

International Telecommunication Union

ITU-R
Radiocommunication Sector of ITU

Report ITU-R BT.2245-2
(10/2016)

**HDTV and UHD TV test materials for
assessment of picture quality**

BT Series
Broadcasting service
(television)



International
Telecommunication
Union

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 Annex 1 of 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 Reports

(Also available online at <http://www.itu.int/publ/R-REP/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

Note: This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.

Electronic Publication
Geneva, 2016

© ITU 2016

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

REPORT ITU-R BT.2245-2

HDTV and UHD TV test materials for assessment of picture quality

(Question ITU-R 81-1/6)

(2011-2014-2016)

Introduction

This Report contains lists of HDTV and UHD TV test materials and related information for assessment of picture quality of television systems. This Report is informatively referred to by Recommendation ITU-R BT.1210.

TABLE OF CONTENTS

	<i>Page</i>
1 Test materials of high definition television (HDTV)	3
2 Test materials of ultra-high definition television (UHD TV) and high definition television (HDTV)	19
Annex 1 – Supplementary information on test materials	20
1 HDTV test materials for the 1 920×1 080/59.94/I, 4:4:4 and 4:2:2, 10-bit and 1 920×1 080/59.94/P, 4:2:2, 10-bit formats listed in Tables 1-2 and 1-3.....	20
1.1 Image characteristics	20
1.2 Production conditions	21
1.3 Status for use of test materials	21
2 HDTV test materials for the 1 920 × 1 080/50/I, 4:2:2, 10-bit formats listed in Tables 1-4	21
2.1 Image characteristics	21
2.2 Production conditions	22
2.3 Status for use of test materials	23
3 UHD TV/HDTV test materials listed in Table 5	23
Attachment 1 to Annex 1 – Thumbnails of the test materials.....	25
Attachment 2 to Annex 1 – Attributes to be evaluated	33
Annex 2 – Choice of statistics that can serve to characterize materials	41
1 Introduction	41
2 Statistics of test materials	41

	<i>Page</i>
2.1 Entropy of PCM data	41
2.2 AC energy	41
2.3 Spectral entropy	42
2.4 Motion vector.....	42
2.5 Motion-compensated prediction error power	43
2.6 Criticality by rate-buffer occupancy method	43
2.7 Criticality by fixed quantizer method	43
Annex 3 – Status for use of test materials.....	47
Annex 4 – File formats for test materials.....	47
1 TIFF file for HDTV RGB 4:4:4 (10 bits)	47
2 YUV file for HDTV YC _B C _R 4:2:2 (10 bits)	48
3 Raw file for UHD TV RGB 4:4:4 (12 bits)	50

1 Test materials of high definition television (HDTV)

TABLE 1
1 920×1 080 HDTV still pictures

Scene No.	Title	Contents	Representative of	Attributes to be examined	Motion	Source	Statistic	Copyright status	Delivery format	Provider name
1	Woman	Bust shot of a woman with a red flower against uniform background	Studio still portrait	False contour, Y/C phase difference Flesh tint and texture reproduction	Still	Slide	See Appendix 1 to Annex 2	See Annex 3	Slide/ CD-ROM	ITE
2	Yacht harbour	Long shot of a yacht harbour with highly detailed yachts	Outdoor still	Waveform distortion Aliasing Sharpness	Still	Slide	See Appendix 1 to Annex 2	See Annex 3	Slide/ CD-ROM	ITE
3	Sweaters and bag	Loose shot of sweaters, towels of various colours, a leather bag, metal pitcher, etc.	Studio still Textured objects	Texture reproduction Lustre	Still	Slide	See Appendix 1 to Annex 2	See Annex 3	Slide/ CD-ROM	ITE
4	Eiffel tower	Long shot of Eiffel tower and landscape of Paris behind it	Outdoor still	Resolution Sensation of reality	Still	Slide	See Appendix 1 to Annex 2	See Annex 3	Slide/ CD-ROM	ITE
5	A hat shop	Scene of a stall and a couple talking beside it	Drama	Gray scale reproduction Interlace artefacts	Still	Slide	See Appendix 1 to Annex 2	See Annex 3	Slide/ CD-ROM	ITE
6	A couple in the snow	Loose contre-jour shot, of a couple facing each other in the snow	Contre-jour scene	Gray scale reproduction Uniformity Large area flicker	Still	Slide	See Appendix 1 to Annex 2	See Annex 3	Slide/ CD-ROM	ITE
7	Guide board	Full shot of a guide board written in various kinds of characters of different sizes	Outdoor still	Waveform distortion Registration legibility	Still	Slide	See Appendix 1 to Annex 2	See Annex 3	Slide/ CD-ROM	ITE
8	Tulip garden	Wide shot of a garden with red and yellow tulips of various sizes	Highly saturated colours	Chrominance/luminance resolution Colour reproduction	Still	Slide	See Appendix 1 to Annex 2	See Annex 3	Slide/ CD-ROM	ITE
9	Chromakey	A woman sitting against blue back with detailed flowers	Chromakey	Chromakey process False contour	Still	Slide	See Appendix 1 to Annex 2	See Annex 3	Slide/ CD-ROM	ITE

ITE: The Institute of Image Information and Television Engineers, 3-5-8 Shibakoen, Minato-ku, Tokyo 105-0011, Japan, Phone: +81 3 3432 4677, Fax: +81 3 3432 4675, E-mail: ite@ite.or.jp.

(Distributor: NHK Engineering Service, Inc., 1-10-11 Kinuta, Setagaya-ku, Tokyo 157-8540 Japan, Phone: +81 3 5494 2400, Fax: +81 3 5494 2152, <http://www.nes.or.jp/en/index.html>)

TABLE 2

1 920×1 080/59.94/I, 4:4:4 and 4:2:2, 10-bit HDTV pictures (see Annex 1)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
101	Ginkgo trees	Loose shot of roadside trees and tight shot of green leaves	Outdoor shooting dissolve	Digital coding Motion reproduction Resolution	Dolly in/ dolly out	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
102	Truck train	Pan shot of a passing colourful truck train	Outdoor shooting	Standard conversion Motion reproduction Colour reproduction Texture	Pan	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
103	Cosmos flowers	Pan up shot of waving flowers and pan shot of a strolling woman	Outdoor shooting	Colour reproduction Digital coding Resolution	Pan up/Pan	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
104	Red leaves (pan up)	Pan up shot from a strolling woman to red leaves under collared leaves	Outdoor shooting	Colour reproduction Digital coding Resolution	Pan up	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
105	Sunlight through leaves	Pan down shot from sunlight through red leaves to a Japanese garden	Outdoor shooting Subtitle	Colour reproduction Digital coding Motion reproduction Resolution Contrast	Pan down	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
106	Red leaves (pan down)	Pan down shot from red leaves to a strolling woman	Outdoor shooting	Colour reproduction Digital coding Resolution	Pan down	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
107	Woman at harbour (circle dolly)	Circle dolly shot of a woman at a harbour	Outdoor shooting Subtitle	Motion reproduction Skin colour	Circle dolly	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
108	Fountain (follow)	Follow shot of a strolling woman at a fountain	Outdoor shooting	Digital coding Motion reproduction Skin colour	Follow	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
109	Fountain (dolly)	Dolly shot of a strolling woman at a fountain	Outdoor shooting Subtitle	Digital coding Motion reproduction	Dolly	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
110	Studio concert (confetti)	Dolly shot of a music concert under varying lighting in confetti	Music	Digital coding Resolution Gray scale reproduction Colour reproduction	Dolly	Camera	See Annex 3	Consecutively numbered TIFF files	ITE

TABLE 2 (continued)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
111	Studio concert	Dolly shots of a series of performers at a music concert under varying lighting	Music	Digital coding Gray scale reproduction Colour reproduction	Dolly	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
112	Drama set (day)	Dolly and tight shots of a woman entering and leaving a Japanese living room	Drama	Standards conversion Resolution Colour reproduction Texture	Dolly/follow	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
113	Drama set (night)	Follow shot of a woman passing in front of a Japanese lantern at night	Drama	Contrast Texture Noise reduction	Follow	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
114	Basketball	Long shot of a basketball game with spectators (1/100 s shutter)	Sports Subtitle	Standards conversion Digital coding Motion reproduction	Pan	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
115	Evening scene (zoom out)	Zoom out shot from a Ferris wheel in the evening	Outdoor shooting	Standards conversion Resolution Gray scale reproduction	Zoom out	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
116	Evening scene (fixed)	A Ferris wheel and high-rise buildings in the evening	Outdoor shooting Subtitle	Gray scale reproduction Motion reproduction	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
117	Night scene (fixed)	A Ferris wheel and high-rise buildings at night	Outdoor shooting Subtitle	Gray scale reproduction Contrast Noise reduction	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
118	Horse racing (dirt)	Long and tight shots of racehorses on a dirt course.	Outdoor shooting	Digital coding Motion reproduction	Pan	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
119	Horse racing (turf)	Long shot of racehorses on a grass course	Outdoor shooting	Digital coding Motion reproduction	Pan	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
120	Woman at harbour (dolly in, zoom back)	Dolly in, zoom back shot of a woman at a harbour	Outdoor shooting	Skin colour Texture	Dolly in, zoom back	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
121	Torch bearer	Follow shot of torchbearers running at a track corner	Outdoor shooting	Digital coding Standards conversion Resolution	Follow	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
122	Children's dance	Tight shot of children dancing on the grass of an athletic field	Outdoor shooting	Digital coding Resolution Texture	Pan	Camera	See Annex 3	Consecutively numbered TIFF files	ITE

