Recommendation ITU-R BT.2111-3

(05/2025)

BT Series: Broadcasting service (television)

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

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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.

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

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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.2111-3

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

(2017-2019-2020-2025)

Scope

This Recommendation specifies reference test patterns for the high dynamic range television systems specified in Recommendation [ITU-R BT.2100](https://www.itu.int/rec/R-REC-BT.2100/en).

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](https://www.itu.int/rec/R-REC-BT.2100/en) 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,

further recommends

that manufacturers should indicate which edition of a Recommendation ITU-R BT.2111 test pattern is implemented in a pattern generator.

Annex 1  
(normative)  
  
Specifications of test pattern

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# 1 Normative references

Recommendation [ITU-R BT.471](https://www.itu.int/rec/R-REC-BT.471/en) ‒ Nomenclature and description of colour bar signals

Recommendation [ITU-R BT.709](https://www.itu.int/rec/R-REC-BT.709/en) ‒ Parameter values for the HDTV standards for production and international programme exchange

Recommendation [ITU-R BT.2100](https://www.itu.int/rec/R-REC-BT.2100/en) ‒ 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](https://www.itu.int/rec/R-REC-BT.2100/en). These systems are distinguished by the proportions of their colour encoding (or “colorimetry”) and by their resolution.

# 4 Sections of test pattern[[1]](#footnote-2)

The various sections of the test pattern for the hybrid log-gamma (HLG) system with narrow range coding are shown in Fig. 1; the pattern for the perceptual quantization (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 to Annex 1.

# 5 Test pattern code value precision

Both 10-bit and 12-bit code values are provided for each signal level comprising the test pattern.

Broadcast production and distribution is in general known to be based around signal flows with 10‑bit precision, although there are situations and processes where 10-bit signals are converted to 12‑bits.

To ensure interoperability of test pattern usage between 10-bit and 12-bit narrow-range signal paths, 10-bit code values are defined as the primary code values from which all derived 12-bit code values maintain 10‑bit precision.

FIGURE 1

Test pattern details for HLG narrow range

A diagram of a color chart

Description automatically generated with medium confidence

FIGURE 2

Test pattern details for PQ narrow range

A diagram of a color scheme

Description automatically generated with medium confidence

FIGURE 3

Test pattern details for PQ full range

A diagram of different colors

Description automatically generated

NOTE – The position of the ramp section of the PQ full range test pattern aligns the 0% level with the left edge of the green colour bar, see Table 6. This positioning differs slightly from earlier editions of this Recommendation.

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

A colorful bars of television

Description automatically generated with medium confidence

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 (1) | 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 (2) | 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 (3) | 48 | 48 | 48 | 192 | 192 | 192 |
| +2% Black (4) | 80 | 80 | 80 | 320 | 320 | 320 |
| +4% Black | 99 | 99 | 99 | 396 | 396 | 396 |
| (1) The code value of the approximate −7% Step is the minimum permitted value of the video data range specified in Rec. [ITU-R BT.2100](https://www.itu.int/rec/R-REC-BT.2100/en) for narrow range signals.  (2) The code value of the approximate +109% image area is the maximum permitted value of the video data range specified in Rec. [ITU-R BT.2100](https://www.itu.int/rec/R-REC-BT.2100/en) for narrow range signals.  (3) The code value of the approximate −2% Black level narrow range signal corresponds to that of the “Slightly darker level” of Rec. [ITU-R BT.814](https://www.itu.int/rec/R-REC-BT.814/en).  (4) The code value of the approximate +2% Black level narrow range signal corresponds to that of the “Slightly lighter level” of Rec. [ITU-R BT.814](https://www.itu.int/rec/R-REC-BT.814/en). | | | | | | |

