



Recommendation ITU-R BT.2035
(07/2013)

**A reference viewing environment for
evaluation of HDTV program material or
completed programmes**

BT Series
Broadcasting service
(television)

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Series	Title
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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.2035

A reference viewing environment for evaluation of HDTV program material or completed programmes

(2013)

Scope

This Recommendation prescribes a method allowing HDTV producers or broadcasters to establish a reference viewing condition for evaluation of HDTV program material or completed programmes that can provide repeatable results from one facility to another when viewing the same material. This includes the display device and the surrounding environment.¹

The ITU Radiocommunication Assembly,

considering

- a) that HDTV CRT displays are no longer available and revised criteria for subjective evaluation of HDTV images is required;
- b) that the picture rendering characteristics differ between CRT and non-CRT displays;
- c) that the impact of the viewing environment can significantly change the perceived image characteristics;
- d) that a defined reference display is required to minimize differences in display technology;
- e) that other ITU Recommendations such as Recommendation ITU-R BT.2022 define other viewing conditions for specific applications;
- f) that repeatable visual evaluations are required to confirm image representations,

recommends

1 that for evaluation of HDTV program material or completed programmes, the characteristics of a reference viewing condition described in Annex 1 should be used.

2 that for the greatest degree of displayed image uniformity, the same display technologies be used between facilities when comparisons are to be made.

NOTE 1 – Not all the possible parameters have been defined and it is assumed that the display device has been qualified for any obvious deficiencies prior to the evaluation process. Display devices intended for consumer displays should not be used for professional evaluation.

¹ High quality, critical viewing facilities can and will continue to be established in many ways by entities involved in editing, colour correction, screening and the like, and this Recommendation is not intended to suggest a need for absolute uniformity in such facilities.

Annex 1

Overview

For the purposes of assessing the performance of a display device, it is necessary to measure or characterize a very large number of parameters such as those described in Report ITU-R BT.2129. For everyday image evaluation it is impractical to perform these measurements; it is therefore suggested that this sub-set of these parameters be used for daily use. This Recommendation also recommends a reference viewing condition.

The huge range of technologies employed in flat panel displays makes the task of defining a single set of parameters for a reference display near impossible. Unlike the CRT where a single technology was deployed for the conversion of electrical signals to a viewable image, the various flat panel technologies provide an infinite number of variables.

The intent of the Recommendation is to provide guidance on the parameter values to be measured to set up the environment and the display parameters keeping in mind that measurement and adjustment of all possible parameters could be very extensive and time consuming.

As a further cautionary note, commercially available measurement instruments may yield different results; these differences may be as a result of different technologies used to sense the light on the display. The manufacturers instruction manuals should be consulted.

1 Reference viewing conditions

The reference viewing environment is intended to provide an environment which can be replicated from one facility to another. The display devices using different technologies may influence the extent to which uniformity of the displayed image can be achieved. This reference viewing environment is intended as a guideline for a practical implementation:

1.1 Viewing environment for subjective assessment

- | | | |
|----|---|--|
| a) | Room illumination: | <i>10 Lux</i> |
| b) | Chromaticity of background: | <i>D₆₅</i> (optionally <i>D₉₃</i> in some regions) |
| c) | Ratio of luminance of background behind picture monitor to peak luminance of picture: | <i>≈ Between 10% ±2% of reference white value</i> |

1.2 Viewing distance

The viewing distance is based on the screen size and it can be selected according to two distinct criteria: the preferred viewing distance (PVD) and the design viewing distance (DVD). For this application the DVD criteria is used.

1.2.1 Design viewing distance

The design viewing distance (DVD), or optimal viewing distance, for a digital system is the distance at which two adjacent pixels subtend an angle of 1 arc-min at the viewer's eye; and the optimal horizontal viewing angle as the angle under which an image is seen at its optimal viewing distance.

Image system	Reference	Aspect ratio	Pixel aspect ratio	Optimal horizontal viewing angle	Optimal viewing distance
1 920 × 1 080	Rec. ITU-R BT.709	16:9	1	31°	3.2 <i>H</i>

1.3 Observation angle

The maximum observation angle relative to the normal should be constrained so that deviations in reproduced colour on the screen should not be visible to an observer. The optimal horizontal viewing angle of an image system under test should also be considered to determine the observation angle.

As a guide to an acceptable numerical value, $\Delta u'$, $\Delta v'$ (CIE 1976 chromaticity differences) should be less than 0.01 for any of the colours within the Recommendation ITU-R BT.709 gamut.