TABLE 2 (continued)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
123	Children's dance (loose shot)	Loose shot of children dancing on the grass	Sports	Digital coding Resolution Texture	Pan	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
124	March	Pan up from athletes to the audience	Sports	Digital coding Resolution	Pan up	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
125	Marathon (pan up)	Pan up shot of crowds of marathon runners	Sports	Digital coding Resolution	Pan up	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
126	Marathon (fixed)	Tight shot of crowds of marathon runners	Sports	Digital coding Resolution	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
151	Rotating disk 59.94/I	A rotating disk with still pictures at 59.94/I	Studio production	Digital coding Standards conversion Motion reproduction Resolution Legibility	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
152	Rotating disk 59.94/I with 1/120 s shutter	A rotating disk with still pictures at 59.94/I (1/120 s shutter)	Studio production	Digital coding Standards conversion Motion reproduction Resolution Legibility	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
153*	Rotating disk 50/I	A rotating disk with still pictures at 50/I (normal shutter speed)	Studio production	Digital coding Standards conversion Motion reproduction Resolution Legibility	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
154*	Rotating disk 50/I with 1/100 s shutter	A rotating disk with still pictures at 50/I (1/100 s shutter)	Studio production	Digital coding Standards conversion Motion reproduction Resolution Legibility	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
155	Pendulum 59.94/I	Pendulum (normal shutter speed)	Studio production	Digital coding Standards conversion Motion reproduction Resolution	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE

TABLE 2 (continued)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
156	Pendulum 59.94/I with 1/120 s shutter	Pendulum (1/120 s shutter)	Studio production	Digital coding Standards conversion Motion reproduction Resolution	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
157*	Pendulum 50/I	Pendulum shot at 50/I (normal shutter speed)	Studio production	Digital coding Standards conversion Motion reproduction Resolution	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
158*	Pendulum 50/I with 1/100 s shutter	Pendulum shot at 50/I (1/100 s shutter)	Studio production	Digital coding Standards conversion Motion reproduction Resolution	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
159	Colourful world A	Toy train passing through colourful objects	Studio production	Digital coding Texture Resolution Legibility Colour reproduction	Pan, fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
160	Colourful world B	Pan shots of colourful objects.	Studio production	Digital coding Texture Resolution Colour reproduction	Pan	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
161	Black dress	A woman dressed in black walks in front of a white wall and a black wall	Studio production	Gray scale reproduction Contrast Skin colour	Pan follow, fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
162	White dress	A woman dressed in white walks in front of a black wall and a white wall	Studio production	Gray scale reproduction Contrast Skin colour	Pan follow, fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
163	Woman with bouquet	Close shot of a woman with bouquet	Studio production	Contrast Skin colour	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
164	Flash photography	A woman under continuous flash lights	Studio production	Digital coding Standards conversion	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
165	Fountain (chromakey)	Mixing a woman and fountains by chromakey	Studio production Outdoor shooting	Digital coding Motion reproduction Skin colour	Fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE

TABLE 2 (*end*)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
166	Night port (camera gain: normal)	Zoom out from a night port (normal camera gain)	Outdoor shooting	Digital coding Contrast Noise reduction	Zoom out	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
167	Night port (camera gain: +6 dB)	Zoom out from a night port (camera gain: +6 dB)	Outdoor shooting	Digital coding Contrast Noise reduction	Zoom out	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
168	Night port (camera gain: +12 dB)	Zoom out from a night port (camera gain: +12 dB)	Outdoor shooting	Digital coding Contrast Noise reduction	Zoom out	Camera	See Annex 3	Consecutively numbered TIFF files	ITE
169	Glasses	Pouring drinks into glasses	Studio production	Colour reproduction	Pan/fixed	Camera	See Annex 3	Consecutively numbered TIFF files	ITE

* The field frequency is 50 Hz.

TABLE 3

1 920×1 080/59.94/P, 4:2:2, 10-bit HDTV pictures (see Annex 1)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
201	Ginkgo trees	Loose shot of roadside trees and tight shot of green leaves	Outdoor shooting Dissolve	Digital coding Motion reproduction Resolution	Dolly in/ dolly out	Camera	See Annex 3	Consecutively numbered YUV files	ITE
202	Truck train	Pan shot of a passing colourful truck train	Outdoor shooting	Standard conversion Motion reproduction Colour reproduction Texture	Pan	Camera	See Annex 3	Consecutively numbered YUV files	ITE
203	Cosmos flowers	Pan up shot of waving flowers and pan shot of a strolling woman	Outdoor shooting	Colour reproduction Digital coding Resolution	Pan up/pan	Camera	See Annex 3	Consecutively numbered YUV files	ITE
204	Red leaves (pan up)	Pan up shot from a strolling woman to red leaves under collared leaves	Outdoor shooting	Colour reproduction Digital coding Resolution	Pan up	Camera	See Annex 3	Consecutively numbered YUV files	ITE
205	Sunlight through leaves	Pan down shot from sunlight through red leaves to a Japanese garden	Outdoor shooting Subtitle	Colour reproduction Digital coding Motion reproduction Resolution Contrast	Pan down	Camera	See Annex 3	Consecutively numbered YUV files	ITE
206	Red leaves (pan down)	Pan down shot from red leaves to a strolling woman	Outdoor shooting	Colour reproduction Digital coding Resolution	Pan down	Camera	See Annex 3	Consecutively numbered YUV files	ITE
207	Woman at harbour (circle dolly)	Circle dolly shot of a woman at a harbour	Outdoor shooting Subtitle	Motion reproduction Skin colour	Circle dolly	Camera	See Annex 3	Consecutively numbered YUV files	ITE
208	Fountain (follow)	Follow shot of a strolling woman at a fountain	Outdoor shooting	Digital coding Motion reproduction Skin colour	Follow	Camera	See Annex 3	Consecutively numbered YUV files	ITE
209	Fountain (dolly)	Dolly shot of a strolling woman at a fountain,	Outdoor shooting Subtitle	Digital coding Motion reproduction	Dolly	Camera	See Annex 3	Consecutively numbered YUV files	ITE
210	Studio concert (confetti)	Dolly shot of a music concert under varying lighting in confetti	Music	Digital coding Resolution Gray scale reproduction Colour reproduction	Dolly	Camera	See Annex 3	Consecutively numbered YUV files	ITE

TABLE 3 (continued)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
211	Studio concert	Dolly shots of a series of performers at a music concert under varying lighting	Music	Digital coding Gray scale reproduction Colour reproduction	Dolly	Camera	See Annex 3	Consecutively numbered YUV files	ITE
212	Drama set (day)	Dolly and tight shots of a woman entering and leaving a Japanese living room	Drama	Standards conversion Resolution Colour reproduction Texture	Dolly/follow	Camera	See Annex 3	Consecutively numbered YUV files	ITE
213	Drama set (night)	Follow shot of a woman passing in front of a Japanese lantern at night	Drama	Contrast Texture Noise Reduction	Follow	Camera	See Annex 3	Consecutively numbered YUV files	ITE
214	Basketball	Long shot of a basketball game with spectators (1/100 s shutter)	Sports Subtitle	Standards conversion Digital coding Motion reproduction	Pan	Camera	See Annex 3	Consecutively numbered YUV files	ITE
215	Twilight scene (zoom out)	Zoom out shot from a Ferris wheel in the evening	Outdoor shooting	Standards conversion Resolution Gray scale reproduction	Zoom out	Camera	See Annex 3	Consecutively numbered YUV files	ITE
216	Twilight scene (fixed)	A Ferris wheel and high-rise buildings in the evening	Outdoor shooting Subtitle	Gray scale reproduction Motion reproduction	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
217	Night scene (fixed)	A Ferris wheel and high-rise buildings at night	Outdoor shooting Subtitle	Gray scale reproduction Contrast Noise reduction	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
218	Horse racing (dirt)	Long and tight shots of racehorses on a dirt course.	Outdoor shooting	Digital coding Motion reproduction	Pan	Camera	See Annex 3	Consecutively numbered YUV files	ITE
251	Rotating disk 59.94/P	A rotating disk attached with still pictures (normal shutter speed)	Studio production	Digital coding Standards conversion Motion reproduction Resolution Legibility	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
252	Rotating disk 59.94/P with 1/120 s shutter	A rotating disk attached with still pictures (1/120 s shutter)	Studio production	Digital coding Standards conversion Motion reproduction Resolution Legibility	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE

TABLE 3 (continued)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
253*	Rotating disk 24/P	A rotating disk attached with still pictures shot at 24/P (normal shutter speed)	Studio production	Digital coding Standards conversion Motion reproduction Resolution Legibility	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
254*	Rotating disk 24/P with 1/48 s shutter	A rotating disk attached with still pictures shot at 24/P (1/48 s shutter)	Studio production	Digital coding Standards conversion Motion reproduction Resolution Legibility	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
255	Pendulum 59.94/P	Pendulum (normal shutter speed)	Studio production	Digital coding Standards conversion Motion reproduction Resolution	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
256	Pendulum 59.94/P with 1/120 s shutter	Pendulum (1/120 s shutter)	Studio production	Digital coding Standards conversion Motion reproduction Resolution	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
257*	Pendulum 24/P	Pendulum shot at 24/P (normal shutter speed)	Studio production	Digital coding Standards conversion Motion reproduction Resolution	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
258*	Pendulum 24/P with 1/48 s shutter	Pendulum shot at 24/P (1/48 s shutter)	Studio production	Digital coding Standards conversion Motion reproduction Resolution	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
259	Colourful world A	Toy train passing through colourful objects	Studio production	Digital coding Texture Resolution Legibility Colour reproduction	Pan, fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
260	Colourful world B	Pan shots of colourful objects	Studio production	Digital coding Texture Resolution Colour reproduction	Pan	Camera	See Annex 3	Consecutively numbered YUV files	ITE
261	Black dress	A woman dressed in black walks in front of a white wall and a black wall	Studio production	Gray scale reproduction Contrast Skin colour	Pan follow, fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE

TABLE 3 (end)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
262	White dress	A woman dressed in white walks in front of a black wall and a white wall	Studio production	Gray scale reproduction Contrast Skin colour	Pan follow, fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
263	Woman with bouquet	Close shot of a woman with bouquet	Studio production	Contrast Skin colour	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
264	Flash photography	A woman under continuous flash lights	Studio production	Digital coding Standards conversion	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE
265	Fountain (chromakey)	Mixing a woman and fountains by chromakey	Studio production Outdoor shooting	Digital coding Motion reproduction Skin colour	Fixed	Camera	See Annex 3	Consecutively numbered YUV files	ITE

* The frame frequency is 24 Hz.

