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| **Recommendation ITU-R BT.2111-0**  **(12/2017)** |
| **Specification of colour bar test pattern for high dynamic range television systems** |
| **BT Series**  **Broadcasting service**  **(television)** |

Foreword

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| Series of ITU-R Recommendations  (Also available online at <http://www.itu.int/publ/R-REC/en>) | |
| **Series** | Title |
| **BO** | Satellite delivery |
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| **BS** | Broadcasting service (sound) |
| BT | Broadcasting service (television) |
| **F** | Fixed service |
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| **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 |

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| ***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.2111-0

Specification of colour bar test pattern for high dynamic   
range television systems

(Question 142-2/6)

(2017)

Scope

This Recommendation specifies reference test patterns for the high dynamic range television systems specified in Recommendation ITU‑R BT.2100.

Keywords

Test pattern, test signal, HDR, HDR-TV, colour bars, PQ, HLG

The ITU Radiocommunication Assembly,

considering

*a)* that test patterns provide a convenient means of assessing chrominance and luminance performance in a television system;

*b)* that such a test pattern may be useful when broadcasting in multiple formats or when converting between formats;

*c)* that the use of a test pattern can simplify test procedures and reduce the opportunity for misinterpretation of signal parameters and misalignment of systems,

noting

that Recommendation ITU-R BT.2100 specifies image parameter values for high dynamic range television for use in production and international programme exchange,

recommends

that the test patterns defined in Annex 1 should be implemented and may be used for production and distribution purposes in high dynamic range television (HDR-TV) systems.

Annex 1   
(normative)  
  
Specifications of test pattern

# 1 Normative references

Recommendation ITU-R BT.471 ‒ Nomenclature and description of colour bar signals

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

Recommendation ITU-R BT.709 ‒ Parameter values for the HDTV standards for production and international programme exchange.

# 2 Purpose

The reference test pattern has several purposes:

– quality control of chrominance and luminance through the production chain;

– checking and adjusting the chrominance and luminance alignment of broadcast equipment, particularly video monitors;

– general testing of equipment for video production, emission and presentation;

– establishing that a video circuit is active and that associated audio is available.

It is not intended that this test pattern be used for black level adjustment, which is best set using a PLUGE signal.

# 3 System types

The pattern described in this Recommendation is intended for use with Recommendation ITU‑R BT.2100. These systems are distinguished by the proportions of their colour encoding (or “colorimetry”) and by their resolution.

# 4 Sections of test pattern[[1]](#footnote-1)

The various sections of the test pattern for the HLG system with narrow range coding are shown in Fig. 1; the pattern for the PQ system with narrow range coding is shown in Fig. 2, and the pattern for the PQ system with full range coding is shown in Fig. 3. A colour diagram is shown in Fig. 4. See also Attachments 1 and 2.

FIGURE 1

Test pattern details for HLG narrow range



FIGURE 2

Test pattern details for PQ narrow range



FIGURE 3

Test pattern details for PQ full range



TABLE 1

Bar size to 2K, 4K and 8K format

|  |  |  |  |
| --- | --- | --- | --- |
| Bar size (pixel) | 2K | 4K | 8K |
| a | 1920 | 3840 | 7680 |
| b | 1080 | 2160 | 4320 |
| c | 240 | 480 | 960 |
| d | 206 | 412 | 824 |
| e | 204 | 408 | 816 |
| f | 136 | 272 | 544 |
| g | 70 | 140 | 280 |
| h | 68 | 136 | 272 |
| i | 238 | 476 | 952 |
| j | 438 | 876 | 1752 |
| k | 282 | 564 | 1128 |