As a guide to an acceptable numerical value, the luminance value should drop less than 10% for viewing angles within $\pm 30^\circ$ horizontally, vertically, and diagonally, and less than 20% for viewing angles within $\pm 30^\circ$ and $\pm 45^\circ$ horizontally, vertically, and diagonally.

1.4 Room environment-colour scheme

The colour of the display background should be the same as the reference white point; for the remaining room surfaces dark matte surfaces should be used. The objective is to minimize stray light on the display screen.

2 Display characteristics

There are a number of display technologies available all with different characteristics. The following text in this section gives a general overall set of criteria that should be used to minimize display technology differences.

2.1 Image size

Images to be evaluated should fill the complete screen. Screen sizes between 25 inches and 60 inches are recommended. Larger screen sizes are not prohibited.

2.2 Display image processing

Monitor processing such as image scaling, frame rate conversion, image enhancement, if implemented, should be done in such a way as to avoid introducing visible artifacts. Any report should indicate whether a de-interlacer is used or not for the presentation of interlaced signals. For interlace images it is preferable not to use a de-interlacer; the displayed image should preferably be presented as interlace.

2.3 Display pixel array

The minimum pixel array should be at least 1 920 × 1 080.

2.4 Ringing

Ringing or overshoots should not be introduced by any processing in the display. Ringing “in the image signal” should be displayed. Monitors should not cut off under- and over-shoots, or sub-black and super-white levels that do not violate protected values used for synchronization.

2.5 Temporal characteristics

Care should be paid to the temporal characteristics of the display for the following reason.

Temporal characteristics of displays vary according to display technologies and display processing parameters. In the past CRT technology was virtually the only display device for television image display; its characteristics were predictable and it ensured the consistency of the temporal characteristics of the displays both in studio and at home.

3 Display adjustment

The topic of display adjustment and setting of values continues to be covered in many industry forums. In many cases the individual manufacturers provide information on individual products that may be necessary to achieve the desired result.

3.1 Interface

The HDTV signal interface defined in Recommendation ITU-R BT.1120 should be used as the input source.

3.2 Reference white and reference black

Reference white (value 940) should correspond to 100 cd/m^2 and reference black (Value 64) should be less than 0.01 cd/m^2 . The waveform defined in Recommendation ITU-R BT.815 may be used to set these levels.

3.3 White point

- i) For a D_{65} white point, the coordinates should be:
 $Y = 100 \text{ cd/m}^2, x = 0.3127, y = 0.3290$.

If CIE1931 XYZ colorimetric system and the colour matching functions are used by the measurement instrument, the measurement instrument may give an erroneous result. The application of the Judd modification³ to these measurements can greatly improve matching results between different technologies. If other CIE reference scales are used appropriate conversions are required.

- ii) In some regions D_{93} is used as the reference white point, in that case:
 $x = 0.2831$ and $y = 0.2971$.

3.4 Gamma characteristics

The gamma characteristics (electro-optical transfer characteristic) of the display should be adjusted to the values of the curve over the full range contained in Recommendation ITU-R BT.1886 – Reference electro-optical transfer function for flat panel displays used in HDTV studio production.

² This measurement may prove to be difficult under some conditions.