ITE: The Institute of Image Information and Television Engineers, 3-5-8 Shibakoen, Minato-ku, Tokyo 105-0011, Japan, Phone: +81 3 3432 4677, Fax: +81 3 3432 4675, E-mail: ite@ite.or.jp.

(Distributor: NHK Engineering Service, Inc., 1-10-11 Kinuta, Setagaya-ku, Tokyo 157-8540 Japan, Phone: +81 3 5494 2400, Fax: +81 3 5494 2152, <http://www.nes.or.jp/en/index.html>)

TABLE 4

1 920 × 1 080/50/I, 4:2:2, 10-bit HDTV pictures (see Annex 1)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
301	Harvest wheat fields	Spacious wheat fields	Outdoor shooting	Resolution Digital coding	Pan	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
302	Crossroad	Shopping street with crowded people and transformations	Outdoor shooting	Motion reproduction	Pan follow Fixed	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
303	Basketball game	Basketball game	Sports	Motion reproduction Digital coding	Fixed Pan	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
304	Beijing opera	Beijing opera actresses and actors in costume with bright rich colors	Drama	Digital coding Resolution Colour reproduction	Fixed	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
305	Bicycle race	The starting and ongrowth of the bicycle race	Sports	Digital coding Motion reproduction	Fixed Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
306	Equestrianism	Scene of the equestrianism	Sports	Digital coding Motion reproduction	Fixed Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
307	Football game	Scene of a football game	Sports	Digital coding Motion reproduction	Fixed Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
308	Swimming	Scene of a swimming game	Sports	Digital coding Motion reproduction	Fixed Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
309	Water polo game	Scene of a water polo game	Sports	Digital coding Motion reproduction	Fixed Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP

TABLE 4 (continued)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
310	Synchronized swimming	Scene of a synchronized swimming game	Sports	Digital coding Motion reproduction	Fixed Zoom in	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
311	Folk dance	Scene of dancing and singing actresses with fresh colorful dresses	Studio	Digital coding Motion reproduction	Fixed	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
312	Scrolling characters	Scrolling to top characters and dancing	Studio production	Digital coding Motion reproduction Resolution	Fixed	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
313	Scrolling characters	Scrolling to left characters and dancing	Studio production	Digital coding Motion reproduction Resolution	Fixed	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
314	The silk dancing team	Parade of people dancing with ribbon belts in square matrix.	Outdoor shooting	Digital coding Motion reproduction Colour reproduction	Fixed Pan	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
315	Northwest Waist drum dancing teams	Yangko dance and waist drum in parade	Outdoor shooting	Digital coding Motion reproduction Colour reproduction	Fixed Pan	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
316	Fireworks	Fireworks and cheering and dancing people celebrating national day during night	Outdoor shooting	Digital coding	Fixed	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
317	Effects	Film clips of a drama party	Effects	Digital coding Colour reproduction	--	Computer	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
318	3d animations	Animations	Animations	Digital coding colour reproduction	--	Computer	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP

TABLE 4 (continued)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
351	Skin color of lady1	A lady with flowers and fruits	Studio	Skin color Colour reproduction Texture	Fixed	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
352	Chromakey (portrait)	A half length lady portrait in front, with colorful fruits and glass container on the right side. The background is with standard blue color.	Studio	Chromakey Colour reproduction	Fixed	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
353	Chromakey (scene)1	On a table with its cloth, there are glass vase, glass fishbowl, colorful wool ball and smog. Above all these, there is a dangling rolling birdcage.	Studio	Chromakey	Zoom in	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
354	Rotating birdcage1	The background is standard blue color. There is a plush toy bird in the rolling birdcage.	Studio	Chromakey Motion reproduction	Zoom out	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
355	Nine-dragon screen	A relief screen with nine-dragon in traditional china style	Outdoor shooting	Resolution	Pan	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
356	Flower garden	A tour bus travelling in the garden with detailed rich colors	Outdoor shooting	Digital coding Resolution Colour reproduction	Pan follow Fixed	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
357	Field of flowers	Brightening red flowers and golden flowers on the up and down hills	Outdoor shooting	Resolution Colour reproduction	Pan	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
358	Amusement park	People whirling up and down in the amusement park--- typical scene of this spot	Outdoor shooting	Digital coding Motion reproduction	Fixed Zoom in and out	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP

TABLE 4 (continued)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
359	City plaza	Actresses wearing dresses with stripe walking in the city plaza with crisscross style	Outdoor shooting	Resolution Standards conversion	Pan follow	Camera1	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
360	Skiing	Sportsmen with bright-colored ski suit in the ski field	Sports	Motion reproduction Luminance level	Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
361	Hebei bangzi	Performance of opera of china	Studio production	Colour reproduction	Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
362	Hebei Bangzi with noises ($S/N = 65$ dB)	Adding noise of $S/N = 65$ dB to the above scene	Noise, signal Processing	Performance of digital signal Processing	Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
363	Hebei Bangzi with noises ($S/N = 53$ dB)	Adding noise of $S/N = 53$ dB to the above scene	Noise, signal Processing	Performance of digital signal Processing	Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
364	Hebei Bangzi with noises ($S/N = 45$ dB)	Adding noise of $S/N = 45$ dB to the above scene	Noise, signal Processing	Performance of digital signal Processing	Pan follow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
365	Textiles and Household articles	Textiles of cotton, linen and woll; product of leather, glass, plastic and wood.	Studio still Textured objects	Texture reproduction	Still	Camera2	See Annex 3	TIFF file	CCTV&A BP
366	Food and containers	Vegetables, fruits, bread, porcelain, metalwork, etc.	Studio still	Texture reproduction	Still	Camera2	See Annex 3	TIFF file	CCTV&A BP
367	Rotating birdcage2	The background is with standard blue color. There is a plush toy bird and two porcelain containers in the rolling birdcage.	Studio	Chromakey Motion reproduction	Zoom in and out	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP

TABLE 4 (continued)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
368	Flowerbed	Flowers on the stairs	Outdoor shooting	Color resolution	Pan slow	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
369	Rotating disc (speed 1)	A rotating disk attached with still pictures	Circle motion	Motion reproduction Resolution	Fixed	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
370	Rotating disc (speed 2)	Idem. Increased speed	Circle motion	Motion reproduction Resolution	Fixed	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
371	Rotating disc (speed 3)	Idem. Increased speed	Circle motion	Motion reproduction Resolution	Fixed	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
372	Dialogue in a Studio	A scene of a woman with a scarf of slender stripe and a male host with thin check suit in the studio. The background is rich in color and detail..	Studio	Resolution Digital coding	Zoom in	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
373	Beijing Opera actress and Noises	Entropy of the picture changes with the varying noises	Studio production	Digital coding	Zoom in	Camera2	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
374	Autumn leaves	Yellow leaves playing in fall wind	Outdoor shooting	Motion reproduction	Fixed	Camera3	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
375	Roses	Roses of various colors under small and tiny water mist	Studio	Digital coding	Fixed	Camera4	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP

TABLE 4 (end)

Scene No.	Title	Content	Representative of	Attributes to be examined	Camera motion	Source	Copyright status	Delivery format	Provider name
376	Skin color of lady2	Lady portrait in half-length, emphasizing face skin. There are fresh flowers on the right side.	Studio	Resolution Color reproduction	Fixed	Camera4	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
377	Horizontal title	Horizontal crawling characters	Studio production	Resolution	--	Computer	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
378	Vertical title	Vertical crawling characters	Studio production	Resolution	--	Computer	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP
379	Flying title	Flying characters	Studio production	Resolution	--	Computer	See Annex 3	Consecutively numbered TIFF files	CCTV&A BP

CCTV&ABP: China Central Television & Academy of Broadcasting Planning. SARRFT. No.2 Fuxingmenwai Street, Beijing, China. Phone: +86 10 86093947, Fax: +86 10 86092720, E-mail: abp@abp2003.cn.
<http://www.abp2003.cn>

2 Test materials of ultra-high definition television (UHDTV) and high definition television (HDTV)

TABLE 5
7 680 × 4 320 (8k), 3 840 × 2 160 (4K), 1 920 × 1 080 (2K) still pictures