FIGURE 4

Colour diagram of the test pattern



TABLE 2

Signal level for HLG narrow range

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10 bits | | | 12 bits | | |
| Image Area | R´ | G´ | B´ | R´ | G´ | B´ |
| 100% White | 940 | 940 | 940 | 3760 | 3760 | 3760 |
| 100% Yellow | 940 | 940 | 64 | 3760 | 3760 | 256 |
| 100% Cyan | 64 | 940 | 940 | 256 | 3760 | 3760 |
| 100% Green | 64 | 940 | 64 | 256 | 3760 | 256 |
| 100% Magenta | 940 | 64 | 940 | 3760 | 256 | 3760 |
| 100% Red | 940 | 64 | 64 | 3760 | 256 | 256 |
| 100% Blue | 64 | 64 | 940 | 256 | 256 | 3760 |
| 75% White | 721 | 721 | 721 | 2884 | 2884 | 2884 |
| 75% Yellow | 721 | 721 | 64 | 2884 | 2884 | 256 |
| 75% Cyan | 64 | 721 | 721 | 256 | 2884 | 2884 |
| 75% Green | 64 | 721 | 64 | 256 | 2884 | 256 |
| 75% Magenta | 721 | 64 | 721 | 2884 | 256 | 2884 |
| 75% Red | 721 | 64 | 64 | 2884 | 256 | 256 |
| 75% Blue | 64 | 64 | 721 | 256 | 256 | 2884 |
| 40% Grey | 414 | 414 | 414 | 1656 | 1656 | 1656 |
| −7% Step | 4 | 4 | 4 | 16 | 16 | 16 |

TABLE 2 (*end*)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10 bits | | | 12 bits | | |
| Image Area | R´ | G´ | B´ | R´ | G´ | B´ |
| 0% Step | 64 | 64 | 64 | 256 | 256 | 256 |
| 10% Step | 152 | 152 | 152 | 608 | 608 | 608 |
| 20% Step | 239 | 239 | 239 | 956 | 956 | 956 |
| 30% Step | 327 | 327 | 327 | 1308 | 1308 | 1308 |
| 40% Step | 414 | 414 | 414 | 1656 | 1656 | 1656 |
| 50% Step | 502 | 502 | 502 | 2008 | 2008 | 2008 |
| 60% Step | 590 | 590 | 590 | 2360 | 2360 | 2360 |
| 70% Step | 677 | 677 | 677 | 2708 | 2708 | 2708 |
| 80% Step | 765 | 765 | 765 | 3060 | 3060 | 3060 |
| 90% Step | 852 | 852 | 852 | 3408 | 3408 | 3408 |
| 100% Step | 940 | 940 | 940 | 3760 | 3760 | 3760 |
| 109% Step | 1019 | 1019 | 1019 | 4076 | 4076 | 4076 |
| Ramp | See Figure 5 | | | | | |
| 75% BT.709 Yellow | 713 | 719 | 316 | 2852 | 2876 | 1264 |
| 75% BT.709 Cyan | 538 | 709 | 718 | 2152 | 2836 | 2872 |
| 75% BT.709 Green | 512 | 706 | 296 | 2048 | 2824 | 1184 |
| 75% BT.709 Magenta | 651 | 286 | 705 | 2604 | 1144 | 2820 |
| 75% BT.709 Red | 639 | 269 | 164 | 2556 | 1076 | 656 |
| 75% BT.709 Blue | 227 | 147 | 702 | 908 | 588 | 2808 |
| 0% Black | 64 | 64 | 64 | 256 | 256 | 256 |
| −2% Black | 48 | 48 | 48 | 192 | 192 | 192 |
| +2% Black | 80 | 80 | 80 | 320 | 320 | 320 |
| +4% Black | 99 | 99 | 99 | 396 | 396 | 396 |

TABLE 3

Signal level for PQ narrow range

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10 bits | | | 12 bits | | |
| Image Area | R´ | G´ | B´ | R´ | G´ | B´ |
| 100% White | 940 | 940 | 940 | 3760 | 3760 | 3760 |
| 100% Yellow | 940 | 940 | 64 | 3760 | 3760 | 256 |
| 100% Cyan | 64 | 940 | 940 | 256 | 3760 | 3760 |
| 100% Green | 64 | 940 | 64 | 256 | 3760 | 256 |
| 100% Magenta | 940 | 64 | 940 | 3760 | 256 | 3760 |
| 100% Red | 940 | 64 | 64 | 3760 | 256 | 256 |
| 100% Blue | 64 | 64 | 940 | 256 | 256 | 3760 |

