Y) - 1) * E'_R) \quad (\text{E-10})$$

$$G = \text{Clip1}_Y(((1 \ll \text{BitDepth}_Y) - 1) * E'_G) \quad (\text{E-11})$$

$$B = \text{Clip1}_Y(((1 \ll \text{BitDepth}_Y) - 1) * E'_B) \quad (\text{E-12})$$

- Otherwise, if `matrix_coefficients` is equal to 2, the interpretation of the `matrix_coefficients` syntax element is unknown or is determined by the application.
- Otherwise (`matrix_coefficients` is not equal to 0, 1, 2, 4, 5, 6, 7, or 8), the interpretation of the `matrix_coefficients` syntax element is reserved for future definition by ITU-T | ISO/IEC.
- If `matrix_coefficients` is not equal to 0 or 8, the following equations apply.

$$E'_Y = K_R * E'_R + (1 - K_R - K_B) * E'_G + K_B * E'_B \quad (\text{E-13})$$

$$E'_{PB} = 0.5 * (E'_B - E'_Y) \div (1 - K_B) \quad (\text{E-14})$$

$$E'_{PR} = 0.5 * (E'_R - E'_Y) \div (1 - K_R) \quad (\text{E-15})$$

NOTE 2 – E'_Y is analog with the value 0 associated with nominal black and the value 1 associated with nominal white. E'_{PB} and E'_{PR} are analog with the value 0 associated with both nominal black and nominal white. When `transfer_characteristics` is not equal to 11 or 12, E'_Y is analog with values in the range of 0 to 1. When `transfer_characteristics` is not equal to 11 or 12, E'_{PB} and E'_{PR} are analog with values in the range of -0.5 to 0.5. When `transfer_characteristics` is equal to 11 (IEC 61966-2-4), or 12 (ITU-R BT.1361 extended colour gamut system), E'_Y , E'_{PB} and E'_{PR} are analog with a larger range not specified in this Recommendation.

- Otherwise, if `matrix_coefficients` is equal to 0, the following equations apply.

$$Y = \text{Round}(G) \quad (\text{E-16})$$

$$Cb = \text{Round}(B) \quad (\text{E-17})$$

$$Cr = \text{Round}(R) \quad (\text{E-18})$$

- Otherwise (`matrix_coefficients` is equal to 8), the following applies.
 - If `BitDepthC` is equal to `BitDepthY`, the following equations apply.

$$Y = \text{Round}(0.5 * G + 0.25 * (R + B)) \quad (\text{E-19})$$

$$Cb = \text{Round}(0.5 * G - 0.25 * (R + B)) + (1 \ll (\text{BitDepth}_C - 1)) \quad (\text{E-20})$$

$$Cr = \text{Round}(0.5 * (R - B)) + (1 \ll (\text{BitDepth}_C - 1)) \quad (\text{E-21})$$

NOTE 3 – For purposes of the YCgCo nomenclature used in Table E-5, Cb and Cr of Equations E-20 and E-21 may be referred to as Cg and Co, respectively. The inverse conversion for the above four equations should be computed as.

$$t = Y - (Cb - (1 \ll (\text{BitDepth}_C - 1))) \quad (\text{E-22})$$

$$G = \text{Clip1}_Y(Y + (Cb - (1 \ll (\text{BitDepth}_C - 1)))) \quad (\text{E-23})$$

$$B = \text{Clip1}_Y(t - (Cr - (1 \ll (\text{BitDepth}_C - 1)))) \quad (\text{E-24})$$

$$R = \text{Clip1}_Y(t + (Cr - (1 \ll (\text{BitDepth}_C - 1)))) \quad (\text{E-25})$$

- Otherwise (`BitDepthC` is not equal to `BitDepthY`), the following equations apply.

$$Cr = \text{Round}(R) - \text{Round}(B) + (1 \ll (\text{BitDepth}_C - 1)) \quad (\text{E-26})$$

$$t = \text{Round}(B) + ((Cr - (1 \ll (\text{BitDepth}_C - 1))) \gg 1) \quad (\text{E-27})$$

$$Cb = \text{Round}(G) - t + (1 \ll (\text{BitDepth}_C - 1)) \quad (\text{E-28})$$

$$Y = t + ((Cb - (1 \ll (\text{BitDepth}_C - 1))) \gg 1) \quad (\text{E-29})$$

NOTE 4 – For purposes of the YCgCo nomenclature used in Table E-5, Cb and Cr of Equations E-28 and E-26 may be referred to as Cg and Co, respectively. The inverse conversion for the above four equations should be computed as.

$$t = Y - ((Cb - (1 \ll (\text{BitDepth}_C - 1))) \gg 1) \quad (\text{E-30})$$

$$G = \text{Clip1}_Y(t + (Cb - (1 \ll (\text{BitDepth}_C - 1)))) \quad (\text{E-31})$$

$$B = \text{Clip1}_Y(t - ((Cr - (1 \ll (\text{BitDepth}_C - 1))) \gg 1)) \quad (\text{E-32})$$

$$R = \text{Clip1}_Y(B + (Cr - (1 \ll (\text{BitDepth}_C - 1)))) \quad (\text{E-33})$$

Table E-5 – Matrix coefficients

Value	Matrix	Informative remark
0	GBR	Typically referred to as RGB; see Equations E-16 to E-18
1	$K_R = 0.2126; K_B = 0.0722$	ITU-R Rec. BT.709-5, ITU-R Rec. BT.1361 conventional colour gamut system and extended colour gamut system, IEC 61966-2-4 xvYCC ₇₀₉ , Society of Motion Picture and Television Engineers RP 177 (1993)
2	Unspecified	Image characteristics are unknown or are determined by the application.
3	Reserved	For future use by ITU-T ISO/IEC
4	$K_R = 0.30; K_B = 0.11$	United States Federal Communications Commission Title 47 Code of Federal Regulations (2003) 73.682 (a) (20)
5	$K_R = 0.299; K_B = 0.114$	ITU-R Rec. BT.470-6 System B, G, IEC 61966-2-4 xvYCC ₆₀₁
6	$K_R = 0.299; K_B = 0.114$	Society of Motion Picture and Television Engineers 170M (1999)
7	$K_R = 0.212; K_B = 0.087$	Society of Motion Picture and Television Engineers 240M (1999)
8	YCgCo	See Equations E-19 to E-33
9-255	Reserved	For future use by ITU-T ISO/IEC

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