Scene No.	Title	Content	Camera motion	Source	Attributes to be examined	Copyright status	Delivery format	Provider name
1	Books	Many books on bookshelves	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE
2	MusicBox	Antique music boxes	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE
3	Moss	Japanese moss garden	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE
4	Kimono	Japanese traditional garment	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE
5	StainedGlass	Hand painted stained glass	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE
6	Butterflies	Colourful butterflies	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE
7	ChromaKey	A doll, a model ship, and small flowers against blue back	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE
8	Sea	Emerald green sea	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE
9	Flowers	Colourful real flowers	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE
10	Ship	Sailing vessel	Still	Camera	See Appendix 2 to Annex 1	Annex 3	Raw file (8K, 4K) Tiff file (2K)	ITE

ITE: The Institute of Image Information and Television Engineers, 3-5-8 Shibakoen, Minato-ku, Tokyo 105-0011, Japan, Phone: +81 3 3432 4677, Fax: +81 3 3432 4675, E-mail: ite@ite.or.jp.
(Distributor: ITE, <http://www.ite.or.jp/en/>)

Annex 1

Supplementary information on test materials

1 HDTV test materials for the 1 920×1 080/59.94/I, 4:4:4 and 4:2:2, 10-bit and 1 920×1 080/59.94/P, 4:2:2, 10-bit formats listed in Tables 1-2 and 1-3

1.1 Image characteristics

Table 6 summarizes the characteristics of the new test materials. The materials are categorized into three series. “Materials A” are 1 920×1 080/59.94/I, 4:4:4, 10-bit format including four sequences at 50/I. “Materials B” are 1 920×1 080/59.94/P, 4:2:2, 10-bit format including four sequences at 24/P. “Materials C” are 1 920×1 080/59.94/I, 4:2:2, 10-bit down-sampled format from “Materials A”.

The materials for each series contain two types of scenes according to the purpose of usage for evaluation, i.e. “attribute-general” or “attribute-specific.” “Attribute-general” materials are similar to typical broadcast programme content, and “attribute-specific” materials are for specific evaluations.

TABLE 6
Image characteristics

Series	Materials A		Materials B		Materials C	
Video standard	Part 2 of Rec. ITU-R BT.709					
Number of pixels	1 920×1 080					
Bit depth	10-bit					
Signal format	RGB		Y _C B _C R		Y _C B _C R	
Colour sampling	4:4:4		4:2:2 ³		4:2:2 ¹	
Scanning	Interlace		Progressive		Interlace	
Frame rate	29.97 Hz (59.94/I) ²		59.94 Hz (59.94/P) ³		29.97 Hz (59.94/I) ⁴	
File format	Consecutively numbered TIFF files		Consecutively numbered YUV files		Consecutively numbered TIFF files	
Duration	Title (1 s) + Test Sequence (15 s)		Title (1 s) + Test Sequence (15 s)		Title (1 s) + Test Sequence (15 s)	
Number of files	480 (400 for 50/I)		960 (384 for 24/P)		480 (400 for 50/I)	
Number of sequences	45		33		45	
	General: 26	Specific: 19	General: 18	Specific: 15	General: 26	Specific: 19
List of sequences	Table 2		Table 3		Table 2	

¹ Down-sampled from Materials A.

² Including four sequences at 50/I, 4:4:4

³ Including four sequences at 24/P, 4:4:4

⁴ Including four sequences at 50/I, 4:2:2

1.2 Production conditions

1.2.1 Equipment used for test materials

Table 7 lists the equipment used for shooting and recording test materials.

TABLE 7
Equipment used for shooting and recording

Camera	HDTV camera (HDC-1500, Sony), see Table 8
Lens	Cinema lens (Canon or Fujinon)
Recorder	Uncompressed HDTV hard disk recorder (HR-7401, ASTRODESIGN, Inc.)

TABLE 8
Camera specifications

Pickup device	Three 2/3-inch type 2.2-megapixel HD progressive CCD
Effective picture elements	1 920 (H) × 1 080 (V)
Built-in filters	ND: clear, 1/4 ND, 1/8 ND, 1/16 ND, 1/64 ND CC: cross, 3 200K, 4 300K, 6 300K, 8 000K
Sensitivity	F10 at 2 000 lx (3 200K, 89.9% reflectance)
Signal-to-noise ratio	54 dB (Typical)
Horizontal resolution	1 000 TV lines
Registration	Within 0.02% (all zones, without lens)

1.2.2 Scrolling subtitle

Sequences indicating “Subtitles” in the column “Representative of” in Table 3 contain superimposed scrolling-subtitles. The speed of scrolling is 300 pixels/s vertically and 600 pixels/s horizontally.

1.3 Status for use of test materials

Usage restrictions fall under the category of “commercially restricted” as described in Annex 3.

2 HDTV test materials for the 1 920 × 1 080/50/I, 4:2:2, 10-bit formats listed in Tables 1-4

2.1 Image characteristics

Table 9 summarizes the characteristics of the new test materials. 1 920 × 1 080/50/I, 4:2:2, 10-bit format.

The materials for each series contain two types of scenes according to the purpose of usage for evaluation, i.e. “attribute-general” or “attribute-specific.” “Attribute-general” materials are similar to typical broadcast programme content, and “attribute-specific” materials are for specific evaluations.

TABLE 9

Image characteristics

Video standard	Recommendation ITU-R BT.709	
Number of pixels	1 920 × 1 080	
Bit depth	10-bit	
Signal format	$Y C_B C_R$	
Colour sampling	4:2:2	
Scanning	Interlace	
Frame rate	25 Hz (50/I)	
File format	Consecutively numbered TIFF files	
Duration	Test sequence (10 s~48 s)	
Number of files	250~1 200	
Number of sequences	47	
	General:19	Specific:28
List of sequences	Table 4	

2.2 Production conditions**2.2.1 Equipment used for test materials**

Table 10 lists the equipment used for shooting and recording test materials.

TABLE 10

Equipment used for shooting and recording

Camera	HDTV camera1 (SRW-9000, Sony), see Table 11 HDTV camera2 (HDC-F950, Sony), see Table 12 HDTV camera3 (HDW-750P, Sony), see Table 13 HDTV camera4 (ARRI D21, RED ONE), see Table 14
Lens	Cinema lens (Canon or Fujinon)
Recorder	Uncompressed HDTV hard disk recorder (JiuHeCheng, Inc.)

TABLE 11

Camera1 specifications

Pickup device	Three 2/3-inch type 2.2-megapixel HD progressive CCD
Effective picture elements	1 920 (H) × 1 080 (V)
Built-in filters	ND: clear, 1/2ND, 1/4 ND, 1/16 ND, 1/64 ND CC: cross, 3 200 K, 4 300 K, 6 300 K
Sensitivity	–
S/N	55 dB (Typical)
Horizontal resolution	1 000 TV lines
Registration	Within 0.02% (all zones, without lens)

TABLE 12

Camera2 specifications

Pickup device	Three 2/3-inch type 2.2-megapixel FIT CCD
Effective picture elements	1 920 (H) × 1 080 (V)
Built-in filters	ND: clear, 1/4 ND, 1/8 ND, 1/16 ND, 1/64 ND CC: cross, 3 200 K, 4 300 K, 6 300 K, 8 000 K
Sensitivity	F10 at 2 000 lx (3 200 K, 89.9% reflectance)
S/N	54 dB (Typical)
Horizontal resolution	1 000 TV lines
Registration	Within 0.02% (all zones, without lens)

TABLE 13

Camera3 specifications

Pickup device	Three 2/3-inch type 2.2-megapixel FIT CCD
Effective picture elements	1 920 (H) × 1 080 (V)
Built-in filters	ND: clear, 1/4 ND, 1/16 ND, 1/64 ND CC: cross, 3 200 K, 4 300 K, 6 300 K
Sensitivity	F10 at 2 000 lx (3 200 K, 89.9% reflectance)
S/N	54 dB (Typical)
Horizontal resolution	1 000 TV lines
Registration	Within 0.02% (all zones, without lens)

TABLE 14

Camera4 specifications

Pickup device	Single Super 35 mm type 6.2-megapixel progressive CMOS
Effective picture elements	1 920 (H) × 1 080 (V)
Sensitivity	ISO 100-500 base ISO 200
Horizontal resolution	1 440 TV lines

2.3 Status for use of test materials

Usage restrictions fall under the category of “commercially restricted” as described in Annex 3.

3 UHDTV/HDTV test materials listed in Table 5

The test materials are provided in three formats: UHDTV formats specified in Recommendation ITU-R BT.2020 with 7 680 × 4 320 pixels and 3 840 × 2 160 pixels and HDTV format specified in Recommendation ITU-R BT.709 with 1 920 × 1 080 pixels. The specifications of each format are listed in Table 15.

TABLE 15
Format specifications

Resolution	UHDTV (Rec. ITU-R BT.2020)		HDTV (Rec. ITU-R BT.709)
Image size (horizontal × vertical)	7 680 × 4 320 pixel	3 840 × 2 160 pixel	1 920 × 1 080 pixel
Aspect ratio	16:9 (square pixel)		
Sampling ratio	RGB 4:4:4		
Bit depth	12 bits for each colour signal		10 bits for each colour signal
Quantization	Rec. ITU-R BT.2020		Rec. ITU-R BT.709
System colourimetry	Rec. ITU-R BT.2020		Rec. ITU-R BT.709
File format	12 bit RAW		16 bit TIFF

A digital single-lens reflex camera H4D-200MS from Hasselblad was used to shoot the test materials. Table 16 shows the specifications. The camera provides both single shot mode and multi shot mode. Single shot mode is a shooting mode which is used in standard single-sensor cameras with the Beyer type colour filter. The colour pixel information is obtained by interpolating process called demosaicing performed to the pixel values containing either R, G, or B information. Whereas a multi shot mode obtains the corresponding pixel values of every colour information of each pixel by shooting the image for 4 times accurately shifting the CCD sensor by one pixel on vertical and horizontal directions. Multi shot mode can obtain faithful colour information without any false colour, however, it is only applicable to still objects.

