|  |
| --- |
| **Recommendation ITU-R BT.2111-1**  **(06/2019)** |
| **S****pecification of colour bar test pattern for high dynamic range television systems** |
| **BT Series**  **Broadcasting service**  **(television)** |

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

# Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from <http://www.itu.int/ITU-R/go/patents/en> where the Guidelines for Implementation of the Common Patent Policy for ITU‑T/ITU‑R/ISO/IEC and the ITU-R patent information database can also be found.

|  |  |
| --- | --- |
| Series of ITU-R Recommendations  (Also available online at <http://www.itu.int/publ/R-REC/en>) | |
| **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.* |

*Electronic Publication*

Geneva, 2019

© ITU 2019

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without written permission of ITU.

RECOMMENDATION ITU-R BT.2111-1

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

(2017-2019)

Scope

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

Keywords

Colour bars, HDR, HDR-TV, HLG, PQ, test pattern, test signal

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.709 ‒ Parameter values for the HDTV standards for production and international programme exchange.

Recommendation ITU-R BT.2100 ‒ Image parameter values for high dynamic range television for use in 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

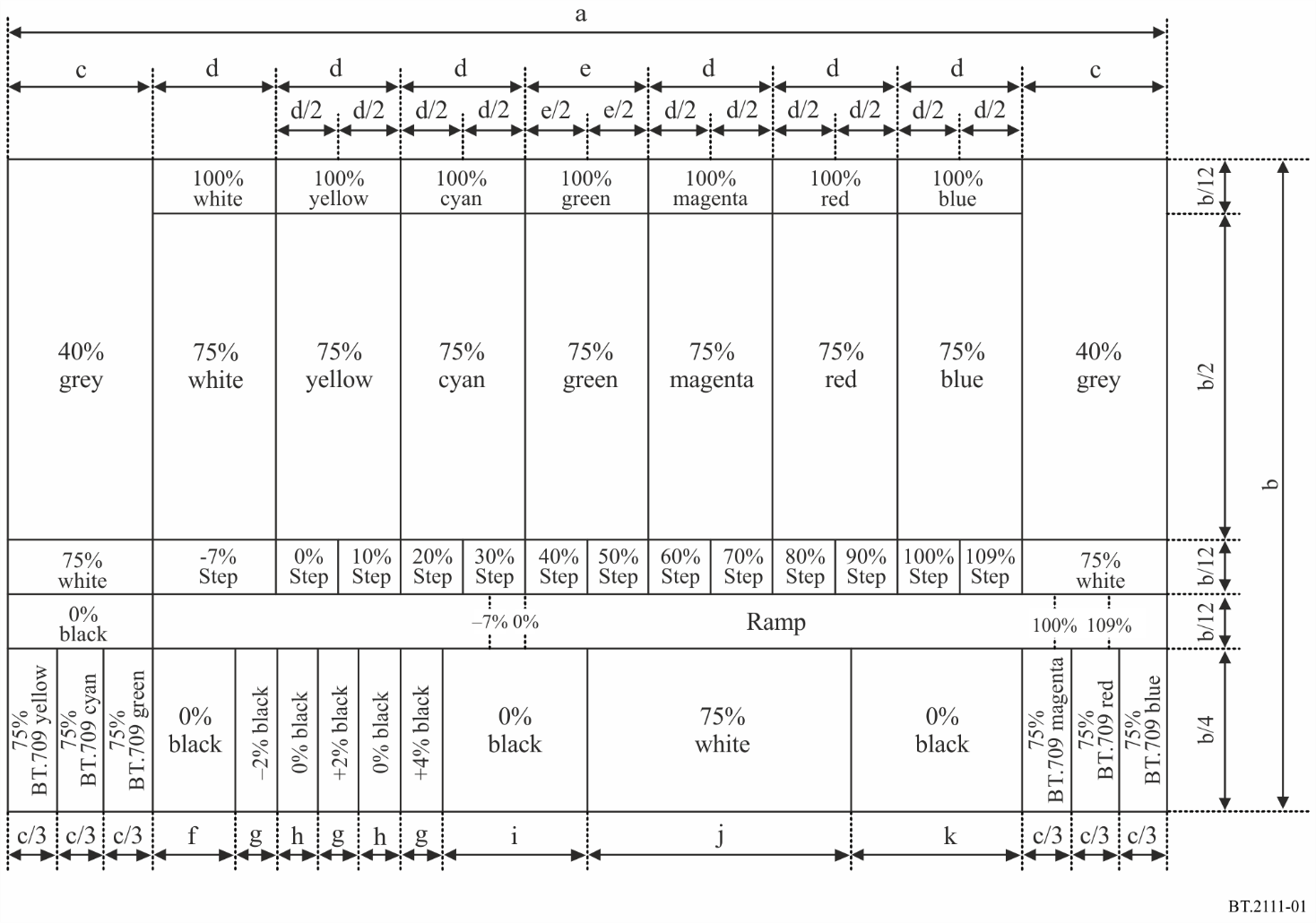


FIGURE 2

Test pattern details for PQ narrow range

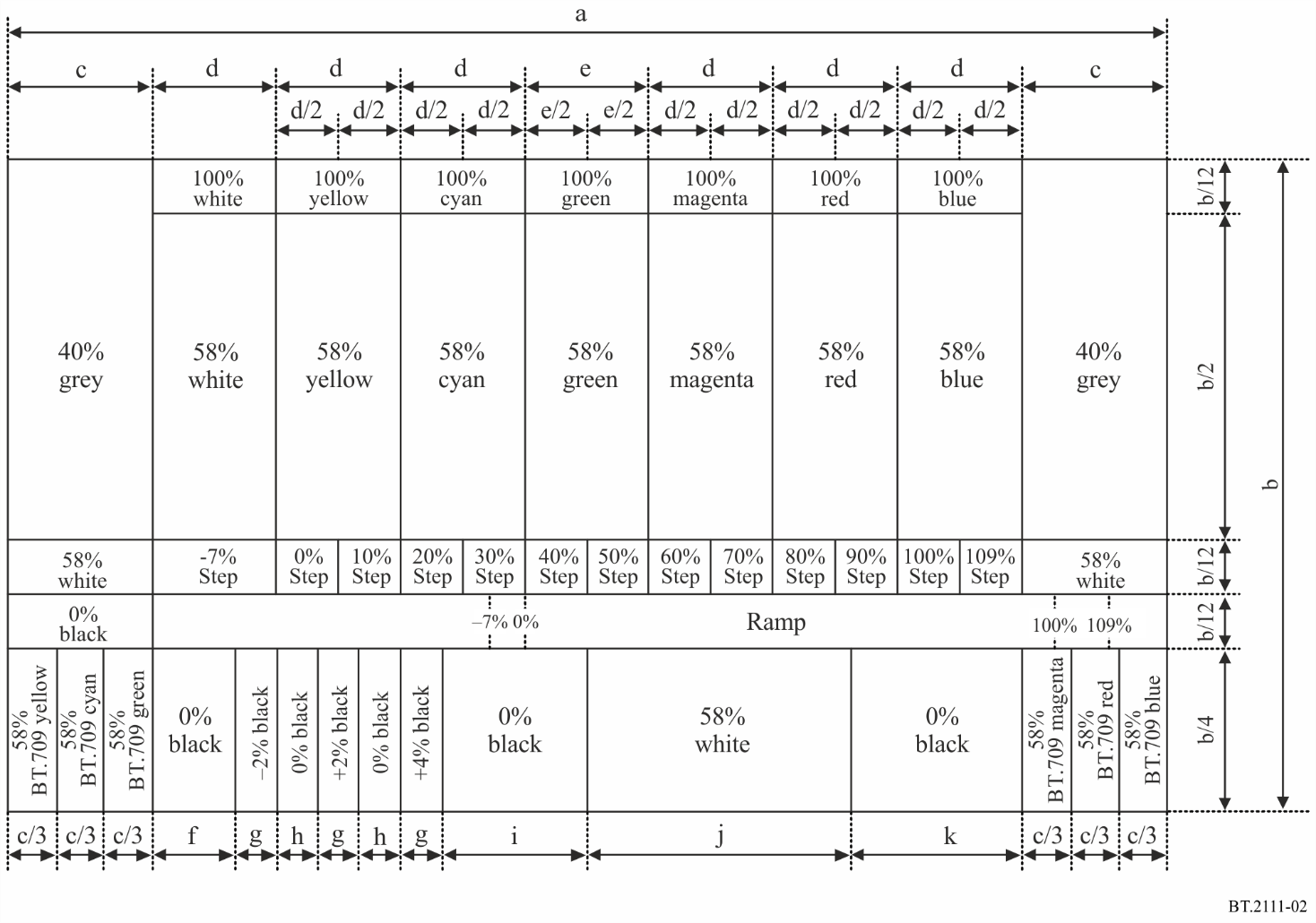


FIGURE 3

Test pattern details for PQ full range

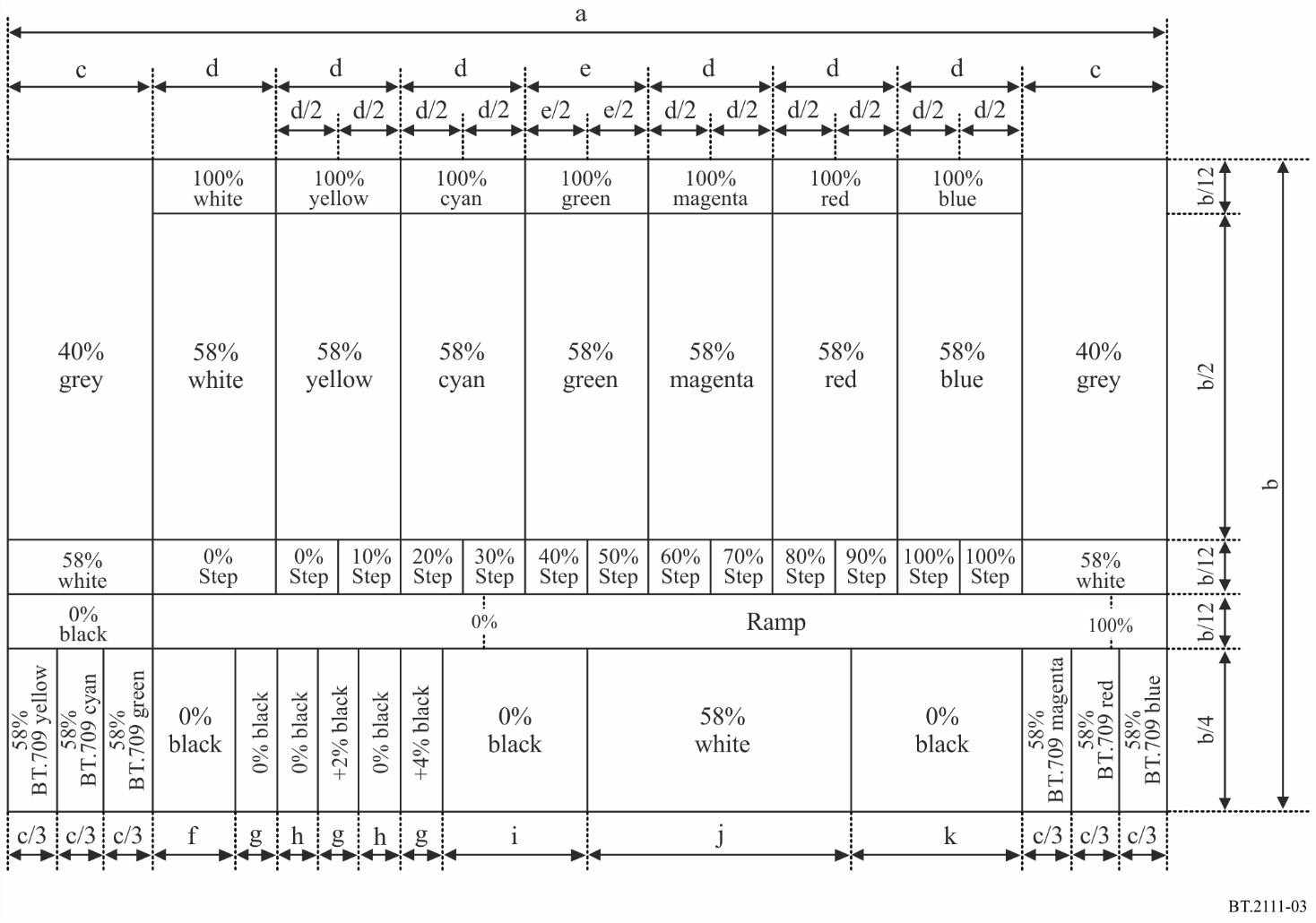


TABLE 1

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 | 3 760 | 3 760 | 3 760 |
| 100% Yellow | 940 | 940 | 64 | 3 760 | 3 760 | 256 |
| 100% Cyan | 64 | 940 | 940 | 256 | 3 760 | 3 760 |
| 100% Green | 64 | 940 | 64 | 256 | 3 760 | 256 |
| 100% Magenta | 940 | 64 | 940 | 3 760 | 256 | 3 760 |
| 100% Red | 940 | 64 | 64 | 3 760 | 256 | 256 |