TABLE 3 (*end*)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10 bits | | | 12 bits | | |
| Image Area | R´ | G´ | B´ | R´ | G´ | B´ |
| 58% White | 572 | 572 | 572 | 2288 | 2288 | 2288 |
| 58% Yellow | 572 | 572 | 64 | 2288 | 2288 | 256 |
| 58% Cyan | 64 | 572 | 572 | 256 | 2288 | 2288 |
| 58% Green | 64 | 572 | 64 | 256 | 2288 | 256 |
| 58% Magenta | 572 | 64 | 572 | 2288 | 256 | 2288 |
| 58% Red | 572 | 64 | 64 | 2288 | 256 | 256 |
| 58% Blue | 64 | 64 | 572 | 256 | 256 | 2288 |
| 40% Grey | 414 | 414 | 414 | 1656 | 1656 | 1656 |
| −7% Step | 4 | 4 | 4 | 16 | 16 | 16 |
| 0% Step | 64 | 64 | 64 | 256 | 256 | 256 |
| 10% Step | 152 | 152 | 152 | 608 | 608 | 608 |
| 20% Step | 239 | 239 | 239 | 956 | 956 | 956 |
| 30% Step | 327 | 327 | 327 | 1308 | 1308 | 1308 |
| 40% Step | 414 | 414 | 414 | 1656 | 1656 | 1656 |
| 50% Step | 502 | 502 | 502 | 2008 | 2008 | 2008 |
| 60% Step | 590 | 590 | 590 | 2360 | 2360 | 2360 |
| 70% Step | 677 | 677 | 677 | 2708 | 2708 | 2708 |
| 80% Step | 765 | 765 | 765 | 3060 | 3060 | 3060 |
| 90% Step | 852 | 852 | 852 | 3408 | 3408 | 3408 |
| 100% Step | 940 | 940 | 940 | 3760 | 3760 | 3760 |
| 109% Step | 1019 | 1019 | 1019 | 4076 | 4076 | 4076 |
| Ramp | See Figure 5 | | | | | |
| 58% BT.709 Yellow | 568 | 571 | 381 | 2272 | 2284 | 1524 |
| 58% BT.709 Cyan | 484 | 566 | 571 | 1936 | 2264 | 2284 |
| 58% BT.709 Green | 474 | 564 | 368 | 1896 | 2256 | 1472 |
| 58% BT.709 Magenta | 536 | 361 | 564 | 2144 | 1444 | 2256 |
| 58% BT.709 Red | 530 | 350 | 256 | 2120 | 1400 | 1024 |
| 58% BT.709 Blue | 317 | 236 | 562 | 1268 | 944 | 2248 |
| 0% Black | 64 | 64 | 64 | 256 | 256 | 256 |
| −2% Black | 48 | 48 | 48 | 192 | 192 | 192 |
| +2% Black | 80 | 80 | 80 | 320 | 320 | 320 |
| +4% Black | 99 | 99 | 99 | 396 | 396 | 396 |

