Standards and Recommended Practices

Proposed SMPTE Standards

Two Proposed SMPTE Standards are published here for a trial period and public review: SMPTE 302M, Television — Linear PCM Digital Audio in an MPEG-2 Transport Stream; and SMPTE 303M, Television — Color Reference Pattern. The proposals will be submitted to the American National Standards Institute if no adverse comments are received from publication. Comments should be addressed to Carlos V. Girod, Jr., Director of Engineering, prior to November 1, 1997. SMPTE 302M is available from Society Headquarters for $13.00 and SMPTE 303M for $18.00.

Proposed SMPTE Recommended Practice

Published here for a trial period and public comment is RP 193, Test Patterns and Test Images for DPX Leader. Comments should be forwarded to Carlos V. Girod, Jr., Director of Engineering, prior to November 1, 1997. The proposal may be obtained from Headquarters for $22.00.

Approved American National Standards

Two American National Standards were approved by the American National Standards Institute recently: ANSI/SMPTE 299M-1997, Television — 24-Bit Digital Audio Format for HDTV Bit-Serial Interface; and ANSI/SMPTE 300-1997, Motion-Picture Color Print Film (35-mm) — Manufacturer-Printed Latent-Image Identification Information. ANSI/SMPTE 299M may be purchased from Headquarters for $18.00 and ANSI/SMPTE 300 for $10.00.

Approved SMPTE Recommended Practice

The Society recently approved an SMPTE Recommended Practice: RP 21-1997, Dimensions of 35- and 70-mm Motion-Picture Rewind Spindles. The practice is available from Headquarters for $10.00.

Reaffirmed SMPTE Recommended Practices

Two SMPTE Recommended Practices were reaffirmed by the Society: RP 73-1992 (R1997), 8-mm Type R (Regular 8) Sprocket Design; and RP 74-1992 (R1997), 16-mm Sprocket Design. Available from Headquarters, the practices are $13.00 each.

— Carlos V. Girod, Jr., P.E., Director of Engineering

Proposals in Upcoming Issues

New proposals and current revisions of approved standards, practices, and guidelines will be in future issues of the *Journal.* Look for publication of RP 194, Film Negative Cutter's Conform List; RP 195, Use of the Reference Mark in Manufacturer-Printed Latent Image Key Numbers for Unambiguous Film Frame Identification; RP 197, Film-to-Video Transfer List; RP 198, Bit-Serial Digital Checkfield for Use in High-Definition Interfaces; and EG 33, Jitter Characteristics and Measurements.

SMPTE Standards Subscription Service

The Society provides a Standards Subscription Service to assist firms, libraries, and individuals in establishing and maintaining a complete and current file of approved American National Standards, SMPTE Recommended Practices, and SMPTE Engineering Guidelines in the motion picture, television, and video magnetic recording fields. Through this service, the Society makes automatic distribution to standards subscribers of all new and revised standards, recommended practices, and guidelines that are approved during the calendar year in these fields.

For further information, write to: Standards Subscription Service, Engineering Dept., Society of Motion Picture and Television Engineers, 595 West Hartsdale Ave., White Plains, NY 10607.

PROPOSED SMPTE STANDARD

SMPTE 302M

for Television —

Linear PCM Digital Audio in an MPEG-2 Transport Stream

1 Scope

1.1 This standard specifies the transport of uncompressed (linear PCM) digital audio in an MPEG-2 transport system.

1.2 Some applications may require linear PCM (pulse code modulated) digital audio in conjunction with compressed video specified in the MPEG-2 4:2:2 profile. The MPEG audio standard defines compressed audio, but does not define uncompressed audio for carriage in an MPEG-2 transport system. This standard augments the MPEG standards to address the requirement for linear PCM digital audio.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI S4.40-1992, Digital Audio Engineering — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data (AES-3)

ISO/IEC 13818-1:1996, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Systems

3 Introduction

MPEG-2 transport streams convey one or more programs of coded data, and may be constructed from one or more elementary coded data streams, program streams, or other transport streams. This standard specifies transport of linear PCM digital audio in an MPEG-2 transport stream. The specifications are described in terms of a model which starts with AES-3 digital audio, constructs elementary streams (ES) from the AES-3 digital audio, then constructs packetized elementary streams (PES) from the elementary streams, and finally constructs MPEG-2 transport streams (MTS) from the packetized elementary streams. Although this model is used to describe the transport of linear PCM digital audio in MPEG-2 transport streams, the model is not mandatory. MPEG-2 transport streams may be constructed by any method which results in a valid stream.

4 Linear PCM digital audio elementary streams

4.1 Linear PCM digital audio elementary streams shall consist of audio sample words, which may be derived from AES-3 digital audio subframes, together with validity, user, and channel status (V,U,C) bits and a framing (F) bit.