| 100% Blue | 64 | 64 | 940 | 256 | 256 | 3 760 |
| 75% White | 721 | 721 | 721 | 2 884 | 2 884 | 2 884 |
| 75% Yellow | 721 | 721 | 64 | 2 884 | 2 884 | 256 |
| 75% Cyan | 64 | 721 | 721 | 256 | 2 884 | 2 884 |
| 75% Green | 64 | 721 | 64 | 256 | 2 884 | 256 |
| 75% Magenta | 721 | 64 | 721 | 2 884 | 256 | 2 884 |
| 75% Red | 721 | 64 | 64 | 2 884 | 256 | 256 |
| 75% Blue | 64 | 64 | 721 | 256 | 256 | 2 884 |
| 40% Grey | 414 | 414 | 414 | 1 656 | 1 656 | 1 656 |
| −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 |

TABLE 2 (*end*)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10 bits | | | 12 bits | | |
| Image Area | R´ | G´ | B´ | R´ | G´ | B´ |
| 30% Step | 327 | 327 | 327 | 1 308 | 1 308 | 1 308 |
| 40% Step | 414 | 414 | 414 | 1 656 | 1 656 | 1 656 |
| 50% Step | 502 | 502 | 502 | 2 008 | 2 008 | 2 008 |
| 60% Step | 590 | 590 | 590 | 2 360 | 2 360 | 2 360 |
| 70% Step | 677 | 677 | 677 | 2 708 | 2 708 | 2 708 |
| 80% Step | 765 | 765 | 765 | 3 060 | 3 060 | 3 060 |