The camera native images were trimmed to 7 680 × 4 320 pixels and developed in the Rec. ITU-R BT.2020 colour space by a raw converter software (Hasselblad Phocus ver. 8.1). The downscaling of the 3 840 × 2 160 and 1 920 × 1 080 images were also processed by the same converter software. The Rec. ITU-R BT.2020 RGB values of 1 920 × 1 080 images was transformed to the Rec. ITU-R BT.709 RGB values by a 3 × 3 matrix multiplication and then clipped to the range's extremes.

It should be noted that the 3 840 × 2 160 and 1 920 × 1 080 images were produced from oversampled images but the 7 680 × 4 320 images are constrained by the camera performance currently available. It is desirable that the 7 680 × 4 320 images are also produced from oversampled images in the future.

TABLE 16
Camera specifications

	Hasselblad H4D-200MS
Image sensor	CCD (49.1 × 36.7 mm)
Effective pixels	8 176 × 6 132 pixel
Colour definition	16 bits
Shooting mode	Single shot, 4-shot and 6-shot
ISO speed range	ISO 50, 100, 200, 400 and 800
Shutter speed	128 seconds to 1/800 second

Attachment 1 to Annex 1

Thumbnails of the test materials



Appendix_1_thumbn
ail.pdf

TABLE A-5

Test materials for HDTV 1 920 × 1 080/50/I, 4:2:2, 10-bit format (attribute-general)

Scene No.	Title	Thumbnail
301	Harvest wheat fields	
302	Crossroad	
303	Basketball game	
304	Beijing Opera	
305	Bicycle race	
306	Equestrianism	
307	Football game	
308	Swimming	
309	Water polo game	
310	Synchronized swimming	
311	Folk dance	

TABLE A-5 (end)







Scene No.	Title	Thumbnail
312	Scrolling characters	
313	Scrolling characters	
314	The silk dancing team	
315	Northwest Waist drum dancing teams	
316	Fireworks	
317	Effects	
318	3D Animations	

TABLE A-6

Test materials for HDTV 1 920 × 1 080/50/I, 4:2:2, 10-bit format (attribute-specific)












Scene No.	Title	Thumbnail
351	Skin color of lady	
352	Chromakey (portrait)	
353	Chromakey (scene)	
354	Rotating birdcage	
355	Nine-dragon screen	
356	Flower garden	
357	Field of flowers	
358	Amusement park	
359	City plaza	
360	Skiing	
361	Hebei Bangzi	

TABLE A-6 (continued)












Scene No.	Title	Thumbnail
362	Hebei Bangzi with noises (S/N = 65 dB)	
363	Hebei Bangzi with noises (S/N = 53 dB)	
364	Hebei Bangzi with noises (S/N = 45 dB)	
365	Textiles and household articles	
366	Food and containers	
367	Rotating birdcage	
368	Flowerbed	
369	Rotating disc (speed 1)	
370	Rotating disc (speed 2)	
371	Rotating disc (speed 3)	
372	Dialogue in a Studio	

TABLE A-6 (end)


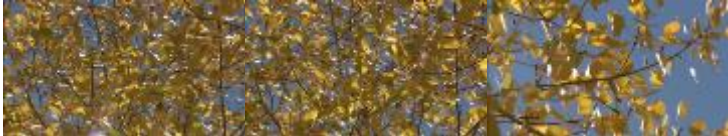





Scene No.	Title	Thumbnail
373	Beijing Opera actress and noises	
374	Autumn leaves	
375	Roses	
376	Skin color of lady	
377	Horizontal title	
378	Vertical title	
379	Flying title	

TABLE A-7
Test materials for UHDTV/HDTV

Scene No.	Title	Thumbnail	Chromaticity distribution
1	Books		
2	MusicBox		
3	Moss		
4	Kimono		
5	StainedGlass		

TABLE A-7 (end)

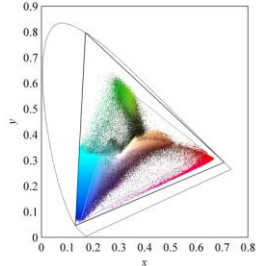
Scene No.	Title	Thumbnail	Chromaticity distribution
6	Butterflies		
7	ChromaKey		
8	Sea		
9	Flowers		
10	Ship		

TABLE A-8 (end)

1 920 × 1 080/59.94/I, 4:4:4, 10-bit HDTV pictures (see Table 2)

Scene no. / Attributes	151	152	153*	154*	155	156	157*	158*	159	160	161	162	163	164	165	166	167	168	169
Digital coding	√	√	√	√	√	√	√	√	√	√				√	√	√	√	√	
Standards conversion	√	√	√	√	√	√	√	√						√					
Motion reproduction	√	√	√	√	√	√	√	√							√				
Resolution	√	√	√	√	√	√	√	√	√										
Gray-scale reproduction											√	√							
Contrast											√	√	√			√	√	√	
Colour reproduction									√	√									√
Skin colour											√	√	√		√				
False contour																			
Texture									√	√									
Noise reduction																√	√	√	
Legibility	√	√	√	√					√	√									

* The field frequency is 50 Hz.

TABLE A-9 (*end*)

1 920 × 1 080/59.94/P, 4:2:2, 10-bit HDTV pictures (see Table 3)

Scene no. / Attributes	251	252	253*	254*	255	256	257*	258*	259	260	261	262	263	264	265
Digital coding	√	√	√	√	√	√	√	√	√	√				√	√
Standards conversion	√	√	√	√	√	√	√	√						√	
Motion reproduction	√	√	√	√	√	√	√	√							√
Resolution	√	√	√	√	√	√	√	√	√						
Gray-scale reproduction											√	√			
Contrast											√	√	√		
Colour reproduction									√	√					
Skin colour											√	√	√		√
False contour															
Texture									√	√					
Noise reduction															
Legibility	√	√	√	√					√	√					

* The frame frequency is 24 Hz.

TABLE A-11

Test materials for UHDTV/HDTV (see Table 5)

No.	1	2	3	4	5	6	7	8	9	10
Image resolution	**	**		**	*	**	**		*	*
Gray-scale reproduction		*			**	**		**		*
Colour reproduction			*	**	**	**		*	**	
Digital coding	**		*	*			**			
Readability	**	*			*					
Sense of presence			**	**	*			*		**
Wide-colour-gamut					**	**		**	**	

** Highly recommended.

* Recommended.

Annex 2

Choice of statistics that can serve to characterize materials

1 Introduction

Many test sequences for subjective assessment are described in this Report, and have been used in various evaluation tests. These sequences contain many different attributes as a whole, while each sequence provides a few attributes. It is important in actual evaluation tests to choose the sequences suitable for the test purposes. Statistics are useful in choosing proper sequences for the assessment purpose, as well as in analysing the quality degradation of the system to be evaluated.

In selecting the statistics described below, it is considered that there are increasing opportunities to conduct the evaluation tests of digital bit-rate reduction systems, the picture quality of which is generally sensitive to the picture contents, and therefore proper test materials must be used in the evaluation tests.

2 Statistics of test materials

2.1 Entropy of PCM data

This entropy, E , represents the amount of information of a picture. It is defined by equation (1):

$$E = - \sum_{i=I_{min}}^{I_{max}} P(i) \times \log_2 P(i) \quad \text{bit/pixel} \quad (1)$$

where:

I_{min} : minimum level of the video signal

I_{max} : maximum level of the video signal

$P(i)$: probability occurrence for the video signal level i .

2.2 AC energy

This represents the degree of picture activity, such as fineness, and is defined to be the square sum of the DCT coefficients except for the DC coefficient, as shown below:

$$AC = \left[\frac{1}{N} \sum_{k=1}^N ac_k \right] / AC_{max} \quad (2)$$

where:

$$ac_k = \sum_{m=0}^7 \sum_{n=0}^7 C(m,n)^2 - C(0,0)^2$$

and $C(m, n)$ denotes the DCT coefficients and N the number of blocks in a field (or frame). AC_{max} is a normalizing factor and the theoretically maximum value of AC energy is taken here, which is obtained with such a picture that a half area within a block is black and the rest of the area within the block is white.

AC energy is calculated under several conditions, i.e. intra/inter-frame/field. Figure 1a) shows examples of the AC energy for intra-frame (frame DCT) and field DCT with motion-compensated frame difference (field DCT-MCFD).

2.3 Spectral entropy

This represents the degree of randomness of the DCT coefficients, and is useful to estimate the necessary bit rate of a DCT-based bit reduction system. It is defined by equation (3):

$$SE = \frac{1}{N} \sum_{k=1}^N (se_k)^2 \quad (3)$$

where:

$$se_k = - \sum_{m=0}^7 \sum_{n=0}^7 \frac{|C(m,n)|}{A} \log_2 \left[\frac{|C(m,n)|}{A} \right]$$

$$A = \sum_{m=0}^7 \sum_{n=0}^7 |C(m,n)|$$

Spectral entropy is calculated under several conditions, i.e. intra/inter-frame/field. Figure 1b) shows examples of the spectral entropy.