4.2 There may be 2, 4, 6, or 8 channels of audio data conveyed in a single audio elementary stream and corresponding packetized elementary stream. Multiple packetized elementary streams may be used in applications requiring more channels. Where multiple packetized elementary streams are used to convey more channels, the ordering of channels within a packetized elementary stream is maintained within the packet, while the ordering across different packetized elementary streams can be maintained through packet identification (PIDs) in the MPEG-2 transport stream.

4.2.1 Since AES-3 data streams use frames based on two subframes, the 2, 4, 6, or 8 channels in an SMPTE linear PCM digital audio elementary stream could be derived from 1, 2, 3, or 4 AES-3 channel pairs.

4.3 The sampling resolution may be 16, 20, or 24 bits per sample. All channels in an elementary stream shall have the same sampling resolution.

4.4 The sampling frequency shall be 48 kHz. The audio sample rate shall be locked to the 27-MHz transport clock. All channels in an elementary stream shall have the same sampling frequency.

4.5 No preemphasis shall be applied.

4.6 Linear PCM digital audio elementary streams shall carry 16-, 20-, or 24-bit audio sample words in a 16-, 20-, or 24-bit space, respectively.

4.6.1 AES-3 subframes consist of data for a single audio sample word as well as additional data including a validity bit, a user data bit, a channel status bit, a parity bit, and auxiliary sample bits. AES-3 subframes may include 24-bit audio sample words as shown in figure 1, or 20-bit audio sample words as shown in figure 2. AES-3 subframes which carry 16-bit audio sample words use a 20-bit space with the four least significant bits (LSBs) of the 20-bit word set to 0. Linear PCM digital audio elementary streams which carry 16-bit audio sample words do not carry the four unused AES-3 LSBs.

4.7 Validity, user, and channel status (V,U,C) bits shall be carried in the MPEG transport stream specified by this standard. Framing information corresponding to the AES frame is carried in an additional framing (F) bit. The framing bit shall be set to 1 for the first subframe of an AES frame and to 0 for all other subframes.

4.8 Elementary streams derived from AES-3 audio sample words and V,U,C bits shall be constructed as shown in figure 3. Elementary streams shall be composed of sample word groups. Each sample word group shall contain one sample word together with the associated V,U,C and F bits for each channel carried in the elementary stream. The bits of the audio sample word shall be the LSBs; V shall be more significant, then U, then C, and the F bit shall be the MSB. The sample words within each sample word group shall be in the order of their channel number. Successive sample word groups shall contain successive words from each of the channels carried in the elementary stream.

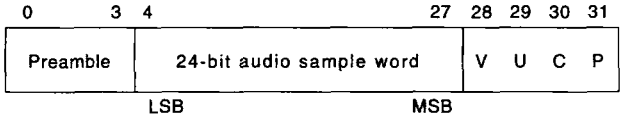

Figure 1 – 24-bit AES-3 subframe

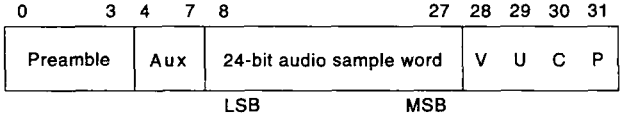

Figure 2 – 20-bit AES-3 subframe

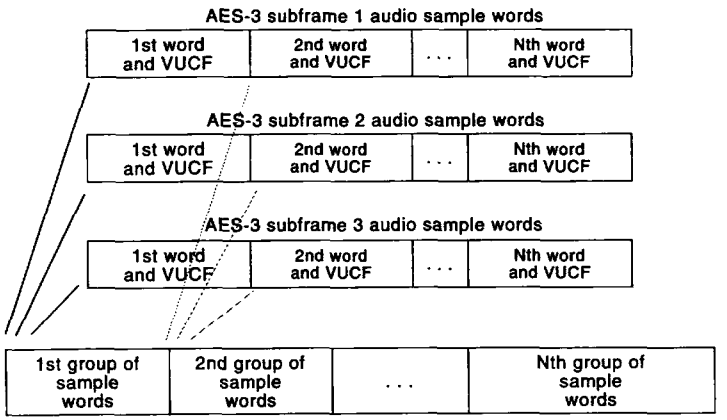

Figure 3 – Linear PCM audio elementary stream

5 Packetized elementary stream

5.1 A packetized elementary stream consists of PES packets, all of whose payloads consist of data from a single elementary stream, and all of which have the same stream_id. PES packets for linear PCM audio shall follow the specifications in ISO/IEC 13818-1 except as noted in this standard.