| 90% Step | 852 | 852 | 852 | 3 408 | 3 408 | 3 408 |
| 100% Step | 940 | 940 | 940 | 3 760 | 3 760 | 3 760 |
| 109% Step | 1 019 | 1 019 | 1 019 | 4 076 | 4 076 | 4 076 |
|  | See Fig. 5 and Table 5 | | | | | |
| 75% BT.709 Yellow | 713 | 719 | 316 | 2 852 | 2 876 | 1 264 |
| 75% BT.709 Cyan | 538 | 709 | 718 | 2 152 | 2 836 | 2 872 |
| 75% BT.709 Green | 512 | 706 | 296 | 2 048 | 2 824 | 1 184 |
| 75% BT.709 Magenta | 651 | 286 | 705 | 2 604 | 1 144 | 2 820 |
| 75% BT.709 Red | 639 | 269 | 164 | 2 556 | 1 076 | 656 |
| 75% BT.709 Blue | 227 | 147 | 702 | 908 | 588 | 2 808 |
| 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 | 3 760 | 3 760 | 3 760 |
| 100% Yellow | 940 | 940 | 64 | 3 760 | 3 760 | 256 |
| 100% Cyan | 64 | 940 | 940 | 256 | 3 760 | 3 760 |
| 100% Green | 64 | 940 | 64 | 256 | 3 760 | 256 |
| 100% Magenta | 940 | 64 | 940 | 3 760 | 256 | 3 760 |
| 100% Red | 940 | 64 | 64 | 3 760 | 256 | 256 |
| 100% Blue | 64 | 64 | 940 | 256 | 256 | 3 760 |