2.4 Motion vector

This represents a motion of an object by a two-dimensional parameter on a block-by-block basis. Block matching is one of the commonly used methods for motion estimation.

To express the degree of motion of the picture, two kinds of statistics are used, i.e. mean magnitude of the vectors averaged over a frame/field and standard deviation within the frame/field. They are calculated separately in horizontal and vertical directions as follows:

$$\mu_X = \frac{1}{N} \sum_{k=1}^N |X_k| \quad \text{and} \quad \mu_Y = \frac{1}{N} \sum_{k=1}^N |Y_k| \quad (4)$$

$$\sigma_X^2 = \left[\frac{1}{N} \sum_{k=1}^N X_k^2 \right] - \mu_X^2 \quad \text{and} \quad \sigma_Y^2 = \left[\frac{1}{N} \sum_{k=1}^N Y_k^2 \right] - \mu_Y^2 \quad (5)$$

where:

X_k and Y_k : horizontal and vertical components of the vector in a block

μ_X and μ_Y : mean magnitude of X_k and Y_k averaged over a field

σ_X and σ_Y : standard deviation of X_k and Y_k , respectively.

The mean magnitudes represent the degree of motions as a whole, while the standard deviations represent the degree of non-uniform motions.

Figures 1c) and 1d) show examples of the motion vector, calculated using block matching.

2.5 Motion-compensated prediction error power

The motion-compensated frame/field-difference signal, i.e. prediction error, is expressed by equation (6):

$$e_k(x, y) = f_0(x, y) - f_1(x - u_k, y - v_k) \quad (6)$$

where $e_k(*)$, $f_0(*)$ and $f_1(*)$ denote the motion-compensated frame/field-difference signal in the k -th block, the current frame/field signal, and the previous frame/field signal, respectively, while u_k and v_k the horizontal and vertical components of motion vector in the block.

The power of the prediction error, EP , is defined to be the mean square value of the difference signals as follows:

$$EP = \frac{1}{N} \sum_{k=1}^N ep_k \quad (7)$$

where:

$$ep_k = \frac{1}{X \times Y} \sum_{x=1}^X \sum_{y=1}^Y e(x, y)^2$$

X and Y denote horizontal and vertical sizes of a block.

This statistic value could be useful to estimate whether the sequence is critical for a bit reduction system using motion compensation.

Figure 1e) shows an example of the motion-compensated prediction error power.

2.6 Criticality by rate-buffer occupancy method

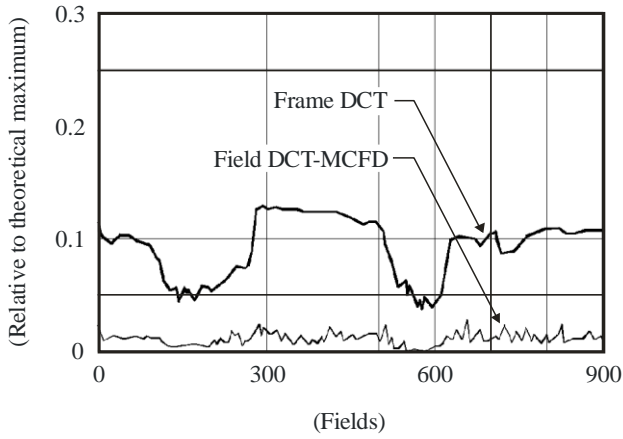
The Independent Television Commission of the United Kingdom and the EBU conducted a study on criticality under the RACE MOSAIC project. The MPEG-1 + coding algorithm with subjectively optimized quantizers was used to measure the criticality of broadcast programmes and test sequences. The criticality was calculated by means of a parallel processing computer using the rate-buffer occupancy, and was expressed in terms of bit/pixel. An example of criticality measurement is shown in Fig. 2.

2.7 Criticality by fixed quantizer method

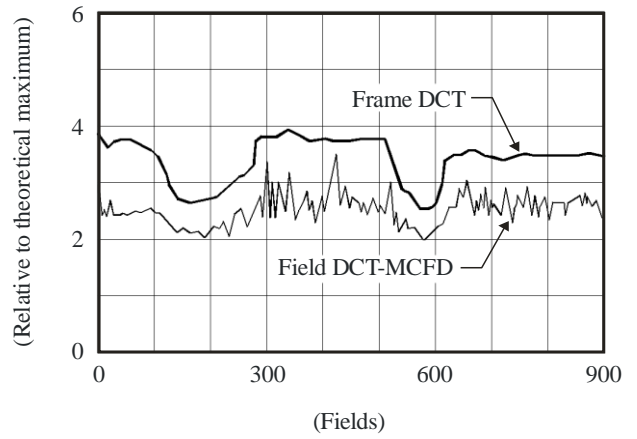
This criticality is defined as “the number of output bits per pixel from MPEG-2 encoder with a fixed quantizer”. The quantizer characteristics are linear and comply with the MPEG-2 standard. The parameter value of “quantizer_scale” gives a quantizer step closely related to picture quality.

FIGURE 1

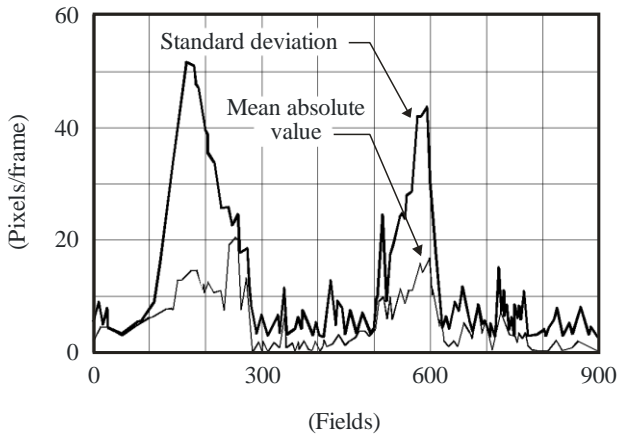
Example of statistics of motion sequences



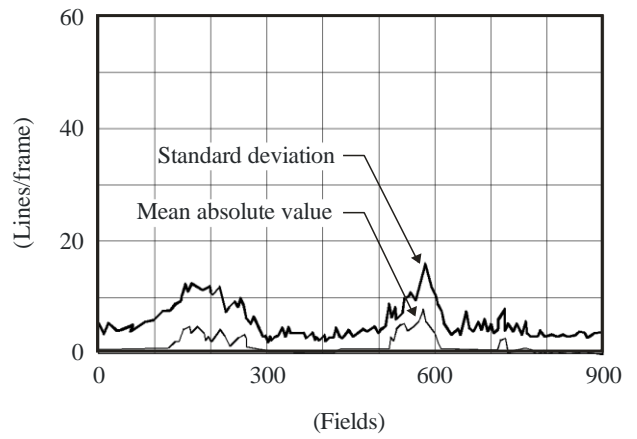
a) AC energy



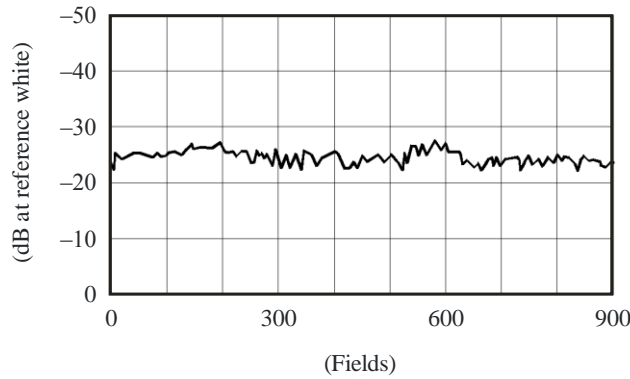
b) Spectral entropy



c) Motion vector (horizontal)



d) Motion vector (vertical)



e) Motion-compensated interframe prediction errors

NOTE 1 – The results are shown only for the luminance signals of the scene “Soccer action”. The ordinate of each chart indicates the statistic value, and the abscissa the field number, counting from the beginning of the sequence (900 fields correspond to 15 s). It can be seen that there are two large horizontal motions around the field numbers 200 and 600, which suppress fine detail components due to the integration effect of the camera, resulting in reduced AC energy and spectral entropy.

Examples of the criticality are shown in Fig. 3. The criticality was measured in each frame under the following condition: quantizer_scale = 12 (q_scale_code = 6 and q_scale_type = 0), field-based forward prediction and intra macroblock refreshment with a cycle of 0.5 s. Figure 3a) shows the fluctuation of the criticality over a 5 s interval. The criticality distribution of broadcast television programmes was measured on an NHK channel for one week, a total of 130 h, from 15 through 22 February 1995. In the measurement, composite NTSC signals were converted into component Y/C signals. The frequency of occurrence of the criticality for television programmes was calculated every 5×10^{-3} bit/pixel. The criticality distribution for different programme genres is shown in Fig. 3b). Sports programmes are relatively critical, while drama programmes are less critical. The statistical distribution of the criticality for overall television programmes is shown in Fig. 3c). This Figure also shows the criticality for test sequences.

