Parameter Values for the Hybrid Log-Gamma (HLG) High Dynamic Range Television (HDR-TV) System for Programme Production

ARIB STANDARD

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Association of Radio Industries and Businesses

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Foreword

The Association of Radio Industries and Businesses (ARIB) investigates and summarizes the basic technical requirements for various radio systems in the form of "ARIB Standards". These standards are developed with the participation of and through discussions amongst radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

ARIB Standards include "government technical regulations" (mandatory standard) that are set for the purpose of encouraging effective use of frequency and preventing interference with other spectrum users, and "private technical standards" (voluntary standards) that are defined in order to ensure compatibility and adequate quality of radio equipment and broadcasting equipment as well as to offer greater convenience to radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

This ARIB Standard is developed for "Parameter Values for the Hybrid Log-Gamma (HLG) High Dynamic Range Television (HDR-TV) System for Programme Production". In order to ensure fairness and transparency in the defining stage, the standard was set by consensus at the ARIB Standard Assembly with the participation of both domestic and foreign interested parties from radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

ARIB sincerely hopes that this ARIB Standard will be widely used by radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

NOTE:

Although this ARIB Standard contains no specific reference to any Essential Industrial Property Rights relating thereto, the holders of such Essential Industrial Property Rights state to the effect that the rights listed in the Attachment 1 and 2, which are the Industrial Property Rights relating to this standard, are held by the parties also listed therein, and that to the users of this standard, in the case of Attachment 1, such holders shall not assert any rights and shall unconditionally grant a license to practice such Industrial Property Rights contained therein, and in the case of Attachment 2, the holders shall grant, under reasonable terms and conditions, a non-exclusive and non-discriminatory license to practice the Industrial Property Rights contained therein. However, this does not apply to anyone who uses this ARIB Standard and also owns and lays claim to any other Essential Industrial Property Rights of which is covered in whole or part in the contents of the provisions of this ARIB Standard.

Attachment 1 (selection of option 1)
（N/A）

Attachment 2 (selection of option 2)
（N/A）

Contents

Chapter 1 General Descriptions

1.1 Objective

This standard specifies the system parameters for the Hybrid Log-Gamma (HLG) high dynamic range television (HDR-TV) including image spatial and temporal characteristics, system colorimetry, signal format and digital representation. The signal format is characterized by opto-electronic transfer function (OETF).

1.2 Scope

This standard applies to the video equipment for programme production of the Hybrid Log-Gamma (HLG) high dynamic range television (HDR-TV).

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Chapter 2 System parameters for HDR-TV

2.1 Image spatial and temporal characteristics

The image spatial and temporal characteristics specified in TABLE 2-1 should be used for HDR-TV.

2.2 System colorimetry

The system colorimetry specified in TABLE 2-2 should be used for HDR-TV.

2.3 Signal format

The signal format specified in TABLE 2-3 should be used for HDR-TV.

2.4 Digital representation

The digital representation specified in TABLE 2-4 should be used for HDR-TV.

TABLE 2-1 Image spatial and temporal characteristics

Parameter	Values
Image Container[1] Shape	16:9
Container Pixel count Horizontal × Vertical	7 680 × 4 320 3 840 × 2 160 1 920 × 1 080
Sampling lattice	Orthogonal
Pixel aspect ratio	1:1 (square pixels)
Pixel addressing	Pixel ordering in each row is from left to right, and rows are ordered from top to bottom.
Frame frequency (Hz)	120, 120/1.001, 60, 60/1.001
Image Format	Progressive

NOTE 1 – Container is used to define the horizontal and vertical constraints of the image format.

TABLE 2-2 System colorimetry

Parameter	Values		
Opto-electronic transfer characteristics before non-linear pre-correction	Assumed linear		
Primary colours and reference white[2]	Chromaticity coordinates (CIE, 1931)	x	y
	Red primary (R)	0.708	0.292
	Green primary (G)	0.170	0.797
	Blue primary (B)	0.131	0.046
	Reference white (D65)	0.3127	0.3290

NOTE 2 – The colorimetric values of the picture information can be determined based on the reference RGB primaries and the reference white.

TABLE 2-3 Signal format

Parameter	Values
Signal format	R', G', B' or Y', C'_B, C'_R
Reference opto-electronic transfer function (OETF)	$E' = \mathrm{OETF}\left[E\right] = \begin{cases} \sqrt{3E} & 0 \le E \le 1/12 \\ a \cdot \ln\left(12E - b\right) + c & 1/12 < E \le 1 \end{cases}$ where E is the signal for each colour component $\{R_S, G_S, B_S\}$ proportional to scene linear light and scaled by camera exposure, normalized to the range [0:1]. E' is the resulting non-linear signal $\{R', G', B'\}$. $a = 0.17883277,\ b = 1 - 4a,\ c = 0.5 - a \cdot \ln\left(4a\right)^3$
Derivation of Y'	$Y' = 0.2627R' + 0.6780G' + 0.0593B'$
Derivation of colour difference signals	$C'_B = \dfrac{B' - Y'}{1.8814}$ $C'_R = \dfrac{R' - Y'}{1.4746}$

NOTE 3 – The values of b and c are calculated to $b = 0.28466892$, $c = 0.55991073$.