TABLE 3 (*end*)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10 bits | | | 12 bits | | |
| Image Area | R´ | G´ | B´ | R´ | G´ | B´ |
| 58% White | 572 | 572 | 572 | 2 288 | 2 288 | 2 288 |
| 58% Yellow | 572 | 572 | 64 | 2 288 | 2 288 | 256 |
| 58% Cyan | 64 | 572 | 572 | 256 | 2 288 | 2 288 |
| 58% Green | 64 | 572 | 64 | 256 | 2 288 | 256 |
| 58% Magenta | 572 | 64 | 572 | 2 288 | 256 | 2 288 |
| 58% Red | 572 | 64 | 64 | 2 288 | 256 | 256 |
| 58% Blue | 64 | 64 | 572 | 256 | 256 | 2 288 |
| 40% Grey | 414 | 414 | 414 | 1 656 | 1 656 | 1 656 |
| −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 | 1 308 | 1 308 | 1 308 |
| 40% Step | 414 | 414 | 414 | 1 656 | 1 656 | 1 656 |
| 50% Step | 502 | 502 | 502 | 2 008 | 2 008 | 2 008 |
| 60% Step | 590 | 590 | 590 | 2 360 | 2 360 | 2 360 |
| 70% Step | 677 | 677 | 677 | 2 708 | 2 708 | 2 708 |
| 80% Step | 765 | 765 | 765 | 3 060 | 3 060 | 3 060 |
| 90% Step | 852 | 852 | 852 | 3 408 | 3 408 | 3 408 |
| 100% Step | 940 | 940 | 940 | 3 760 | 3 760 | 3 760 |
| 109% Step | 1 019 | 1 019 | 1 019 | 4 076 | 4 076 | 4 076 |
| Ramp | See Fig. 5 and Table 5 | | | | | |
| 58% BT.709 Yellow | 568 | 571 | 381 | 2 272 | 2 284 | 1 524 |
| 58% BT.709 Cyan | 484 | 566 | 571 | 1 936 | 2 264 | 2 284 |
| 58% BT.709 Green | 474 | 564 | 368 | 1 896 | 2 256 | 1 472 |
| 58% BT.709 Magenta | 536 | 361 | 564 | 2 144 | 1 444 | 2 256 |
| 58% BT.709 Red | 530 | 350 | 256 | 2 120 | 1 400 | 1 024 |
| 58% BT.709 Blue | 317 | 236 | 562 | 1 268 | 944 | 2 248 |
| 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 | 1 023 | 1 023 | 1 023 | 4 095 | 4 095 | 4 095 |
| 100% Yellow | 1 023 | 1 023 | 0 | 4 095 | 4 095 | 0 |
| 100% Cyan | 0 | 1 023 | 1 023 | 0 | 4 095 | 4 095 |
| 100% Green | 0 | 1 023 | 0 | 0 | 4 095 | 0 |
| 100% Magenta | 1 023 | 0 | 1 023 | 4 095 | 0 | 4 095 |
| 100% Red | 1 023 | 0 | 0 | 4 095 | 0 | 0 |
| 100% Blue | 0 | 0 | 1 023 | 0 | 0 | 4 095 |
| 58% White | 593 | 593 | 593 | 2 375 | 2 375 | 2 375 |
| 58% Yellow | 593 | 593 | 0 | 2 375 | 2 375 | 0 |
| 58% Cyan | 0 | 593 | 593 | 0 | 2 375 | 2 375 |
| 58% Green | 0 | 593 | 0 | 0 | 2 375 | 0 |
| 58% Magenta | 593 | 0 | 593 | 2 375 | 0 | 2 375 |
| 58% Red | 593 | 0 | 0 | 2 375 | 0 | 0 |
| 58% Blue | 0 | 0 | 593 | 0 | 0 | 2 375 |
| 40% Grey | 409 | 409 | 409 | 1 638 | 1 638 | 1 638 |
| 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 | 1 229 | 1 229 | 1 229 |
| 40% Step | 409 | 409 | 409 | 1 638 | 1 638 | 1 638 |
| 50% Step | 512 | 512 | 512 | 2 048 | 2 048 | 2 048 |
| 60% Step | 614 | 614 | 614 | 2 457 | 2 457 | 2 457 |
| 70% Step | 716 | 716 | 716 | 2 867 | 2 867 | 2 867 |
| 80% Step | 818 | 818 | 818 | 3 276 | 3 276 | 3 276 |
| 90% Step | 921 | 921 | 921 | 3 686 | 3 686 | 3 686 |
| 100% Step | 1 023 | 1 023 | 1 023 | 4 095 | 4 095 | 4 095 |
| Ramp | See Fig. 6 and Table 6 | | | | | |
| 58% BT.709 Yellow | 589 | 592 | 370 | 2 356 | 2 370 | 1 480 |
| 58% BT.709 Cyan | 491 | 586 | 592 | 1 964 | 2 345 | 2 368 |
| 58% BT.709 Green | 478 | 584 | 355 | 1 915 | 2 339 | 1 420 |
| 58% BT.709 Magenta | 551 | 347 | 584 | 2 206 | 1 389 | 2 336 |
| 58% BT.709 Red | 544 | 334 | 225 | 2 178 | 1 337 | 900 |
| 58% BT.709 Blue | 296 | 201 | 582 | 1 184 | 805 | 2 328 |
| 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

