



Recommendation ITU-R BT.1769
(06/2008)

**Parameter values for an expanded hierarchy
of LSDI image formats for production and
international programme exchange**

BT Series
Broadcasting service
(television)

Foreword

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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.1769*

Parameter values for an expanded hierarchy of LSDI image formats for production and international programme exchange*****

(Question ITU-R 15/6)

(2006)

Scope

Some LSDI applications require certain resolution and scanning formats that go beyond HDTV in order to give viewers enhanced visual experiences. This Recommendation specifies an expanded hierarchy of LSDI image formats for production and international programme exchange while retaining the tiered relationship with the formats in existing Recommendations.

The ITU Radiocommunication Assembly,

considering

- a) that LSDI (large screen digital imagery) is a family of digital imagery systems which can be used in a wide variety of applications including programme presentations such as dramas, plays, sporting events, concerts, etc.;
- b) that hierarchical image formats for LSDI are required in order to cover the various applications;
- c) that ITU-R Recommendations cover three levels of image formats, namely 0.5 Mega pixels, 1 Mega pixels and 2 Mega pixels and that the 2 Mega pixels systems specified in Recommendation ITU-R BT.709 is the highest picture quality which ITU has ever standardized;
- d) that parameter values for an expanded hierarchy of LSDI image formats should provide conformity with Recommendation ITU-R BT.709;
- e) that Recommendation ITU-R BT.1201 – Extremely high resolution imagery, recommends image resolutions related to $1\,920 \times 1\,080$ based on Recommendation ITU-R BT.709 by simple integer ratios;
- f) that Recommendation ITU-R BT.1680 – Baseband imaging format for distribution of large screen digital imagery (LSDI) applications intended for presentation in a theatrical environment, recommends image formats up to HDTV resolution as members of a hierarchy of LSDI digital image formats;

* *Note by the BR Secretariat* – This Recommendation was amended editorially in July 2008.

** LSDI is a family of digital imagery systems applicable to programmes such as dramas, plays, sporting events, concerts, cultural events, etc., from capture to large screen presentation in high-resolution quality in appropriately equipped theatres, halls, and other venues.

*** The two image systems specified in this Recommendation belong to the family of EHRI (extremely high-resolution imagery) systems as specified in Recommendation ITU-R BT.1201.

g) that some LSDI applications will require resolutions beyond that specified in Recommendation ITU-R BT.1680, since viewing angles determine the required level of image resolution and visual experiences with wider viewing angle give viewers a higher sensation of reality. For example, some television productions intended for very large venues may require such higher resolutions;

h) that LSDI image formats are different from motion picture image formats;

j) that parameters for the network transport of the expanded hierarchy of LSDI image formats are contained in ITU-T Recommendation J.601,

recommends

1 that in order to expand the hierarchy of LSDI image formats for production and international programme exchange, beyond the image formats recalled in *considerings* c) and h) and excluding motion picture image formats, image formats based on Table 1 characteristics should be used when required.

TABLE 1
Picture characteristics

| Item | Parameter | Values | |
|------|--------------------------|---|---------------------------|
| | | 3 840 × 2 160 LSDI system | 7 680 × 4 320 LSDI system |
| 1.1 | Picture aspect ratio | 16:9 | |
| 1.2 | Samples per active line | 3 840 | 7 680 |
| 1.3 | Active lines per picture | 2 160 | 4 320 |
| 1.4 | Sampling lattice | Orthogonal | |
| 1.5 | Order of samples | Left to right, top to bottom | |
| 1.6 | Pixel aspect ratio | 1:1 (square pixels) | |
| 1.7 | Sampling structure | 4:2:0, 4:2:2, 4:4:4 | |
| 1.8 | Frame rate (Hz) | 24 ⁽¹⁾ , 25, 30 ⁽¹⁾ , 50, 60 ⁽¹⁾ | |
| 1.9 | Image structure | Progressive | |
| 1.10 | Bit/pixel | 10, 12 | |
| 1.11 | Colorimetry | See Recommendation ITU-R BT.1361 | |

⁽¹⁾ For the 24, 30 and 60 Hz systems, frame rates having values divided by 1.001 are also included.

NOTE 1 – An example of LSDI system that gives viewers visual experiences of a high-sensation of reality is explained in Appendix 1.

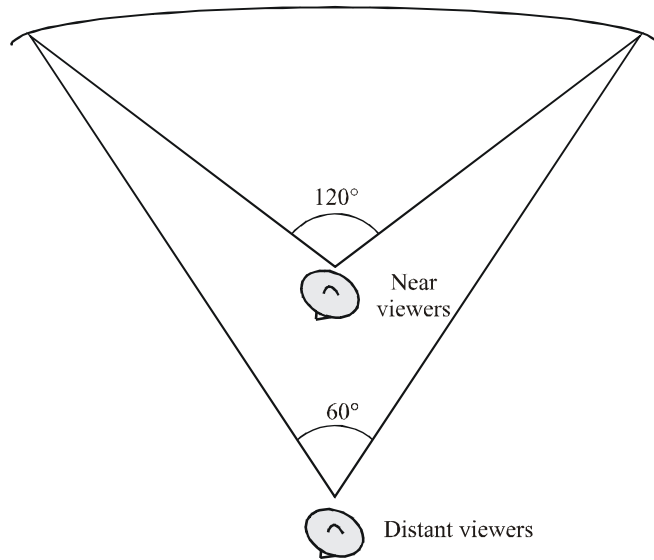
NOTE 2 – Viewing angles for the hierarchy of LSDI image formats are shown in Appendix 2.