TABLE 2-4 Digital representation

<table>
<tr><th>Parameter</th><th colspan="4">Values</th></tr>
<tr><td>Coded signal</td><td colspan="4">R', G', B' or Y', C'_B, C'_R</td></tr>
<tr><td>Sampling lattice
– R', G', B', Y'</td><td colspan="4">Orthogonal, line and picture repetitive co-sited</td></tr>
<tr><td rowspan="3">Sampling lattice
– C'_B, C'_R</td><td colspan="4">Orthogonal, line and picture repetitive co-sited with each other.
The first (top-left) sample is co-sited with the first Y' samples.</td></tr>
<tr><td>4:4:4 system</td><td colspan="2">4:2:2 system</td><td>4:2:0 system</td></tr>
<tr><td>Each has the same number of horizontal samples as the Y' component.</td><td colspan="2">Horizontally subsampled by a factor of two with respect to the Y' component.</td><td>Horizontally and vertically subsampled by a factor of two with respect to the Y' component.</td></tr>
<tr><td>Coding format</td><td colspan="4">10 or 12 bits per component</td></tr>
<tr><td>Quantization of R', G', B', Y', C'_B, C'_R</td><td colspan="4">$DR' = \text{Round}\,[(219 \times R' + 16) \times 2^{n-8}]$
$DG' = \text{Round}\,[(219 \times G' + 16) \times 2^{n-8}]$
$DB' = \text{Round}\,[(219 \times B' + 16) \times 2^{n-8}]$
$DY' = \text{Round}\,[(219 \times Y' + 16) \times 2^{n-8}]$
$DC'_B = \text{Round}\,[(224 \times C'_B + 128) \times 2^{n-8}]$
$DC'_R = \text{Round}\,[(224 \times C'_R + 128) \times 2^{n-8}]$
Where:
Round(x) = Sign(x) * Floor(| x | + 0.5)
Floor(x) = the largest integer less than or equal to x
$\text{Sign}(x) = \begin{cases} 1 & ; \ x > 0 \\ 0 & ; \ x = 0 \\ -1 & ; \ x < 0 \end{cases}$
The n represents the bit depth of coding format.</td></tr>
<tr><td colspan="2">Quantization levels</td><td colspan="2">10-bit coding</td><td>12-bit coding</td></tr>
<tr><td colspan="2">Timing Reference</td><td colspan="2">0 - 3 and 1 020 - 1 023</td><td>0 - 15 and 4 080 - 4 095</td></tr>
<tr><td colspan="2">Video data</td><td colspan="2">4 - 1 019</td><td>16 - 4 079</td></tr>
<tr><td rowspan="2">DR', DG', DB', DY'</td><td>Nominal Peak (100%)</td><td colspan="2">940</td><td>3 760</td></tr>
<tr><td>Black (0%)</td><td colspan="2">64</td><td>256</td></tr>
<tr><td rowspan="3">DC'_B, DC'_R</td><td>Nominal Peak (+50%)</td><td colspan="2">960</td><td>3 840</td></tr>
<tr><td>Achromatic (0%)</td><td colspan="2">512</td><td>2 048</td></tr>
<tr><td>Nominal Peak (-50%)</td><td colspan="2">64</td><td>256</td></tr>
</table>

Version 2.0 Revision History

Page	Item No.	Description	Reason
	Title and Foreword	~~Essential~~ Parameter Values for the Hybrid Log-Gamma (HLG) ~~Extended Image~~ High Dynamic Range Television (~~EI~~HDR-TV) System for Programme Production	Clarification of specified contents.
1	1.1	This standard specifies the system parameters ~~essential~~ for the Hybrid Log-Gamma (HLG)~~extended image~~ high dynamic range television (~~EI~~HDR-TV) including image spatial and temporal characteristics, system colorimetry, signal format and digital representation. The signal format is characterized by opto-electronic transfer function (OETF). ~~For the other system parameters, other television system standards may be referred to.~~	Ensure consistency with ITU-R BT.2100-1.
1	1.2	(Editorial revision due to title change.)	
1	Footnote 1	(Delete all text because it is no longer needed.)	
3	Chapter title	(Editorial revision due to title change.)	
3	2.1	(Add full text to ensure consistency with Recommendation ITU-R BT.2100-1.)	
3	2.2 - 2.4	(Renumber the sections 2.1 – 2.3 to the sections 2.2 – 2.4 due to newly added section 2.1.)	
4	TABLE 2-1	(Add the whole table to ensure consistency with Recommendation ITU-R BT.2100-1.)	
4	TABLE 2-2	(Renumber TABLE 2-1 and NOTE 1 to TABLE 2-2 and NOTE 2, respectively, due to the insertion of TABLE 2-1 and NOTE 1, and fix a typo.)	
4 - 7	TABLE 2-3 ~ 2-4	(Renumber TABLEs 2-2 and 2-3 to TABLEs 2-3 and 2-4, respectively.)	
5	TABLE 2-3	(Use the same mathematical expression as Recommendation ITU-R BT.2100-1.)	
6	TABLE 2-4	(Use the same mathematical expression as Recommendation ITU-R BT.2100-1, and delete constant “r”.)	

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ARIB Standard Name (No.)	**Parameter Values for the Hybrid Log-Gamma (HLG) High Dynamic Range Television (HDR-TV) System for Programme Production**		
Sections to be completed by sender			
Name:		Date	/ / /
TEL:	FAX: E-mail:		
Company name Department name			
Page / Section	(Please describe your proposal or present your questions or comments in concrete terms.)		
(Response)		Sections to be completed by secretariat	
		Date of receipt	/ / /
Classification:		Ref. No.	—
		Remarks	

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If you complete this form in English, please provide Japanese translation alongside the English.

Parameter Values for the Hybrid Log-Gamma (HLG) High Dynamic Range Television (HDRTV) System for Programme Production

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