5.2 Linear PCM audio PES packets shall have an MPEG-2 PES header as described in ISO/IEC 13818-1, clauses 2.4.3.6, "PES packet," and 2.4.3.7, "Semantic definition of fields in PES packet." Additional SMPTE linear PCM audio header information shall appear at the beginning of the MPEG-2 PES packet payload as shown in figure 4.

5.3 The linear PCM audio PES packets shall conform to the semantic definition for private_stream_1 in ISO/IEC 13818-1, clause 2.4.3.7. The semantic definition for private_stream_1 includes presentation time stamps (PTS) and other useful information. (Note that the semantic definition for private_stream_2, which is an abbreviated header, is not used in this standard.)

5.4 Linear PCM audio PES packets shall have PTS_DTS_flags set to 'XO.'

5.5 In linear PCM audio PES packets, the ESCR_flag, ES_rate_flag, DSM_trick_mode_flag, additional_copy_info_flag, and PES_extension_flag shall be set to '0.'

5.6 Each linear PCM audio PES packet payload shall include a SMPTE linear PCM audio header which shall be carried at the beginning of the associated MPEG-2 PES payload. This header shall include audio_packet_size, channel_identification, number_channels, and bits_per_sample as described below. This header shall apply to all of the audio channels in the PES packet.

5.7 Linear PCM audio header data shall be as defined in table 1.

(Note that uimsbf means unsigned integer with most significant bit first, as used in ISO/IEC 13818-1.)

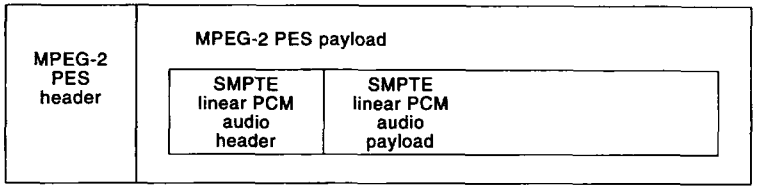

Figure 4 – Linear PCM audio PES packets

Table 1 – SMPTE linear PCM audio header

audio_packet_size	16 uimsbf [1]	SMPTE audio payload packet size in bytes exclusive of SMPTE header
number_channels	2 uimsbf	00 = 2 audio channels 01 = 4 audio channels 10 = 6 audio channels 11 = 8 audio channels
channel_identification	8 uimsbf	channel number of first channel
bits_per_sample	2 uimsbf	00 = 16 bits/sample 01 = 20 bits/sample 10 = 24 bits/sample 11 = reserved
alignment bits	4 uimsbf	SMPTE header byte alignment (reserved, set to 0)

[1] Unsigned integer with most significant bit first.

5.8 Linear PCM audio PES packets shall be integer numbers of bytes in length.

5.9 The frequency of presentation time stamp coding in the MPEG-2 transport stream is specified in ISO/IEC 13818-1, clause 2.7.4, for video streams and audio streams. Linear PCM audio, as specified in this standard, shall have the same frequency of presentation time stamp (PTS) coding as required for MPEG-2 compressed audio.

5.10 Groups of audio sample words associated with individual video frames shall be collected into audio access units corresponding to the video frames. The payload of each linear PCM audio PES packet shall contain one audio access unit. The PES packet payload length shall be set according to the size of the associated audio access unit. In the case of video frame rates which do not have a simple integer relationship to the audio clock, not all audio access units will contain the same number of audio sample words.

5.11 Audio sample words in groups of audio samples shall be packed, leaving no unused data space. In the case of 16- and 24-bit audio sample resolution, the audio payload is inherently packed since the sample word lengths are multiples of 8 bits. In the case of 20-bit audio sample resolution, data shall be packed without sample byte alignment. Since only even numbers of channels are allowed, the resulting length of a 20-bit audio payload will be an integer number of bytes.

6 MPEG-2 transport system

6.1 MPEG-2 transport streams (MTS) incorporating linear PCM audio PES packets shall conform to the specifications of ISO/IEC 13818-1 (systems).

6.1.1 MPEG-2 transport stream (MTS) packets are 188 bytes long. The PES packets described in this standard are substantially longer. Construction of MTS from PES packets is described in ISO/IEC 13818-1.

6.2 The registration_descriptor is used to identify formats of private data, as described in ISO/IEC 13818-1, clause 2.6.8. Linear PCM audio as specified in this standard shall use the format_identifier of [to be assigned by ISO].

6.3 The transport buffer TBn is specified to be 512 bytes in ISO/IEC 13818-1 (systems). For uncompressed audio, the transport buffer shall be drained (Rxn) at 1.2 times [Rmax].