FIGURE 2
Criticality measurement result of rate-buffer occupancy method

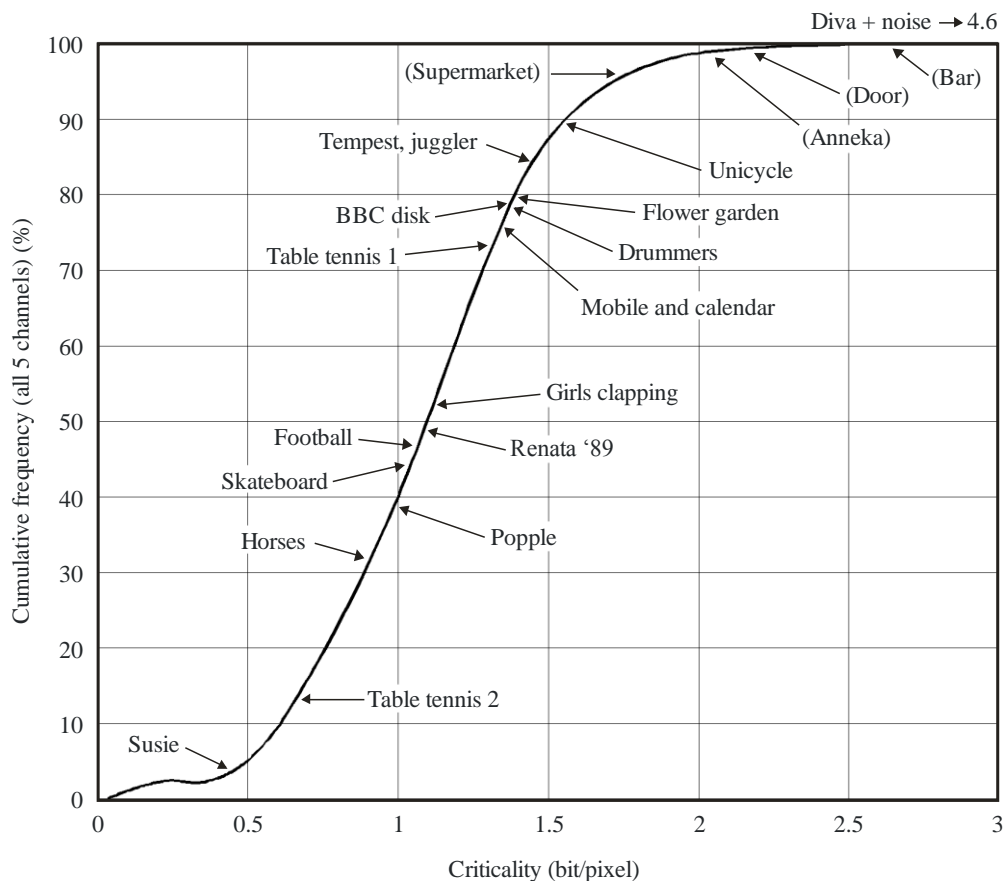
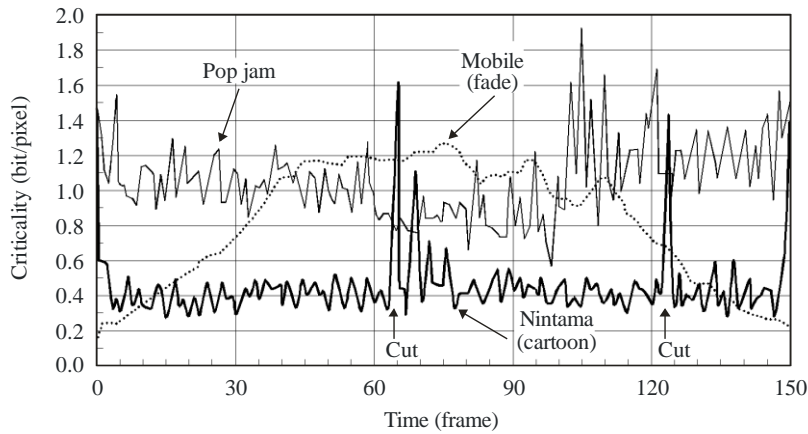
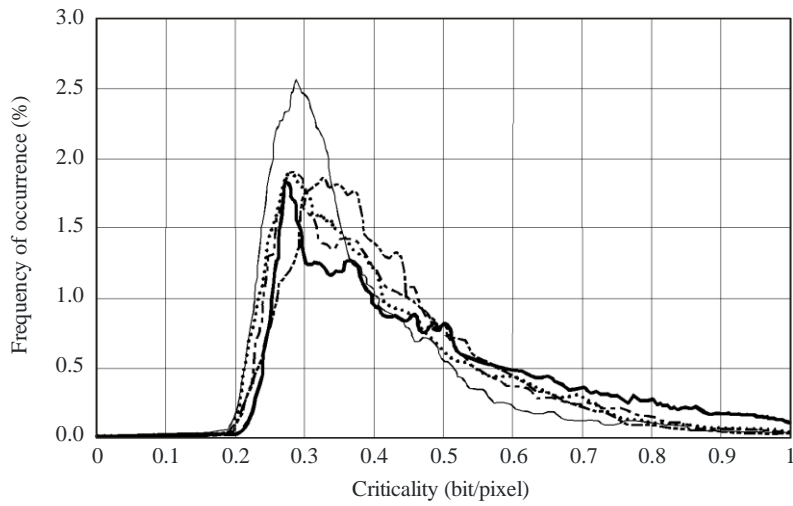


FIGURE 3

Criticality measurement results of fixed quantizer method

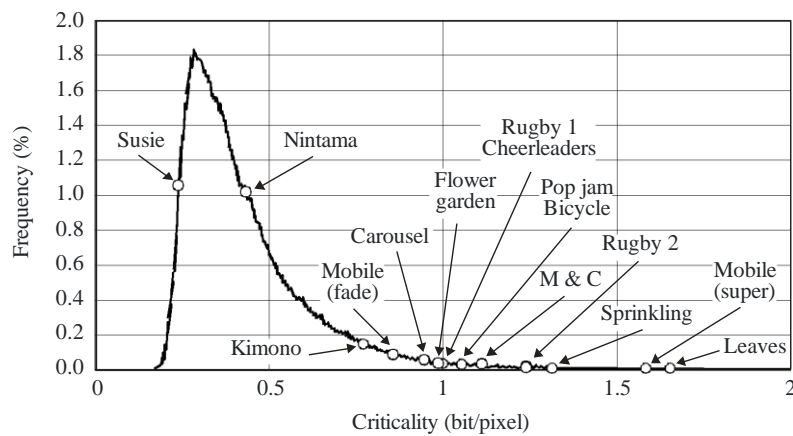


a) Fluctuation of criticality for 5 s interval



b) Criticality distribution for classified television programmes

— Drama ····· Culture - · - · Variety
 - - - News — Sports



c) Distribution of criticality for television programmes and criticality of test sequences

q_scale_code = 6

Annex 3

Status for use of test materials

Use of the test materials described in Tables 1, 2, 3 and 4 is restricted to the following purposes.

- a) Technical evaluations, including:
 - research and development of equipment and systems;
 - testing of equipment during development and production processes;
 - testing of transmission conditions for broadcasting and telecommunication;
 - maintenance of equipment.
- b) Technical demonstrations, including:
 - presentations at technical conferences and workshops;
 - presentation of performance and functionality of equipment at exhibitions.

Inclusion in commercial products and promotional demonstration of commercial products are not permitted.

NOTE 1 – Usage restrictions as proposed above can be considered as falling under the following category:

Commercial restricted

The test materials may be used for research projects, to verify equipment specifications, and public demonstrations of commercial products. Inclusion in commercial products is not allowed. Reproductions for distribution may only be made by the copyright holder or authorized distributor.

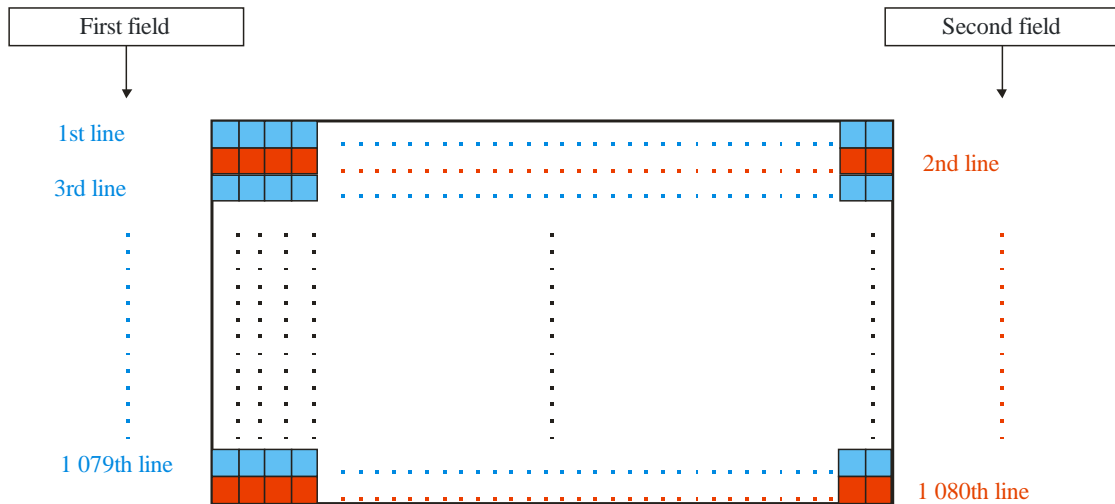
Annex 4

File formats for test materials

1 TIFF file for HDTV RGB 4:4:4 (10 bits)

The video data of two interlaced video fields are combined once into a frame and then recorded in a single Tagged Image File Format (TIFF) file (specified by Adobe Developers Association). Consequently, each file contains the TIFF header and tag information as well as pixel data of the full image size (1 920 × 1 080 pixels, RGB). The number of files corresponds to the video length. The first field in each frame is mapped into odd lines (including the first line of the frame data) and the second one is mapped into even lines. This is the so called “top field first” and is illustrated in Fig. 4.