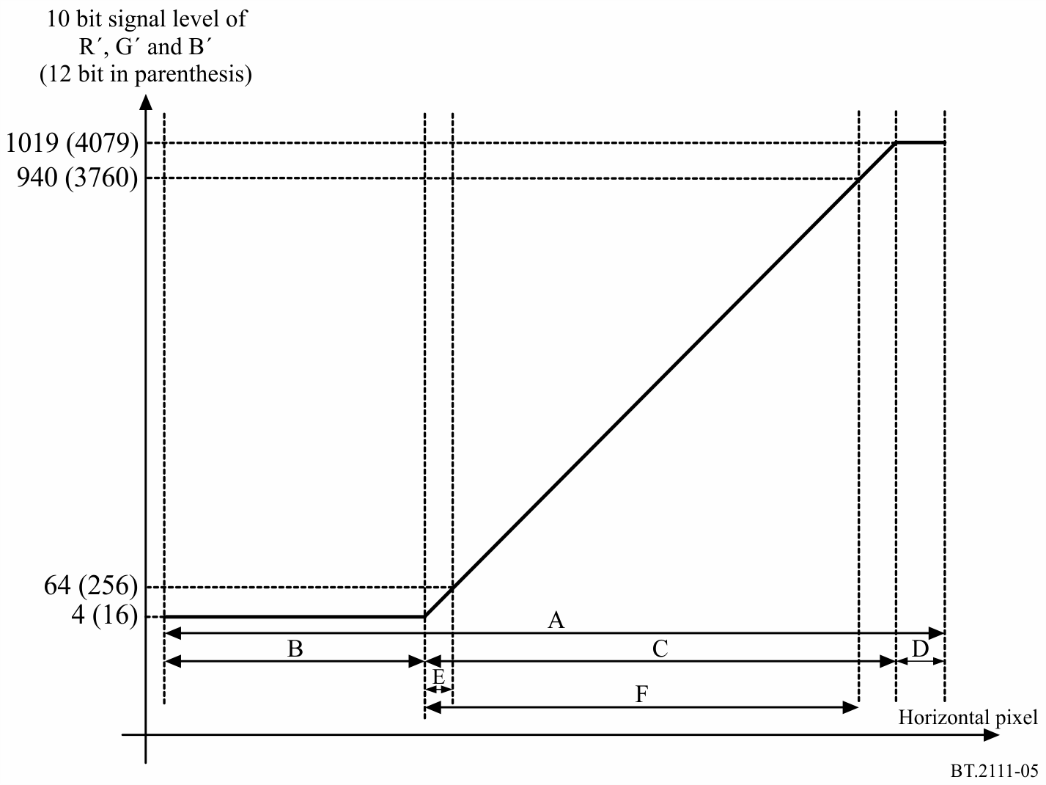


TABLE 5

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Width (pixel) | 2K | | 4K | | 8K | |
| 10 bits | 12 bits | 10 bits | 12 bits | 10 bits | 12 bits |
| A | 1 680 | 1 680 | 3 360 | 3 360 | 6 720 | 6 720 |
| B | 559 | 559 | 1 118 | 1 117 | 2 236 | 2 233 |
| C(1) | 1 014 | 1 015 | 2 028 | 2 031 | 4 056 | 4 062 |
| D | 107 | 106 | 214 | 212 | 428 | 425 |
| E(2) | 59 | 59 | 118 | 119 | 236 | 239 |
| F(3) | 935 | 935 | 1 870 | 1 871 | 3 740 | 3 743 |
| (1) C corresponds to the signal level range from 5 to 1 018 in 10 bits and from 17 to 4 078 in 8K 12 bit, 18 to 4078 in 4K 12 bit, and 20 to 4076 in 2K 12 bits.  (2) E corresponds to the signal level range from 5 to 63 in 10 bits and from 17 to 255 in 8K 12 bit, 18 to 254 in 4K 12 bit, and 20 to 252 in 2K 12 bits.  (3) F corresponds to the signal level range from 5 to 939 in 10 bits and from 17 to 3 759 in 8K 12 bit, 18 to 3758 in 4K 12 bit, and 20 to 3756 in 2K 12 bits. | | | | | | |