NOTE 3 – A study result on psychological effects of wide-screen video system for LSDI applications is shown in Appendix 3.

Appendix 1

An example of LSDI system that gives viewers visual experiences of a high-sensation of reality

FIGURE 1
Horizontal viewing angle of LSDI system



1769-01

Appendix 2

Viewing angles for the hierarchy of LSDI image formats

TABLE 2

Horizontal viewing angle for the hierarchy of LSDI image formats

| | | | |
|---|---------------|---------------|---------------|
| LSDI system | 1 920 × 1 080 | 3 840 × 2 160 | 7 680 × 4 320 |
| Viewing distance (relative to picture height) | 3 | 1.5 | 0.75 |
| Viewing angle (degrees) | 31 | 58 | 96 |

These values are calculated, assuming the distance at which scanning lines just cannot be perceived by people with visual acuity of 1.0.

Appendix 3

A study on psychological effects of wide-screen video system for LSDI applications

1 Introduction

This Appendix describes the psychological evaluation results of “sensation of reality” of LSDI covering from HDTV format to expanded format. The results would contribute toward determining system parameter values such as display size, viewing distance and spatial resolution.

2 Subjective evaluation experiments

A single stimulus method with seven-categorical scale (1 = no presence at all; 7 = very strong presence) was used for evaluating the “sensation of reality” of images projected on a screen. The size of images was varied by changing the number of scanning lines from 1 000 to 4 000. The viewing distance was determined to be the point at which viewers with normal vision could no longer discern the scanning line structure. This corresponds to three times the picture height when the image size is $1\,920 \times 1\,080$. The viewing angle varies between 33° and 100° according to the image size. Table 3 lists the experimental conditions. Forty-one non-expert subjects evaluated five still landscape pictures listed in Table 4. They were shot with two different camera angles of 60° and 100° to see the effect of spatial distortion resulting from the mismatch between the screen-viewing angle and camera angle, and it can result in a reduced “sensation of reality”.

The display sub-system of ultra-high definition video system with 4 000 scanning lines (8k \times 4k display system) was used for an experiment apparatus. The system is reported in Report ITU-R BT.2053 – Large screen digital imagery. The display is equipped with four 8-million-pixel liquid crystal on silicon devices, and a pixel offset method enhances the resolution as equivalent to 32 million pixels. The screen size is approximately 7 m horizontally and 4 m vertically (320-inch diagonally). Screen brightness is 50 cd/m^2 and contrast ratio is more than 700:1. Table 5 lists the major items of the system’s signal format.

3 Results

“Sensation of reality” evaluated in seven-grade categorical scale was converted to interval scale to perform a multivariate analysis of variance (MANOVA) with a three-factor within-subject design (screen-viewing angle, camera angle and picture content). Significant values were obtained for the main effect of the screen-viewing angle, the main effect of the picture content, and for screen-viewing angle \times camera angle interactions. The main effect of the picture content was significant because picture 1 was rated higher than the other pictures. If MANOVA is performed without the results for picture 2, then significant results are not obtained for the main effect of the picture content. Figure 2 shows the relationship between the average score of pictures 1-5 and the screen-viewing angle for different camera angles. “Sensation of reality” increases monotonously with viewing angle, although the results for camera angle of 60° slightly levels off at the viewing angle above 90° .

4 Conclusion











The results confirm that wider viewing angle generates higher “sensation of reality”. It also implies that LSDI with higher resolution than HDTV would be needed for applications that require higher “sensation of reality”. On the other hand, it is known that decreases of comfortableness would arise when the viewing position is too close to wide-screen images.

In order to facilitate a wide variety of LSDI applications, study of expanded hierarchy of LSDI systems should be advanced.

**TABLE 3
Experimental conditions**

| | | | | | | | | | |
|------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Scanning lines | 1 000 | 1 143 | 1 333 | 1 600 | 2 000 | 2 667 | 3 200 | 3 556 | 4 000 |
| Picture aspect ratio | 16:9 | | | | | | | | |
| Picture size diagonally (inch) | 75 | 86 | 100 | 120 | 150 | 200 | 240 | 267 | 300 |
| Viewing distance (m) | 2.8 | | | | | | | | |
| Viewing distance (H) | 3.0 | 2.6 | 2.2 | 1.9 | 1.5 | 1.1 | 0.93 | 0.84 | 0.75 |
| Horizontal viewing angle (degrees) | 33.2 | 37.6 | 43.3 | 51.0 | 61.6 | 76.9 | 87.3 | 93.3 | 100.0 |

**TABLE 4
Test pictures**

| | | | | | |
|----------------------------|--|--|--|--|--|
| Camera angle 60 (degrees) | 1  | 2  | 3  | 4  | 5  |
| Camera angle 100 (degrees) | 1  | 2  | 3  | 4  | 5  |

**TABLE 5
Signal format of 8k × 4k display system**

| Parameter | Value |
|--------------------------|----------------------|
| Picture rate | 60 frames per second |
| Image structure | Progressive |
| Sample per active line | 7 680 |
| Active lines per picture | 4 320 |
| Picture aspect ratio | 16:9 |

FIGURE 2
Sensation of reality vs. viewing angle