Annex A (informative)
Bibliography

EBU Tech. 3250 (1992), Specification of the Digital Audio Interface

ISO/IEC 13818-2:1996, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Video

ISO/IEC 13818-3:1995, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Part 3: Audio

PROPOSED SMPTE STANDARD

for Television — Color Reference Pattern

1 Scope

This standard defines the electrical and physical representation of a television color reference pattern. It also specifies colorimetry, geometry, and related parameters.

2 Colorimetry

2.1 Colorimetric data in tables 1, 2, and 3 represent the color reference pattern using white-point definitions for television (D_{65}), studio lighting (3100 K), and film (D_{55}). The data are based on a 2° standard observer (CIE S002).

2.2 The CIE tristimulus data specified in tables 1, 2, and 3 are aim-point specifications for each color reference pattern sample.

2.3 Common television practice is to set up the camera for the desired appearance on a D_{65} monitor, regardless of the original scene illumination. Therefore, tables 4, 5, 6, and 7 are based on D_{65}, and values for 3100 K studio lighting are not included. The values in table 8, based on D_{55}, should not be used for television.

3 Geometry

3.1 The color reference pattern is made up of 24 sample colors whose colorimetric designations are distributed throughout the color television gamut. These samples are square and arranged in four rows of six samples per row. The first two rows consist of colors that are designed to simulate the color appearance of natural objects. The third row consists of colors that represent subtractive primaries (cyan, magenta, and yellow) as well as the binary combinations of these colors (red, green, and blue). The last row consists of a six-step neutral gray scale; the neutral numbers are Munsell values.

3.2 Each color sample is represented as a square 18% of picture height.

3.3 The rows and columns of color samples are separated by black spaces around the color samples. The black spaces are 3% of picture height.

3.4 The six columns of color samples are surrounded by a black border on the left and right. The left and right borders are 5% of picture height at 4:3 aspect ratio and 27.5% of picture height at 16:9 aspect ratio.

The four rows of color samples are surrounded by a black border at the top and bottom of the chart. The top and bottom borders are defined to be 9.5% of picture height for both 4:3 and 16:9 aspect ratios. Some existing charts have a 5% border and do not provide 4:3 aspect ratio. These older charts should be framed to fill a 4:3 raster horizontally, giving overscan at the top and bottom of the chart. They should be overscanned both vertically and horizontally in 16:9 applications to match best the geometric specifications of this standard (see figure 1).

4 Video color representations

4.1 All video signal levels are calculated using SMPTE RP 177, the standard television system D_{65} white point, and each of the following standard television primary colorimetry definitions: ITU-R BT.709, ANSI/SMPTE 170M / ANSI/SMPTE 240M, PAL (EBU), and original NTSC (1953 FCC) (see table 9). In addition, a set of video color representations is calculated using illuminant D_{55} for only the ITU-R BT.709 primaries.

4.2 The linear video signal levels in tables 4 through 8 are video voltages ranging between 0.0 V (black) and 1.0 V (white). The user must apply the appropriate gamma or transfer characteristic. Because of the number of possible gamma or transfer curves which could be used, no gamma correction is applied to any of the video representations listed in this standard.

4.3 Any color sample having any video levels outside the 0.0 V to 1.0 V range cannot be reproduced using the reference primaries for that system. For example, the cyan sample 18 results in a negative red value with ITU-R BT.709, PAL, and ANSI/SMPTE 240M primaries and a D_{65} white point. Both yellow sample 16 and cyan sample 18 result in negative values with illuminant D_{55} and ITU-R BT.709 primaries (see figure 2).

4.4 The video signal levels in tables 4 through 8 assume that 1.0 V corresponds to a perfect 100% white reflector.

5 Considerations in using the color reference pattern

5.1 The color reference pattern should be illuminated and the camera positioned as shown in figure 3. The illuminator, camera, and reference pattern should be in the same horizontal plane. The illuminator should be positioned to the side at 45° off camera axis. Two illuminators, one on each side, may make it easier to achieve uniform illumination.

5.2 The camera should be properly set up using other appropriate test patterns. The gray samples on this reference pattern are not intended to be used for setting camera color balance, white levels, or black levels. The preferred white reference is a 100% reflecting white sample, such as halon or barium sulfate. Alternately, gain may be set to match the white levels shown in tables 4-8. The preferred black level reference is a capped lens or light trap.

