



Recommendation ITU-R BT.2100-2
(07/2018)

**Image parameter values for high dynamic
range television for use in production and
international programme exchange**

BT Series
Broadcasting service
(television)



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Foreword

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Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R BT.2100-2¹**Image parameter values for high dynamic range television for use in production and international programme exchange**

Question ITU-R 142-2/6

(2016-2017-2018)

Scope

High Dynamic Range Television (HDR-TV) provides viewers with an enhanced visual experience by providing images that have been produced to look correct on brighter displays, that provide much brighter highlights, and that provide improved detail in dark areas. This Recommendation specifies HDR-TV image parameters for use in production and international programme exchange using the Perceptual Quantization (PQ) and Hybrid Log-Gamma (HLG) methods.

Keywords

High dynamic range, HDR, television, HDR-TV, image system parameters, television production, international programme exchange, wide colour gamut, perceptual quantization, PQ, hybrid log-gamma, HLG

The ITU Radiocommunication Assembly,

considering

- a) that digital television image formats for HDTV and UHDTV have been specified by the ITU-R in Recommendations ITU-R BT.709 and ITU-R BT.2020;
- b) that these television image formats have been limited in the image dynamic range they can provide due to their reliance on legacy cathode ray tube (CRT) characteristics that limit image brightness and detail in dark areas;
- c) that modern displays are capable of reproducing images at a higher luminance, greater contrast ratio and wider colour gamut than is conventionally employed in programme production;
- d) that viewers expect future television viewing to provide improved characteristics compared with the current HDTV and UHDTV in terms of a more realistic sensation, greater transparency to the real world and more accurate visual information;
- e) that high dynamic range television (HDR-TV) has been shown to increase viewer enjoyment of television pictures;
- f) that HDR-TV provides a “step-change” improvement in viewer experience by means of substantially increased brightness and detail in highlights and diffuse reflecting objects, while providing greater detail in dark areas;
- g) that the combination of extended dynamic range and extended colour gamut give HDR-TV a substantially larger colour volume;

¹ Revisions to parameter values within this document should be compared to those in the previously published version of this Recommendation.

h) that the HDR-TV image formats should have, where appropriate, a degree of compatibility with existing workflows and infrastructure;

i) that a reference viewing environment including display parameters should be defined for HDR-TV image formats,

further considering

that due to rapid developments in HDR technology the ITU may wish to consider early updates and improvements to this Recommendation,

recognizing

that Report ITU-R BT.2390 contains much information on two methods to achieve HDR-TV,

recommends

that for programme production and international exchange of HDR-TV, the perceptual quantization (PQ) or Hybrid Log-Gamma (HLG) specifications described in this Recommendation should be used.

NOTE – The PQ specification achieves a very wide range of brightness levels for a given bit depth using a non-linear transfer function that is finely tuned to match the human visual system. The HLG specification offers a degree of compatibility with legacy displays by more closely matching the previously established television transfer curves. Report ITU-R BT.2390 provides additional information on PQ and HLG, conversion between them, and compatibility with previous systems.

TABLE 1
Image spatial and temporal characteristics

Parameter	Values
Image Container ^{1a} Shape	16:9
Container Pixel count ^{1b} 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, 100, 60, 60/1.001, 50, 30, 30/1.001, 25, 24, 24/1.001
Image Format	Progressive

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

Note 1b – Productions should use the highest resolution image format that is practical. It is recognized that in many cases high resolution productions will be down-sampled to lower resolution formats for distribution. It is known that producing in a higher resolution format, and then electronically down-sampling for distribution, yields superior quality than producing at the resolution used for distribution.

TABLE 2
System colorimetry

Parameter		Values		
		Optical spectrum (informative)	Chromaticity coordinates (CIE, 1931)	
			x	y
Primary colours	Red primary (R)	monochromatic 630 nm	0.708	0.292
	Green primary (G)	monochromatic 532 nm	0.170	0.797
	Blue primary (B)	monochromatic 467 nm	0.131	0.046
Reference white		D65 per ISO 11664-2:2007	0.3127	0.3290
Colour Matching Functions		CIE 1931		

Table 3 specifies parameters to establish a reference viewing environment for critical viewing of HDR programme material or completed programmes that can provide repeatable results from one facility to another when viewing the same material. Viewing facilities can and will continue to be established in many ways by entities involved in editing, colour correction, screening and the like, and the specifications in this Table are not intended to suggest a need for absolute uniformity in such facilities.

TABLE 3
Reference viewing environment for critical viewing of HDR programme material

Parameter	Values
Surround and periphery ^{3a}	Neutral grey at D65
Luminance of surround	5 cd/m ²
Luminance of periphery	≤ 5 cd/m ²
Ambient lighting	Avoid light falling on the screen
Viewing distance ^{3b}	For 1 920 × 1 080 format: 3.2 picture heights For 3 840 × 2 160 format: 1.6 to 3.2 picture heights For 7 680 × 4 320 format: 0.8 to 3.2 picture heights
Peak luminance of display ^{3c}	≥ 1 000 cd/m ²
Minimum luminance of display (black level) ^{3d}	≤ 0.005 cd/m ²

Note 3a – “Surround” is the area surrounding a display that can affect the adaptation of the eye, typically the wall or curtain behind the display; “periphery” is the remaining environment outside of the surround.

Note 3b – When picture evaluation involves resolution, the lower value of viewing distance should be used. When resolution is not being evaluated, any viewing distance in the indicated range may be used.

Note 3c – This is not to imply this level of luminance must be achieved for full screen white, rather for small area highlights.

Note 3d – For PQ in a non-reference viewing environment, or for HLG (in any viewing environment), the black level should be adjusted using the PLUGE test signal and procedure specified in Recommendation ITU-R BT.814.