FIGURE 6

**PQ full range signal levels of the ramp**

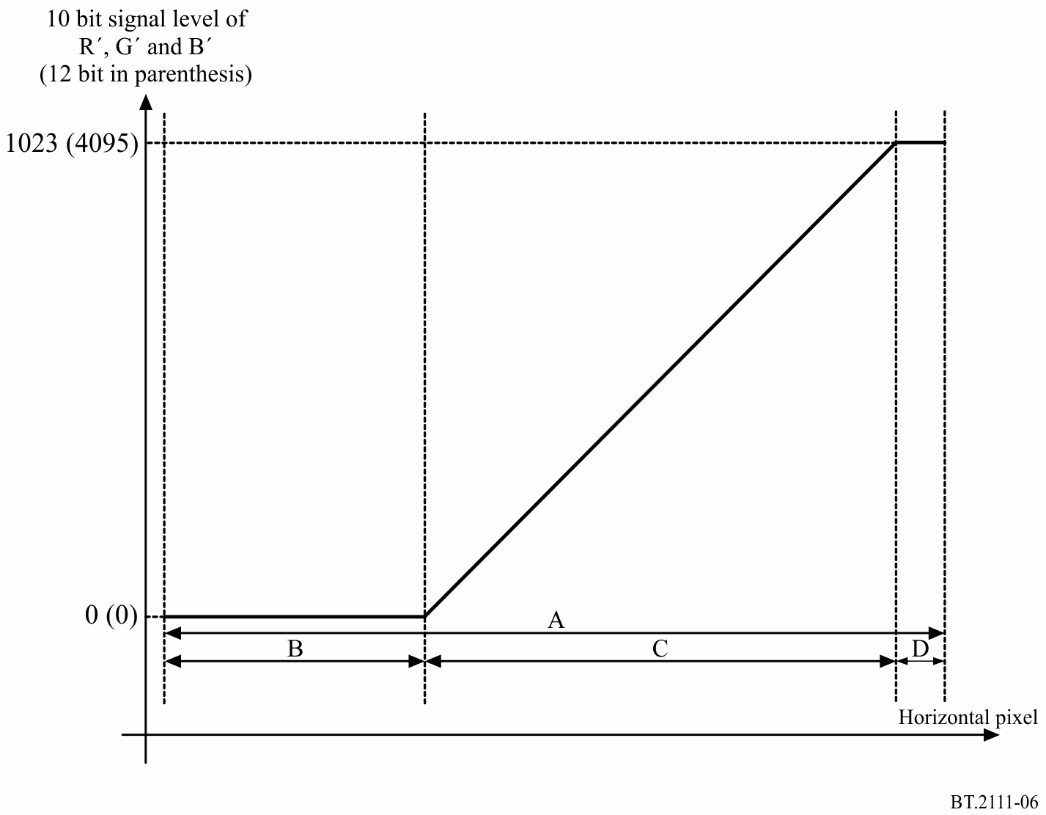


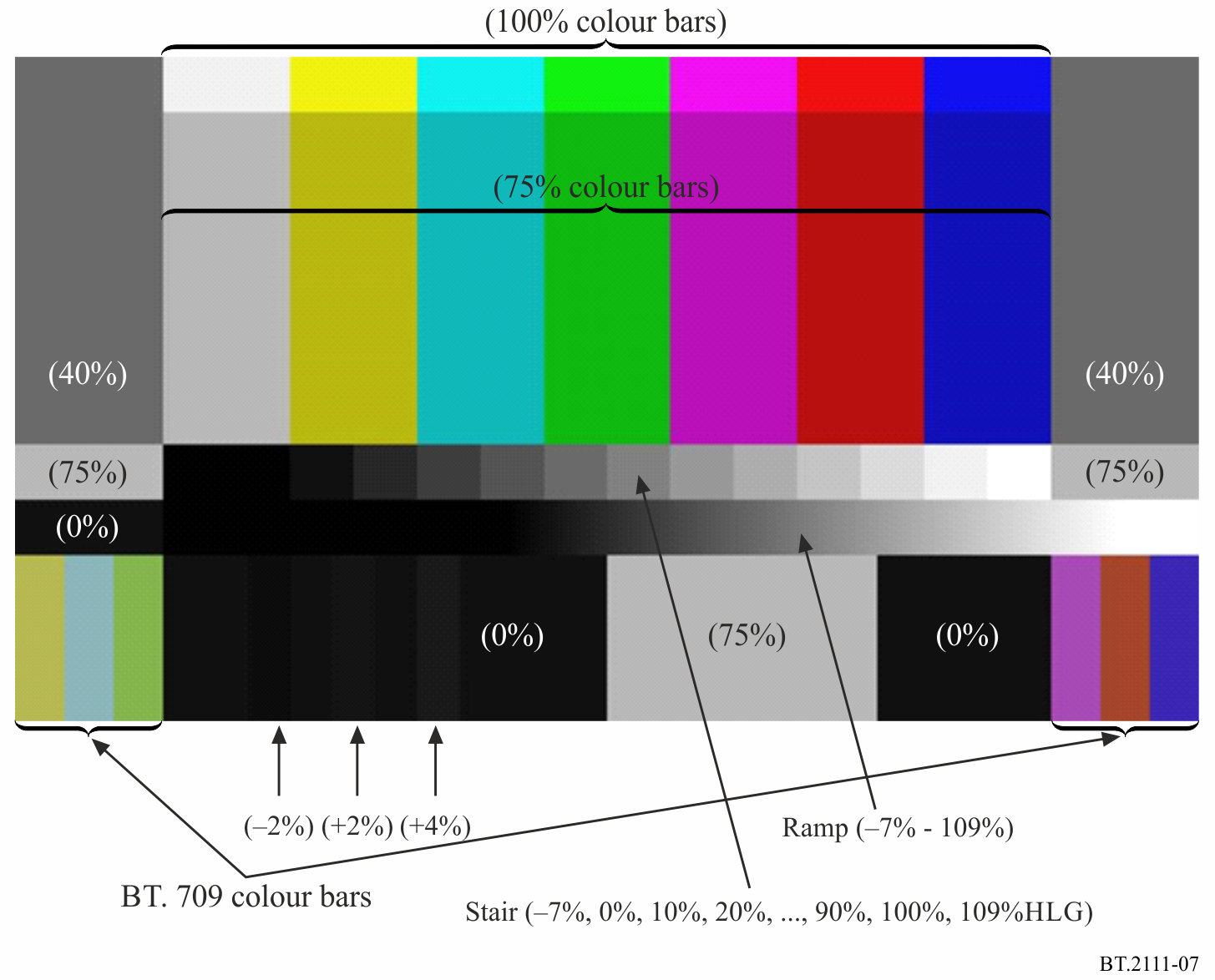
TABLE 6

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Width (pixel) | 2K | | 4K | | 8K | |
| 10 bits | 12 bits | 10 bits | 12 bits | 10 bits | 12 bits |
| A | 1 680 | 1 680 | 3 360 | 3 360 | 6 720 | 6 720 |
| B | 551 | 551 | 1 102 | 1 101 | 2 204 | 2 201 |
| C(1) | 1 022 | 1 023 | 2 044 | 2 047 | 4 088 | 4 094 |
| D | 107 | 106 | 214 | 212 | 428 | 425 |