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 |
| 58% White (1) | 573 | 573 | 573 | 2 292 | 2 292 | 2 292 |
| 58% Yellow (1) | 573 | 573 | 64 | 2 292 | 2 292 | 256 |
| 58% Cyan (1) | 64 | 573 | 573 | 256 | 2 292 | 2 292 |
| 58% Green (1) | 64 | 573 | 64 | 256 | 2 292 | 256 |
| 58% Magenta (1) | 573 | 64 | 573 | 2 292 | 256 | 2 292 |
| 58% Red (1) | 573 | 64 | 64 | 2 292 | 256 | 256 |
| 58% Blue (1) | 64 | 64 | 573 | 256 | 256 | 2 292 |
| 40% Grey | 414 | 414 | 414 | 1 656 | 1 656 | 1 656 |
| −7% Step (2) | 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 (1) | 569 | 572 | 381 | 2 276 | 2 288 | 1 524 |
| 58% BT.709 Cyan (1) | 485 | 566 | 571 | 1 940 | 2 264 | 2 284 |
| 58% BT.709 Green (1) | 474 | 565 | 368 | 1 896 | 2 260 | 1 472 |
| 58% BT.709 Magenta (1) | 537 | 362 | 564 | 2 148 | 1 448 | 2 256 |
| 58% BT.709 Red (1) | 531 | 351 | 257 | 2 124 | 1 404 | 1 028 |
| 58% BT.709 Blue (1) | 318 | 236 | 563 | 1 272 | 944 | 2 252 |

TABLE 3 (*end*)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10 bits | | | 12 bits | | |
| Image area | R´ | G´ | B´ | R´ | G´ | B´ |
| 0% Black | 64 | 64 | 64 | 256 | 256 | 256 |
| −2% Black (3) | 48 | 48 | 48 | 192 | 192 | 192 |
| +2% Black (4) | 80 | 80 | 80 | 320 | 320 | 320 |
| +4% Black | 99 | 99 | 99 | 396 | 396 | 396 |
| (1) The code values of the approximate 58% levels correspond to 75% HLG at the 1 000 cd/m2 reference level (203.15 cd/m2). Code values differ slightly from those specified in earlier editions of this Recommendation.  (2) The code value of the approximate −7% Step is the minimum permitted value of the video data range specified in Rec. [ITU-R BT.2100](https://www.itu.int/rec/R-REC-BT.2100/en) for narrow range signals.  (3) The code value of the approximate −2% Black level narrow range signal corresponds to that of the “Slightly darker level” of Rec. ITU-R BT.814.  (4) The code value of the approximate +2% Black level narrow range signal corresponds to that of the “Slightly lighter level” of Rec. ITU‑R BT.814. | | | | | | |

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 (1) | 594 | 594 | 594 | 2 378 | 2 378 | 2 378 |
| 58% Yellow (1) | 594 | 594 | 0 | 2 378 | 2 378 | 0 |
| 58% Cyan (1) | 0 | 594 | 594 | 0 | 2 378 | 2 378 |
| 58% Green (1) | 0 | 594 | 0 | 0 | 2 378 | 0 |
| 58% Magenta (1) | 594 | 0 | 594 | 2 378 | 0 | 2 378 |
| 58% Red (1) | 594 | 0 | 0 | 2 378 | 0 | 0 |
| 58% Blue (1) | 0 | 0 | 594 | 0 | 0 | 2 378 |
| 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 |

TABLE 4 (*end*)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10 bits | | | 12 bits | | |
| Image area | R´ | G´ | B´ | R´ | G´ | B´ |
| 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 (1) | 589 | 593 | 370 | 2 359 | 2 373 | 1 483 |
| 58% BT.709 Cyan (1) | 491 | 586 | 592 | 1 967 | 2 348 | 2 371 |
| 58% BT.709 Green (1) | 479 | 585 | 355 | 1 918 | 2 342 | 1 423 |
| 58% BT.709 Magenta (1) | 552 | 348 | 584 | 2 209 | 1 391 | 2 339 |
| 58% BT.709 Red (1) | 545 | 335 | 225 | 2 181 | 1 339 | 901 |
| 58% BT.709 Blue (1) | 296 | 201 | 582 | 1 186 | 806 | 2 331 |
| 0% Black | 0 | 0 | 0 | 0 | 0 | 0 |
| +2% Black (2) | 19 | 19 | 19 | 75 | 75 | 75 |
| +4% Black | 41 | 41 | 41 | 164 | 164 | 164 |
| (1) The code values of the approximate 58% levels correspond to 75% HLG at the 1 000 cd/m2 reference level (203.15 cd/m2). Code values differ slightly from those specified in earlier editions of this Recommendation.  (2) The code value of the approximate +2% Black level corresponds to that of the ‘Slightly lighter level’ of Rec. ITU-R BT.814. Code values differ slightly from those specified in earlier editions of this Recommendation. | | | | | | |