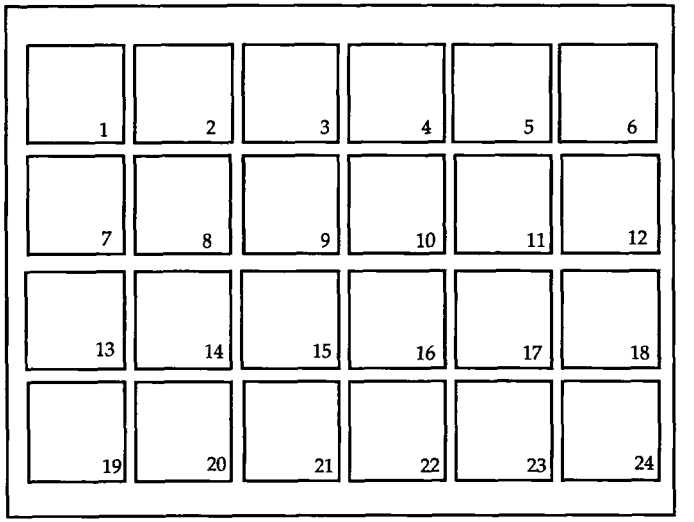

Figure 1 – Color reference pattern sample numbers

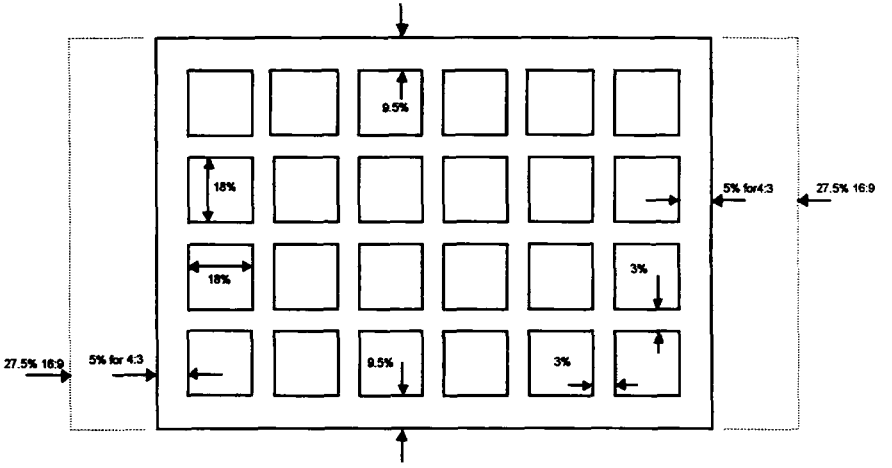

Figure 2 – Color reference pattern geometry expressed in percentage of picture height

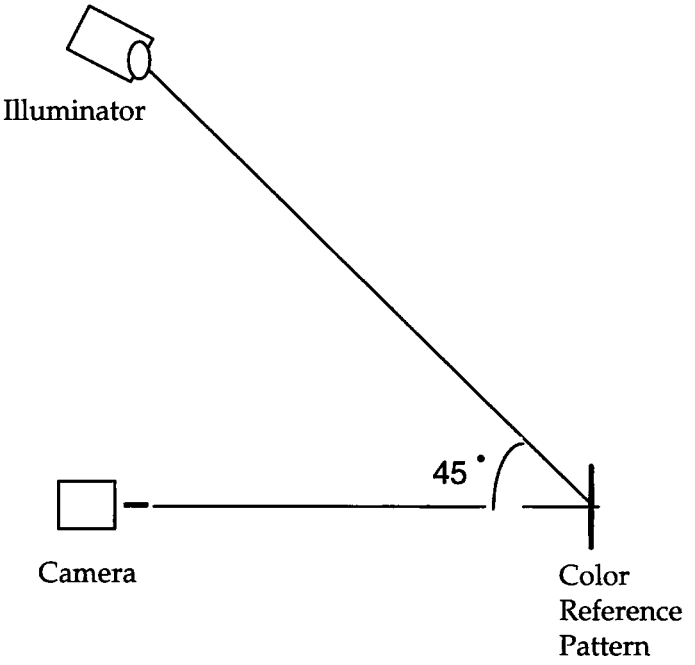

Figure 3 – Measurement configuration

Table 1 – Colorimetric specifications with illuminant D_{65}

Sample number	Color name	CIE X	CIE Y	CIE Z
1	Dark skin	10.97	9.70	6.06
2	Light skin	38.12	35.58	25.92
3	Blue sky	17.86	19.08	34.52
4	Foliage	10.10	12.98	6.69
5	Blue flower	25.83	24.38	45.32
6	Bluish green	31.27	42.73	44.69
7	Orange	36.46	29.32	5.89
8	Purplish blue	13.42	11.76	37.23
9	Moderate red	28.45	19.22	13.75
10	Purple	8.68	6.52	14.69
11	Yellow green	33.20	43.66	11.19
12	Orange yellow	46.17	43.12	8.40
13	Blue	8.40	6.22	30.00
14	Green	14.50	23.58	9.51
15	Red	20.17	11.82	5.20
16	Yellow	56.05	59.64	9.56
17	Magenta	29.42	19.27	30.29
18	Cyan	14.47	19.87	39.52
19	White	83.98	88.76	92.35
20	Neutral 8	55.88	58.87	62.87
21	Neutral 6.5	33.67	35.51	38.11
22	Neutral 5	18.30	19.30	20.83
23	Neutral 3.5	7.96	8.40	9.06
24	Black	2.83	2.95	3.22

