

I n t e r n a t i o n a l T e l e c o m m u n i c a t i o n U n i o n

**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

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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**

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.

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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<sub>C</sub> is equal to BitDepth<sub>Y</sub>
- 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<sub>C</sub> is equal to BitDepth<sub>Y</sub>
- BitDepth<sub>C</sub> is equal to BitDepth<sub>Y</sub> + 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'<sub>R</sub>, E'<sub>G</sub>, and E'<sub>B</sub> 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'<sub>R</sub>, E'<sub>G</sub> and E'<sub>B</sub> are analog with a larger range not specified in this Recommendation.
- Nominal white is specified as having E'<sub>R</sub> equal to 1, E'<sub>G</sub> equal to 1, and E'<sub>B</sub> equal to 1.
- Nominal black is specified as having E'<sub>R</sub> equal to 0, E'<sub>G</sub> equal to 0, and E'<sub>B</sub> 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**

<b>Value</b>	<b>Matrix</b>	<b>Informative remark</b>
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 <sub>709</sub> , 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 <sub>601</sub>
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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