FIGURE 5

HLG/PQ narrow range signal levels of the ramp

A diagram of a triangle with lines and arrows

Description automatically generated

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

A diagram of a line graph

Description automatically generated

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 (2) | 618 | 618 | 1 236 | 1 236 | 2 472 | 2 472 |
| C (1) | 1 022 | 1 023 | 2 044 | 2 047 | 4 088 | 4 094 |
| D (2) | 40 | 39 | 80 | 77 | 160 | 154 |
| (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.  (2) Pixel widths of B and D differ slightly from those specified in earlier editions of this Recommendation. | | | | | | |

Attachment 1  
to Annex 1  
(informative)   
  
Sections comprising the HLG test pattern

figure 7

A close-up of a color bar

Description automatically generated

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 limited precision matrix shown in Recommendation ITU-R BT.2087. It should be noted that if these bars were generated using higher precision colour conversion matrices, slightly different levels would result in some cases. 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.

NOTE – The approximate −7%HLG and 109%HLG levels are the minimum and maximum permitted values respectively of the video data range specified in Recommendation [ITU-R BT.2100](https://www.itu.int/rec/R-REC-BT.2100/en) for narrow range signals. The code values of the approximate −2% and +2% video levels correspond to those of ‘Slightly darker level’ and ‘Slightly lighter level’ respectively of Recommendation ITU-R BT.814.

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)

A screen shot of a graph

Description automatically generated

Attachment 3  
to Annex 1  
(informative)  
  
Information on conversion of HLG/BT.2020 colour bars to SDR/BT.709

Figure 9 shows the HLG/BT.2020 colour bars including the BT.709-equivalent colour bars and their snapshots of the waveform and vectorscope set to BT.2020 colorimetry.

Figure 11 shows the colour bars converted from HLG/BT.2020 to SDR/BT.709 using the scene‑referred conversion method depicted in Fig. 10, which is the inverse of the “SDR to HDR mapping (scene-referred)”. Note this method does not include tone-mapping. HDR signals are hard-clipped when converted to SDR. The BT.709-equivalent colour bars land on the vectorscope targets after the scene-referred conversion.

Figure 13 shows the colour bars converted from HLG/BT.2020 to SDR/BT.709 using the display‑referred conversion method depicted in Fig. 12, which is the inverse of the “SDR to HLG mapping without gamma adjustment (display-referred)”. Note this method does not include tone-mapping. HDR signals are hard-clipped when converted to SDR. The BT.709-equivalent colour bars land on slightly different positions of the vectorscope targets.

Table 7 summarises the signal levels for input 75%HLG and BT.709-equivalent colour bars and the converted SDR/BT.709 colour bars. The BT.709-equivalent colour bars are converted to the same signal levels as the original SDR/BT.709 colour bars by the scene-referred conversion. Some of the signal levels of the resultant SDR colour bars by the scene-referred conversion are not exactly the same levels as the original SDR/BT.709, for example the signal levels of the Green bar are not (64, 940, 64) but (71, 939, 66) due to rounding errors.