| (1) C corresponds to the signal level range from 1 to 1 022 in 10 bits and from 1 to 4 094 in 8K 12 bit, 2 to 4094 in 4K 12 bit, and 4 to 4092 in 2K 12 bits. | | | | | | |

Attachment 1  
to Annex 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.

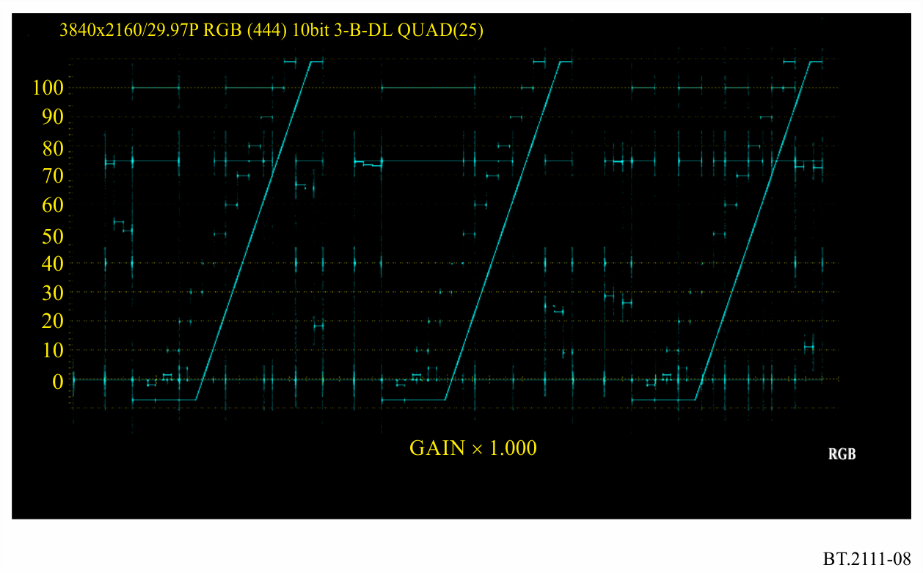
Grey bars (right and left): These areas may optionally be used to include other patterns for specific needs.

Attachment 2  
to Annex 1  
(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)