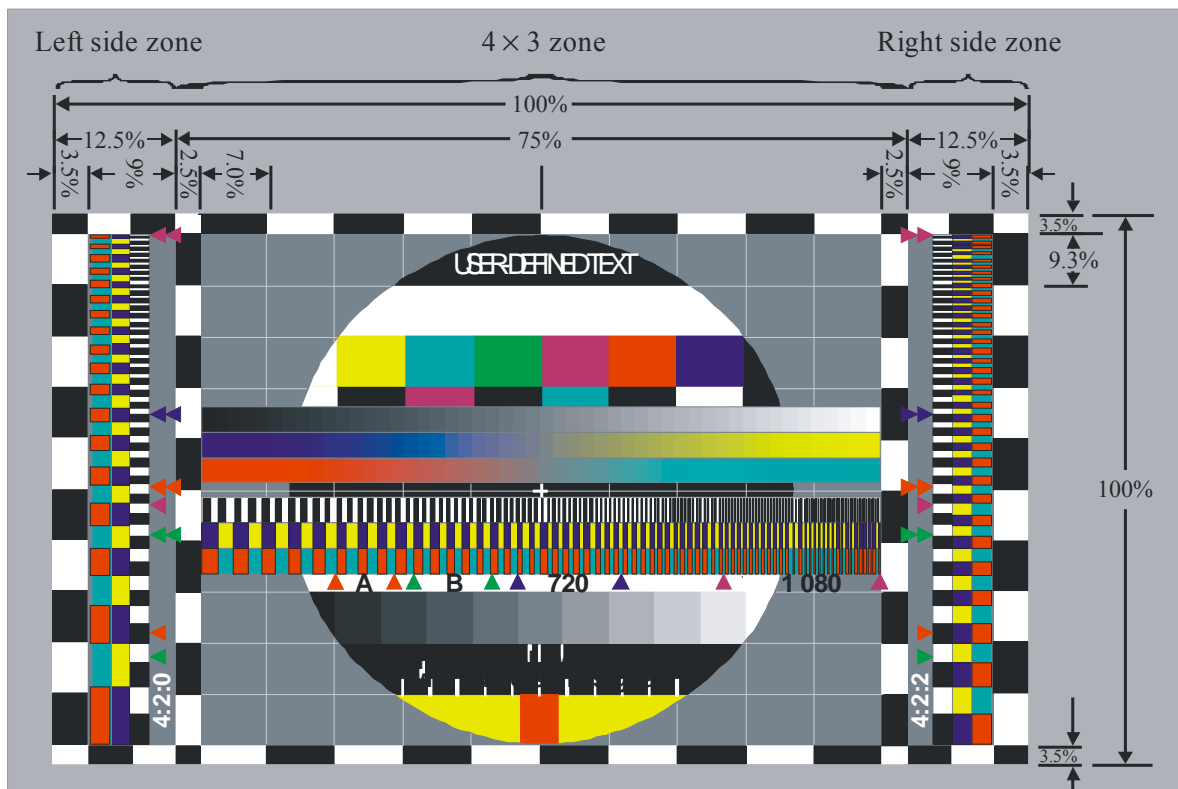
³ CIE 1988 2 Å° Spectral Luminous Efficiency Function for Photopic Vision.

3.5 Test pattern

The test pattern, as defined by Recommendation ITU-R BT.1729 – Common 16:9 or 4:3 aspect ratio digital television reference test pattern, may be used to confirm linearity of the display device. Confirm that clipping does occur beyond the reference white level (and reference black level). Recommendation ITU-R BT.1729 defines all signal parameters that may be used to set up the display device other than the parameters contained in § 3.1 through § 3.5, which correspond to Recommendation ITU-R BT.815.

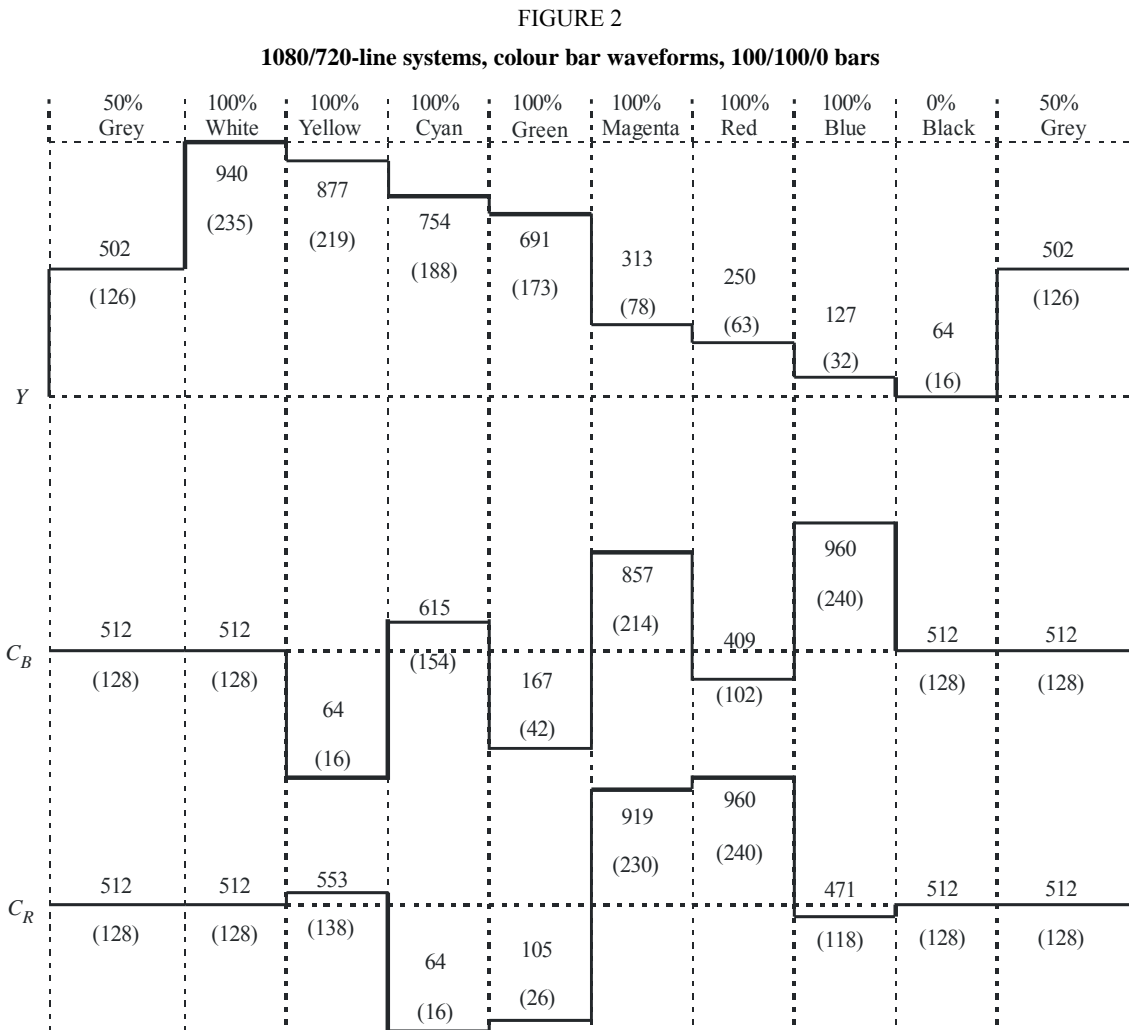
3.5.1 100% Colour Bar x, y values (Zone 4)