NOTE – Assuming CIE illuminant D_{65} relative to CIE 1931 (2°) standard observer:

CIE D_{65} white point: x = 0.3127; y = 0.3290

Table 2 – Colorimetric specifications with illuminant 3100 K

Sample number	Color name	CIE X	CIE Y	CIE Z
1	Dark skin	14.18	10.80	2.35
2	Light skin	48.32	38.29	10.28
3	Blue sky	17.23	17.77	13.07
4	Foliage	11.82	12.74	2.70
5	Blue flower	27.21	23.81	17.12
6	Bluish green	32.16	39.10	17.90
7	Orange	49.53	35.09	2.35
8	Purplish blue	11.44	10.55	13.89
9	Moderate red	39.18	23.72	5.21
10	Purple	9.62	6.88	5.32
11	Yellow green	40.39	43.56	4.99
12	Orange yellow	60.94	48.69	3.51
13	Blue	6.01	5.23	11.17
14	Green	15.83	21.84	4.07
15	Red	30.23	15.92	1.99
16	Yellow	73.31	64.24	4.45
17	Magenta	37.96	22.79	11.14
18	Cyan	12.05	16.42	15.59
19	White	95.41	88.97	35.79
20	Neutral 8	63.16	58.94	24.28
21	Neutral 6.5	37.98	35.53	14.70
22	Neutral 5	20.61	19.30	8.03
23	Neutral 3.5	8.95	8.40	3.49
24	Black	3.20	2.96	1.24

NOTE – Assuming 3100 K illumination relative to CIE 1931 (2°) standard observer:

3100 K (Planckian) white point: x = 0.4299; y = 0.4016

Table 3 – Colorimetric specifications with illuminant D_{55}

Sample number	Color name	CIE X	CIE Y	CIE Z
1	Dark skin	11.38	9.87	5.13
2	Light skin	39.39	35.98	22.08
3	Blue sky	17.37	18.86	29.12
4	Foliage	10.30	12.97	5.71
5	Blue flower	25.51	24.24	38.21
6	Bluish green	31.00	42.19	38.16
7	Orange	38.36	30.22	5.01
8	Purplish blue	12.69	11.52	31.37
9	Moderate red	29.89	19.88	11.59
10	Purple	8.62	6.56	12.24
11	Yellow green	34.23	43.76	9.73
12	Orange yellow	48.33	44.04	7.21
13	Blue	7.71	6.02	25.33
14	Green	14.65	23.38	8.21
15	Red	21.60	12.43	4.39
16	Yellow	58.61	60.47	8.37
17	Magenta	30.29	19.75	25.37
18	Cyan	13.72	19.29	33.71
19	White	84.73	88.79	78.30
20	Neutral 8	56.30	58.87	53.26
21	Neutral 6.5	33.91	35.52	32.27
22	Neutral 5	18.42	19.30	17.64
23	Neutral 3.5	8.01	8.40	7.67
24	Black	2.85	2.95	2.73

NOTE – Assuming CIE illuminant D_{55} relative to CIE 1931 (2°) standard observer:

CIE D_{55} white point: x = 0.3324; y = 0.3474

Table 4 – RGB values before gamma correction based on D_{65} and ITU-R BT.709 primaries

Sample number	Color name	R	G	B
1	Dark skin	0.176192	0.078161	0.050369
2	Light skin	0.559217	0.308765	0.222598
3	Blue sky	0.113384	0.199172	0.335883
4	Foliage	0.094429	0.148387	0.049854
5	Blue flower	0.236358	0.225838	0.443659
6	Bluish green	0.133698	0.517089	0.402597
7	Orange	0.701529	0.199095	0.022732
8	Purplish blue	0.069851	0.106012	0.376989
9	Moderate red	0.558012	0.090525	0.121956
10	Purple	0.107833	0.044287	0.146799
11	Yellow green	0.348986	0.501909	0.047688
12	Orange yellow	0.791553	0.364908	0.026515
13	Blue	0.027033	0.047735	0.309077
14	Green	0.060008	0.305765	0.060487
15	Red	0.446057	0.028404	0.042073
16	Yellow	0.852001	0.579539	0.010575
17	Magenta	0.506210	0.088935	0.297217
18	Cyan	−0.033561	0.248928	0.385235
19	White	0.896718	0.889514	0.841782
20	Neutral 8	0.592520	0.588894	0.575523
21	Neutral 6.5	0.355289	0.355648	0.349110
22	Neutral 5	0.192522	0.193346	0.190980
23	Neutral 3.5	0.083667	0.084194	0.083056
24	Black	0.030311	0.029250	0.029592