TABLE 4

Signal level for PQ full range

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10 bits | | | 12 bits | | |
| Image Area | R´ | G´ | B´ | R´ | G´ | B´ |
| 100% White | 1023 | 1023 | 1023 | 4095 | 4095 | 4095 |
| 100% Yellow | 1023 | 1023 | 0 | 4095 | 4095 | 0 |
| 100% Cyan | 0 | 1023 | 1023 | 0 | 4095 | 4095 |
| 100% Green | 0 | 1023 | 0 | 0 | 4095 | 0 |
| 100% Magenta | 1023 | 0 | 1023 | 4095 | 0 | 4095 |
| 100% Red | 1023 | 0 | 0 | 4095 | 0 | 0 |
| 100% Blue | 0 | 0 | 1023 | 0 | 0 | 4095 |
| 58% White | 593 | 593 | 593 | 2375 | 2375 | 2375 |
| 58% Yellow | 593 | 593 | 0 | 2375 | 2375 | 0 |
| 58% Cyan | 0 | 593 | 593 | 0 | 2375 | 2375 |
| 58% Green | 0 | 593 | 0 | 0 | 2375 | 0 |
| 58% Magenta | 593 | 0 | 593 | 2375 | 0 | 2375 |
| 58% Red | 593 | 0 | 0 | 2375 | 0 | 0 |
| 58% Blue | 0 | 0 | 593 | 0 | 0 | 2375 |
| 40% Grey | 409 | 409 | 409 | 1638 | 1638 | 1638 |
| 0% Step | 0 | 0 | 0 | 0 | 0 | 0 |
| 10% Step | 102 | 102 | 102 | 410 | 410 | 410 |
| 20% Step | 205 | 205 | 205 | 819 | 819 | 819 |
| 30% Step | 307 | 307 | 307 | 1229 | 1229 | 1229 |
| 40% Step | 409 | 409 | 409 | 1638 | 1638 | 1638 |
| 50% Step | 512 | 512 | 512 | 2048 | 2048 | 2048 |
| 60% Step | 614 | 614 | 614 | 2457 | 2457 | 2457 |
| 70% Step | 716 | 716 | 716 | 2867 | 2867 | 2867 |
| 80% Step | 818 | 818 | 818 | 3276 | 3276 | 3276 |
| 90% Step | 921 | 921 | 921 | 3686 | 3686 | 3686 |
| 100% Step | 1023 | 1023 | 1023 | 4095 | 4095 | 4095 |
| Ramp | See Figure 6 | | | | | |
| 58% BT.709 Yellow | 589 | 592 | 370 | 2356 | 2370 | 1480 |
| 58% BT.709 Cyan | 491 | 586 | 592 | 1964 | 2345 | 2368 |
| 58% BT.709 Green | 478 | 584 | 355 | 1915 | 2339 | 1420 |
| 58% BT.709 Magenta | 551 | 347 | 584 | 2206 | 1389 | 2336 |
| 58% BT.709 Red | 544 | 334 | 225 | 2178 | 1337 | 900 |
| 58% BT.709 Blue | 296 | 201 | 582 | 1184 | 805 | 2328 |
| 0% Black | 0 | 0 | 0 | 0 | 0 | 0 |
| +2% Black | 20 | 20 | 20 | 82 | 82 | 82 |
| +4% Black | 41 | 41 | 41 | 164 | 164 | 164 |

FIGURE 5

HLG/PQ narrow range signal levels of the ramp



TABLE 5

HLG/PQ Narrow Range Ramp width to 2K, 4K and 8K format

|  |  |  |  |
| --- | --- | --- | --- |
| Width (pixel) | 2K | 4K | 8K |
| A | 1680 | 3360 | 6720 |
| B | 559 | 1118 | 2236 |
| C | 1015 | 2030 | 4060 |
| D | 106 | 212 | 424 |
| E | 60 | 120 | 240 |
| F | 936 | 1872 | 3744 |

FIGURE 6

PQ full range signal levels of the ramp



TABLE 6

PQ Full Range Ramp width to 2K, 4K and 8K format

|  |  |  |  |
| --- | --- | --- | --- |
| Width (pixel) | 2K | 4K | 8K |
| A | 1680 | 3360 | 6720 |
| B | 551 | 1102 | 2204 |
| C | 1023 | 2046 | 4092 |
| D | 106 | 212 | 424 |

Attachment 1   
(informative)   
  
Sections comprising the HLG test pattern

figure 7



Colour Bars: The main colour bars are 75%HLG, with 100%HLG colour bars at the top.

BT.709 Colour Bars: Generated by using the HLG OETF and a linear matrix. BT.709 colour bars are placed at the left and right bottom to avoid overlaps with the main colour bars on a waveform monitor.

Ramp: Levels are from −7%HLG to 109%HLG. 0% video level is at the left edge of the Green bar.

Stair: Levels are from −7%HLG to 109%HLG. Left edge of the 0% step is at the left edge of the Yellow bar. 10% interval between 0%HLG and 100%HLG. The width of each step is a half of the colour bar. The step signal and the ramp signal are placed not to overlap on a waveform monitor.

Black signal: consisting of 0%, −2%, 0%, +2%, 0%, +4% and 0% video levels are placed at the lower left away from the bright areas for better visibility.

Grey bars (right and left): These areas may optionally be used to include other patterns for specific needs.

Attachment 2   
(informative)   
  
HLG waveform on a waveform monitor

Figure 8 shows the HLG waveform of the test pattern on a waveform monitor.

FIGURE 8

Waveform on waveform monitor (Red, Green, and Blue, respectively)



1. It is desirable that implementers should include in this test signal some visual identification of the signal format (HLG narrow range, PQ narrow range, or PQ full range). The test pattern includes grey bars (top right and top left) that may optionally be used for this and/or other purposes. [↑](#footnote-ref-1)