FIGURE 4
Structure of video data



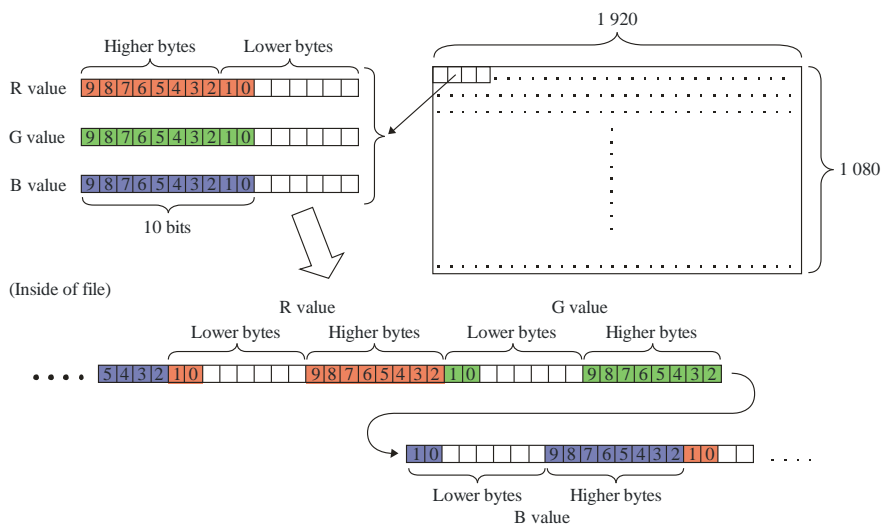
Report BT.2245-04

Pixel values of RGB components in the TIFF file are treated as 16-bit integers. Since the actual pixel value only has 10 bit depth, it is stored in the higher 10 bits of the 16-bit integer and the remaining 6 bits are set to “0”.

Byte order in the TIFF file is low-to-high (little endian). The arrangement of pixel data in the file is illustrated in Fig. 5.

Filename is formatted as “sXXX_NNNNN.tif” where XXX means a three digit scene number while NNNNNN indicates a six digit frame number.

FIGURE 5
Data arrangement for RGB 4:4:4 (10 bits)



Report BT.2245-05

2 YUV file for HDTV YC_BC_R 4:2:2 (10 bits)

Video data of full image size (1 920 × 1 080 pixels and YC_BC_R) are stored in a single file without header or timing information.

































Two video fields are combined into a frame for interlaced video content before it is stored into the file. See Fig. 4 for the video data structure.

The Y component of video data contains $1\,920 \times 1\,080$ samples as seen in Fig. 6 while each of the C_B and C_R components has $960 \times 1\,080$ samples. The horizontal positions of C_B and C_R samples are aligned to those of odd samples in the Y component.

Sample values in the file are arranged in order of C_B , Y, C_R , Y, ... Three 10 bit sample values are stored in the higher 30 bits of a 4 byte (32 bits) integer and the remaining lower 2 bits are set to "0". As a result, 12 data samples within six pixels, i.e. 6 Y samples and 3 pairs of C_B and C_R samples, are packed into the sixteen byte data in the file shown in Fig. 7.

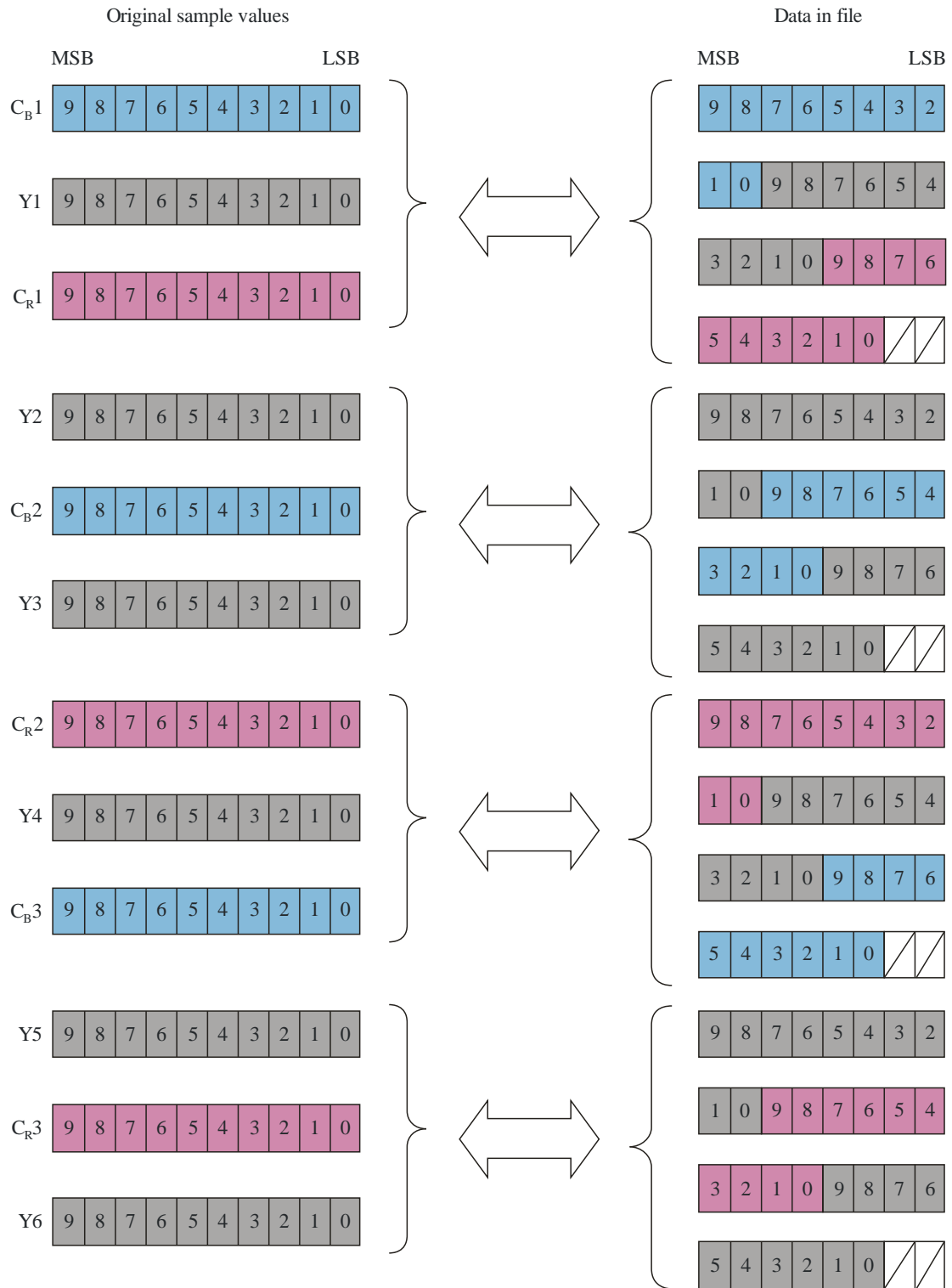
Filename is formatted as "sXXX_NNNNN.yuv10" where XXX means the three digit scene number while NNNNNN indicates the six digit frame number.

FIGURE 6
Sampling positions in frame

 Y1,1 C_B 1,1 C_R 1,1	 Y1,2	 Y1,3 C_B 1,2 C_R 1,2	 Y1,4	 Y1,5 C_B 1,3 C_R 1,3	 Y1,6	...	 Y1,1 919 C_B 1,960 C_R 1,960	 Y1,1 920
 Y2,1 C_B 2,1 C_R 2,1	 Y2,2	 Y2,3 C_B 2,2 C_R 2,2	 Y2,4	 Y2,5 C_B 2,3 C_R 2,3	 Y2,6	...	 Y2,1 919 C_B 2,960 C_R 2,960	 Y2,1 920
 Y3,1 C_B 3,1 C_R 3,1	 Y3,2	 Y3,3 C_B 3,1 C_R 3,1	 Y3,4	 Y3,5 C_B 3,3 C_R 3,3	 Y3,6	...	 Y3,1 919 C_B 3,960 C_R 3,960	 Y3,1 920
•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•
 Y1 080,1 C_B 1 080,1 C_R 1 080,1	 Y1 080,2	 Y1 080,3 C_B 1 080,2 C_R 1 080,2	 Y1 080,4	 Y1 080,5 C_B 1 080,3 C_R 1 080,3	 Y1 080,6	...	 Y1 080,1 919 C_B 1 080,960 C_R 1 080,960	 Y1 080,1 920

 : Y samples  : C_B and C_R samples

FIGURE 7
Data arrangement for YC_BCr 4:2:2 (10 bits)



Report BT.2245-07

3 Raw file for UHDTV RGB 4:4:4 (12 bits)

Figure 8 illustrates the file formats. Each 8K or 4K image consists of three raw files separated by the colour channel. The size of each raw file is 66 355 200 bytes for 8K images and

16 588 800 bytes for 4K images, respectively, using 2 bytes in the big-endian format for each pixel. The 2K images are individually recorded in an uncompressed 16 bit TIFF format. The size of each file is 12 441 600 bytes for 2K images with the header information. The six least significant digits are zero-padded.

FIGURE 8

File format