NOTE – The following conversion matrices are assumed:

$$[A] = \begin{bmatrix} 0.412391 & 0.357584 & 0.180481 \\ 0.212639 & 0.715169 & 0.072192 \\ 0.019331 & 0.119195 & 0.950532 \end{bmatrix}$$

$$[A]^{-1} = \begin{bmatrix} 0.588099 & 0.179133 & 0.183223 \\ 0.289661 & 0.605640 & 0.104699 \\ 0.000000 & 0.068241 & 1.020817 \end{bmatrix}$$

Table 5 – RGB values before gamma correction based on D_{65} and ANSI/SMPTE 240M primaries

Sample number	Color name	R	G	B
1	Dark skin	0.182879	0.076701	0.050697
2	Light skin	0.576451	0.305289	0.223528
3	Blue sky	0.106411	0.198569	0.334917
4	Foliage	0.091884	0.151095	0.050361
5	Blue flower	0.234872	0.221987	0.442360
6	Bluish green	0.109775	0.526532	0.402663
7	Orange	0.736137	0.192181	0.024618
8	Purplish blue	0.063353	0.102215	0.375289
9	Moderate red	0.588262	0.080821	0.122529
10	Purple	0.110965	0.041324	0.146283
11	Yellow green	0.343520	0.512510	0.050184
12	Orange yellow	0.822823	0.362193	0.029257
13	Blue	0.023072	0.043769	0.307464
14	Green	0.046388	0.314693	0.061568
15	Red	0.473226	0.019975	0.042672
16	Yellow	0.875491	0.583708	0.014459
17	Magenta	0.531413	0.077257	0.296639
18	Cyan	−0.053390	0.252193	0.383950
19	White	0.897665	0.890171	0.842081
20	Neutral 8	0.592890	0.589047	0.575609
21	Neutral 6.5	0.355331	0.355765	0.349149
22	Neutral 5	0.192492	0.193402	0.190993
23	Neutral 3.5	0.083644	0.084224	0.083062
24	Black	0.030377	0.029223	0.029591

NOTE – The following conversion matrices are assumed:

$$[A] = \begin{bmatrix} 0.393521 & 0.365258 & 0.191677 \\ 0.212376 & 0.701060 & 0.086564 \\ 0.018739 & 0.111934 & 0.958385 \end{bmatrix}$$

$$[A]^{-1} = \begin{bmatrix} 3.506003 & -1.739791 & -0.544058 \\ -1.069048 & 1.977779 & 0.035171 \\ 0.056307 & -0.196976 & 1.049952 \end{bmatrix}$$

Table 6– RGB values before gamma correction based on D_{65} and PAL primaries

Sample number	Color name	R	G	B
1	Dark skin	0.172057	0.078161	0.050038
2	Light skin	0.548651	0.308765	0.221570
3	Blue sky	0.117003	0.199172	0.337515
4	Foliage	0.096705	0.148387	0.048678
5	Blue flower	0.235914	0.225838	0.446259
6	Bluish green	0.149872	0.517089	0.401231
7	Orange	0.680333	0.199095	0.020628
8	Purplish blue	0.070091	0.106012	0.380222
9	Moderate red	0.538291	0.090525	0.122331
10	Purple	0.105152	0.044287	0.148022
11	Yellow green	0.355437	0.501909	0.042267
12	Orange yellow	0.773555	0.364908	0.022477
13	Blue	0.027906	0.047735	0.312196
14	Green	0.070375	0.305765	0.057560
15	Red	0.428438	0.028404	0.042236
16	Yellow	0.840507	0.579539	0.037854
17	Magenta	0.488607	0.088935	0.299702
18	Cyan	−0.021644	0.248928	0.386862
19	White	0.896414	0.889514	0.841212
20	Neutral 8	0.592367	0.588894	0.575364
21	Neutral 6.5	0.355304	0.355648	0.349032
22	Neutral 5	0.192557	0.193346	0.190952
23	Neutral 3.5	0.083689	0.084194	0.083042
24	Black	0.030267	0.029250	0.029596

NOTE – The following conversion matrices are assumed:

$$[A] = \begin{bmatrix} 0.430554 & 0.341550 & 0.178352 \\ 0.222004 & 0.706655 & 0.071341 \\ 0.020182 & 0.129553 & 0.939322 \end{bmatrix}$$

$$[A]^{-1} = \begin{bmatrix} 3.063361 & -1.393390 & -0.475824 \\ -0.969244 & 1.875968 & 0.041555 \\ 0.067861 & -0.228799 & 1.069090 \end{bmatrix}$$