FIGURE 9

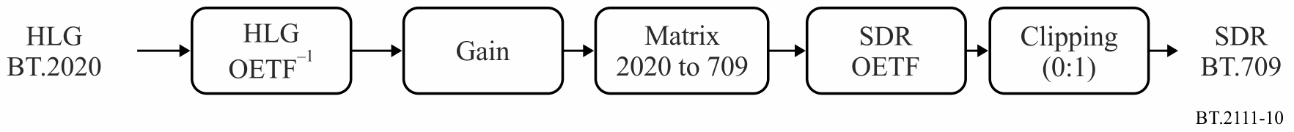
HLG/BT.2020 colour bars and their snapshots of the waveform and vectorscope set to BT.2020 colorimetry

Graphical user interface, application

Description automatically generated

FIGURE 10

Scene-referred conversion method from HLG/BT.2020 to SDR/BT.709



NOTE – The gain is set so that 75%HLG corresponds to 100%SDR. The colour conversion matrix is as described in § 2 of Report [ITU-R BT.2407](https://www.itu.int/rec/R-REP-BT.2407/en) – “Simple conversion from BT.2020 to BT.709 based on linear matrix transformation”. Note other methods may result in different signal levels for input signals outside of the BT.709 colour volume.

FIGURE 11

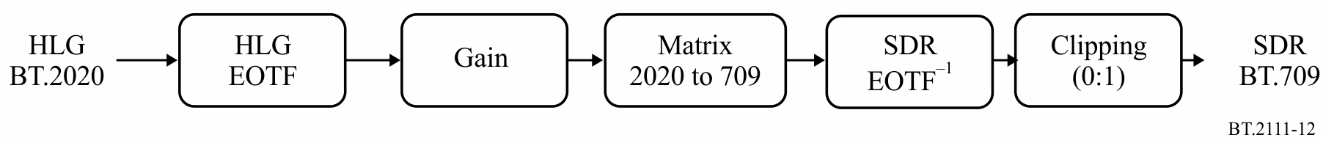
Colour bars converted to SDR/BT.709 using the scene-referred conversion and their snapshots  
of the waveform and vectorscope set to BT.709 colorimetry

Graphical user interface

Description automatically generated

FIGURE 12

Display-referred conversion method from HLG/BT.2020 to SDR/BT.709



NOTE – The gain is set so that 75%HLG corresponds to 100%SDR. The colour conversion matrix is the same as that in Fig. 10.

FIGURE 13

Colour bars converted to SDR/BT.709 using the display-referred conversion and their snapshots of the waveform   
and vectorscope set to BT.709 colorimetry

Graphical user interface

Description automatically generated

TABLE 7

Signal levels in 10 bits for input 75%HLG and BT.709-equivalent colour bars and   
output SDR/BT.709 colour bars converted by the methods in Figs 10 and 12

| Image Area | Input signal level (HLG/BT.2020, 10 bits) | | | Output signal level (SDR/BT.709, 10 bits) (No tone-mapping applied, simple colour conversion) | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scene-referred conversion | | | Display-referred conversion | | |
|  | R | G | B | R | G | B | R | G | B |
| 75% White | 721 | 721 | 721 | 940 | 940 | 940 | 940 | 940 | 940 |
| 75% Yellow | 721 | 721 | 64 | 940 | 940 | 64 | 940 | 939 | 64 |
| 75% Cyan | 64 | 721 | 721 | 64 | 940 | 940 | 64 | 940 | 924 |
| 75% Green | 64 | 721 | 64 | 64 | 940 | 64 | 64 | 940 | 64 |
| 75% Magenta | 721 | 64 | 721 | 940 | 64 | 940 | 940 | 64 | 894 |
| 75% Red | 721 | 64 | 64 | 940 | 64 | 64 | 940 | 64 | 64 |
| 75% Blue | 64 | 64 | 721 | 64 | 64 | 940 | 64 | 64 | 789 |
| 75% BT.709 Yellow | 713 | 719 | 316 | 939 | 940 | 64 | 933 | 934 | 64 |
| 75% BT.709 Cyan | 538 | 709 | 718 | 64 | 940 | 939 | 64 | 924 | 922 |
| 75% BT.709 Green | 512 | 706 | 296 | 71 | 939 | 66 | 124 | 915 | 99 |
| 75% BT.709 Magenta | 651 | 286 | 705 | 940 | 65 | 940 | 854 | 89 | 853 |
| 75% BT.709 Red | 639 | 269 | 164 | 940 | 64 | 64 | 835 | 64 | 64 |
| 75% BT.709 Blue | 227 | 147 | 702 | 66 | 64 | 940 | 93 | 64 | 768 |

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-2)