FIGURE 1
Multi-format test pattern – as seen on screen



BT.2035-01

(Diagram copied from Recommendation ITU-R BT.1729.)



BT.2035-02

(Diagram copied from Recommendation ITU-R BT.1729.)

TABLE 1
Test pattern zone 4 typical values

Colour/Y value	L (cd/m ²)	x	y
Reference Black (64 ₁₀)	0.0001	0.3889	0.3701
Reference White (940 ₁₀)	100.001	0.3127	0.3290
Yellow (877 ₁₀)	91.9090	0.4165	0.5027
Cyan (754 ₁₀)	76.2150	0.2179	0.3283
Green (691 ₁₀)	69.2110	0.2876	0.6001
Magenta (313 ₁₀)	29.3650	0.3279	0.1585
Red (250 ₁₀)	22.2500	0.6373	0.3304
Blue (127 ₁₀)	7.2947	0.1501	0.0605

The above values are not absolute values and are provided as a sample of measured values.

TABLE 2

Test pattern zone 4 calculated values

Colour/Y value	<i>x</i>	<i>y</i>
Black (64 ₁₀)	0.3889	0.3701
White (940 ₁₀)	0.3127	0.3290
Yellow (877 ₁₀)	0.4193	0.5053
Cyan (754 ₁₀)	0.2246	0.3287
Green (691 ₁₀)	0.2876	0.6001
Magenta (313 ₁₀)	0.3209	0.1542
Red (250 ₁₀)	0.6400	0.3300
Blue (127 ₁₀)	0.1501	0.0605

3.5.2 Grey scale tracking (Zone 11)

The 10 step grey scale in zone 11 should be measured to confirm that there is no non-linear processing distorting the grey scale. There should be no visual coloration of the grey scale.

3.6 Display motion artefacts

The display should not introduce motion artifacts that are introduced by specific display technologies. Motion effects included in the input signal should be represented on the display. In addition the refresh rate of flat panel displays (FPDs) may not be at the same rate as the native rate of the image. Care should be taken to ensure that no difference in motion rendition is introduced.

Appendix 1 (Informative)**Display characteristics in general**

Note that using different display technologies may yield different image characteristics. Thus, it is strongly recommended that characteristics of the display used should be checked beforehand. Recommendation ITU-R BT.1886 – Reference electro-optical transfer function for flat panel displays used in HDTV studio production, and Report ITU-R BT.2129 – User requirements for a flat panel display (FPD) as a master monitor in an HDTV programme production environment, may be referred to when professional FPD monitors are used for subjective image assessment.