Table 7– RGB values before gamma correction based on D_{65} and NTSC 1953 primaries

Sample number	Color name	R	G	B
1	Dark skin	0.144900	0.081539	0.053913
2	Light skin	0.478764	0.318281	0.232637
3	Blue sky	0.144518	0.189652	0.325483
4	Foliage	0.107855	0.153175	0.055296
5	Blue flower	0.240366	0.213305	0.429699
6	Bluish green	0.248636	0.516911	0.403232
7	Orange	0.540014	0.218391	0.043100
8	Purplish blue	0.089166	0.089516	0.358724
9	Moderate red	0.414254	0.097060	0.128208
10	Purple	0.091569	0.039438	0.141268
11	Yellow green	0.381202	0.525697	0.074476
12	Orange yellow	0.648109	0.392310	0.056061
13	Blue	0.042164	0.032102	0.291736
14	Green	0.127950	0.315689	0.072057
15	Red	0.317143	0.035084	0.048594
16	Yellow	0.748624	0.617645	0.052361
17	Magenta	0.383905	0.084242	0.291092
18	Cyan	0.058489	0.235909	0.371371
19	White	0.892894	0.892430	0.845010
20	Neutral 8	0.590951	0.589740	0.576456
21	Neutral 6.5	0.355182	0.356024	0.349529
22	Neutral 5	0.192698	0.193469	0.191119
23	Neutral 3.5	0.083792	0.084251	0.083120
24	Black	0.029994	0.029249	0.029588

NOTE – The following conversion matrices are assumed:

$$[A] = \begin{bmatrix} 0.588099 & 0.179133 & 0.183223 \\ 0.289661 & 0.605640 & 0.104699 \\ 0.000000 & 0.068241 & 1.020817 \end{bmatrix}$$

$$[A]^{-1} = \begin{bmatrix} 1.971026 & -0.549468 & -0.297418 \\ -0.953709 & 1.936318 & -0.027418 \\ 0.063755 & -0.129442 & 0.981441 \end{bmatrix}$$

Table 8 – RGB values before gamma correction based on D_{55} and ITU-R BT.709 primaries (not for television applications)

Sample number	Color name	R	G	B
1	Dark skin	0.1735	0.0780	0.0491
2	Light skin	0.5556	0.3064	0.2209
3	Blue sky	0.1158	0.2002	0.3388
4	Foliage	0.0960	0.1478	0.0481
5	Blue flower	0.2387	0.2263	0.4476
6	Bluish green	0.1502	0.5136	0.4062
7	Orange	0.6826	0.1998	0.0154
8	Purplish blue	0.0704	0.1076	0.3827
9	Moderate red	0.5482	0.0892	0.1197
10	Purple	0.1064	0.0452	0.1467
11	Yellow green	0.3515	0.4998	0.0396
12	Orange yellow	0.7729	0.3655	0.0161
13	Blue	0.0281	0.0494	0.3154
14	Green	0.0674	0.3040	0.0574
15	Red	0.4412	0.0260	0.0402
16	Yellow	0.8407	0.5774	–0.0028
17	Magenta	0.4996	0.0886	0.2972
18	Cyan	–0.0181	0.2461	0.3942
19	White	0.8972	0.8886	0.8423
20	Neutral 8	0.5924	0.5886	0.5758
21	Neutral 6.5	0.3551	0.3558	0.3491
22	Neutral 5	0.1923	0.1934	0.1911
23	Neutral 3.5	0.0835	0.0842	0.0831
24	Black	0.0303	0.0292	0.0297

NOTE – The following conversion matrices are assumed:

$$[A] = \begin{bmatrix} 0.455311 & 0.352891 & 0.14862 \\ 0.23477 & 0.705782 & 0.059448 \\ 0.021343 & 0.11763 & 0.782731 \end{bmatrix}$$

$$[A]^{-1} = \begin{bmatrix} 2.935457 & -1.39246 & -0.451609 \\ -0.982134 & 1.900917 & 0.042108 \\ 0.067556 & -0.247705 & 1.283564 \end{bmatrix}$$

Table 9 – Television primaries

Television standard	Primary	CIE x	CIE y
ITU-R BT.709	Red	0.640	0.330
	Green	0.300	0.600
	Blue	0.150	0.060
ANSI/SMPTE 170M and ANSI/SMPTE 240M	Red	0.630	0.340
	Green	0.310	0.595
	Blue	0.155	0.070
PAL (EBU)	Red	0.640	0.330
	Green	0.290	0.600
	Blue	0.150	0.060
Old NTSC (FCC 1953)	Red	0.670	0.330
	Green	0.210	0.710
	Blue	0.140	0.080

Annex A (informative)
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